Inside: Bonus All-Mac Supplement (follows page 240)

BYTE

DECEMBER 1988 A McGRAW-HILL PUBLICATION

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)ebugger, Turbo Pascal 5.0

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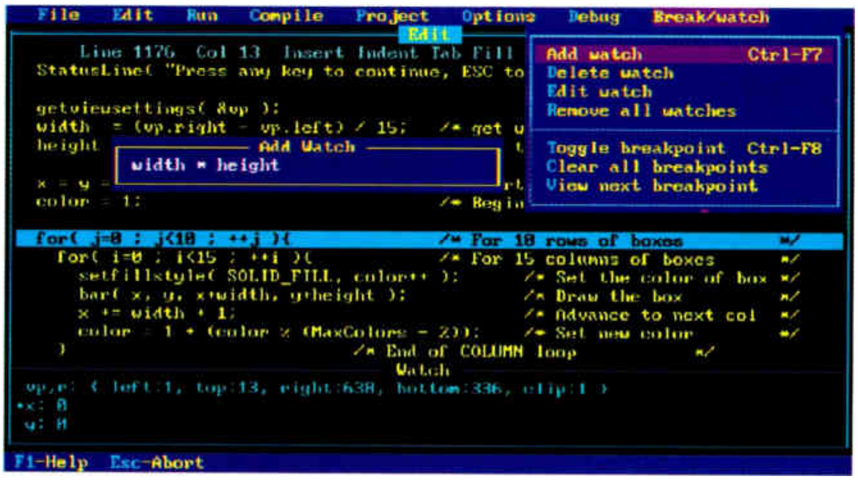

Debugging in the Turbo environment: shown here an expression is being added to the Watch window in Turbo C. The Execution Bar highlights the next line the debugger will execute.

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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TURBO ASSEMBLER/ DEBUGGER
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TURBO PASCAL

Turbo Assembler, Turbo D

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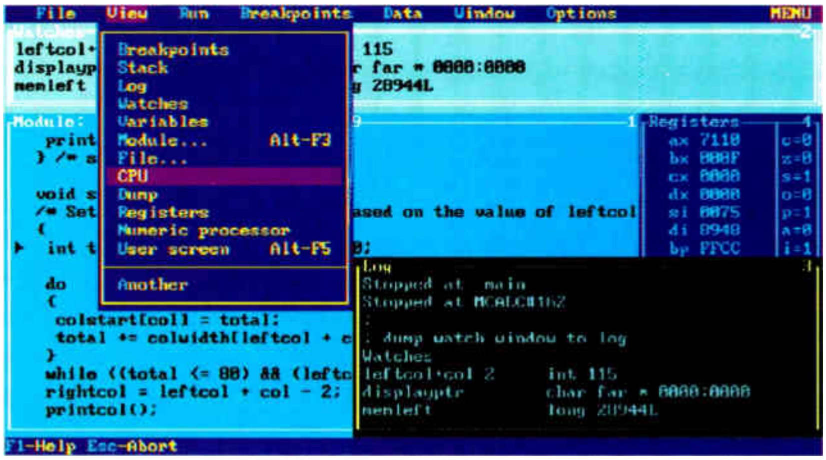
Our breakpoints give you more control than anyone else's. Ordinary debuggers only get you to a stop, then they stop. When our breakpoints are triggered you can simply stop, or you can print expressions, run code, send messages to the session log, or even evaluate an expression with user-defined function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

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- Actions: stop, run code, log expression
- Break on condition, memory changed
- Software ICE capabilites
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Debug any program

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Feature highlights

- Faster than other assemblers
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- 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.

and Turbo C 2.0!

Turbo C 2.0 has the best of everything

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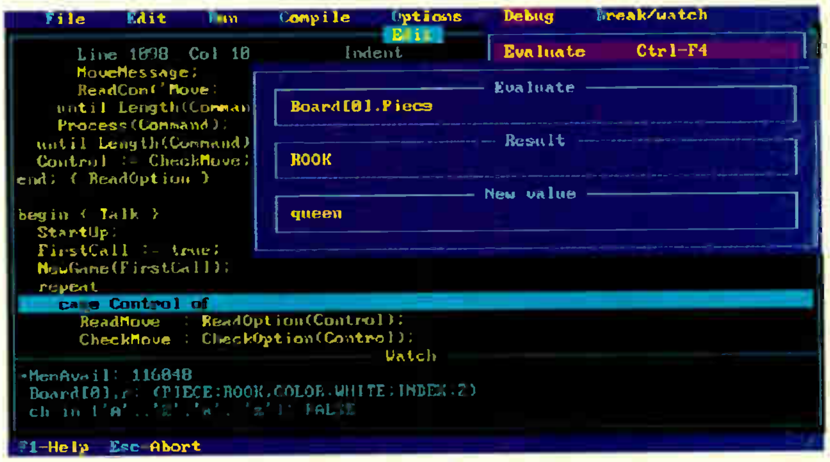

Shown here is the Evaluate/Modify window of Turbo Pascal: look at expressions, examine structured data types, change variables on the fly.

It's completely integrated and bullet-fast.

Turbo Pascal's new integrated debugger takes you inside your code for fast fixes. You step, trace, set multiple breakpoints. You modify variables as you debug and watch full expressions at runtime.

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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.

Turbo Pascal Professional®

Turbo Pascal 5.0 plus *both* Turbo Assembler & Turbo Debugger: all three programs rolled into one—the *one* Pascal package that has everything. A complete set of tools that caters to every level of programming expertise. Turbo Pascal Professional: $250.

TURBO PASCAL 5.0 SIEVE BENCHMARK	TURBO PASCAL 5.0	Turbo Pascal 4.0
.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

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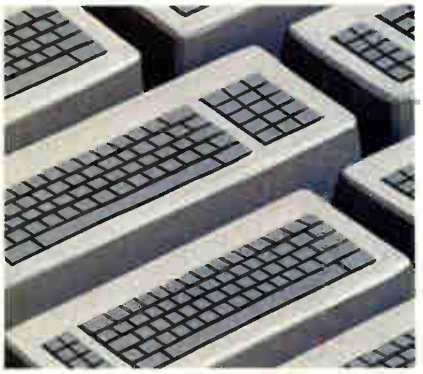

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LISA LIVES

The NeXT cube bears some startling resemblances to an earlier innovative machine Steve Jobs once produced

Remember Apple's Lisa? We have one in our Lab, where it sits like a living fossil: a robust proto-Mac that has been superseded by its more gracile descendants.

It was a marvel of its day, embodying the characteristics that would evolve into today's smaller, faster, cheaper Macintoshes. And its influence has spread far into the non-Mac world: Windows, Presentation Manager, Open Look, Intuition, and other graphical environments all owe some debt to Lisa and the Mac.

Yet the Lisa itself was something of a commercial flop. It was too expensive ever to achieve the kind of critical mass needed to come into wide use, and it didn't cost enough to allow Apple to continue making it in relatively small quantities.

Now consider the NeXT computer. With powerful and innovative hardware coupled with an effortless user interface and perhaps the easiest-ever serious programming environment, it's a technological gem.

And the cube already is having an impact beyond its immediate venue. For example, IBM has licensed NextStep—the cube's Window Server, Application Kit, Display PostScript, and Workspace environment—so it's a safe bet that a NeXT-like environment will eventually show up on reduced-instruction-set computers and Intel-based machines bearing IBM's brand. Naturally, the clones will follow.

But the cube may also carry with it the same problem that proved the death of Lisa: It's simultaneously very expensive for a personal computer, yet possibly too inexpensive to survive as a low-volume specialty device.

Yes, it's true that several "mainstream" personal computers cost as much or even more than the NeXT cube does, but they have wide acceptance; they're proven, stable designs; they can be configured in endless variations and can run literally thousands of applications (as announced, there's not even a good way to load new software into the cube, except via the network connector in the back); and so on. The cube, being brand new, can counter these established strengths only with its bright promise.

The promise might be enough, especially given that the machine is targeted at some of the best, brightest, and most enthusiastic early adopters of new computer technology: students. But even here, reality adds its grain of salt: A cube costs as much as a semester at MIT. How many students can afford that?

A comment written by Mark Welch (a participant in BIX's NeXT conference) said it very well: "What type of student, exactly, is the NeXT cube aimed at?

"I assume engineering and computer science students would drool over this [computer].... But the students I know (the science types) are struggling really hard, or taking out the maximum $2500 student loan to buy a Mac with enough goodies to make it usable. How, and why, would those students afford a NeXT system?

"I assume I am not one of the target students (I am a law student, and about 50 percent or more of law students own PClones running WordPerfect, with a good 10 percent using Macs and Microsoft Word or WriteNow or some such).

"Surely I am not in their target financial market, given my poverty level. (Q: I wonder if the $6500 price tag of a NeXT workstation is above or below the average [annual] income of a university student?)

"I do question, rather substantially, any theory that a student could buy a $6500 computer, even over 4 years."

As I write this, less than a week after the formal announcement of the NeXT machine, lots of people are questioning it. Of course, the universities themselves might foot the bill, hiding the costs in the form of increased tuition, or maybe finding a way for benefactors to at least partially pick up the tab. But even here there's a snag: Remember that NeXT refuses to sell to anyone other than universities. Would you donate to your alma mater's computer fund, knowing that the money would go to buy computers that deliberately will be prevented from being used in the wider world outside academia?

Something here doesn't add up. To me, it looks as though a portion of Steve Jobs's history is going to replay itself. In the not-too-distant future, I think we'll see a less-expensive, equally capable NeXT machine that will be available outside academia. This machine will be to the cube as the Mac is to the Lisa.

None of this is to suggest that we should write off the cube, or NeXT. The cube already is a technological success that will have far-reaching implications, no matter what happens in the marketplace. As such, it's a bellwether of computer technology that bears close scrutiny. And within one niche market—wealthy students and/or the best-endowed universities—it may also be a commercial success.

Actually, I hope it does succeed, because we all benefit from innovation, and the cube—like the Lisa before it—is truly innovative.

But as for getting and using one, well, I guess we'll just have to wait until NeXT or someone else produces a cube for, er, the rest of us.

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

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Don't forget to fasten your seat belt.

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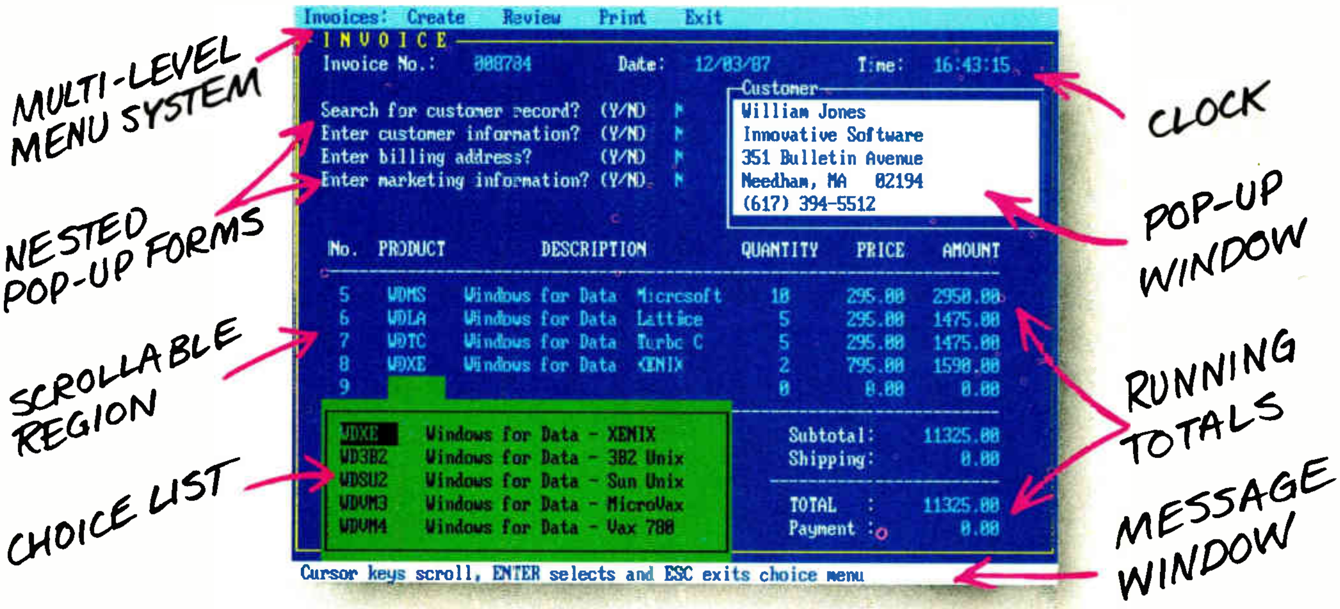

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FROM END TO BEGINNING

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MICROBYTES

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

OOPS Meets SQL in HP's Distributed Database System

Hewlett-Packard has been nursing an odd combo in its Palo Alto, California, research dens that may prove to be just the ticket for graphics-intensive database chores like CAD, CASE, and corporate publishing. Known as Iris, HP's prototype database mixes object-oriented programming methods and Structured Query Language (SQL) with relational algebra to produce a distributed database system. This technology could enable database management systems not just to store information, but to spot flaws and inconsistencies in the information as well.

Key to the real-world potential of Iris is its SQL module. SQL is already well-established as a database access language among corporate users. HP's object-oriented variant, OSQL, capitalizes on the basic SQL syntax, substituting objects for field names in a query. The HP approach could, for example, enable administrative personnel in an engineering work group to use familiar query tools to extract cost or productivity data from an object-oriented database. Since the objects contain not only data but also procedures for handling that data, such a database could easily handle a wide variety of data, including different types of graphics images.

In some CAD applications, OSQL can be used to help find flaws in designs. For example, according to Thomas Ryan, HP's product manager for database technology, the system can be used to find bugs in circuit diagrams. "Imagine a circuit designer trying a command like this with a regular CAD system: 'Show me all the chips I haven't hooked wires to yet.' It can't be done."

HP demonstrated the technology at a recent object-oriented-programming convention in San Diego, California, and said it was basically testing the waters. If response is compelling enough, HP could kick Iris out of research and into marketing.

The company has no official timeline for commercialization. But according to Ryan, Iris has been essentially complete for 2 years. It currently runs on HP's Unix systems. Iris technology could be delivered on just about any computing platform, said Ryan. "That would be marketing's decision."

Three-Dimensional Display: They Do It with Mirrors

It's not a hologram, and you don't need specially polarized glasses to see it, but a three-dimensional image on the new SpaceGraph Display System appears to float in a black void under the hood of the massive (150-pound) unit. BBN Laboratories (Cambridge, MA) has developed this unique system that generates the images from any standard CAD files containing *x*, *y*, and *z* coordinates, such as those produced by CADkey or AutoCAD.

The heart of the $30,000 SpaceGraph Display System is a 16-inch circular mirror that's made of 3-mm-thick acrylic. Thirty times a second, the mirror is alternately deformed between concave and convex. What you see is the reflection of the face of the *x-y* display (the monitor mounted above). Because of the optics of curved mirrors, the CRT appears to move about 80 times as far as the center of the mirror actually moves, effectively creating a deep display from a tiny shift of the mirror. According to BBN scientist Lawrence Sher, it's effectively the same concept as the three-dimensional display your eye would see if you could oscillate a regular monitor back and forth 30 times a second. Because of the persistence of vision, your eyes "see" a true three-dimensional image.

The actual size of the visible display is a cube about 10 inches square, and the actual number of points that can be displayed in the visible area is 32,768. You can move your head about 30 degrees to either side of the mirror's center line, and within these limits, you can look over, under, and around the image.

BBN uses a unique method to oscillate the mirror: sound. The acrylic mirror is designed so that it resonates at exactly 30 Hz, and a loudspeaker mounted in back of the mirror provides the 30-Hz tone. Sher said it's essential that an absolutely pure 30-Hz tone be created,

continued

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• The recent **price hikes by Apple** Computer (Cupertino, CA) drew more flack than any recent price changes we can recall. Users, even in the religious quarters of the Macintosh community, were steamed. Some few apologists justified the Mac's relatively high price as a result of Apple's considerable R&D investment, but most users felt the company went too far this time. **Mac owners** on BIX made it clear they were not happy; the messages commenting on the increases—which, for example, saw a 1-megabyte Mac II (with a 40-megabyte hard disk) jump from $5369 to $6169—were emphatically negative. Mac rooters felt the new prices make it tougher for their favorite machine to compete against IBM PC clones. An Apple spokesperson told us the increases were due to "many factors that are impacting our business, DRAM and component pricing among them." The DRAM defense was generally considered suspect, particularly since machines that use the same RAM did not go up in relative proportions.

• If we want to give computing power to the people who need it, we have to isolate them from the **confusion** of multiple hardware and software standards, **Borland** International (Scotts

continued

NANOBYTES

Valley, CA) president **Philippe Kahn** told the Capital Microcomputer Users Forum in Washington, DC, recently. Things have gotten too confusing even in the Mac environment, Kahn said. "It's a mess. Now you can go and buy things and they won't work. You don't build products for functionality any more; you build them for check marks in product reviews."

• **Advanced Logic Research** (Irvine, CA), which makes some very fast IBM PC-compatibles, hopes to be the first company to bring to market a system based on the new **EISA** (Extended Industry Standard Architecture) specification. ALR is aiming for the second quarter of next year. Most other manufacturers have said that they will not have such a machine until the second half of 1989.

The ALR system, company officials said, will use a 33-MHz 80386 processor and have a 128K-byte memory cache and a **128-bit bus**, 64 more bits than the EISA specification calls for. It would presumably have 64-bit-wide buses for both data and addresses, and would thus be faster than the proposed normal EISA bus.

• Here's what **IBM** chairman **John Akers** had to say about the EISA gang. "We'll be trying to beat their brains out before they beat our brains out. Which is as it should be," he told a Yale University audience. "I gather that they [the EISA consortium] won't be introducing a product for at least a year," he said.

continued

both to move the mirror and to avoid harmonics that might be audible. The tone is stored as a digitized waveform on a ROM in SpaceGraph's interface board, and it's converted to frequency by a D/A converter. According to Sher, this is one of the major secrets for highly accurate control of the mirror's motion.

The display system's full-length interface board plugs into a 16-bit slot of any IBM PC AT or compatible computer. Because SpaceGraph uses a nonraster analog display, the board is packed with proprietary chips and four D/A converters. The unit comes with a command-driven program that performs some simple format conversion on CAD files.

Sher said the U.S. Navy is using SpaceGraph to plot underwater weapon trajectories, and an aerospace firm is using it to graphically display finite element analysis. He said the price of SpaceGraph will drop when it goes into volume production.

When the Decade Turns: What's Ahead for the Industry?

As we get closer to the 1990s, the decade loses a little of its Flash Gordon sheen. It looks now like we won't all be walking around with wristwatch computers as powerful as the ones on our desks, with tiny screens showing full-motion video pictures sent through the air and controlled by software that's compatible with everything. (That stuff will have to wait for the late 1990s.)

After sitting through facts and figures and projections at a recent Dataquest-sponsored conference and consulting our own crystal ball, we have a more modest view of the next few years. And while we always view market projections cautiously and with a keg of salt nearby—as 3COM's Bill Krause joked, "They always start in the lower left-hand corner and go up at a 45 degree angle"—they provide at least a general picture of what's ahead.

Analysts at Dataquest forecast early-'90s growth in the industry at about 12 percent worldwide, and most of the hardware and software executives at the conference agreed. John Roach of Tandy said he didn't "like those figures worth a damn," but he expects his company to sell lots of equipment to a suddenly booming home-computer market. Europe is projected to be a slightly bigger market than the United States.

Most of the computers sold will still be based on Intel processors, except that the majority of systems will use the 80386, and the minority will use the 8088 and 8086 (a reversal of the current situation). Systems running on Motorola 680x0 processors will be popular but not predominant (Dataquest projects about 14 percent, but that could all change depending on the sales of Macintoshes, NeXT Computers, Suns, and so on.)

Laptops, which will continue to get lighter and yet more powerful, will finally tap into the market that's out there for portable computing, including satellite offices and roving personnel. The number of integrated circuits required to build a full-functioning personal computer could drop to about 40 by 1992, compared to 200 ICs used in the PC AT in 1982 and about 80 ICs in the PS/2 Model 50. Recent developments, such as the LEAP chip set from Chips & Technologies, better methods of building display screens, and lightweight, high-capacity disk drives—a new company called PrairieTek (Longmont, CO) has announced a 20-megabyte 2½-inch hard disk drive—point to improved laptops.

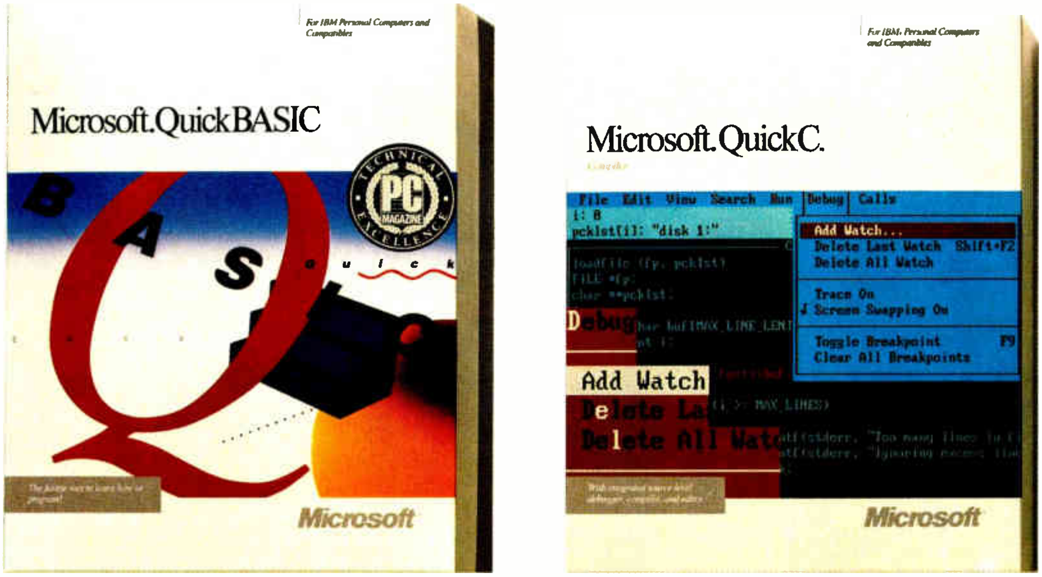
Networks will have to get easier to install and operate if the real world is to come anywhere near matching the forecasts that see scenarios with 50 to 90 percent of all personal computers hooked into local-area networks (currently, it's 13 percent, Dataquest says). Major improvements in network throughput or bandwidth will take place in the next decade, 3COM's Krause says. Ethernet currently has a bandwidth of 10 megabits per second. According to Krause, Fiber Distributed Data Interchange (FDDI) technology will allow transfer rates of 100 megabits per second. The network model will also change. The terminal-to-host model of the mainframe is already fading into the past, replaced by the client/server model. In the 1990s, according to Krause, networks will be served by "special-purpose" network computers with built-in circuitry for controlling the network and the Ethernet bus. These machines will act not only as file servers, but also as "compute servers," providing databases and communications control, as well as monitoring the network. If vendors develop "plug and play" networks, we could see an end to what Krause called "islands of LANs with no bridges."

Despite the eagerness of some industry observers and their broadcasters to bury OS/2, evidence at the Dataquest conference indicated that the obituaries are premature. The researchers

continued

If anyone tries to tell you that one language fits all, turn the page.

To each



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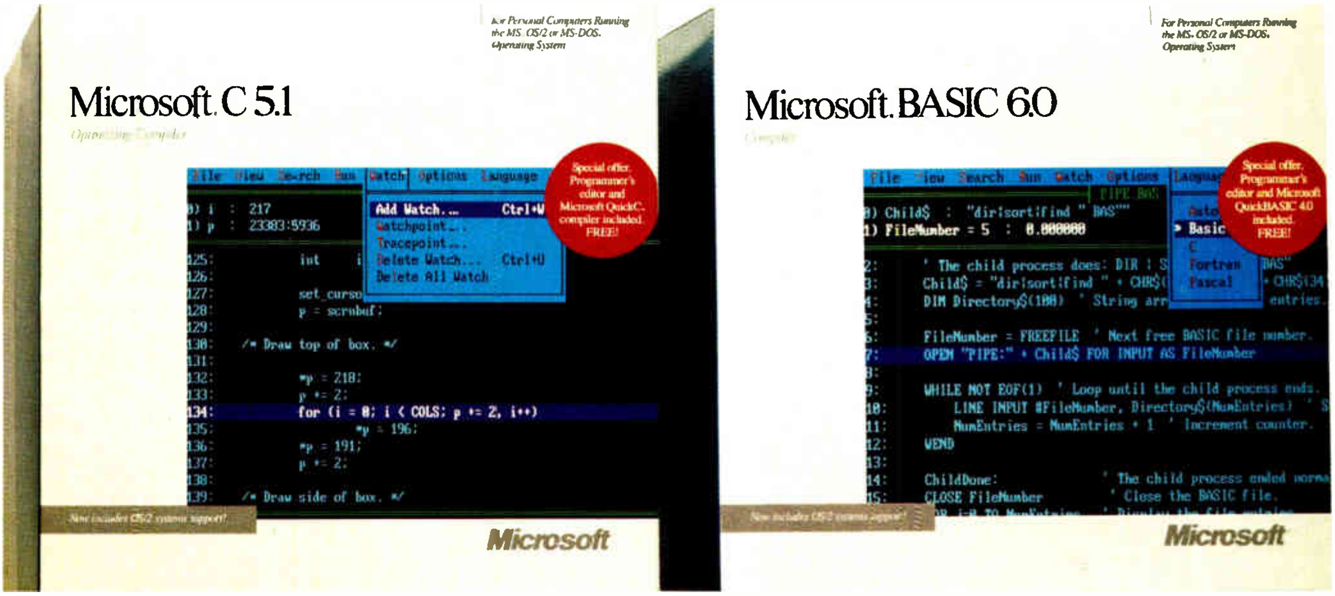

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"That's a long time in the PC business," he noted, saying that the history of consortium arrangements in the computer industry has not been very successful.

• Meanwhile, IBM Entry Systems president **Bill Lowe** told an audience at the Dataquest conference that the EISA bus only adds to the confusion in the industry. Because of the "limited clocking speeds" of the PC AT bus, upon which the EISA spec is built, an improved architecture is needed, and that improved architecture is the Micro Channel, Lowe said. He said that there are about 500 third-party applications available for the MCA.

Lowe defended IBM's recently announced PS/2 **Model 30-286** as a logical move to continue "pushing down price/performance." He said IBM will do the same thing to the Model 25 at some point. "When we can afford to do it, we'll put MCA on the whole product line," he said.

• The **Open Software Foundation** (Lawrence, MA), which continues to gain members, has listed the 26 companies whose technologies it will consider as "candidates" in its search for a graphical user interface for Unix. The OSF says it will develop within the next two years an **open version of Unix**; AT&T and Sun Microsystems are also working on a new Unix. Among the organizations asked to present their technologies are Adobe Systems, American Management Systems, Hewlett-Packard, Microsoft, Carnegie-Mellon University,

continued

said they polled 1500 software developers and found that about half of them are working on OS/2 applications; 25 percent are working on Macintosh or Unix applications. Sun Microsystems' Scott McNealy questioned why anybody would want to port to OS/2 when Unix is already a robust, working operating system that runs on multiple platforms. "Can you imagine OS/2 on anything but an Intel platform?" he asked. Perhaps what McNealy is overlooking is all those Intel-based machines out there. Fred Gibbons of Software Publishing said it's a matter of return and that most big software vendors see OS/2 as a much bigger opportunity than Unix. "I get a 1-to-1 return on my investment dollar, whether I invest in OS/2 or Unix," said Gibbons. "I'm going to invest on the biggest return. And that is clearly OS/2 and the Presentation Manager."

As McNealy has suggested in recent months, low-cost workstations based on Sun's SPARC architecture will flood the market in the next few years, and we keep hearing that Sun's first SPARC PC will arrive early next year. Alan Hald, founder of the MicroAge chain, said low-cost graphics workstations will be common in retail outlets. Certainly the machines we have to choose from will be more advanced, but no one has offered any evidence that they will be dramatically less expensive.

So what will the personal computer of the 1990s look like? According to Gordon Campbell of Chips & Technologies, the typical microcomputer will have 2- to 4-megabyte 3½-inch floppy disk drives, 80- to 140-megabyte 3½-inch hard disk drives, and a 500- to 1000-megabyte optical disk drive. The machine will have a 32-bit CPU, 4 to 16 megabytes of RAM, a 1-megapixel display, SCSI and audio interfaces, and built-in local and remote communications channels. More software will be built into silicon in the form of programmable processors. According to Campbell and also to Zenith's John Frank, both the Micro Channel and EISA bus architectures will coexist in the next decade. No one in the computing mainstream is talking much about voice input, but if designers can come up with systems that can handle big vocabularies and varying pronunciations, people might soon be talking to their computers instead of tapping keys or moving mice.

One thing will not change: Users will still be the factor that determines what succeeds in the marketplace. Rival companies and consortia will continue banging it out, while users look for the system that solves their problems and helps them produce. Most will be bored by vendor politics, not caring if it's OS/2 or Unix, Open Look or OSF. As Tandy's John Roach told an audience of industry executives, "It's the users who drive this industry and not the people in this room."

The Voice: a Hand-Held Computer You Can Talk To

There was a great scene in the last Star Trek movie, when the Enterprise crew returns to modern-day Earth: Engineer Scott boldly approaches a Macintosh computer, picks up the mouse, and speaks into it, assuming that the Mac will respond to his voice commands. The scene was good for a laugh. But if The Voice computer from Advanced Products & Technologies (Redmond, WA) lives up to its developers' claims, that part of the future could soon be here.

The Voice "holds the promise of becoming the world's most friendly, portable, and powerful hand-held computer," claimed company CEO Steve Rondel. Due to roll out last month, The Voice contains proprietary natural-language speech-input software. The Voice is able to understand any speech input, regardless of dialect, Rondel claimed; it doesn't need or use a keyboard for additional input. The product is set to sell for $2000.

The device "is wider but not as long as two videocassettes taped together," said marketing manager Greg Ness. It weighs about 3½ pounds and is equipped with a 16-line LCD display. It has "100,000 times the file access speed, 6 times the memory capacity (4 megabytes), and more processors (8 and 16 bits) than the IBM PC," Rondel said. The Voice has its own operating system, specially designed software, and custom chips. Rondel said the proprietary operating system was developed because "computer operating systems today are too slow; speech recognition software is too archaic."

The Voice operates via a series of what Ness calls "application cartridges," which are roughly the size of a microfloppy disk. Each cartridge holds a different application in firmware. Initial application cartridges are for language translation. The Voice stores the speaker's speech pattern and is able to provide translation into another language, company officials said. The language translation depends on which cartridge is plugged in at the time.

continued


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DEC, Virtual Machine Corp., Neuron Data, Digital Research, Apollo, and Sony Supermicro Systems. Not to mention AT&T Bell Labs.

• Chip giant **Motorola** (Chandler, AZ) and **PCPI** (San Diego, CA), which makes laser printers and boards, say they'll work together to develop a line of chips that will mean **faster but cheaper** laser-printer controllers. The first pair of chips will boost laser printers built around Motorola's 680x0. Related announcements would arrive around Comdex Fall, they said in early autumn.

• Researchers in artificial intelligence, by de-

continued

"We're able to provide this kind of speed and recognition because we've broken the speech recognition problem into domains of application," said Ness. "Other voice recognition systems try to take on the whole English language; we've made our cartridges so that they recognize only certain segments of speech necessary for a particular application."

Other working applications for The Voice include voice-driven calculation with optional voice response, and an appointment calendar. "With a little name dropping, you can access the person's address, phone number, and tones to dial the telephone, all in less than a second," said Ness.

Advanced Products has shipped development systems to several software companies. Although Ness declined to identify any of the companies, he said, "Just think of the biggest names in the software industry that have developed the most popular software packages, and you wouldn't be too far off the mark as to those already developing applications for The Voice."

When asked about potential compatibility problems, he said, "I can't comment on that now, but we'll have another announcement regarding that subject in 3 to 4 months. We don't think it's a problem."

Object-Oriented Application Generator Uses Visual Programming

While object-oriented programming is bound to become more prevalent in the personal computer industry, typical object-oriented systems tend to be difficult for many people to learn. But a new company called Maxem (Mesa, AZ) has a database application generator that promises to let both programmers and nonprogrammers take advantage of the benefits of object-oriented programming. What's equally notable is that the new program, called Cause, runs on both the Macintosh and IBM families of systems. Cause

continued

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veloping successful expert systems, "have created an enabling technology for the creation of national wealth," AI pioneer Edward Feigenbaum told the American Association of Artificial Intelligence. Feigenbaum said use of expert systems is growing rapidly, and with it, gains in productivity. Today there's an estimated 2000 expert systems deployed in the U.S., Japan, and Europe, he said. "In the postindustrial society of the knowledge worker," said Feigenbaum, "a change of 0.1 percent in the nation's productivity will result in the creation of $50 billion in the course of a decade."

may be very useful for both consultants and microcomputer managers who need to develop large numbers of reliable special-purpose applications.

Object-oriented programs are so named because they are divided into objects—small modules that contain both programming instructions and data. Since the modules or objects are completely separate from one another, object-oriented programs are easy to modify; you can change an object without any regard for side effects in other parts of the program. However, it hasn't been easy for most people to get accustomed to the syntax used in object-oriented systems.

Cause gets around the syntax problem by using a visual programming interface. You select items from various menus of choices. The menu-based approach ensures that syntax is always correct.

When you finish designing your application, the system saves your choices as a program in a proprietary object-oriented metalanguage. Maxem has already written several of these programs, which it calls Effects. You cannot modify this code directly, but you can do so using Cause's visual-programming interface. You can also execute the code using the system's interpreter, compile it into a stand-alone application, or transfer it either from the Mac to the IBM or vice versa.

Maxem claims that the underlying database engine is a rather standard engine precompiled in C, and it is thus as fast as any other database system.

Cause, scheduled to ship this month for both the Mac and the PC, will sell for about $495. For $100 more, you can obtain a renewable, 1-year license to market an unlimited number of application programs created with Cause.

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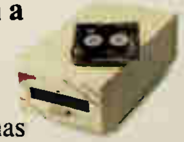

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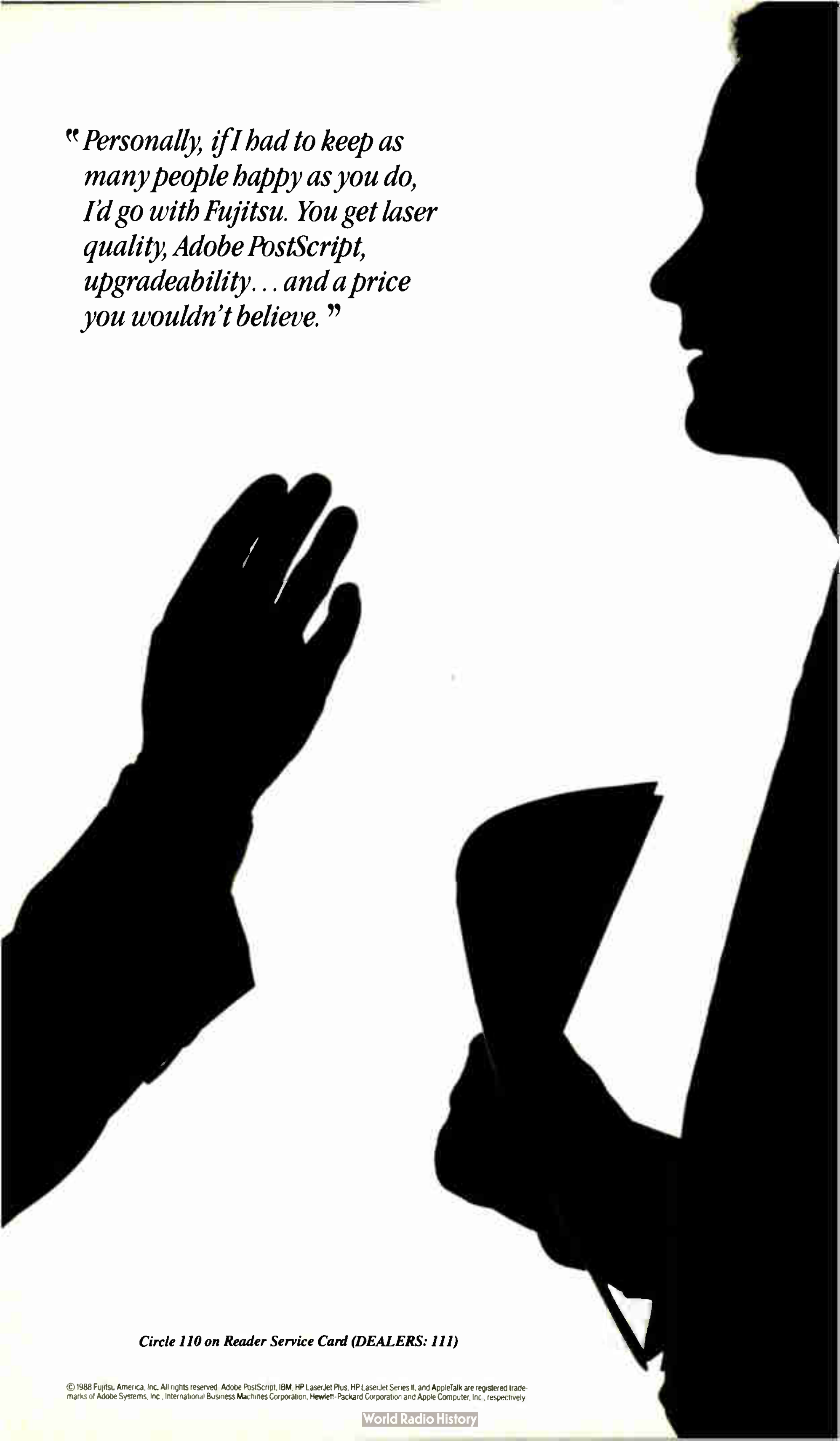

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Circle 110 on Reader Service Card (DEALERS: 111)

LETTERS

Burks's Reply

My wife, Alice R. Burks, and I greatly appreciate G. Michael Vose's review of our book, *The First Electronic Computer: The Atanasoff Story* (September). Vose provides an unusually perceptive account of John V. Atanasoff's electronic computer, emphasizing the significance of his original algorithm for the design of the entire machine. He also gives an excellent summary of the Honeywell–Sperry Rand court case that proved both the primacy of Atanasoff's computer and its influence on the ENIAC, emphasizing here the significance of John W. Mauchly's own admissions on the witness stand.

My purpose now is to correct a misconception about my motivation in co-authoring this book, as expressed in Vose's statement that "[Burks] had no qualms about encouraging his later employer, Honeywell, to challenge his old comrade's patent claims," and that the attendant "strong economic motivation taints ever so slightly Burks's role in telling the story."

It is true that I was a consultant for Honeywell in its suit against Sperry Rand over the validity of the ENIAC patent, but I actually worked in this capacity for only 12 days (over a period of 6 months). Moreover, I also consulted for Sperry Rand, Bell Telephone Laboratories, and IBM, all with regard to legal actions involving the ENIAC patent. My income for these services was not great: a total of $7000 from all four parties.

As to Vose's belief that I encouraged Honeywell to challenge the ENIAC patent claims, this is simply not true. Honeywell neither needed nor received any encouragement from me in its pursuit of this case. Indeed, only after its attorneys gave me copies of critical documents that it (and Control Data Corp.) had unearthed did I begin to see that some of Atansoff's ideas had been incorporated in the ENIAC (and the EDVAC). For Honeywell—as for the other firms—I merely provided information about the ENIAC as one who had been intimately involved throughout its design, development, and debugging stages.

Let me also make clear that I had held a high opinion of John Mauchly, for both creative ability and professional integrity, up until my exchanges with Honeywell and the ensuing court case, when I became convinced that electronic computing concepts I had understood to be Mauchly's were actually Atanasoff's. In an early meeting on the EDVAC, for example, in which arithmetic circuits to interact with J. Presper Eckert's mercury-delay-line memory were being explored, Mauchly suggested a binary serial adder, radically different from the parallel decimal counters of the ENIAC. Needless to say, at that point in history we were all impressed, and no one thought anything of it when Mauchly and Eckert took out patents on several serial binary adders. Only through the ENIAC patent case was it revealed that the basic electronic element of Atanasoff's computer was just such an adder; that Mauchly had examined it and found it to work exactly as intended; and, indeed, that Atanasoff had designed his adder for use in conjunction with his own separate capacitor memory. Thus, while the Honeywell–Sperry Rand patent trial was gratifying in that it finally established who invented what, for me it was disillusioning as well.

Arthur W. Burks
Professor Emeritus
Philosophy and Electrical Engineering and Computer Science
University of Michigan
Ann Arbor, MI

continued

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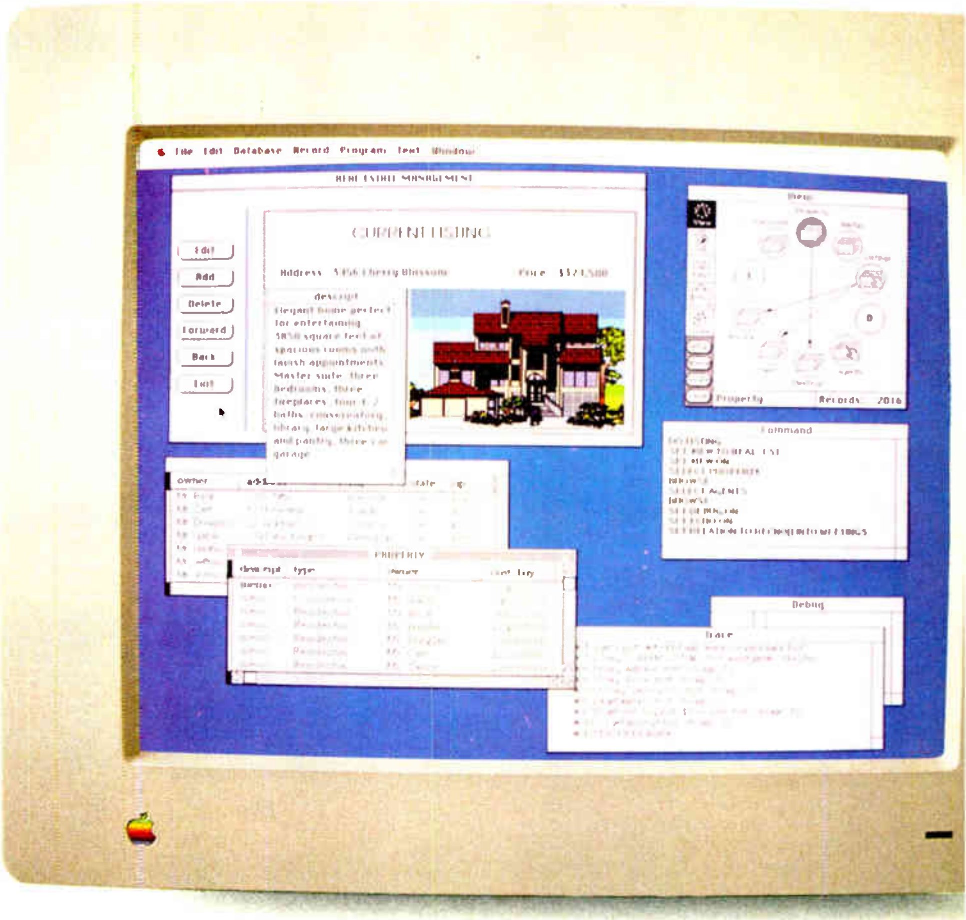

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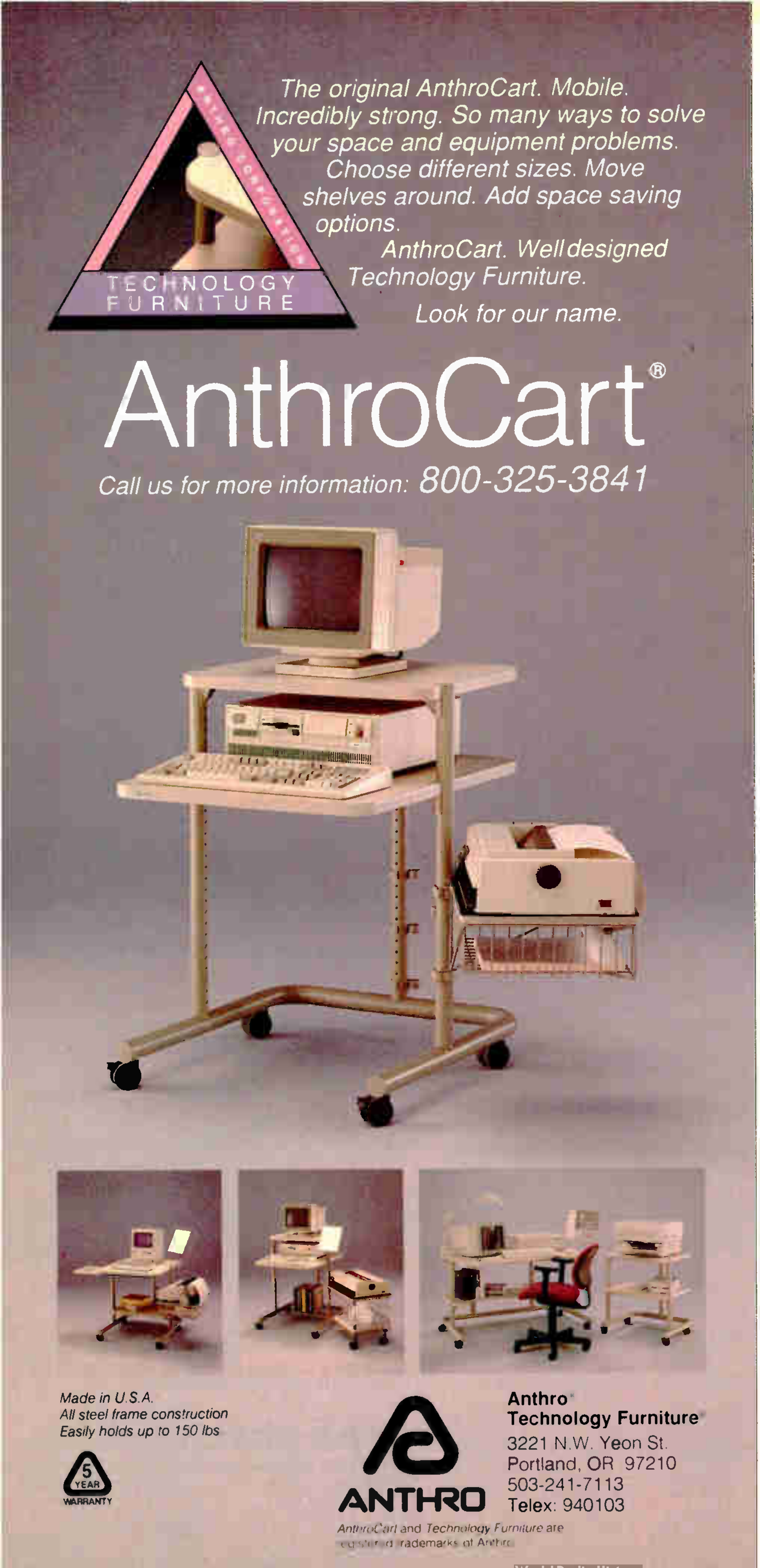


Where Blame Is Due

In the Nanobytes column (August), Apple Chief Del Yocam was quoted as saying, "The scarcity of 1-megabit chips is due to Japanese failure to foresee the growth in demand for 1-megabit chips and the Reagan administration's trade embargoes." This statement backs up the axiom, "The half-life of the facts is about 90 days."

The truth of the matter is that the Japanese are forced to limit their export of semiconductor memories to the U.S. by the protectionist measures put in place by the U.S. Congress. The Reagan administration opposed the measures. See you again in 90 days.

Al Cacace
Fort Lauderdale, FL

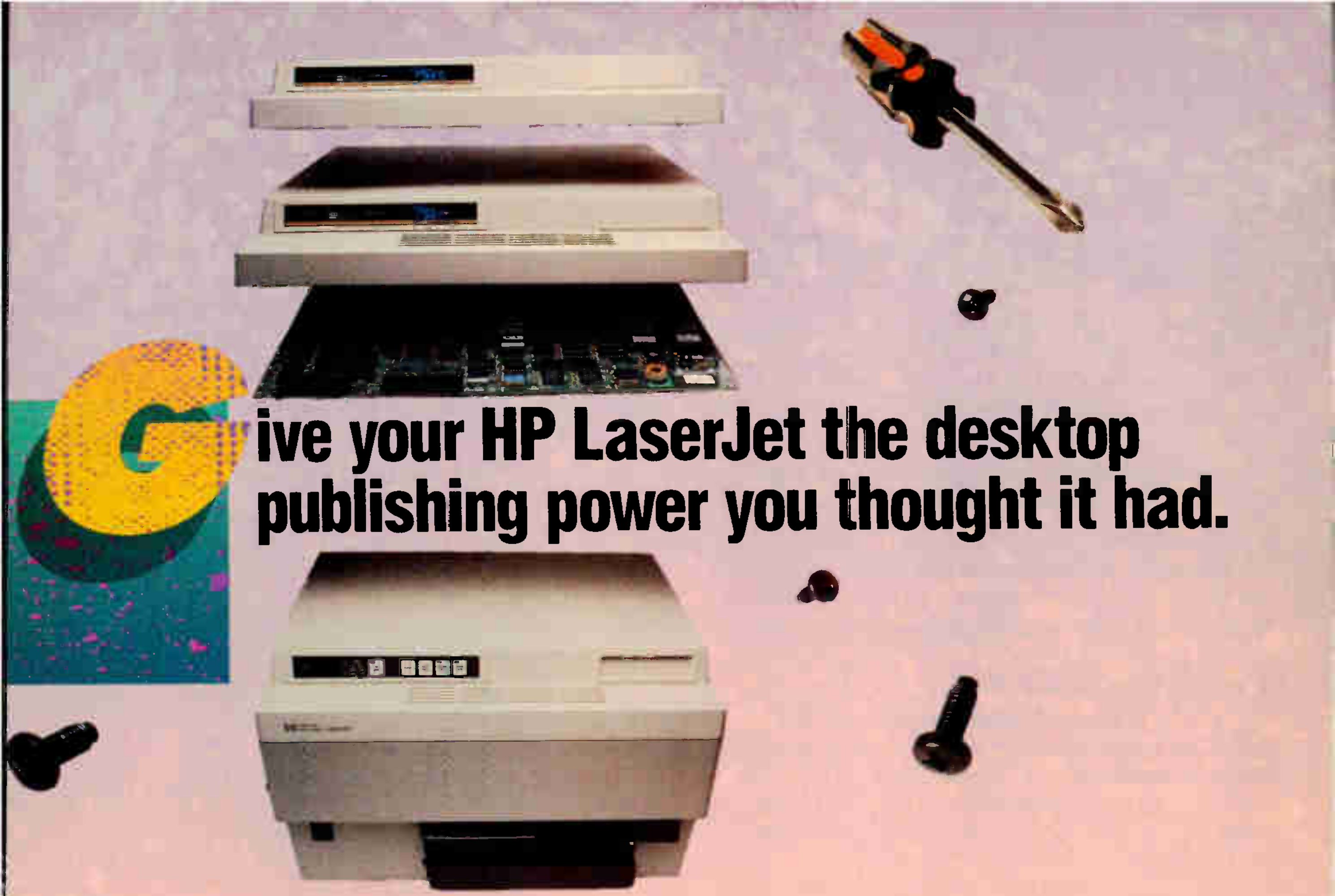
Image Compression

The advanced computer class of Rabat (Morocco) American School had been investigating fractal geometry when I read "A Better Way to Compress Images" by Michael F. Barnsley and Alan D. Sloan (January). In the interest of showing the class this impressive means of creating images with only a few bytes of information, I wrote a program in Applesoft BASIC using Barnsley and Sloan's random-iteration algorithm. I changed their "a, b, c, d, e, f" input to an input of rotation, scale factor, and translation for each affine transform. Adapting the iterated function system (IFS) image codes in the article's tables 1 to 4 into terms of rotation, scale factor, and translation was the beginning of our class solving the challenge of finding the two transformations that generate the spiral image in figure 13.

To develop an understanding of how and why a transform works, we investigated simple, single, and double transforms point by point. Then we made horizontal, vertical, and diagonal line segments using two or three transforms. Here, clues from the IFS tables helped. Progressively, we came to understand these and other transforms—what they do and why they work as they do.

At this point, we were prepared to tackle the challenge spiral. First, we made Archimedean spirals. Making measurements from figure 13, one can directly deduce the scale factor and rotation needed to make an Archimedean spiral with the same proportions as the figure's. But to restart the spiral inward, another transform is needed to relocate the point to the spiral's beginning (at point (1,1) in this case). This explains the translation of transform 1. Also, the

continued



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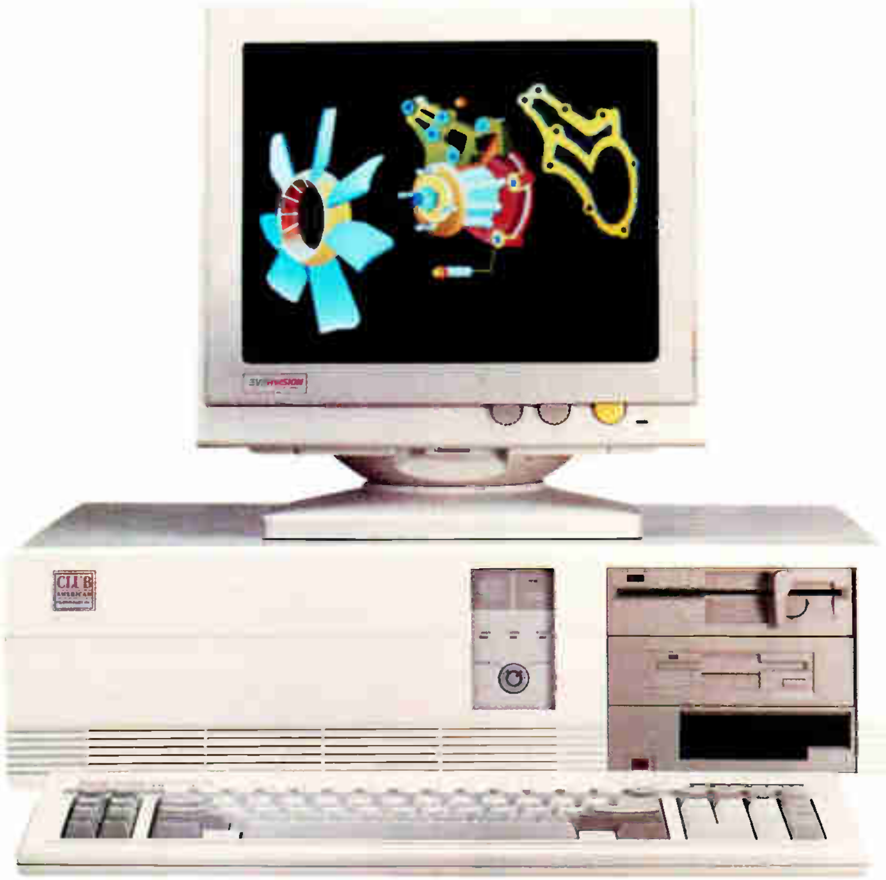
212D with 40MB	$2190	$2550	$2790
212D with 70MB	$2445	$2805	$3045



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smaller self-similar images have to be reduced to avoid overlapping. A scale-down of about +¼ works well. But at this point, it is apparent that the challenge figure's subspirals were flipped 180 degrees. Changing the sign of the scale factors to negative makes the flip. At this point, you only need to do some fine-tuning of the rotation to duplicate the challenge image of figure 13.

In their article, Barnsley and Sloan derived a relation for selecting the best probabilities for each transform. This relation works well for most, but not all, cases. In some cases where one transform probability is near zero, the resulting random distribution of points is clearly inadequate for efficiently plotting the image. Consequently, in these cases adjustment and testing are needed to find the optimal probabilities.

The spirals within spirals in the challenge image are clearly self-similar. (Note that x and y have equal rotations, scale factors, and translations for both transforms.) Also, the ideal one-dimensional points of the figure do not touch. By infinitely repeating the spirals within spirals, the figure undoubtedly becomes a fractal—but how does one determine its Hausdorff dimension?

Robert Dale Hall
Rabat, Morocco

Enabling Factors

Brock Meeks's "Computer Conferencing Homecoming" (September) provides a good perspective between the potential of computer conferencing and the reality encountered today. Emphasis on the human factor is the key from a needs requirement (business or social).

The other essential enabling factor is standards to simplify usage and drive market demand.

Information contained in this type of article is very helpful to the user community and complements the high quality of BYTE.

I'm looking forward to Meeks's assessment of the Prodigy videotex service.

C. Robert Hering
Doylestown, PA

Bus Advocacy

Recent articles in BYTE and elsewhere have pointed up the growing problem of the limitations that the IBM PC AT bus imposes on ever-more-nimble personal computers. Manufacturers have attacked the problem by building 80386 machines with dedicated, proprietary high-bandwidth memory paths in addition to the standard PC and PC AT buses. This helps memory access, but the incompatible 32-bit slots don't help the buyer, and they don't help the computer's access to high-speed disks, graphics adapters, and data acquisition peripherals.

Here are two possible clues to the answer: (1) Compaq and Dell have shown interest in the NuBus. This is the higher-performance, 32-bit bus that Texas Instruments has used in its Explorer AI workstation and Apple has used in its Mac II. (2) Microcomputers often follow the lead of their minicomputer cousins, and minicomputers have lately been hosting older buses on newer, higher-bandwidth buses to avoid making orphans of older products. This has been done by placing a bus adapter for the old bus into the backplane of the newer, more capable bus. The now-classic example of this is Digital Equipment Corp.'s VAX family of computers. IBM says to jump ship to its new Micro Channel, but we may well see the PC-compat-

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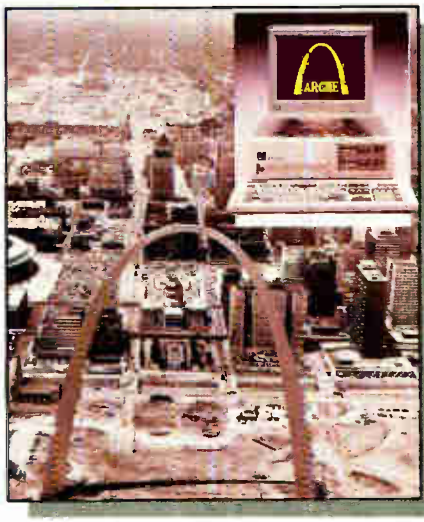

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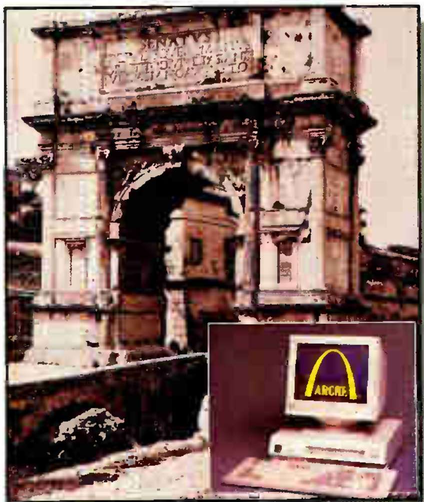

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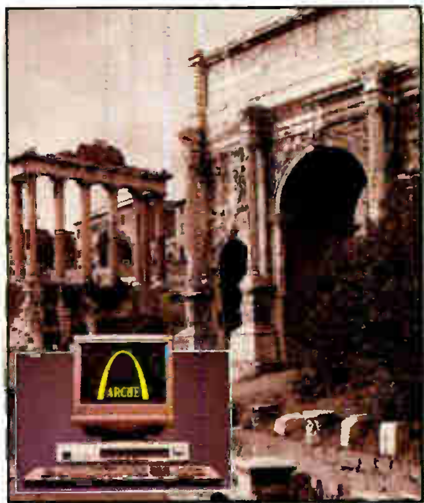

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Circle 23 on Reader Service Card (DEALERS: 24)

ible market move gracefully toward NuBus, either with a few built-in PC AT–compatible slots for existing peripherals or with a minicomputer-style, optional bus adapter and PC AT–compatible card cage.

Where would this leave users? Probably better off. First, we wouldn't lose our investment in expansion cards. Second, we could grow into a new, more powerful architecture as our needs demanded without sacrificing industry-standard memory slots. Third, having expansion options in common with the growing Mac II market could bring on the sort of bargain prices that the PC AT bus market now enjoys.

Dr. James G. Collins
Melbourne, FL

Printer Woes

Regarding Don Crabb's laments about Apple ("What's Up with Apple?," August): The software problems associated with the Imagewriter LQ, which took me 4 months to sort out, give a new meaning to the word "stonewall." Apparently what you see is indeed what you get; no more, no less.

Spencer Merz
Waltham, MA

MacTip

Your special section on the Macintosh (August) is great. I have one piece of information that just might be handy to pass on to everyone.

When you have a situation in which you have to click and type, then click somewhere else and type, and so on, try the Tab key instead of the mouse. In most situations, the Tab key will move the cursor between fields for you.

Mark Favor
Bowie, TX

FIXES

• The address and phone number given for Xanadu in "Hyper Activity" (October) are wrong. The correct information is as follows: The Xanadu Operating Co., 550 California Ave., Suite 101, Palo Alto, CA 94306, (415) 856-4112.

• The listings we published in "T800 and Counting" (November) contained errors. Here are the correct listings:

(a)

```
CHAN OF INT chan1, chan2:
       -channel declarations
PAR
 INT A : - local variable scope is
         - first SEQ
 SEQ
  chan2 ? A - input into A on chan2
  chan1 ! 6 - output 6 on chan1

 INT B : - local variable scope is
         - the second SEQ (not shared)
 SEQ
  chan1 ? B - input on chan1 into B
  chan2 ! 9 - output a 9 on chan2
:
```

(b)

```
PLACED PAR
 PROCESSOR 0 T8 - processor 0 is a T800
  PLACE chan0.out AT link0.out : - put
                 -chan0 at hard link0.out
  navier.stokes( ) - solve the Navier-
                        -Stokes equations
 PROCESSOR 1 T8 - processor 1 is a T800
  PLACE chan0.in AT link0.in : - put
                 -chan1.in at hard link0.in
  graphics.output( ) - dump the output (in
                  -real time)
:
```
■

At Microsoft, first we make it possible.

If you happened to catch the January 1975 issue of *Popular Electronics,* you were one of the lucky few to witness the debut of the personal computer.

Impossible as it seems, a magazine with less than one-tenth the readership of *Time* or *Newsweek* launched a technology race roughly parallel to that of the space program.

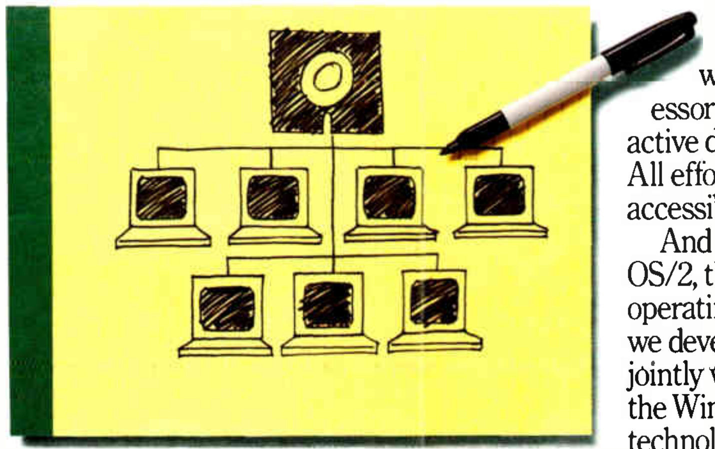
The world wasn't waiting. We were. The PC makes its debut.

It also launched a company that immediately assumed center stage in the exciting new world of personal computing. The company was Microsoft, and the tenet upon which it was founded was a simple one. To see a computer on every desk and in every home.

To take that rudimentary new contraption that was the early personal computer and turn it into the powerful machine that has literally changed the way we work, required some important steps. The first order of business was to create not simply products, but standards. Microsoft® BASIC became the first universal programming language for the personal computer. And set a standard upon which an industry could grow.

Next came what is now the world standard PC operating system, MS-DOS,® developed by us and chosen by IBM for its first personal computers. Today, 20 million machines run on it, and so does a billion-dollar software industry.

And when the Macintosh® was being developed, we were there. That early participation allowed us to write its richest and most important software. These crucial pieces include the powerful Microsoft Word, the much-applauded Microsoft Excel, and Microsoft Works, the single-solution program for the diverse needs of small business.



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As we were contributing to the development of the Mac,® we were also developing a system to put graphics interface technology into the world of IBM® PCs and compatibles.

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But Windows is more than just a useful tool. It is an important technological feat, one that becomes critical to bringing into final focus that original Microsoft vision. Through Windows, any number of software applications will seamlessly integrate. Sophisticated spreadsheet programs. Powerful word processors. Interactive databases. All effortlessly accessible.

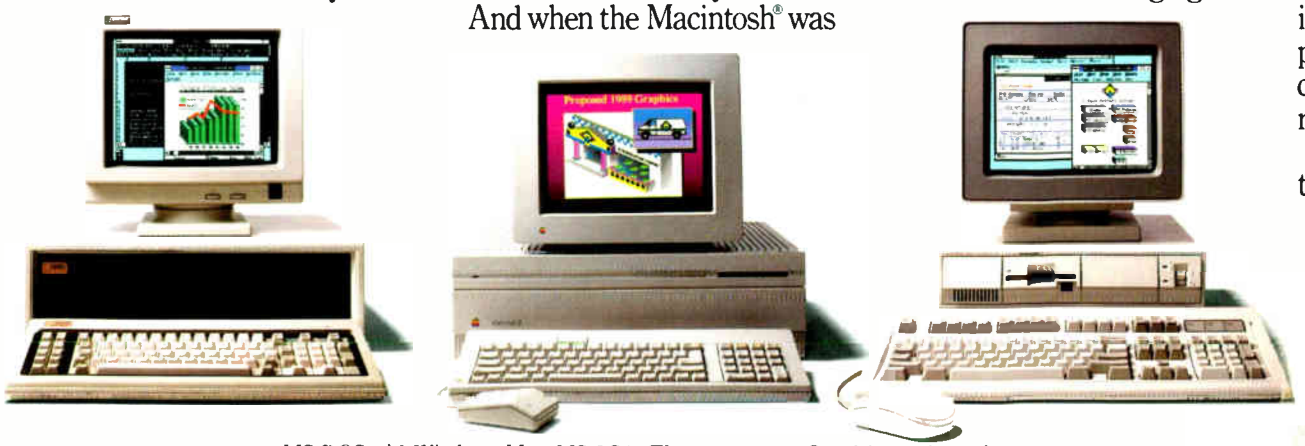
And in MS® OS/2, the new operating system we developed jointly with IBM, the Windows technology (called Presentation Manager) gets even more exciting. Opening up mega-amounts of power and memory. Opening up your screen to do several tasks at once. And opening up endless possibilities for developers using the Microsoft family of languages.

But all this doesn't end at the desktop. With Microsoft OS/2 LAN (local area network) Manager, it's as easy and natural to work on a network as it is to work alone.

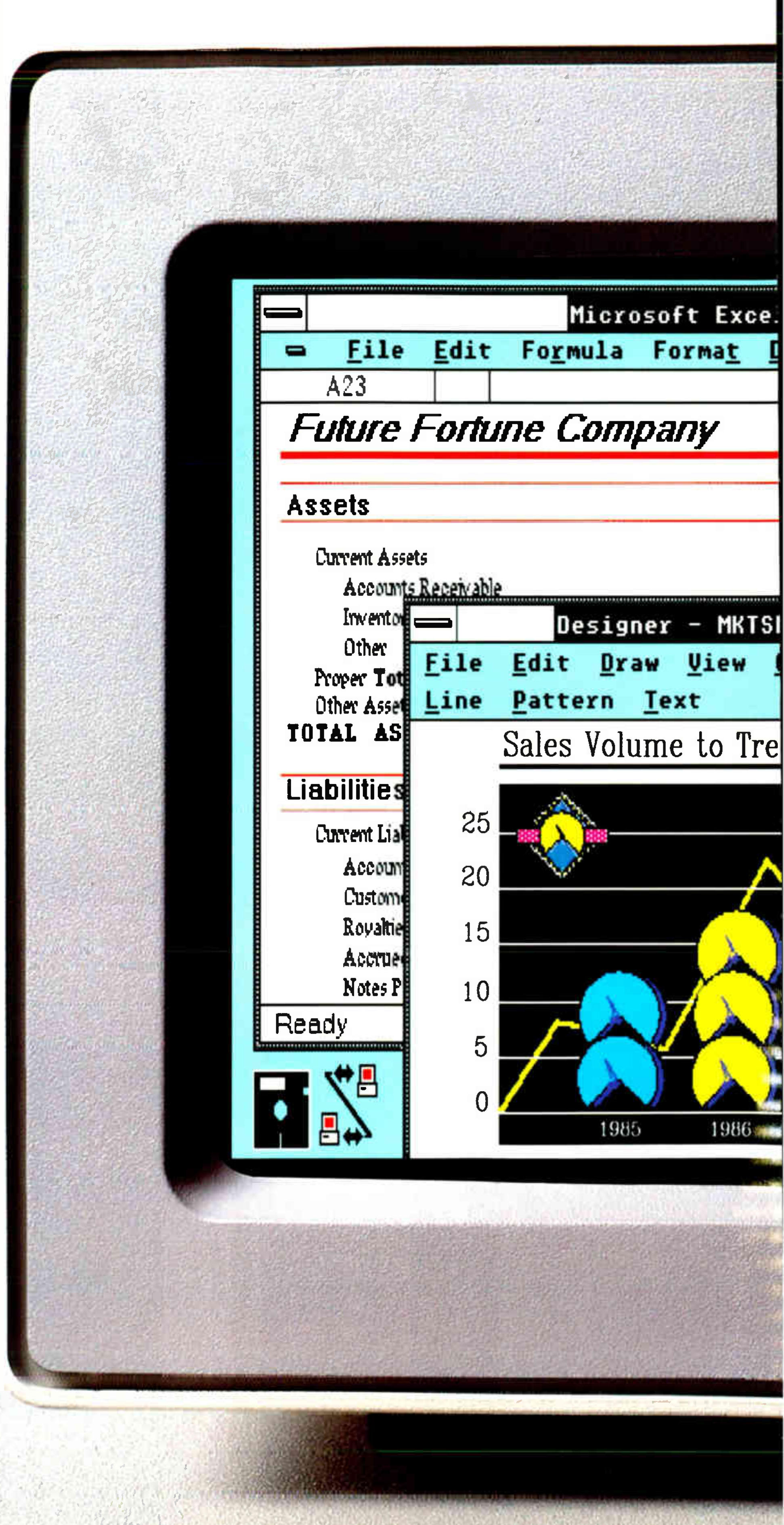
By linking users via software, information can be shared and exchanged by members of a group. Projects are worked on together, instead of bit by bit. And it's amazing how a company communicates once it's joined by electronic mail.

There is no question that the advanced productivity springing from today's personal computer is the direct result of our continued commitment to superior technology.

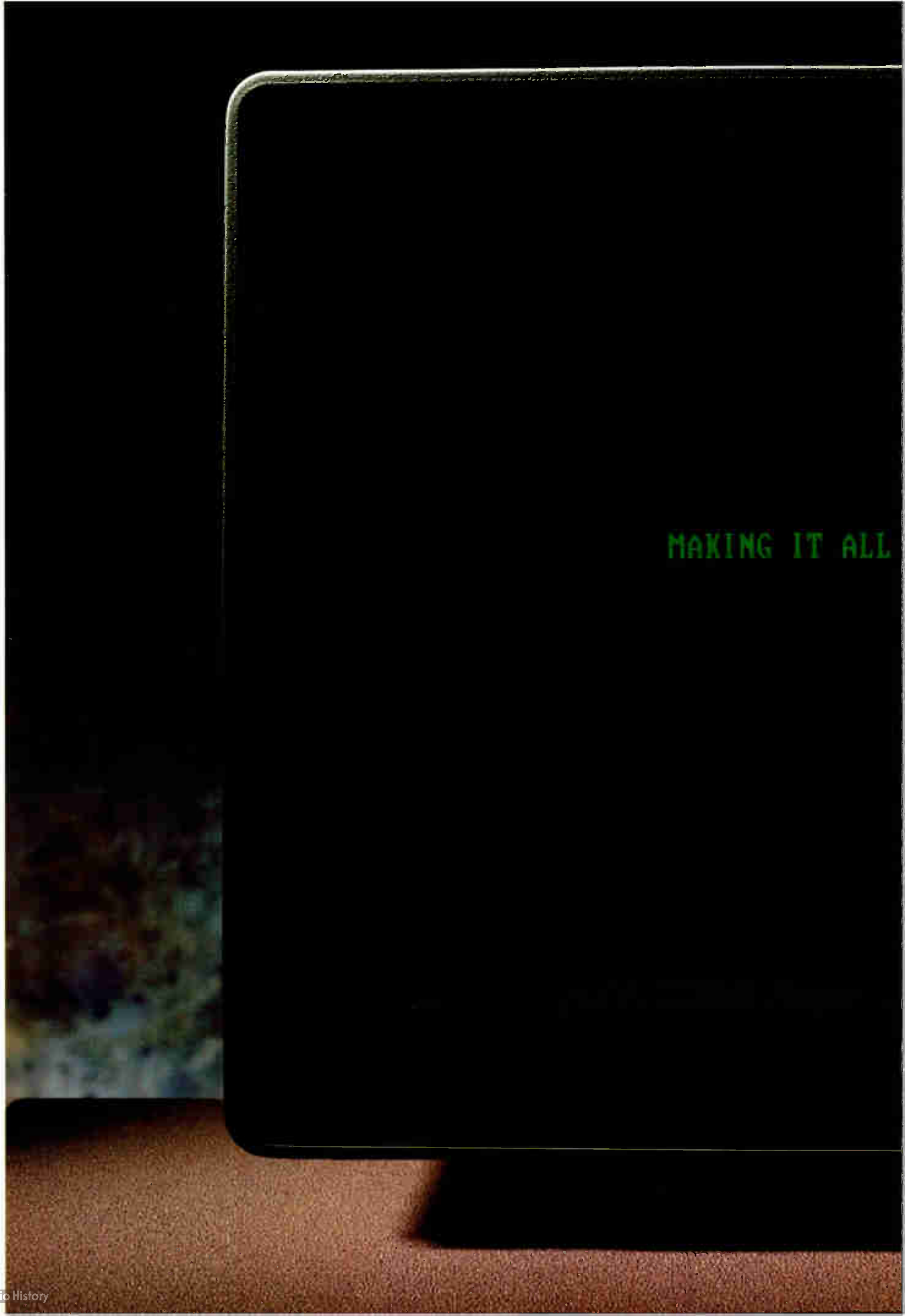
But even so, that's only half of the equation.

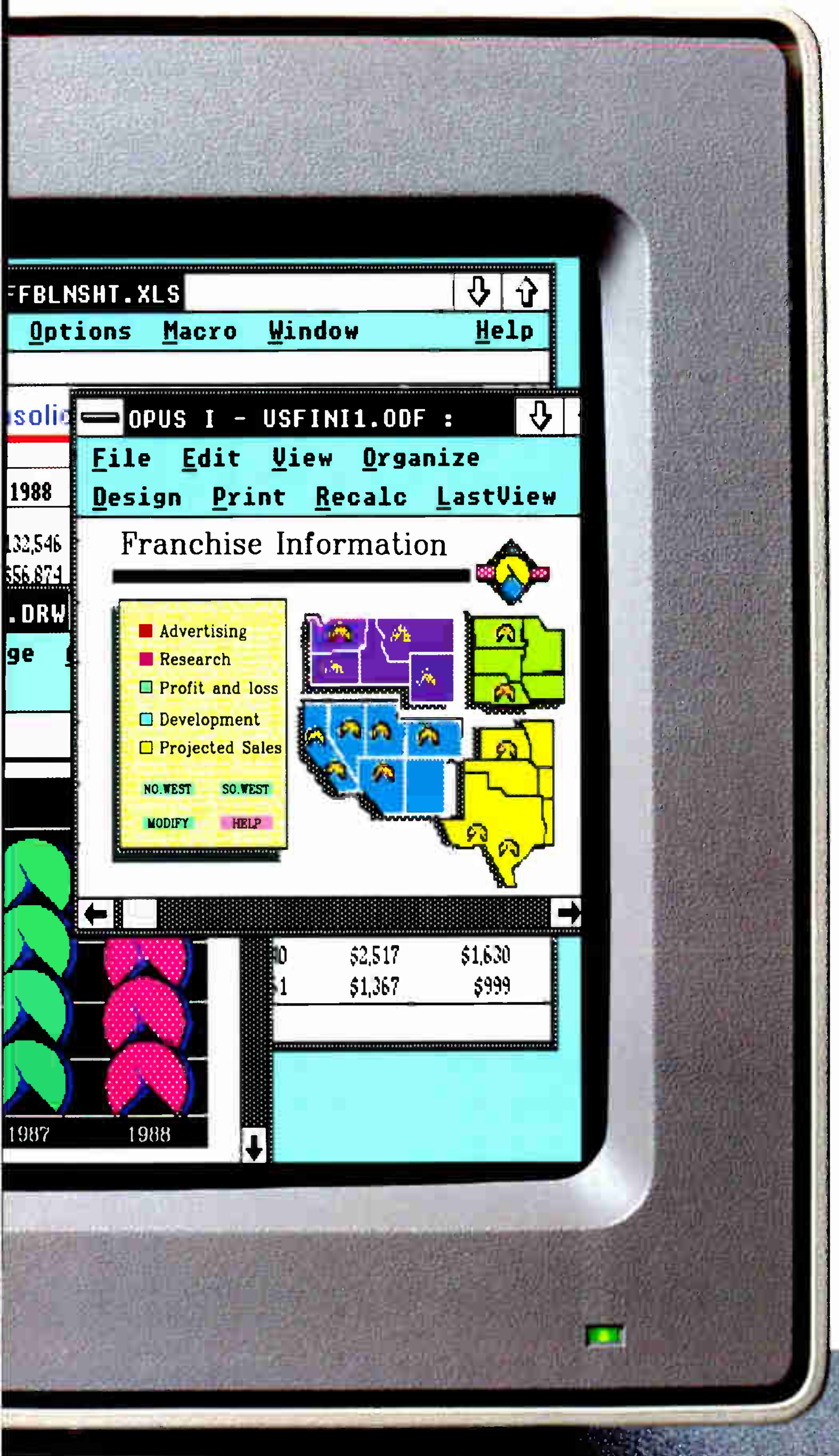


MS-DOS with Windows. Mac. MS OS/2. Three ways to go. One driver. Microsoft.



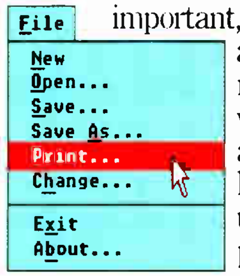
The future of personal computing now rests on just one thing.





Then we make it practical.

The philosophy behind Microsoft includes another, equally important, notion. That all the technology in the world doesn't add up to a hill of beans unless it is practical, useful and, above all, easy.



Easy commands from pull-down menus make window-shopping easy.

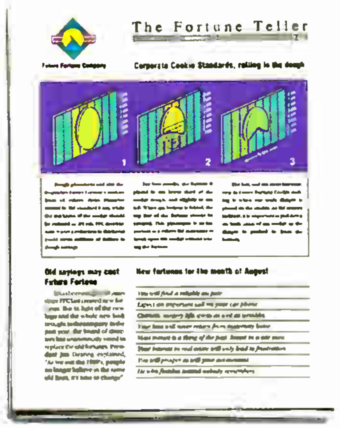
Unless it makes sense.

That's why, whether you're using a Microsoft application on a Mac, an MS-DOS or even an OS/2 machine, it will have a comforting familiarity. Because today's computers share a common software guardian. Microsoft.

Thanks to our groundbreaking work on the graphical interface for the IBM PC and its compatibles, virtually every personal computer can give its user a simpler way to get a lot more done. With a screen that thinks in pictures instead of words, arranged like papers on a desk. Naturally, working with pictures makes the work you turn out much more interesting. Which is why the introduction of Microsoft Windows to the IBM PC and compatibles brought with it a whole new category of software with impressive credentials. Like desktop publishing. And presentation applications that let you create a sophisticated graphics show, from your office instead of the art studio's.

With Windows giving laser printers their marching orders, all manner of documents take on a more finished look. And no matter what application you're using, Windows will take over the job of running your printer.

There is also a hardware complement to graphical applications: the Microsoft Mouse. An unprecedented 1.5 million users have found that a simple point and click eliminates complicated keyboard commands.



WYSIWYG, as in What You See Is What You Get. No translation needed.

Our Windows spreadsheet program, Microsoft Excel, goes so far beyond just simple number-crunching that it has received unparalleled acceptance in corporate America. More powerful than any other, it also easily delivers sophisticated charts, graphs, text and data pulled simultaneously from several sources. And to make it even easier, we built it to graciously accept files and macros from other programs.

The new generation of PCs will run OS/2 with Presentation Manager, taking our graphical screen to even greater heights. By unlocking the capability of these machines, users can easily switch between programs almost instantly. Members of a workgroup can work together on an unlimited number of tasks.

A simple point and click replaces mumbo-jumbo keyboard commands.

And finally, every kind of program, from spreadsheets to electronic mail to word processing, works in a common way. To the user, learning one is a quick step toward learning them all. To the corporate bottom line, it means far less valuable time and money are spent on training.

But the real practicality of the graphical user interface comes to life when, inevitably, it appears on every computer screen, everywhere. And networking becomes not only possible, but required in this competitive world.

When you think about it, the goal Microsoft set in 1975 of seeing a computer on every desk and in every home seems close at hand. Because, at Microsoft, our fierce pursuit of technology comes with a promise to keep.

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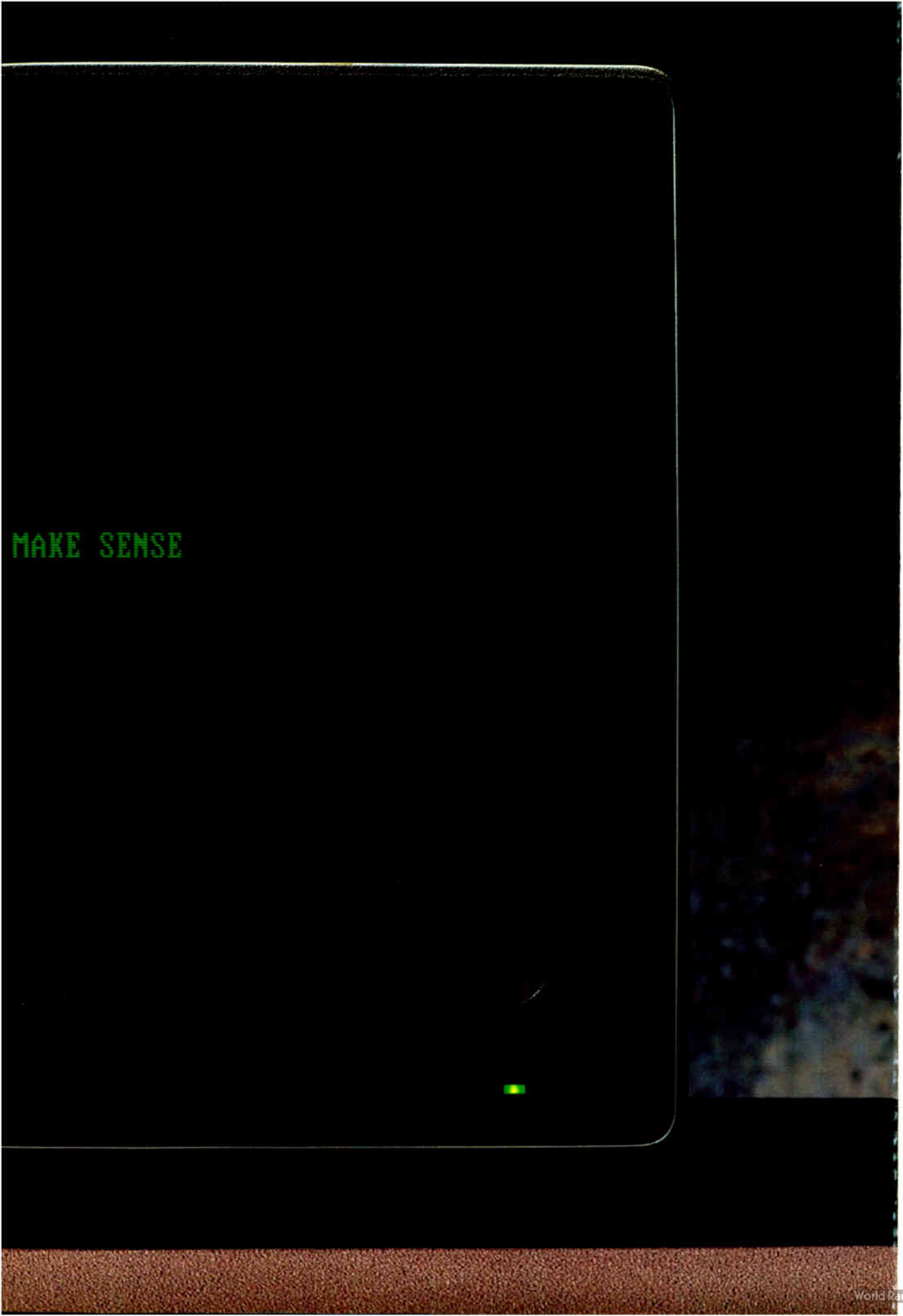

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CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

Keeping a Perspective on Viruses

Dear Jerry,

As a great admirer of your and Mr. Nivens's work, it saddens me to read of your exaggerated fear of viruses. I have been a sysop for several years on several different types of systems, ranging from an IBM PC AT to even 8-bit (a less reputable computer type cannot be found) computer systems. My current system is an XT-class AT&T PC6300 with 60 megabytes of drive space.

As a sysop of a larger-scale system, I have many files going in and out of my system, both from users and from the international FidoNet mail network. A virus cannot be transmitted through a dongle (a hardware security device) while it is attached to a parallel port; it's unlikely that a virus can enter any kind of data that would affect the system memory or disk drive(s). Virus transmission can be done with expansion cards, but *not* with copy-protection dongles.

As a rule, public domain (shareware, what have you) programs are usually well tested and devoid of harmful infectious programs. If we get an upload from someone we don't know, and we don't recognize it, we don't run it to begin with. If the program is then downloaded to another system of a user, and it proves to be harmful, it is then removed.

At one point, my system was infected by a virus that allocated itself as bad sectors and was well beyond my reach to fix without reformatting my drive. I knew that it came from one of my users, but I didn't know who or what program it was. We can at times have hundreds of archived files to sort through, and if we get hit, there's nothing you can do but delete files and start over. The virus's sole purpose, by the way, was to fragment my hard disk drive, one sector at a time.

Viruses can come from any source, truly enough. About your only clues are if a package comes from an unknown software house or user, contains no instruction files (e.g., *.DOC or *.TXT,), is distributed under public domain precepts, or is simply unsavory looking. Beyond that, and aside from a detailed debug or analysis of the program, you cannot tell if you're in for trouble or not. Oddly enough, if a program is pirated, it is more often than not quite safe. Many piracy groups mean to do nothing more than distribute the "broken" software. In general, if the source is older than 21 and/or is a relative or friend, you should be safe with duplicates.

If a program is in any way suspicious, simply don't run it, or wipe it out. Also, programs from retail sources are usually reliable. . . most of the time.

Lastly, beware of software that is packaged as public domain, shareware, and so on, that is actually a pirated version of a reputable package. One example is a package called FIGHTER.ARC, which was actually a cracked version of subLOGIC's Jet. All evidence of the original company was wiped out and replaced with notices of the program's "public domain" origin. I got this package from an upload from a user. I was lucky in that FIGHTER was harmless, but I've seen what not-so-harmless ones have done to other sysops.

Michael Kitchin
Potomac, MD

Well, I wouldn't call it an exaggerated fear of viruses; I go whole days without thinking about them. Perhaps I did overdramatize, particularly in the case of the dongles. I really consider dongles an unlikely source of virus infection. But I don't think it's impossible.

As for my protection system, I won't run software of unknown origins on my primary system; and all my software is backed up on a WORM drive, so that if somehow I do get an infection, a disk reformat followed by a restoration from the WORM cures all.—Jerry

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."

Correcting Word 4.0's Macro Delays

Dear Jerry,

Allan Fries's advice on Microsoft Word 4.0's macro delays (July) was not quite correct; the delays are longer the further from the top of the current page you are, and Word is not page-oriented. You could type all day and still be on page 1. So to reduce response time, you simply repaginate the document. Unless you're ready to print, don't even verify the page breaks. You'll see the macros react much faster than at the end of a long unrepaginated document.

The delay, however, does need to be corrected by Microsoft, as does the fact that you can't view a simple list of macros and their hot keys—they're mixed up (in alphabetical order) with the rest of the glossary. Even so, as Mr. Fries says, Word 4.0 is the most elegant and versatile writing tool there is.

Robert E. Hawkins
Greenville, MS

Thanks for the tip. I thought there was something odd about the way the macro delays happened.

I'm not using Microsoft Word at the moment. It's a good editor with a lot of features, though, and I sure don't discourage anyone from using it.—Jerry

Found: Two Medical Dictionaries

Dear Jerry,

I noticed Michael Hanson's letter inquiring about a medical dictionary (June), and I wanted to tell you about the dictionary I've been using.

I'm a graduate student at the University of Southern California, and I'm writing my dissertation on legal ethics. I've been using a legal dictionary with my IBM PC that has been very useful. The software is produced by R. A. Davis & Associates (520 South Marengo, Pasadena, CA 91101, (818) 794-6532). The version I am using works on all IBM PCs and clones, and it is compatible with a large number of word processing systems. I understand that the company that wrote the package also has dictionaries available for medical, engineering, general sciences, and social science fields.

Clifton V. Philpott
Los Angeles, CA

Thanks.—Jerry

Dear Jerry,

Aiming a spelling checker at a medical CD-ROM is a clever solution for producing a dictionary, as you said in your reply to Michael Hanson. However, an easier and possibly cheaper solution for those without the CD-ROM would be to buy Stedman's Medical Dictionary ($89) from Reference Software (330 Townsend St., San Francisco, CA 94107).

Stephen Furlong
Randolph, MA

Thanks.—Jerry

The Case for GOTOs

Dear Jerry,

I have a few comments to make on your column entitled "Transparent Conversions? Hah!" (March).

First, your decision to use trial-and-error techniques for the program conversion violates one of the cardinal principles of software engineering. The reason people go to universities to study computer science instead of computer art is because you're supposed to use scientific techniques in computing, and the trial-and-error approach is definitely not one of them. It might be OK if you're con-

continued

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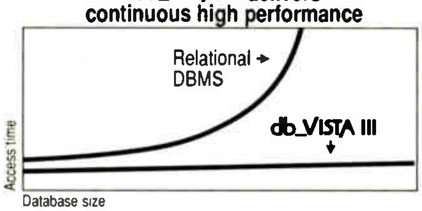

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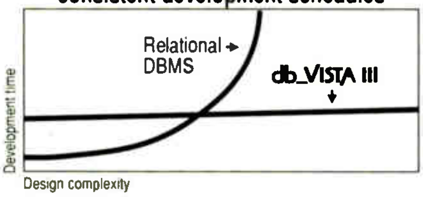

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verting four lines of code, but not for anything more.

Second, I agree with Bruce Tonkin's approach. In fact, that is the recommended style for interpretive BASIC. An understanding of the behavioral characteristics of interpreters and compilers will make this clear.

An interpreter is a program that takes in each line of source code, converts it to machine code for the computer to understand, and executes it immediately. This process is repeated for each and every line of source code it encounters, irrespective of how many times the line of code is encountered. This line-by-line interpretation results in slow program execution, since the computer spends more of its time interpreting rather than computing. One of the techniques of improving program performance is to use GOTOs wherever possible, instead of GOSUB-like commands when calling a module, since the latter require that the calling address be pushed into a stack and popped back after the execution of the module: GOTOs do not.

A compiler, on the other hand, takes in the source program file, translates it into machine code once only, and creates an output object file that after linking is ready to execute. Program execution is fast, since the source code is translated only once, and the resultant module can be executed by the operating system as often as required without retranslation. Hence, GOSUB-like commands are preferable to GOTOs from the point of view of modularity and program readability.

Third, I don't agree with either you or Edsger Dijkstra that GOTOs are harmful. Careless use of GOTOs, yes; controlled use, no. In fact, for certain real-time applications in which procedure or subroutine call overheads are undesirable, or even when you're trying to escape the structured constructs due to a particular condition, GOTOs can be invaluable.

There are certain taboos about GOTOs, though. The main one is never to use a GOTO to pass control from one module or procedure into the middle of another. That will constitute what is known as "pathological connection" and can indeed be harmful.

GOTOs can be likened to very sharp knives. To say, "very sharp knives are dangerous, so don't use them" is the wrong admonition. The proper advice should be, "very sharp knives are dangerous, so use them with care."

Dogmatic use of the structured constructs can be harmful. And structured programming does not mean GOTOless programming. Indeed, the key to successful computing is flexibility.

Mobolaji E. Osunsanya
Lagos, Nigeria

Your letter brings back memories of the early days of my column, when GOTO was often—and vehemently—debated.

My own view is that GOTO statements sometimes make things a lot easier, but the problem is not the GOTO; it's the label to which the GOTO refers: When you're trying to analyze code and you can't figure out how the program goes to that label, you can go mildly nuts; then when you discover there are three different ways it can get there, it gets worse. Thus, when someone sends me a program, I really would prefer that it didn't have GOTO statements.

On the other hand, I'm not above using them once in a while myself when I'm in a hurry and no one's looking.—Jerry ■

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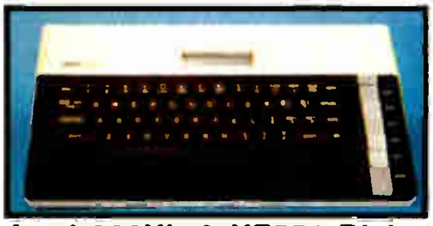

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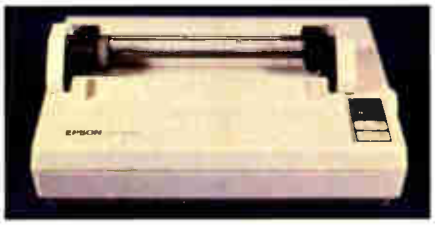

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Dear Steve,

I am writing for two reasons.

First, I have an EPROM board with its own operating system, but the "burn-test-debug-burn" cycle is a chore, and I'm losing EPROMs in the process. Stuart R. Ball's emulator ("Build the Emulo-8," April 1986) is almost the ideal solution; it emulates EPROMs from 2716 up to 2764, but my needs are for 27128s to 27512s.

Since Mr. Ball's article was published more than 2 years ago, I'm not sure that he is at the same address, so I'm writing to you. Could you tell me how you would modify his design to emulate a wider range of EPROMs, particularly the 27512? Or you could design one of your own from scratch. This project would be usable by any computer with a serial port, so BYTE readers would surely welcome it. I would like to see the emulator do the following:

- Emulate the full range of EPROMs currently on the market.
- Provide a maximum of 64K bytes of RAM for socketed chips (e.g., eight 6264s). You shouldn't have to install the entire 64K bytes of memory. Regardless of what amount of memory you install, it would be mapped in a single, contiguous block. You would install the correct number of 6264s (eight, four, or two), depending on whether a 27512, 27256, or 27128 was being emulated.
- Direct output to a specific 6264 RAM chip. A user-written assembly language program on the host computer would prompt for the number of 8K-byte blocks to be transferred. From the default start address, the program would transfer a block of data over the serial port. At the end of each block transfer, the emulator would switch to the next chip and download the next block until the designated number of blocks had been transferred. I foresee that, when debugging a ROMable development project, I could change a specific byte in a selected chip. In this way, I could download, test, return to the host, correct the error, and download however many bytes were required to fix the bug.

Undoubtedly, a BASIC version of the program would come from the Circuit Cellar. You could challenge BYTE readers to convert it to write their own in assembly language for the microcomputer of their choice. BYTE could publish the best of the lot, and the authors would place them in the public domain.

Regarding my second question: Often, I have read in the pages of BYTE and other computer periodicals that most knowledgeable engineers agree that the MC68000 processor family is superior to the iAPX. Though the 68000's superiority is arguable, no one denies that its linear memory addressing is easier to program than the 80x86's segmented memory.

Your Circuit Cellar designs usually use the latest chips, but I have yet to see one designed around a member of the MC68000 family. In recent years, you have given us ZAP (Z80), the SB180 (HD64180 running Z-System), MPX-16 (8088 running CP/M-86 and MS-DOS), and the CCAT (POACH 80286 running MS-DOS). If there is a bias in favor of the Intel chips, please tell us why. If not, it should be a challenge for you to design a 68000-based computer.

Basil Johnson
Nepean, Ontario, Canada

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

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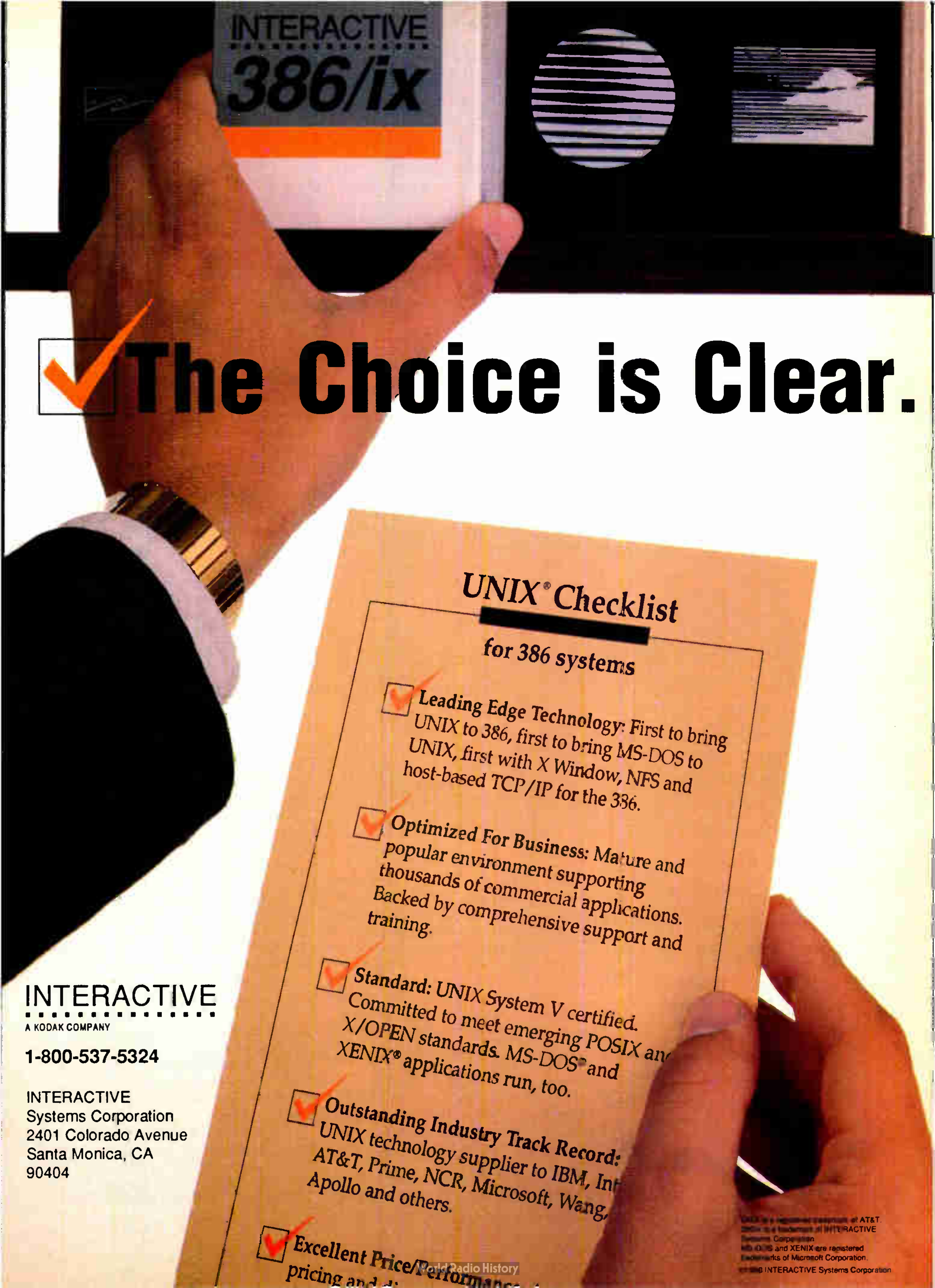
The Ask BYTE staff includes manager Harv Weiner and researchers Eric Albert, Tom Cantrell, Bill Curlew, Ken Davidson, Jeannette Dojan, Jon Elson, Frank Kuechmann, Tim McDonough, Edward Nisley, Dick Sawyer, Robert Stek, and Mark Voorhees.

Stuart R. Ball's design can be readily modified to accommodate larger EPROMs. To emulate a 27512, you need 16 address lines; the published design has 12 driven by IC2, a 4040 12-bit binary counter, and a 13th driven by half of IC9, a D flip-flop clocked by the last stage of IC2. The simplest way to get the 16 address lines is to replace IC2 and half of IC9 with two 74LS393 (or similar—e.g., 74HC393, 74HCT393) dual binary counters. These counters are cascaded in such a fashion that the high-order output of one counter drives the input of the next-higher counter. The 16 outputs of these counters become address lines, which can be buffered in the same way as the ones shown in Mr. Ball's design. You should add another 74LS244 package to the design in order to handle the extra lines. You could use multiplexers such as 74LS157s in place of the 74LS244 packages to allow control of RAM addresses from two sources.

For the additional RAM, the simplest route would be to use two 43256 32K-byte by 8-bit chips. The A15 line low enables one RAM, and A15 high enables the other (you'll need an inverter here). Given the relatively low cost of 43256s from sources such as Jameco and JDR (about $12), this approach makes considerable economic sense. A somewhat more complex approach, closer to your description, would use a 74LS138 decoder with select inputs that are driven by A13–A15. The eight outputs of the '138 each enable a 6264 or similar 8K-byte by 8-bit RAM chip.

A reasonable way to add address selection to this design would be to replace the two 74LS393 counters with four 74LS161 presettable counters, with A–F readout thumbwheel switches to select the count, and a debounced push button activating the LOAD inputs of the counters to set the value selected onto the address lines.

continued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With these simple modifications, you can extend Ball's design to the size you require and incorporate the features you want.

On to your second question. The Intel versus Motorola debate has been an endless one. In general, programmers seem to prefer the orthogonal architecture of the 68000 series, although there are many less vocal programmers who like the 80x86 series best. The content of the debate is frequently misleading; for example, the 68000's virtue of linear memory is eliminated when you use the 68451 or 68851 memory management units, since they segment or page memory. The net effect is like Intel, with extra hardware to get it. Thus, the 68000 series doesn't always have linear memory.

While I might, with unlimited resources, be tempted to develop a 68000-series design, there are a number of reasons for not doing so in the real world. Engineers like myself tend to be more interested in hardware than software, and the 68000 requires more attention to software. To cover development costs, I would need to think in terms of commercial products. Products require support, and that means a knowledgeable staff. All these expenses would need to be covered by sales, and Motorola isn't doing all that well against Intel in the volume industrial markets that spell the difference between success and bankruptcy.

Additional reasons for going with Intel for designs like the CCAT include the relatively low cost of designing for MS-DOS as opposed to, for example, OS-9. My staff is already experienced and familiar with the chips we work with; I have access to less expertise in the 68000 arena, and developing that expertise would require resources best expended in other directions at the present time. The market outlook for a 68000 design is rather limited, and too many people fighting over too small a pie makes us all starve. With all this said, however, there is an ongoing project based on the 68000 in Circuit Cellar INK.

For two ways to convert 68000 designs to use 68020s, see the June 20, 1985, and January 9, 1986, issues of EDN.—Steve

Too Many Files

Dear Steve,

I've been trying for months to find an explanation for a `Too Many Files Open` message from the operating system while it's running a COM file from a Turbo Pascal source code.

The boot disk has a CONFIG.SYS with the lines FILES=30 and BUFFERS=30. The DOS manual doesn't say anything about how to fix this error, and for this particular application I need more than 15 files opened simultaneously (15 is the maximum number of files I get before the message appears).

Is there some way to fix this error?

Santiago Lopez
Tampico, Mexico

Your `Too Many Files Open` *problem is due to the limit DOS places on the number of file handles that can be open at one time. This limit is either the default 8 if you don't specify a different number in your CONFIG.SYS file, the number you specify, or 20—whichever is smaller. In other words, you cannot have more than 15 files open at one time in any version earlier than DOS 3.3, no matter what you put into the CONFIG.SYS file.*

Now, why only 15? Well, DOS takes the first five for the DOS devices `stdin` *(keyboard),* `stdout` *(screen),* `stdprn`, `stderr`, *and* `aux` *or* `com1`. *This leaves 15 handles for you.*

It is possible to open more files using DOS versions earlier than 3.3 by building your own file control blocks. See the IBM DOS technical reference manual for details on this method of opening files. This is complicated using Turbo Pascal, but I believe it is possible.

If you can run DOS 3.3, you can increase the number of allowable handles for your program by using DOS function 67H (set handle count). You'll still have to set the FILES= statement in CONFIG.SYS to allow the larger number of handles. Again, see the IBM DOS 3.3 technical reference manual for details.

The more common method of getting around this problem is to open files when needed and close them when they're not in use. Remember that when opening a file to write to it, you will need to open the file in append mode to prevent losing all previously written data.—Steve

The Mysterious Vanishing Graphics

Dear Steve,

I am a Spanish computer enthusiast. I have an old Commodore-64 and a Sinclair Spectrum. I think I understand these machines well, so I decided to acquire an IBM PC compatible, and I bought Commodore's PC 10-II. Then some friends sent me some programs, two of which were Summer Games and Winter Games.

That's when the problem started: I have to reset my PC to run the games, because the program starts at sector 0. In other PC compatibles, the games work right, but when I tried to run them on my

continued

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Commodore, I couldn't see any graphics, because I must run VSET before working in graphics mode (when you reset the PC 10-11, it sets itself up in text mode).

What can I do to set the advanced graphics adapter to remain in emulation text mode? There should be a way to do it, perhaps by changing the reset routine.

I have a second question. I would like to send tones down a wire—the telephone line, for example—and I'd like to choose those tones from those shown in table 1. The tones work in the U.S. systems, and I believe they work here in Spain as well. They must be within 30 Hz of the frequencies I've shown and should have distortion of less than 1 percent. What equipment should I use?

Jordi Roca Mas
Tarragona, Spain

Table 1: *List of requested frequencies.*

Tone	Number frequency
1	2600 Hz
2	1740 & 1980 Hz
3	1860 & 1980 Hz
4	1380 & 1500 Hz
5	1380 & 1620 Hz
6	1500 & 1620 Hz
7	1380 & 1740 Hz
8	1500 & 1740 Hz
9	1620 & 1740 Hz
10	1380 & 1860 Hz
11	1500 & 1860 Hz
12	1620 & 1860 Hz
13	1740 & 1860 Hz

There are often variations in the way similar computers function, and DOS is often "customized" by manufacturers; these differences and changes can create problems. There is no certainty, but you can probably solve your problems with the Commodore graphics adapter display modes by using the MS-DOS mode command. You can issue the appropriate commands from the keyboard or in a batch file (see table 2). Check the MS-DOS manuals for more information.

You can find information on DTMF tone encoding/decoding in the December 1981 Circuit Cellar, which can also be found in volume II of the reprints under the same title published by BYTE books. National Semiconductor's 1982 Linear Data *book contains specifications and*

continued

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Table 2: Mode *command syntax.*

Command	Description
MODE CO80	Sets hi-res graphics, color enabled
MODE CO40	Sets lo-res graphics, color enabled
MODE BW80	Sets hi-res, color disabled
MODE BW40	Sets lo-res, color disabled

applications information for several pertinent ICs.

For information relating specifically to the Spanish phone system, I'd suggest visiting a technical or university library and researching the appropriate CCITT communications standards.—Steve

Gotta Get That RAM

Dear Steve,

Many of us are looking at buying RAM chips on the open market to fill in a variety of boards and projects that come with that little "0K installed" note. However, there is often a question of speed to consider.

Could you give me some idea of the upper limits of the clock speeds that can safely be run with the 150-nanosecond, 120-ns, and 100-ns RAM chips? I'd also appreciate general notes about any "gotchas" that might be hiding in the bushes for us novices, and any ideas about the future of RAM chip speeds.

I noticed that some of the 20-MHz 80386 machines (like the new AST) say they have 13 megabytes of RAM that use one wait state and 64K bytes of cache memory that has no wait states. How fast does cache RAM have to be, or are there other considerations besides RAM speed?

Jeffrey Kutz
Los Angeles, CA

The maximum access time for 2164A memory chips running with an 8086 processor at zero wait states is given in the Intel memory components handbook as shown in table 3. The 12-MHz point is extrapolated from the Intel data. The handbook also shows a sample design using 150-ns chips with an 8086 at 10 MHz.

These times are probably optimized, in that there are likely to be some timing delays due to hardware design that are not accounted for in the Intel calculations.

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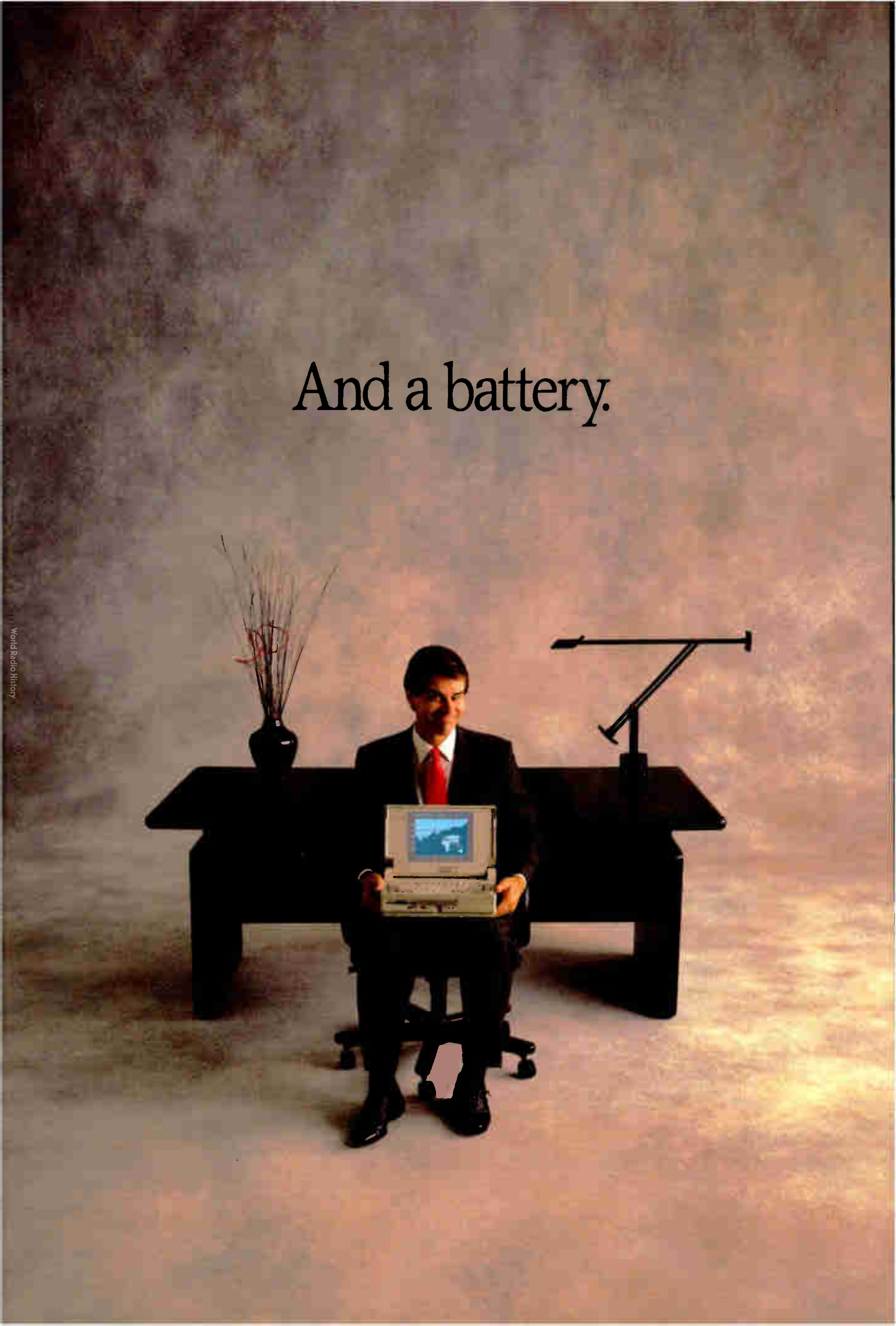
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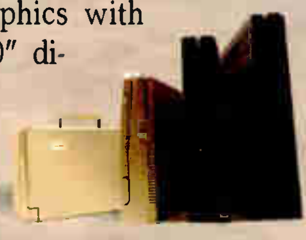

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Table 3: *Maximum memory access times with associated CPU clock speeds.*

Clock speed (MHz)	Access time (ns)
5	313
8	173
10	138
12	117

In a more conservative vein, IBM used 250-ns chips with zero wait states for normal memory access but one wait state when direct memory access (DMA) is in use at 4.77 MHz. Table 3 would lead you to believe that you don't need the wait state with chips that fast; indeed, some people have run IBM PCs at around 7 MHz with speed-up kits.

The AST Premium/286 is also a little conservative compared to the table. It uses 100-ns chips at 10 MHz with no wait states in the "Fast RAM" slots and one wait state in normal AT-style expansion slots. The AST Fast RAM slots contain a special connector to a bus with direct access to the CPU. The table indicates that 120-ns RAM is fast enough for this machine, but it seems AST thinks differently.

It probably pays to be a little conservative with memory speed, and a practical limit for a zero-wait system probably is 100-ns chips at 10 MHz, possibly pushing to 12 MHz with a very well-made bus and some risk of errors. If one wait state is used, 120-ns chips should be okay at 12 MHz.

The 20-MHz 80386 machines with zero-wait cache RAM use static RAM with access times around 55 ns, which is consistent with the table. There are timing considerations other than access time in designing a memory system, but for estimating, this is good enough.—Steve

Pinning Down a Bug

Dear Steve,

Three months ago, I bought an IBM PC AT board from JDR Microdevices. The system is supposed to work fine at 6 or 8 MHz with one wait state, but since the beginning I have had I/O problems that the retailer has not been able to solve.

Once I've done more than 20 or 40 disk writes, the system crashes completely with a message, `RAM parity error... Offending segment 0000`. It doesn't happen with a disk read. The BIOS is issued by Award. Otherwise, the system is running fine. I checked the disk controller by exchanging it with another, but I had the same problem, so I suppose it is coming from the same motherboard. How can I determine the cause?

Philippe Wetterwald
Ambler, PA

Exchanging the disk controller pins down the problem to two areas: It's either the system board memory or the interface between the system board and the disk controller, which is usually a timing problem.

The timing for memory operations differs depending on whether the processor is reading instructions, reading data, or performing a DMA operation. In the IBM PC AT, the hard disk doesn't use DMA, so there's actually less trouble with that than with a floppy disk. You don't say which sort of disk you're using, but I'll bet it's a floppy disk.

I suspect that one of the RAM chips in the high-order addresses is "soft" and has a slightly slower timing than the rest. It works OK under normal reads and writes, but fails under the DMA timing. Here's how to track it down.

Your board uses 256K-byte dynamic RAMs, so there are four banks of nine chips each. If you don't have a full megabyte of RAM, there will be one or two empty rows; the problem isn't coming from those unless there's a software bug that tries to read from memory that doesn't exist.

I'll assume that you've got a megabyte of RAM, with all four banks full. Set the configuration so that you've got only 512K bytes of RAM defined, then remove the top two banks. See if the problem still occurs; if it doesn't, the bad chip is in one of the two banks on your desk.

If it still happens, swap one of the banks on the system board for one that you removed, and try again. If it still happens, replace the other system board bank. If that doesn't fix it, you need more help than a letter can provide.

Assuming that you've pinned the bug down to one bank of RAM, replace it. Don't try to isolate it to a single chip—buy nine more chips and replace the whole bank. You'll have eight spare chips (and one dud that you'll have to sort out later) in case a RAM chip dies later on.

If you can't pin it down to a single bank of RAM, there may be two or more slow chips in the lot. Check to make sure that the speed rating (the number after the dash in the part number) is the same for all the chips: If one or two are different, those are the troublemakers.—Steve ■

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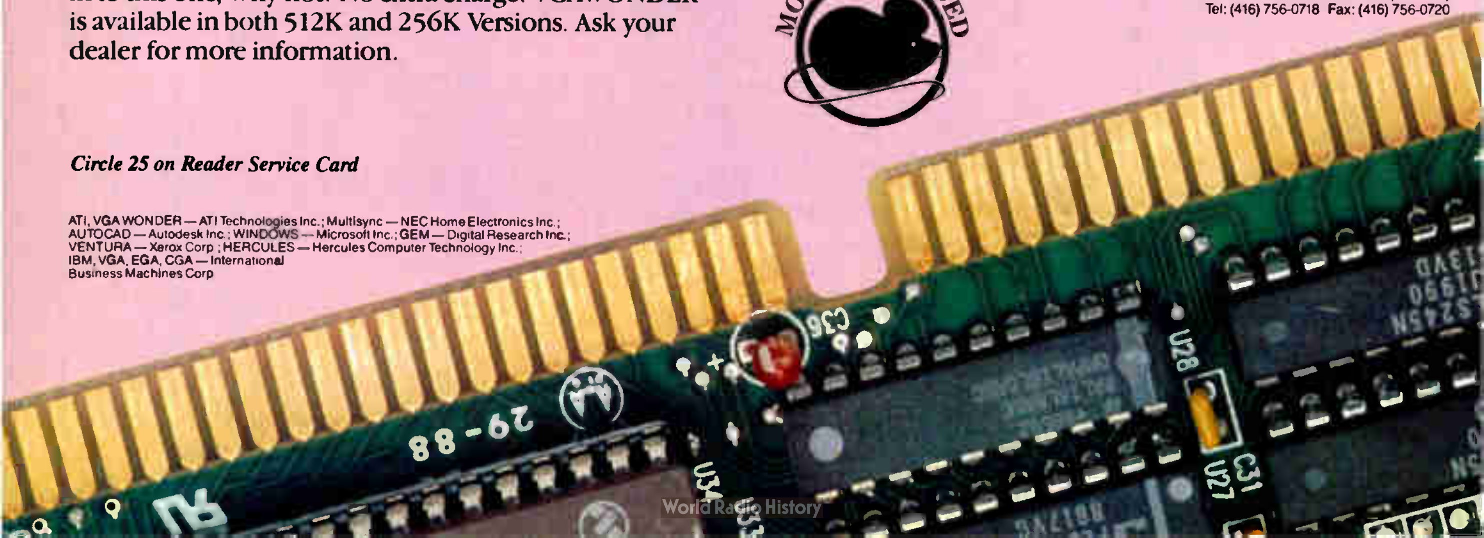

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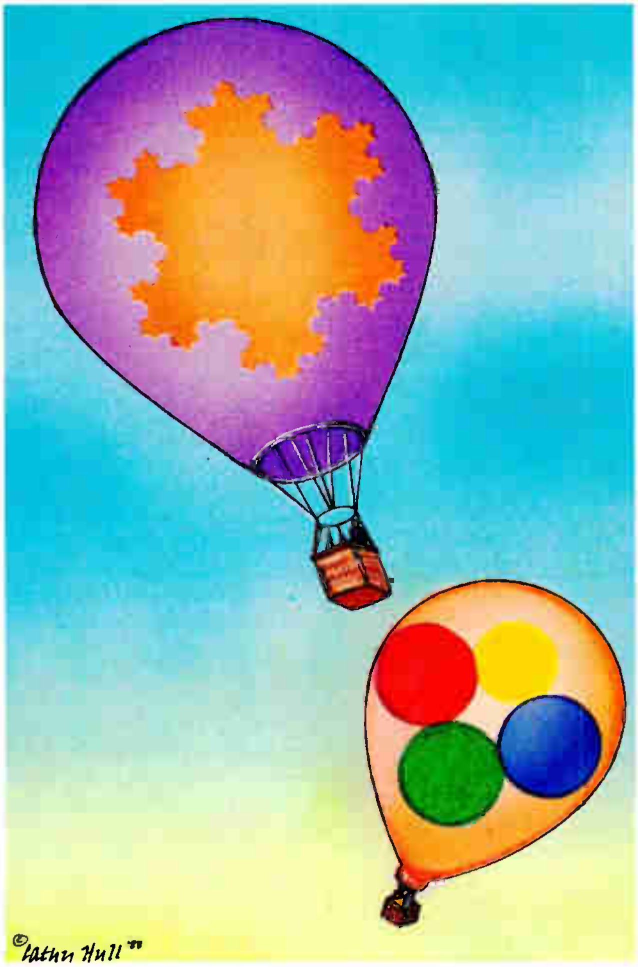
BOOK REVIEWS

The Science of Fractal Images

Edited by Heinz-Otto Peitgen and Deitmar Saupe

Springer-Verlag, New York: 1988, 312 pages, $34

Reviewed by Eric Bobinsky



Fractals are undeniably becoming an important part of our high-tech world, quickly gaining ground in areas as diverse as pattern recognition, plasma physics, data compression, and cell physiology, as well as in their established place in computer graphics. The professional programmers, engineers, scientists, and educators who will be expected to deal with them must learn what they are and how to use them. Fortunately, the last 2 years have seen the publication of several excellent books on fractals. The latest and perhaps most distinguished addition to this collection is Springer-Verlag's *The Science of Fractal Images*, edited by Heinz-Otto Peitgen and Deitmar Saupe.

Based on the notes of a very good intensive short course presented at SIGGRAPH '87, *Fractal Images* is written by six authors whose names constitute a Who's Who of some of the world's top fractal researchers.

Following an amusing foreword by Benoit Mandelbrot, the book contains five lengthy and expertly presented chapters on producing fractal imagery: "Fractals in Nature: From Characterization to Simulation" by Richard Voss, "Algorithms for Random Fractals" by Dietmar Saupe, "Fractal Patterns Arising in Chaotic Dynamical Systems" by Robert Devaney, and "Fractal Modelling of Real World Images" by Michael Barnsley. Three appendixes cover additional details, and a fourth, written by photographer Michael McGuire, is an intriguing look at the aesthetics of fractal imagery, with the added pleasant surprise of nine photographs by Ansel Adams.

As was true with Peitgen's earlier book, *The Beauty of Fractals* (for a review, see the May 1987 BYTE), this work contains a wealth of beautifully reproduced color plates and numerous black-and-white images.

The book contains many pseudocoded algorithms and is aimed at the professional who intends to produce and use fractal images in his or her work. The level of mathematical sophistication is fairly high, and it would not be unreasonable to assume that the reader has some knowledge of digital signal processing (or at least basic Fourier transforms and spectral analysis), basic probability theory and some statistical mechanics, affine transformations, and perhaps basic theory of dynamical systems, with a little real or complex analysis thrown in for good measure.

This book is not for the mathematically faint of heart, but it will be accessible to most college graduates with a science or engineering degree of some kind. In addition, the text is so clearly written and so easy to follow that even readers without knowledge of a particular specialty should be able to follow the arguments by their context alone.

The Science of Fractal Images will no doubt be used as a textbook, a programming sourcebook, and, perhaps, a coffee-table conversation piece, but it will also prove invaluable in helping guide a generation of researchers in many diverse fields into a new and provocative area of the imagination. Fractal geometry may become as fundamental a tool as calculus, which made it possible for us to reach the planets. As Mandelbrot exhorts in his foreword, "Let us all pay to the book the high compliment of promptly making it quite obsolete."

continued

ALSO REVIEWED

- *Using QuickBASIC 4*
- *Unix Programming: Methods and Tools*
- *A Few Good Men from Univac*
- *The Electronic Sweatshop*
- *Mind, Language, Machine: Artificial Intelligence in the Poststructuralist Age*
- *Artificial Intelligence and Human Learning*

ILLUSTRATION: CATHY HULL © 1988

BRIEFLY NOTED

Using QuickBASIC 4 *by Phil Feldman and Tom Rugg, Que Corp., Carmel, CA: 1988, 713 pages, $19.95.* Every time a software product undergoes a substantial revision, new books about that new version invariably appear. Often these books—presumably like the product itself—get better, and bigger, than previous similar versions. Later versions can build on earlier efforts.

With books about software, there are two approaches. The author can create a comprehensive volume that contains something for everyone; this tactic usually also means there will be some text everyone will skip. Alternatively, the author can focus on some subset of the software to provide a rich information resource for people with special needs; this limits the book's potential audience.

Publishers often use the first approach in hopes of selling the greatest possible number of books. Readers must then decide if they want to spend the cover price to acquire some information that they'll use.

Using QuickBASIC 4 uses the comprehensive approach. But the book is intelligently broken into four segments, each of which might be useful to different groups of readers. The segments cover the fundamentals of the software, such as loading and running the QuickBASIC environment; introductory programming; advanced programming; and a 101-page QuickBASIC reference.

The first section provides a rich overview of QuickBASIC, including some excellent material on the differences between BASICA/GWBASIC and QuickBASIC. This material makes the section valuable for the person making the switch from the old to the new version of Microsoft BASIC. The section also provides a chapter called "Up and Running in Ten Minutes," which will help the person familiar with his or her machine and general BASIC programming principles get started quickly.

The second section covers programming fundamentals, including an excellent treatment of handling disk files. When I first learned BASIC, disk I/O routines were the hardest part of the language to understand. But this book's explanations, along with simple but useful sample code, illustrates the key principles nicely.

The Advanced Programming section deals with functions, subprograms, and QuickBASIC modules. It also has a good chapter on memory management and some excellent material on invoking MS-DOS and ROM BIOS interrupts from your QuickBASIC programs.

As an experienced QuickBASIC programmer, I found the last two sections of this book very useful. For a newcomer to QuickBASIC, this book would suffice both to get you started and as a reference for many months to come.

—*G. Michael Vose*

Unix Programming: Methods and Tools *by James F. Peters III, Harcourt Brace Jovanovich, New York: 1988, 447 pages, $25.* James Peters, a Ph.D. computer science student at Kansas State University, is the author of a book designed specifically as a thorough and elementary presentation of the use of Unix System V. The beauty of *Unix Programming: Methods and Tools* is in its pedagogy. Each chapter begins with amusing and relevant quotations from computer scientists and a series of "aims" clarifying the topics covered. At the end of each chapter is a summary, a review quiz, and a reading list.

Peters sprinkles numerous examples throughout the book, and all of them have been tested under generic Unix System V and Xenix. Rather than treating many Unix topics superficially, Peters focuses on the Bourne

continued

BOOK REVIEWS

shell, the C shell, sed, and awk. He also presents common user commands and the two most common Unix editors, ed and vi.

Unix Programming is one of the few books I have seen that would be an excellent self-teaching guide for beginners. Access to a computer running Unix System V is almost essential, even though the book goes further than most in showing and explaining output. It does not, as the title might lead you to expect, teach anything about programming in C. Programs are written in the shell command language and awk. It is an excellent introduction to the methods and tools of Unix. *—Jason Levitt*

A Few Good Men from Univac *by David E. Lundstrom, MIT Press, Cambridge, MA: 1987, 227 pages, $19.95.* Author David E. Lundstrom recalls a time when the physical impressiveness of computers matched their electronic sophistication.

The title of this book is misleading, for it is not really about the early Univac computers: It begins after the Univac I and only briefly describes the construction of the Univac II. Lundstrom concentrates primarily on the formation and rise of Control Data Corp. out of the Univac division of Sperry Rand. He writes from first-hand knowledge, having worked for CDC for many years.

The early chapters are rich with interesting anecdotes about early computers: central processing units with "hallways" inside for access by engineers, massive disk drives whose spinning platters created eerie winds in the computer room, and the early exploits of Seymour Cray, CDC's hotshot designer who eventually left to form Cray Research and build supercomputers. We get a fascinating portrait of life in the Stone Age of the computer era, when each computer cost millions of dollars and Minneapolis/St. Paul (home to both Univac and CDC) was the Silicon Valley of the Midwest.

The strongest section in *A Few Good Men* is Lundstrom's description of a computerized radar-tracking system developed by Univac for the Navy. The Naval Tactical Data System (NTDS) seems to be an early predecessor of the controversial AEGIS system, and it is notable for its innovation and sophistication.

The late 1950s were exciting times; large computers were being transistorized and coming into their own, and new applications like the NTDS were arising every day. What the early 1980s were to personal computers, this era was to mainframes: a period of unprecedented technical progress that was driving a young industry into exploding markets.

Unfortunately, Lundstrom's story seems to follow a course similar to that of CDC. It progresses from the compact and technically interesting world of computer design to the slow and bureaucratic realm of corporate planning and politics.

The latter half of the book portrays mostly minor developments in peripheral technology and loses its technical interest, largely, I think, due to Lundstrom's career change from engineering to marketing. The final chapters concern mostly salespeople and their stories, even recounting in detail CDC employees' vacations in Acapulco.

In a sense, the shift in focus of the book is appropriate, if a little disappointing, since it illustrates the evolution of a typical computer company from an exciting technical start-up to a clumsy technocracy. Apple, take note!

—David A. Mindell

The Electronic Sweatshop *by Barbara Garson, Simon and Schuster, New York: 1988, 288 pages, $17.95.* Electronic automation has been hailed as a means to achieve increased efficiency and higher quality,

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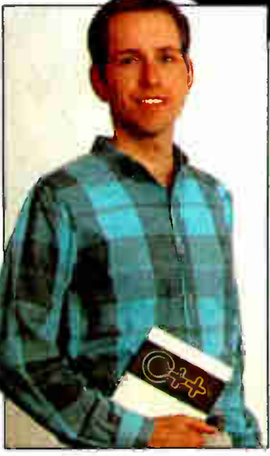

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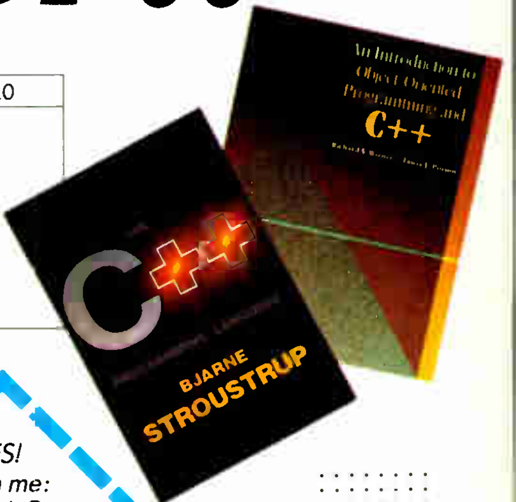

Performance benchmarks

Benchmark	Zortech C	Zortech C++	Turbo C 1.5	Quick C 1.0
Sieve	20.49	20.54	23.62	22.72
Rsieve	20.49	20.54	23.62	22.03
Integer	1.32	1.38	6.31	6.49
Float	0.17	0.22	52.29	51.03
*Float	32.73	37.74	52.39	51.63
Pointer	17.91	17.96	17.13	16.87
Rpointer	17.79	17.91	17.14	16.64
Loop	3.90	3.90	3.90	3.90
Optimize	0.49	0.60	8.46	8.79

Benchmarks were run on an 80286 based IBM compatible at 6Mhz with no 8087.

*The float benchmark was re-run without optimization.

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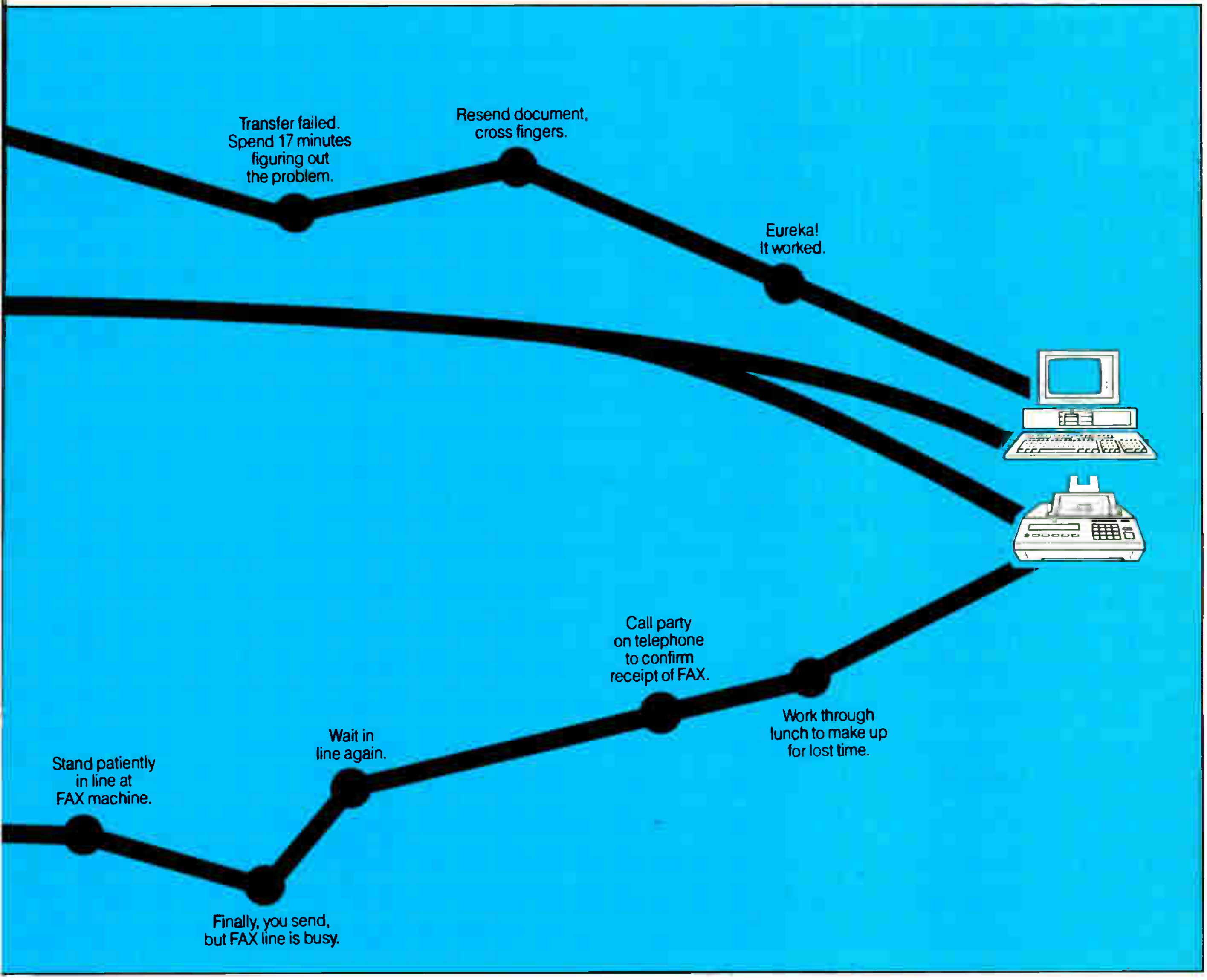

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but Barbara Garson has a different opinion. In her book, Garson suggests that computerization of the workplace is the effort of a mean-spirited top management to control workers and make them as interchangeable as automobile parts.

The Electronic Sweatshop is based on a series of interviews with workers who labor in jobs in various states of automation. The first two chapters focus on working conditions in industries we regularly encounter: the high-tech fast-food restaurant and the streamlined airline reservation system. It is almost frightening how easy it was for Garson to do some of her research, for these easily accessible environments provided her with everything she was looking for. Workers describe standardized and fast-paced processes, tasks that have been stripped of all skill or discretion required for their performance, and regular and strict electronic monitoring of performance statistics.

As she moves to other industries, however, Garson's data ceases to be so clear, but she is unwilling to modify her thesis accordingly. In a welfare office, both workers and managers are ambivalent about the effects of their new computer system. A financial office has an expert system that might replace the knowledge of the brokers, but none of those interviewed use the system. The middle chapters of this book suffer from a lack of coherence, leaving the reader with a disconnected series of anecdotes.

The book's strongest chapter is on a large corporate automation project designed to break the "monogamous" relationships between bosses and secretaries. The questions thus raised are the source of Garson's best insights, for she recasts automation as a feminist issue. On one hand, computers are able to turn a highly skilled and multitalented secretary into a dronelike "information processor." On the other hand, newly created "administrative services" organizations are large, powerful, and composed primarily of women. This development provides a useful support structure for women within the company and can serve to insulate them from overly demanding male bosses. Garson thus reveals automation to be a social issue as well as a technological one.

The personal-interview approach of *The Electronic Sweatshop* furnishes valuable insights into the intelligence with which people handle unintelligent jobs. Garson's thesis, however, that automation is imposed not for efficiency or quality but solely for control and domination, is at best questionable and at worst a generalized and unsupported case of technophobia.

—David A. Mindell

Mind, Language, Machine: Artificial Intelligence in the Poststructuralist Age *by Michael L. Johnson, St. Martin's Press, New York: 1988, 339 pages, $29.95.* During the 1960s and early 1970s, the fashionable style of literary criticism was called structuralism, a method that adapted anthropological and linguistic theories about universal myths and mental structures to the analysis of literary texts. Structuralism in turn gave way to poststructuralism, which abandoned the quest for universals and focused on language itself as a web of relations that paradoxically describes and constitutes reality.

In this book, English professor Michael L. Johnson reviews the field of artificial intelligence from the poststructuralist perspective. He discerns a grand convergence between the two fields, like the convergence between physics and mysticism outlined by Fritjof Capra in *The Tao of Physics*.

Johnson pitches his writing to an academic audience that presumably can digest sen-

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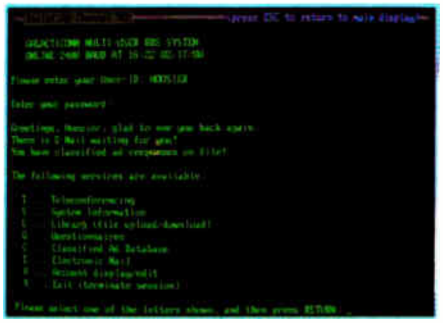

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tences like the following: "Verbal language takes the (plexiform) form of a spoken or written text, a *textus*, something cybernetically 'woven' of (open) binary events (the processes performed in relation to it) in two dimensions, as it were, continually transmuting (as Walter Porzig has noted) all relationships into spatial relationships . . ." Along the way, the familiar touchstones of artificial intelligence (AI)—Chomsky's transformational grammar, Weizenbaum's ELIZA program, Winograd's SHRDLU, Schrank's MARGIE, Hofstadter's Strange Loops, and so forth—undergo similar treatment as Johnson weaves them into a discourse that, in the best poststructuralist tradition, tries to undermine itself and succeeds.

The interactions among minds, languages, and computers are mysterious and endlessly fascinating. Does the mind compile language? Is thought like symbolic computation? Can programs execute mental algorithms, and, if so, can they be said to think? Exploring these issues, AI workers have wandered into deep philosophical waters. Language—the central mystery—remains the only vehicle for such explorations. Yet the theorists and modelers to whom Johnson refers manage to construct theories, build systems, and write books describing their results. Readers interested in those theories and systems would be better off consulting the original sources or one of the many excellent overviews that are available. This book sheds obscurity on subjects that already have plenty of that to spare. —*Jon Udell*

Artificial Intelligence and Human Learning, *edited by John Self, Chapman & Hall, New York: 432 pages, $42.50.*

Anyone interested in applying computers to the improvement of instructional methods cannot ignore this book, which contains 24 insightful articles on the current status of ICAI (Intelligent Computer-Aided Instruction) by American and British researchers. The main topics consist of (1) theoretical issues common to all ICAI research projects, (2) specific tutorial techniques and methodologies, and (3) examples of ICAI application programs.

The book is divided into three corresponding parts. Part 1 includes examinations of such topics as "Representing Complex Knowledge in an Intelligent Machine Tutor" and "Requirements of Conceptual Modelling Systems." The articles are far from being unanimous on the direction of ICAI; for instance, Jim Ridgway argues that current attempts are seriously deficient in both pedagogical and epistemological assumptions.

Part 2 treats specific techniques such as "failure-driven learning," a resolution-based method for discovering students' misconceptions. Important topics in Part 3 include "Design Choices for an Intelligent Arithmetic Tutor," discussion of the Writer's Assistant, ELECTRE Tutor, and the Help system for Unix Mail.

The book ends with an examination of PROUST, which analyzes programs written by novice programmers, and BRIDGE, a complete tutorial environment for beginning programmers.

—*Dong H. Kim* ■

CONTRIBUTORS

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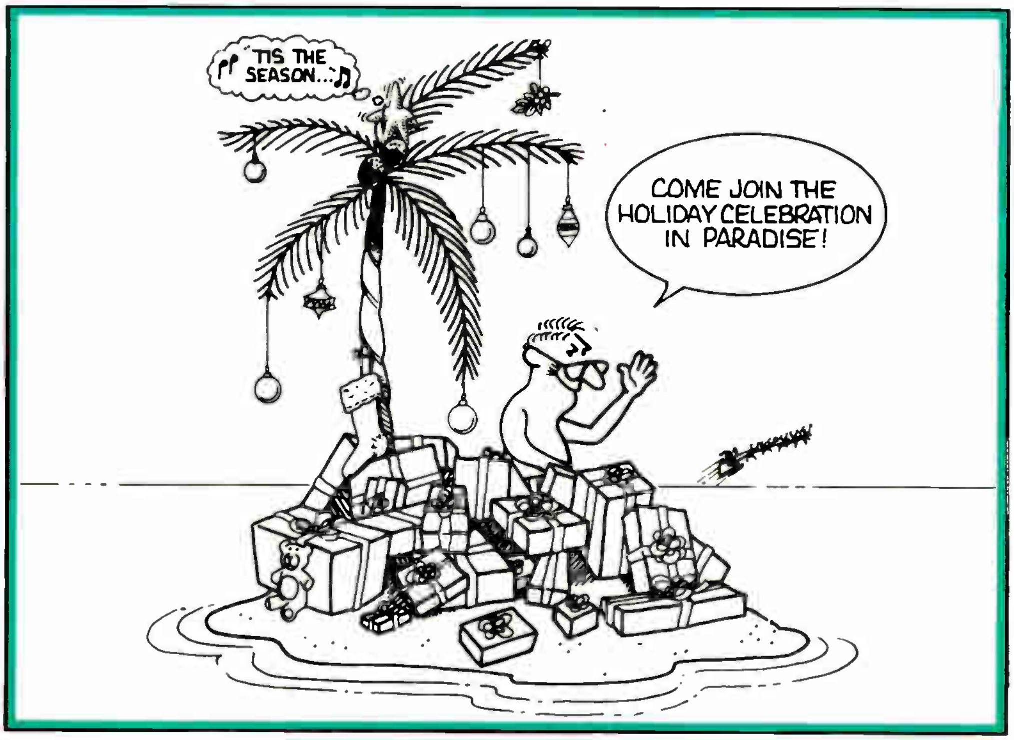

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MKS LEX & YACC
New 100% UNIX compatible compiler construction tools for the DOS C programmer. MKS LEX & YACC work together efficiently to simplify the creation of new languages for applications, or to develop new programming language compilers.
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LIST: $325 OURS: $229

HALO

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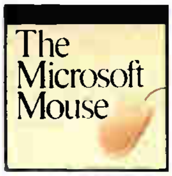
WENDIN-DOS is the new multi-tasking, multi-user MS-DOS replacement operating system for IBM compatible Personal Computers. Version 2.5 allows users to create hard disk partitions greater than 32 MB. WENDIN-DOS uses the MS-DOS file system, and supports MS-DOS commands while providing new ones to enable multi-tasking, file protection, and command language extensions and enables you to access your files with DOS, UNIX, or VAX/VMS style file names—whichever you prefer. WENDIN-DOS supports several users on the same computer. WENDIN-DOS now includes XTC, Wendin's ULTIMATE PROGRAMMER'S EDITOR!

Minimum 512K memory.

LIST: $139 OURS: $109

WENDIN

MICROSOFT MOUSE



If your PC has you trapped into using the same old software, it's time you took a look at the new Microsoft Mouse. It's the fastest, most efficient way to tap into a wealth of business programs—at last count, over 250 compatible applications. It's also the mouse that outperforms all others. The new Microsoft Mouse points more accurately, works faster, takes up less desk space, and doesn't even require a pad.

LIST: $150 OURS: $99

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VEDIT PLUS

New VEDIT PLUS 3.0 is the ideal programmer's editor with stunning performance, speed and versatility. New features include 1000 level undo, columnar blocks, true regular expressions, an easy to use pull-down menu system and context sensitive help. You also get multiple file editing (any file size), windows, unlimited keystroke macros, total configurability and the most powerful macro programming language available. The new automatic compiler support is highly flexible and comes ready to use for Microsoft, Borland and many other compilers and assemblers.

LIST: $185 OURS: $115

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■ 64Kbytes from hard disk to emulation memory in 5 seconds. That's moving. But today you've got to be fast just to stay in the race for better microprocessor designs.

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■ The 8620 with O-bus gives you complete program diagnosis — and solutions — in real time. For more than 150 different microprocessors. Using **the same command set** environment.

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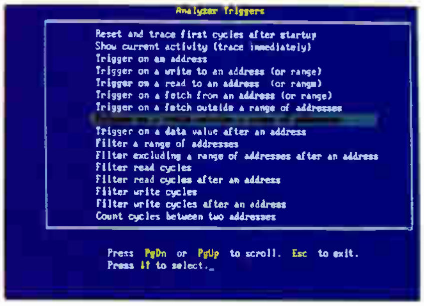

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■ On top of that, you get UniLab's trademark ability to debug by symptom, not just by breakpoint and single step. And, to help you complete the job on time, on the spot, a stimulus generator and EPROM programmer are included.

■ Ease of use, another Orion trademark, is also built in. So you have all the familiar features and formats you're used to working with. It doesn't matter if your project is a single chip controller or complex 16-bit microprocessor, the 8620 is the top price/performance analyzer-emulator that does it all. At just $4380. With processor Personality Paks typically $550 each.

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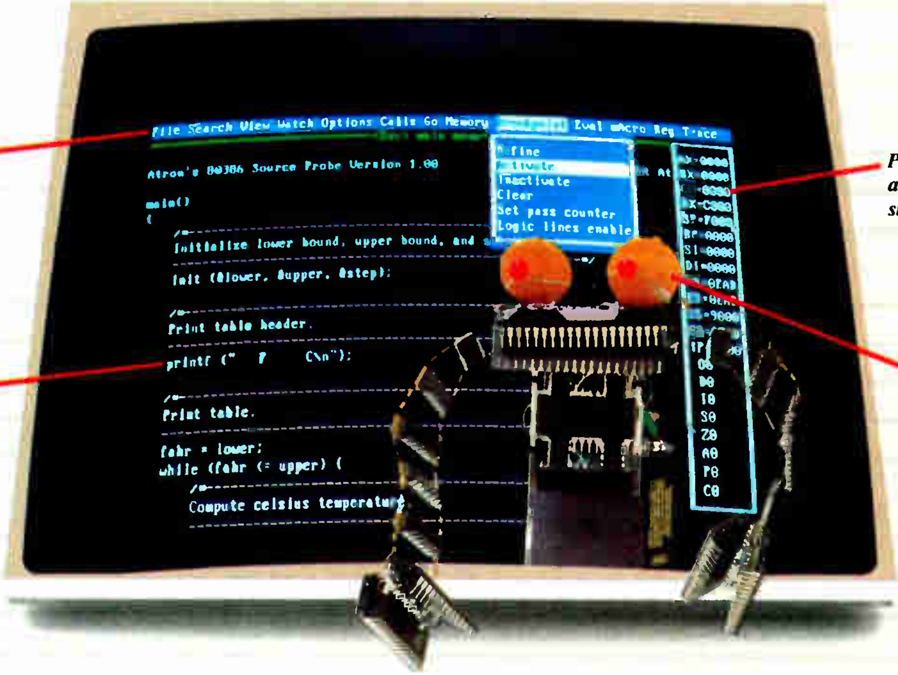
PRODUCTS IN PERSPECTIVE

IT'S TIME TO DO SOME SERIOUS 386 BUGBUSTING!



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.

Now, with the 386 PROBE, you have the capability to set a *qualified breakpoint*, so the breakpoint triggers only if the events are coming from the wrong procedures. So you don't have to be halted by breakpoints from legitimate areas. You can even detect obscure, sequence-dependent problems by stopping a breakpoint only after a specific chain of events has occurred in a specific order.

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.

COULD A GOOD NIGHT'S SLEEP PUT YOU IN THE TOP TEN?

Look at it this way. Nine of the top-ten software products in any given category were created by Atron customers. Maybe their *edge* is — a good night's sleep.

Call and get your free, 56-page bugbusting bible today. And if you're in the middle of a nightmare right now, give us a purchase order number. We'll FEDEX you a sweet dream.

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Circle 26 on Reader Service Card

3Com's Answer to a LAN Workstation

The 3Station/2E, built around an Ethernet local-area network, is 3Com Corp.'s latest answer to an intelligent personal computer for the business masses.

Unlike the 3Station that it replaces, the 3Station/2E provides for graphics- and computation-intensive applications such as desktop publishing and spreadsheets. It also has a faster clock rate. The 256K-byte video display buffer supports the higher-resolution VGA (800 by 600 pixels) that is used in Microsoft Windows, AutoCAD, Ventura Publisher, and GEM Desktop Publisher.

Specifically, the 3Station/2E motherboard combines a 10-MHz 80286 microprocessor with a VGA graphics driver, 1 to 5 megabytes of RAM, an Ethernet connection, and a socket for an optional math coprocessor. What this workstation doesn't have is a disk drive—mass storage can sometimes best be managed by the network file server, 3Com says.

With 3Com's Maxess SNA Gateway software/card combination, PCS/TCP, and PCS/XNS software, the 3Station/2E provides for communication with Systems Network Architecture, Transmission Control Protocol/Internet Protocol, and asynchronous host connectivity, respectively.

You can connect some peripherals with either of the two RS-232C asynchronous serial ports (9- and 25-pin), and you can connect a printer through the Centronics-compatible parallel port.

Each 3Station/2E can function as a DOS workstation or as an OS/2 workstation. The network operating system software can be 3Com's 3+ or 3+Open LAN manager or Novell's NetWare, version 2.1.

Price: $2495, without a monitor.

Contact: 3Com Corp., 3165 Kifer Rd., Santa Clara, CA 95052, (408) 562-6400.

Inquiry 1101.

Laptops Follow Function

The Toshiba T5200 laptop, an 80386-based 20-MHz machine with 2 megabytes of RAM and a VGA slot, is now the company's most powerful portable.

The gas-plasma display has built-in VGA capabilities, and there's a VGA port for adding a bigger monitor. It has 16-gray-scale functionality, with a resolution of 640 by 480 pixels. Standard equipment also includes a 40-megabyte hard disk drive and a 1.44-megabyte 3½-inch floppy disk drive that's PS/2-compatible.

The keyboard is a 91-key AT compatible with separate cursor-control keys and a numeric keypad. In all, the portable weighs almost 19 pounds and is about 4 inches thick—a tad heavy and probably too big for your average briefcase.

Each system comes with a full-length 16-bit expansion slot and a half-length 8-bit expansion slot.

Options include an internal 2-megabyte memory module that's compatible with the Lotus/Intel/Microsoft Expanded Memory Specification, a 2400-bit-per-second internal Hayes-compatible modem, and a carrying case.

Price: $9499 with 40-megabyte hard disk drive; $10,999 with 100-megabyte hard disk drive.

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

Inquiry 1100.

Hewlett-Packard's 80386

The Hewlett-Packard Vectra QS/16 is a 32-bit, 80386-based desktop box that's basically a smaller version of the Vectra RS/16 floor-standing unit.

The QS/16 can run MS-DOS, OS/2, or Santa Cruz Operations' Xenix. But HP Vectra DOS and Microsoft Windows/386 are included. The basic machine comes with 1 megabyte of memory (with space for 16 megabytes on the motherboard), a 1.2-megabyte 5¼-inch floppy drive, and seven expansion slots.

Also standard is a hard disk controller, an RS-232C port, and a Centronics parallel port. There's an 80387 numeric coprocessor socket and an HP Human Interface Loop Port that simultaneously supports up to seven input devices, such as a touchscreen, a mouse, and a graphics tablet.

A 40-megabyte hard disk drive with disk caching is available as an option, as is a 14-inch color or monochrome display and a 3½-inch floppy drive. An AT-style 101-key keyboard is also standard.

Price: $3995; $5095 with a 40-megabyte hard disk drive.

Contact: Hewlett-Packard Co., Inquiries, 19310 Pruneridge Ave., Cupertino, CA 95014, or call HP as listed in your local white pages.

Inquiry 1102.

SEND US YOUR NEW PRODUCT RELEASE

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

The Portable with a Desktop Punch

Sporting a 20-MHz 80286 microprocessor and weighing much less than its desktop cousins is the LCD-286 portable from Scantech Computer Systems.

It comes standard with 1 megabyte of zero-wait-state RAM, a 20-megabyte hard disk drive, and a 1.2-megabyte 5¼-inch floppy disk drive. The LCD screen is 80 columns by 25 rows. Inside the machine are three full-length and two half-length slots.

Support for CGA and EGA graphics is also available.

Price: $3495; $3995 for CGA version; $5495 for EGA version.

Contact: Scantech Computer Systems, Inc., 12981 Ramona Blvd., Unit I&H, Irwindale, CA 91706, (818) 960-2999.

Inquiry 1103.

continued

PERIPHERALS

Tapes Store Gigabytes at File Servers

Because networks are generally using central-file-server technology, where the main memory backup systems need to be located at the file servers, MIS managers are interested in gigabyte-capacity tape storage.

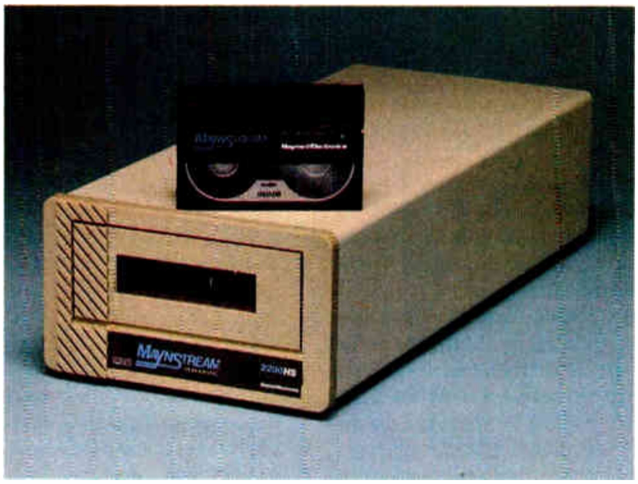
The portable MaynStream 2200HS allows for backup of more than 2 gigabytes of data on a removable and rewritable 8-millimeter cassette tape. Data transfer is rated at 250K bytes per second, and Maynard's standard multitasking software is included.

About the size of a hard disk drive, the 2200HS is based on helical-scan technology. This involves magnetically writing on the tape in thin diagonal stripes, reducing the size necessary for the Maxell cassette tapes. Each cassette tape is slightly larger than a standard audiocassette tape.

Features include read-after-write error checking and automatic rewrite, an error-correction code that corrects up to 264 bytes in each data block, and a head-to-tape speed of 150 inches per second.

The software has two main features to help you maintain up-to-date files. You can save backup specifications in a script file to automate routine backup sessions. You can also make the routine backups automatically using a background program called Autoback.

The Archive feature saves hard disk space by making it easier for you to transfer inactive hard disk files onto a backup cassette. The basic XT- and AT-compatible package includes software, drive, controller cards, cables, and a cassette. PS/2 is offered as an option.



Gigabytes for your file server.

Price: $6995; $7095 for PS/2 models.
Contact: Maynard Electronics, 460 East Semoran Blvd., Casselberry, FL 32707, (407) 331-6402.
Inquiry 1104.

Portable Printer with Desktop Capabilities

The ExpressWriter 311 is a compact, 11-pound, 24-pin letter-quality printer that prints 180 characters per second in draft mode and features a maximum resolution of 360 by 360 dots per inch.

It includes a 16K-byte buffer with an additional 32K bytes available through an optional RAM card that can be used as a buffer or for downloadable fonts. Three resident emulations include Toshiba/Qume, IBM ProPrinter, and Epson LQ Series.

Resident fonts include high-speed draft, Courier, Prestige, Elite, condensed, and proportional. Paper can be as wide as 10 inches.

Price: $589.
Contact: Toshiba America, Inc., Information Systems Division, 9740 Irvine Blvd., Irvine, CA 92718, (714) 583-3000.
Inquiry 1105.

Scanner Handles 4388 Pixels per Inch

Nikon has a full-color film scanner for graphics art and desktop publishing. It's the Nikon LS-3500 film scanner, and it reads both color and monochrome 35mm film positives and negatives directly.

Existing film scanners use a 300-pixel-per-inch reading resolution. The LS-3500 will read at a resolution of 6144 by 4096 pixels, or 4388 pixels per inch. It can be connected to computers through RS-232C and GPIB interfaces, with half-length cards sold by many companies besides Nikon.

Operation of the 11- by 15- by 6-inch, 13-pound scanner involves placing the 35mm slide in the film holder; the scanning sequence starts immediately. A CCD element strip, consisting of 4096 elements in a vertical bar, reads image data in lines as the film passes in front of the CCD chip. The film passes three times in front of the CCD element—once each for blue, green, and red—with 6144 vertical increments scanned for each color.

The image data is automatically, continuously transferred to the computer for processing. At the GPIB rate of 750K bytes per second, a 4096-byte vertical strip is transferred every 5 milliseconds to the host computer bus. The 6144 vertical readings take 15 seconds each, with three vertical readings per slide, totaling 45 seconds per slide.

Once the image is stored in your PC, XT, AT, or Mac II, you can combine the image data with word processing data for printing, or you can store the image on a hard disk, for example.

Price: $9995 without GPIB card (which is priced about $450 from other vendors).
Contact: Nikon, Inc., Electronic Imaging Division, 623 Stewart Ave., Garden City, NY 11530, (516) 222-0200.
Inquiry 1106.

Ventek Upgrades VGA

Two pages side by side or one page with a display resolution of 1280 by 1024 pixels are two of the features of Ventek's AT-compatible AT 2000 desktop publishing/CAD system.

The system consists of a board with built-in VGA and a 20-inch monitor. Each board includes proprietary hardware for updating a standard 640- by 480-pixel screen at twice the rate, Ventek claims.

In its high-resolution mode, drivers are supplied for Microsoft Windows, AutoCAD, Ventura Publisher, GEM, Lotus 1-2-3, and WordPerfect. With the MS-Windows driver, you can use Aldus PageMaker.

Price: $2695.
Contact: Ventek Corp., 31336 Via Colinas, Suite 102, Westlake Village, CA 91362, (818) 991-3868.
Inquiry 1107.

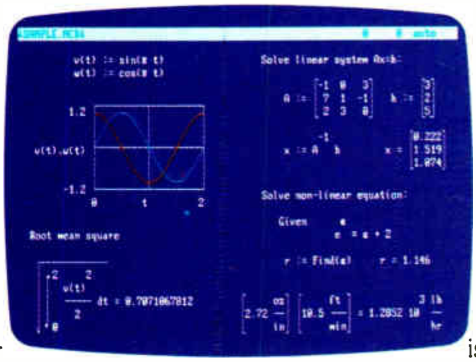
continued

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 two new applications packs to increase your productivity?

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

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

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

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

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 174 on Reader Service Card

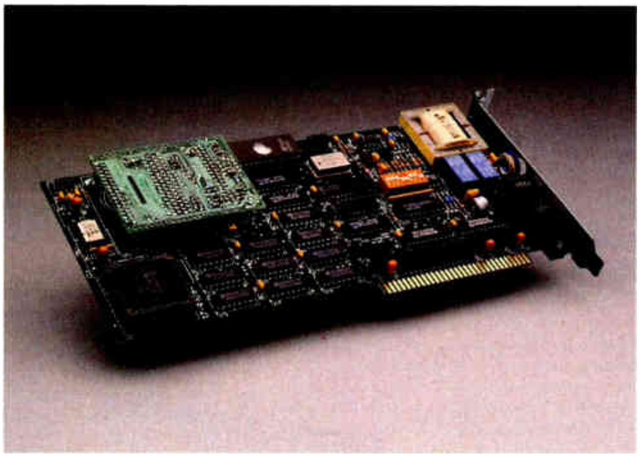
Faxes Almost Send Themselves

An on-board 80188 microprocessor lets the 9600-bit-per-second, ¾-length JT Fax 9600 PC board transmit to the 3 million Group III facsimile and PC faxes in the world, according to the manufacturer.

Group III (denoting the best facsimile standard using analog telecommunications transmission) limits the data rate to 9600 bits per second. Group IV facsimiles can travel at up to 64K bits per second. But Group IV requires *digital* telecommunications transmission—something telephone companies are working furiously toward but that isn't currently available on more than 10 percent of all telecommunications lines.

The JT Fax 9600 PC is designed with a proprietary "convert-and-send capability," Quadram claims, which automatically strips out printer-command sequences and subsequently converts the file to ASCII and to fax format as it's transmitting. For one page, it takes about 30 seconds.

Software is memory resident, using 190K bytes of RAM. Should you need that RAM for a memory-intensive application, for example, you can remove the software from active memory with an Exit command at the DOS prompt. Another helpful feature permits transmission of faxes using the software Print command so a fax can be sent from the screen from a stored file, or created from previously received faxes or scanner input. Received faxes can be displayed on-screen, stored on disk, or output to a dot-matrix or laser printer.



Quadram adds luxury 9600 fax board.

Other features include a graphics/text merge, a high-resolution mode, and a compressed print mode to reduce spreadsheets to 8½-by-11 size.
Price: $795.
Contact: Quadram, One Quad Way, Norcross, GA, 30093, (404) 564-5566.
Inquiry 1109.

Double Your Disk Capacity

The DiskDoubler is a half-length card that doubles storage capacity on all your disk drives—floppy drives, hard drives, and RAM drives.

It uses a proprietary data-compression technology and is compatible with the IBM PC, XT, AT, and compatibles that operate under DOS 2.0 or higher. The DOS shell, a TSR (terminate-and-stay-resident) program called DD.COM, acts to compress and uncompress the files as they are handled by DOS.

The interface to the disk is interactive and does not require that the entire file be uncompressed for use—it automatically compresses and uncompresses only those being addressed.

System files with the extensions .EXE, .COM, .SYS, .BAT, and .BIN aren't automatically compressed or uncompressed because DOS can't recognize them in a compressed state. But you must manually compress these files for them to work with the add-in.

The DiskDoubler works best with English text, though there are algorithms for data in the form of spreadsheets and dBASE files. Compression ratios vary, so some disk capacities could be more than doubled.
Price: $189.
Contact: Datran Corp., 2505 Foothill Blvd., La Crescenta, CA 91214, (800) 332-0456; in California, (818) 248-8780.
Inquiry 1111.

A "Foxy" Development System

The SC/FOX parallel coprocessor and the Harris RTX 2000 real-time processor come bundled with a software development system that includes a Forth optimizing compiler, editor, and run utility operating from MS-DOS.

SC/FOX denotes the manufacturer, Silicon Composers, and the idea of the parallel coprocessor, Forth-Optimized Express. All you add is code, and you can perform multiple applications, including real-time control, image and signal processing, data acquisition and compression, and computation-intensive applications.

All nonmemory access instructions execute in one clock cycle. Memory access instructions execute in two cycles. Up to five high-level Forth instructions can be combined and executed in parallel in a single clock cycle.
Price: $1995.
Contact: Silicon Composers, Inc., 210 California Ave., Suite K, Palo Alto, CA 94306, (415) 322-8763.
Inquiry 1110.

Fiber Optic Integration

Proteon has introduced integrated token-ring cards for its ProNet 10, which the company claims was the first commercially available token-ring network in 1981.

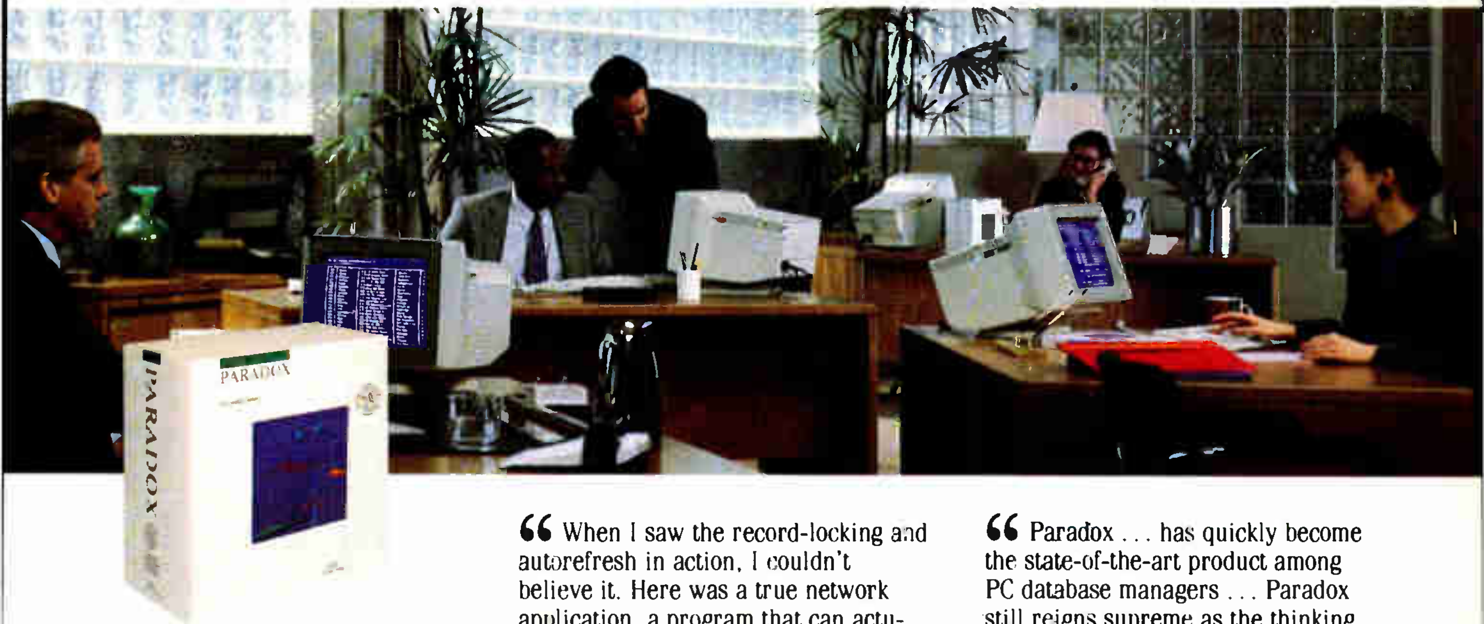
These new cards, model number p1307, have the optical fiber connection with an SMA 905 connector directly on the card rather than on a separate box, which the cards plug into with shielded twisted-pair cabling.

Proteon's shielded twisted pair (unlike the unshielded twisted-pair cabling installed by telephone companies) allows transmission distances of up to 160 meters.

Each p1307 plugs into the expansion slot of an IBM PC, XT, AT, or compatible.
Price: $1200.
Contact: Proteon, Inc., Two Technology Dr., Westborough, MA 01581, (617) 898-2800.
Inquiry 1112.

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.

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Circle 43 on Reader Service Card (DEALERS: 44)

Grabbing Frames Compatibly

The Variable-Scan 100-AT, an AT-compatible image processor, works with more nonstandard video sensors than any other board, claims the manufacturer. Of course, it also works with all the standard video sensors as well.

The board, from Imaging Technology, supports image acquisition of up to 1024 by 1024 pixels on RS-170 and CCIR cameras, as well as on CCD sensors that don't conform to fixed industry standards such as linescan, fast-frame-rate area scan, X-ray, and high-resolution cameras—which are used for many specialized applications.

The VS 100-AT includes a trigger that allows the board to be synchronized with external events, which helps in capturing images when a part of a conveyor belt passes under a camera for inspection.

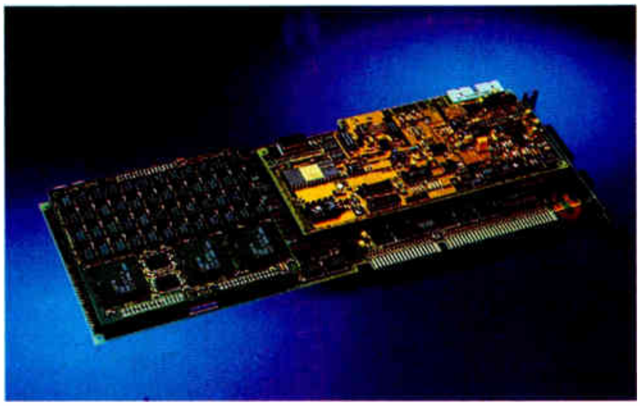
A 768- by 512-pixel image-capture mode provides for square pixel acquisition and display when working with CCIR cameras. A programmable gain and level is used to correct fluctuations in lighting and to interface with nonstandard video signals with output levels. A digital input port eliminates the interim digitation step if the video sensor outputs digital data directly.

Software support comes from a library that includes about 150 high-level image-processing and control functions. Included are functions that improve the signal-to-noise ratio of the captured image and find edges.

Price: $4495; $995 for ITEX 100 software.

Contact: Imaging Technology, Inc., 600 West Cummings Park, Woburn, MA 01801, (617) 938-8444.

Inquiry 1113.



VS 100-AT grabs nonstandard images.

Workstation-Quality Graphics

The Artist Designer 16 MC is a 16-bit Micro Channel card for 1664- by 1200-pixel resolution for monochrome applications.

Designed by Control Systems, it supports the Direct Graphics Interface Standard developed by Graphic Software Systems through on-board firmware.

DGIS drivers support VersaCAD, AutoCAD, PageMaker, Ventura Publisher, Lotus 1-2-3, CADvance, P-CAD, and others.

The Artist Designer 16 MC controller incorporates the Texas Instruments 34010 microprocessor, which uses display-list processing techniques for 5-MIPS RISC performance. This relieves the host CPU from complex processing tasks associated with graphics algorithms and software emulation, for example. It is especially useful in custom graphics programming, the manufacturer claims.

Operation can be either 1 bit or 2 bits per pixel, software-selectable. The display window of 4096 by 2048 pixels or 2048 by 2048 pixels is displayable memory. In the 2-bit-per-pixel operating mode, four shades of gray can be displayed, with a resolution of about 150 dots per inch on a page-size monitor.

Price: $3995.

Contact: Control Systems, Inc., 2675 Patton Rd., St. Paul, MN 55113, (612) 631-7800.

Inquiry 1114.

Kit Transforms Your PC into a CAD System

CADPak includes everything you need to transform your PC into a CAD system, says developer GTCO Corp.

There's a CADcontroller graphics controller, an asynchronous communications adapter, a micro Digi-Pad digitizer, 1 megabyte of extended memory, and software.

The controller offers 1024- by 768-pixel or 800- by 600-pixel resolution, interlaced or noninterlaced color graphics, and a Hitachi Advanced CRT Controller.

The Micro Digi-Pad digitizer works in a 12- by 12-inch active area and includes a 4-button cursor with Binary Stylus with two barrel switches. The software disk drivers are included for AutoCAD Release 9, VersaCAD, Generic CADD, and others.

Price: $999; $1489 with 1 megabyte of RAM.

Contact: GTCO Corp., 7125 Riverwood Dr., Columbia, MD 21046, (301) 381-6688.

Inquiry 1115.

Scan Converters Enhance Graphics

The RGB/Videolink converts microcomputer video graphics to NTSC video (television) for videotaping, video projection, and video transmission. RGB previously offered scan converters designed only for workstations made by such companies as Sun and Apollo.

The Mac II-, PC- and PS/2-compatible scan converters offer 24-bit color and real-time performance as long as you have an EGA or a VGA frame buffer.

An optional RGB/Videolink Plus includes a built-in video mixer that allows you to overlay computer graphics over live video—in windows or in the background, for example.

The main feature of both RGB dedicated image processors is a proprietary filter that eliminates the flicker problem, RGB claims.

That flicker problem generally accompanies interlaced video transmission. The filter makes possible a composite television image similar to the original computer image in stability.

The RGB/Videolink accepts full-screen, noninterlaced RGB input and provides genlock, sync generation, and encoding to output the NTSC video. Complete scan conversion is accomplished in real time. The RGB/Videolink requires no software modifications, and it doesn't affect performance of the host or its RGB monitor.

Price: $9900; $11,400 for the RGB/Videolink Plus.

Contact: RGB Technology, 2550 Ninth St., Suite 114, Berkeley, CA 94710, (415) 284-4330.

Inquiry 1116.

continued

~~Five~~ Six easy ways to boost your BASIC

PROBAS™ (updated)
Professional Basic Programming Library

Announcing PROBAS Version 3.0, now with over 335 assembly routines to really kick QuickBASIC and BASCOM into high gear. BYTE magazine calls PROBAS a "Super-charger for QuickBASIC". Thousands of programmers rely on PROBAS to make their life easier and to enhance their programs with features like:

- **An 800-page 3-part manual**
- **Full-featured windowing**
- **Screen snapshots (Text & Graphics)**
- **String, array, and pointer sorts**
- **Lightning-fast file I/O**
- **Full mouse support**

Create dazzling screens in text mode, CGA, EGA, VGA or Hercules graphic modes. Save and restore screen snapshots to arrays, EMS memory or files. Full featured windowing to meet the most demanding jobs. The PROBAS system of virtual screens allows you to draw full or partial screens to memory, and then snap them on in an eyeblink. You can even create vitural screens far larger than the display screen.

Sick of running out of string space? Store hundreds of K in numeric arrays or megabytes in extended or expanded memory. Tired of using a kludgy SHELL to DIR to read a directory or archive files? Scan subdirectories or .ARC files using wild-cards and store thousands of file names, dates, and times. Wish you could drag a window containing text or a menu around the screen with a mouse? It's easy!

PROBAS gives you a complete set of blazingly-fast file routines. Read or write huge chunks of data at a clip, with file locking and error handling so that you can even use them in subprograms. You'll never want to use BASIC's file I/O again! Sort data with lightning fast array and pointer sorts. Search files or arrays at assembly speeds. PROBAS also has over 200 other essential services including handy string, date, time, directory and array manipulation, string, screen and data compression, full mouse support, valuable equipment and input routines and faster replacements for most BASIC commands.

Whether you are a professional or a novice, PROBAS will boost your BASIC in ways you never dreamt possible. PROBAS allows professionals to save time and work and lets novices write professional-quality programs quickly and easily. After all, how much is a few hundred hours of your time really worth?

For all versions of QuickBASIC and BASCOM including BASCOM 6.0 for OS/2. ***Just $135.00!***

PROREF™
On-Line Help For PROBAS

PROREF provides pop-up help for the routines in PROBAS and is an extension of the QuickBASIC programming environment. Find help on any routine with a few keystrokes or mouse clicks. Pop-up an ASCII chart, calculator, scan code module, box diagram, your own help information or almost any DOS program via a hot-key. ***Just $50.00!***

PROSCREEN™
Professional Screen Management System

PROSCREEN is a full-featured screen generator/editor that will save you more design and coding time than you ever thought possible. PROSCREEN treats screens like a word processor treats text to provide complete control over characters, colors, and placement. Design input screens with up to 130 fields and 19 pre-defined and 2 user-defined masks. Use PROBAS or the included BASIC/Assembler subroutines to access the screens. No kludgy code generators here! Comes with subroutine source, extensive on-line help, and a 285 page manual. ***Just $99.00!***

PROMATH™ (new!)

PROMATH is a collection of over 150 high-level routines that provide mathematical functions and operations for programmers who often work in mathematics, science, or engineering. Complex variables, real and complex matrices, real and complex trigonometric and hyperbolic functions and their inverses, solution of linear equations, integration, differential equations, Fast Fourier transforms and many other useful routines are provided.

For years Fortran has been the language of choice for scientific and engineering applications, but it lacks many of the useful features of QuickBASIC. PROMATH contains most of the Fortran mathematical and numeric functions and allows you to easily translate Fortran code to BASIC or write new programs in BASIC while retaining Fortran's numerical prowess.

The PROMATH manual is over 200 pages and provides a complete description of each routine, including any algorithm and the mathematical formula the routine uses, shown in standard notation. For QuickBASIC 4 and BASCOM 6 only. ***Just $99.00!***

PROBAS™ TOOLKIT

The TOOLKIT is a collection of assembly and BASIC modules that use the PROBAS library to save you even more hours of grunt work. Why spend hundreds of hours re-inventing the wheel when you can just plug in TOOLKIT modules like:

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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 115,200 baud. You get:

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- **Auto Dialer & data base**
- **Documented BASIC source**

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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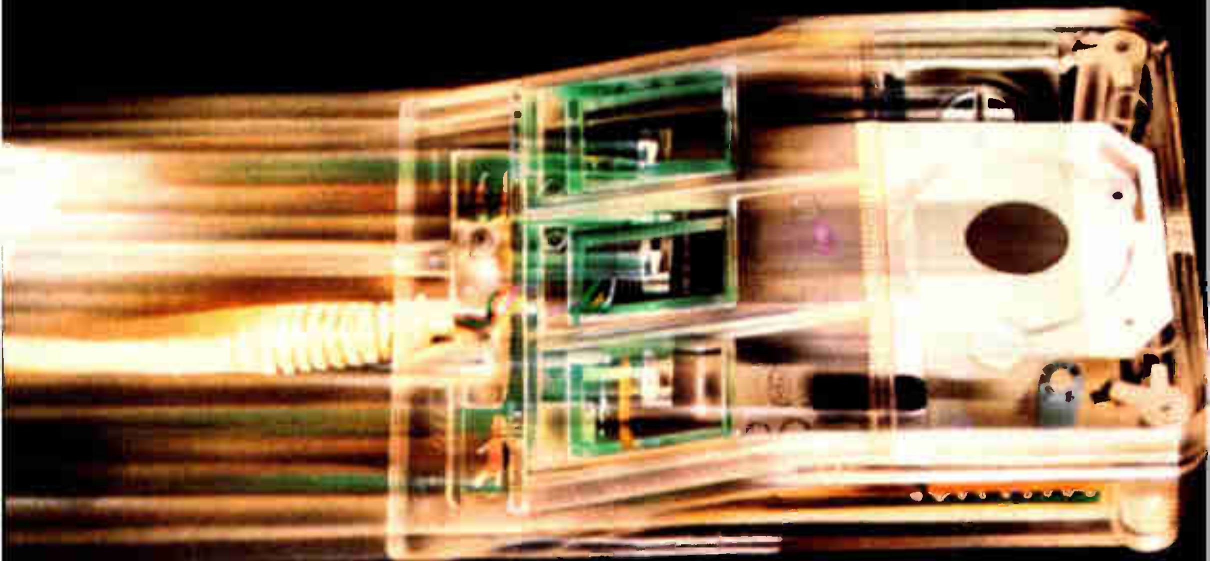

like PaintShow™ which, it so happens, comes with your ClearCase Mouse.

You get everything for $149. The package includes: the Logitech ClearCase Mouse for IBM PC, XT, or AT and PS/2 or 100% compatibles; a 9-25 pin adapter; Plus Package™ software; and Logitech PaintShow™ (which requires a graphics card).

*Pick up the ClearCase Mouse at your computer dealer, or call: **800-231-7717.** (In California call **800-552-8885.**)*

LOGITECH

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Infrared Gateway Links Ethernets

Sometimes there's a river between your two Ethernet local-area networks, and sometimes there's a city street 30 floors down. Both times it's just not cost-effective to run a coaxial or fiber link.

But Laser Communications' latest product solves that problem. The LCI Lace Model L00-18 is a 10-megabit-per-second, optical transmission system that will link two Ethernet networks (at distances of up to 1 kilometer) as long as there's a clear line of sight.

It uses a gallium arsenide semiconductor laser diode as a light source and a silicon avalanche photodetector to receive the light signal. There's no need to lay cable, no need to obtain any rights-of-way, no licensing requirement, and no need for encryption for secure transmissions.

Like optical-fiber cabling, the system is immune to electromagnetic interferences (i.e., the cable doesn't radiate and disturb other electrical equipment).

Some critics have said that LCI's previously available products, which have transmitted at the telecommunications data rate of 1.544 megabits per second or lower, haven't worked in rain, snow, or even fog. But company representatives vehemently reject this claim.

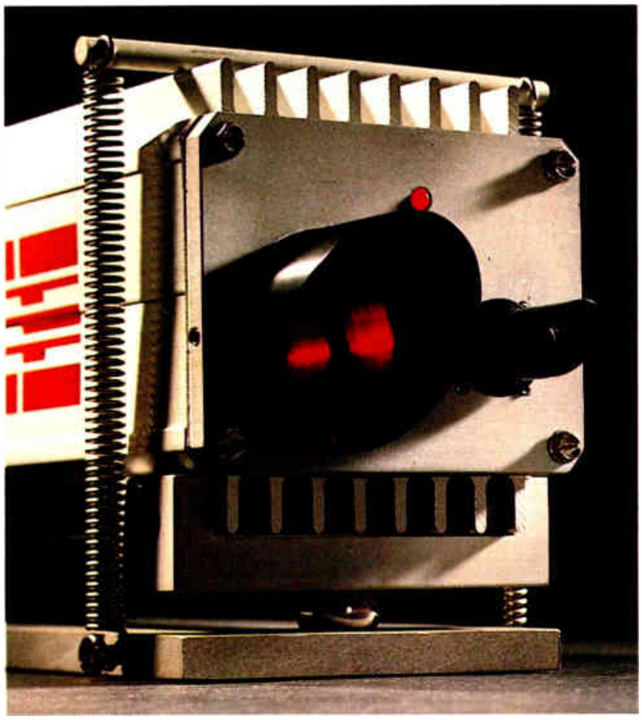
The company claims that LCI Lace is "not dependent on visual sighting ability between sites in poor weather." The company also says that the low level of power output of the lasers makes them "virtually harmless."

Each Lace uses horizontal and vertical positioning elements and visual and audio signals for aiming adjustment. Requirements are standard coaxial cabling with 15-pin D-connectors on each end. AC power requirements are 115 volts. Each 4- by 6- by 20-inch unit weighs 10 pounds.

Price: $14,190.

Contact: Laser Communications, Inc., 1848 Charter Lane, Suite F, Lancaster, PA 17601, (800) 527-3740; in Pennsylvania, (717) 394-8634.

Inquiry 1117.



Infrared beams fly between Ethernets.

Low-Level Network Uses AC Lines Instead of Cabling

Carrier Current Technologies designed the Carrier Net, the CarrierNet Plus, and software for low-level networking through your power lines. It's mainly designed for peripheral sharing, where file transfer is most important.

The system transfers data through your network at 38.4K bits per second to the RS-232C port on your computer or to the RS-232C port on the stand-alone CarrierNet Plus.

Like similar recently introduced products, the network device plugs into the nearest wall outlet. The only limitation is that networked computers and peripherals must be on the same side of a power transformer, which usually means intrabuilding communication is no problem.

CarrierNet acts as a peripheral designed for the IBM PC, XT, AT, and compatibles. CarrierNet Plus is designed to function separately, with its ability to store print commands with either 6K bytes or 1 megabyte of RAM.

Up to 16 devices can be connected with both hardware and software on this Carrier Current network, the company says.

Price: $199 to $219 for CarrierNet; $395 for CarrierNet Plus; $89 for software.

Contact: Carrier Current Technologies, Inc., 1804 West Southern Pkwy., Bldg. A-112, Durham, NC 27707, (919) 490-4970.

Inquiry 1120.

Ethernet Concentrator Features Network Management

David Systems has introduced electronics for your Ethernet LAN that work with the unshielded twisted-pair wiring the telephone company has been installing in buildings and homes for years.

The advantage of David Systems' ExpressNet network concentrator over recently introduced twisted-pair electronics products, the company says, is its provision for network management through RS-232C ports. An Intel 8031 microprocessor is designed into each ExpressNet specifically for this function.

Each ExpressNet is designed for a group of 12 users; additional ExpressNets can be purchased for adding more users up to the limit of 1024 users.

The workstations can be organized in a star network configuration using existing building wiring, with Ethernet cards in the PCs connected to the wiring with twisted-pair interface devices called TP-MAUs.

Network management can include diagnostics of packet count, collision count, and identification of links with traffic and collisions. In addition, 17 LEDs on ExpressNet and 4 LEDs on the TP-MAUs give you a visual identification of the status without a network management terminal.

Price: $2495 per hub; $149 for each TP-MAU.

Contact: David Systems, Inc., 701 East Evelyn Ave., Sunnyvale, CA 94086, (408) 720-8000.

Inquiry 1119.

continued

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According to PC Week, Professional ORACLE is "the most versatile database management system available on the PC." It includes the ORACLE SQL database engine, utilities and Oracle's 4th-generation application development tools. Professional ORACLE is network-ready, and is the same ORACLE that runs on minis and mainframes. Use it as your standard PC workgroup database, and to provide connectivity to corporate data.

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A Window on Processor Activity

Secant Corp. has a device for observing processor activity on any IBM PC, XT, or AT compatible.

The PCM displays all 20 address lines of the PC, XT, or compatible system bus or the most significant 20 address lines of the AT bus. Also displayed are the eight data bus lines and the I/O read and write control signals.

Sixteen of the LEDs on the panel can be turned on or off under program control, and the settings of sixteen toggle switches can likewise be read under program control.

Because the memory bus address lines are displayed in a row of 20 LEDs, the current address of the executing program is always visible as a pattern of lights of varying intensity; thus, it can provide a good indication of program activity. That is, it gives an indication of whether the program is performing I/O, waiting on I/O, has died in the loop, or is executing normally.

Data acquisition and process control applications can use the 16 LED's for annunciating events appropriate to their applications.

The product includes source code to Hilite, a performance monitoring program. When the Hilite program is running as the lowest-priority task under any multiprocessing operating system, it uses the LED register as a horizontal bar graph that indicates the instantaneous percentage of processor cycles being used and the percentage of processor capacity still available.

Price: $349; $295 without switch registers.

Contact: Secant Corp., P.O. Box 7000-733, Redondo Beach, CA 90277, (213) 378-7779.

Inquiry 1125.

Beta version of Secant's CPU window.

Videoconferencing Reaches the PC

Affordable full-motion videoconferencing between personal computers is now available from Concept Communications. You simply add a full-length IBM PC XT- or AT-compatible video processor board and an optional full-length audio processor board to your PC, hook up video cameras, and you're set to go.

From one of the long distance carriers or your local telephone company (depending on what two points you need conferencing), you can purchase a "Switched 56" kilobit-per-second digital line. Or you can go through one of the satellite-transmission services and purchase digital transmission at up to 384K bps—much better quality if your subjects need to be seen moving around, for example. But 56K is sufficient for board meetings, company officials are quick to add.

Image 30 is full-motion in the same way television today is full-motion—with a refresh rate of 30 frames per second. Silicon on the video board compresses the video in 10 milliseconds, while silicon on the audio board digitizes sound and mixes it into the video datastream. Or you can purchase the video board and use a speaker phone connected through standard telephone company analog telephone lines.

Each board features four ports—one NTSC input, one NTSC output, one RGB input, and one RGB output. In each of these ports, you can support peripherals such as video cassette recorders and video printers.

Price: $12,000 for video card; $2000 for audio card.

Contact: Concept Communications, Inc., Infomart, 1950 Stemmons Freeway, Suite 4038, Dallas, TX 75207, (214) 746-3888.

Inquiry 1122.

continued

Document Reader Could Lower Cost of Optical Scanning

Calera Recognition Systems is offering a system that the company says significantly lowers the cost of scanning printed text and graphics into a computer and using that material in an application program.

The TrueScan document recognition system consists of an IBM PC-compatible add-on board and software that works with most low-cost ($1000 or less) optical scanners. Calera says it is capable of reading most fonts and maintaining formats.

TrueScan processes whatever document you have loaded into the scanner and allows you to convert it to a host of word processing, spreadsheet, or graphics file formats (including TIFF, PC Paintbrush, PCX, and CCITT Group IV for fax images). TrueScan can recognize boldface, italics, underlines, and other text attributes and convert these to the host word processor's formatting codes.

You feed the document into the scanner and choose the appropriate word processing, spreadsheet, or graphics file format. TrueScan saves the scanned document as a file on disk that you can then load into your software package. While processing speed varies depending on the complexity of the document, a typical page of text takes about 45 seconds to convert.

Using proprietary document-recognition algorithms, TrueScan can recognize virtually any printed font from typewritten to typeset, the company says. The algorithms "go beyond the limitations of matrix matching and feature extraction. They work on a statistical basis of certainty to identify individual characters, as well as other page attributes," says the company.

The basic system has 2 megabytes of RAM and scans documents at a speed of about 70 characters per second. A premium system with 4 megabytes of RAM is rated at a speed of 100 cps.

Price: $2495 with 2 megabytes of RAM; $3495 with 4 megabytes.

Contact: Calera Recognition Systems, Inc., 2500 Augustine Dr., Santa Clara, CA 95054, (408) 986-8006.

Inquiry 1121.

6 ways Genoa takes the gamble out of data backup.

It isn't the hardware or the software, it's the data that's the most valuable part of your personal computer. The hundreds of hours spent creating and editing data, plus its inherent value to your operation, make it priceless.

Protect that expensive data with a dependable backup system. Only Genoa's Galaxy family of tape backup systems offers 6 high-performance advantages in data protection.

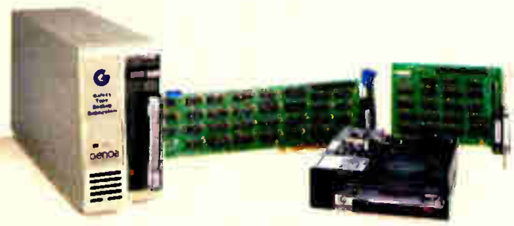
1. On-Line

Galaxy software provides on-line network support. Galaxy and Galaxy/MC tape backup systems come with Genoa's Novell Advanced Netware 86 or 286 compatible software driver, a $200.00 value, *free!*

The SlimBox cassette is a space efficient way to provide tape backup for IBM PC/XT/ATs.

2. Fast

At 5MB a minute, Galaxy systems are among the fastest tape backups around. You can back up the whole data file in just a few minutes.



Pictured are our internal and external cartridge backups for IBM PC/XT/ATs.

3. Easy

Simple command menus make Galaxy systems so easy to operate, most users can start backing up data within minutes.

4. Automatic

Never again will you worry about forgetting to back up data. Galaxy's autoscheduler feature lets you preset an exact date and time, then it *automatically* does the backup for you.

The Galaxy Micro Channel family makes it possible to exchange data between IBM PC/XT/ATs and PS/2 models 50, 60 and 80.

5. Reliable

Galaxy boasts one of the lowest return rates in the industry. Plus a full year warranty.

6. IBM Compatible

Galaxy works with all IBM PCs and compatibles, including the new Micro Channel. For the PC/XT/AT, there are external and internal models. Both are available in cassette and cartridge versions. We also offer a SlimBox model for the PC/XT/AT. It's an efficiently sized external cassette system.

For the Galaxy dealer nearest you, contact Genoa, 75 E. Trimble Rd., San Jose, CA 95131. Fax: (408) 434-0997. Telex: 172319. Phone: (408) 432-9090. Or fill out the coupon below, we'll send you more information. You've got nothing to lose—except the most valuable part of your personal computer.

Genoa
SYSTEMS CORPORATION

I want to protect my investment in data!

Please send me more information on Galaxy tape backup subsystems.

Name ________
Title ________
Company ________
Address ________
City ________ State ____ Zip ____
Phone (____) ________ Ext. ____

Please check all that apply: ☐ PC ☐ XT ☐ AT
☐ PS/2, Model 50 ☐ PS/2, Model 60 ☐ PS/2, Model 80

Mail to: Geri Scheer, Genoa Systems Corporation, 75 E. Trimble Rd., San Jose, CA 95131

Circle 115 on Reader Service Card

Clarion's low-end package includes eight applications.

A Clarion Call for Nonprogrammers

Yet another easy-to-use custom application generator comes from Clarion Software, best known for its Clarion database package. You might think of the Clarion Personal Developer (CPD) as the smaller (and less expensive) sibling of the company's still-available Clarion Professional Developer.

According to the company, you don't need any coding experience or special technical knowledge to create eye-popping programs with sophisticated features. You can routinely include features such as point-and-shoot menus, scrolling data tables, pop-up data-entry forms, lookups, computed fields, and hot-key procedures. And Clarion doesn't require you to purchase a license if you want to copy and distribute your custom applications to others.

The CPD comes with eight ready-to-run applications that you can use as-is or modify. Once you think you've gone beyond the CPD's capabilities, you can use Clarion's Professional Developer package to enhance CPD-developed programs. The professional package lets you add complex application code, C or assembly language, local-area-network support, and advanced file management such as transaction processing and file encryption.

To use the CPD, you'll need an IBM PC, XT, AT, PS/2, or compatible with 512K bytes of RAM (640K bytes is recommended), a floppy disk drive, and a hard disk drive. The CPD runs on MS-DOS 2.1 or higher.

Price: $169.

Contact: Clarion Software Corp., 150 East Sample Rd., Pompano Beach, FL 33064, (305) 785-4555.

Inquiry 1128.

Layout Makes the CASE

Matrix Software calls its newest software contribution Matrix Layout, describing it as a CASE (computer-aided software engineering) tool for users of the IBM PC, XT, PS/2s, and compatibles.

Using Layout to create a custom application involves several steps, the first of which is creating an on-screen graphic flowchart. You then interactively design programming objects, such as files, graphics, and variables. After you're done, Layout does its thing by creating the program in your choice of Turbo Pascal, Microsoft C, Turbo C, Lattice C, or QuickBASIC. You can also have Layout create an executable (.EXE) file.

Layout also comes with Matrix Paint (a paint package), Matrix Helpmaker (a hypertext-based help program), and Matrix Desktop, a DOS utility that works with files and disks.

Price: $149.95.

Contact: Matrix Software Technology Corp., One Massachusetts Technology Center, Harborside Dr., Boston, MA 02128, (800) 533-5644; in Massachusetts, (617) 567-0037.

Inquiry 1126.

Cause and Effect

In an industry filled with acronyms, Cause surprisingly isn't one. But it is the name of a software package that Maxem calls a visual and intuitive programming environment. With Cause, you use a mouse, graphics, icons, windows, and color to create your own custom applications for either the PC or the Macintosh.

With Cause, you don't need to learn a programming language and the associated syntax. In fact, the company claims you can create an entire application without having to touch the keyboard except to type in labels for windows and data. A B-tree/ISAM database is the underlying engine that Cause uses. Cause programming basically involves creating a series of windows.

Price: Consumer version, $495; author version, $595.

Contact: Maxem Corp., 1550 East University Dr., Mesa, AZ 85203, (602) 827-8181.

Inquiry 1127.

Evertrak Tracks Your Programs

If you're a professional programmer who makes your living off the software you develop and sell, the thorny problem of keeping track of the number of copies out in the field and avoiding "sharing" is one that can keep you awake nights. How do you control distribution without using copy protection? Evertrak from Az-Tech Software can help.

As its name implies, Evertrak can keep track of your software. Among its features are its ability to thwart reverse-engineering by keeping your program from being disassembled or run under a debug system. It also lets you place a secure alphanumeric serial-number string in your program. The company claims this 60-character string is totally secure from hackers.

Evertrak can also build an expiration date into your program that will limit the amount of time it can be used. It can also restrict the type of media your program will operate on.

You don't need to make any changes in your source code to use Evertrak. The company says it will work with any program that runs under MS-DOS 2.0 or higher on the IBM PC, XT, AT, PS/2s, or compatibles. It also comes with a 30-day money-back guarantee.

Price: $295.

Contact: Az-Tech Software, Inc., 305 East Franklin, Richmond, MO 64085, (800) 227-0644; in Missouri, (816) 776-2700.

Inquiry 1129.

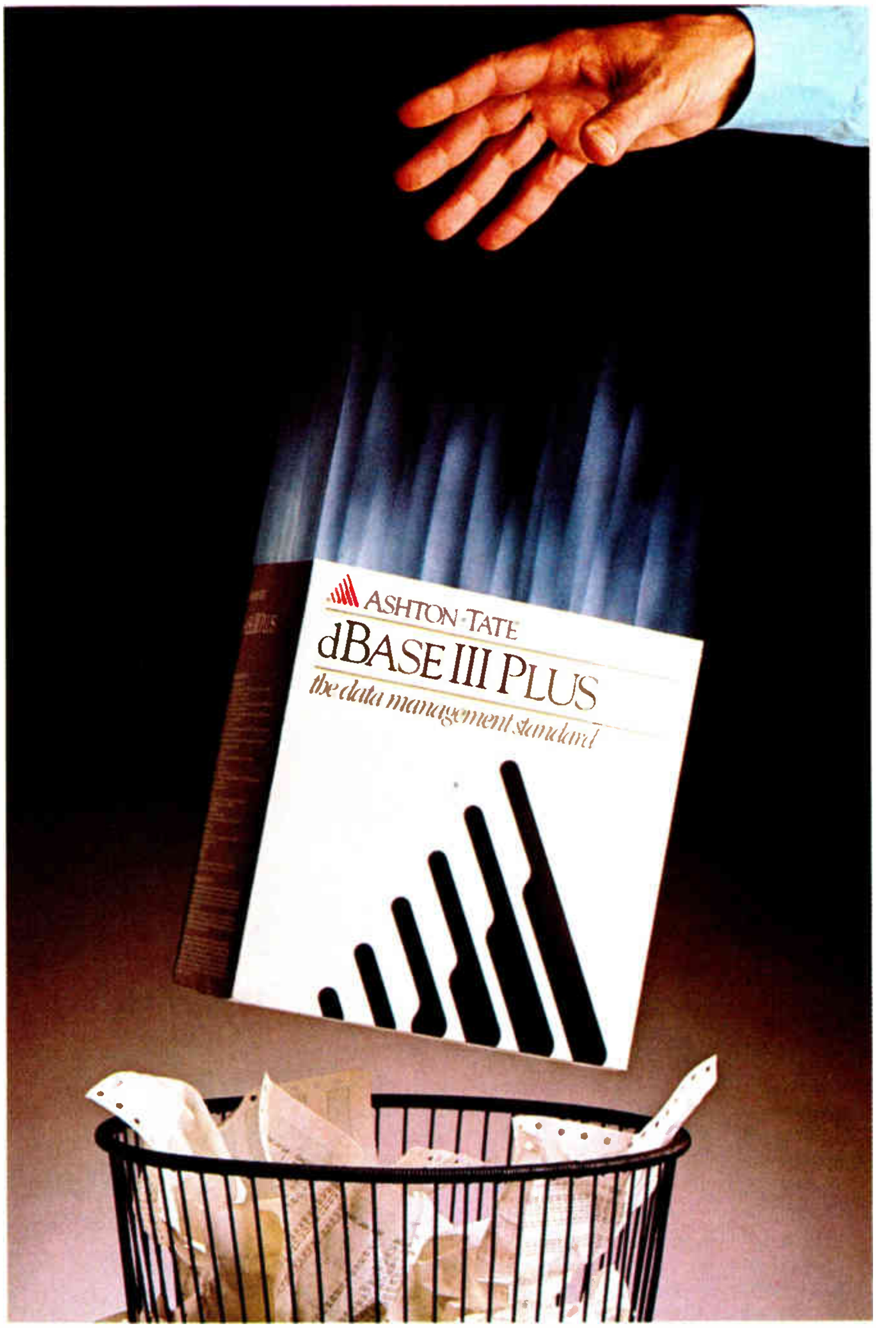
continued

EVERYBODY

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

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

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



Why are they switching to R:BASE?

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

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

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

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

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

Data is data, but information is power.

R:BASE gives you that power.

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

IS DOING IT.

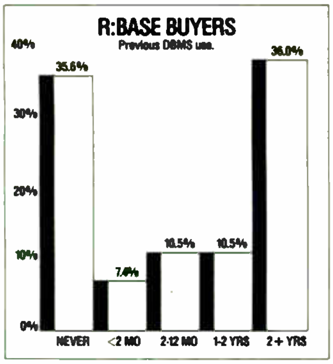
R:BASE their highest marks.

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

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

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

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



And R:BASE is relational, so your rules stay with the tables—applications can't avoid or change them. And forms can be set up to cascade changes through related tables. So you can trust the information you get.

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

PC MAGAZINE

Software Digest

datapro

INFO WORLD

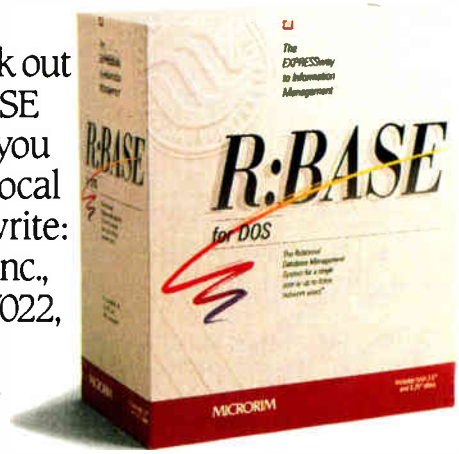
And networking is free for up to three users. It's also easy, so any single-user application can be run on a multi-user LAN with a single command. And our advanced concurrency control, unlike earlier-generation auto-refresh in other DBMSs, won't bring your network to its knees when you expand with our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

Applications that just won't quit.

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

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

DO IT.



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

Call 1-800-624-0810 today.

Complete Chromatography Control

Axxion says you can install its Model 747-993 Chromatography Data System Kit in any IBM PC, XT, AT, PS/2, or compatible in less than 10 minutes. Besides the software, the kit includes a custom A/D board and gives you full operational control of up to three HPLC, GC, SFC, or CZE systems.

Using auto-integration software or peak integration parameters, the package lets you store up to 150 user-definable manual or batch methods in memory. While you're conducting new analyses, you can edit or recalibrate the prior completed runs that the software stores on disk.

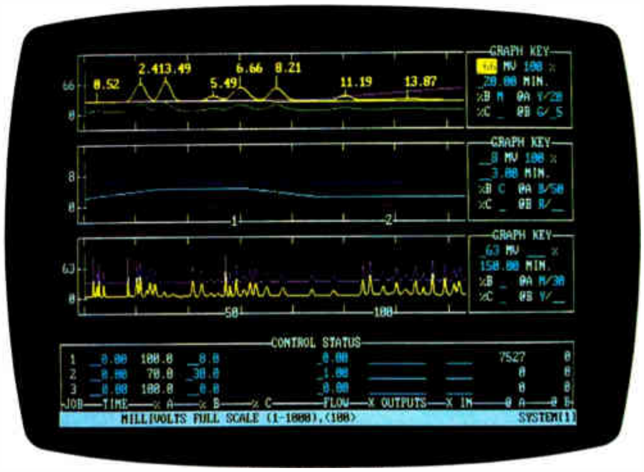
You access the Chromatography Data System Kit with a hot key. With an EGA card and monitor, the system can display high-resolution real-time chromatographic data from up to six detectors.

Axxion also offers an optional pump interface board that gives you HPLC gradient control for up to six pumps in binary or ternary configurations.

Price: $9600.

Contact: Axxion Chromatography, 23966 Craftsman Rd., Calabasas, CA 91302, (818) 346-1800.

Inquiry 1134.



The Chromatography Data System displays data in real time.

Take an Active Role in Filter Design

The newest release of Active Filter Design software from RLM Research can now perform sensitivity and worst-case analysis of the filter circuits that you've designed. AFD lets you design Butterworth, elliptic, Chebyshev, and Bessel low-pass, high-pass, band-pass, band-stop, and all-pass active filters. It also lets you directly enter pole and zero locations, or transfer functions. The package can convert low-pass prototype poles and zeros to your filter configuration.

AFD is menu driven, and RLM says it's designed to be easy to use no matter what your experience level. The program supports manual or automatic pole/zero pairing as well as uneven gain distributions. You'll also find active implementations of type MFB, VCVS, biquad, state variable, and Reticon or National MF-10 switched capacitor filters.

Once you've entered your data, you can output filter descriptions, pole/zero locations, transfer functions, and component locations, as well as amplitude, phase, and group delay frequency response of the entire filter or of individual sections. There's also a graphics facility that lets you analyze impulse and step response.

Price: $725.

Contact: RLM Research, P.O. Box 3630, Boulder, CO 80307, (303) 499-7566.

Inquiry 1131.

MathEdit Makes Your Equations Visible

The limited number of characters available in most word processors can put a severe cramp into your style if you need to put complex math equations into a document. But help is on the way from K-Talk Communications, whose MathEdit package lets you construct even the most complex math equations for insertion into your documents.

MathEdit can output equations in two formats: WordPerfect 5.0 for printing with an Apple LaserWriter, or TEX for typesetting use. Its makers say MathEdit has a particularly user-friendly interface that walks you through the process.

The program has a display window that lets you view the equations as you create them. An EGA- or Hercules-compatible card is recommended for optimal on-screen viewing.

MathEdit runs on the IBM PC, XT, AT, PS/2s, and compatibles and requires 256K bytes of RAM and MS-DOS 2.1 or higher.

Price: $149.

Contact: K-Talk Communications, 50 McMillen Ave., Suite 100, Columbus, OH 43201, (614) 294-3535.

Inquiry 1133.

continued

Making Order Out of Chaos

Nonlinear systems and chaos are hot topics today, and if you're a mathematician, scientist, or amateur who's interested in learning more, Dynamical Software is your ticket to the nonlinear world. It comes in two flavors, with Dynamical Software I.4 getting things started. It includes an Adams Type Integrator with noise addition, two-dimensional and three-dimensional plotting, next amplitude, time-one and circle maps, and time-series embedding.

Dynamical Software II.2 takes you a step further: It includes a Runge-Kutta integrator, a delay-differential equation integrator, phase portraits, bifurcation diagrams, spectral analysis, and fractal dimensions.

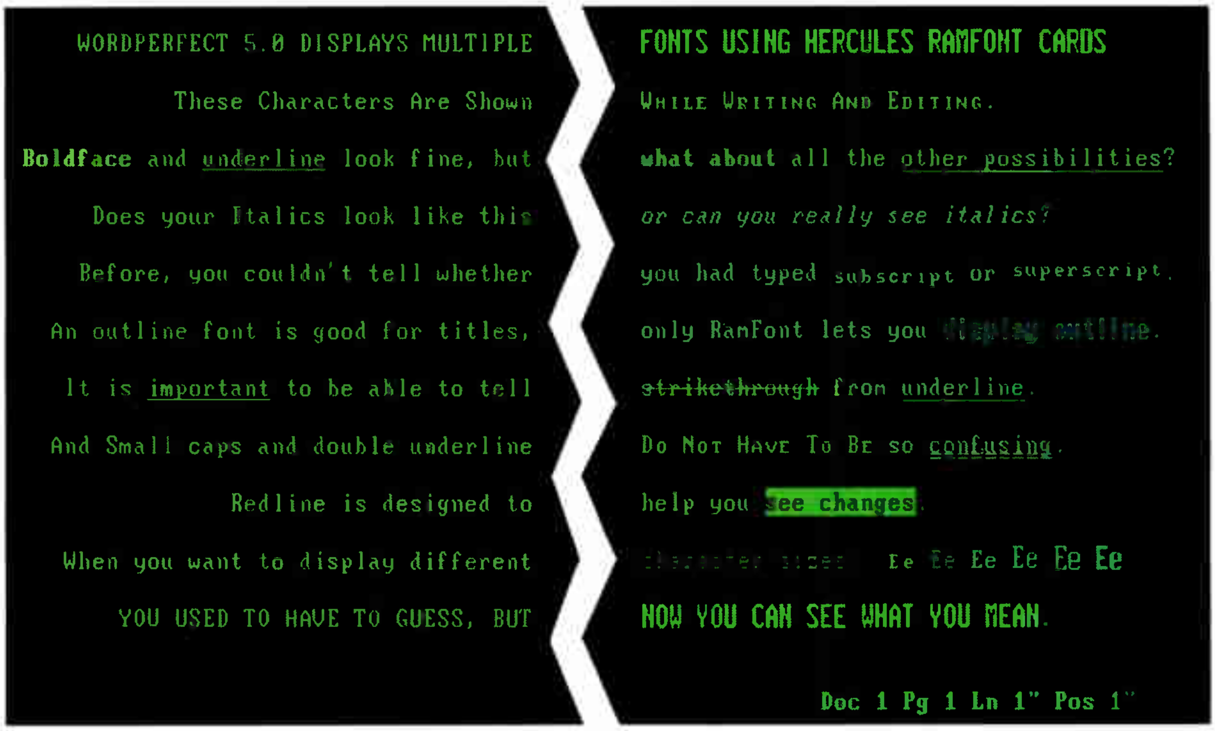
Both versions use a common file format, so the output of one can serve as the input for another. There are also standard shell scripts for automatic compilation and linking of external subroutines. To enter the world of chaos you'll need an IBM PC, XT, AT, PS/2, or compatible with 640K bytes of RAM and a graphics card. A hard disk drive, mouse, and math coprocessor are recommended, but not required. If you'll be linking user-defined subroutines, you'll also need the Microsoft FORTRAN compiler.

Price: I.4, $250; II.2, $350; both packages, $550; manuals, $25; demo disk, $10.

Contact: Dynamical Systems, Inc., P.O. Box 35241, Tucson, AZ 85740, (602) 825-1331.

Inquiry 1132.

WordPerfect 5.0 Users...Choose Sides



Without Hercules RamFont **With Hercules RamFont**

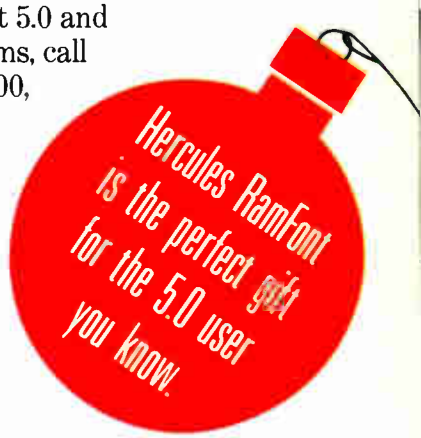
Only Hercules video cards with RamFont allow WordPerfect 5.0 users to display multiple type styles and attributes while writing and editing. No other video cards offer these advanced capabilities. Add Hercules graphics for WordPerfect's new page preview and you've got the best display anywhere for WordPerfect 5.0.

Hercules RamFont and graphics are available only on the Hercules family of video cards: The Hercules Graphics Card Plus, monochrome video with a parallel port. The Hercules Network Card Plus, monochrome video with a TOPS "FlashCard" compatible network port. And the Hercules InColor Card, featuring the Hercules graphics and RamFont modes in 16 colors.

Improve your system where you'll see it the most—on-screen. Hercules, the inexpensive upgrade.

For more information about how Hercules improves WordPerfect 5.0 and other favorite programs, call toll-free 1-800-532-0600, ext. 921 (U.S.) or 1-800-323-0601, ext. 922 (Canada).

Circle 127 on Reader Service Card (DEALERS: 128)



Hercules.

The RamFont Advantage.

Xerox Upgrades Ventura

Xerox is shipping what it's calling a "new generation" of Ventura Publisher. Version 2.0 has more than 70 new features that offer increased functionality and greater ease of use. The company is also offering a Professional Extension package and a Network Server package.

Documents you've developed on version 1.1 are upward-compatible to version 2.0. Among the new features are more than 250 context-sensitive help screens in dialog boxes, a combination of pull-down or pop-up menus, and increased mouse functionality.

There's also increased image support and color controls, new pagination and page makeup tools, typography features such as discretionary hyphenation, more font control, and increased printer support.

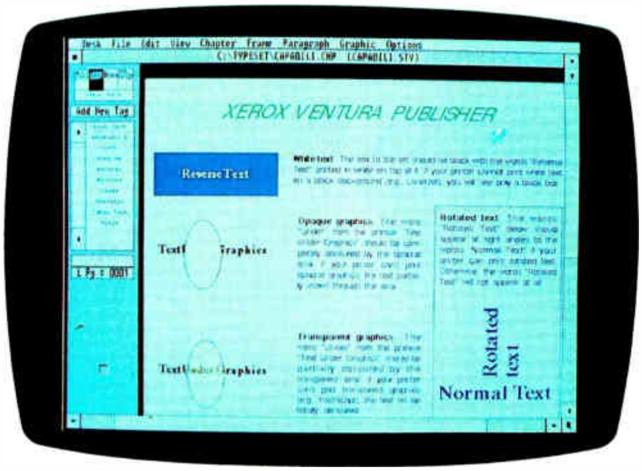
Ventura Publisher's Professional Extension package is designed to help you if you're creating more sophisticated documents such as contracts, manuals, and technical documentation.

The package has expanded memory support for long documents and densely packed pages such as directories and catalogs.

Professional Extension provides complete WYSIWYG generation of equations. It also has a cross-reference feature that lets you mark locations for later insertion of chapter and page numbers, as well as figures and tables.

If you generate documents in an installation where there are multiple contributors, the Network Server supports 3Com, Novell, and PC Lan local-area networks. And with the Network Server, you can configure Ventura Publisher to accommodate individual requirements and preferences such as screen fonts and printer drivers.

Price: $895; upgrade from 1.0 or 1.1, $100; Professional Extension, $595; Network Server with Ventura Publisher, $1295.
Contact: Xerox Corp., P.O. Box 24, Rochester, NY 14692, (800) 832-6979, ext. 121E.
Inquiry 1161.



Ventura Publisher 2.0 has over 70 new features.

Point and Shoot 1-2-3

Chances are that just about anything you'd like to do with a 1-2-3 macro can be found in 101 Macros Plus for Lotus 1-2-3, the latest incarnation of Individual Software's macro series for popular application packages.

The new package offers you a complete new organization, an instant macro locator, a cherry-picking facility for gathering selected macros into a separate file, and a new point-and-shoot method of accessing macros through a pop-up list of macro "short names."

Among the more than 30 new macros added to the collection are routines that allow you to calculate the median of a column of numbers, create organizational charts, print out check amounts in words, and calculate loans.

Price: $69.95.
Contact: Individual Software, Inc., 125 Shoreway Rd., Suite 3000, San Carlos, CA 94070, (800) 331-3313; in California, (415) 595-8855.
Inquiry 1147.

Word Does Windows

The developers and major proponents of Windows have finally released a word processing package that's specifically tuned for Windows' graphic interface. It's called Microsoft Word for Windows (WfW), and it offers all the features of Word's non-Windows sibling, plus lots more.

WfW takes advantage of Windows' advanced graphics by giving you a full WYSIWYG view of your document along with full editing features.

To use WfW, you'll need an IBM AT, PS/2, or compatible, Windows 2.0 or higher, and MS-DOS 3.0 or higher.

Price: $495; network node package, $250; upgrade from any version of Word, $125.
Contact: Microsoft Corp., 16011 Northeast 36th St., P.O. Box 97017, Redmond, WA 98073, (800) 426-9400; in Washington, (206) 882-8080.
Inquiry 1149.

Editing Gets Groupware

Editing and reviewing documents, be they proposals, reports, or manuscripts, is a process that usually requires the input of a group of people. According to Mainstay, that makes it notoriously painstaking and time-consuming. So the company has entered the fast-growing "groupware" market with MarkUp for the Macintosh.

If you're one of the many folks who need to comment on a document, you can use MarkUp to mark, highlight, expand, and annotate reports, spreadsheets, drawings, art, scanned photos, or other types of documents.

MarkUp is based on the metaphor of marking a transparent overlay on the original document. The program's print driver produces an image of the original document that you load into a multiuser database. Each group member gets a set of tools for working with the document, including a text tool, a note tool for pop-up notes, a highlighter, and tools for lines, arrows, and rectangles, as well as a lasso.

The program can support a physical workgroup on a network like AppleShare, as well as a logical workgroup where the members are dispersed and trade their files via disks or telecommunications.

Price: 2-user pack, $495; 5-user pack, $995; supplemental user packs, $195 each.
Contact: Mainstay, 5311-B Derry Ave., Agoura Hills, CA 91301, (818) 991-6540.
Inquiry 1146.

continued

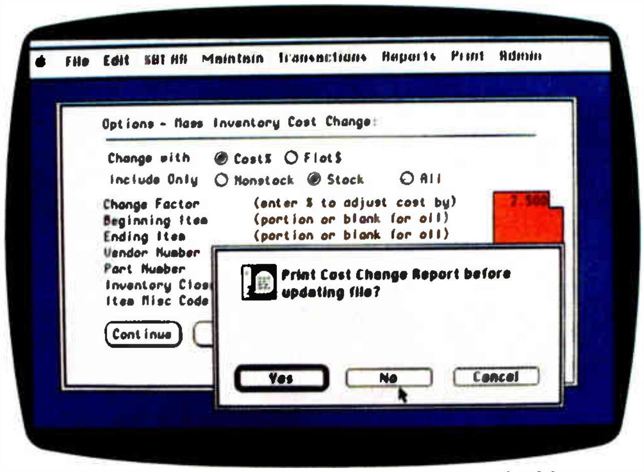
SBT Goes to the Macs

Small Business Technology Corp., best known for its wide range of accounting software for MS-DOS and Unix, has entered the territory of the Macintosh with the first of its Series Six Plus/Mac products. SBT has started the ball rolling with general ledger, inventory/accounts receivable, and accounts payable packages.

The company claims the products, created with FoxBASE+/Mac, take full advantage of the Mac's menu and window control, typeface-selection, and screen management capabilities. Because the packages are built on a relational database structure, you get quick access to key information and can easily modify data or look at areas that share common data.

The modules, whose names are dLedger, dInvoice/dStatements, and dPayables, support up to 99 companies, with up to 999 departments per company. Besides being backed by a 5-year warranty, there's multilevel password protection and a variety of report formats.

Series Six Plus/Mac requires a Macintosh Plus, SE, or II with at least a megabyte of RAM and a 20-megabyte hard disk drive. Versions are also available for MultiNet, as well as versions in FoxBASE+/Mac source code. The company says it will ship eight more modules by the end of 1989.
Price: Single-user compiled version, $295 per module; single-user source code version, $395 per module; MultiNet source code version, $595 per module.
Contact: Small Business Technology Corp., One Harbor Dr., Sausalito, CA 94965, (415) 331-9900.
Inquiry 1145.



Series Six Plus accounting software now runs on the Mac.

A Pair for Forms Design

One of the latest trends in business software is the proliferation of forms software, designed for automating the common and repetitive (not to mention boring) job of filling in those ubiquitous paper forms. Case in point: Deerfield Systems' DisplayForm II is a data-entry tool that includes word processing, spreadsheet, and database management features, all focused on the job of forms processing.

With DisplayForm II, you can start with a form that you've entered into the program via an optical scanner or from any program (such as PC Paintbrush) that's capable of producing .PCX files. Once you've imported your form, it's displayed on-screen as a WYSIWYG image, automatically adjusted for the resolution of the monitor you're using. From there, you can place any information anywhere on the form by simply moving the cursor.

The program can also merge data from dBASE II files, letting you generate multiple forms using database information. When everything's to your satisfaction, you can either print the data on preprinted forms or print both the form and text on any dot-matrix or laser printer.

To use DisplayForm II, you'll need an IBM PC, XT, AT, PS/2, or compatible, MS-DOS 2.0 or higher, 512K bytes of RAM, a hard disk drive, and a graphics display. If you don't have an optical scanner, the company will also scan your forms to disk.
Price: $495.
Contact: Deerfield Systems, Inc., 221 Elizabeth St., Utica, NY 13501, (315) 797-1805.
Inquiry 1143.

And while we're on the subject, Per:FORM from Delrina Technology is another package for handling lots of data and lots of paper. Using the GEM graphical interface, the package includes both a forms-design module and a form-fill module, both of which function independently.

Although you can scan your preexisting forms into Per:FORM, you can also use its forms-design module to create your own custom forms. This module's features include boxes with multiple lines, rounded-corner boxes, automatic line spacing, vertical and horizontal text in different sizes and fonts, and exact placement of objects on-screen.

The package prints either the entire form or text only. It will also print to disk. This enables you to delay printing or to send the completed forms via modem to a remote site for later printing.

The package runs on the IBM PC, XT, AT, PS/2s, and compatibles. A graphics card is also a necessity.
Price: $259.95.
Contact: Delrina Technology, Inc., 10 Brentcliffe Rd., Suite 210, Toronto, Ontario, Canada M4G 3Y2, (416) 423-0456; in the U.S., (800) 268-6082; in New York, (716) 835-0405.
Inquiry 1144.

continued

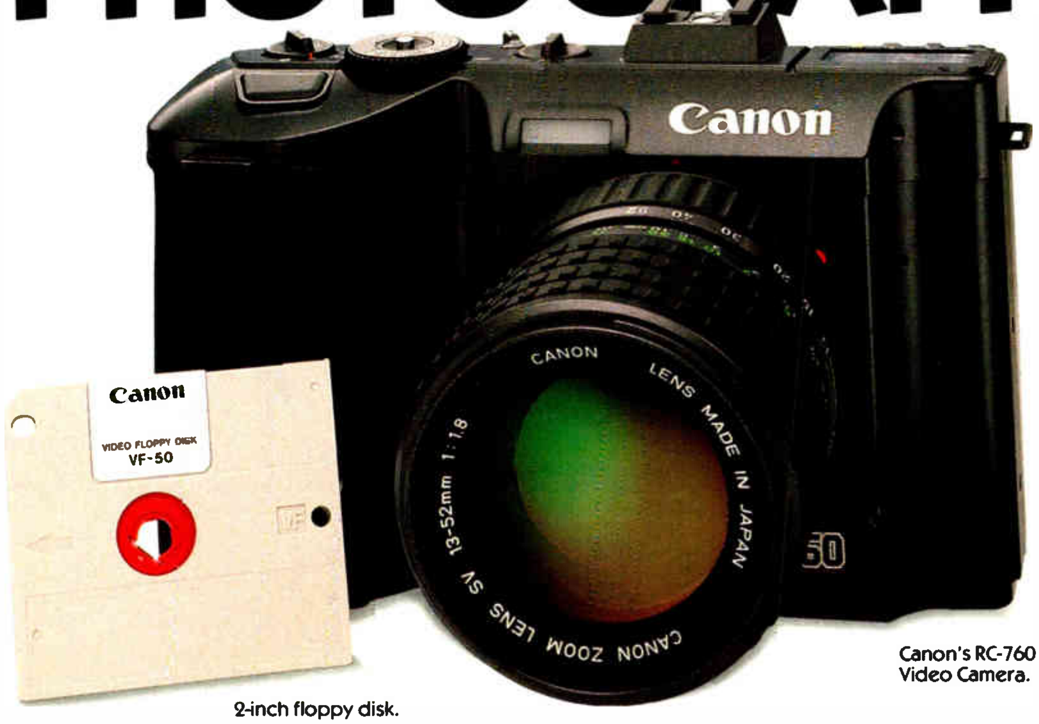
Phone Messages Get Computerized

Those pink "while you were out" telephone message slips are the bane of many a businessperson's existence. They're forever being misplaced. So why not computerize them?

That's exactly what Enhanced Systems has done. Its Pinksheet is a memory-resident program that can be run on individual PCs or on a local-area network.

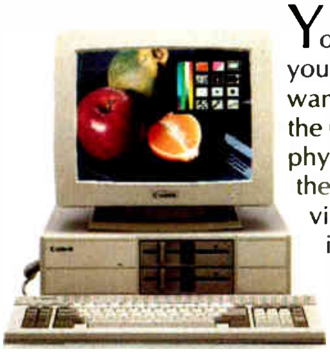
Pinksheet gives the message-taker a simple notepad-like screen, as well as a directory screen that shows extension status and messaging statistics. You can output messages to a printer, as well as use archive and retrieve functions. The program also has a reports module that organizes messages into detailed phone logs and follow-up reports.
Price: $185.
Contact: Enhanced Systems, Inc., 6961 Peachtree Industrial Blvd., Norcross, GA 30092, (404) 662-1503.
Inquiry 1148.

COMPUTER READY PHOTOGRAPHY.



2-inch floppy disk.

Canon's RC-760 Still Video Camera.



Computer graphics come of age.

Canon's RR-450 Still Video Recorder/Player.

You're looking at something your computer has always wanted: a camera. It's part of the Canon Still Video photography system. And it means that the days of struggling with a video camera to load inferior images into your computer are over. For good.

For very good, in fact, because no video camera delivers both the convenience and high resolution of the Canon Still Video system.

Take a good look. The Canon Still Video camera looks and feels just like a regular camera. You use it exactly the same way you use a regular camera. But there's no film. Instead, up to 50 images are recorded on a 2-inch floppy disk. With a Canon Still Video Recorder/Player, these images can be loaded into any computer that has a video interface board compatible with NTSC or RGB signals. Then the fun begins.

Now you're ready to use the entire array of computer graphic capabilities at your computer's disposal. For desktop publishing. Presentation graphics. Creating your own image storage library. You name it. Play with the image any way you like. You can store the original and the changed image in the Recorder/Player.

What kind of image quality are we talking about? How about 600,000 CCD pixel resolution. More than any other still video image system. Hard copy? Canon makes a full color printer that connects directly to the system. It delivers a remarkable 160 pixels per inch, with a 64-step gradation.

The Canon FP-510 Printer.

If you're ready to hear more, the best thing to do is call Canon now. Our experts can tell you all you need to know. Just call: 1-800-221-3333, ext. 313.

The Canon Still Video System; it's what you, and your computer, have been waiting for.

CRT images are simulated.

Enjoy easy extended payments with the Canon Credit Card. Ask for details at participating Canon dealers and retailers. Available only in U.S.

Canon

Canon U.S.A. Inc., One Canon Plaza, Lake Success, NY 11042 © 1988 Canon U.S.A. Inc.

Circle 53 on Reader Service Card

Sprint® software free with T1200F purchase.

The Small Have Been Made Powerful.

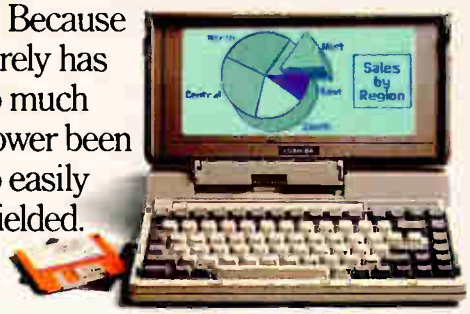
Behold the new Toshiba T1200F.

It's easily small enough to fit in the average briefcase, yet it's packed with a full megabyte of RAM, two 720KB 3½″ diskette drives, and a variety of ports.

It comes in either reflective or backlit LCD models. A full-size keyboard. And for a limited time, it also comes with our exclusive version of Sprint,® Borland's powerful word processing software. Absolutely free. And because it weighs only 9.8 pounds, it's one of the lightest IBM-compatible dual diskette PCs on earth. It even has removable, rechargable batteries, so you can work with it just about anywhere you want.

Those who've used the T1200F have hailed it as a small miracle.

Because rarely has so much power been so easily wielded.



And The Mighty Brought Down To Size.

Where is it written that hard disk has to mean hard to carry?

Witness the Toshiba T1200HB.

It only takes up about one square foot of desk and weighs less than eleven pounds, but it's packed with all the features of our T1200F and comes with a single diskette drive and 20 megabyte hard disk.*

Which means it's big enough to store just about all the applications you'll ever use. All the time.

And, like the T1200F, it has the convenience of Resume mode, which remembers your place even after the unit is turned off.

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In Touch with Tomorrow

TOSHIBA

Toshiba America Inc. Information Systems Division

Circle 289 on Reader Service Card (DEALERS: 290)

Software Saves the Network

Backing up data from multiple users on a network has always been a problem for the system administrator. The basic problem boils down to keeping track of what data belongs to whom. But Emerald Systems says it has a solution in EmSave, the first backup software designed specifically for performing and managing the backup chore on a network.

EmSave works with all cassette and cartridge backup systems, though it's optimized for Emerald's Rapid-Recover hardware. If you're a local-area-network administrator who performs backup and restore functions on multiple file servers, Emerald says the package will let you control those centrally located archival tasks more efficiently. For example, EmSave locates all network server files and volumes automatically, then shows them to you on-screen. There's also an intuitive mouse-based user interface; if you use the package on Emerald's RapidRecover drives, you'll also get a graphical tree display of volumes, directories, subdirectories, and files.

EmSave is shipped with five data cartridges (or cassettes) and a media-storage case. To use it, you'll need an IBM AT, PS/2, or compatible, along with MS-DOS 3.0 or higher. And of course, you'll also need a cartridge or cassette backup unit. Emerald's RapidRecover series of backup hardware starts at $995.

Price: Cassette version, $350; cartridge version, $495.
Contact: Emerald Systems Corp., 4757 Morena Blvd., San Diego, CA 92117, (800) 553-4030; in California, (619) 270-1994.
Inquiry 1165.

EmSave tracks and controls network backup.

A SchoolMate for the Classroom

The Radio Shack folks are making a concerted effort to make their Tandy PC compatibles a big factor in the classroom. Their latest strategy is SchoolMate, a classroom networking system based on Tandy's DeskMate integrated software, MS-DOS, and either the low-cost TandyLink network or 3Com's 3+Share.

Tandy calls SchoolMate an integrated collection of applications and utilities that are specifically designed to assist students, teachers, and administrators in organizing, creating, and sharing information, software, time, and resources.

SchoolMate's classroom management applications include Roster, Grade Book, Lesson Scheduler, and Exam Maker. The administrative system can be used on a standalone system as well as on a network. In any case, student access to the SchoolMate network is limited to teacher-scheduled applications.

According to Tandy, there are currently more than 80 education-specific packages that run on SchoolMate, with more on the way. SchoolMate is compatible with the entire line of Tandy computers and can support up to 35 workstations and 2000 student log-ins per network. Each workstation and file server needs 640K bytes of RAM.

Price: $999.95 (includes 3+Share).
Contact: Radio Shack, 1700 One Tandy Center, Fort Worth, TX 76102, (817) 390-3700.
Inquiry 1168.

Remote-Control Connectivity

Programs that let you take control of computers remotely using modems and a telephone line have been growing in popularity, especially for people who take their work home at night or need to support computer users who are spread over a wide geographical area.

In the time-proven spirit of competition, each new generation of these programs includes new features. For instance, as its name implies, pcAnywhere III is the latest and greatest incarnation of pcAnywhere.

The program lets you run any PC, terminal, non-IBM compatible with terminal emulation, or even a Macintosh from another PC at a remote location via modem, or locally through an RS-232C connection. New features include automatic callback from the host machine to the remote PC.

The pcAnywhere package comes with the software necessary for both sides of the connection.

Price: $145.
Contact: Dynamic Microprocessor Associates, Inc., 60 East 42nd St., Suite 1100, New York, NY 10165, (212) 687-7115.
Inquiry 1166.

continued

Time on Your LANs

Project management software essentially becomes groupware when it runs on a network. Recognizing that fact of local-area-network life, Symantec has moved its popular Time Line project management package to PC-based LANs.

Time Line 3.0 works on all popular LANs. Once you install the main File Server version on your network's file server, multiple users can share access to both project files and the program itself. Each user on the network who wants to work with Time Line also needs an individual LAN Pack.

According to Symantec, one of the biggest advantages of Time Line on a network is the hefty amount of hard disk space it saves.

Price: File Server version, $595; Individual LAN Pack, $195.
Contact: Symantec Corp., 10201 Torre Ave., Cupertino, CA 95014, (408) 253-9600.
Inquiry 1164.

Bring Perspective to Your Graphics

Tired of flat and lifeless PC graphics? You can spiff up those two-dimensional charts and graphs with a new low-cost version of Three D Graphics' Perspective package. It's called Perspective Junior, and with your investment of $149, you can make your desktop publishing and spreadsheets come more alive. With a few keystrokes, Perspective Junior transforms your data into two- and three-dimensional color graphics.

Perspective Junior can directly import data from 1-2-3, SuperCalc, Quattro, Excel, and most other spreadsheets. After it's done its work, the program exports images directly into Aldus PageMaker, Ventura Publisher, GEM Publisher, WordPerfect 5.0, and most other desktop publishing packages.

According to its makers, Perspective Junior features a simplified yet more sophisticated version of the user interface introduced by the original Perspective. It offers you 64 preset color combinations, as well as a custom color mixer. You can also change the viewing angle of any of the program's three-dimensional graphics.

Perspective Junior can output to most laser, dot-matrix, and color ink-jet printers.

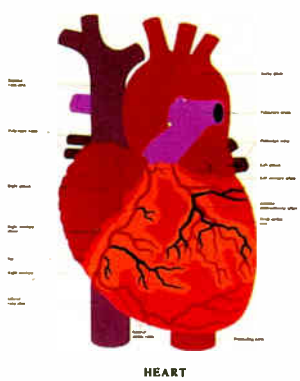
The program runs on any IBM PC, XT, AT, PS/2, or compatible and requires 512K bytes of RAM, a hard disk drive, MS-DOS 2.1 or higher, and a color graphics or Hercules-compatible card.
Price: $149.
Contact: Three D Graphics, 860 Via de la Paz, Pacific Palisades, CA 90272, (213) 459-7949.
Inquiry 1138.

Turn 2D into 3D with Perspective Junior.

Draw, Pardner

Micrografx is a company that has staked its claim on Microsoft Windows–compatible graphics. And it has just introduced two new packages for that sometimes-venerable graphical operating environment.

The first is Draw Plus, an enhanced version of the company's Draw free-form graphics software. Draw Plus is designed for business professionals who want to create organizational charts, project flowcharts, or related graphics. It gives you both drawing primitives and design tools and includes enhancements such as context-sensitive help, the ability to use scanned images, object rotation, flexible labeling and text editing, and 8 color palettes with over 100 colors, including gray scales.



Micrografx's ClipArt has an Anatomy library.

Draw Plus needs an IBM PC, XT, AT, or compatible with 512K bytes of RAM and an EGA or VGA card. It's compatible with all input and output devices that are compatible with Microsoft Windows.

Micrografx has also introduced four new ClipArt libraries. They are Anatomy, Sports and Recreation, Business Forms, and Headline Typefaces IV.

Anatomy is a collection of professional illustrations detailing all aspects of human anatomy. Each illustration has layers, labels, and symbol IDs.

Sports and Recreation is a collection of sports images useful for newsletters and other publications.

Business Forms includes certificates, expense reports, invoices, ledgers, memos, order forms, and statements.

Headline Typefaces IV has six new typefaces: African, Balloon, Bayou, Jersey, Scoreboard, and Surf.

Each library includes Portfolio, a utility that lets you bring the art into programs such as PageMaker and Ventura Publisher.
Price: Draw Plus, $395; ClipArt Libraries, $79.95 each, except for Anatomy, which is $149.95.
Contact: Micrografx, Inc., 1303 Arapaho, Richardson, TX 75081, (800) 272-3729; in Texas, (214) 234-1769.
Inquiry 1140.

Navigate the 1-2-3 Waters Graphically

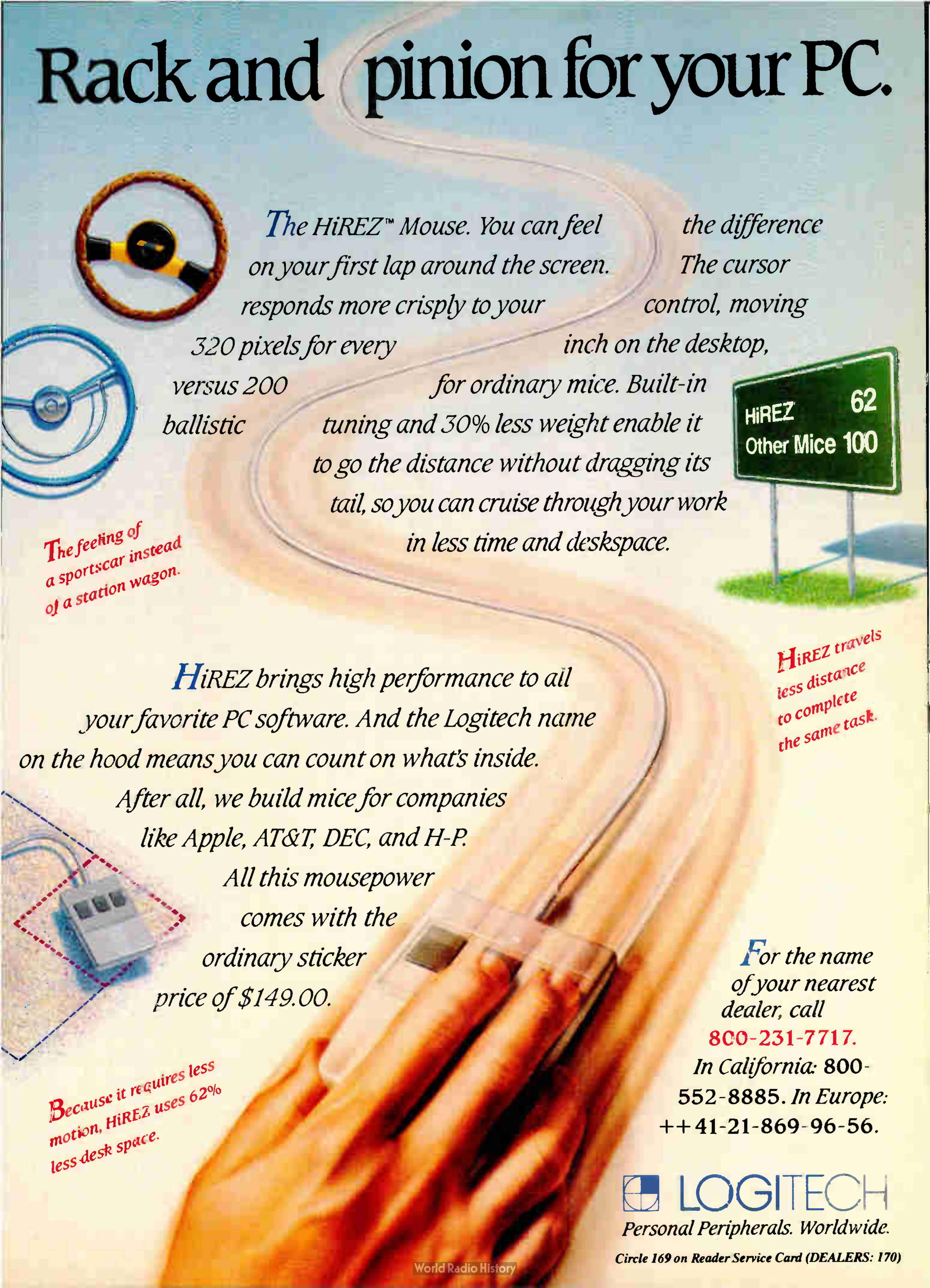
For those of you with fatigued fingers from all the keystrokes needed to use Lotus 1-2-3, Marq Technologies has relief in the guise of MarqNavigator, a graphical user interface for the popular spreadsheet that provides what the company calls "fingertip control."

MarqNavigator lets you use a mouse with 1-2-3 to graphically perform common functions. You can, for instance, open and move worksheet windows, use drop-down menus and submenus for selecting commands, drag or push worksheet portions off the screen, execute status and function keys, and accelerate data entry.

Marq claims the package offers significant performance gains over the keyboard-only method. It's especially effective if you work with large spreadsheets, where editing, moving, and cell positioning can be time-consuming indeed.

The package works with Lotus 1-2-3 versions 2.0 and 2.01 and requires 30K bytes of RAM. And, of course, you'll need a mouse.
Price: $149.
Contact: Marq Technologies, 6285 Nancy Ridge Dr., San Diego, CA 92121, (800) 336-8366; in California, (619) 452-2373.
Inquiry 1142.

continued



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hDC Windows Express makes Windows even more graphic.

Windows ClickStart Goes Express

You Microsoft Windows users who crave more graphics menu options now have more choices than ever in hDC Windows Express 2.1, an enhanced version of the Windows graphic menu system that used to be known as hDC ClickStart.

The hDC Windows Express package gives you a larger number of display preferences and expanded features. For instance, you can create your own personalized icon libraries. A library with 50 icons is included.

The program also gives you an uncluttered screen with color icons instead of a screenful of file and program names.

You can also start applications with a single keystroke or mouse-click, as well as store related applications and documents in icon-represented folders.

If others will be using your system, you can use passwords to guard access to sensitive files or restrict access to MS-DOS.

The hDC Windows Express program is compatible with most Windows applications.

Price: $79.95.

Contact: hDC Computer Corp., 15379 Northeast 90th St., Redmond, WA 98052, (206) 885-5550.

Inquiry 1169.

The Great HP Font Conversion

If you own a Hewlett-Packard DeskJet ink-jet printer and feel more than a little constrained by its limited selection of low-cost fonts, there's SoftFontWare's LaserJet to DeskJet font-conversion package.

As its name implies, the package will happily convert any soft font designed for the LaserJet so it will work on the DeskJet.

There are hundreds of widely available public domain and shareware fonts available from bulletin boards.

Price: $42.

Contact: S.H. Moody & Associates, Inc., SoftFontWare, 1810 Fair Oaks Ave., South Pasadena, CA 91030, (818) 441-2260.

Inquiry 1173.

Products on the Stack

The trickle of HyperCard stacks for the Apple Macintosh is fast becoming a torrent, and innovative uses are fast being found. Like shopping, for instance. Here are two prime examples:

If you're an inveterate bargain hunter, HyperShopper will keep your attention for hours on end. It's a HyperCard stack that lists over a thousand discount mail-order companies and factory outlets. It also lists the products they sell and the brands they carry.

In order to qualify for a listing in HyperShopper, a company must sell its products at least 30 percent below retail or sell truly unique or hard-to-find merchandise.

Price: $19.95.

Contact: Camtronics Software, 224 Nelson Lane, P.O. Box 1, Camas Valley, OR 97416, (503) 445-2824.

Inquiry 1171.

And for Macintosh users, dealers, and consultants who need to keep track of the latest information about Macintosh-related services, products, programs, and peripherals, there's SuperMasterFile. It's a HyperCard stack with over 5000 Macintosh-related product cards.

SuperMasterFile runs on the Mac Plus, SE, and II and requires HyperCard 1.1 or higher, plus a hard disk with at least 3 megabytes of free space. The package includes five disks in a carrying wallet, with the disks in Apple's HD Backup format. Quarterly updates are available.

Price: $59.95.

Contact: New Edge, Inc., Noone Falls, Peterborough, NH 03458, (800) 284-3330; in New Hampshire, (603) 924-9100.

Inquiry 1172.

A File by Any Other Name

Memory-resident programs that let you use long textual descriptions of files instead of often-cryptic 8-character filenames are becoming a hot item. The latest comes from Carmel Computer Products, whose File Control lets you use names up to 108 characters long.

But there's more. File Control also lets you organize documents in named folders and manage individual files or whole folders in a cross-referenced index. The only files you see in an index are the ones you store.

The program has a natural-language interface that's designed to let anyone who uses your computer system find a file easily. There's also a keystroke recorder that lets you create macros—which the company calls *controls*—for almost any application. Predefined controls are included for WordPerfect, Lotus 1-2-3, WordStar, SuperCalc, and other programs.

File Control works with most popular application programs, including those named above plus, among others, Quattro, Microsoft Word, Symphony, PFS:First Choice, and XyWrite III Plus. The program uses about 90K bytes of RAM and requires an IBM PC, XT, AT, PS/2, or compatible with MS-DOS 2.11 or higher. File Control is not copy-protected.

Price: $59.95.

Contact: Carmel Computer Products, Inc., Carmel Valley Village Center #8, P.O. Box 215, Carmel Valley, CA 93924, (408) 659-3155.

Inquiry 1170.

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WHAT'S NEW

Group Helps Nonprofit Organizations

One of the most important tasks of a nonprofit organization is to organize its information, especially regarding possible sources of hard-to-find funding. Many nonprofits use donated computer equipment to accomplish this, but the equipment is often obsolete or the wrong solution. Connect is an organization dedicated to providing information and referral services to nonprofit organizations that don't have the money or the work hours to invest in sophisticated systems but need the technology to compete.

According to Mitchell Rosenberg, program director for Connect and vice president of parent company Technical Development, since the spring of 1988, Connect has been sponsoring two-day courses on how nonprofit groups can use computers. This fall, the program started offering instant telephone support and referral services to members.

According to Rosenberg, part of Connect's mission is to ensure that nonprofits not only get good technology but know how to use it efficiently, especially as large corporations start parting with their 8088-based machines. It's a complex job, but he said that donations from Lotus, the Fidelity Foundation, and the United Way have helped.
Price: $150 to $250 fee (depending on your budget).
Contact: Lisa Breit, Connect, c/o Technical Development Group, 11 Beacon St., Boston, MA 02108, (617) 523-7557.
Inquiry 918.

Advanced LAN Conference

Local-area networks are growing in popularity due to increased demand for productivity and efficiency in the work place. A conference that will deal with LAN productivity, management, security, and standards will be held in New York from November 30 to December 2.

The conference is designed to help attendees define their requirements, choose the right system, and understand configurations available with today's LAN. The chairperson will be Roy Pepper, a consultant with 23 years of experience in the communications field. The seminar is for business managers, technicians, and planners.
Price: $995.
Contact: Digital Consulting, Inc., 6 Windsor St., Andover, MA 01810, (508) 470-3880.
Inquiry 920.

Shopping for the Silicon Set

A museum that claims it's the only one in the world solely dedicated to computers and their impact on society is now offering a catalogue of gifts that you can give to your favorite techie for Christmas. If that human hard disk of

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Circle 515 on Reader Service Card

yours, called the brain, has just gone blank on gift ideas, the catalog has everything from pins and earrings made out of circuit boards to an affordable make-your-own robot kit.

The Computer Museum is also offering a collection of books to brush up on computer pioneers and history, circuit-design silk ties for the fashion-conscious programmer, and another tie with a scaled-down version of a slide ruler.

Also available are computer puzzles, games, posters, and card sets.

Price: The catalog is free of charge.

Contact: The Computer Museum Store, 300 Congress St., Boston, MA 02210, (617) 426-2800.

Inquiry 919.

The Computer Flea Market Hits Northern New Jersey, Too

Ken Gordon Productions has been sponsoring computer shows since 1980, and according to its president, it is the largest and oldest promoter of computer shows in the U.S. The show welcomes companies as large as Computerland Stores and as small as mom and pop (or kid) garage operations.

One will be held at the Sheraton Hotel in Boxborough, Massachusetts, off Route 495's exit 28, from 10 a.m. to 4 p.m. on December 11. Another will be held at William Paterson College in Wayne, New Jersey, on December 17.

Contact: Ken Gordon Productions, P.O. Box 13, Franklin Park, NJ 08823, (800) 631-0062; in New Jersey, (201) 297-2526.

MacWorld Expo in San Francisco

If you missed the crowds (and the heat) at MacWorld Expo in August, held in three locations in Boston, you have another chance to catch up on the latest new products and applications for the Macintosh, only this time the Expo will be held in balmy San Francisco, from January 20–22.

The Expo will start off with an industry day on January 19, open only to dealers, vendors, and third-party developers. More than 1200 booths and displays are expected for the show.

Price: $20 for exhibits only; $75 for the conference and exhibits.

Contact: Mitch Hall Associates, P.O. Box 155, Westwood, MA 02090, (617) 329-9911.

Inquiry 921.

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STANDARD A/T MODEL IQ-80286

SPECIFICATIONS

MOTHERBOARD:	Intel 80286 microprocessor key selectable normal (8.0 mhz) and turbo (12.5 mhz) processing speeds, socketed for the 80287 math coprocessor, eight expansion slots (2 eight bit—6 sixteen bit), clock-cal, 1 meg. RAM included. Multi I/O and Phoenix or Award Bios included.
POWER:	200 watt, switching power supply with leads for 4 devices.
DISKS:	(1) 1.2 meg, half height, dual sided—quad density floppy drive. (1) 40 megabyte, half height, fixed disk drive. 40MS access time.
CABINET:	Full size AT style drawer cabinet with corporate security lock panel mounted reset switch, and status LEDs for turbo, power and fixed disk.
KEYBOARD:	Enhanced style, 101 keys with LEDs to indicate NUM locks and CAPS lock status, separate cursor pad, numeric touch pad, top mounted function keys.
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MODEL IQ 80286—THE WISE CHOICE

STANDARD A/T MODEL IQ-80386

SPECIFICATIONS

MOTHERBOARD:	Intel 80386 microprocessor, user selectable (4.77, 8.0 and 18.0 mhz) upgradeable to 20 mhz. Processing speeds, socketed for the 80287 math coprocessor, eight expansion slots (2 eight bit, 5 sixteen bit, and 1 thirty-two bit), clock-cal, 2 meg. RAM included, upgradeable to 8 meg. Includes Phoenix or Award Bios and Multi-I/O card
POWER:	200 watt, switching power supply with leads for 4 devices
DISKS:	(1) 1.2 meg, half height, dual sided—quad density floppy drive and 1.44 floppy (1) 80 megabyte, full height, fixed disk drive. Seagate
CABINET:	Full size AT style drawer cabinet with corporate security lock panel mounted reset switch, and status LEDs for turbo power and fixed disk.
KEYBOARD:	Enhanced style, 101 keys with LEDs to indicate NUM lock and CAPS lock status, seperate cursor pad, numeric touch pad, top mounted function keys.
DISPLAY UNIT:	Hi-res, text and graphics, monochrome card (Herc. compat.) hi-res, TTL amber monocrhome monitor, 1 parallel port.
WARRANTY:	1 year on parts and labor limited depot warranty. 30 day money back guarantee if not satisfied with our product for any reason.

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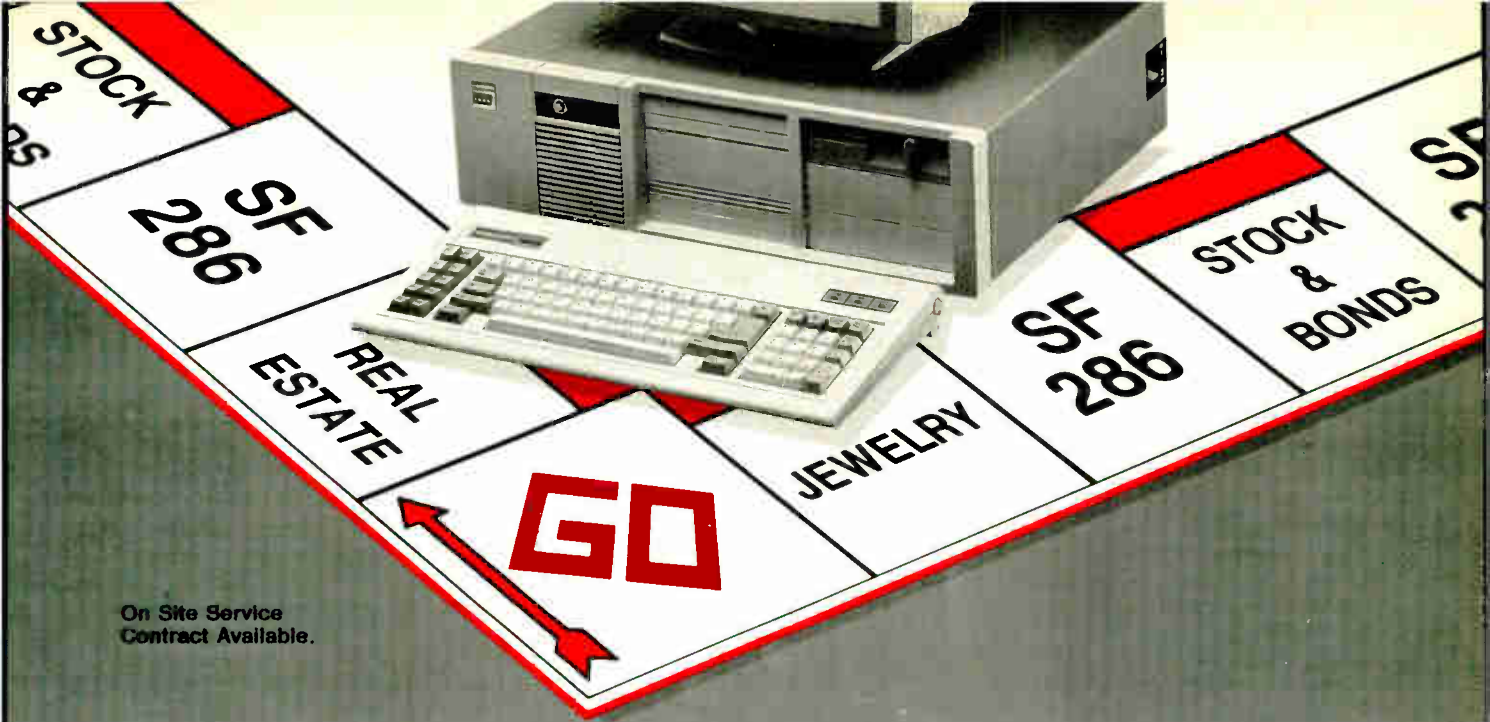

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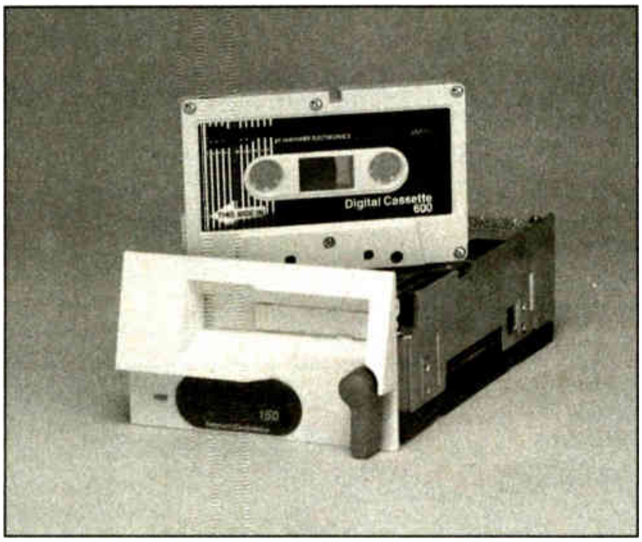
Tape Backups for PC, PS/2 Support SCO Xenix 386

Maynard Electronics' MaynStream 150 is a 150-megabyte 3½-inch cassette tape backup system for IBM PS/2s, including the Model 50Z and the three Model 70s. A separate system is also available for IBM PCs, XTs, ATs, and compatibles. The system for the PS/2s supports SCO Xenix 386 version 2.2 and can back up a cassette's worth of data in 24 minutes.

The systems include scripts that let you back up related files as a group, and an archive feature, which transfers inactive hard disk files onto a backup cassette, freeing more space on your hard disk. The systems' read-after-write and error-correction code capabilities can help ensure data integrity. The systems also feature electronic automatic-tension control and direct-drive tape motors.

The MaynStream 150 is a digital data cassette system that uses standard d/CAS-85 tape format and works with most local-area networks, including Novell, 3Com, and IBM's Token Ring, according to Maynard. Both systems include a half-height drive, cables, software, cassettes, and a controller card. The controller card for your PC or compatible occupies a half-length slot, and the PS/2 controller card occupies a full-length slot. To support SCO Xenix 386, Maynard provides driver software that you can install using an auto-configuration routine.

Price: $1525 for IBM PCs; $1725 for IBM PS/2s.
Contact: Maynard Electronics, 460 East Semoran Blvd., Casselberry, FL 32707, (800) 821-8782; in Florida, (407) 331-6402.
Inquiry 905.



MaynStream 150 digital data cassette backup system.

Windows-Based Word Processor

Amí is a Windows-based word processor that lets you control more than just the words of your document. You can edit your document in either of two modes: Draft mode is for text-only work, and layout mode lets you edit in WYSIWYG format, complete with on-screen formatting of the document. In the program's layout mode, you can wrap text; control fonts, spacing, and text placement; and set up graphics frames, according to Samna, the program's publisher.

Amí lets you import Samna, WordPerfect, WordStar, and ASCII files or bit-mapped graphics in PCX or Tag Image File Format into the frames, which you can place anywhere in the document. You can scale, reposition, or crop the graphics once you've placed them in the frame.

Word processing capabilities include search and replace; cut, copy, and paste; a 130,000-word spelling checker, an undo command, and headers and footers. You can use the program's predefined style sheets or design the document's layout yourself.

Amí requires an IBM PC AT, PS/2, or 80286/80386 compatible with a Hercules, EGA, VGA, or IBM 8514-A graphics card, 640K bytes of RAM, a hard disk drive, and DOS 3.0 or higher. The program is bundled with a run-time version of Microsoft Windows and can run with a Microsoft or compatible mouse.

Price: $199.
Contact: Samna Corp., 5600 Glenridge Dr., Atlanta, GA, 30342, (800) 831-9679; in Georgia, (404) 851-0007.
Inquiry 907.

Accounting Software for Quick Print Industry

When a customer comes in with a big printing job, many "quick print" shops do the cost estimating for the job by hand. Because of the rush factor and the number of elements involved, it's often easy to forget to account for the number of copies, color of ink, letterhead, envelope, typesetting, and layout requirements and thus miscalculate the cost. With Printers Inc., you can automate this process.

Once a customer's requirements are entered, the program calculates labor, wash-up, waste, and registration costs and stores it in customizable tables. The program is fully integrated with the Great Plains Accounting Series, so you can use the information to generate a work order and invoice, along with entries in the accounts receivable and general-ledger programs.

Printers Inc. works on the Mac II, Plus, and SE with a 20-megabyte hard disk drive, 1024K bytes of RAM, System 3.2 or higher, Finder 5.3 or higher, and a Imagewriter, LaserWriter, or compatible printer. A recommended starting configuration includes Great Plains' Accounts Receivable ($795) and Printers Inc.

Price: $1495.
Contact: Great Plains Software, 1701 Southwest 38th St., Fargo, ND 58103, (701) 281-0550.
Inquiry 915.

Wendin-DOS 2.15 Breaks 32-megabyte Hard Disk Partitions

With Wendin-DOS 2.15, you can create hard disk partitions of up to 4 gigabytes. Based on a VAX VMS kernel, it lets you run most DOS-compatible programs that require less than 340K bytes of memory. The program includes DOS 3.3 extended partition support and improved PIPING and SHELL OUT functionality.

The operating system runs on the IBM PC, XT, AT, and compatibles and requires 300K bytes of memory.

Price: $139.
Contact: Wendin, Box 3888, Spokane, WA 99220, (509) 624-8088.
Inquiry 913.

EW!

Turn Your PC Into A Duplicating Machine!

Duplicating is a *snap* with THE DUPLICATOR TOOLKIT! Whether you need to make one copy or 100, this program is for you. It begins where DISKCOPY leaves off!

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Get the *power* DISKCOPY can't give you. Order today!

MINIMUM SYSTEM REQUIREMENTS: IBM PC, XT, AT or compatible and 256K Ram. PC or MS DOS 2.0 or higher. Hard disk recommended. Not copy-protected.

THE DUPLICATOR TOOLKIT and Copy Technologies are Trademarks of Copy Technologies.

COPY TECHNOLOGIES
14252 Culver Drive, Suite 323
Irvine, CA 92714
(714) 975-1477

Circle 507 on Reader Service Card (DEALERS: 508)

I've had it with DISKCOPY! turn *my* PC into a Duplicating Machine! Please send me:

______copies of THE DUPLICATOR TOOLKIT at $79.95 each plus $4.50 shipping ($10.00 Canada and outside U.S.). CA residents please add 6% sales tax.

NAME ______________________

ADDRESS ______________________

CITY ____________ STATE ________ ZIP ________

☐ Check/Money Order ☐ Visa ☐ Master Card

Account Number ______________ Exp. date ________

mail coupon to: **COPY TECHNOLOGIES**
14252 Culver Drive, Suite 323
Irvine, CA 92714

Hard Disk System for the Amiga 2000

Supra's line of hard disk drives for the Amiga 2000 lets you connect an Amiga and an IBM PC XT running DOS to the same hard disk drive using the Amiga Bridgeboard Interface. Running under that configuration, you can do multitasking on the Amiga while running an application in DOS using the disk drive's MS-DOS partitions.

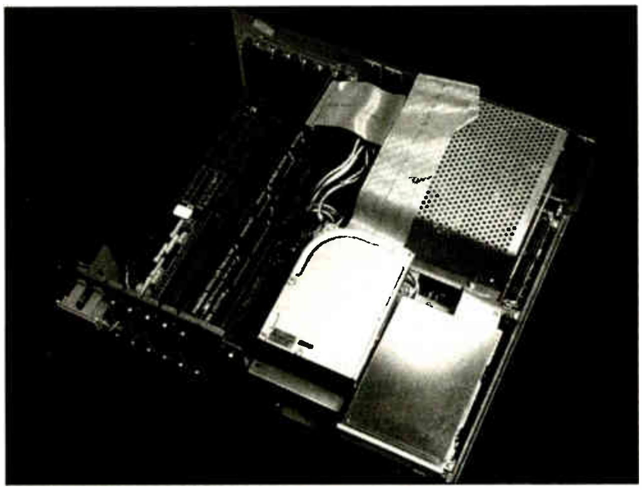
Both internal and external SupraDrives are available in 20-, 30-, 60-, 120-, and 250-megabyte systems. The internal model comes with a direct-memory interface, disk drive, controller, cables, and screws. To plug in the external drive, you place the Supra interface in an Amiga expansion slot and plug in the hard disk drive. CLImate, a command-line interpreter, is also included.

Supra Interface Kits are also available for those who already have a hard disk drive and want to mount it internally. The kits are available with or without controllers.

Price: SupraDrive Hard Disk Systems: from $699 for the 20-megabyte system to $3995 for the 250-megabyte system. Supra Interface Kits: $399.95 with controller; $249.95 without controller.

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

Inquiry 917.



Supra's double-duty hard disk drives.

Enhancement for DOS Command-Line Interface

Enhance! 1.1 is a memory-resident program that adds several features to DOS without supplanting DOS's COMMAND.COM functions. You can load and run the program in Lotus-Intel-Microsoft Expanded Memory.

The program, which is not menu-driven, includes these enhancements: The ability to correct a lengthy command's typo with four keystrokes; display the last 20 commands entered; save current drive/directory locations, switch to other drives/directories, and return to saved location by pressing the RETURN key; type several commands without entering them until you want to send them to DOS one at a time; display a sorted list of all files changed or called in a day; and copy all files on drive C changed within a week to drive D.

You can also use it to display your hidden files in current and \BIN directories, prevent someone from undeleting your deleted files, change the time and date associated with a file to current time and date, and more.

Enhance! 1.1 runs on the IBM PC, XT, AT, PS/2s, and compatibles and requires 256K bytes of RAM and DOS 2.0 or higher.

Price: $79.95.

Contact: Cortex Computing Corp., P.O. Box 116788, Carrollton, TX 75011, (214) 492-5124.

Inquiry 914.

Give Commands with Single Keystrokes

Dos-Mate is an ASCII-based shell for PC users that lets you execute DOS commands such as Copy, Delete, MAKEDIR, REMDIR, EDLIN, and other file management commands with a single keystroke. The program displays help and status information at the top of the screen, while a 14-character column on the right side gives a directory of your files and subdirectories.

You can also use Dos-Mate to make, remove, change, and delete directories on your hard disk drive. The program has a built-in editor that's as powerful as WordStar, according to publisher Intuitive Software. You can also use the program to hide and protect files and directories protected under password protection.

Dos-Mate runs on IBM PCs, XTs, ATs, PS/2s, and compatibles and requires 40K bytes of RAM and DOS 3.0 or higher. The program works with Hercules, CGA, VGA, EGA, and MCGA cards.

Price: $49.95

Contact: Intuitive Software, P.O. Box 6041, Bozeman, MT 59715, (406) 587-3348.

Inquiry 851.

Analyze Source Code Complexity

A program developed by SET Laboratories to determine the difficulty level of understanding, testing, and modifying another program's source code can now analyze multiple programs per run. If a project is divided among several programmers, the program can analyze the separate files as one unit.

PC-Metric 2.0, a program that uses complexity metrics to analyze a program's source code, also has a bridge that lets you analyze the program's output using Lotus 1-2-3's statistical and graphics capabilities.

The program uses techniques such as the Cyclomatic Complexity and the Software Science measures to report on the likely number of programming errors in the code, amount of required time to write a program, and difficulty of working with the code. By analyzing multiple programs per run, PC-Metric 2.0 can take a program that's been segmented among several programmers and analyze the program as one file, SET Laboratories reports.

Versions are available in C, Pascal, COBOL, Modula-2, and FORTRAN. All versions run on IBM PCs, XTs, ATs, and compatibles with DOS 2.11 or higher and 256K bytes of RAM. The program also requires Lotus 1-2-3 or a compatible spreadsheet to use the 1-2-3 bridge.

Price: $199 per language.

Contact: SET Laboratories Inc., P.O. Box 03627, Portland, OR 97203, (503) 289-4758.

Inquiry 853.

JASMINE COMPUTER SYSTEMS

XT-3000 BY SAMSUNG $699.00

- Small Footprint • Phoenix BIOS
- 8088-2 Turbo 4.77-8 MHz(SI 1.7)
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- All Systems FCC Class B approved

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- Math co-processor slot
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- 101 Enhanced Keyboard
- Lock/Led/Reset/Turbo case
- Parallel, Serial Port, Clock/ Calendar
- All Systems FCC Class B approved
- Mono. monitor (tilt & swivel)
- Monochrome graphics adapter

286-12 SYSTEM $1099.00

386-16 SYSTEM $1999.00

(Optional 20 MHz)

- 8 /16 MHz 0 Wait
- 1,024K RAM up to 2,048K
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P.O. BOX 755 • 100 MAIN STREET
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(603) 893-3332
(617) 682-5953

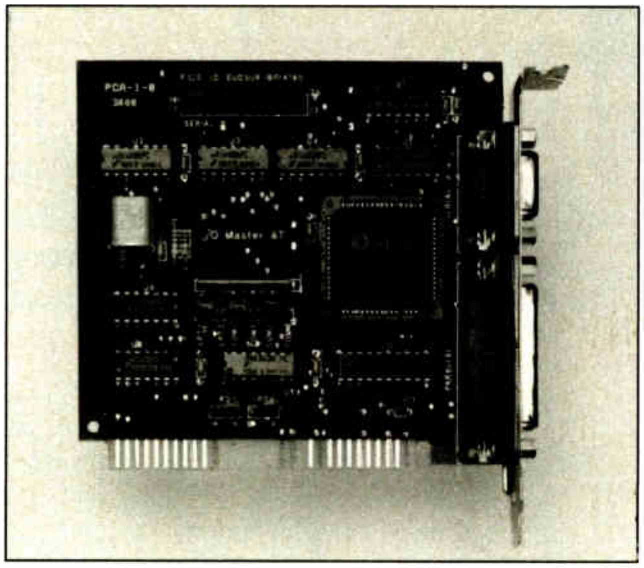
Circle 513 on Reader Service Card (DEALERS: 514)

Add Serial Ports to Your PC

PC users are finding more and more uses for their machines these days—desktop publishing, telecommunications, and networking, to name a few. But with the increasing capabilities, the number of peripherals you can attach to your PC can exceed the number of unused serial and parallel ports. Boca Research has introduced the IO/AT, an expansion board that has two options: the IOAT41, equipped with a 25-pin parallel and 9-pin serial port; and the IOAT42, with both ports plus an additional 25-pin serial port.

Running with two IO/AT boards in tandem, your PC can support as many as four additional serial ports and two additional parallel ports, enough to run any device-dependent system, the company reports. Boca designed the board to run specifically with the IBM AT—the board uses a very-large-scale-integration high-speed universal asynchronous receiver/transmitter NS16450-compatible chip—but it will run on other machines, too.

The short card (4½ by 4⅕ inches) connects to any AT or 8-bit PC-style bus. No additional software is required (you implement the board with jumper settings). Both cards work on the IBM PC, XT, AT, PS/2 Models 25 and 30, and compatibles.
Price: IOAT41, $119; IOAT42, $129.
Contact: Boca Research, Inc., 6401 Congress Ave., Boca Raton, FL 33487, (407) 997-6227.
Inquiry 911.



Boca Research's IOAT41 in a 25-pin/9-pin configuration.

Corporate Environment Manager

Hardly a month goes by without corporate executives having to hear or deal first-hand with the following horror stories: A disgruntled employee gets fired and destroys the last six months' worth of payroll files; workers are making unauthorized copies of expensive commercial or proprietary software for personal use; or someone uses an unauthorized public domain program infected with a virus that corrupts the company's valuable files. FoundationWare's Vaccine Corporate 2.1 can prevent these and other mishaps, the company reports.

A system manager can install the program and designate which company-approved commercial and proprietary software can run on company PCs. A 5K-byte memory-resident module intercepts any attempt to write directly to hard disk drives, and a 1K-byte memory-resident and disk-resident module checks each program and selected files for signs of tampering. A special disk, called the Blue Disk, is available with a database of signature checks for over 5000 certified virus-free public domain and shareware programs.

Vaccine Corporate 2.1 runs on the IBM PC, XT, AT, PS/2s, and compatibles with 384K bytes of RAM and DOS 3.0 or higher. A hard disk drive and a floppy disk drive are required.
Price: $189.
Contact: FoundationWare, 2135 Renrock Rd., Cleveland, OH 44118, (800) 722-8737; in Ohio, (216) 932-7717.
Inquiry 912.

Visualize Data with Perceptual Mapping

Mapwise is a statistical program for marketing, research, and advertising companies that describes data relationships with a perceptual map and creates scattergrams. You can use the scattergrams in presentations as a visual description of your statistical market data.

According to the program's publisher, you can also use Mapwise to assess advertising effectiveness, position products, describe benefit segments, measure brand loyalty, target new products, and more.

Mapwise formats up to 10,000 numbers in a data file, and it summarizes up to 96 tables and up to 100 rows and 100 columns of data with one map. The program automatically tests for data significance.

Mapwise runs on the IBM PC, XT, AT, PS/2s, and compatibles with 256K bytes of RAM. The program can also import ASCII and Lotus 1-2-3 data files.
Price: $495; $9.95 for limited feature version.
Contact: Market Action Research Software, Bradley University, Business Technology Center, Peoria IL, 61625, (309) 677-3299.
Inquiry 909.

Analyze Transfer Functions to the Fifth Order

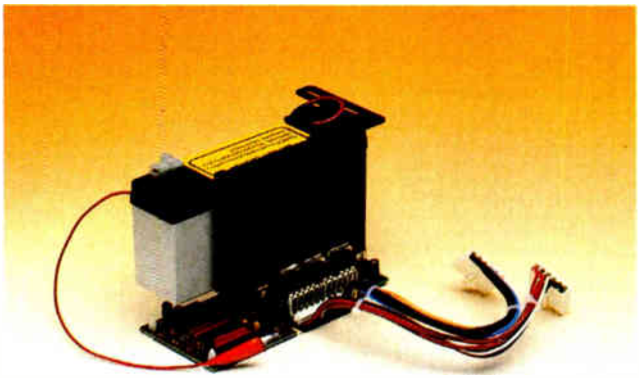
Transfer Function Analysis can analyze transfer functions and polynomials up to the fifth order. It can list, plot, or file magnitude and phase versus frequency in both logarithmic (Bode) and linear ranges.

The program's full-screen displays with protected fields allow for coefficient entry and update.

Transfer Function Analysis works on the IBM PC, XT, AT, PS/2s, and compatibles and requires 64K bytes of RAM, DOS 2.0 or higher, and a CGA, EGA, or VGA graphics card. IBM monochrome graphics is not supported.
Price: $40.
Contact: CastleSoft, 990 Oakwood, Castle Rock, CO 80104, (303) 688-2954.
Inquiry 908.

SHORT TAKES

BYTE editors offer hands-on views of new products



Boomerang Makes Your System Bounce Back

While the overall reliability of computers and peripherals has continually gotten better, there's not as much you can do about one part of your system, namely, the AC power. Surge protectors and RF filters make the power smoother, but you're up the creek if nothing is coming out of the wall.

Backup power supplies are one solution. They're essentially high-capacity batteries with enough juice to power your computer for 10 to 20 minutes. However, they're big, they're expensive, and they don't help much if the power fails when your computer is working unattended.

There must be a better way, and MicroSync has a unique solution in a product called **Boomerang**. You might think of it as a miniature backup power supply. But it's much more than that, with a few tricks up its electronic sleeve.

Boomerang consists of a circuit board, a lithium battery, and a few connectors. Measuring 5⅓ by 3¼ by 3¾ inches overall, Boomerang is designed to fit *inside* your system unit. Using a cleverly designed bracket, it hangs in that previously unused dead space between the power supply and the expansion slot area.

With its small battery, Boomerang obviously isn't designed to be a full-fledged backup power supply. And it isn't. It works in concert with RAM-resident software. As soon as Boomerang detects a loss of AC power, the software saves an image of your RAM on your hard disk, parks the disk heads, and shuts down the system. This usually takes less than 30 seconds, depending on whether you're using extended or expanded memory, and it's all done automatically.

When the power comes back and your system reboots, you just type a command, and your system is returned to the exact place it was when the power failed. You can even place the command in your AUTOEXEC.BAT file, letting you automatically return every time to where you were the last time you turned off your computer.

Boomerang takes some time and a modicum of skill to install. You need to connect the unit between your power supply and motherboard, as well as place a jumper into a terminal of one of your expansion slots. Though I consider myself hardware-savvy, I had a difficult time interpreting the wordy installation instructions. A few well-placed illustrations would have made the process considerably easier.

The fit is relatively tight, and if you're using an IBM PC AT or compatible, you really should have a second battery ($50), which fits piggyback on the first. This makes things even tighter.

Once Boomerang is installed, you'll have to get used to the strange sensation of not having your computer turn off when you turn off your system's power switch.

Boomerang is a reasonably priced and eminently useful add-in to any PC. And if you live in an area that has frequent power burps, it can save your sanity.

—Stan Miastkowski

THE FACTS

Boomerang
$299; extra battery
(for AT or compatible),
$50

Requirements:
IBM PC, XT, AT, or compatible, 256K bytes of RAM, internal hard disk drive, and MS-DOS 2.1 or higher.

MicroSync
15018 Belay Dr.
Dallas, TX 75244
(214) 788-5198
Inquiry 1001.

Thinking of a Mac C Environment? Think of Think C

Think Technologies introduced its Lightspeed C compiler for the Macintosh in 1986. It featured a novel integrated environment that combined the editor, C compiler, object linker, and resource linker in one application module. It supercharged a programmer's edit-compile-link development cycle, producing tight, fast code to boot. And as icing on the cake, it cost only $175. Things have changed since then: We've got the Mac Plus, Mac SE, and Mac II computers. We also have several new software managers, color, and MultiFinder.

Think Technologies (now owned by Symantec) has managed to keep pace with these new developments by providing free updates to Lightspeed C owners via commercial on-line systems and bulletin boards. However, it reached the point where a major upgrade of the compiler was in order. The company has responded to the need for change with Lightspeed C 3.0, which is now called **Think C**.

The new compiler features user-selectable 68020 and

continued

68881 code generation, supports the latest MultiFinder and Color QuickDraw traps, and generates debugging information for MACSbug or TMON. When you build an application, you can specify its MultiFinder attributes (i.e., MultiFinder-aware, Can background, and Accept suspend/resume events) and its memory partition size.

But the biggest news is that Think C sports a source code–level debugger. It lets you single-step through your C code in a source window while dynamically displaying the contents of variables or structures you've selected in a second data window. This feat is accomplished by running the debugger application in tightly coupled control with your application as it runs with Think C under MultiFinder.

Think C operates comfortably in 1 megabyte, but you'll need 2 megabytes of RAM to support the MultiFinder/debugger environment. Perhaps the best part is that Think C *still* costs only $175.

You can point and click on source code statements in the debugger's source window to set/reset breakpoints or to help set conditional breakpoints. You can single-step or trace into or out of functions either by clicking buttons on this window or by using a menu selection. An arrow in the source window points to the statement that's currently being executed.

The debugger's data window lets you examine variables in the format you specify (i.e., hexadecimal, decimal integer, pointer, floating-point, address, or char). You can even examine the fine detail of structures by entering the appropriate C syntax statements.

For example, the statement `(**the_Palette).pmInfo[count].ciRGB.red` lets you look at the contents of the red component of a particular palette entry as determined by the value in `count`. For complicated looping functions, you use an automatic mode feature that cycles continuously through source code statements and updates the data window as the variable contents change.

THE FACTS

Think C (Lightspeed C 3.0)
$175 (registered users can upgrade for $69)

Symantec Corp.
Think Technologies Division
135 South Rd.
Bedford, MA 01730
(617) 275-4800
Inquiry 1000.

Requirements:
Mac Plus, SE, or II running System 4.3/ Finder 6.0 or higher; 2 megabytes of RAM and MultiFinder required to use source code–level debugger.

I tried the debugger on a Mac II with 2 megabytes of RAM and two color monitors: an AppleColor 13-inch monitor and Mac II video board, and a SuperMac 19-inch monitor and Spectrum/24 video board. I also tried it on a Mac Plus with 2 megabytes of RAM to see how well the debugger fared on a typical low-end machine.

On the large SuperMac screen, you get generously sized source and data windows. On the Mac Plus, these windows are cramped, but you can resize them to make it work. If you have a second monitor on your Mac II, you can redirect the debugger windows to it so that you can observe your program's output without the screen becoming cluttered with debugging information. This feature worked reliably no matter which monitor I used for the debugging output.

The debugger worked admirably on both machines, and it let me find some problems I'd been having with a program within a matter of minutes—simply because I could see what was happening inside it.

Think C comes with two softbound manuals: a user's manual and a libraries reference. The user's manual provides good information on how to call Mac Toolbox routines. Unfortunately, the libraries manual provides information only on the standard Unix-style C library functions. I sorely miss having the list of Toolbox calls and their Think C calling conventions that were available in the version 1.0 manual. And I still wish the compiler would give an assembly language listing, for help in those nasty debugging situations where the source code won't do or can't be used (the debugger works only on application programs).

One thing you can't do is restart the debugger once you've reached the end of an interesting trace. You must exit the debugger, which in turn loses all your data window tracing information. Think Technologies is working on a way to save this information so that you can reenter the debugger without having to reenter the data. This is the only glitch I found marring the stellar performance of an already excellent development language. If you want a powerful C compiler with a good debugging tool, at a cost that won't blow your budget, Think C is the one to buy.

—*Tom Thompson*

SOTA 286i Turns Dinosaur into Ripsnorting Demon

So what if I work for a magazine at the cutting edge of personal computing technology—my old Tandy model 1200 HD is just fine by me. The 8088 processor is steady and reliable, and I've heard too many horror stories about accelerators gunking up people's systems because of some indeterminate incompatibility. After all, this old Tandy has never let me down, and I've been using it day in and day out for 3 years. But when we received a **SOTA 286i** universal accelerator board containing a 12.5-MHz 80286 and the company promised it would be easy to install and sure to work, I decided to give it a shot.

Putting the 286i into the Tandy was about as tough as changing the oil filter on a car, but much cleaner. I slipped off the case, removed the 8088 from the motherboard, stuck it into its slot on the 286i, ran a supplied ribbon cable from the 8088's old socket to a spot on the SOTA board, and then put the 286i into a slot (it will fit in a long or short slot).

I was able to boot the Tandy in 8088 mode and then, by throwing a toggle switch that sticks out of the back of the machine, boot up in 80286 mode. But that 80286 mode is pretty meaningless without installing the accompanying software driver.

When I installed the driver program and ran my most commonly used software, the difference in speed was remarkable. XyWrite, which used to chug into memory, now loads visibly quicker, and operations like formatting files are almost instantaneous. Procomm fetches material for uploads to BIX fast enough to simulate use of a 2400-bit-per-second modem.

continued

Embedded systems designers have already used **CrossCode C** *in over 291 different applications.*

CrossCode C comes with four powerful tools to help you program your 68000-based ROMable applications

From C source to final object, each tool takes you one step closer to your finished ROMable design

CrossCode C is designed specifically to help you write ROMable code for all members of the Motorola 68000 family. Four powerful tools take you from C source to object code:

1. COMPILER: To get truly ROMable code, you have to start with a truly ROMable compiler. Here are three **CrossCode C** features that you won't find in any ordinary C compiler:

- Compiler output code is split into five independent memory sections that you can assign into ROM or RAM as you please.
- You can optimize the code for your application because *you* control the sizes of data types. For example, you can optimize for speed by using two byte *ints*, or get maximum versatility by using four byte *ints*.
- You can easily write assembly language routines that call C functions and vice versa, because the compiler uses simple, well documented parameter passing conventions.

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

- The assembler features an advanced macro language, conditional assembly, "include" files, and an unlimited size symbol table.
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3. LINKER: The **CrossCode C** linker is designed to handle truly huge loads. There are no limits on the number of symbols in your load or on the size of your output file. And you can always count on full 32 bit target addressability, because the linker operates comfortably in the highest ranges of the 68020's address space.

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

Why Wait

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SOFTWARE DEVELOPMENT SYSTEMS, INC.
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What's going on here is the 286i running the programs with no wait states on most read and write cycles.

There's also a 16K-byte memory cache built into the board. SOTA says the cache hit rate with its proprietary approach is 95 percent on the average. A driver that comes with the board lets you enable the cache to work with the hard disk and video BIOS. If for some reason you want to slow it down to approximate 8088 speed for timing-dependent programs, you can do so easily from the keyboard (it takes only three keys).

SOTA rightfully warns about potential problems with caching on video RAM and the hard disk BIOS, but I didn't have any trouble with the Tandy system. There's also a RAM disk driver included in the software; the driver supports conventional and expanded memory.

Accelerator boards that soup up 8088- and 8086-based computers are plentiful, but I haven't seen one yet that's easier to hook up than the 286i. It took just a little more than a half hour to put the board in and install the software. I didn't have to mess with anything else, but you might have to make a few adjustments, depending on what brand of 8088- or 8086-based computer you have (SOTA notes a few minor tunings that have to be made with the AT&T 6300 and Zenith machines). The 286i works with the Lotus/Intel/Microsoft Expanded Memory Specification, SOTA says, but I didn't test this capability. The replacement board also has a socket for an 80287 math coprocessor.

The Norton SI program said the 286i makes the Tandy 1200 about 11 times faster than it normally is. Numbers like that sound almost meaningless until you run some applications. I prefer a real-world test like the Cup of Java benchmark: Operations that used to take long enough for me to go fetch a cup of coffee now are finished before I can even get out of my chair.

—D. Barker

continued

THE FACTS

SOTA 286i
$595 for 12.5-MHz version; $495 for 10-MHz version

Requirements:
8088- or 8086-based computer with at least 64K bytes of available memory for the 286i, an expansion slot, and about 5 watts of power.

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657 North Pastoria Ave.
Sunnyvale, CA 94086
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Inquiry 1002.


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Flatbed 24-pin Printer Handles Paper Better Than Print

The **ALPS Allegro 24** is a $499 24-pin dot-matrix printer that goes head-to-head with other low-cost 24-pin printers, like the Epson LQ-500 and the NEC P2200 (see the April BYTE for a review of 24-pin printers). The ALPS unit, though, takes a different approach to paper handling and to printing; as a result, it exceeds at one and falls short at the other.

The Allegro 24 comes with four resident fonts, which can be selected from the front panel, and a 7K-byte RAM buffer (expandable to 32K bytes). An optional cartridge provides three additional fonts. Character pitch and proportional spacing are also selected from the front panel. The Allegro 24 uses its memory rather than DIP switches for storing default settings. These can be easily modified in the printer's memory mode, which lets you change settings by pressing selection buttons on the front panel. The Allegro 24 emulates Epson LQ-500 commands and control codes.

The Allegro 24 performs comparably to other low-cost 24-pin printers. In draft mode, using the same test as in the April article, the Allegro printed about 85 characters per second (substantially lower than the 180 cps that ALPS claims). The Epson LQ-500 printed 100 cps using the same file. In letter-quality mode, the Allegro printed 39 cps versus 44 cps for the LQ-500. The NEC P2200 printed at almost the exact same speed as the Allegro 24 in both draft and letter-quality modes.

The print quality of the Allegro 24 leaves something to be desired. In draft mode, the quality is inferior to that of my 9-pin IBM Proprinter. In letter-quality mode, the print is comparable to that of a good electric typewriter, but the density is not uniform. I would say that the suspended head does not print as consistently as the more standard platen-based design. Also, the somewhat precarious ribbon probably contributed to the unsatisfactory print quality.

What differentiates the Allegro 24 from its competition is its flatbed paper guide. Instead of traveling around a platen, the paper in this unit travels straight across the bottom of the printer, with the print head suspended above the paper. ALPS claims that this design virtually eliminates paper jams and lets you use a greater variety of paper thicknesses. The paper loads easily in the front of the printer. The Allegro has fold-up legs that raise the printer enough to store about 2 inches of pin-feed paper beneath it.

The Allegro 24 has some good paper-handling features, like forms parking and automatic tear-off positioning. The forms-parking feature lets you "park" pin-feed paper while you're printing single sheets or envelopes. But I hit my first snag with the Allegro 24 using this feature. While the flatbed design may be good for paper handling, the suspended print head is very sensitive to paper thickness. I found that switching from standard pin-feed paper to a standard envelope required an adjustment of the paper-thickness lever. Otherwise, the envelope would push the ribbon out of its guide next to the print head. In fact, it was

continued

THE FACTS

ALPS Allegro 24
$499

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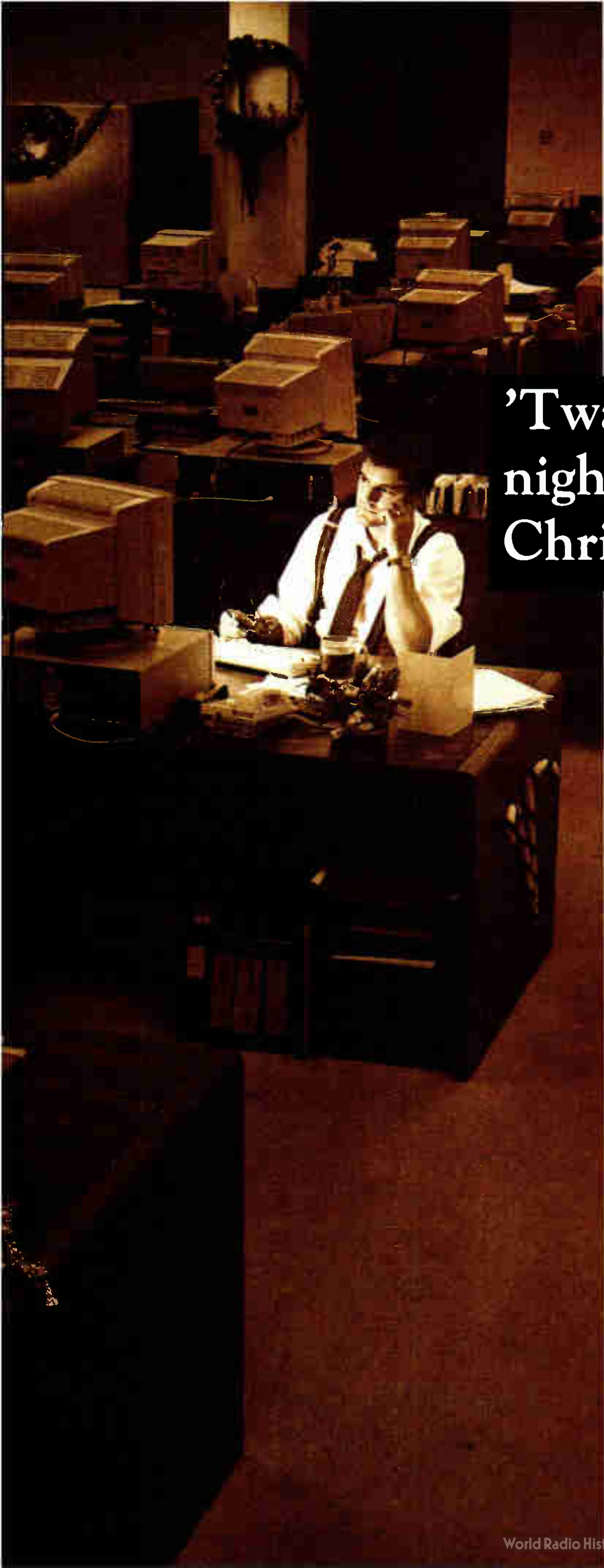
San Jose, CA 95134
(408) 432-6000
Inquiry 1004.



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difficult to install the ribbon in the print-head guide, and it tended to slip out.

The printer's noise level, tested with a Radio Shack 33-2050 sound meter, is about 72 decibels, which is about the same as that of the LQ-500 and the NEC P2200.

The real strong point of the ALPS Allegro 24 is its paper-handling features. However, oversensitivity to paper thickness and the inadequate print quality are major drawbacks.

—Nick Baran

An Expert System for Family Health Care

As a new parent and an artificial-intelligence enthusiast, I was particularly interested in **FamilyCare Software**; it's advertised as an expert system that you can use to help diagnose children's medical problems. You use menus to select one of four areas (accidents, general, skin problems, and newborns) and a topic within that area (e.g., head injuries, fever, or crying). Then you engage in a dialogue with the program; it solicits the information it needs from you, in a question-and-answer format, and then dispenses some advice.

Since I've got a 3-month-old child, I picked the category newborns/crying. The program asked: "Does crying worsen when you pick up the baby and rock him/her?" I said no. (But if you answer yes, the program responds: "URGENT! Get medical help now. Your child should see a physician within 60 minutes.") Then the program asked: "Does your baby seem to be in severe pain, or pain that lasts for more than 2 hours?" Again I said no. (But again, if you answer yes, the program shouts the same strident warning.)

Finally, the program asked: "Are you afraid that the crying might make you lose your temper?" Well, yes, aren't we all? Again the program shrieked "URGENT!"; to its standard admonition, it appended the ominous words, "Avoid a tragedy, seek help." That's a far cry from the calm and reasonable advice in *Dr. Spock's Baby and Child Care*.

Other areas of the program exhibit the same behavior. You don't need artificial intelligence to tell you to get help if a child is unconscious or not breathing; you just need a smidgen of common sense.

What knowledge the FamilyCare database does possess is hidden behind the question-and-answer interface; there's no provision for browsing, so you can't thumb through the information on the disk the way you can page through a book. To get at the program's expertise and data, you must engage in a question-and-answer/symptoms-and-advice session.

For the $99 price of this package, with its half-megabyte nonindexed database, you could buy Dr. Spock's well-indexed classic and a dozen other pediatric medical reference books.

—Jon Udell ■

THE FACTS

FamilyCare Software
$99

Requirements:
IBM PC or compatible with 256K bytes of RAM and DOS 2.0, or Macintosh with 512K bytes of RAM.

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Personal Computing Magazine

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* Warranty applies to IBM PC XT, AT Systems and their compatibles. Refer to Tatung VGA Card Manual for specific details. All detials included with each Tatung VGA card. All names trademarked are properties of their respective manufactures

At Long Last, Laptop

Compaq's 286 SLT laptop finally arrives, featuring a high-resolution display, battery-boosting technology, and a silver-plated price tag

It's been a long time coming, but Compaq—the company that made its name with IBM-compatible portable computers—has finally produced a computer for your lap. The Compaq 286 SLT is a real laptop that actually pushes the state of the art forward—though not necessarily in the ways you might expect. With a high-resolution display and an innovative approach to conserving power, Compaq's new laptop is designed to harness all the power of a desktop PC in a computer that's genuinely portable.

What You Get

The Compaq 286 SLT is a battery-powered laptop that looks at first glance like a miniature version of Compaq's AC-powered portables; when it's packed for traveling it resembles a tool chest more than a briefcase. As you'd expect from its name, the processor is a CMOS version of the 80286, running at either 8 or 12 MHz. The standard complement of RAM is 640K bytes, expandable to 3.6 megabytes. There's a single 3½-inch floppy disk drive built in, along with a hard disk drive—20 megabytes on the Model 20, 40 megabytes on the Model 40. The price of the system starts at about $5400 for the 20-megabyte system.

The first thing you notice when you turn on the Compaq laptop is that Compaq has decided not to compete head-to-head with Zenith with its display. The "paper-white" LCD screen on the Zenith TurbosPort 386 makes it the envy of the industry; it would be hard to match the quality of that display. Compaq has taken a more standard approach, using a 10-inch LCD display with ordinary backlighting.

But while Zenith's paper-white display is a beautifully clear, easy-to-read CGA screen, the Compaq screen is a 640- by 480-pixel VGA display with eight levels of gray. It displays anything in VGA, EGA, or CGA mode (with 16 levels of gray in CGA). I had no difficulty using the Compaq's display; it has good contrast, and is easily readable from a wide range of viewing angles.

The detachable keyboard matches Compaq's standard layout. Compaq boasts that the keys are full-size with standard spacing; they were certainly easy enough to use, and felt normal for typing. There are LED indicators for Caps Lock, Num Lock, and Scroll Lock,

continued

and separate cursor-control keys. As on many laptops, there's also an embedded keypad: instead of a separate keypad, part of the regular keyboard doubles as the numeric pad. It didn't bother me, since I rarely use a numeric keypad, but it's an inconvenience at best for those who do. Fortunately, however, Compaq will be offering an external numeric keypad ($129) that can be easily plugged into the system.

The good news about the keyboard is that while you can use it attached to the main unit, it also easily detaches. In fact, the SLT is one of the few laptops to have this feature. When it is attached, it sits on a shelf above the floppy disk drive and in front of the LCD screen. When detached, the keyboard is linked to the main unit with a coiled cable. The detachable keyboard makes this laptop very comfortable to use at a desk. For actual use in your lap, it balances better with the keyboard nested in its niche beneath the screen. Even at 14 pounds, this computer still sits comfortably on your lap.

Just below the keyboard in its niche is the rechargeable battery pack—it's spring-loaded, and easily pops in and out. The nickel-cadmium battery is specially manufactured for Compaq to stretch the time between charges. Compaq says the battery lasts about 3 hours between charges, assuming fairly heavy use of the hard disk. (One Compaq engineer told me that when he ran non-disk-intensive programs the system had lasted more than 5 hours.) The batteries charge automatically whenever the machine is plugged in, and there's a fast-charge mode when the computer's not in use—they'll fully charge in 1½ to 3 hours.

Across the back of the machine runs the usual collection of connectors—parallel printer port, serial port, external monitor port, and external disk drive connector. The external 5¼-inch floppy disk drive ($275) works, but the version I tested was big and noisy. It also didn't seem to be well integrated with the laptop—sitting next to the laptop on a desk, the external drive looked and felt like a gargantuan kludge. While I had no difficulty reading, writing, and formatting disks once it was properly installed, it took a while to get it working in conjunction with the internal floppy disk drive. Until I reran the configuration program, the computer would recognize either the internal or external floppy disk drive—but not both. Compaq offers a 40-megabyte tape backup unit ($799) as well; it plugs into the external disk drive port.

There's also a connector for an external keyboard. It's possible to leave the Compaq laptop folded for traveling, attach an external keyboard and VGA monitor, turn it on, and use the computer without even opening it up. I tried various combinations of connecting an external monitor and keyboard, and they all worked as expected.

Finally, there's a connector for what Compaq calls a Desktop Expansion Base. The idea behind the expansion base is to make it easier for those who want to use their laptop as a desktop machine. Instead of constantly disconnecting and reconnecting cables to the computer itself, the cables can be connected once to the expansion base; the computer slides into the base, and all the connections are made automatically. The expansion unit can also take up to two AT-compatible expansion cards, solving another common laptop problem. (The price of the Desktop Expansion Base will be $999. How well all this will work is speculation; Compaq didn't even have a working prototype available when I saw the laptop.)

Photo 1: *At the office, the Compaq 286 SLT can be placed in its optional Desktop Expansion Base, which contains two standard expansion slots. At the left is another option, a 5¼-inch external floppy disk drive.*

Expansion options inside the laptop's case are more limited but relatively painless: Remove six screws from the back and an internal chassis slides part way out, giving you easy access to most of the installable options. There are Compaq-standard memory-expansion slots for up to 3 megabytes of additional RAM (which is compatible with the Lotus/-Intel/Microsoft Expanded Memory Specification 3.2). There's also a modem slot, designed for either an internal 2400-bps modem or an additional serial-port board. The one internal expansion option that's not easily accessible is the socket for an 8-MHz 80287 floating point coprocessor—it's well to the front of the machine, and requires more work to get at.

Power Trip

What makes the Compaq laptop unique is its approach to extending battery life. Like most laptops, the Compaq shuts down the display backlight when typing stops for a sufficient period of time, which saves a substantial amount of battery power.

But Compaq has taken that idea to new levels with this machine. Many parts of the system are powered down during periods of inactivity (you can even modify the power-monitoring system defaults). The hard disk, for example, which normally chews up lots of power, is powered down in a two-step process. Powering down the read circuitry adds an almost imperceptible delay in hard disk reads; powering down the motor adds a substantial delay when it's time for a hard disk access, but saves much more power. You can power-down parts of the modem if they're not being used. Only one bank of memory is at full power at all times. You can put the 12-MHz 80286 into standby mode, or run it at a slower speed (8 MHz), or bring it to a halt—all of which save power.

Once power really does run low, this laptop goes to extremes to protect you from losing your data. At about 10 per-

continued

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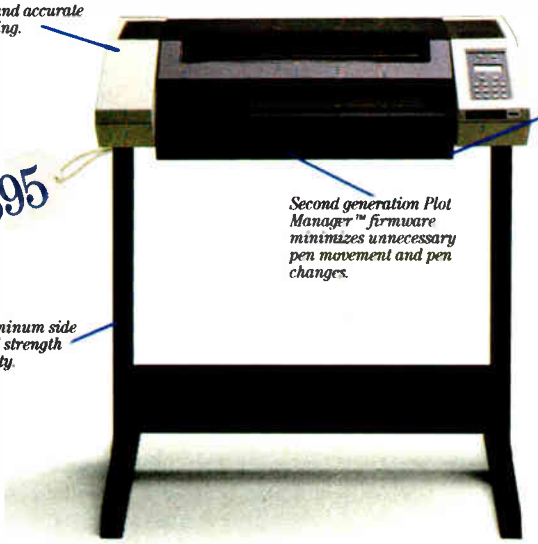

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cent power—roughly 20 minutes before the batteries run dry—the machine beeps, and begins blinking a low-battery light. When the system runs critically low on power, it beeps twice, then begins to put the system into standby mode. The standby mode simply shuts down the system as much as possible without losing what's in memory: It turns off the display backlight and clears the display, halts the CPU, powers down the hard disk and modem, and stops all memory access except refreshes. Once you've reconnected external power, you can return from standby mode—and you're right where you left off, with your data intact and your program still running. Compaq claims that, in standby mode, a few minutes worth of battery power can be stretched to hours.

You can also manually put the machine into standby mode with a button on the front of the computer. This is a convenient way to suspend work without actually turning the computer off—one of the nicest features of early laptops such as the Radio Shack Model 100. I tested the standby mode with several different programs, and it suspended and resumed each of them perfectly.

How It Performed

In tests with a number of BYTE Lab benchmarks, the Compaq performed admirably, if not spectacularly. In its fast mode, the system ran the CPU tests on par with some of the better 12-MHz AT clones—about 50 percent faster than an 8-MHz AT. (For comparison, see "Outclassing the AT," July BYTE; the Compaq laptop was just slightly slower than the Arche Rival 286 in the CPU benchmarks, and in line with systems from Amdek, Dell, and Epson for hard disk tests.)

Pricey, But Worth Carrying Around

Compaq has plenty of experience building computers that can be carried around, but this new laptop is clearly designed to be more than portable—it's made to be used in places where power is not available. It has much better battery life than other hard disk–equipped AT laptops, and far more power than machines with a similar battery life, such as the Zenith Z-181. It's light enough (at 14 pounds) to be carried easily, and powerful enough that it's worth carrying around.

The Compaq laptop also offers things you won't find in most laptops—like VGA graphics and a button that lets you suspend and resume your work.

At $5399 for the 20-megabyte model ($5999 for the 40-megabyte model), this laptop is certainly pricey. And it will compete head to head with a number of lower-priced machines that are already firmly entrenched in the laptop market. These include Zenith, with its SuperSport 286, and Toshiba and NEC, which have both recently introduced similar 80286-based systems. But it's the first laptop to carry the Compaq label, which has almost become synonymous with quality.

We had expected that when Compaq finally introduced its laptop, it would be a significant machine, a system offering convenience approaching that of a Model 100 combined with the power and display capabilities of a desktop system. On the whole, Compaq has proved us right. ■

Frank Hayes is a BYTE associate news editor at the magazine's San Francisco office. He can be reached on BIX as "frankhayes."

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SEEING RED

Jerry deals with a temperamental VGA board and has an Amiga transplant

I think these machines are trying to drive me crazy. They're all in it together, you know.

It all started when we got back from 2 weeks in San Antonio (mostly for work) and New Orleans (for the World Science Fiction Convention). The trip was great. The problem was that when I got back, I was confronted with about 21 cubic feet of packages—software, hardware, and letters—all of it unopened, and I had to deal with the stuff.

Near the top was the latest version of Fractal Magic. I've mentioned the program before; it's a reasonable one for examining fractal images. I'd hoped Sintar Software would improve the documentation and user interface, but they haven't done much. (For example, you have to use the mouse to tell the program you want it to plot something; but then to get the menu of files it can plot, you must let go of the mouse and hit Return; after which, you must use the mouse again to choose one of the programs thereby displayed. Why they couldn't have let the mouse handle it all is beyond me. Oh, well.)

Anyway, it's a relatively painless way to look at recursive plots, things like the Mandelbrot set and the Ikenada equations (which have some similarities to the Mandelbrot set). This was a new version that could make use of VGA resolution (as well as CGA and EGA). Now all I had to do was put in a VGA board.

I also had the new VGA Paint program from RIX SoftWorks, which is said to be a doozy. Certainly, their EGA Paint is excellent. Before I left for New Orleans, RIX's Doc Livingston said he'd arrange for a major outfit to send me a VGA board that showed up VGA Paint very well. When I looked in the huge stack of stuff, there it was. This, I thought, is going to be easy. I'll put in the new board and test a whole slew of VGA programs. I got out the automatic screwdriver—I'm getting very fond of those things—and opened up the Zenith Z-386.

Then I opened up the VGA board. It came with an invoice that said it was being lent to me for 30 days (which had started 2 weeks ago), after which I'd be billed for it; and if I sent the board back without calling them first to get a return authorization number, they wouldn't accept it. It also said that opening the package constituted acceptance of those terms. Of course, I couldn't read the terms before opening the package.

I can't possibly accept anything on a short-term loan like that, so the board went into the out stack. I don't have time to telephone them about it. If they really do refuse its return, I'm sure Notre Dame can use a VGA board.

Then I noticed that there already was a VGA board in the Z-386. It turns out that when we were experimenting with Unix, we discovered that SCO Unix with the Locus DOS-under-Unix package won't work with the Zenith Z-448 EGA video board, so Alex had installed our Video Seven Vega VGA board. That had worked just fine to drive the Zenith Flat Technology Monitor for Unix. (See last month's column. Incidentally, Zenith says they'll have new video boards worthy of their wonderful FTM Real Soon Now.)

I figured the Vega board was just what I needed. It's very fast. One thing I'll be working on with the Z-386 is Windows/386, and believe me, that *needs* a fast video board. Anyway, the Vega board was already installed, so all I needed to do was put the machine back together and install Fractal Magic.

That was simple enough. The only thing was that when I turned the machine on, there was no color red on the screen. Plenty of greens and blues, in nice high resolution, but nary a flicker of red. I fussed about with it for a while. I was sure it wasn't the program, but just to be absolutely certain, I exited to DOS and invoked Norton Utilities to set the screen attributes to red on white.

Nothing happened. When we took Unix off the Z-386, we installed IBM DOS 4.0, and Norton Utilities don't work with DOS 4.0. (I now have a version that does.)

IBM DOS 4.0 has a bunch of reported bugs. So does the unofficial DOS 4.01; I've decided to wait for a real update, so that had to be removed. No time like the present. It didn't take long to go back to the Zenith clone DOS, which is something like version 3.21-R. Now I could invoke Norton's screen attribute command to tell it to display red on white.

I got black on white. No red.

OK, I thought. It's probably the board, but maybe it's the monitor. All I have to do is connect the FTM to the Cheetah's video output—the Award video card has both EGA and VGA outputs—and see if any red shows up. That monitor is heavy, and there wasn't any suitable table or other flat surface near the Cheetah, but I managed to get the FTM perched precariously on my desk—only to discover that I no longer have the Award EGA/VGA board in the Cheetah.

The Award board had worked fine with the Electrohome 19-inch variable-sync monitor until I tried Windows/386; but that had been too much for the Award board, so I'd put a good vanilla EGA board in the Cheetah. The EGA board outputs EGA on a 9-pin output jack. The 31-kHz analog FTM wants 15 pins.

That took care of that test. I could have put a new board in the Cheetah, but working on a tower-configuration machine isn't easy. You have to sit on the floor, and my knees were giving me fits anyway. Heck with it. Back to the Z-386.

continued

learn about using the Mac in a couple of days—the Amiga has lots of capabilities, and it deserves more time than I've been willing to give it.

On the other hand, the machine is sometimes beastly slow, especially at disk access.

Recently, some of that changed. Commodore sent Andy Finkel ("afinkel" on BIX) out to update my Amiga 2000 and see that I got properly checked out on using it. I also invited the local Amiga guru, Joanne Dow ("jdow"), to come over so she'd know what Andy did in case I needed help after he left.

The first thing Andy did was quite literally jack up my hard disk drive and run a new machine under it. While we were at it, we looked for a place to put a Supra hard disk drive, but there just isn't room for two of them inside the Amiga 2000's case.

The new Amiga has a 68020 processor. It also has new ROMs with the version 1.3 operating system. Prior versions of AmigaDOS required you to boot up the machine with a Kickstart floppy disk, even if you had a hard disk drive installed. No more. Now the Amiga boots up from the hard disk, just like any other computer.

The next thing they did was save all the stuff from my hard disk and reformat it. There are new disk-access techniques that speed things up something wonderful. You no longer have time to grow a beard while the Amiga loads files.

Then they did a lot of tricks with the start-up sequence. I don't understand most of them. It's not that I *can't* understand, just that it will take time: the Amiga is a bit different from any other machine we have here. For example, to the Amiga, the command to get the disk directory is just another command file on the disk; before it can give you a directory, the machine has to go get the directory reading program and bring that into memory. Needless to say, that slows things a bit.

However, with the new AmigaDOS, it's possible to make that directory command a memory-resident program. DOS does this automatically—that is, a certain number of DOS utilities like DIR are brought into memory and left there on start-up. AmigaDOS 1.3 will let you do the same thing, except that, unlike PC-DOS, AmigaDOS lets you choose which utilities you want in memory and which stay as disk files.

Interlacing

The normal video mode for an Amiga is 200 lines. Actually, the machine traces out 400 lines per frame, but lines 201–400 are identical to lines 1–200 and are put right on top of the previously painted set.

There's another mode, called interlace, in which lines 201–400 are different from lines 1–200. Line 201 goes in between line 1 and line 2; 202 between 2 and 3, and so on. The result is higher resolution. Alas, on the usual monitor, the image seems to jump up and down, and if you watch it long, you'll get a headache. You can make interlace mode usable for some programs by careful attention to colors and contrasts, but at its best it won't be all that easy to look at.

The problem is that for good CAD programs, you can use the higher resolution you get from interlace. One of the better programs, Intro CAD, doesn't even have a noninterlace mode. No matter what you

continued

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do, trying to use the program with an ordinary monitor is nearly impossible; after a while, the flicker will drive you nuts.

However, if you're willing to spend the money, there's an elegant remedy. The Amiga has built-in video and stereo output, but there's also a video slot that can accommodate a third-party video board. Joanne Dow brought over the most popular one, a board called Flicker Fixer from MicroWay. Flicker Fixer outputs analog color at 31 kHz, and thus will play to most multiple-frequency monitors. In particular, it works with the NEC MultiSync monitor, and spectacularly well with the FTM. (We had no problem with red, even on my flaky old FTM.) The result is gorgeous.

Make Your Own Movies

One of the standard programs for the Amiga is Deluxe Paint II from Electronic Arts. At least one version of Deluxe Paint has been around since the early days of the Amiga, and indeed, the program helped make the machine popular. Now there's Deluxe Productions, which lets you take pictures drawn with Deluxe Paint II (or, for that matter, pictures taken from any other source, including scanned-in pictures, provided only that they're stored in the Amiga standard image data format) and mix them. You can also mix in images from a VCR.

The results can be rather spectacular. Bring in, say, a map of the U.S.; overlay that with clouds and lightning; move the clouds across the map as the lightning flashes; bring in other weather fronts and move those; add titles and text boxes; and so forth. You can do an illustrated weather show that your local TV station would be proud of.

Deluxe Productions is quite easy to use, in the sense that it won't take an hour to learn how to do what I described above. It might take a lot longer than that to get it *right*, but that's a matter of artistic talent, not understanding the program. There is a learning curve, but much of what you must do is intuitive, and the rest is fairly simple to remember.

Deluxe Productions is capable of a kind of animation. It has a dozen ways to wipe images on and off. ("Wipe" is the term used to describe the way the image appears: does it start at the upper left corner and wipe itself on down to lower right? Or perhaps start in the middle and sort of spiral on?) You can bring in various objects, move them, and control how long they move and how long they pause. Wipe in a new background picture. Bring in more objects. Edit all the scenes that you've created. There are a bunch of other features, all described in a thick manual that for once has lots of examples and is easy to read.

I don't create ads, but if I did, I'd want a capability like this. It's sure great for just noodling around with images.

The manual says you need an Amiga with at least 1 megabyte of RAM. More memory helps; so does a hard disk drive. The manual also says you need Kickstart 1.2. We found that the program works fine with the 68020 machine running AmigaDOS 1.3.

Coming Attractions

The Deluxe Productions manual informs you that the program uses all the "chip RAM" it can get, and it warns you to close all extraneous windows before you use it. Chip RAM is peculiar to the Amiga: the special Amiga chip set has 512K bytes of very fast "video RAM"

continued

built into the system. (There is also "fast RAM," which corresponds to "motherboard RAM" on an IBM PC.) Chip RAM controls the Amiga's screen images. Programs can get into trouble if you have left a lot of screen windows open and the program needs more chip RAM than is available.

By the time you read this, Commodore will have upgraded the Amiga: there will be an optional new chip that contains a full megabyte of chip RAM, enough that no program should have any problems.

The PC Side

The Amiga 2000 was designed to compete with the IBM PC. The notion was that the PC is boring; the average banker or businessperson would really prefer an exciting computer like the Amiga but unfortunately has no choice because the work must be done. Enter the Amiga 2000, which has an IBM PC built into it.

This was no bad marketing notion, but it wasn't carried out very well. For one thing, there's no real attempt to marry the Amiga capability to the PC side. As far as graphics are concerned, the Amiga side of the system might as well not exist. Another problem is that the PC side is absolutely and completely vanilla—a slow, cumbersome, and rather boring machine; the rest of the world has moved on to PC AT technology. Worse, most available speedup boards that convert a vanilla PC into an AT don't work on the Amiga 2000, which isn't *quite* 100 percent PCompatible.

It's pretty close to 100 percent, however. The standard test programs, like Flight Simulator, work well enough. So do most DOS utilities, like Norton Utilities and Norton Commander.

We were even able to get the LANtastic local-area network running. (You have to set the LANtastic board to use interrupt request 5, but that's no problem.) As a result, you can access CD-ROM and WORM (write once, read many times) drives through the network, making the PC side of the Amiga a great deal more useful. You can also use LANtastic to access the PC side of the Amiga from your remote PC or AT.

The Amiga itself is a fascinating machine, the sort of thing most BYTE readers always wanted, especially back in the early days when all we really wanted from our machines was a bit of fun. It's the greatest games machine in existence. (Wait until you see Rocket Man. Also, about the time you read this, Dungeon Master will be available for the Amiga.)

The Amiga also has enormous potential for education. It's cheaper than a Mac II, and powerful enough for nearly anything you'd want in a classroom.

Unfortunately, there isn't much business software for the Amiga side of the 2000, and while the Amiga in the hands of an expert can do things few PCs will ever do, it takes, if not an expert, at least someone very dedicated to learning the machine to get serious work out of it. There are still bugs, and AmigaDOS, while powerful, has some odd quirks.

Commodore is making progress. The 68020 Amiga with AmigaDOS 1.3 is a giant step in the right direction.

Scanning, Faxing, and Printing

The Amiga doesn't have much business software, but the Mac II certainly does. It's got other stuff, too.

We recently got an upgrade for the LaserWriter. Plugging it in is no prob-

continued

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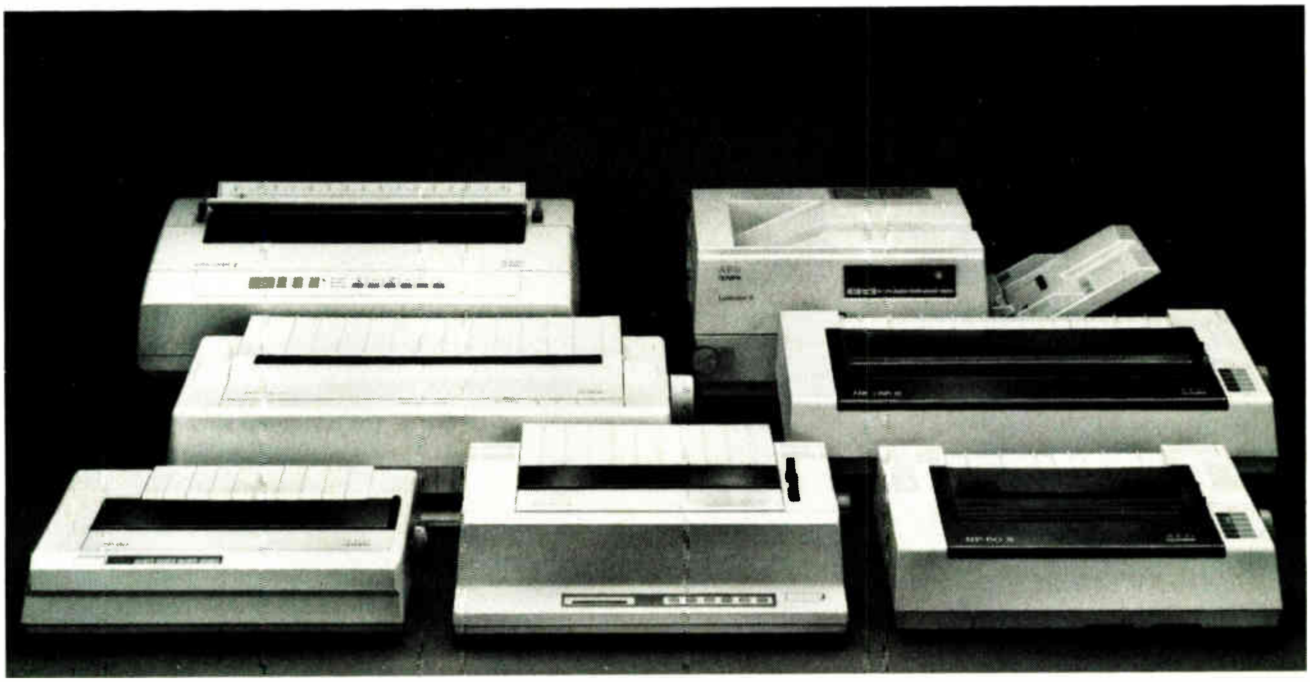

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lem, or at least it isn't for ordinary establishments. My LaserWriter sits on a low shelf below the Hewlett-Packard LaserJet in the printer corner of the office; getting at that sucker in order to change boards isn't easy. It's especially hard just now, since every rolling test stand and table seems to be covered with machinery. They're all in this together, I tell you.

Anyway, eventually we cleared off a test stand so we could work on the LaserWriter. After that, upgrading it to NTX II status was a snap: loosen two screws, pull out the old smarts board, and insert the new one. Whole operation took about a minute. Of course, it took another 10 minutes to get the upgraded LaserWriter back where it belongs and connect all the cables, but that's not the machine's fault. (Actually, it is Apple's fault: not that the LaserWriter is large and heavy, but that the silly little cables are small, delicate, and a bear to connect properly.)

Once that was done, we could connect up the Apple scanner. That turns out to be easy: it's a small-computer-system-interface device, so all you have to do is select a unique number for it and connect the cable. Naturally, the cable Apple supplied is *just* too short to let me put the scanner in the most convenient place, but why did I expect anything else?

Using the scanner seems to be easy enough. There are a lot of fine points I haven't picked up, but in general the Macintosh philosophy has been followed: the way to do something is generally obvious, and if you noodle around with menus to see what various options do, you'll learn quickly enough. There's also quite a nice tutorial.

Once an image has been scanned in, you can diddle with it a bit, then save it. The software recognizes two save formats—a PICT format, which can print to PostScript printers, and a MacPaint format. The MacPaint image can't be bigger than 8 by 10 inches. The AppleScan software can read only PICT files.

When you have your image in memory—it will be a *big* file, and you'll much appreciate having Priam's 330-megabyte MacDisk if you're going to save many images—you can print it on the LaserWriter II, or send it by facsimile if you have an AppleFax board. You can also accept an incoming fax to be printed on the LaserWriter or stored on disk. We've got AppleFax, but what with all the other activity around here, it never got installed. Next week for sure. I have no doubt it works.

Apple equipment isn't cheap, espe-

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cially top-of-the-line stuff like I have, and particularly since their latest price increases; but the Macintosh and its software are easy to learn, and everything works. For desktop publishing, the Mac II with its built-in fonts works better than anything we've seen on a PC.

The other day, my son Phillip, the U.S. Navy Midshipman, had to put out a newsletter for his battalion. The material was all written on PCompatibles (the Navy, like the other services, uses the Zenith Z-248). Alex transferred the files from the PC to the Macintosh with Traveling Software's PC Mac Link, then set up the newsletter on the Mac II with Aldus PageMaker. They had the whole job printed on the LaserWriter II in one evening, even though neither had much experience with PageMaker before.

Alex also found a use for the MultiFinder: you can play Spectrum Holobyte's Solitaire Royale while PageMaker is formatting and sending your documents off to be printed. There are eight different solitaire card games, including two I never heard of before. They play smoothly, and the cards have changeable backs. Changing the backs changes the figures on the court cards. Alex is particularly fond of the vampire deck. Meanwhile, PageMaker was doing a fine job with the newsletter.

What with IBM and the Gang of Nine fragmenting the PCompatible world, Apple looks better every day. There's even a good Lisp for the Mac II.

Photon Paint

Everyone writes paint programs, but MicroIllusion has come out with the neatest Macintosh paint program I've ever seen. They call it Photon Paint, and what you can do with it on a Mac II is just plain spectacular. It makes me sad that I can't draw, since we're in the middle of preparing the Lunar Society's briefing for potential sponsors; I could make some really great color slides with the Datacam screen camera, if only I could draw. Photon Paint says it's compatible with other third-party art and presentation software and can handle imported pictures of any size, so I presume I can scan images into the Mac II, then tweak them with Photon Paint.

We'll be making up our final briefing charts pretty soon; more next month.

Stars!

Years ago, the Los Angeles Science Fantasy Society took a trip out to the desert. One chap had never been outside LA before. He stared up at the sky and was lost.

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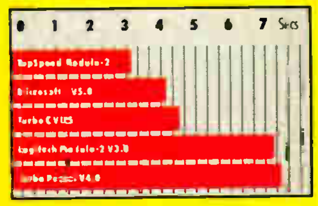

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Come morning, he was lying fully clothed on the sand, still staring up at the sky and muttering, "Stars!"

You won't get quite that experience with this program, but it's close.

Sky Travel is also published by Micro-Illusion. Available for the Commodore 64/128, the Mac II, and the Amiga, this is billed as "an all-encompassing astronomy program" and pretty well lives up to it. Want to know where the planets are, will be, or used to be? Look at distant galaxies? Find constellations and see them from any point on the earth? Like to know which star was the North Star when the Great Pyramid at Giza was built? Take a guided tour of the universe?

Any of that and more comes with this program. If you or anyone in your family is interested in science or astronomy, you can't afford not to have this. Highly recommended.

DESQview vs. OS/2

I presume that everyone knows that DESQview is a sort of MultiFinder for DOS: it lets you keep a number of programs running concurrently. I generally turn off the capability that lets applications run in the background (unless they're communications programs, of course); that way, I have only one program *running* at once, but several are loaded into memory, so that I can jump from one to the other almost instantly.

I have a beta-test copy of the latest version of DESQview. (You should be able to buy it about the time you're reading this.) It has a couple of silly bugs that Quarterdeck's people won't have any trouble fixing. Otherwise, it's very nice.

For one thing, it's a lot smaller than the old DESQview, meaning that you can have larger windows. For another, you can change program parameters on the fly. With the earlier DESQview, you had to reset the system before parameter changes took effect. No more.

The new DESQview doesn't work with IBM's DOS 4.0, but then nothing else works very well with it, either. We can be certain IBM will clean up their act. When that happens, you'll be able to have large disk drives—as large as you like. You can, using the Phar Lap extensions, write programs larger than 640K bytes, and, using Quarterdeck's new API (Application Programmer Interface), you can adapt those programs for smooth data transfers, graphics, and other stuff, as well as have multiple processes at work.

Finally, since it is DESQview, you can run a number of programs at the same time or, like me, keep a number of them in memory and flash back and forth between them.

Given all that, it's hard to understand what OS/2 is going to do for us.

DESQview, after all, runs the programs you already have. In theory, OS/2 can do that—that is, it can run one of your existing programs at a time in a thing called the compatibility box. However, your program will run quite slowly compared to its speed outside OS/2. If you want to run more than one program at a time with OS/2, the programs have to be specially rewritten so they can run under OS/2. The big surprise is that if you get specially rewritten versions of your programs, the results will be disappointing. Even programs written for OS/2 are blooming slow.

continued

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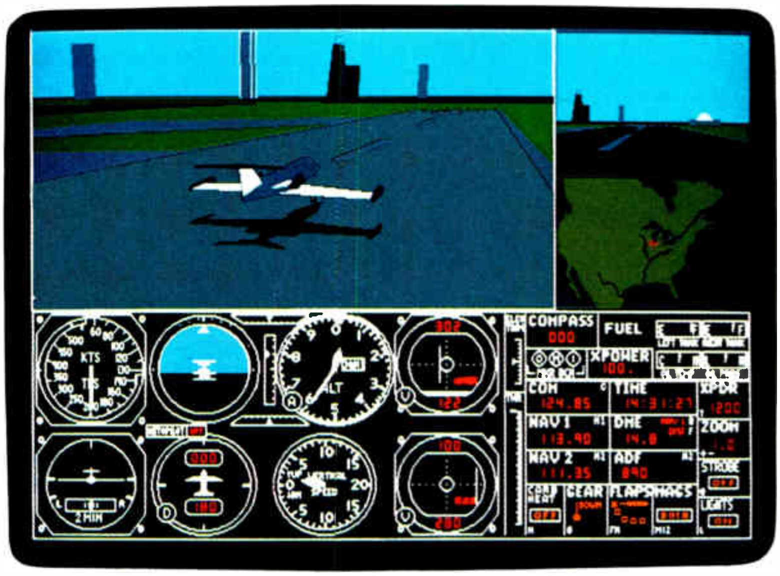

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DESQview, on the other hand, runs existing DOS programs about as fast as they ever ran under DOS without DESQview. If you have a lot of programs running in the background, you certainly can slow things down; but that shouldn't surprise you. DESQview and OS/2 both are nothing more than ways to let your programs share cycle time on the CPU chip, and, fast as our machines are, you can overload them. The point is that, in general, your standard DOS program will run faster under DESQview than the specially written version of the same program will run under OS/2.

I am fast coming to the conclusion that OS/2 is just too big and too late to keep up with the competition. If you're in program development, you can't afford not to keep up with where DESQview is heading.

Toning Up

Mrs. Pournelle had just finished the outline and some sample chapters of her new book when her Mannesmann Tally laser printer started spewing out blank pages. This shouldn't have surprised us. We've had that printer a long time, and we've put a lot of paper through it without ever changing cartridges or doing any other maintenance; and since they're all in it together, it should be no surprise that the printer waited for a Friday afternoon with a critical job before it complained.

Actually, it could have been worse. We had a couple of hours before everything closed for the weekend.

A quick inspection of the printer's documents revealed that it is built around the Kyocera laser-printer engine. It doesn't use cartridges of the kind favored by the LaserJet, with its Canon laser engine. Instead, you put in toner. I had a horrible memory of trying to pour toner into an ancient Xerox copier, but that wasn't to be: the toner comes in a sealed container.

Quick calls to Priority One and the local ComputerLand revealed that neither one stocked Mannesmann Tally—or Kyocera—toner cartridges.

"Call Mannesmann Tally," I told Roberta. "They'll know."

Indeed, they did, and there was a store not far from us. The cartridges aren't cheap: $150 for four of them. On the other hand, they last quite a while. The documents say 3000 sheets, but in our case it was well over 5000. We've been using that machine pretty heavily for months.

Replacing the toner box turned out to be a bit beyond Roberta's strength: she could get the box in place all right, but when it came time to pull the tape out (thus releasing the toner), she just couldn't do it. I had to come help, although I suspect that Roberta could have done it if she'd been confident that all she had to do was pull harder.

We sealed up the toner well and turned on the printer. It complained that its case door was open. Then it jammed a sheet of paper. There were a couple of other minor glitches, none serious, and probably all caused by our being in a hurry. I cursed the machine horribly, turned it off, and turned it back on.

It worked fine, and now I know how to change the toner box.

Procomm Plus and Zenith

While we were off on our trip, I used the Zenith SupersPort Z-286 portable to keep in touch. Just before we left Los Angeles (by train), I used LapLink to squirt over the entire Procomm Plus subdirectory to the SupersPort. When we got to San Antonio, I called to get the local Tymnet access number, added that to the Procomm Plus menu, and fired up.

The result was goofy. Procomm Plus announced that I was connected at 300 bits per second. Of course, I had set the system for 1200 bps; and when I tried to send anything, Tymnet curled up and died. Clearly, I was trying to communicate at the wrong speed.

If I altered my program to communicate at 300 bps, it worked fine—except that I was connected at 300 bps, and that's horrible.

For a couple of days I made do, while asking on BIX if anyone had ever had this experience. After all, the *identical* software had worked perfectly when run on my 20-MHz Cheetah driving the US-Robotics Courier HST modem; why didn't it work now?

I still don't know the answer to that, but I did get things working. There is among the Procomm Plus menus a set of options. One of them is automatic baud rate adjustment. I had that set to On.

When you first access Tymnet, it sends you some stuff at 300 bps. Then, when you transmit back at some other speed—1200 or 2400 bps—Tymnet adjusts. However, the combination of Procomm Plus and the Zenith internal 300-/1200-bps modem in the SupersPort did something else. When the Zenith modem heard that initial 300-bps signal from Tymnet, it locked onto that speed, and it apparently even sent some kind of acknowledgment. Thus, Tymnet thought I was connected at 300 bps. Then, when Procomm Plus started transmitting at

continued

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1200 bps, Tymnet died.

The remedy was to set that automatic baud rate adjustment option to Off and leave it that way. After that, I'd get on at 1200 bps, Tymnet's introductory 300-bps string would show up on my screen as gibberish, then we'd lock on at 1200 bps for the rest of the session. Worked fine.

I still don't know why the Zenith and USRobotics modems work differently with identical software. I expect it's all part of the plot. They really are all in this together.

Winding Down

Once again I've been unable to finish the piles of stuff I laid out. I still owe you a report on FastTRAP, the mouse substitute (I am beginning to like it). I have new advanced versions of Norton Commander and Norton Utilities; if you have a PC and don't have the Utilities, you're nuts; and for that matter, there's really nothing better for cleaning up your disk and organizing things than Norton Commander.

I haven't mentioned GrandView, Symantec's new outline and word processing package: this software is so good you could write books with it, and I might be tempted to try it except that Q&A Write has been improved again, largely at my suggestion.

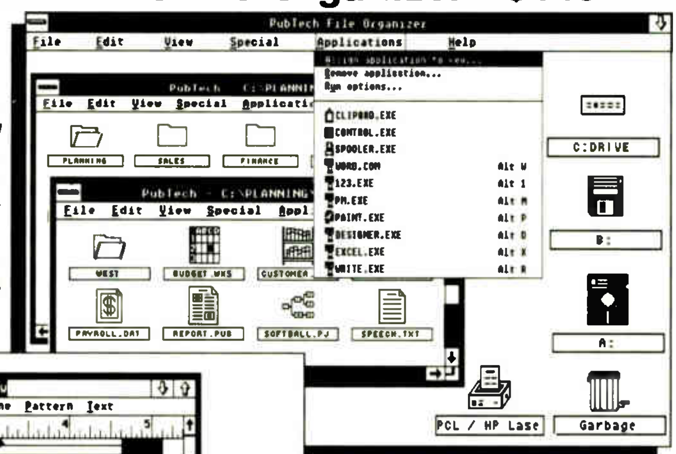
When I tried to send anything, Tymnet curled up and died.

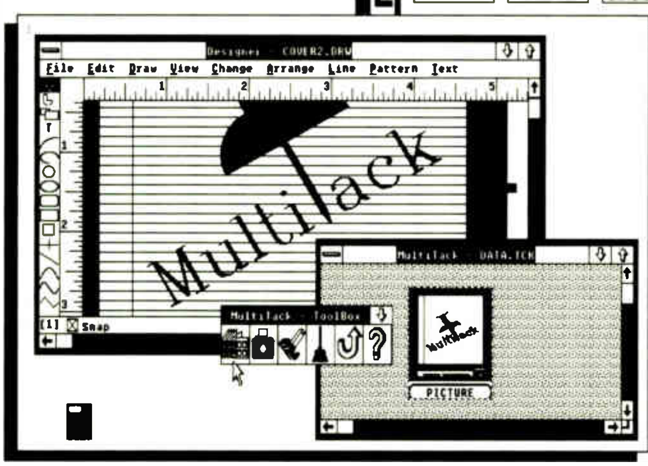
I've got a new version of MacSpin for the Macintosh: this is a statistics program designed by some of John Tukey's graduate students. Tukey is one of the top figures in statistics. The program reflects his philosophy of examining your data and playing with it so you understand it before applying various statistical formulas. If you have a Mac and you work with statistics, get this program.

The book of the month is John Keegan's *The Mask of Command*, an entirely different kind of military history by the man that Tom Clancy says is the best military historian alive. The computer book of the month is *LaserJet Unlimited* by Ted Nace and Michael Gardner (Peachpit Press, 2nd ed., $24.95). I didn't much care for the first edition, but this one is an excellent reference work on everything you ought to know about LaserJet printers.

Almost everything, actually: they don't seem to know that all these machines really are plotting insurrection. ■

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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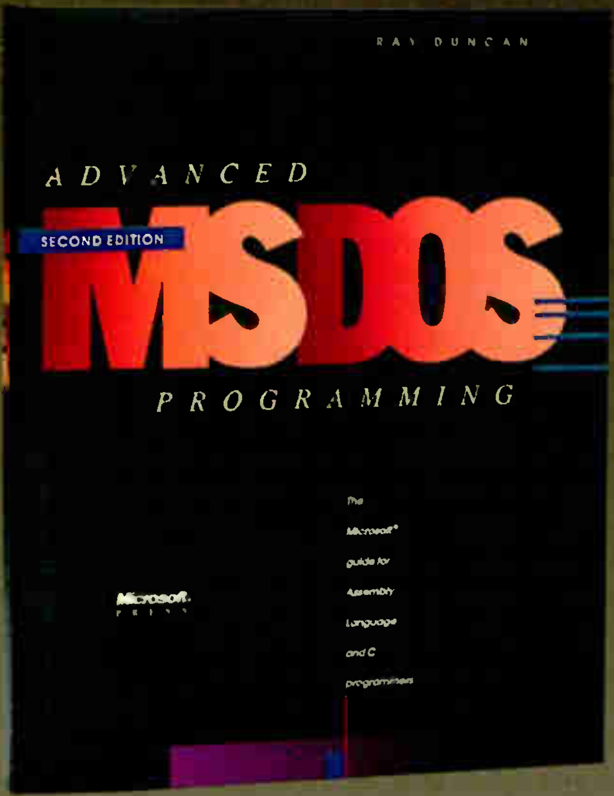

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BYTE magazine
John Unger, IBM Issue 1986

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Ray Duncan, DOS authority and noted columnist, explores key programming topics including character devices, mass storage, memory allocation and management, and process management. In addition to his expert advice, he has packed his book with a healthy assortment of updated assembly-language and C listings that range from code fragments to complete utilities. These include a fully functional terminal-emulation program, a nifty DOS shell, and the framework for customized critical-error interrupt handlers.

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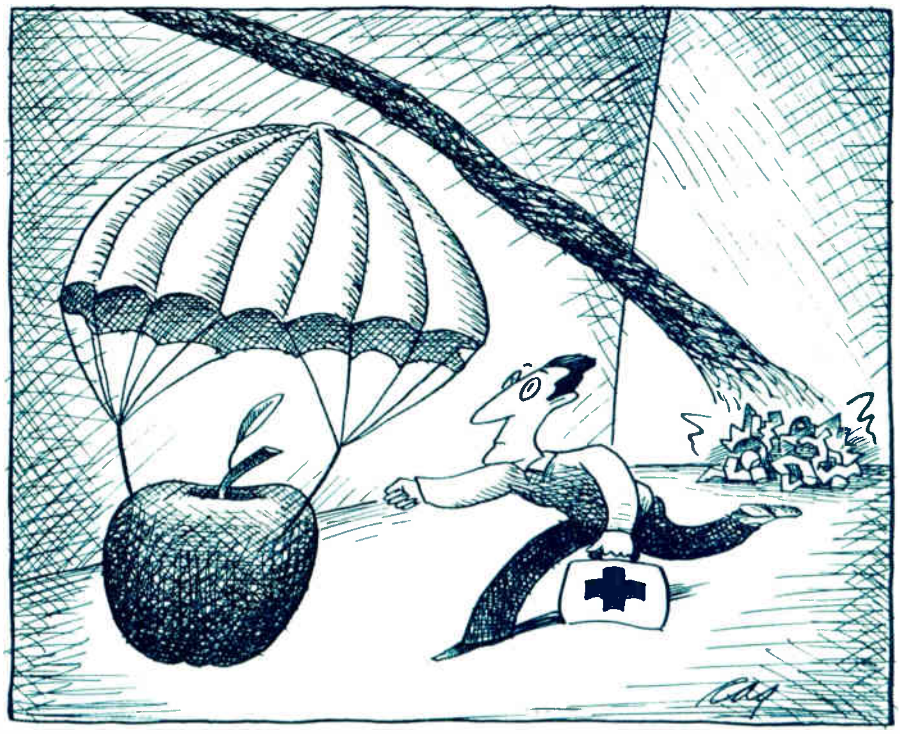
CRASH!

A hard disk wipeout points up the Mac's fragility, and 1st Aid Kit comes to the rescue



OK, OK. I admit it. I got what I deserved. A couple of weeks ago, I managed to trash all 160 megabytes of the external Jasmine hard disk I have hooked up to my Macintosh SE. I was running a bunch of older programs under MultiFinder—a dangerous practice—when all of a sudden, in the middle of writing a file to disk, the cursor froze in the upper right corner of the screen next to the MultiFinder icon. Blam! I hit the reset switch as quickly as I could, but by then it was too late.

I have to tell you, there is nothing more ominous than the silence that greets you when you're waiting for a corrupted hard disk to boot. The damage was nearly total; I'd managed to wipe out the entire directory structure of the disk. Since I'd actually remembered to back up my personal files several weeks earlier, my life wasn't completely ruined, but finding and loading all the original program disks took the better part of a week. This ugly lesson has me out in the stores, checking the prices of tape drives; I simply can't afford the time this has cost me.

I'm also really upset with the Macintosh operating system. Like all Mac owners, I've grown accustomed to the sporadic system crashes that characterize life on the Mac. Every so often, the machine grinds to a halt with no discernible explanation, but usually the only files affected are unsaved documents still open at the time of the crash. I really wasn't expecting to utterly destroy the disk simply by using software. With years of rigorous use of both CP/M and MS-DOS computers, I have never produced such a disastrous effect without deliberately fiddling with areas I knew I shouldn't touch.

With fonts and desk accessories and MultiFinder and CDEVs and INITs and such, the Mac operating system—none too stable to begin with—has reached the point of no return. My Macintosh system is now more fragile than my MS-DOS machine loaded with its most cantankerous pop-up programs. It's a sorry state of affairs when using my two primary computers fills me with dread.

To make matters worse, Apple claims to be rewriting the operating system from the ground up. This should be cause for rejoicing, but I note that Apple's frequent system releases have been more bug-laden and crash-prone than Microsoft's MS-DOS updates, and Microsoft has managed to compile a pretty dismal record on that front. So what are we going to get from Apple? The equivalent of OS/2 for the Mac? The mind reels.

Seems to me that it's time the microcomputer industry got its act together. I don't care how it's done, nor which operating system triumphs. As a lowly end user, I'm just tired of excuses, rationalizations, explanations, and the sick feeling in the pit of my stomach every time I use a personal computer. The computer revolution is no longer a new phenomenon; how long must we wait for our data to be safe?

Lifesaver

When the hard disk crashed, I was smart enough to ignore the warning messages that told me to reinitialize the beast; I knew that by so doing I would forfeit any chance I had to peel off some of the lost data. I booted off the Mac SE's internal drive and tried to see if any of the utilities I had would recognize the Jasmine.

continued

ILLUSTRATION: RICHARD A. GOLDBERG © 1988

Nothing worked. I tried Apple's utilities, Jasmine's utilities, and a couple of long-shot disk-editing tools that I thought might do the trick. Zilch. In desperation, I went out and found a copy of 1st Aid Kit (1st Aid Software, $99.95), which several Mac hackers had told me was the best product on the market for recovering seemingly dead hard disk drives.

To my amazement, the program did work. It recognized the disk that every other program had told me was gone for good, read through it sector by sector, derived a full directory, and asked me if I wanted to try to resurrect the files. This was a tedious process, as I had to select files one at a time and off-load them onto floppy disks, but I had just about given up hope. And the miracle was not a complete success; many of the files that had been fragmented into discontiguous blocks through normal hard disk use were beyond repair. However, the fact that I was able to salvage even a few files was impressive.

I believe that 1st Aid Kit (not to be confused with Apple's Disk First Aid program) is one of those lifesaving utilities that no Mac owner with precious files should be without. Even if you never use it, you'll sleep easier. If you do need it to recover from a bad crash, either on a hard disk or a floppy, you'll thank all the gods you pray to for its existence.

The documentation that accompanies the program is at least as important as the software itself. The manual contains the most comprehensive and intelligent discussion of the Mac's filing system I've ever seen. It's thorough, logical, and disarmingly easy to read; though the material is technical in nature, you won't have to slog through it. If you've ever been frustrated with Apple's skimpy efforts at documentation, buy 1st Aid Kit for the manual alone.

This one is highly recommended.

Items Discussed

Crystal Quest $39.95
QuickDEX $60
Greene, Inc.
15 Via Chualar
Monterey, CA 93940
(408) 375-0910
Inquiry 1005.

1st Aid Kit $99.95
1st Aid Software, Inc.
42 Radnor Rd.
Boston, MA 02135
(617) 783-7118
Inquiry 1006.

HyperDialer $39.95
DataDesk International
7651 Haskell Ave.
Van Nuys, CA 91406
(818) 780-1673
Inquiry 1007.

ProPoint $139.95
Abaton
48431 Milmount Dr.
Fremont, CA 94538
(415) 683-2226
Inquiry 1008.

Maccessories

On a brighter note, I recently bought myself a couple of dandy Macintosh peripherals and found the perfect software to go with them. The prize of the lot is the ProPoint trackball (Abaton, $139.95). I'd noticed an unpleasant stiffness in my mouse elbow, so pronounced that it ached for hours after a long session with a graphics program. There's been no recurrence since I retired my mouse and started using ProPoint.

The ProPoint unit itself plugs into the ADB port on either the keyboard or the Mac SE itself. It's about the size of a detached numeric keypad, and it greatly reduces the space you need in your work area. My favorite feature is the location of the two buttons to the lower left of the ball. With your fingers on the ball, a large click/drag button rests conveniently under your thumb. A smaller lock button lies directly below it, for use in long-distance dragging.

As a result of this design, you don't have to lift your fingertips from the ball to work the buttons. You can operate ProPoint in much the same fashion as you would operate a mouse; no other trackball I've seen makes the transition this painless. The buttons are built for right-handed people, but if you're a lefty, they're no more inconvenient than the buttons on some other trackballs.

I have been honing my trackball skills with Crystal Quest (Greene, $39.95), a mindless but addictive shoot-'em-up game. You maneuver a "ship" around obstacles, while nasties converge on you from all directions; you can either shoot at them or avoid them to rack up points. It's wonderfully effective training for eye-hand coordination on the trackball, and I don't feel at all guilty for playing it. After all, it's part of my work, isn't it?

The other hardware add-on I've acquired is HyperDialer (DataDesk, $39.95), a telephone-dialing peripheral that plugs into the Mac's sound port rather than tying up a serial port and a modem. It's basically a teeny tone generator that attaches between the handset and the base of a Touch-Tone phone, and it cheerfully plays the little seven-note melodies that represent phone numbers in this digital age.

HyperDialer comes from the same folks who bring you the DataDesk keyboards, and it's a quality item. I passed this product by for some time because I thought it worked only with HyperCard (a logical conclusion, considering the name). Wrong. It can also be driven by QuickDEX (Greene, $60), a truly marvelous desk accessory for storing free-form text data. QuickDEX is ideal for address material, and a built-in Dial command will send a selected phone number to HyperDialer.

QuickDEX lets you create half a dozen databases made up of individual cards. No field names are required, and a speedy search function is the major operating feature. The fact that there are no stylistic limitations on the text you enter means that you can store notes (as well as phone directories) either in separate databases or all jumbled together. I find it faster to load and much more useful for the way I work than either the outliner desk accessories (like Acta) or the miniature editors (like MockWrite and MiniWriter).

In many respects, it's the Macintosh equivalent of MemoryMate, my favorite memory-resident program on MS-DOS machines. My only gripe is that the cards are only about a third the size of the Macintosh screen and hold only 12 lines of data, not nearly enough for serious note-taking. But QuickDEX is rapidly becoming indispensable, especially teamed with HyperDialer, and I don't know how I survived without the duo.

These are all relatively inexpensive products, further proof that you don't have to spend a fortune to get quality goods. Any or all of them are definitely worth buying. ■

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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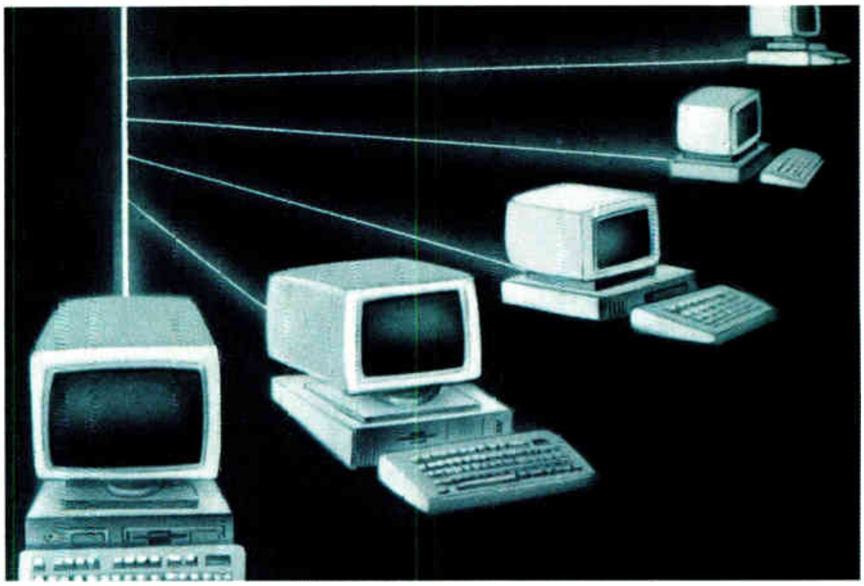
DO YOU REALLY NEED A LAN?

If all you need for your office is a way to share one laser printer, a LAN might be overkill



A recent BYTE survey revealed that 9 out of every 10 large businesses (over 1000 employees) intend to install a local-area network sometime in the next few months. That's a lot of LANs. Many of them will do much to facilitate communications within their companies. Many will allow employees to share files, coordinate their activities, and make better use of expensive resources such as laser printers. Some, on the other hand, will accomplish a great deal less.

One of the first things that I usually notice when I talk to clients about installing a LAN is that their ideas about the network's function are not fully formed. "We've got to communicate," one will say. "I want to move stuff around," another will explain. "We all need to use the printer," a third client will state.

All these factors are valid uses for a LAN, provided these vague requirements can be translated into more specific information. What kind of communication, and with whom? What kind of "stuff" needs moving, how often, and to how many users? What kind of printer, and how often are there overlapping needs to use it?

Answers to these questions will tell you a lot more about the requirements for the LAN. They may also tell you that a LAN really might not be the answer. A good example is the person who will tell you he or she needs a LAN so that several people in the same office can use the laser printer. This is usually thought of as a normal use for a LAN. A laser printer is an expensive resource, and it is fast enough that several people's printing requirements can be satisfied by one printer, such as the Hewlett-Packard LaserJet II.

As it turns out, though, there are alternatives to buying and installing a LAN. One answer that can be quite useful for a small business or a small department within a large business is a device called a printer server. Essentially, this is a print buffer that is set up to take input from several sources and send it to one or more printers. Exactly how this device works will depend on the individual server.

A typical example of an office where a LAN might be overkill is the law office of Bill Miller, a patent attorney in Ponca City, Oklahoma. Bill has a fairly typical legal office with three attorneys and one legal secretary. He's adding an HP laser printer and he wants it to be available to the entire staff. A LAN could do the job for him, but so could a printer server. It's Bill's computer inventory that tips the balance. As is the case with many offices, not all his computers are IBM PC clones. He also has some Victor computers that probably won't support most LANs.

A printer server will work just fine, though, and it will cost a lot less. He can use the standard serial or parallel output that he would send to any other printer and send it to the server instead. The server will store the text and send it to the laser printer as required.

Printer Servers

Since Bill is planning to use an HP LaserJet II, it makes sense for him to use printer servers designed specifically for this printer. Two of these are the Simp-LAN ServerJet II and the Extended Systems ShareSpool. Both these devices are circuit cards designed to fit into the LaserJet II's expansion slot. They have sockets for four modular plugs like the ones on your telephone. These are for serial connections. The ServerJet II also has a parallel port.

To use these devices, you remove a cover from the rear of the HP, then slide in the card until it is seated. Next, you

continued

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attach to your serial port a special DB-25 or DB-9 connector (depending on what your particular computer requires). These connectors have a modular socket to which you attach a piece of standard modular telephone cable. The other end of the cable attaches to the socket on the card that you just installed in the laser printer.

Once you have done this, you can use any computer that will attach to a standard serial connector. I was able to use my old Zenith Z-100 with this device, along with a Tandy XT clone and a Zenith Z-248. All of them worked fine, and the printer servers were able to handle files from all the machines at the same time.

As long as you have only four or five users and you want to use an HP LaserJet II, these devices will work fine. They are controllable through commands embedded in your text files, and they have enough memory (256K bytes standard) to handle the needs of most offices.

Larger Needs, Larger Boxes

While both the internal printer servers above will meet Bill's immediate needs, they won't offer much room for growth. If he adds another secretary, for example, the ShareSpool's capacity will be exceeded, and there's no way he can add another printer to the system.

SimpLAN and Extended Systems have both anticipated this situation. SimpLAN has its Printer Server, a device that allows you to attach six computers and four printers. Extended Systems still limits you to four computers with its desktop publishing MultiSpool, but with this product, you can operate up to three printers.

Because these servers are capable of more complex tasks, they are more complex to use. The MultiSpool, for example, requires that you add a device driver through the CONFIG.SYS file in MS-DOS. This effectively limits its use to PC clones. On the other hand, you can configure the SimpLAN Printer Server using information embedded in the data stream, just as you would with its ServerJet II stablemate. This opens it up to use by a wider variety of computers.

Neither server is particularly difficult to set up and use, although, since MultiSpool will use your computer's parallel output, it probably is slightly easier. The SimpLAN Printer Server I tried uses serial data from the computer. This device is slightly more complex to set up but lets you move the data over longer distances, which could be important where users are a good ways apart.

Items Discussed

LaserJet Series II $2695
Hewlett-Packard
3000 Hanover St.
Palo Alto, CA 94304
(800) 367-4772
(415) 857-1501
Inquiry 957.

MultiSpool $1695
(desktop publishing)
ShareSpool $495
(for HP LaserJet Series II)
Extended Systems, Inc.
P.O. Box 4937
6062 Morris Hill Lane
Boise, ID 83711
(208) 322-7163
Inquiry 955.

Printer Server $695
ServerJet II $495
Intelligent Buffer $395
SimpLAN ASP Computer
Products, Inc.
1026 West Maude Ave., Suite 305
Sunnyvale, CA 94086
(800) 445-6190
(408) 746-2965
Inquiry 956.

While the versions that mounted inside the LaserJet were fairly similar, these devices are quite different from each other. The MultiSpool has only a reset button on the front panel, while the SimpLAN Printer Server has a full control panel. With the Printer Server's panel, you have more control over the flow of information to the printers and are able to use functions such as a pause button to halt output while you add or change paper.

Finally, there's the SimpLAN Intelligent Buffer. This device attaches to the parallel ports of up to three computers and funnels output to a single printer. It's probably the easiest of the lot to use because it requires no configuration in the computers. You simply hook up the cables and run.

Because the Intelligent Buffer supports only parallel connections, the distance the computer or printer can be from the buffer is only about 10 feet. This setup is fine in a small office but could be very limiting in a large one. On the other hand, it is easy to use and works well with most software. I did have to change its built-in timer so that it would wait for drawings from Generic CADD instead of ejecting them while they were about one-third finished.

Which One to Use?

For offices that have only one printer and no plans to add more users, the obvious choice is one of the devices that fits inside the LaserJet II and lets you connect four or five computers to it. People in these offices have only one printer that they plan to use, and they don't plan to add any more users. This solution is a simple and effective one.

The SimpLAN Intelligent Buffer meets similar needs, but it will support only three users. The SimpLAN's advantage is that it will work with any parallel printer, so your choice is not limited to the HP LaserJet II.

Either of the two more capable printer servers is a good solution for an office like Bill Miller's. Both will allow him to use more than one printer—an option that would be an advantage to a patent attorney who may need to use a plotter to produce drawings. The SimpLAN Printer Server, however, is the best choice for Bill's office. The MultiSpool would not be able to handle even one more user. With the Printer Server, he can send documents to the printer from any of his computers, and because the SimpLAN Printer Server uses serial communications, he can send them from quite a distance.

On the Other Hand...

Maybe Bill does need a LAN. If you already generate a hefty load of documents, it would be convenient for others in the office to be able to review them. You might also like to have electronic mail and a way to keep up with the schedules of several busy people.

These issues bring us back to the original question. Clearly, not all offices need a LAN—sometimes there's an alternative. On the other hand, sometimes the need for a LAN is more obvious. How do you tell? Check back here next month. ■

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

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

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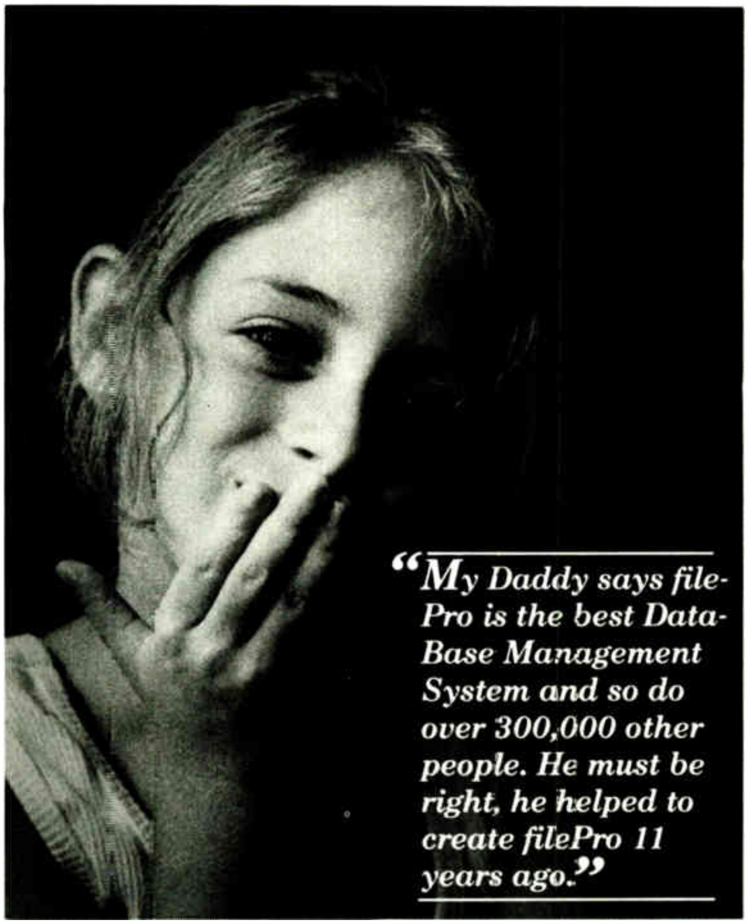

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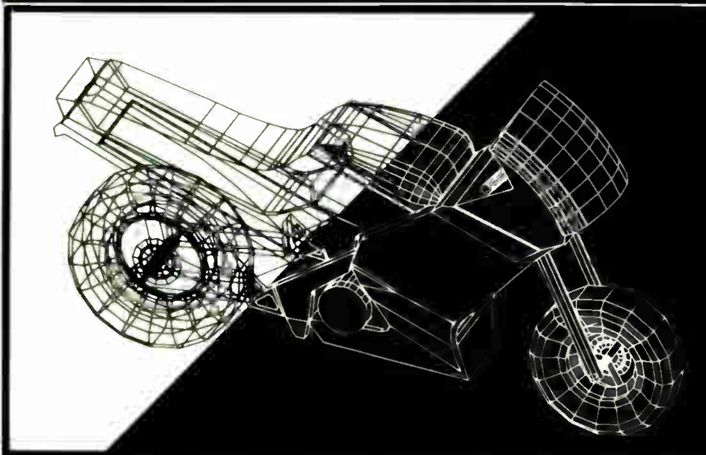
Circle 260 on Reader Service Card

AW . . . WHAT THE HECK!



The first question asked by many people is, "Why is *DesignCAD 3-D* priced so low?" The answer? After developing *DesignCAD 3-D* we were unable to decide how the product should be priced. We consulted experts. We used the finest spreadsheets on the market. We took employee polls. We asked our lawyers and accountants for their opinion. We even asked our Mothers, Wives, and childhood Sweethearts! Finally in the greatest American Tradition, we said, *"Aw . . . What the Heck! Let's see the other guys beat this price!" DesignCAD 3-D* sells for $299 complete. No add-ons, nothing else to buy!

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Circle 21 on Reader Service Card

VLSI Design and Network Help

A look at a CAD package and a network troubleshooting application

Although a large number of generalized CAD systems (such as VersaCAD, Claris CAD, MicroCAD, and others) are currently available for the Macintosh II, those that focus on very-large-scale-integration circuit design are almost nonexistent. It's a shame, too, since the very features of a Mac II—its high-resolution color graphics and built-in math coprocessor—that make it so suitable for CAD work also make it suitable for VLSI design. It also happens that one good system for teaching and researching VLSI design techniques doesn't come from a commercial vendor: It's the Magic system from the computer science division of the electrical engineering and computer sciences department of the University of California at Berkeley.

Spurred on by the need for such software on low-cost workstations and the availability of the source code from Berkeley, the University of Chicago is investigating the porting of Magic to the Mac II running A/UX. We've undertaken this investigation despite the fact that Magic has been superseded in recent years by better commercial Unix-based VLSI design tools because these packages are currently expensive ($20,000 to $30,000) and the source code is not available for porting.

First, let me explain what Magic is and then what we're doing. Magic and its related VLSI tools all run under various flavors of Berkeley Unix, which isn't too surprising given their origins. Naturally, the software will run on VAXes running 4.2 and 4.3 BSD, as well as under DEC's Ultrix, Sun 2s and 3s running SunOS (versions 2 and 3), and under OSx on a Pyramid minicomputer.

Magic lets you design and modify VLSI circuit layouts using an interactive, multiwindow display system. Magic works with a color graphics display workstation and needs a mouse or a graphics tablet. Magic enables you to design basic circuit cells and assemble them into complete logic systems. Unlike some other VLSI layout editors on the market, Magic does not just automate electrical drafting with its color display. It understands some basic "facts" about how circuits operate. This built-in knowledge base permits Magic to provide a number of design aids that are especially helpful in learning VLSI design methods and in validating a circuit topology.

Built-in Rule Set

Magic "perceives" how logical components can be connected and understands how a transistor functions. It actually includes a built-in hierarchical circuit extractor to provide high-level layout checking. When you're using Magic to create a VLSI layout, its built-in rule set constantly monitors your design and editing. When you attempt to create a structure that violates its rule set, Magic warns you of the inconsistency. Magic includes a function known as Plow (probably from its operation on the display) that can compact or stretch the dimensions of the circuit cells. Connecting the modified cells is also a snap since Magic provides a set of routing tools that allow you to make the necessary (and optimized) interconnections among larger circuit components.

The rule set programmed into Magic follows the Mead-Conway simplified style of design. These rules allow VLSI novices to create working designs quickly, supported by Magic's design aids. There are drawbacks associated with Magic's Mead-Conway implementation, of course. The most serious is that component density is compromised by its simplified rule set, which doesn't let you cram as many components into a given physical space as some sophisticated designers might like or as would be possible under more complex rules and their resulting structures.

In VLSI design parlance, Magic permits only "Manhattan" designs, where the topology of the cell edges is vertical or horizontal. Put another way, wedge or corner design topologies cannot be accommodated directly. According to professional circuit designers who have used Magic, the simplified rule set results in a loss of theoretical circuit density of about 7 to 10 percent. While such density losses may be important in commercial VLSI applications, they mean practically nothing in instruction and research, where the function of the design is to educate, not necessarily to be cast in silicon.

Magic comes as part of a total VLSI design and analysis package from Berkeley called VLSI Tools. The package includes more than a dozen different programs, authored by Gordon Hamachi, Robert Mayo, John Ousterhout, Walter Scott, George Taylor, and other researchers outside Berkeley.

In addition to Magic, the design package offers a timing analyzer, known as Crystal, that helps circuit designers find performance problems in the design; a logic equation converter (Eqntott) that converts logic equations into a truth-table format for design input; and a high-level description compiler (Peg) that compiles a high-level description of a finite-state machine into logic equations that can be input into the layout tools for automatic layout and finite-state-machine optimization. A separate program, called Spice2summary, provides summary information about a circuit's operating speed, power, and electrical properties as it has been designed using Magic.

Magic needs a color display with enough bit planes to render all the circuit

continued

layers clearly. Single-bit-plane monochrome monitors can display Magic designs, but the resulting use of hatched and dotted lines makes it tough to keep your layers clear. The color displays supplied with VAXstation, AED, Sun, Apollo, and Lexidata workstations can be used with the monitor drivers supplied. At the University of Chicago we teach VLSI using Magic on Sun-3/160s that include 19-inch, 8-bit-plane color monitors. On Suns, Magic requires the SunTools windowing environment to display its multiple windows (display, command, etc.). Sun versions for X-Windows, NeWS, and Open Look do not yet exist.

Slow Progress

At the University of Chicago we are trying to port Magic and the other Berkeley VLSI design tools to run under A/UX on Mac IIs. The progress so far has been slow for several reasons. First of all, A/UX is a System V release, and Magic was developed under Berkeley Unix and is full of "Berkeleyisms." Second, we need to write color-output A/UX console drivers for the Mac II's 13-inch RGB monitor. Furthermore, version 1.0 of A/UX is excruciatingly slow for graphics operations (we're hoping that versions 1.1 and 2.0 will be much faster).

On a Mac II, Magic really works best on a 19-inch RGB monitor like the SuperMac Trinitron unit, for which a special A/UX driver must also be written. Certainly, 256 different colors are adequate for rendering circuit layers and cells, but when the new 24-bit Mac II color cards become more prevalent, I expect that Magic drivers will be written to take advantage of their multimillion-color display capabilities.

Almost any interested designer or researcher can obtain the Berkeley VLSI Tools since they were developed, in part, with National Science Foundation grants, giving them a kind of public domain status. The price (approximately $100) reflects the costs of preparing and mailing a nine-track tape (1600 or 6250 bits per inch) that contains Magic, the other tools, and their combined documentation (`ditroff` source files and Unix `man` pages). The tape contains about 20 megabytes of Unix `tar` binary files, including installation scripts for BSD 4.3 and Sun OS 2.0.

As I mentioned, we've used Magic and its related tools for the last couple of years in my department to teach VLSI. Because it is easy to install and maintain on our Unix workstations and minicomputers, it has worked well in our instructional and research situations. That's the big reason we're so closely following the effort at A/UX ports of programs such as Magic. While we don't expect A/UX Mac IIs to replace Suns and Apollos in our department or on our campus, we do expect them to turn up in a number of locations, because of the great Apple University Consortium price and their ability to run both Unix and Mac software—a big win in our environment.

Items Discussed

InterPoll NetWork Administrator's Utility $129
Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
Inquiry 1150.

Magic VLSI Tools $100
Computer Science Division
Electrical Engineering and
Computer Sciences Department
University of California
Berkeley, CA 94720
(415) 642-3214

InterPoll—An AppleTalk Network Management Tool

Network management ranks right up there with ingrown toenails, fever blisters, and sunburn as being both annoying and painful. Although my experience with managing AppleTalk networks leans toward the annoying side of that duality, it's still not one of my favorite duties.

One example typifies the kind of problems that crop up with a network. Recently, some of my students and I spent several days trying to figure out why a Mac II on a lab LocalTalk network wasn't showing up under TOPS when we looked from other TOPS nodes on the same network. We replaced the LocalTalk connector and the section of cable leading into it, and still it wouldn't show up. We were about ready to pull out all our cabling and install new cables—a bad scene—when we came across Apple's InterPoll NetWork Administrator's Utility.

We fired this baby up, and lo and behold, we found the problem: a broken cable at the opposite end of the network. No, I'm still not sure *why* this made the Mac II at the opposite end of the network disappear, but at least I knew *what* the problem was. With the recabling disaster averted, I played with InterPoll some more to find out what it could and couldn't do. As far as I can tell, it's based on the old freeware program called NetCheck 2.0 that used to be found on several on-line services (including AppleLink) and was useful for monitoring AppleTalk networks.

What the Tools Can Do

InterPoll encompasses a bunch of tools, all of which are pretty helpful. The list includes ones that give you a complete or selective list of devices that are active on any AppleTalk network (although I have yet to try it over EtherTalk) and help you create a network topology map, perform network integrity tests (the tool we used successfully to find our busted cable), report on the versions of the systems files being run at each AppleTalk node, and report network status across internetwork bridges (such as the Kinetics FastPath and Hayes InterBridge). Should your desires tend in that direction, InterPoll can also create readable network management reports.

InterPoll runs on a Mac II, SE, or Plus running System Tools 6.0.2 and comes with three disks: the InterPoll administrator's disk (for the network manager), an 800K-byte workstation disk (for each user on the network), and a 400K-byte version of the workstation disk. You'll receive a decent manual, too. The AppleTalk Responder INIT has to be installed in the System Folder for InterPoll to work properly.

InterPoll does its dirty work by using five of the AppleTalk protocols: the Name Binding Protocol (NBP) to find network devices, the Link Access Protocol (LAP) to find unnamed devices, the Echo Protocol (EP) to determine link integrity and performance, the Printer Access Protocol (PAP) to get information about the status of printers on the network, and the AppleTalk Transaction Protocol (ATP) to get general system information.

If you have AppleTalk networks, InterPoll is a handy item to keep in your toolbox. It certainly beats pulling new cable. ■

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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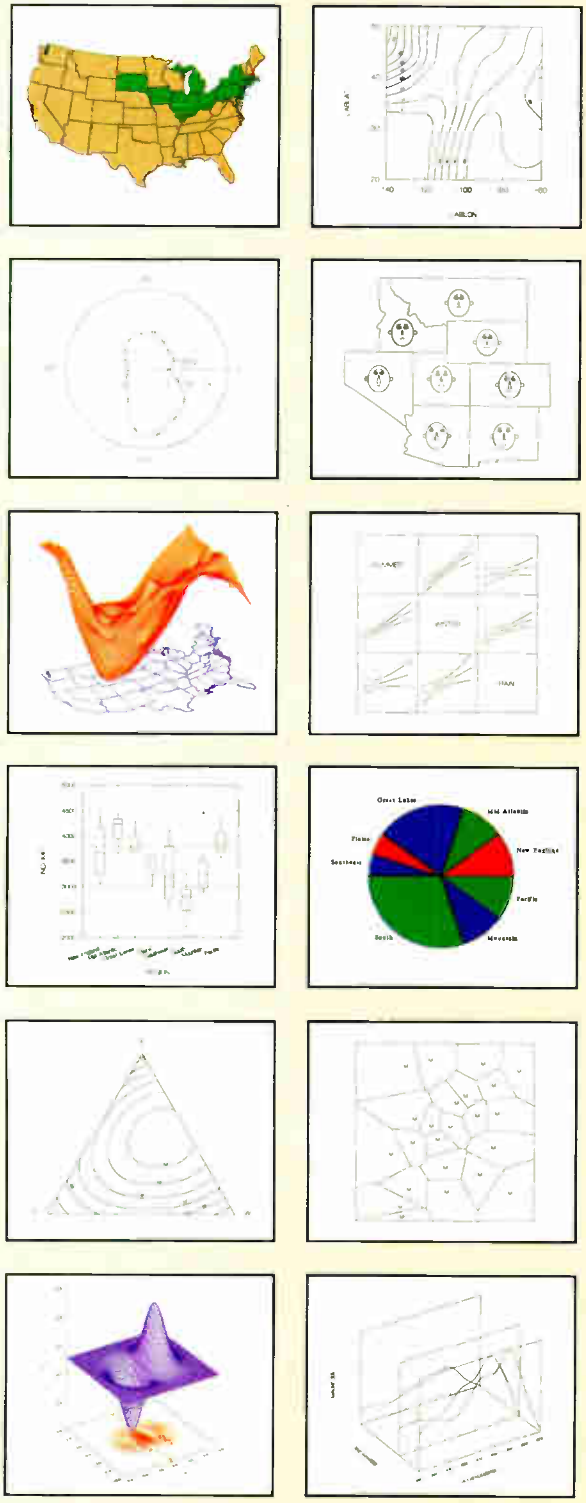

Statistics Basic statistics, frequencies, t-tests, post-hoc tests Multiway crosstabs with log-linear modeling, association coefficients, PRE statistics, Mantel-Haenszel, asymptotic standard errors Nonparametric statistics (sign, Runs, Wilcoxon, Kruskal-Wallis, Friedman two-way ANOVA, Mann-Whitney U, Kolmogorov-Smirnov, Lilliefors, Kendall coefficient of concordance) Pairwise/listwise missing value correlation, SSCP, covariance, Spearman, Gamma, Kendall Tau, Euclidean distances, binary similarities Linear, polynomial, multiple, stepwise, weighted regression with extended diagnostics Multivariate general linear model includes multi-way ANOVA, ANOCOVA, MANOVA, repeated measures, canonical correlation Principal components, factor analysis, rotations, components scores Multidimensional scaling Multiple and canonical discriminant analysis, Bayesian classification Cluster analysis (hierarchical, single, average, complete, median, centroid linkage, k-means, cases, variables Time series (smoothers, exponential smoothing, seasonal and nonseasonal ARIMA, ACF, PACF, CCF, transformations, Fourier analysis Nonlinear estimation (nonlinear regression, maximum likelihood estimation, and more).

Graphics Overlay plots Drivers for most graphics devices *Two dimensional:* Error Bars Scatterplots Line and Vector Graphs Vector, Dot, Bubble and Quantile Plots Bar Graphs (single, multiple, stacked, range) Box plots (single and grouped) Stem-and-leaf diagrams Linear, quadratic, step, spline, polynomial, LOWESS, exponential smoothing Confidence Intervals and ellipsoids (any alpha value) Smooth mathematical functions Rectangular or polar coordinates Log and power scales ANOVA interaction plots Histograms (regular, cumulative, fuzzy) Stripe and jitter plots Gaussian histogram smoothing Scatterplot matrices Voronoi Tesselations Minimum spanning tree Maps with geographic projections (U.S. state boundary file included) Chernoff faces Star plots Fourier plots Pie charts Contour plots on regularly and irregularly spaced points Control charts and limits *Three dimensional:* Data plots Smooth function plots Vector plots Linear, quadratic, spline, least squares surface smoothing Three-dimensional type fonts.

Data Management Import/export Lotus, dBase, and DIF files Full screen data editor Full screen text editor Unlimited cases Missing data, arrays, character variables Process hierarchical, rectangular or triangular files, irregular length records Character, numeric, and nested sorts Merge and append large files Unlimited numeric and character variable transformations Subgroup processing with SELECT and BY Value labels and RECODE Statements Macro processor with programming language, screen control, file manipulation, applications generation, and report writing.

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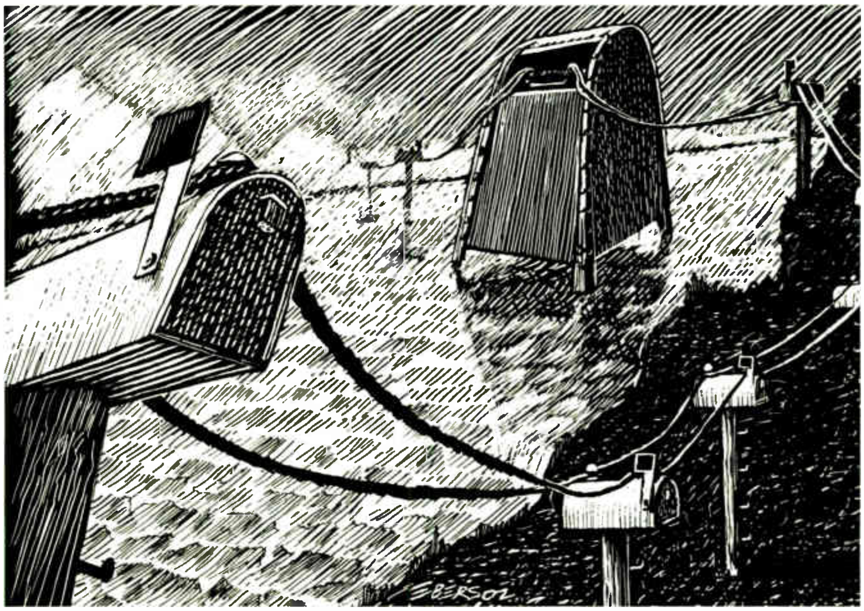
Circle 258 on Reader Service Card (DEALERS: 259)

X.400 GROWS UP

The final version of this international standard should advance global E-mail interconnectivity



Electronic message delivery has entered a new era. This year, deemed the "Year of Interconnectivity" by the Electronic Mail Association, will see the approval of the final version of X.400, the international standard for interconnecting electronic mail systems.

In 1980, the International Telegraph and Telephone Consultative Committee (CCITT) initiated formal work on a universal interconnection standard via a working group referred to as a "special rapporteur." In 1984, the first X.400 standard was hammered out in CCITT volume VIII—Facicle VIII.7, known as the "Red Book."

Since 1984, the standard has been undergoing revision. The 1988 version, though not ratified at this writing, was expected to be ratified in November. The new X.400 standard will be contained in the "Blue Book."

Before X.400, residents of the so-called global village who needed worldwide communications capability made do with adequate, but antiquated, tools such as the telex—a real-time, dial-up communications technology from Western Union. But in today's high-tech environment of global competitiveness, the telex machine is too slow and unreliable, and it's useless for binary file transfers.

It's a small leap from the telex to the Advanced Research Projects Agency network, a worldwide E-mail network used first by the military to link its research labs and installations. ARPAnet deteriorated (some say evolved) into several other networks, such as Usenet and Bitnet, that still function today. But years of neglect and apathy have taken their toll on these networks; they resemble the root system of a weeping willow more than a sophisticated and efficient messaging system.

Until X.400 became a reality, the idea of a universal electronic messaging system that worked on any mainframe and down to the personal computer level and allowed anyone to send a message to anyone else, worldwide, regardless of what E-mail system he or she used, was only so much science fiction. But X.400 will move us from fiction to fact.

X.400 provides for the sending of messages, files, and even telexes among different mainframes. Users of X.400-compatible E-mail systems won't have to concern themselves with the idiosyncrasies of host-system protocols.

The X.400 standard outlines the architecture, protocols, and message "envelope" formats that allow E-mail users to exchange messages independently of the E-mail systems they use. For example, X.400 makes it possible for DEC's All-In-1 to swap messages with Data General's CEO, and MCI Mail users can trade messages with users of CompuServe's EasyPlex E-mail service.

"Four years ago, the ink was just drying on the X.400 draft standard," says Richard Miller, president of Telematica, a data communications consulting firm specializing in electronic messaging protocols. "The childhood of X.400 is at an end, and with some 40 vendors now offering X.400-compatible products, we're seeing an era of 'plug and play' systems hitting the market." Products include X.400-compliant E-mail systems and X.400 gateways, which allow interconnection between proprietary E-mail systems that do not support X.400 internally.

Inside X.400

X.400 is part of the International Standard Organization's Open Systems Inter-

continued

ILLUSTRATION: ROB EBERSOL © 1988

connection model. OSI's seven layers can be compared to a cake; each successive layer builds on those below it. The lowest layers, which are closest to the communications hardware, make certain that the raw bits of data make it through the physical medium intact. The upper layers preserve the integrity of the data; they ensure that the bits sent have the same meaning when you receive them at your end. X.400 is the first stable protocol in OSI's application layer—the highest level in the protocol stack.

To establish a truly universal store-and-forward (E-mail) network, you need to specify the interface details for all E-mail systems to be interconnected. X.400 provides the technical glue for these systems and their interfaces, and it does so in enough detail to satisfy the needs of anyone who wants to build his or her own X.400 message-handling system (MHS). Not surprisingly, the language of the X.400 specification is technically precise. Some critics say it's too complex, but X.400 products are alive, well, and in use.

The X.400 specification itself contains several components. First, the MHS is a group of interconnected store-and-forward systems. Messages themselves can contain any kind of electronic data. The messages you generate are sent to a User Agent, which functions like a post office box. It provides a place for messages to be delivered to each user on the system. The UA acts on your behalf to exchange messages between your keyboard and the Message Transfer Agent.

X.400 is the first stable protocol in OSI's application layer.

MTAs function as post offices. Each MTA serves a particular group of UAs, just as your local branch post office handles your paper mail. It collects messages, sorts them by destination, and then forwards them, in bulk, over the network.

The MTA also routes messages to all recipient UAs and makes copies automatically if a message is being sent to several people in a distribution list. Likewise, the MTA sorts and delivers incoming messages. The X.400 P3 protocol defines the method for submission and delivery of messages between a UA and an MTA.

MTAs perform these store-and-forward functions via the X.400 P1 protocol, which defines the rules of the road for how interactions between MTAs take place. P1 also defines how a particular system deals with the delivery of message envelopes. All the MTAs working together are defined as a Message Transfer System. Thus, ACME's corporate mainframe in Toledo, Ohio, is considered an MTA, as is the branch office mainframe in Hoboken, New Jersey. The interconnection of these MTAs is the MTS.

There also may be direct interaction between cooperating UAs on, say, the same local-area network. This is defined by the P2 protocol and includes the capability for services such as finding out if the recipient UA has enough room to hold the message you've sent, and sending an acknowledgment when the recipient UA has read the message.

Sorry, No Listing

To have any kind of global interconnected network, you need a directory of some sort. The standard for establishing such a directory is X.500. Even though some systems, such as MCI Mail and CompuServe, currently provide interconnection via X.400, users of either system must already know the address of the intended recipient; there is currently no provision to look up a CompuServe user's electronic address from within MCI Mail.

Enter X.500. Think of it as a kind of digital directory assistance and then some. According to the X.500 standard (which is expected to be ratified along with X.400), individual entries will contain information "corresponding to each of the communications methods by which that person can be reached, selected from an open-ended list which includes at least the following: Telephony, E-mail, telex, Integrated Services Digital Network, physical delivery (postal address), and facsimile. In some cases,

Think of X.500 as a kind of digital directory assistance.

such as E-mail, the entry will have some additional information, such as types of information that the user's equipment can handle."

The X.500 standard enables users to implement a distributed global directory (the specification doesn't mention any time frame for this to take place or address its feasibility, of course, and both are points of controversy). On the local level, X.500 would enable users in an IBM PROFS environment to look up the E-mail addresses for users within the same company who are using a different system, such as DEC's All-In-1.

X.500 will let users browse through user listings just as if they were looking through a telephone book. It could also set up a type of Yellow Pages browsing capability based on the type of business or service.

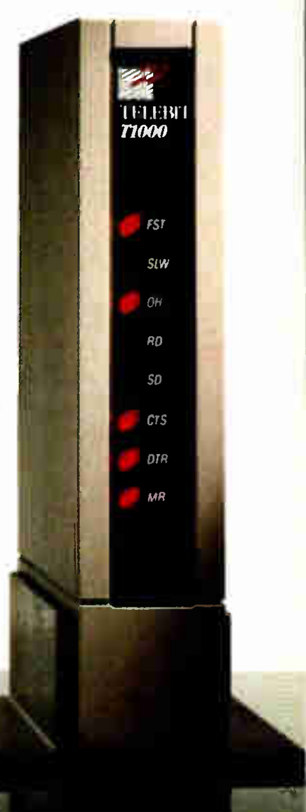
The growth of a global directory would come from major E-mail service vendors and private networks linking their perspective user lists. Jeanne Bracken, Pacific Bell director of message-handling systems, says the standard would create a "basic directory assistance [service] magnified a million times in terms of information you can get."

Where's the Beef?

If X.400 is as grown up and worldly as its supporters claim, why can't you simply log on to an E-mail system and exchange electronic messages with anyone, anywhere, at any time? Good question. The answer has to do with conformity and commerce.

First, no standard exists for testing the conformity of X.400 products, and no public E-mail system is going to allow an untested X.400 product to connect to its backbone without some kind of proof that it won't sabotage the entire system. Some companies, such as Telenet, have insti-

continued



tuted proprietary conformity testing procedures. That's fine for vendors targeting their products at Telenet's network. However, Telenet's conformity procedure doesn't apply to any other system, such as Dialcom. This lack of a standardized conformity test will hamper the rapid implementation of X.400 products universally.

The other major issue is that public E-mail networks will not interconnect worldwide until administrative questions, such as billing procedures, are addressed. How will the revenue be split between service providers when a message is sent from the U.S. to the German PTT's system? Should the revenue be split evenly? What if the message from the U.S. consists of a distribution list? If the PTT has to deliver hundreds of copies of a single message sent from the U.S., how does the revenue from that message transfer get fairly distributed across the two commercial systems? Such questions are stumbling blocks to true interconnectivity.

Global Grab Bag

The technology for a ubiquitous E-mail network has been available for years. The standards are now in place. But we may be well into the next decade before anything approaching global connectivity emerges. In the meantime, there will be limited interconnections. And if your corporation needs worldwide messaging, you can certainly pay dearly for it by signing on with one of a few companies, such as Dialcom and Telenet, that provide international E-mail service. Of course, you'll also have to convince your clients to sign on with the same system.

Individual users will have to wait out the corporate suits while they negotiate in high-tech board rooms, and rely on the ARPAnet offspring, if they can stomach the inherent irritations and frustrations associated with such systems. Or they can use the rather limited existing commercial interconnections (MCI Mail and CompuServe) or commercial third-party message "porting" services.

Or they might simply do as the two most powerful offices in the world—the White House and the Kremlin—have done for decades: Use a telex. ■

Brock N. Meeks is a San Diego-based freelance writer who specializes in high technology. You can reach him on BIX as "brock."

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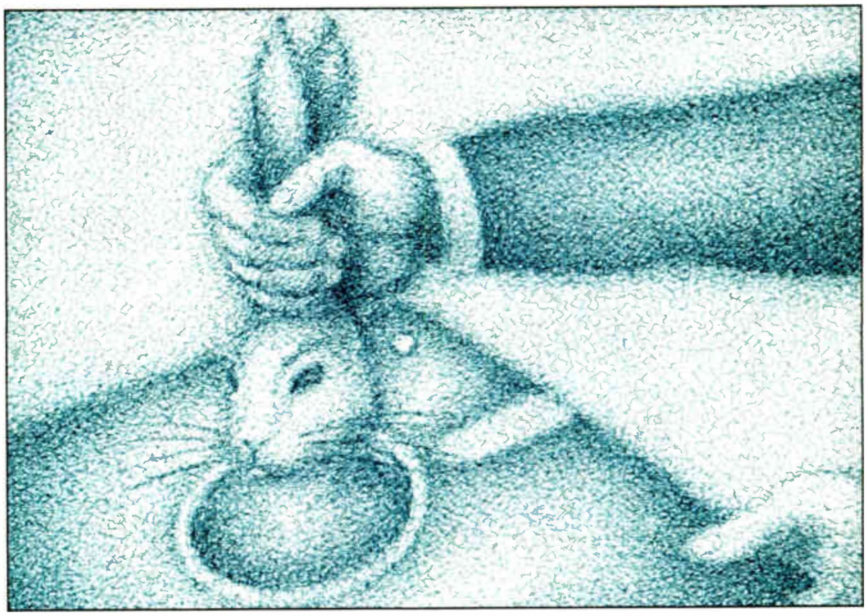
OS/2 CONSUMERISM

Fake software, fake hardware, and virtual memory revisited



The biggest problem with OS/2 isn't the bugs. They go away eventually. The biggest problem is finding software that runs under OS/2. Software development takes time, and I hate waiting. Thus, when I found out about two $99 programs—California 10 Pak and HelpMe—from California Software Products, Inc., I ordered them posthaste.

California 10 Pak claims to be a set of "programming tools for the IBM PC, PS/2, and compatibles running DOS or OS/2." HelpMe is a "diagnostic utility for the IBM PC, PS/2, and compatibles running DOS or OS/2." When I talked to the CSPI folks, I asked if the "DOS or OS/2" stuff was really true. I was told yes, that from this point on, CSPI would ship both OS/2 *and* DOS versions of its software.

California 10 Pak does indeed come in both versions. But HelpMe comes with a sheet of paper that says, "ATTENTION: OS/2 USERS. HelpMe is a DOS-mode program and must be run in the DOS 'compatibility box' of OS/2. The program was designed to run in DOS mode for analyzing OS/2 systems because more convenient and extensive access to the system is available in this mode for the analyses performed by HelpMe (e.g., ROM BIOS information)." CSPI repeated this assertion over the phone and denied that it was just a DOS program with an OS/2 name on it.

For those who don't follow OS/2 religiously, the compatibility box is just the section of OS/2 that runs DOS programs. Saying a program must run in the compatibility box is the same as saying that it's a DOS program.

Come on, CSPI. If you haven't gotten around to writing the OS/2 version yet, just say so. Don't tell me that it was "designed" for the compatibility box because of "convenience" (to whom?). For a program that's "designed" for OS/2, it's got some odd features. For example, it can't recognize a VGA, and the VGA appeared before OS/2 did.

HelpMe also tells me that all my OS/2 .EXE files—programs written to run under OS/2—have a "bad .EXE checksum." Yes, the checksums look wrong if all you know is DOS. OS/2 uses a new .EXE format, but HelpMe should know that. There are many such peculiarities. It does have some neat features, though; I hope the company writes a real OS/2 version soon.

I'm burned up about HelpMe, but what about California 10 Pak? Well, the 10 programs are OS/2 programs. They are sort of Norton Utilities-ish. There are a few file browsers, hexadecimal and ASCII; a few smart file-comparison programs; a directory program; programs that display the file allocation table, the environment, and the contents of memory (including extended memory!); a disassembler; and a sort program.

The display programs are interesting, but they're less informative than Norton's. Additionally, they let you look but not touch—you can't edit anything with them. The disassembler is better than Debug's, but Sharpe Systems' MasterKey program is much better, although it's currently limited to DOS. The sort program is limited, like DOS's, to files no larger than 64K bytes.

OS/2 Apartheid

There's not only fake OS/2 software, there's fake OS/2 hardware. OS/2's local-area-network control software is called the LAN Manager. Like all network operating systems, it requires programs (called *drivers*) to talk to specific devices. If you have an XYZ LAN board, you need an XYZ driver. The theory is that eventually all LAN hardware vendors will write LAN Manager drivers for

continued

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—J. Burt Totaro, Publisher

their boards, so that when you buy a board, you also get a disk with LAN Manager drivers on it. No matter whose boards you're using, the LAN Manager will run fine on it, provided you have a LAN Manager driver for that board.

Now, I have the beta LAN Manager, and I'd like to try it and tell you how it works. Unfortunately, no LAN vendors are shipping LAN Manager drivers yet. Microsoft attempted to solve this problem for developers by including drivers for several boards, to serve as a stopgap until the vendors get around to shipping their own drivers. Unfortunately, all the boards that Microsoft shipped drivers for are pretty expensive.

One such board is 3Com's EtherLink Plus, a nice Ethernet card that has a not-so-nice price of $800. So I was interested when a company—let's call it Company X—claimed that it had developed an EtherLink Plus clone that I could buy for about $300. Hot dog, I thought—for

Listing 1: *This program, a paraphrase of the one in my September column, allocates and fills an array of integers.*

```
rem BIGIJ (original program)
rem Examines virtual memory.
rem Needs /ah compiler switch
defint a-z
rem $DYNAMIC
rem $INCLUDE:'bsedospe.bi'
retcode= dosmemavail(mem&)
if command$="" then
  input "array dimension";ad
else
  ad=val(command$)
  print "Using dimension ";ad
end if
c&=timer
dim a(ad,ad)
for i = 1 to ad
    for j=1 to ad
       a(i,j)=100
    next
next
b&=timer
print "Total time:";b&-c&
```

Listing 2: *This program does what the program in listing 1 does, but much faster because it traverses the array in an orderly manner.*

```
rem BIGJI (modified program)
rem Examines virtual memory.
rem Needs /ah compiler switch.
defint a-z
rem $DYNAMIC
rem $INCLUDE:'bsedospe.bi'
retcode= dosmemavail(mem&)
if command$="" then
  input "array dimension";ad
else
  ad=val(command$)
  print "Using dimension ";ad
end if
c&=timer
dim a(ad,ad)
for i = 1 to ad
    for j=1 to ad
       a(j,i)=100
    next
next
b&=timer
print "Total time:";b&-c&
```

Table 1: *Results for the programs in listings 1 and 2, and a comparison of virtual memory to real memory performance. (Times are in seconds.)*

Array size (in K bytes)	BIGIJ time	BIGJI time	In-memory time	Ratio BIGJI/memory
10	1	1	1	1
40	4	4	4	1
90	8	7	8	0.88
160	13	14	14	1
250	22	21	21	1
360	31	31	31	1
490	1694	47	43	1.09
640	19,780	84	55	1.52
810	Years	106	70	1.51
1000		149	87	1.71
1210		184	106	1.73
1440		220	126	1.74
1690		261	148	1.76
1960		302	171	1.76
2250		349	196	1.78
2560		397	224	1.77
2890		450	259	1.73

$600 I can set up a two-node LAN that will run LAN Manager with the software I've got.

Being older and wiser, I figured I'd double-check before plunking down my $600. So I called the manufacturer to get the whole story. After a week of calls and promises that I'd be called back, I finally talked to someone who could answer my questions.

"Is your board EtherLink Plus-compatible? Will it run the OS/2 LAN Manager with the EtherLink Plus drivers?"

"Let's see here...no, you can't use EtherLink Plus drivers. We supply drivers for our board for most networks, but not yet for LAN Manager," replied the voice at the other end.

Puzzled, I asked, "But if you can't run the EtherLink Plus LAN Manager drivers, and you don't supply a LAN Manager driver for your board, how can you say that you support the LAN Manager?"

"I think we mean that we support the LAN Manager kind of like we support Nelson Mandela," he chuckled.

Caveat emptor. Or, more appropriate for this business, *cave canem* (beware of the dog).

Items Discussed

California 10 Pak $99
HelpMe $99
California Software Products, Inc.
525 Cabrillo Park Dr.
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(714) 973-0440
Inquiry 1009.

MasterKey $80
Sharpe Systems Corp.
2320 E St.
La Verne, CA 91750
(714) 596-0070
Inquiry 1010.

Virtual Memory Revisited

You can't trust OS/2 software vendors, you can't trust OS/2 hardware vendors—you can't even trust OS/2 columnists. I discussed OS/2's virtual memory capabilities in the beginning of the September column; several readers raised questions about the program I used. Here's more on the subject of virtual memory and another look at the test.

First, here's some background. Virtual memory under OS/2 is *segment-oriented*. Segments, as I have discussed, can be up to 64K bytes in size. (They can also be smaller, but for this discussion, let's assume that they're all 64K bytes.) Programs or data structures larger than 64K bytes must be divided into multiple segments.

Let's say that a computer running OS/2 has enough memory for 100 segments of programs (and associated data), that currently running programs account for all 100 segments, and that you try to load a program that needs one segment. A DOS-like operating system would simply say "out of memory" and refuse to load that last program.

OS/2 instead *swaps* one segment to disk (a segment that hasn't been used recently and so, as a rough rule of thumb, probably won't be needed soon) to create one segment of real memory for the last program. The swapped-out segment might belong to, for example, Excel, which you loaded hours ago and haven't done anything with since. If you start using Excel again, OS/2 will restore that segment from disk (swapping out something else that hasn't been used recently, if need be).

This works nicely, as long as you have segments that have not been used recently. If the least recently used segment hasn't been touched in an hour, swapping it to disk is a safe bet. But suppose you touch every segment every few seconds? In such a case, the operating system *thrashes*—that is, it spends so much time swapping segments that it accomplishes little real work.

The virtual memory test in September's column—paraphrased here as the program BIGIJ in listing 1—inadvertently caused the operating system to thrash for that reason. It's a consequence of the way BASIC lays out a two-dimensional array and the way BIGIJ accesses the elements of that array. If the dimensions of an array are `i` and `j`, we like to view it as a table—`i` rows by `j` columns.

But in memory, it's a linear array of elements. There are two ways to linearize the table—you can lay all the rows end to end, or all the columns end to end. BASIC does the latter, but BIGIJ acts as though it did the former. Memory accesses are disjointed; they're separated by the number of elements in a column, and as the dimensions of the array grow, that separation eventually exceeds the size of a segment so that each access requires a segment swap.

The program BIGJI (see listing 2) traverses the array by columns. As a result, memory accesses are sequential; when OS/2 loads a segment, it can use it for a while before having to swap in another one. I ran BIGIJ and BIGJI on a machine with little memory, to force disk swapping, and again on the same machine with more memory, where virtual memory was deactivated. As table 1 shows, BIGJI performs in a very acceptable manner. Under these conditions, virtual memory is only about 70 percent slower than real memory; that's a reasonable penalty for the extra capacity.

By the way, virtual memory isn't just a way to load more programs than will fit in real memory. It also lets those programs use more data than can fit in real memory. This is something that many DOS programs already do. For example, I use the IBM Personal Editor, which can edit a file larger than 640K bytes by swapping some material to a disk file. The Microsoft DOS Linker employs a similar strategy when it creates a temporary file during large links. Until now, every application program that provides this capability has had to supply its own virtual memory code. OS/2's built-in virtual memory feature frees application programmers from having to continually reinvent this particular wheel—and that's what an operating system is for.

Thanks very much to the people who wrote in asking about virtual memory and the test.

OS/2 Tip of the Month

A few months back, I discussed the order of device drivers for the COM ports and mice. What I *didn't* mention is that if you have a serial mouse, you must use either the COM driver *or* the serial mouse driver—not both. OS/2 will use the COM port as either a serial port or a mouse port, depending on which driver you tell it to load.

If you tell OS/2 to use both drivers, and you insert the DEVICE=COM01.SYS before the DEVICE=MOUSA02.SYS, you'll get an error on the mouse driver. Do it the other way around, and you'll get an error on the serial driver. This means that if you, like me, sometimes use your COM1 port for modem communication and sometimes for mouse connection, you must change your CONFIG.SYS and reboot. ■

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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Plotters in Perspective

For many applications, the pen plotter can't be beat—but choosing the wrong unit can bring unnecessary headaches

Stanford Diehl
and Steve Apiki

In an industry where new products can become obsolete before they're unwrapped, few technologies have held their appeal as long as the pen plotter.

Architects and engineers prefer pen-plotter output, especially for large-format media. For business presentations, it's hard to beat the sharp colors and excellent line quality of the old pro.

Unglamorous? Perhaps, but as we tested 24 plotters in the BYTE Lab, seasoned computer vets kept wandering in, snagged by the inexplicable lure of an evolving plot. There's something fascinating about watching these bizarre mechanisms spin and rattle like a Rube Goldberg contraption.

Plotter Groups

Pen plotters are intelligent mechanical output devices that produce high-quality graphics on a variety of media. They are often divided into three categories by the size of media they accept: small format, which can work with ANSI A- and B-size sheets; medium format, for C and D; and large format, for E. The letters refer to ANSI size designations: A is the familiar 8½ by 11 inches, and B is 11 by 17 inches. Succeeding letters are determined by doubling the shorter dimension of the next lower size. Architectural and International Standards Organization (ISO) size specifications roughly conform to the ANSI standard.

It is also possible to group plotters by whether they use a friction roller, flatbed, or drum mechanism. Friction-roller plotters rely on a grit wheel to move the paper in one lateral direction, while the pen moves mechanically along the other axis. Drum plotters are similar, but they accept continuous medium and use a clamp or tractor-feed scheme to hold and move the paper.

In contrast, flatbed plotters anchor the medium while moving the pen along both axes. Each type has its advantages: Friction rollers are simple mechanically and can automatically feed paper; flatbeds are relatively quiet, and the medium is less subject to wear; and the drum plotter's continuous-feed capability makes it the ideal choice for chart recording.

In times past, plotters used a single pen and required constant attention. But the venerable pen plotter has learned to adapt as manufacturers install higher intelligence, more efficient pen-changing mechanisms, and crafty optimization techniques. Hewlett-Packard's plot language, HPGL, has become an established industry standard, and CAD software drivers are widely available. These changes have kept the pen plotter one step ahead of other printing technologies (see the text box "Subplots: Looking at Pen-Plotter Alternatives" on page 164).

This month, we take a look at a cross section of plotters that are ideally suited for microcomputer applications. We used flexible inclusion criteria so that we could sample from the broadest range of plotters available: We asked for medium- or small-format color plotters, and we set the price cap at $6000.

When Speed Counts

Unlike a newspaper reporter, those who depend on pen plotters for their hard copy are concerned with only two of the five *W*s, namely, when will I get my plot, and what will it look like? These two questions are often of nearly equal weight. Slow plotting, especially when last-minute revisions to the drawing must be made, is often intolerable.

Mechanical factors play a dominant role in determining overall throughput. Commonly quoted specifications, like maximum pen velocity and acceleration, provide the most accurate measure of throughput. High velocity will make its presence felt on large area fills and long, straight lines; plots with many tight curves or short, unconnected lines will benefit most from high acceleration. Our complex CAD checkplot benchmark required both (see the text box "Plotter Benchmarks" on page 176), and the resulting speed graphs (see figure 1) reveal a close correlation between these specifications and real performance.

Careful examination of the numbers reveals exceptions, however (see table 1). For example, the Enter SP1800's relatively poor performance is primarily due to a quality-enhancement feature, shared by Houston Instrument's DMP-61 and the CalComp Artisan 1023, known as constant-velocity plotting. Pen velocity is most often listed as an axial measure (see table 2). When plotting along a diagonal, however, speed is substantially increased to the vector sum of the two axial velocities. These variances can lead to uneven line weights, so constant-velocity plotting regulates the speed in all directions to no more than axial. While the DMP-61 and Artisan 1023 provide a toggle to remove the feature for checkplots, the SP1800 does not; thus, its performance is degraded.

Acceleration heavily influenced the results. With only half the speed but twice the acceleration, Houston Instrument's DMP-52 handled small circles and curves much faster than the SP1800. Acceleration specs are typically not listed for flatbeds, but they are generally poor, at below 1 g. All the flatbeds turned in lesser performances than their velocities would indicate.

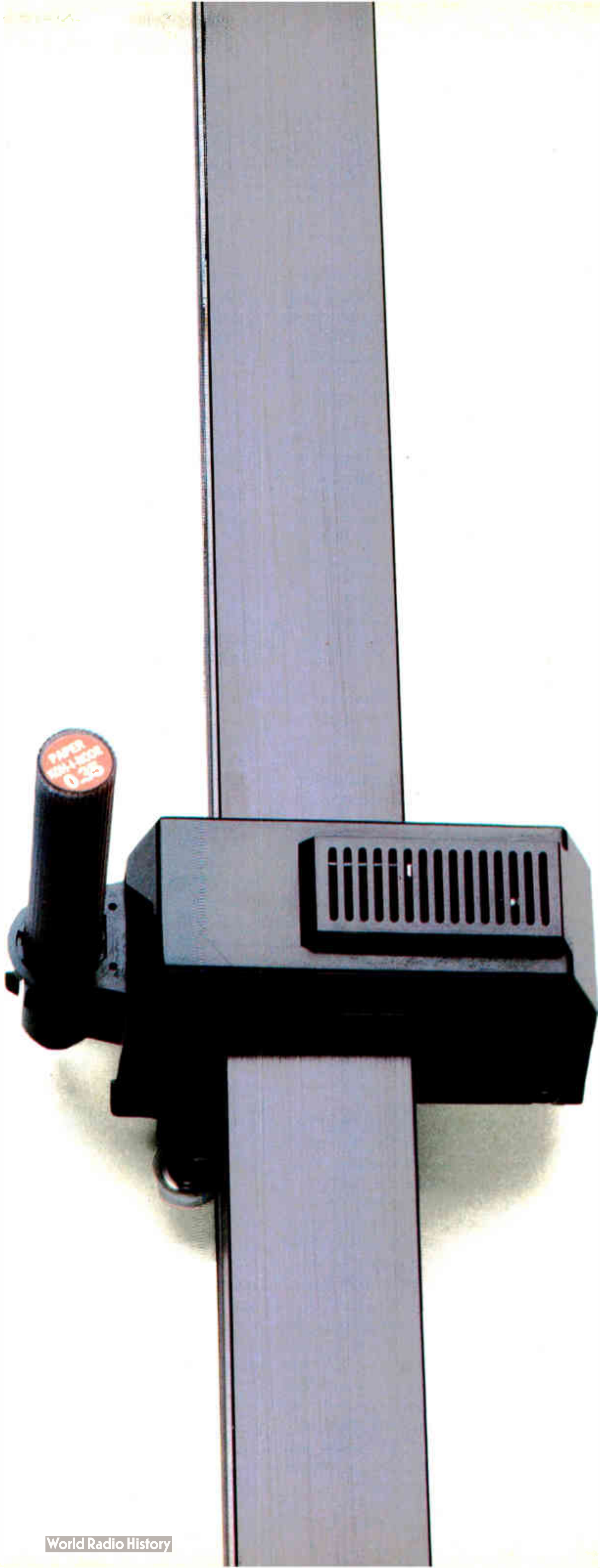
Pen-changing time, though less publicized, is another crucial factor in multicolor plots. Drawing applications often plot object by object rather than color by color, making dozens of pen changes common for even a moderately complex plot. While our CAD plots were optimized to require only one pen change per color, our presentation graphics test was not, and several plotters demonstrated superior pen changes.

The most notable of these was Bruning's Zeta 8, which excelled on the presentation graphics benchmarks. The Zeta 8's plotting mechanism totes all the pens in a moving carrier, and pen changes require only a small shift in the drawing arm. Most plotters keep pens in a carousel off to the side of the drawing surface when not in use, and the pen carrier must move off the page, select the pen, and return to the active area. Though the Hitachi plotters and Houston Instrument's PC Plotter 695A also provide moving carriers, their mechanism is less efficient in that they require moving off the medium.

Processing power also comes into play, especially on the larger plotters. The two top performers on our benchmarks, the Artisan 1023 and the DMP-61, both supplement excellent mechanical specs with 32-bit CPUs, in contrast to the more common 8-bit processor. The Artisan 1023, Enter SP1800, and Roland DG GRX-300 also offer plot optimization through pen sorting or vector preprocessing, though our preoptimized benchmark files did not test this feature.

The time the personal computer spends driving the plotter is often more critical than actual plot time, and a large data buffer can cut that time dramatically. The DMP-61 and Roland DG DXY-1300 plotters, with the largest buffers, freed up our IBM PC AT well before plotting was complete.

continued



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Subplots: Looking at Pen-Plotter Alternatives

With the rising emphasis on computer graphics, competing technologies are bearing down hard on pen plotters, cutting in on a lucrative market. Pen plotters are hanging tough, with a wealth of admirable virtues: low cost, high quality, media versatility, and software compatibility.

Though pen plotters for microcomputer CAD applications range from $600 to $10,000 or more, you can find a sufficient model for less than $6000. Pen plotters offer sharp color output at a reasonable price, but they're relatively slow when compared to other printing technologies. But just how well do these competing technologies stack up against the pen plotter? Here's a look at some alternatives.

Electrostatic Plotter

This device offers the ultimate in plot throughput. Nibs on the electrostatic plotter's print head charge selected areas of the paper, which then attract toner. The advent of the color electrostatic plotter makes it an attractive alternative, especially for large-medium plots.

Only high cost keeps this technology from booming. Prices typically range from $12,000 for the 11- by 17-inch format to as much as $120,000 or more for larger formats. The need for dielectric paper further ups the ante. However, the plotter's impressive speed opens the door to multiuser networking, thus slashing the cost per user. Manufacturers are beginning to respond to this advantage by offering multiple interfaces, including Ethernet.

Electrophotography

This up-and-coming technology also generates toner-based output, but it uses a light source to charge selected areas of the paper. Lasers are the most commonly used source, but devices using LEDs and liquid crystal shutters are also available. Drivers for CAD applications have yet to proliferate, but this should change.

Electrophotographic devices provide fast throughput at high resolution. Some now boast output at 1200 dots per inch. Compared to electrostatic devices, these devices are inexpensive, usually falling in a range from $4000 to over $20,000 for high-resolution models. Their major drawback is lack of color. Look for color technology to come to market soon—along with a major price hike. Initially, you can expect prices to range from $10,000 to $120,000.

Thermal Transfer

Thermal-transfer printers are slowly entering the plotter arena with lower prices and larger formats. This technology uses individual heating elements to melt color wax and fuse it to the paper. Colors can be striking, but the look and feel of thermal-transfer output is highly subjective. Resolution typically falls within the 160- to 300-dpi range, while prices range from $300 to $9000. The major disadvantage here is the high cost of supplies.

Liquid Ink-Jet

Reliability problems have thwarted the promise of ink-jet technology. Newer models belie that reputation, but low resolution and slow throughput are still legitimate gripes. One type of ink-jet printing is the continuous-stream method. High pressure propels streams of color and black ink from print nozzles, while a selective charge determines which areas of the paper will attract the ink. Drop-on-demand printers use timing signals to properly eject drops from the nozzles. Prices for ink-jet printers typically range from $700 to $7000, although some specialized large-format models can cost up to $75,000. Supply costs are moderate.

Serial Dot-Matrix

Vendors are souping up these machines with 24-pin quality, expanded buffering, larger-format handling (typically A to C), impressive intelligence, and color. Supplies are cheap, and when the printer isn't occupied with plotting, you can do all the word processing chores normally associated with a dot-matrix printer. Unfortunately, a few bucks no longer puts a dot-matrix printer on every desk. With prices ranging from $400 to $7000, these specialty printers come with a price tag comparable to that of pen plotters. And while they're fast, they simply can't match the pen plotter's high-quality output.

Price ranges were provided by Naomi Luft Cameron, associate director of research at Datek Information Services, a Waltham, Massachusetts, research and publishing firm that specializes in electronic-imaging technologies.

Quality Control

When discussing plot quality, it's easy to get bogged down on mechanical issues and complicated technical specifications; yet, in the final analysis, the most important elements in the quality equation are also the most obvious. Find yourself a good pen and a sheet of paper that takes the ink best, and you're almost home.

Using a pen plotter sounds simple, but annoying anomalies have a way of rearing up. Each plotter accepts a different range of pen-and-paper combinations. They even require different types of pens and recommend their own medium. Once you've squared all that away, you must next tackle the problem of proper pen pressure and plotting speed.

If speed were the only consideration, most manufacturers would recommend a ballpoint pen on a translucent medium. Quality suffers, though, as area fills, line quality, and color contrasts are all inadequate. This combination works best for speed checkplots, where quality is of minimal concern. High-quality bond paper and fiber-tip pens blend well, and it's the one pen-and-medium combination that most plotters will accept.

However, the best medium for high-quality plots is vellum or Mylar; the best pen, liquid ink or ceramic. A plotter, no matter how impressive its resolution or accuracy, will not produce the highest-quality plots possible if it doesn't support one of these combinations. As our quality benchmarks show, plotters that support only fiber on bond just can't match the quality of liquid ink on vellum.

Once pen and medium standards are met, three main technical specifications come in to play: resolution, repeatability, and accuracy. Mechanical resolution, the smallest move a plotter can make in any direction, differs from addressable resolution, the smallest move allowed through user programming. Addressable resolution is the most meaningful specification; moves of such small increments will usually be directed by software. High resolution enhances consistency and also makes arcs appear smoother. Most of the plotters support an addressable resolution of 0.025 millimeters. The CalComp Artisan 1023 and the

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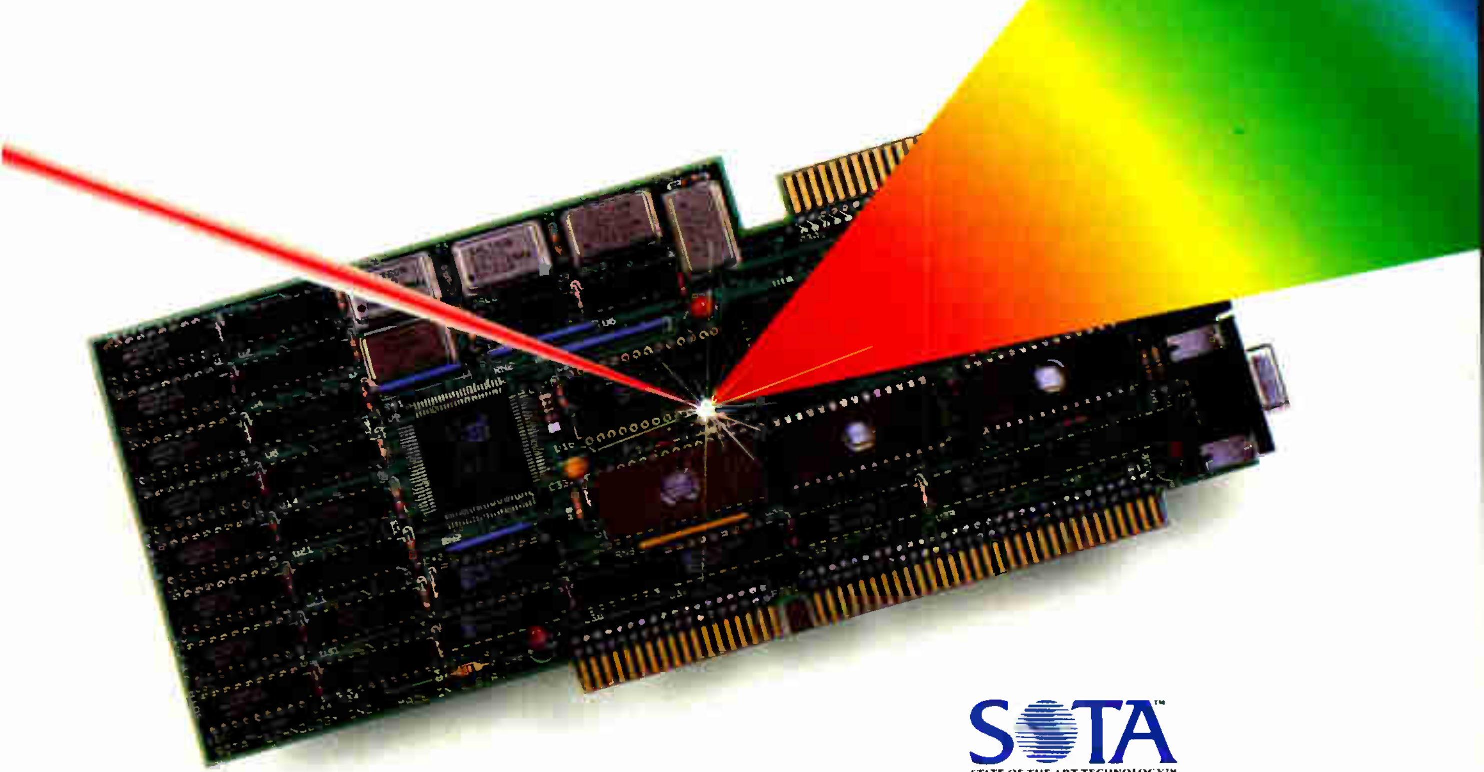

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Resolution, repeatability, and accuracy are the main technical specifications.

Roland DG DPX-2000 claim the highest resolution, twice that of the norm, at 0.0125 mm.

Repeatability measures how accurately a plotter returns the pen to its point of departure. Bad repeatability results in mismatched corners and lines not joined. The norm for repeatability is 0.1 mm. Once again, the DPX-2000 checks in at twice the norm, along with the Houston Instrument DMP-61 and DMP-52.

Accuracy defines a plotter's precision. It tells you how exactly a plotter will move a pen to a prescribed point. Pens, media, and humidity can all significantly affect a plotter's accuracy. Most manufacturers offer two numbers for accuracy. One number gives the accuracy as a percentage of the total move. Sometimes, however, the move is so small that the percentage for accuracy is no longer valid. In this case, a second number represents the finest accuracy the plotter can achieve, regardless of the size of the move. Some manufacturers don't publish accuracy numbers.

Other specifications also come into play. Quality depends on proper pen setting. This can be a trying experience, especially if you're depending on a thumbwheel or some other imprecise mechanical adjustment. So look for firmware control of pen pressure, or better yet, choose a plotter that uses pen sensing to automatically adjust pressure and speed. Constant-velocity capability also improves quality. This feature sets your plotter to a standard velocity in both axial and diagonal directions, ensuring uniform line widths and consistent output.

Beyond the Specs

What sets a plotter apart from the crowd is more than just a combination of good performance ratings and broad pen and medium support. Front-panel controls, reliable mechanical design, and interfacing options can make a critical difference between an outstanding plotter and one that merely gets the job done.

We examined each plotter with an eye toward bringing out the details that distinguish it from the rest of the pack. Our observations are divided into two sections, one for medium-format, floor-standing models, and the other for small-format desktops.

Medium-Format Plotters

CalComp Artisan 1023: CalComp takes no prisoners when it comes to processing power, packing two 10-MHz 68000s into this impressive model. The Motorola chips contribute to the unit's excellent speed specs. Its benchmark times were rivaled only by the Houston Instrument DMP-61. Add the 1- or 2-megabyte buffer option, and you'll have an extremely efficient plotter. And you won't be sacrificing quality. The Artisan 1023 draws sharp, consistent plots on almost any medium.

Automatic pen sensing and an eight-pen removable carousel minimize the need for manual adjustments, but if you need to do so, the menu-driven liquid crystal display (LCD) will guide you along (see photo 1). The CalComp Artisan 1023 enjoys an excellent reputation, and for good reason. It's a solid product at $4895.

Enter SP1800: Enter's low-end model, the $4695 SP1800, comes fully featured and has excellent pen and medium support. An outstanding front panel includes a backlit LCD and a comprehensive 23-key keypad. Our one complaint is that the display sits too low to read without stooping. As with the CalComp plotter, all parameters can be accessed through layers of menus.

Pen type is sensed automatically for default pressure and speed settings, but the sensing mechanism is awkward and lends itself to user errors: You have to insert small plastic tabs into the pen carousel in different combinations for different pen types.

Excellent plot quality more than made up for the SP1800's disappointing speed. The trade-off seems intentional; the unit's constant-velocity feature can't be disabled. Other quality enhancements include curve-plotting algorithms, which process all vectors in a curve before putting the pen on the paper, producing a smoother line.

Hewlett-Packard DraftPro: Hewlett-Packard ships two carousels with this plotter, one for fiber-tip pens and one for drafting pens. The plotter senses the carousel installed and adjusts pen parameters accordingly. If you need to change

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the pen speed manually, you simply push a few buttons on the control panel. Explanatory icons and clear documentation make features simple to implement.

DIP switches enable enhanced plotting features like margin expansion and pen sorting. If you run into any trouble, the user's manual includes helpful sections on troubleshooting, interfacing, and interconnections. The DraftPro fell in the middle of the pack in terms of both plot quality and speed, but its $3995 price makes it an attractive choice.

Houston Instrument DMP-61: Delivering beautiful output at sizzling speed, the DMP-61 scored top honors on both our quality and throughput benchmarks (see photo 2). The 68000 CPU and an axial pen speed of 32 inches per second top a list of impressive specs.

The user interface, though somewhat cumbersome, offers a wide range of parameters, letting you easily customize a job for specific needs. For instance, you can disable the constant-velocity option for checkplots, then set it back on for final-quality output. The DMP-61 draws its menu on paper, and you position the pen over a desired option. It's not as slick as an LCD, but it's also not as limited.

The multipen accessory, simple to install and to adjust, enables six-pen operation. Unless you have mainly monochrome applications, this upgrade is a necessity. We also recommend upgrading to a 1-megabyte buffer. Houston Instrument offers the fully enhanced DMP-61 for $5445, an expensive proposition, but one of the best buys around.

Houston Instrument DMP-52: This plotter shares the DMP-61's user interface: The plotter draws a menu on paper, and you position the pen over an option to select it. Although you sacrifice some time (and a sheet of paper), you can see which parameters are currently loaded, and you can retain a hard-copy record.

The DMP-52 also shares another characteristic with its more expensive cousin: outstanding plot quality. However, unlike the DMP-61, the DMP-52 didn't include a multipen accessory. Single-pen operation is too slow and too awkward, and it demands too much user intervention—a big minus. It also lacks the DMP-61's impressive specs, claiming half the axial pen speed (16 ips) and a less powerful CPU. On the other hand, it carries an attractive $3295 price tag. Remember, though, that the DMP-52 accepts only architectural-size drawings; so, for ANSI sizes, make sure to ask for the DMP-51.

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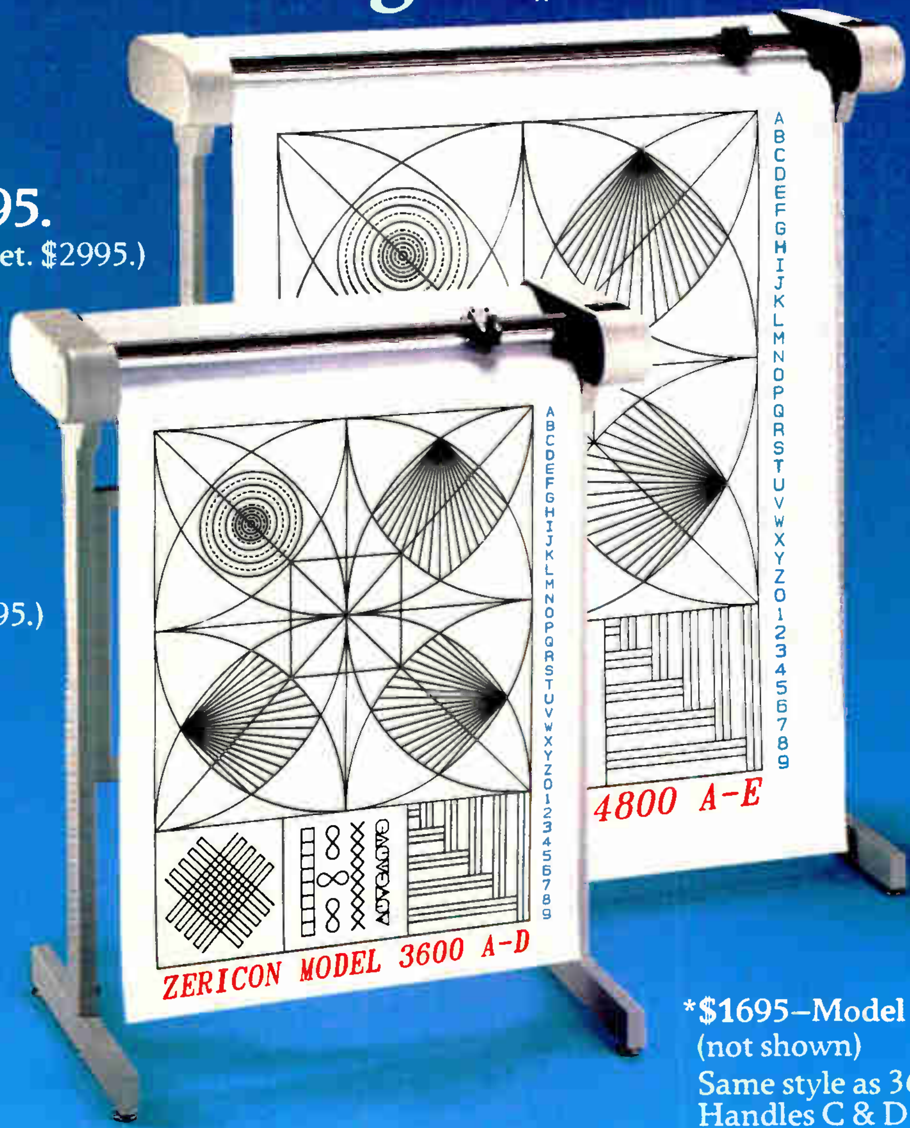

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IBM 6184: At $4150, the 6184 resembles the Hewlett-Packard DraftPro in just about everything except price. Like the DraftPro, the 6184 scored credibly on both the quality and throughput benchmarks but excelled on neither.

The carousel automatically determines pen velocity and force, but you can manually change parameters from a logical control panel. DIP switches enable pen sorting and margin expansion, while front and rear paper stops facilitate simple medium loading. As for documentation, we often found ourselves referring to the well-organized user's manual for general information (e.g., proper pen speeds for a particular medium and pen type). It's an excellent manual, but that doesn't justify the $155 difference in price between it and the DraftPro.

Numonics 5860: This eight-pen $3195 plotter offers price as its most appealing feature. A slow pen-changing mechanism coupled with sluggish pen speed resulted in unacceptable throughput in our tests. The 60K-byte buffer helps, freeing the host before the entire plot is complete, but speed is still slow.

Unfortunately, the Numonics 5860's slow throughput doesn't result in plot quality that stands out. You must adjust pen pressure by turning a thumbwheel,

Table 1: *For testing purposes, plotters were grouped by size. The different tests were optimized for speed or quality using CAD and graphics applications.*

Medium format	Simple CAD file			Complex CAD file		
	Final drawing quality score	Checkplot time	Final drawing time	Final drawing quality score	Checkplot time	Final drawing time
Houston Instrument DMP-61	7	2:34	3:13	8	24:39	33:20
Enter SP1800	7	4:01	5:11	7	33:53	43:34
CalComp Artisan 1023	7	3:12	3:42	7	24:45	32:35
Houston Instrument DMP-52[1]	7	3:27	3:41	7	31:04	36:08
Roland DG GRX-300	7	3:08	3:24	7	30:22	34:38
IBM 6184[2]	6	3:55	4:01	6	34:27	39:40
Roland DG DPX-2000	7	7:24	7:37	6	1:19:14	1:28:48
Hewlett-Packard DraftPro[2]	6	3:55	4:11	6	34:46	41:19
Numonics 5860	4	7:43	7:57	6	1:23:01	1:25:43
United Innovations Mural 8000	3	10:14	10:53	3	1:25:31	1:27:19

Small format	Presentation graphics			Complex CAD file		
	Final drawing quality score	Checkplot time	Final drawing time	Final drawing quality score	Checkplot time	Final drawing time
American Graphtec MP3300	8	28:59	29:04	6	38:01	40:52
Roland DG DXY-1100[2]	7	20:17	20:20	7	30:59	31:06
Roland DG DXY-1300[2]	7	20:05	20:51	7	29:55	31:25
American Graphtec PD9311/F[3]	6	28:52	29:26	4	24:23	28:39
Hitachi 672-XD	6	30:22	30:30	7	36:33	36:57
Bruning Zeta 8[4]	6	7:32	10:11	6	15:22	20:21
Hitachi 673-BM[5]	6	12:46	13:05	5	17:52	21:10
IBM 6182	5	19:18	19:55	7	15:14	19:19
Hewlett-Packard 7550A	5	19:35	19:53	7	16:19	19:31
IBM 6180[6]	5	33:07	33:07	4	N/A	33:03
Hewlett-Packard 7475A[6]	5	21:45	21:45	5	N/A	33:36
Houston Instrument 695A[7]	4	42:33	42:44	5	43:02	47:35
Fujitsu ImageGraph[6]	3	29:02	29:02	1	28:50	28:50
Enter SP600[6]	3	29:58	29:58	3	N/A	23:38

Plotters are sorted by quality scores using the complex CAD file for medium-format plotters and the presentation graphics file for small-format plotters.
Listed numbers are median scores on a scale of 1 (worst) to 10 (best). Rankings for plotters with the same median score were determined by mean score.

All times are in minutes:seconds.

Plotters were tested using roller-ball pens on translucent bond for the checkplot and stainless-steel ink pens on vellum for the final drawing, except where noted.

NOTES: [1] Bond paper provided by Houston Instrument was used for the checkplots for size reasons.
[2] Checkplots were run with fiber-tip pens on medium-bond paper.
[3] Final drawings used ceramic pens.
[4] Bond and vellum used in tests were provided by Bruning in continuous-roll format.
[5] Checkplots were run with ceramic pens.
[6] Final drawings used fiber-tip pens on medium bond.
[7] Hard-nib pen on glossy bond was used for checkplots.

and that just won't do when plot quality demands precise pen force. The plotter accepts a wide range of pens and media, including A- and B-size paper with an optional adapter. The 5860 was easy to set up and load, but we can't recommend a plotter with as many shortcomings as this one.

Roland DG DPX-2000: Our $5495 DPX-2000 flatbed plotter came with an optional stand, but you can just as easily put it on a desk. The plotting mechanism and electrostatic hold can operate at up to 80 degrees above horizontal to save space.

Though performance was very poor, plot quality was acceptable. The unit's flatbed design lets you watch for errors, and a front-panel Pause key can help in aborting a bad plot. Other controls are limited, however, and the LED displays only pen position.

Dual Centronics and RS-232C ports provide for easy interfacing. Other features include fully automatic pen sensing and extremely quiet operation.

Roland DG GRX-300: The GRX-300, which sells for $5295, is another excellent plotter in a crowded field. It's a friction-roller model with an axial pen speed of 23.6 ips. It supports a wide range of pens and media.

The GRX-300 sports consistently high numbers on both speed and quality tests. The plotter senses pen type and automatically adjusts pen speed and force. All parameters, including pen sorting, are easily adjusted from a menu-driven LCD. It's a shame everything is so easy: You may not even need the thorough, well-organized user's manual. With products like this representing the norm for medium-format plotters, it's hard to make a bad purchasing decision.

United Innovations Mural 8000: The Mural 8000 boasts some admirable features. You can mount it on the wall to save valuable space; it plots up to E size and beyond; and the $2495 price tag looks tempting. These virtues, however, can't redeem an inadequate product.

We had a variety of criticisms after testing the Mural 8000. The unit takes only one pen at a time, so you've got to keep an eye on it. It's pitifully slow, even

continued

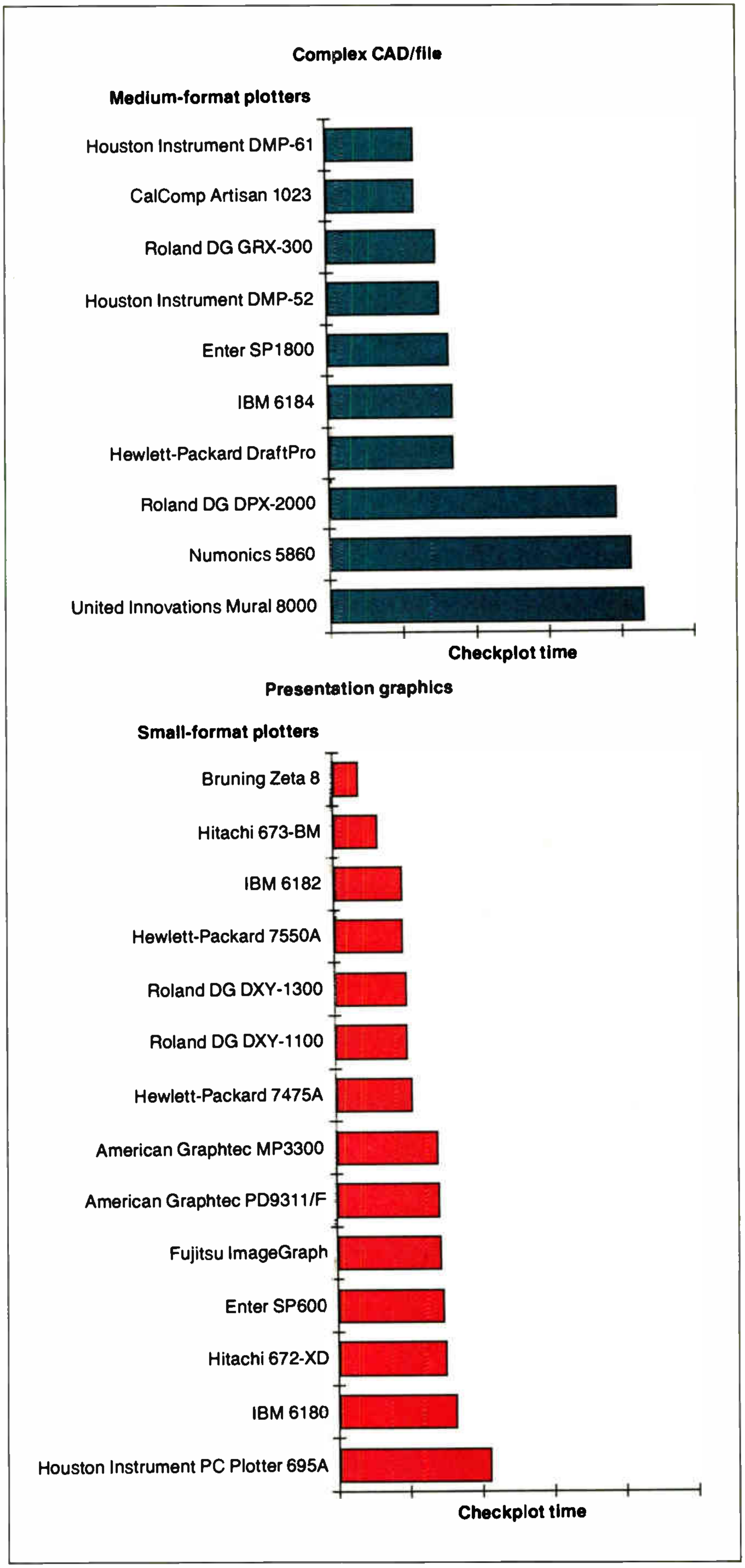

Figure 1: *Plotters ranked by performance. Graphed values are for representative checkplots: a presentation graphic for small-format plotters, and a complex CAD drawing for medium-format devices.*

Table 2: *Accuracy, repeatability, and resolution specifications are good indicators of plot quality; acceleration and axial pen speed likewise tend to determine performance (● = yes; ○ = no).*

Plotter	Price	Media sizes	Media	Pens	Auto-capping	Pens supported	Mechanism	Auto-feed	CPU speed	Buffer (in bytes)
American Graphtec MP3300	$1875	ISO A3/A4, ANSI A/B	Bond, vellum, film	8	●	F,B,C,L	Flatbed (electrostatic)	○	N/A	24K
American Graphtec PD9311/F	$3595	ISO A3/A4, ANSI A/B	Bond, vellum, film	4	●	F,B,C	Friction roller	●	N/A	6K
Bruning Zeta 8	$5950	ISO A3/A4, ANSI A/B	Translucent, glossy bond, vellum, matte film, clear film	8[3]	○	B,F,L,D	Drum	●	8088	18K
CalComp Artisan 1023	$4895	ASO A4-A1, ANSI A-D, Arch. A-D	Translucent, #22 bond, glossy bond, vellum 1411, film	8	●	B,F,P,L,D	Friction roller	○	2MC68000/10	100K [2M]
Enter SP600	$995	ANSI A/B	Bond, film	6	●	F	Friction roller	○	6800	1.5K
Enter SP1800	$4695	ISO A4-A1, ANSI A-D, Arch. A-D	Translucent, bond, vellum, clear film	8	●	B,F,L,D	Friction roller	○	6800	16K
Fujitsu ImageGraph	$1295	ISO A3/A4, ANSI A/B	Bond, film	6	●	P,B,F	Friction roller	○	Z80/10	12K
Hewlett-Packard DraftPro	$3995	ISO A1/A2, ANSI C/D, Arch. C/D	Bond, vellum, matte film	8	●	F,D,L	Friction roller	○	8032/12 8051	7448
Hewlett-Packard 7475A	$1895	ISO A3/A4, ANSI A/B	Bond, film	6	●	F,D	Friction roller	○	6802	1K
Hewlett-Packard 7550A	$3900	ISO A3/A4, ANSI A/B	Bond, glossy bond, vellum, film	8	●	B,F,L,D	Friction roller	●	68000	12.8K
Hitachi 672-XD	$895	ISO A3/A4, ANSI A/B	Bond, clear film	4	○	F,C,B,L	Friction roller	○	HD6809/3.7	512
Hitachi 673-BM	$1695	ISO A3/A4, ANSI A/B	Bond, clear film	4	●	B,F,D,C,L	Friction roller	●	HD6809/2 HD63C01Y0/2	128K
Houston Instrument DMP-52	$3295	ISO A1/A2, Arch. C/D	Bond, vellum, matte film	1	○	P,L,D	Friction roller	○	Z80, Z8	7K
Houston Instrument DMP-61	$5445[6]	ISO A4-A1, ANSI A-D, Arch. A-D	Bond, vellum, matte film	6	●	P,L,D	Friction roller	○	M68000/7.6	1M
Houston Instrument PC Plotter 695A	$795	ANSI A/B	Bond, vellum, clear film	4	○	P,L	Friction roller	○	Z8681	256K
IBM 6180	$1435[4]	ISO A4, ANSI A	Bond, clear film	8	●	F	Friction roller	○	8032/12	1K
IBM 6182	$4150	ISO A3/A4, ANSI A/B	Bond, glossy bond, vellum, film	8	●	F,B,D,L	Friction roller	●	M68000/6	12.5K
IBM 6184	$4150	ISO A1/A2, ANSI C/D	Bond, vellum, matte film	8	●	F,D,L	Friction roller	○	8032/12	7448
Numonics 5860	$3195	ISO A1/A2, ANSI C/D [A/B], Arch. C/D	Bond, vellum, matte film	8	○	F,B,P,D,L	Friction roller	○	6802/8	60K
Roland DG DXY-1100	$1295	ISO A3/A4, ANSI A/B	Bond, vellum, film	8	●	F,C,D,L	Flatbed (magnetic)	○	Custom VLSI	1K
Roland DG DXY-1300	$2395	ISO A3/A4, ANSI A/B	Bond, vellum, film	8	●	F,C,D,L	Flatbed (electrostatic)	○	Custom VLSI	1M
Roland DG DPX-2000	$5495	ISO A4-A2, ANSI A-C	Bond, vellum, film	8	●	F,C,B,D,L	Flatbed (electrostatic)	○	Custom VLSI	15K
Roland DG GRX-300	$5295	ISO A4-A1, ANSI A-D, Arch. C/D	Bond, vellum, film	8	●	F,C,B,D,L	Friction roller	○	Custom VLSI	18K [1M]
United Innovations Mural 8000	$2495	To 27" × 36"[5]	Bond, vellum, film, board	8	○	B,L,D,P	Flatbed (tape)	○	Z8/10	500 [88K]

[1]Includes stand.
[2]Includes paper rack.
[3]8 fiber-tip or ball; 4 drafting.
[4]Includes Graphic Enhancement Cartridge, $150.
[5]May do larger sizes in multiple passes.
[6]Price includes multipen adapter ($595) and memory upgrade ($995). Standard memory is 16K bytes.
Brackets ([ ]) indicate optional features not included in review units.

Pens: B=Ball
F=Fiber or nylon tip
P=Plastic tip
C=Ceramic tip
L=Refillable liquid ink
D=Disposable liquid ink
G=Graphite pencil

Language	Character sets	Interfaces	Acceleration	Axial pen speed (ips)	Accuracy (inches)	Repeatability (same pen)	Resolution (addressable)	Dimensions (inches)	Weight (lbs.)	Doc. (pp)
GP-GL, HPGL	6	RS-232C, Centronics	N/A	15.7	0.3%	0.1 mm	0.025 mm	22.6 × 17.9 × 4.1	14.3	327
HPGL [GP-GL]	5	RS-232C, [Centronics, IEEE-488]	2 g	18	0.2%	0.2 mm	0.025 mm	20.4 × 23.2 × 14.2	31	185
GML, HPGL, CalComp 960, PLOT 10		RS-232C, [IEEE-488, 3287 emulation]	2 g	25	0.1%, move > 10″ 0.01%, move < 10″	0.1 mm	0.025 mm	24 × 12 × 10	32	240
CPGL, HPGL, CalComp 960, PCI	10	RS-232C	2 g	30	0.01 (0.1%)	0.127 mm	0.0125 mm	37.5 × 21 × 42.5[1]	79[1]	218
HPGL, SPGL	18	RS-232C, Centronics	3 g	14	N/A	0.1 mm	0.025 mm	18 × 3.2 × 11.5	8	23
HPGL	19	RS-232C	2 g	31.5	0.02 (0.2%)	0.1 mm	0.025 mm	41 × 39 × 8[1]	143[1]	139
HPGL	19	RS-232C, Centronics	1 g	10	0.01 (0.5%)	0.1 mm	0.025 mm	16.5 × 10 × 4	10	108
HPGL	19	RS-232C, [HPIB]	2 g	15.7	0.02 (0.2%)	0.1 mm	0.025 mm	40.6 × 45 × 20.5[1]	66[1]	149
HPGL	19	RS-232C	2 g	15	N/A	0.1 mm	0.025 mm	5 × 22.4 × 14.5	16	313
HPGL	19	RS-232C, HPIB	6 g	31.5	N/A	0.1 mm	0.025 mm	8.5 × 26.4 × 17	38	563
HPGL	19	RS-232C, Centronics	1 g	7.9	0.008 (0.4%)	0.3 mm	0.025 mm	18.7 × 8.6 × 5.3	13.5	64
HPGL	19	RS-232C, Centronics	1 g	15.7	0.008 (0.3%)	0.2 mm	0.025 mm	18.9 × 8.6 × 5.3	14.3	91
DM/PL	8	RS-232C	4 g	16	0.01 (0.1%)	0.05 mm	0.025 mm	36.4 × 33.5 × 9.6[1]	52[1]	66
DM/PL	11[12]	RS-232C	4 g	32	0.01 (0.2%)	0.05 mm	0.025 mm	42 × 41 × 24[1]	52[1]	213
DM/PL	8	RS-232C (RJ-12 port)	N/A	3	N/A	0.1 mm	0.025 mm	9.2 × 17.5 × 7.8[2]	6.5	62
IBM-GL, HPGL	19[4]	RS-232C, [IEEE-488]	1.2 g	16	N/A	0.1 mm	0.025 mm	5 × 18.4 × 12.3	12	310
IBM-GL, HPGL	20	RS-232C, IEEE-488	6 g	31.5	N/A	0.1 mm	0.025 mm	26.4 × 17 × 8.5	38	398
IBM-GL, HPGL	33	RS-232C, [IEEE-488]	2 g	16.5	0.02 (0.2%)	0.1 mm	0.025 mm	40.6 × 44.9 × 20.5	66	186
HPGL	20	RS-232C, [IEEE-488]	N/A	7.7	0.5%	0.1 mm	0.025 mm	5.9 × 8.3 × 31.9[1]	50[1]	43
HPGL, DXY-GL	9	RS-232C, Centronics	N/A	16.5	0.1 (0.3%)	0.1 mm	0.025 mm	24 × 16.3 × 4.2	12.6	203
HPGL, DXY-GL	9	RS-232C, Centronics	N/A	16.5	0.1 (0.3%)	0.1 mm	0.025 mm	24 × 16.3 × 4.2	12.6	203
RD-GLII	9	RS-232C, Centronics	N/A	15.7	0.002 (0.2%)	0.05 mm	0.0125 mm	30.9 × 5.5 × 23.2	38	178
RD-GLII	9	RS-232C, Centronics	3 g	23.6	0.004 (0.1%)	0.1 mm	0.025 mm	52.8 × 48.2 × 21.1[1]	132[1]	370
HPGL	5	RS-232C	N/A	7	0.35%	0.089 mm	0.089 mm	4 × 45 × 31	50	66

N/A = Data not available from manufacturer.

Photo 1: *The CalComp Artisan 1023 rated tops overall for an outstanding combination of features and performance.*

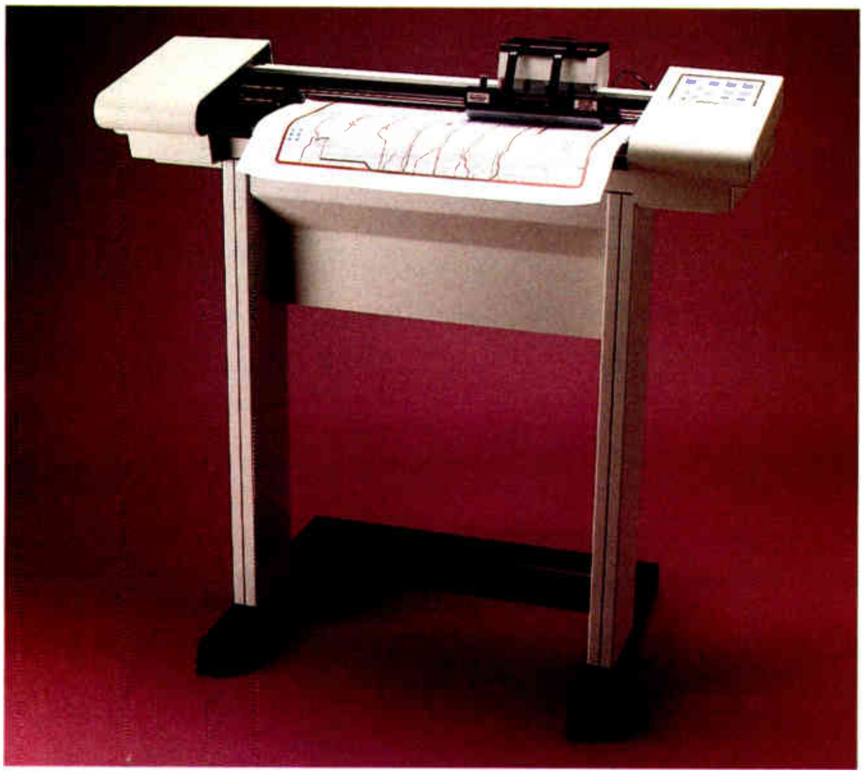

Photo 2: *Houston Instrument's DMP-61 was the fastest plotter we tested. It also came out on top in our quality ratings.*

when you ignore the time wasted switching pens yourself. Pen adjustments require tweaking of inconveniently located hexagonal screws, and the haphazard documentation doesn't simplify matters much. On top of all that, the plots were of poor quality.

Small-Format Plotters

Bruning Zeta 8: At $5950, the Zeta 8 is by far the most expensive of the small-format plotters we tested. But it offers a good return on your investment: It's a fast, versatile device that produces above-average plots.

The Zeta 8's drum and continuous-feed mechanism can generate repeated plots on paper rolls or fanfold media without pausing. If you don't need continuous A- or B-size plots, Bruning offers a D-size version for the same price that also handles cut sheets from A through C size. Front-panel controls, though extensive, require entering cryptic key combinations without benefit of a display. A terminal interface avoids that problem and makes the plotter suitable for a mainframe environment.

One small flaw mars this otherwise superior plotter: the use of a moving pen-carrier mechanism rather than a carousel and moving arm design. While the carrier provides excellent pen-changing speed, the physical hold on the pens is limited, and they occasionally work their way out of alignment.

Enter SP600: Designed primarily for use with business graphics, the $995 Enter SP600, the "Sweet-P," offers economy at the expense of performance and plot quality. Even quiet operation and user controls are sacrificed for low cost.

Front-panel control is almost nonexistent, with three switches allowing pen selection, pausing, and the running of a demonstration plot. Application software often provides drivers for this popular plotter; for software that does not, a compatible driver for the Hewlett-Packard 7475A will work. Dual Centronics and RS-232C ports make interfacing easy.

Fujitsu ImageGraph: The ImageGraph suffered more from a lack of adequate pen support than from any glaring design defect, but the result was the same: poor-quality plots. While the other plotters were benchmarked using fine-tipped pens, Fujitsu offers only the 0.5-mm size. Unfortunately, the plotter will not accept a more standard pen format (like the Hewlett-Packard pen type), so you're stuck with the Fujitsu offering. A small

continued

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Plotter Benchmarks

Two factors are of paramount importance to plotter users, as they are to users of any output device: speed and output quality. The most difficult task in developing a suite of plotter tests is in maintaining consistency. Both speed and quality are dependent on the choice of pens and media, and plotters differ drastically in the types of drafting equipment they support.

Our solution was to split the tests into two groups: a checkplot test, optimized for drafting speed, and a final plot test, where quality was gained at the expense of speed. Wherever possible, the checkplot test used roller-ball pens on light translucent bond to produce satisfactory output at the plotter's maximum rated speed. Plotters that didn't support roller-ball pens were tested using whichever pens were recommended for high-speed plots.

For the quality test, we used disposable liquid ink and drafting pens on vellum when supported, and the nearest-quality equivalent when not. We also used fine-tip pens, usually 0.35 mm, when supported. Details on the pens and media used for each plotter are listed in table 2.

We further subdivided the tests to take into account the difference between small-format and medium-format plotters. Because medium-format plotters are most often used for CAD applications, we tested them by producing two multicolor AutoCAD test files. The first is AutoCAD's sample Pump drawing, a short, simple plot composed primarily of lines and large circles. For a complex file, we used Softwest, a printed circuit-board layout from Great Softwestern made up of lines, small circles, area fills, and text. Both files are plotted one color layer at a time, minimizing the effect of pen-changing time on total speed.

Small-format plotters, used primarily for presentation graphics, were tested using a bar chart developed under Harvard Graphics. The chart consists of small drawings and requires repeated pen changes. To minimize software influence, all plots, including checkplots, were produced in Harvard Graphics' high-quality mode. The software configuration uses complete (not hatched) area fills and drawn letters, rather than the plotter's internal character sets. While charts and graphs are rarely plotted on vellum, the test provided a consistent quality rating easily extrapolated to other plotting media. As a check on CAD compatibility, Softwest was also run on the small-format plotters.

All plots were hand-timed using an 8-MHz IBM PC AT as a testing platform, and each plotter was connected to the AT via an RS-232C serial connection. Quality was determined by BYTE editors, who rated the plots on the following criteria: line-weight consistency, registration, evenness of area fills, and overall clarity.

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carousel holds the pens, and a push of one button loads the paper.

The model we had offered RS-232C and Centronics interfaces; a slightly different model interfaces through a GPIB or IEEE-488 port. It supports ISO A3 and A4, ANSI A and B, and paper up to 11.7 by 32 inches. Pen support is the principal drawback of the ImageGraph. Unfortunately, it's enough to make this $1295 plotter a risky investment.

Hewlett-Packard 7475A: Hewlett-Packard's smallest plotter, the $1895 7475A, is a standard in the small-format business graphics market. It's also a capable CAD plotter, with B-size media and drafting pen support. As a standard, it's supported by virtually every CAD and graphics application package. The 7475A posted only middle-of-the-road scores on our quality and speed benchmarks, however.

Control switches allow complete pen and medium movement control, but pen pressures and speeds aren't selectable. The 7475A is a solidly built plotter, and it is easily put to use. Hewlett-Packard dedicates half the operation manual to making a proper serial connection and offers detailed instructions for connections to a variety of personal computers.

Hewlett-Packard 7550A: The 7550A supports four special pen carousels for drafting, roller-ball, paper, and transparency. The carousel determines the plotter's speed and force to ensure the proper default for each type of pen. Quality plots were delivered quickly.

Front-panel controls enable automatic sheet feeding, easy medium loading, pen selection, and manual pen movement (see photo 3). The Replot key stores the last plot and draws up to 99 copies on request. The keys also drive a small message display. If you need multiple color copies of a single plot, automatic sheet feeding and independent replotting make the $3900 7550A a logical choice.

Hitachi 672-XD and 673-BM: Hitachi's two entries both offer good output quality for the money ($895 for the 672-XD, and $1695 for the 673-BM); the 673-BM even puts up some impressive benchmark numbers on our speed tests. Unfortunately, they both suffer from a lack of reliability that can make everyday plotting a trying experience.

These two plotters are suited for business graphics, and both support A- and B-size media. The 673-BM's better speed ratings, substantially larger data buffer, and automatic-feed option make it more suitable for high-speed, high-volume production. Both produced a fair plot, but only after repeated trials; the 672-XD's plot quality was slightly better than the 673-BM's.

Using drafting pens on the 673-BM is a nightmare. In contrast to the Hewlett-Packard-style holder, Hitachi's pen holder is unthreaded and relies on friction to hold the pen steady. Pens often work their way out during rapid plotting. We should mention that the holders, though provided by Hitachi, were manufactured by a third party; Hitachi holders should be available by the time this article reaches print.

A related problem both plotters share lies in the pen-carrier mechanism. The pen holders, supported on springs, can easily become misaligned, as can the contact arm that pushes the pens to the page.

Houston Instrument PC Plotter 695A: An unusual pen carousel, an odd RS-232C connection, and a non-HPGL programming language combine to make the PC Plotter unique among the small-format plotters we reviewed. And at $795, it's also the cheapest. Houston Instrument's proprietary DM/PL language is well supported by application software, so the programming point is minor. The other unusual features, however, are definite detriments.

The RS-232C port has an RJ-12 con-

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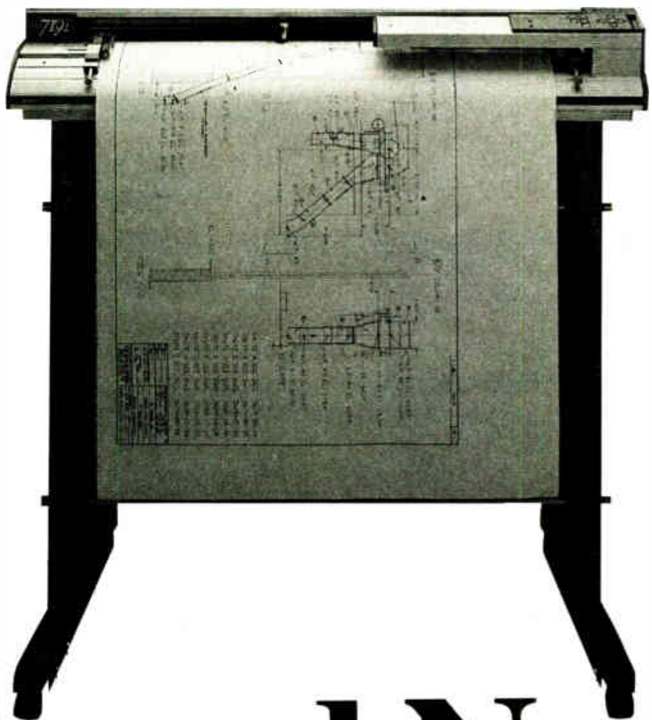

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nector, making it incompatible with most serial devices in the personal computer market. The four-pen carousel moves along the drawing surface and rotates the selected pen into position against the page. The design is noisy and prone to accidental contact between pen and medium, and it results in very slow pen changes and very slow operation overall.

Houston Instrument's hard-nib pens tear apart standard paper and can produce legible results only on coated bond. Though drafting pens are supported, the lack of pen-pressure control makes them unreliable for use on vellum. Not surprisingly, quality ratings were low.

IBM 6180: IBM's low-end plotter is designed to go head-to-head with the Hewlett-Packard 7475A. Though the performance specs differ slightly and the 6180 is significantly cheaper at $1435, any user familiar with operating one will have no trouble making the switch to the other. User controls are identical, allowing plot rotation and size setting, in addition to pen and medium movement control. Throughput is the only real difference between the two; both turned in acceptable times on our CAD test, but the 6180 performed poorly on pen-changing-intensive graphics.

Our review unit included an optional Graphics Enhancement Cartridge, a small ROM module that adds buffer memory, character sets, and IBM 7372 plotter emulation. The 6180's lack of drafting-pen capability hurt it on our output quality test and makes it unrealistic for CAD, but the fiber-tip pens produce fine chart graphics on standard paper.

IBM 6182: Don't be fooled by the 6182's third-place finish in the presentation graphics speed test—except for pen changes, this $4150 model is the fastest desktop plotter we reviewed. The 6182 features an automatic-feed mechanism and a replot buffer that allows running multiple plots unattended.

Different carousels for each pen type are detected and used to set default speeds and pressures. IBM provides full front-panel controls with an LCD and menu-driven parameter selection. This is more typical of a medium-format plotter.

Plot quality was average overall, comparable to Hewlett-Packard's high-speed desktop 7550A. A good quality score on the CAD benchmark makes this an excellent choice for a small-format CAD plotter.

Roland DG DXY-1100 and DXY-1300: These two flatbed plotters share many characteristics, including outstanding quality scores and adequate throughput. They even share the same manual. But while the DXY-1300 uses electrostatic absorption to hold the paper in place, the DXY-1100 uses a set of magnets (see photo 4).

The DXY-1300 further justifies its higher price by including a standard 1-megabyte buffer and an *x,y* coordinate display. A row of pen-selector switches on the DXY-1300 makes it easy to adjust pen speed, but the less advanced pen-speed adjustment that is found on the DXY-1100 is simple enough.

Both plotters support a wide range of pens and media, but the pen-changing

continued

Photo 3: *The Hewlett-Packard 7550A was among the fastest and most versatile of the small-format plotters.*

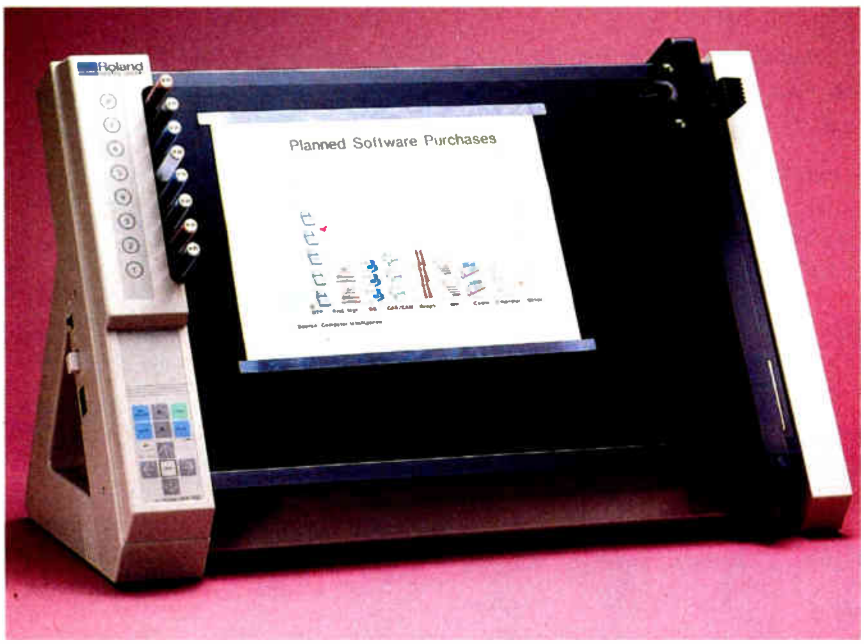

Photo 4: *The Roland DG DXY-1100 flatbed plotter offers moderate performance at a good price.*

Company Information

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Hitachi America, Ltd.
6 Pearl Court
Allendale, NJ 07401
(201) 825-8000
Inquiry 1029.

Houston Instrument
8500 Cameron Rd.
Austin, TX 78753
(800) 531-5205
Inquiry 1030.

IBM
Neighborhood Rd.
Kingston, NY 12401
Contact local representative
Inquiry 1031.

Numonics
101 Commerce Dr.
Montgomeryville, PA 18936
(215) 362-2766
Inquiry 1032.

Roland DG
7200 Dominion Cir.
Los Angeles, CA 90040
(213) 685-5141
Inquiry 1033.

United Innovations
Crossroads Industrial Park
Holyoke, MA 01040
(800) 323-3283
Inquiry 1034.

mechanism is sluggish. The $1295 DXY-1100 is the best of the low-cost plotters we tested, but you may wish you had the additional features and expanded memory of the $2395 DXY-1300.

American Graphtec MP3300: Like the Roland flatbeds, the $1875 MP3300 is quiet and aesthetically pleasant and can be tilted to preserve desk space. It also provides plots of unrivaled quality. Unfortunately, its speed performance lags far behind that of many of the other plotters we tested.

You can set pen speed through the control switches, and an LCD panel echoes speed selection as well as giving a coordinate display. Pen pressure must be set with a mechanical lever on the pen holder itself. An automatic pen-return feature lifts any idle pen left in contact with the medium's surface for longer than a specified interval and returns it to its holder. Both HPGL and American Graphtec's proprietary GP-GL languages are supported, as are both Centronics and RS-232C interfaces.

American Graphtec PD9311/F: This unit is a scaled-down version of the Hewlett-Packard 7550A, with automatic-feed capability and a lower price tag ($3595). With the lower price comes significantly lower performance numbers, however; benchmark speed numbers were only average. Drafting pens aren't supported, and the carousel accepts only four pens at a time. However, the PD9311/F plotter produces excellent charts with ceramic pens.

Automatic pen-type sensing sets the default speed and pressure. You can control pen speed and paper movement from the front panel; a six-LED display indicates switch settings. You set communications parameters via DIP switches on a plug-in communications card installed in the plotter. The modular approach to interface cards makes it possible to configure the plotter for IEEE-488 or parallel operation with optional cards. HPGL or GP-GL language support is available.

Drawing Conclusions

Picking the best medium-format plotter from such a fine field is no easy task. All but a few are good candidates for CAD applications, with high-speed plotting, quality output, and almost universal software support.

Houston Instrument's DMP-series plotters stand out with roundly excellent scores on all our benchmarks. The DMP-61 tops both categories, and it adds detailed parameter selection to fine-tune plots for speed or for quality. CalComp's Artisan 1023 also turned in a spectacular performance, with ratings almost comparable to the DMP-61 and a price tag $550 less. But other features—like plot-optimization capability, greater room for buffer expansion, automatic pen sensing, and menu-driven front-panel controls—give the Artisan 1023 the edge.

There seems to be a nearly inverse relationship between speed and quality among the small-format plotters. For high-volume, high-speed plotting, the best choice is undoubtedly the Hewlett-Packard 7550A. Although the 7550A lacks the high-speed pen-changing mechanism sported by Bruning's Zeta 8 and the Hitachi 673-BM, it is also prone to fewer problems. IBM's 6182 is also excellent, but it is priced above the 7550A while delivering only comparable performance.

Individual users with low-volume requirements may find the higher-performance small-format plotters beyond their price range. Though most small-format desktop units are advertised as low-cost, the actual median price for those we reviewed is in the neighborhood of $1700. At $1295, the best low-cost plotter we looked at is the Roland DG DXY-1100, which offers good plot quality, satisfactory speed, and quiet flatbed operation. ■

Stanford Diehl and Steve Apiki are BYTE Lab testing editors. They can be reached on BIX as "sdiehl" and "apiki," respectively.

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The Sun386i

A Unix color graphics workstation that runs MS-DOS

John Unger

A new animal has appeared in the microcomputer zoo. It's a Unix/DOS hybrid, and it inhabits the first Intel CPU powerful enough to run Unix acceptably—the 80386. The prime specimen is the Sun386i, a Unix workstation that can emulate instances of DOS in Unix processes and thus behave like a multitasking personal computer. ("Merge 386" on page 207 describes another Unix/DOS hybrid.)

DOS processes appear as windows in the SunView desktop environment; you can run a DOS application in each window. (SunView also assigns each Unix process to a window.) Since DOS emulation employs the virtual 8086 mode of the 80386, a DOS window can run real-mode but not protected-mode software.

So don't expect the Sun386i to act like a 20-MHz or 25-MHz 80386 MS-DOS machine. Its forte as a personal computer is that it supports true multitasking of DOS processes and that it integrates DOS and Unix files and applications. But of course, the Sun386i isn't just a personal computer; its SunOS Unix operating system, high-resolution graphics, networking capabilities, and price (almost $10,000 for the least expensive stand-alone system) qualify it as a true Unix workstation.

Nuts and Bolts

Because BYTE wanted to test the networking capability of the Sun386i—the machines communicate using Sun's NFS (Network File System) on an Ethernet local-area network (LAN)—I reviewed two Sun386i machines. Each was a Model 386i/250 and came with the standard features: a 25-MHz 80386 CPU, a 25-MHz 80387 coprocessor, 8 (expandable to 16) megabytes of dynamic RAM (DRAM), an Intel 82385 cache controller, a 32K-byte high-speed static RAM (SRAM) cache, and a 1.44-megabyte 3½-inch floppy disk drive. The workstation that I set up as the network file server had a 327-megabyte hard disk drive; the client workstation had a 91-megabyte hard disk drive.

The Sun386i doesn't come cheap. My two review systems—both with color video boards and 16-inch color monitors—retail for $19,990 (the 327-megabyte server) and $15,990 (the 91-megabyte client). The least expensive stand-alone system is the Model 386i/150, configured with a 91-megabyte hard disk drive and a 15-inch monochrome monitor; it sells for $9990. The 386i/150 comes with 20-MHz 80386 and 80387 chips, only 4 megabytes of DRAM, and no SRAM cache (it's available as an option). (For a more detailed description of the Sun386i hardware, see "Sun's New Workstation: the Sun386i" by Tom Thompson, July BYTE.)

The colors on the review systems' monitors, combined with their high resolution (1152 by 900 pixels), give absolutely spectacular color graphics. To sample the Sun386i's color capabilities, I experimented with the SunView palette editor, a tool that lets you create colors by varying relative saturations of red, green, and blue. The screen can display 256 colors simultaneously, and you can

continued

Sun386i/250

Company
Sun Microsystems, Inc.
2550 Garcia Ave.
Mountain View, CA 94043
(800) 821-4643
(800) 821-4642 (in California)

Components
Processor: 25-MHz 80386 with zero wait states; 80387 math coprocessor
Memory: 8 megabytes of DRAM, expandable to 16 megabytes; Intel 82385 memory cache controller with 32K bytes of SRAM
Mass storage: 1.44-megabyte 3½-inch floppy disk drive; optional 91- and 327-megabyte SCSI hard disk drives; optional cartridge tape backup drive
Display: 16-inch color monitor; 1152-pixel by 900-pixel 8-bit color video board
Keyboard: 107 keys (accommodates both IBM Enhanced and Sun-3 layouts)
Unix I/O interfaces: Four proprietary 32-bit expansion slots running at 25 MHz for system memory and display frame buffer; three IBM PC AT 16-bit expansion slots; one IBM PC 8-bit expansion slot; one RS-232C asynchronous serial port; one Centronics-compatible parallel port; 10-megabit-per-second Ethernet interface; one SCSI connector

Size
16 x 7½ x 20½ inches; 50 pounds

Software
SunOS 4.0 Unix operating system (a combination of 4.3 BSD and AT&T System V.3 Unix) with SunView desktop manager and MS-DOS 3.3

Options
14-inch color monitor and frame buffer: $3300
16-inch color monitor and frame buffer: $4780
19-inch color monitor and frame buffer: $7780
15-inch monochrome monitor and frame buffer: $1650
19-inch monochrome monitor and frame buffer: $2780
91-megabyte hard disk drive: $2200
327-megabyte hard disk drive: $6600
60-megabyte tape backup: $1485
4-megabyte memory module: $3000

Documentation
186-page User's Guide; 157-page System Setup and Maintenance; 316-page Advanced Skills; 222-page SNAP Administration; thousands of pages of additional Unix documentation

Price
Sun386i/250 with 8 megabytes of RAM, 327-megabyte hard disk drive, and 16-inch color monitor: $19,990

Inquiry 885.

select them from a palette of over 16 million colors.

SunOS Unix and MS-DOS share three standard hardware devices: the floppy disk drive, the serial port, and the parallel port. Unix uses the 3½-inch floppy disk drive as the primary I/O device (`/dev/fd0c`)—the drive you use to load the operating system and optional software, and to back up the system's hard disk. (There may be a crueler punishment than having to back up a full 327-megabyte hard disk using 1.44-megabyte floppy disks, but I can't think of one. Clearly, you'll want to use the optional 60-megabyte ¼-inch cassette tape drive for this purpose.) Under DOS, the floppy disk drive serves as drive A. When a DOS window is active, it owns the serial port; Unix applications can't use it unless DOS explicitly relinquishes it. Unix controls the parallel port and uses it as a spooled device, which, to DOS, looks like LPT1.

Up and Running in Half an Hour

The designers of the Sun386i have done much to simplify the normally arduous task of setting up a Unix system. First, Sun preloads the important parts of the operating system on the hard disk; all you have to do to get the system up and running is physically connect the components of the system (as described in a very straightforward and well-illustrated brochure), plug in the power cord, and flip on the switch. Sun claims that it shouldn't take more than about a half an hour to get from a boxed Sun386i to a live system; it's true. If you've ever installed Unix on a workstation, you know how impressive that is.

Network configuration, based on Sun's NFS, is just as simple. It's a three-step process. First you connect each machine to the network controller with Ethernet cables. Then you power on the machine you've designated as the server and answer some questions about that machine. Finally, you power up the rest of the computers that belong to the network, answering questions about each in turn. The system automatically configures the critical files `hosts`, `rc.boot`, and `yellow pages`. Again, Unix users who have struggled with these tasks can imagine my delight when I followed these three steps and the system simply worked.

When the system comes up, it prompts for a user name and leads you through the steps required to create an account for that user. The system software handles the tasks that a system administrator must normally perform at this point: It creates a home directory and a log-in script, and, if the machine belongs to a network, it broadcasts the user's name to the other machines on the network and arranges for access to network resources.

By now, I had such confidence in the Sun386i's ease of use that I urged a Unix-naive friend to set up an account for himself. He chose a password that included a space; Unix doesn't permit that. After a few minutes, the system complained and referred my friend to the system administrator—that is, to the person sitting next to him with a worried look on his face and not the slightest idea of what to do. Things were really awry; I found that I couldn't add any more users to either machine in the network. I called Sun's technical-support representative and found out about a tool that would unconfigure the system, and that solved the problem.

The moral of this story is that although the Sun386i tries hard to conceal Unix, Unix is still grumbling under the hood, and there are times when you need a mechanic.

Three in One

There are really three operating systems on the Sun386i: Unix, SunView, and DOS. Each has its own unique personality. Unix is the fundamental operating system; both SunView and DOS draw on its resources. SunOS 4.0 is the flavor of Unix on the Sun386i. In practice, SunOS blends Berkeley Unix (4.2/4.3 BSD) with a dash of AT&T System V.3. You can run the Bourne shell or the C shell.

As far as I could determine, Sun's implementation of Unix is faithful and complete. And the SunOS extensions to Unix—that is, the SunView desktop environment in which Unix processes appear as windows—make this version more powerful than other Unix variants. There's one quirk that may offend those who prefer raw Unix. When you log in as the root (superuser), Unix controls the monitor and uses a large, clear font on the full screen. But normal users log directly into SunView. The command line window available there is considerably smaller than the full screen, and it uses a reduced font.

SunView implements an iconic desktop. Icons present by default represent the Unix shell, the Unix mail system, Sun's text editor, a file-management utility, and a hypertextual help system that provides smooth access to information about SunView programs. To ask the help system about a particular application, you point to that application's icon and press the Help key. A basic descrip-

continued

Sun386i

APPLICATION-LEVEL PERFORMANCE

Sun386i **13.2***

WORD PROCESSING	
XyWrite III + 3.52	Medium/Large
Load (large)	:08
Word count	:02/:15
Search/replace	:05/:17
End of document	:02/:08
Block move	:07/:07
Spelling check	:06/:45
Microsoft Word 4.0	
Forward delete	:27
Aldus PageMaker 1.0a	
Load document	:12
Change/bold	:20
Align right	:17
Cut 10 pages	:14
Place graphic	:03
Print to file	1:11
Index:	**3.24**

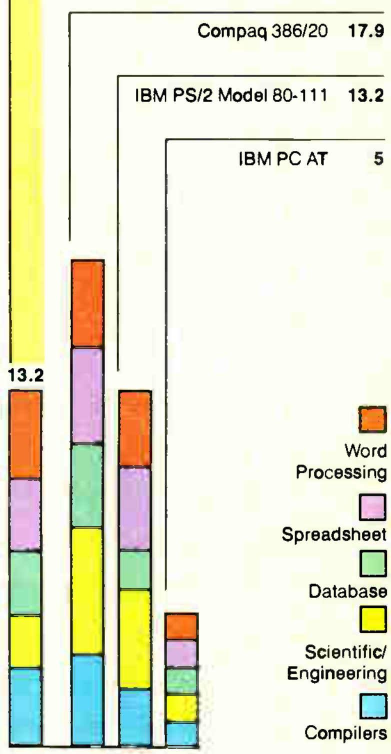
SPREADSHEET	
Lotus 1-2-3 2.01	
Block copy	:03
Recalc	:01
Load Monte Carlo	:20
Recalc Monte Carlo	:04
Load rlarge3	:06
Recalc rlarge3	:01
Recalc Goal-seek	:04
Microsoft Excel 2.0	
Fill right	:06
Undo fill	1:31
Recalc	:02
Load rlarge3	:22
Recalc rlarge3	:01
Index:	**2.66**

DATABASE	
dBASE III + 1.1	
Copy	:28
Index	:08
List	5:53
Append	:47
Delete	:02
Pack	:34
Count	:06
Sort	:50
Index:	**2.36**

SCIENTIFIC/ENGINEERING	
AutoCAD 2.52	
Load SoftWest	1:45
Regen SoftWest	1:33
Load St. Pauls	:16
Regen St. Pauls	:10
Hide/redraw	10:44
STATA 1.5	
Graphics	2:24
ANOVA	:51
MathCAD 2.0	
IFS 800 pts.	:15
FFT/IFFT 1024 pts.	:14
Index:	**1.94**

COMPILERS	
Microsoft C 5.0	
XLisp compile	3:08
Turbo Pascal 4.0	
Pascal S compile	:04
Index:	**2.96**

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]

CPU	
Matrix	2.74
String Move	
Byte-wide	32.44
Word-wide:	
Odd-bnd.	26.56
Even-bnd.	16.59
Sieve	17.01
Sort	12.93
Index:	**3.61**

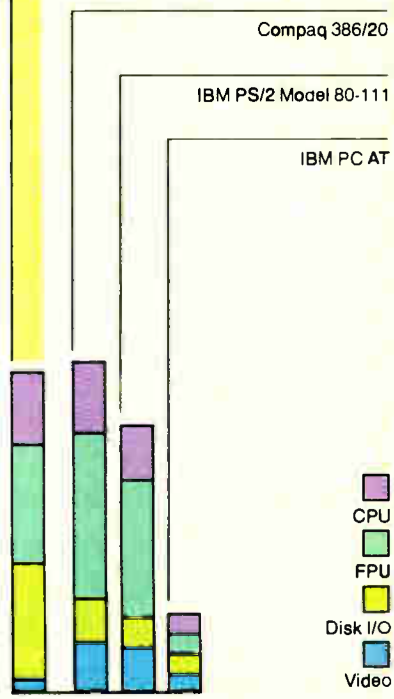
FLOATING-POINT	
Math	6.99
Error[2]	
Sine(*x*)	3.30
Error	
e^x	3.19
Error	
Index:	**6.02**

DISK I/O	
Hard Seek[3]	
Outer track	0.77
Inner track	0.73
Half platter	0.94
Full platter	0.82
Average	0.81
DOS Seek	
1-sector	2.13
32-sector	3.42
File I/O[4]	
Seek	0.18
Read	0.28
Write	0.29
1-megabyte	
Write	2.40
Read	1.12
Index:	**5.87**

VIDEO	
Text	
Mode 0	N/A
Mode 1	N/A
Mode 2	N/A
Mode 3	N/A
Mode 7	38.56
Graphics	
CGA:	
Mode 4	N/A
Mode 5	N/A
Mode 6	N/A
EGA:	
Mode 13	N/A
Mode 14	N/A
Mode 15	N/A
Mode 16	N/A
VGA:	
Mode 18	N/A
Mode 19	N/A
Hercules	3.11
Index:	**0.70**

CONVENTIONAL BENCHMARKS	
LINPACK	173.67
Livermore Loops[5] (MFLOPS)	0.17
Dhrystone (MS C 5.0) (Dhry/sec)	7002.00

N/A = Not supported by graphics adapter.
[1] All times are in seconds. Figures were generated using the 8088/8086 and 80386 versions (1.1) of Small-C.
[2] The errors for Floating-Point indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.
[3] Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).
[4] Read and write times for File I/O are in seconds per 64K bytes.
[5] For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance.



For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June BYTE.

tion appears; you can scroll or follow links quickly and easily using just the mouse. I found the help window useful at first, but as I progressed, I had to resort more and more to the manuals.

To activate a SunView application, you point to its icon and click the left button of the three-button mouse; an overlapping window opens on the desktop. SunView and its applications use the three mouse buttons consistently. The left button selects items, activates buttons or toggles, or confirms decisions. The center button drags windows or objects or, in conjunction with the Control key, resizes windows. The right button pops up menus and then selects items from them.

The menu that appears when you click the right button depends on the position of the mouse cursor. If you're pointing to the gray desktop background, you'll see the main desktop menu, which you use to open new command windows and invoke system services; if you're pointing to the top border of an open window, you'll see the Frame menu, which you use to move and resize windows.

To open an MS-DOS window in SunView, you click the right mouse button in the gray desktop area, highlight the Commands choice on the menu that pops up, slide the cursor to the right to open the Commands submenu, highlight the MS-DOS choice, and finally select that choice by clicking the right button again. (SunView's telescoping submenus will be familiar to Interleaf users.) In a few seconds, a new window opens; MS-DOS 3.3 boots itself in that window, and you are ready to enter the third level of our operating environment adventure game. As with all mouse-based operations, the description of how to do something—in this case, opening an MS-DOS window—sounds complicated but is actually quite simple.

Good Old DOS

On the 16-inch monitor, the DOS window's dimensions are 6½ by 4¼ inches. Yes, that's right, the entire 80-column, 25-row CRT display is projected, in Hercules monochrome mode, into that rather small rectangle. To read text in the DOS window, I had to move uncomfortably close to the monitor.

On a 19-inch monitor, the DOS window would be proportionately larger—since the 19-inch monitor has the same pixel resolution (1152 by 900) as the 16-inch monitor—and therefore easier on the eyes. Although in general you can resize SunView windows and alter the fonts they use, the dimensions of the DOS window and the fonts it uses are fixed. The Sun386i supports three graphics modes in the DOS window: MDA, CGA, and Hercules.

You can open multiple overlapping DOS windows, but only the first one has write access to the floppy disk drive, the emulated drive C, and the serial port. To reassign one or more of these devices to a DOS window other than the original one, you have to select the Devices option from the menu that appears when you click the right mouse button in a DOS window. You can use the emulated C drive to store files that you create under DOS, but Sun recommends that you use it sparingly. It's really a Unix file that is specially formatted to look like a hard disk drive to DOS; you can even run CHKDSK on it. To Unix, however, it's just a file, and none of its directory structure is available under Unix.

Other parts of the Unix file structure are available to both Unix and DOS, so you require a C drive only for DOS software packages with copy-protection schemes that rely on the DOS disk format. It's best to use other logical drive letters—ones that SunOS maps into the Unix file system—to store your DOS programs and files. For example, SunOS maps your home directory to drive H.

The SunView DOS window isn't just small, it's slow: I/O seems to crawl. One way to circumvent these limitations is to use a third-party EGA or VGA board in conjunction with an extra monitor. You install the board in one of the three AT-compatible slots in the Sun386i; the Sun386i's Advanced Skills manual explains how to do that. Then you edit two Unix files so that SunOS knows that you have installed a board in one of the AT slots. Now when you start up a new DOS window in SunView, you'll see a blank window on the desktop, and normal DOS screen I/O will occur on the external monitor connected to the video board. Because the SunView system does not have to intercept all the video hardware calls and reroute them to Sun's graphics software, screen I/O speed should improve greatly; I wasn't able to test this.

DOS software runs, but it suffers from poor screen I/O. I tried WordPerfect 4.2, and the cursor responded so poorly that it was invisible much of the time. Microsoft Windows 2.0 behaved similarly. Both the emulated mouse cursor and the keyboard responded very sluggishly. The cursor lagged behind the mouse movements so much that it made the mouse and Windows unusable. Sun is aware of this problem, but it is finding it difficult to speed up Windows because SunOS has to handle a large number of interrupts when Windows is running in the DOS window. Of course, SunView obviates the need for Microsoft Windows, so the experiment was perhaps a bit unfair.

I also had problems using the serial port in the DOS window. Because almost none of my MS-DOS software is on 3½-inch disks and because Sun does not offer an external 5¼-inch disk drive for the machine, I had to transfer software from my AT&T machine to the Sun386i by way of Procomm and an RS-232C cable connecting their serial ports.

To make a long story short, it didn't work. I couldn't reliably establish communications with Procomm (running on both systems) at any data transfer rate greater than 1200 bits per second, and even at 1200 bps the largest file I was able to transfer using either XMODEM, YMODEM, or Kermit was about 20,000 bytes. When I tried to transfer larger files, DOS on the Sun386i would crash without warning, and its window would disappear. SunOS said something about unsupported or illegal interrupts, but I had no other clues to what was going on.

I called Sun Microsystems, and the company confirmed it was having problems in the DOS environment with the serial port, since, as with screen I/O, SunOS must intercept and handle all the hardware interrupts. In this case, the system thought it had intercepted an illegal instruction, and the 80386's memory management hardware told Unix to kill the process responsible for the bad instruction—the DOS window.

On the bright side, the protection works. In a multitasking system, it's essential to isolate processes from one another, and the Sun386i does. And the serial port works fine as a Unix I/O port. Nevertheless, Sun needs to fix the bugs in the way the port works with the DOS window.

In a last-ditch effort to transfer some DOS programs, I installed an AT-type expansion card with a serial port that added COM2 to the Sun386i's DOS environment. This second serial port can be used only by DOS applications and is not usable by Unix. But it suffered from the same data transfer problems as the built-in serial port. In the end, I was never able to transfer any of my 5¼-inch-format DOS software to the system and could only run programs that I happened to have in the form of 3½-inch PS/2 disks.

Administration and Documentation

As I've said, it's straightforward to set up a Sun386i machine running NFS on an Ethernet LAN and to create new user accounts. SunOS handles these operations all but automatically. The SunView environment provides a tool called SNAP (System and Network Administration Program) that simplifies the remaining administrative chores: file backup and restoration; user and group account modification; and terminal, modem, and printer configuration.

SNAP is a window-oriented SunView program that you launch from the desktop's Services menu. It's very easy to use. As with all SunView desktop tools,

In a multitasking system, it's essential to isolate processes from one another, and the Sun386i does this.

you use the mouse extensively; the hypertextual help system is available and provides context-sensitive assistance as you use SNAP. SNAP comes with a set of reasonable default privileges, so you can get started right away.

The documentation that comes with the Sun386i weighs more than many systems I have reviewed. Fortunately, Sun has published four manuals just for this workstation that will answer 95 percent of your questions. They are entitled System Setup and Maintenance, SNAP Administration, Advanced Skills, and User's Guide. These manuals are a cut above the documentation that normally comes with a Unix system. They are clearly written and easy to use; indexes and tables of contents are complete. Additional documents serve the experienced Unix hand who wants to get under the hood of SunOS.

You won't be able to drop in at your local computer store and see a Sun386i in action. Sun markets its hardware using its own sales force, just as minicomputer and mainframe manufacturers do. This arrangement works fine for large businesses, but it's less convenient for individuals or smaller organizations. Sun is changing its sales organization to include value-added retailers for its hardware, especially the Sun386i.

Sun backs the Sun386i with a 90-day warranty. During this time, Sun will replace any defective components, but it's your responsibility to ship the bad part to the company for replacement. An important feature of the warranty is that Sun provides a toll-free telephone line for free software and hardware technical help. Sun staffs this system with real professionals who are dedicated to solving your problems. You generally get a response to your initial call within a few hours. This service disappears after the warranty period unless you decide to sign up for Sun's maintenance program.

Performance

As you look at the results of the DOS applications and low-level benchmarks for the Sun386i, you should keep several factors in mind. Every program running in a DOS window is executing in virtual 8086 mode; the DOS CPU performance can't equal what you get with a 25-MHz 80386 DOS machine, since concurrent Unix tasks necessarily use some cycles. And because of the way SunOS handles DOS interrupts related to screen I/O, the BYTE video index is low. If you add a video card and an external monitor, the video index should approximately match the video index for comparable 80386 systems.

On the other hand, the BYTE disk I/O index is significantly higher than for the other systems; that's a function of the fast small-computer-system-interface (SCSI) hard disk drive in the 386i/250 test machines. The rest of the results are fairly consistent and show that a single DOS task running as a process under SunOS compares favorably with 20-MHz 80386 DOS machines. The Sun386i pegs even with IBM's PS/2 Model 80-111, for example.

Unfortunately, these benchmarks don't convey an impression of how DOS programs feel on the Sun386i: sluggish. Users perceive speed not primarily in terms of spreadsheet recalculation or raw disk I/O, but rather as a function of keyboard and screen response time. The Sun386i's DOS window does poorly in these respects. I've reviewed many DOS machines that compute more slowly than the Sun386i but nevertheless seem faster because they can keep up with the user much better.

In terms of Unix benchmarks, the Sun386i clearly outperforms its older brother, the Sun-3/160—which has a 68020 CPU running at 16 MHz—in all

continued

Table 1: *The Sun386i outperforms its older brother, the Sun-3/160, on standard Unix benchmarks.*

Unix benchmarks

Machine	Unix version	Pipe			System call			Function call
		Real	User	System	Real	User	System	Delta user
Sun386i	SunOS 4.0	1.5	0.0	0.7	1.6	0.1	1.5	0.1
AT&T PC 6300	Xenix V	11.70	0.07	3.62	15.32	1.10	14.05	1.52
AT&T Unix PC	System V	4.2	0.0	1.6	8.1	0.2	7.5	0.7
Sun-3/160	4.2 BSD	2.73	0.00	1.90	2.75	0.48	2.13	0.20
VAX 8600	4.3 BSD	0.67	0.00	0.28	0.77	0.05	0.55	0.12

Machine	Sieve			Write	Read	Shell			Loop		
	Real	User	System	Real	Real	Real	User	System	Real	User	System
Sun386i	0.5	0.3	0	0.4	0.3	1.8	0.2	0.6	1.2	0.9	0
AT&T PC 6300	4.42	3.85	0.40	7.23	17.35	12.38	0.43	3.98	16.62	15.8	0.37
AT&T Unix PC	2.4	2.1	0.0	3.9	11.6	5.1	0.2	1.2	6.8	6.2	0.1
Sun-3/160	0.73	0.62	0.00	1.33	1.00	2.78	0.08	0.77	2.00	1.80	0.02
VAX 8600	0.32	0.28	0.00	0.32	0.13	1.07	0.00	0.15	0.73	0.60	0.00

Multitasking Unix benchmark (real time)

Machine	Unix version	Number of concurrent processes 1	2	3	4	5	6
Sun386i	SunOS 4.0	2.0	3.4	4.9	6.1	7.5	8.7
AT&T PC 6300	Xenix V	12.52	16.38	22.97	28.33	35.78	43.33
AT&T Unix PC	System V	6.3	8.7	12.7	19.2	22.8	29.8
Sun-3/160	4.2 BSD	2.63	3.14	3.69	4.25	4.85	5.51
VAX 8600	4.3 BSD	1.17	1.51	1.83	2.17	2.53	2.83

User time is time spent executing nonprivileged instructions. System time is time spent executing privileged (kernel) commands (i.e., system calls) plus system-level overhead (e.g., context switching between processes). Real time is elapsed time, and it is often not the sum of the user and system times; the difference is the time spent waiting for I/O operations to complete, waiting for a signal from another process, "sleeping," or being swapped into memory or out to disk. Pipe measures how long it takes to set up a pipe and pass 0.5 megabyte of data through it. System call queries the operating system 25,000 times concerning its process identity with the `getpid()` system call. Function call runs two programs: One uses a function call to accomplish a goal, and one doesn't use the function call for the same goal. The user time of the program not using the function is subtracted from the user time of the program using the function; the difference is function-call overhead, shown in the table as Delta user. Sieve runs one iteration of the Sieve of Eratosthenes. Write and Read test the random-access disk implementation. Write creates, opens, and writes a 256- by 512-byte file. Read reads this file and then removes it. The Shell tests invoke background processes. The shell statement `wait` causes the shell script in `multi.sh` to pause until all the requested background processes have terminated. The background process `tst.sh` invokes several commonly used Unix commands and exercises disk access with them. Loop tests long-integer arithmetic and is mostly processor-bound. All times are in seconds.

but the multitasking benchmark (see table 1). That's an impressive showing. A true test of Unix performance would be to benchmark the Sun386i against another 25-MHz 80386 system running Xenix, A/UX, or SCO Unix. But there's no doubt that this system runs Unix as well as computers that have traditionally been considered fast, multiuser Unix workstations.

On Balance

As I've already said, you have to view the Sun386i primarily as a Unix workstation. As such, it excels. If this machine had been available when I got my Sun-3/110, which I use for three-dimensional geological modeling, I'd have bought the Sun386i instead; it's cheaper and more versatile. But the point bears repeating: You'll be disappointed if you think of the Sun386i as an 80386 DOS machine that also runs Unix. If you want serious DOS-only performance, this is definitely not the machine for you; get one of the many 20-MHz or 25-MHz 80386 microcomputers now on the market. If, however, you require a top-quality Unix workstation that can (as a bonus) multitask DOS programs and seamlessly exchange data between Unix and DOS, then this is the computer for you.

The cost of the Sun386i seems high, and it is; but be sure to take a close look at what you get for your money. Consider the features that are standard on the Sun386i but that would be options on most other systems: a 25-MHz 80387 coprocessor, complete Ethernet hardware and software, 8 megabytes of RAM, and complete Unix and DOS system software, as well as all the SunView applications. Don't forget the important fact that all hardware and programs come from the same vendor. They're integrated from the ground up, and they work well together.

And finally, even if you don't specifically require the Sun386i's graphical capabilities in your work (as I do in mine), you'll love the way the iconic SunView desktop spruces up Unix. There's no substitute for the way SunView represents processes as windows; it makes Unix's multitasking capabilities concrete and useful in ways that—for me, anyway—they never were before. ■

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. You can reach him on BIX as "junger."

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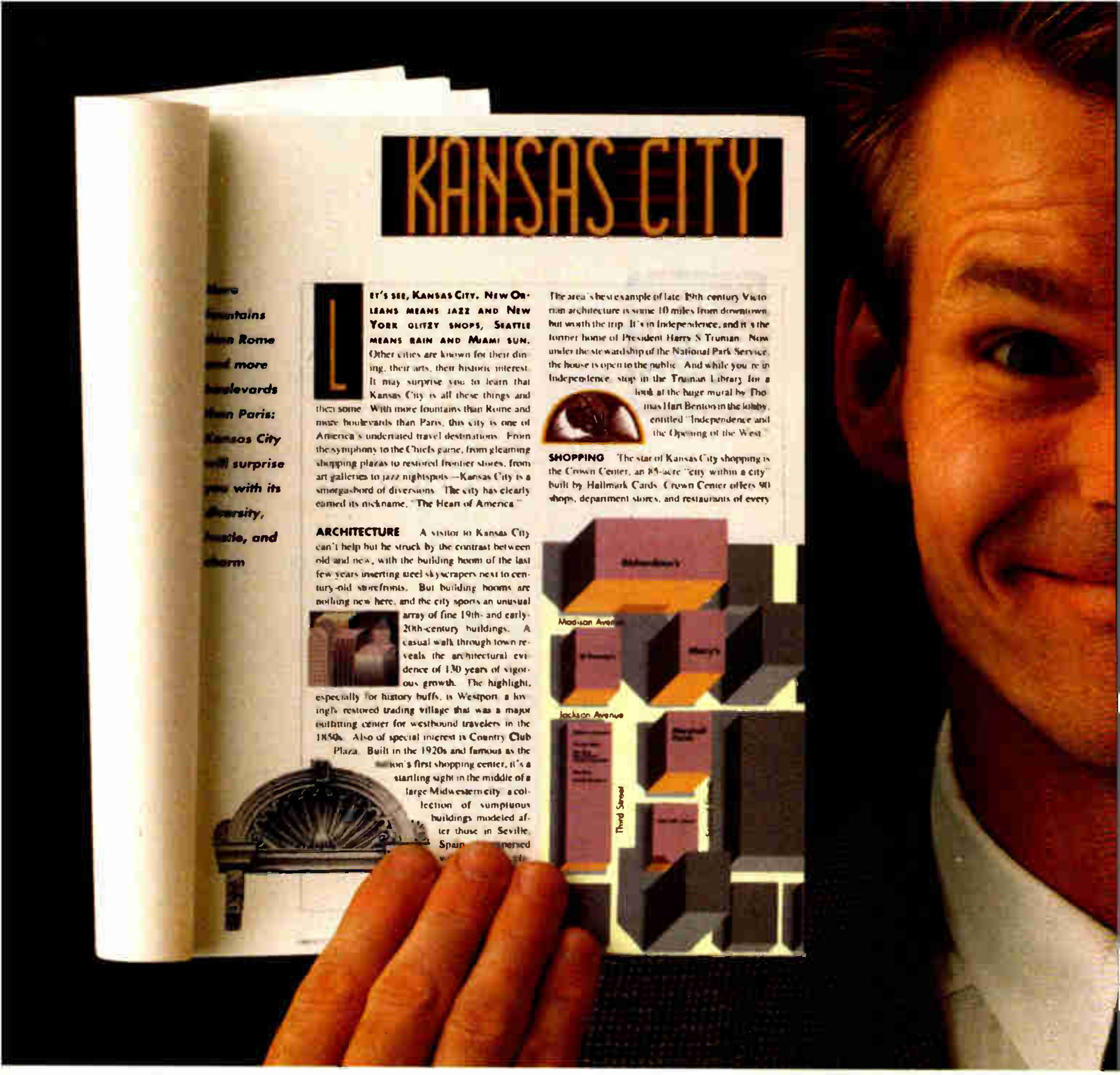

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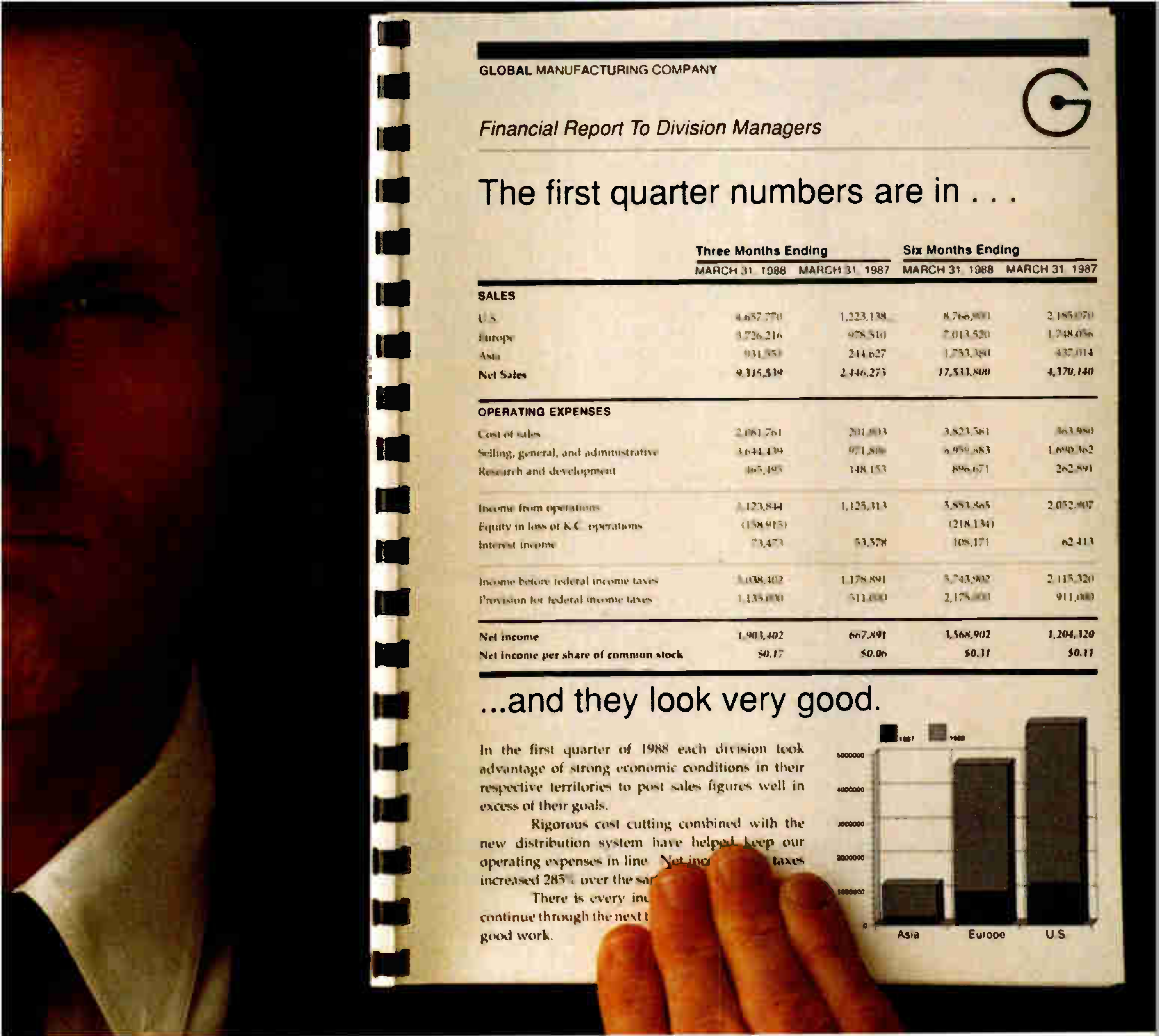

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A Nimble AT

Dell's System 220 puts AT speed in a new class

Jeff Holtzman

How do you stuff 10 pounds of sand (well, silicon) into a 5-pound sack? Several companies have tried, but Dell has come closest to figuring out the secret. With its 20-MHz 80286, the Dell System 220 marks the high end of AT compatibles and even holds its own against 80386-based machines. It's a compact, lightweight system with all the basics on the motherboard: video adapter, I/O ports, and disk controllers. Just plug in the keyboard and VGA monitor.

You can buy the System 220 in three configurations. The base model, which has a list price of $2299, includes 1 megabyte of 80-nanosecond dynamic RAM (DRAM), one 1.44-megabyte floppy disk drive, one parallel and two serial ports, a VGA port, a monochrome VGA monitor, a 101-key Enhanced-style keyboard, floppy and hard disk controllers, and three empty 16-bit expansion slots. For color VGA, add $200 to the price of the desired model; for a fine-pitch color VGA monitor, add $300. A 12-month on-site service contract is included with these systems at no extra charge.

The motherboard has a socket for an 8-MHz 80287 math coprocessor and space for an additional megabyte of RAM. Dell plans to introduce 1-megabyte single in-line memory modules that can be substituted for the standard 256K-byte SIMMs. This would let you pack a maximum of 8 megabytes of RAM on the motherboard. However, pricing and availability have not yet been established. Maximum system memory is 16 megabytes.

The review unit came with 2 megabytes of 80-ns DRAM, an 8-MHz 80287, a single Sony 1.44-megabyte 3½-inch floppy disk drive, a 40-megabyte 3½-inch Conner Peripherals CP-342 hard disk drive, a Mitsubishi color VGA monitor, and MS-DOS 3.30 (a $120 option).

Packing It In

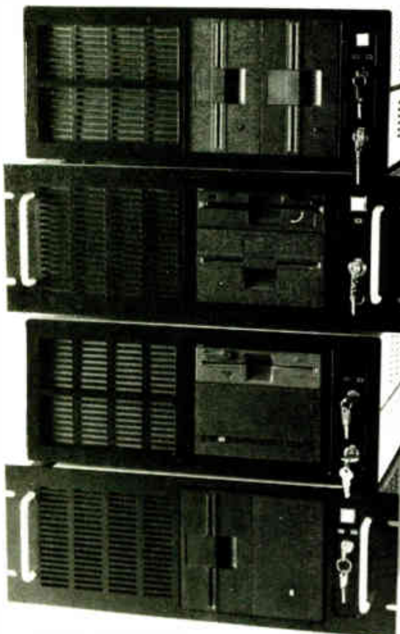
Two 3½-inch disk drive bays dominate the clean front panel. In the lower right corner is the power switch, and in the upper left corner is a keyboard interlock switch. An LED indicates hard disk activity. There is no reset switch.

The System 220 has space for only two 3½-inch floppy disk drives and a single 3½-inch low-profile hard disk drive. There is no provision for internal tape backup. The power supply (rated at 85 watts) is about two-thirds the size of a normal AT power supply. As in the PS/2 Model 30, the three 16-bit expansion slots are horizontally oriented.

The motherboard uses the Chips & Technologies chip set. Many of the chips are prominently marked as working at 20 MHz. The motherboard has a number of jumper blocks that let you disable the on-board VGA, hard and floppy disk controllers, and so on, should one develop problems or if you want to add your own video card or another conflicting device in an expansion slot. The review unit's motherboard also had four engineering-change jumpers.

A large motherboard diagram and instruction sheet is affixed to the case, ensuring that essential setup information will remain with the machine. Interestingly, an edge connector corresponding

continued



Dell System 220

Company
Dell Computer Corp.
9505 Arboretum Blvd.
Austin, TX 78759
(800) 426-5150

Components
Processor: 20-MHz 80286 with zero wait states; socket for 8-MHz 80287 math coprocessor
Memory: 1 megabyte of interleaved DRAM standard, expandable to 8 megabytes on system board
Mass storage: 1.44-megabyte 3½-inch floppy disk drive; 40- and 100-megabyte hard disk drives optional
Display: On-board VGA; monochrome VGA monitor standard, color monitors optional
Keyboard: 101-key IBM Enhanced-style keyboard
I/O interfaces: Two DB-9 RS-232C ports; one DB-25 parallel printer port; three standard 16-bit expansion slots

Size
4 × 15 × 16 inches; 22 pounds

Options
MS-DOS 3.30: $120
Microsoft OS/2 version 1.0: $325
8-MHz 80287: $400
1 megabyte of RAM (SIMMs): $1000
3½-inch floppy disk drive: $200
3½-inch 40-megabyte hard disk drive: $700
3½-inch 100-megabyte hard disk drive: $1599
Serial mouse: $60
Color VGA monitor: $200
Fine-pitch color VGA monitor: $300

Documentation
85-page System 220 Owner's Manual; 134-page System Support Manual

Price
Base model with VGA monochrome monitor: $2299
With 40-megabyte hard disk drive: $2999
With 100-megabyte hard disk drive: $3799
System as reviewed: $4719

Inquiry 884.

to the VGA feature connector runs along the left edge of the motherboard. The System 220 is FCC class B certified.

What Works and What Doesn't

Using the System 220 is a pleasure. The Key Tronic keyboard has an excellent feel—not as springy as IBM keyboards, but much better than cheap clone keyboards. You can slow the System 220 down to an 8-MHz clock rate at any time by pressing Ctrl-Alt-\. Using a ROM-based program, you can also set the machine up to boot at either 8 or 20 MHz.

The Mitsubishi monitor provides a clean, stable image in both text and graphics modes and has front-mounted power, brightness, and contrast controls. However, it has no tilt-and-swivel stand—just a single bar on which the front of the monitor can be propped.

I had no trouble installing and using a Tandy serial mouse with various graphics packages, including AutoCAD release 9.0, AutoSketch enhanced version 1.01, and Windows 2.1, as well as Excel 2.0, PageMaker 3.0, and Micrografx Designer 1.2 running under Windows. Microsoft's extended-memory driver (HIMEM.SYS) ran fine, giving Windows about 58K bytes more workspace. I also had no trouble installing and running DESQview 2.01, WordStar Professional 4.0, a beta version of WordStar Professional 5.0, Turbo Pascal 4.0, Microsoft BASIC 6.0, Lotus 1-2-3 version 2.01, VP-Planner 1.0, Professional CED 1.01a, DeskLink 2.21, and Brooklyn Bridge 2.0.

I also installed a Hayes 2400-bit-per-second modem, which worked fine with Procomm 2.4.2 but would not work with Smartcom III. Whenever the program tried to access the modem, the system crashed. Dell's technical-support people tracked down the problem to a conflict between the COM port on my modem and the motherboard COM chip. The company says a patch is available now, and a revised BIOS will be available to all registered System 220 owners.

How It Runs

The System 220 has an interleaved memory system that operates with zero wait states with 1 or 2 megabytes of DRAM. On the original version of the review system with 1 megabyte of DRAM, one wait state was forced. With the new "enhanced" Phoenix 80286 ROM BIOS Plus version 3.10 15, 1-megabyte systems run with zero wait states. All current versions of the 220 will have the new BIOS. The benchmarks were run with 1 megabyte of DRAM on the motherboard.

In a 1-megabyte system, you can use the extra 384K bytes as extended memory. Otherwise, you can use it to run copies of the system BIOS and the VGA BIOS, both of which run several times faster from RAM than from ROM. In systems with 2 or more megabytes of memory, you cannot use the extra 384K

continued

Dell System 220

APPLICATION-LEVEL PERFORMANCE

Dell System 220 **11.4***

WORD PROCESSING

XyWrite III+ 3.52	Medium/Large
Load (large)	:11
Word count	:03/:21
Search/replace	:05/:23
End of document	:01/:15
Block move	:09/:09
Spelling check	:09/1:03
Microsoft Word 4.0	
Forward delete	:14
Aldus PageMaker 1.0a	
Load document	:05
Change/bold	:28
Align right	:22
Cut 10 pages	:21
Place graphic	:06
Print to file	1:54
Index:	**2.71**

SPREADSHEET

Lotus 1-2-3 2.01	
Block copy	:03
Recalc	:02
Load Monte Carlo	:18
Recalc Monte Carlo	:05
Load rlarge3	:04
Recalc rlarge3	:01
Recalc Goal-seek	:03
Microsoft Excel 2.0	
Fill right	:06
Undo fill	2:11
Recalc	:01
Load rlarge3	:29
Recalc rlarge3	:01
Index:	**2.68**

DATABASE

dBASE III+ 1.1	
Copy	1:19
Index	:21
List	1:28
Append	2:00
Delete	:02
Pack	1:25
Count	:18
Sort	1:36
Index:	**1.39**

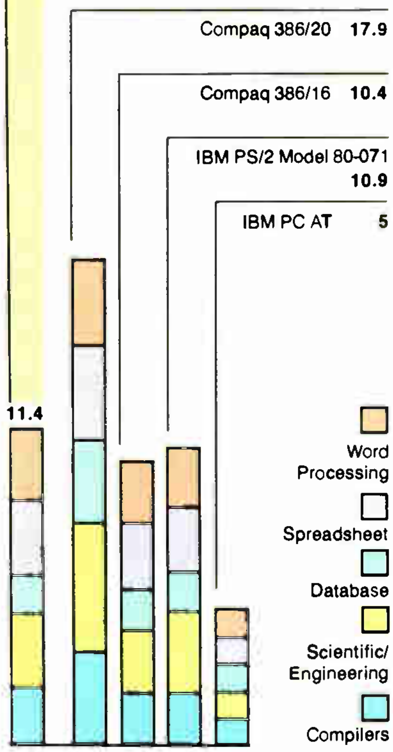
SCIENTIFIC/ENGINEERING

AutoCAD 2.52	
Load SoftWest	1:15
Regen SoftWest	1:03
Load St. Pauls	:15
Regen St. Pauls	:09
Hide/redraw	15:49
STATA 1.5	
Graphics	:26
ANOVA	:16
MathCAD 2.0	
IFS 800 pts.	:22
FFT/IFFT 1024 pts.	:24
Index:	**2.55**

COMPILERS

Microsoft C 5.0	
XLisp compile	4:50
Turbo Pascal 4.0	
Pascal S compile	:05
Index:	**2.11**

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 220

CPU

Matrix	4.25
String Move	
Byte-wide	40.55
Word-wide:	
Odd-bnd.	30.69
Even-bnd.	20.27
Sieve	22.83
Sort	19.01
Index:	**2.72**

FLOATING-POINT

Math	26.73
Error[2]	
Sine(*x*)	11.73
Error	
e^x	9.89
Error	
Index:	**1.73**

DISK I/O

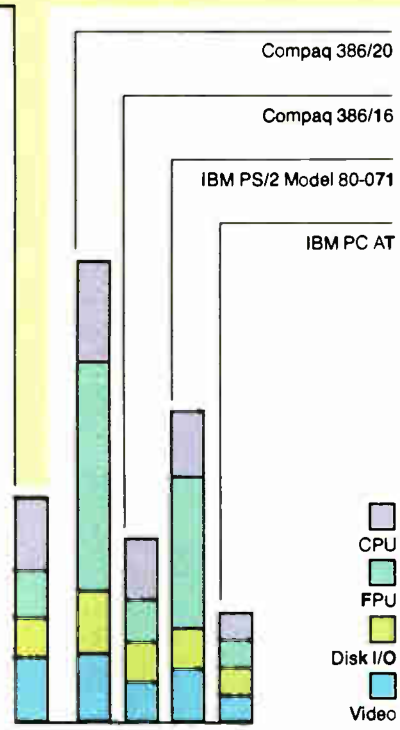
Hard Seek[3]	
Outer track	3.31
Inner track	3.31
Half platter	8.31
Full platter	9.99
Average	6.23
DOS Seek	
1-sector	14.64
32-sector	45.40
File I/O[4]	
Seek	0.09
Read	1.19
Write	1.06
1-megabyte	
Write	6.57
Read	7.12
Index:	**1.40**

VIDEO

Text	
Mode 0	5.00
Mode 1	5.02
Mode 2	4.89
Mode 3	4.89
Mode 7	N/A
Graphics	
CGA:	
Mode 4	1.98
Mode 5	1.98
Mode 6	2.09
EGA:	
Mode 13	3.63
Mode 14	3.88
Mode 15	N/A
Mode 16	3.87
VGA:	
Mode 18	4.01
Mode 19	2.03
Hercules	N/A
Index:	**2.02**

CONVENTIONAL BENCHMARKS

LINPACK	557.99
Livermore Loops[5] (MFLOPS)	0.04
Dhrystone (MS C 5.0) (Dhry/sec)	4945.00



N/A = Not supported by graphics adapter.
[1] All times are in seconds. Figures were generated using the 8088/8086 and 80386 versions (1.1) of Small-C.
[2] The errors for Floating-Point indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.
[3] Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).
[4] Read and write times for File I/O are in seconds per 64K bytes.
[5] For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance.

For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June BYTE.

bytes as extended memory, but you can still use it to run the BIOS.

The benchmark results, run with a 1-megabyte system, put the System 220's performance in perspective. The 220's CPU index indicates a raw speed nearly three times that of a stock IBM PC AT. That score also makes it from 25 percent to 100 percent faster than typical 10- and 12-MHz AT compatibles, placing the System 220 squarely in the ballpark with Compaq's new 386s, the older 16-MHz Compaq 386, IBM's 16-MHz Model 80, and other low-end 80386-based systems. The 20-MHz Model 80 is only slightly faster. The 220's excellent CPU performance is due to the fast clock rate, the fast 80-ns DRAM, and the interleaved memory system.

The floating-point ratings, on the other hand, show that an 8-MHz 80287 is simply no match for an 80387, even the 16-bit version used in the Compaq 386s. The System 220 was a healthy 73 percent faster than the IBM PC AT, but that is less than one-third the speed of the 386s.

The hard disk and controller combo is about 40 percent faster than a stock AT and about 10 percent faster than the better AT-clone disks, and it is again comparable to that of the low-end 80386 machines, including both Model 80s and the 16-MHz Compaq. The video system's 16-bit bus interface and its ability to run the video BIOS from RAM allow the System 220 to perform more than twice as fast as an AT or the high-performance compatibles.

The application benchmarks turned up few surprises. As expected, the System 220 outscored the 10- and 12-MHz AT-class machines in all categories, was generally competitive with the low-end 80386 systems, and fell behind the faster 80386 systems.

The exceptions were the math and CAD tests. Because of the 8-MHz 80287, the System 220 did not do well in the MathCAD FFT calculations. Given those results, you might also expect poor AutoCAD performance, but such was not the case. The 220's fast system clock and its excellent video performance helped the machine put in a respectable performance.

Running the benchmark tests with 2 megabytes of RAM should improve the performance slightly because of increased efficiency in the memory interleaf circuitry.

Having It All

The Dell System 220 isn't the ultimate performance machine. Its 8-MHz math coprocessor is a weak point for serious CAD or numerical analysis work, and its three expansion slots, 85-W power supply, and lack of 5¼-inch disk drive bays are also limiting factors. You'll also have to consider carefully whether raw performance today is most important, compared to 80386-based machines with memory management and virtual-mode capabilities in the future.

On the other hand, if you're looking for a fast, sleek, and cost-effective AT compatible, the System 220 has it all: all the hardware necessities, speed, excellent documentation, toll-free telephone support, on-site service contracts, and the best price/performance ratio in its class. ■

Jeff Holtzman owns Publishing Concepts, a firm that specializes in evaluation, verification, and documentation of high-technology products. He lives in Ann Arbor, Michigan, and he can be reached on BIX c/o "editors."

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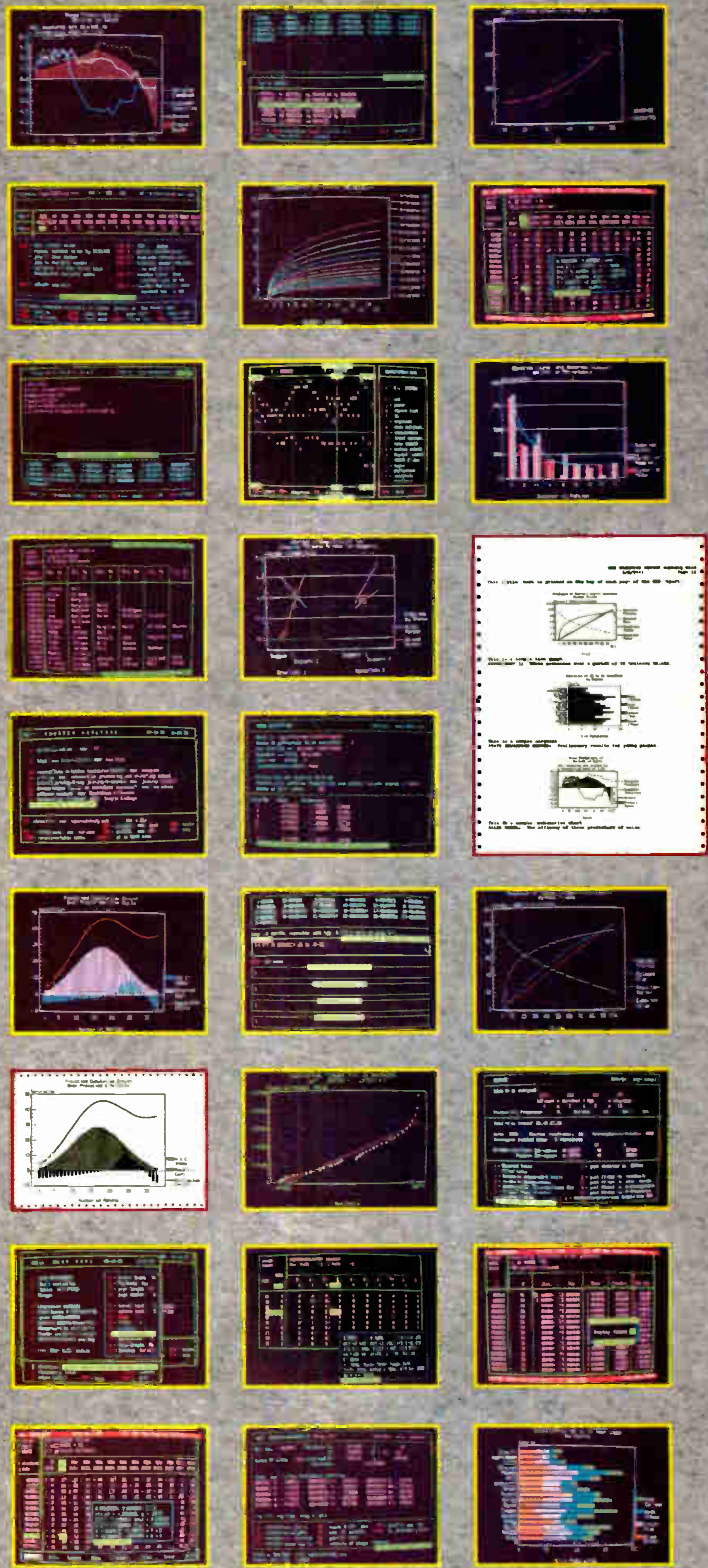

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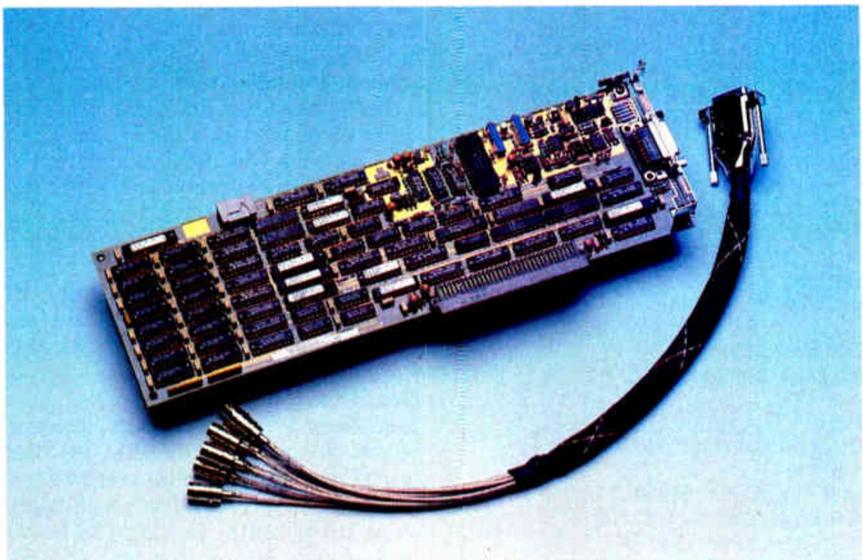
A Quick Look at QuickCapture

Spice up your work with video and other gray-scale images on your Mac II

Joel West and Dwight Newton



A new generation of devices for the Macintosh promises to do for data input what the LaserWriter did for output. One such product is Data Translation's QuickCapture package ($1139), consisting of a video digitizer board (or "frame grabber") and software for the Mac II.

QuickCapture records still gray-scale images from any video camera or VCR. The board can connect up to four devices simultaneously, although you can capture images from only one device at a time. Captured images can be displayed, enhanced, and written to files in various image formats. Although most useful for desktop publishing and graphics design, digitized images have applications in everything from medical imaging to slide making—basically, any application that can benefit from visual data.

Early input devices for the Mac were stand-alone units with their own power supply. QuickCapture takes advantage of the Macintosh II's ability to accept a plug-in board, which offers advantages in data transfer rate, economy, and power requirements.

QuickCapture is a standard-length NuBus board with a DB-15 connector mounted on the rear panel; you'll also need an external cable harness ($125) to convert this to more standard BNC video connectors. If you want to connect the board to your VCR or video camera, you may also need a converter (which is not available from Data Translation) for an RCA phono jack.

QuickCapture uses the Mac II's ROM-based Color QuickDraw capability, which lets each pixel of an image assume one of 256 gray levels or 16.7 million colors. While resolution is a relatively well known factor in image fidelity, the number of distinct colors (or shades of gray) available is just as important. QuickCapture gives you the maximum number of gray levels (256) that the Mac II supports.

A Gray Area

The QuickCapture board can capture only gray-scale images, even though you can connect it to a color input source and it comes preconfigured for one. The Mac II, however, supports color directly, so you have to consider the trade-offs between gray scale and color.

Several color digitizers for the Mac II are available from, or being readied by, companies such as RasterOps, TrueVision, and Data Translation itself. These digitizers vary greatly in features and price: You can expect to pay anywhere from $1500 to $3000. Due to current memory prices, some companies, including Data Translation, add a RAM surcharge to their basic package cost.

Gray-scale digitizers provide an affordable alternative to the high cost of color. Current output technology also favors gray scale. You can print a decent gray-scale image on a dot-matrix or laser printer with little trouble. Generating color output with more than a handful of hues requires either the costly process of four-color printing or an expensive thermal color printer. In addition, only the Mac II supports color directly: The Mac Plus and SE are strictly black-and-white machines (although the Mac SE can use add-in cards for gray scale and limited color). Right now, in everything short of

continued

QuickCapture

Type
Frame-grabber board and software for Macintosh II

Company
Data Translation, Inc.
100 Locke Dr.
Marlborough, MA 01752
(508) 481-3700

Features
NuBus board with 60-kHz scan rate; support for 256 gray scales; 640- by 480-pixel resolution; RGB NTSC-compatible; QuickCapture 1.0 software

Hardware Needed
Macintosh II with at least 1 megabyte of RAM; VCR or video camera; 20-megabyte hard disk drive recommended

Software Needed
Finder 6.1/System 6.0

Options
EP205 cable harness: $125

Documentation
137-page User Manual

Price
QuickCapture board and software: $1139
With ImageStudio: $1299
With Digital Darkroom: $1215
With GraphistPaint II: $1465
With LaserPaint Color II: $1565
(Prices include $144 DRAM surcharge)

Inquiry 883.

monitor display, gray scale is the more realistic technology.

What You'll Need

Although QuickCapture will operate in a two-color environment, you'll definitely want a gray-scale monitor and gray-scale (or color) card to view your creations in their full glory. We used Apple's standard 8-bit video card with a Sony Extra Fine Pitch 12-inch monitor.

The QuickCapture application software is a real memory hog; the company suggests 2016K bytes for the application partition. Due to the peculiarities of Mac II memory upgrades, you'd need at least a 4-megabyte machine for that. You can get by adequately with a 2-megabyte machine (as we did) by resetting the application partition to a more modest 1024K bytes. If you want to use MultiFinder, you'll probably need to decrease the application partition again or trim out unnecessary fonts, desk accessories, and extra INITs. We ran all our tests under System 6.0.

You'll also want at least a 20-megabyte hard disk drive, although we recommend 40 megabytes or more if you want to capture lots of images. Each uncropped QuickCapture image is roughly one-third of a megabyte, so it doesn't take long to fill up a hard disk.

Last, you'll need a video input source. For testing purposes, we used an inexpensive VCR and a hand-held color video camera. Unfortunately, the camera was not particularly sharp, and it produced low-contrast images indoors. The camera itself, not the QuickCapture board, limited the quality of our images.

Before acquiring any video digitizer, think about the video source you'll use with the board. The best procedure is to find a camera with only the features you need and with the same limitations of image quality as the QuickCapture board. Also, if you're using a video camera, you'll need a tripod. As with still photography, steadiness and focus are crucial if you want good-quality images.

Ready to Roll

Data Translation is an established vendor of add-on boards for the IBM PC. But QuickCapture is the company's first Macintosh product, and a few rough edges were still visible. Getting the board ready to use for the first time was not quite up to the plug-in-and-use nature of other Mac products.

Installing the board was no more difficult than for any other Mac II board, but connecting a video signal was another story. If you don't buy the EP205 cable harness, you'll have an afternoon of soldering in front of you. The harness is optional, but it's essential if you plan to use the product with off-the-shelf cabling.

We used the cable harness, which lets you connect four input sources to the board. The harness consists of a 15-pin female connector at one end, which attaches to the QuickCapture board, and an eight-headed Hydra of BNC connector cables at the other end for connecting input and output devices. Even with the harness installed, don't expect to try out your board without the manual: The only labels on the connectors are the numbers 0 through 7, with no clue to what they do.

Although BNC connectors are typical for professional video production, we found them inconvenient for use with common home video electronics. We had several composite video sources with RCA phono jacks, but no BNC jacks or cables. Since no cables are supplied with the board or harness, we weren't able to use the board right out of the box.

We solved the problem by buying a simple male BNC-to-RCA phono jack adapter from Radio Shack (#287-254, $2.49). After that, the video signal could be connected using a simple dual-RCA patch cord, something any audiophile or videophile will probably have on hand.

The QuickCapture board has several rarely used settings that are controlled by jumpers. These include low-pass filters for noisy signals (1 MHz) and color chrominance information (3.58 MHz) for capturing from color cameras, as well as three choices for synchronization. The default settings were fine for our purposes: The input limiting filter was disabled, and the chrominance filter and standard video sync were enabled.

But using these jumpers is a pain in the neck. After powering off the machine, you must open the Mac II, pull the board out, move the jumper connector, and then reassemble and reboot the machine. Maybe jumpers are the norm for IBM PC products, but software control of the various settings would be far more appropriate for the Mac II. Even DIP switches on the rear panel would be satisfactory, assuming the changes took place immediately rather than when the machine was rebooted.

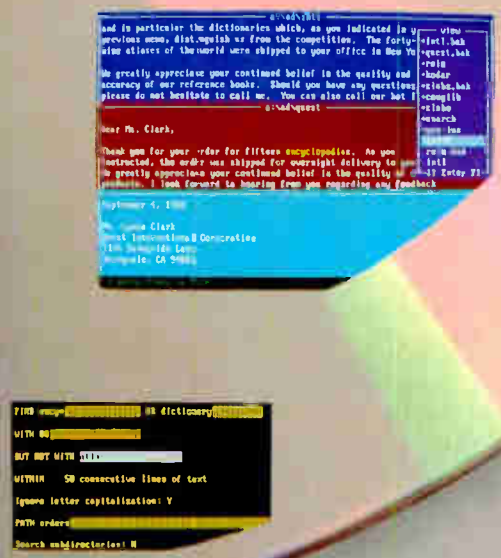
Not Ready for Real Time

The QuickCapture board comes in two configurations. The one we tested is designed for North American and Japanese markets, with 60-Hz National Television System Committee (NTSC) video signals and a frame size of 640 by 480 pixels. The other configuration is the 50-Hz phase-alternate line (PAL) model, consistent with the standard for most of Western Europe and with a frame size of 768 by 512 pixels.

When viewing the output of an NTSC video camera on a television, you see a 60-Hz interlaced (updated in pieces) image, each piece of which is updated 60 times a second, so that the total image is completely updated 30 times a second. This is called real-time video. Real-time video is extremely nice since it lets you quickly adjust equipment and your subject without switching between adjusting the environment and capturing and displaying the image to see what it will look like. The faster the refresh rate, the greater the control you have over lighting, camera focus, composition, and so on, particularly when you're photographing a moving subject.

Both the QuickCapture application

continued



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and the drivers for third-party image-editing software fall short of real-time video. The refresh rate for the application is four frames per second for a full-size image window. The rate for the drivers is about two frames per second for Letraset's ImageStudio and about one per second for Silicon Beach Software's Digital Darkroom. The closest we were able to get to real-time display was to shrink the image window in the QuickCapture application to its minimum size. Although this makes the window too small to give you a good idea of how the captured image will look, you can get refresh rates close to real time.

One solution is to hook an additional analog monitor to the board via the EP205 cable, allowing live, real-time video display on the analog monitor while you capture and edit on the other. This requires the extra expense of another monitor, but an old black-and-white television set is probably adequate for most applications.

Editing Images

The board comes with an 800K-byte 3½-inch disk containing the QuickCapture 1.0 application, the QuickCapture INIT, a sample IRIS image (IRIS is Data Translation's proprietary file format), and a manual. The company said it would also be releasing source code for the application (which should now be available) for around $300 to $400.

The software installation, which is documented in the manual, is trivial. Once it was installed, we found that the QuickCapture application provides complete control of the hardware and offers plenty of options for capturing, saving, and manipulating images. The software also boasts extra features that are usually found only in gray-scale editing programs, such as ImageStudio and Digital Darkroom.

The QuickCapture application has six menus: File, Edit, Image, GrayScale, Enhance, and Windows. The File menu contains the usual options for manipulating files, plus an option (Save A Copy) that lets you save an intermediate copy while you work with an image.

Currently, QuickCapture can store files in IRIS, PICT, TIFF, RIFF, and Encapsulated PostScript File format but can read only files stored in its proprietary IRIS format. Although other gray-scale image-editing software can edit files saved in any of these formats except IRIS, it would be useful if the QuickCapture application could read these formats as well.

The Edit menu also has the usual options, including Undo, Cut, Copy, Paste, Clear, Select All, Show, and Clipboard. An additional option is Disable Undo. Since it's possible to Redo (i.e., to Undo an Undo), the utility of this option is uncertain, except perhaps as extra insurance against mistakes.

The Image menu gives you options to capture, display, or both capture and display an image. The most useful choice, though, is Live Video, which displays continuous images from the camera to the screen prior to capture. In Live Video, images are passed to the camera at the rate of four per second for a full-size image window, but nothing is captured until you click the mouse button.

Using this option, you can interactively focus the camera, set up the lighting, and compose the image. Even if you've set up the shot, the Live Video option is very useful, and we used it almost exclusively. An additional Statistics feature displays a histogram of the image's gray levels—a nice feature for image analysis.

Options on the GrayScale menu let you capture and display images in 256, 64, 16, or 2 gray levels. You can also select either positive (normal) or negative (inverted) modes. All the gray-scale options work with Live Video capture, so you can see exactly what the image will look like before you capture it, as opposed to after-the-fact editing using Digital Darkroom or ImageStudio. You can also multiply or divide the image by a factor of 2 or 4, providing a crude form of brightness control. We would have preferred slider controls for the brightness, as they are much easier to use and allow greater control.

There's also an option to custom-configure the thresholding for two-gray-level capture. You can choose the range of values that will be mapped to the foreground color and background color, and you can change the foreground and background colors to shades other than black and white. By experimenting with the gray-scale features, you can easily achieve some dramatic effects that you can see in Live Video form before you capture them.

The Enhance menu offers such features as image sharpening, smoothing, and four different types of edge detection. In all cases, the process of enhancing a full-size image was relatively quick (8 to 9 seconds at most). The results of applying the detection filters to the image were a little disappointing, as the resulting images were all white-on-black and generally muddy-looking. Digital Darkroom's trace-edges capability was much better for most graphics purposes; QuickCapture's edge detection was more suitable for analytic purposes. The QuickCapture software also lets you do histogram equalization on a captured image, which heightens image contrast.

A unique feature for enhancing images is an "image calculator" that performs operations on images as if they were numbers. You can subtract one image from another, add two images together, multiply and divide an image by a constant (i.e., change its brightness), and perform logical functions (AND, OR, NOR, XOR) on images. Although the manual provides only a single example for using the image calculator, it's likely to be a nifty tool. For example, you could capture images of a scene at two different times and use the subtract operation to find out what changed during that interval. Although the image calculator certainly has artistic possibilities, it is probably of most use in image processing or analysis.

Finally, the Windows menu lets you fit an image within a window and switch back and forth easily between multiple open windows. Even with an application partition of 1024K bytes, we were able to have several windows open at once, although we were probably pushing it a bit.

Editing Alternatives

The QuickCapture application provides good image-editing features, but image-editing software like Digital Darkroom and ImageStudio give you even more capabilities. These include, for example, touching up images with an airbrush or pen tool, scaling the image, and arbitrarily modifying the gray-level histogram. You can transport images from

continued

QuickCapture to Digital Darkroom or ImageStudio in TIFF, PICT, or RIFF files.

Drivers for Digital Darkroom and ImageStudio let you operate the QuickCapture board from within these applications. We used ImageStudio 1.5, which supports 256 gray levels in its native file format and provides a realistic rendition of images. We found ourselves using ImageStudio for most of our testing, since we could do almost everything we needed from within the application.

ImageStudio contains two special options in its File menu: QuickCapture and Digitize. The QuickCapture option brings up a configuration dialogue, with choices to select either single-image or continuous capture, automatic or external trigger, and one of the four QuickCapture input channels. The external trigger option allows frame acquisition according to a signal originating outside the computer (such as a camera button).

Selecting the Digitize option brings up a scanner display window. In continuous-capture mode, ImageStudio displays a dynamically updated (½ second per frame) image that you can capture to the image buffer by a single mouse-click. You can then manipulate the image in the same way as any other ImageStudio document.

We experienced intermittent problems when capturing images from ImageStudio. We could capture, display, and edit the images nicely, but when we tried to print them, all we got was a black dot in the center of the page. Further investigation revealed that the input image buffer had been scrambled so that ImageStudio thought we had a very tiny picture at about 7000 dots per inch instead of 75 dpi. (The resolution of an image and its dimensions are inversely proportional: The larger the dpi, the smaller the image. This allows the total number of pixels to remain constant.) The result was an image printed at one one-hundredth of the actual size.

When we tried to reset the settings using the Set Image Size option under the File menu, the program asked if we wanted to save the old image and then created a new blank image with the input image settings we specified. When we read the old image back in, it looked fine, but it still had incorrect image buffer settings. We tried saving it in PICT and other formats, but we couldn't read it from any application, including ImageStudio.

Letraset says that this is indeed a bug. The company hasn't yet tracked down its source, but if the problem occurs in version 1.5, you can remedy it by holding down the Option key while selecting Set Image Size from the File menu. This brings up a dialog box where you can reset the dpi value.

We also tried Digital Darkroom 1.0 with the QuickCapture card. Silicon Beach provided a prerelease version of a QuickCapture driver, although the final driver will be sold by Data Translation. The company said that the driver would be available by the time you read this, although a price had not been set as of this writing.

Initially, the QuickCapture board was inconvenient to configure.

The driver is implemented as a Digital Darkroom plug-in module. Selecting the QuickCapture module from the software's Acquire menu brings up an image display window and places the board in continuous-capture mode.

The version of the driver we tested had a refresh rate that's half the speed of the ImageStudio module, which made focusing and image composition much more difficult. This driver is also hard-coded to use channel 0 video input, with no options regarding continuous capture or external triggering. We experienced none of ImageStudio's image size problems, though, which made Digital Darkroom much more straightforward to use.

QuickCapture is also available bundled with GraphistPaint II and LaserPaint Color II. We did not test these packages, however.

Getting Help

The 137-page QuickCapture manual is straightforward and clear, although not lavish. It's illustrated with simple line drawings (dealing with card installation and video hookups) and digitized images (for application examples). Actual pictures of the board and its hookups would have been far more explanatory than the simplistic line drawings.

The manual thoroughly covers the installation procedures and software. It has a good reference section that deals with troubleshooting, changing jumpers, connectors (which novices will appreciate), and specifications. Also included is useful information for programming the board and pin assignments for the board's 15-pin male connector for do-it-yourself cablers. Although the latter information seems skimpy, Data Translation says that it's sufficient for bypassing the expense of the EP205 cable harness. The manual is complete enough to get started with, but those wishing to customize the hardware or software will probably require extra support.

Data Translation provides a phone number (not toll-free) for technical support. We never had a problem getting a call through, and we were generally content with the technical support we got.

Although the manual provides information on programming the QuickCapture board, you'll probably be forced down into assembly language at some point or another. For those who don't like to get down to such low levels of coding, a nice shortcut is to build a HyperCard stack based on QuickCapture XCMDs, which let HyperCard access external devices. Data Translation includes a stack with the board. The stack serves as an animated set of release notes with cutesy sounds, and it's heavy on the marketing hype.

A Good Image

Initially, we found the QuickCapture board somewhat inconvenient to configure, but once it was installed, we had nary a problem with it. We would have preferred an easier means than jumpers for switching settings; in our case, though, this was no real problem, since our requirements didn't change while we were using the card.

We were pleased with the QuickCapture application, although we think that most users will quickly want to graduate to a full-featured gray-scale image-editing program. Overall, coupled with a full-function gray-scale editing program and an appropriate camera, QuickCapture makes a convenient and cost-effective way to create and manipulate gray-scale images for graphic art, desktop publishing, or any other application that might benefit from manipulation of black-and-white visual data. ■

Joel West is the president of Palomar Software in Oceanside, California, and a regular contributor to BYTE. Dwight Newton is a graduate student at the University of California, San Diego, and develops image-conversion software for Palomar. They can be reached on BIX c/o "editors."

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Merge 386

Run Unix and DOS together on an 80386

Jeff Holtzman

Unix and DOS: two operating systems, two cultures. Unix provides a secure multitasking environment, and DOS supports a number of applications that don't run under Unix. Merge 386 from Locus Computing ($795 for two users) lets you use both simultaneously on an 80386-based PC. Unlike some DOS/Unix hybrids that place the two operating systems into separate bootable partitions, Merge 386 lets Unix and DOS share the same file system. The system boots under Unix and runs DOS as a Unix process. Unix- and DOS-hosted programs can run concurrently—for example, you can run Lotus 1-2-3 under DOS while compiling a program under Unix. Since multiple DOS processes can coexist, you can, at the same time, telecommunicate in a background DOS process. You can mix DOS and Unix commands on the command line of either environment and in batch files and shell scripts.

Merge 386 runs under Unix System V version 3 and requires an 80386-based PC with at least 2.5 megabytes of RAM, a 40-megabyte hard disk drive, a 1.2-megabyte floppy disk drive, and an EGA, CGA, or MDA monitor. I installed Bell Technologies' Unix V.3 and Merge 386 on a Dell System 300 with 3 megabytes of static RAM, two floppy disk drives, an 80287 coprocessor, and a 40-megabyte hard disk drive.

Installing from 17 Floppy Disks

You have to install Unix first, then Merge 386. The Unix installation is lengthy—Bell Technologies delivers the system on fourteen 1.2-megabyte floppy disks—but relatively painless. The more you know about Unix, the better; but any experienced DOS user should have little trouble getting a system up and running. Fine tuning takes longer, of course; you should allot at least 3 hours.

First, you must boot a minimal Unix kernel from a floppy disk. That kernel transfers itself to the hard disk drive. Then you boot Unix from the hard disk drive and, assisted by a Unix shell program, you copy the contents of the 14 disks to the hard disk drive. The shell program then prompts you for one or more user names and passwords and performs the necessary accounting for these users. Finally, it builds a complete Unix kernel. At this point, you can boot from the hard disk and command the entire Unix arsenal.

Now you can install Merge 386. It's a similar process—you copy an installation script from a floppy disk and run it. It prompts you for the three Merge 386 floppy disks, copies their contents to the hard disk, and creates a new Unix kernel containing the Merge 386 extensions. (The program saves the old Unix kernel so that you can boot the vanilla Unix.) Finally, you boot once again to activate the hybrid Unix/DOS system.

The Two-Headed Beast

The system boots Unix, so you have to type your user name and password to log on. Most of the standard Unix tools are at hand, including `ed`, `vi`, `grep`, `chmod`, `ln`, `pr`, and `ls`. Notable exceptions include the text-formatting tools `troff` and `nroff`, which Bell Technologies markets separately as part of the Documenter's Workbench, and `man`, the gateway to Unix's on-line documentation, which has been replaced by a friendlier but less informative menu-driven help facility.

Locus has done much to ease the transition for DOS users. Many DOS commands work at the Unix command line. For example, to get a list of the files in the current directory, you can type either `ls` or `dir`. There is, however, a perceptible delay when you issue the `dir` command under Unix, since Unix has to create a transient DOS process to execute it. So `ls` runs much faster than `dir` under Unix. You can also run many common Unix commands from the DOS command line. Again, the native version of the command runs faster than the foreign one, so that, under DOS, `dir` is faster than `ls`.

To start a DOS session, you simply type `dos` at the Unix command line. Unix creates a process that emulates a 640K-byte DOS machine. The DOS `chkdsk` command doesn't work, but I was able to use a Windows utility to check the available memory; 555K bytes were free. You can vary the amount of memory allocated to DOS in several ways. The `dos` command takes an argument that specifies how much memory DOS can use, so, to create a 384K-byte DOS environment, you can type `dos +m384`. You can also use the Merge 386 `dosadmin` facility to alter the size of the DOS environment and to specify the amount of memory allotted to individual DOS applications.

When you start a DOS session, you're logged into drive C. This isn't a physical partition, but rather a Unix file simulating a partition; it grows and shrinks as you create and delete files. The root of drive C is identical to the Unix root, and all files and directories are visible under both operating systems. Your privileges as a Unix user determine how you can access those files under Unix or DOS. You can `cat` or `type` `/etc/passwd`, for example, but you can't change the file unless you've logged on to Unix as the superuser.

Drive D is a subset of drive C. The root of D is your home directory—for example, /usr/jeff. Often, it's more convenient to log on to drive D and work there.

continued

Merge 386 version 1.0

Type
Combined Unix/DOS environment

Company
Locus Computing Corp.
9800 La Cienega Blvd.
Inglewood, CA 90301
(213) 670-6500

Format
Unix: 14 1.2-megabyte 5¼-inch floppy disks; Merge 386: 3 1.2-megabyte disks

Language
C

Hardware Needed
An 80386-based computer with 2.5 megabytes of (preferably 32-bit) memory; a 40-megabyte hard disk drive; a 1.2-megabyte floppy disk drive; EGA, CGA, or MDA monitor

Software Needed
None (Unix V.3 and DOS 3.21 supplied)

Documentation
250-page Merge 386 User's Manual
75-page Merge 386 System Administrator's Manual

Price
For 1 or 2 users without Unix: $695
For 1 or 2 users with Unix: $795
For unlimited users without Unix: $1195
For unlimited users with Unix: $1595

Inquiry 902.

If you type `cd \` while logged on to drive C, you'll end up at the Unix root, which is probably not what you want. The same command on drive D takes you to your home directory. Applications that expect files to be in or below the root directory (in the DOS sense) are easier to manage on drive D.

If you created a physical DOS partition during the Unix installation, Merge 386 maps drive E to it. You don't need a physical DOS partition to run Merge 386, since the shared Unix/DOS file system lives in the primary Unix partition. There are two reasons you might want one. First, it allows you to install copy-protected DOS applications that require direct access to a DOS-formatted hard disk. Second, it gives you the option of booting raw DOS, though you'd have to use `fdisk` to make the DOS partition bootable.

I did ask for a DOS partition during the Unix installation, but the mapping of drive E to the DOS partition didn't work: I couldn't get access to it under Unix. After some experimentation, I was able to attach drive B explicitly to the file `/dev/dsk/dos` (the Unix name for the physical partition); I even installed Lotus 1-2-3 on drive B and ran it from there. I reinstalled the Merge 386 software several times—and even obtained and installed a new version from Locus—but never got drive E to work as advertised. Locus' technical-support representative was puzzled—apparently, many Merge 386 users are happily accessing their E drives—and is investigating the problem.

Multitasking on the 80386

Merge 386 exploits the memory-paging and virtual-mode capabilities of the 80386 microprocessor to let you boot and run multiple independent DOS processes simultaneously using the normal Unix syntax. For example, to start a background DOS process in which GW-BASIC interprets DATA.BAS, you'd type `gwbasic data.bas&`. The ampersand tells Unix to spawn a background DOS process, run the program in it, and return control to the command line. You can also start background DOS processes from DOS or Unix by means of the `newdos` command.

You use Ctrl-Alt-SYSRQ to cycle among processes; Merge 386 switches contexts instantaneously. It's like the OS/2 program selector, but OS/2 supports just one DOS process, whereas Merge 386 handles many. And, of course, OS/2 doesn't support multiple users. If you do configure Merge 386 as a multiuser system, however, the type of each user's terminal determines which programs that user can run and how the user can multitask those programs. Memory-mapped terminals (e.g., EGA, CGA, or MDA) work best: you can run multiple display-oriented programs (programs that write directly to video RAM), each can have its own screen, and you can switch between screens. You can connect standard ASCII terminals to the Merge 386 system as well, but they are less useful: They can't display bit-mapped graphics, and they are unable to run display-oriented programs in the background.

Mixing DOS and Unix Commands

We've seen that you can run many of the standard Unix and DOS programs from either command line. Merge 386 accomplishes this by means of two techniques. In the case of a DOS command that is external to COMMAND.COM, like `tree`, the Merge 386 installation program links TREE.EXE to a file called simply TREE. You can accomplish the same thing yourself with the Unix tools `ln` and `chmod`. For example, suppose you compile FOO.C under DOS to create FOO.EXE. When you type `foo` under DOS, the program runs, but when you type `foo` under Unix, the system reports that it can't find the file. You need to create an alternate directory entry (`ln foo.exe foo`), enable its execute privilege (`chmod +x foo`), and either add FOO's directory to the Unix search path or move FOO to a directory that's already on that path (e.g., `mv foo /bin`). Now you can run `foo` from the Unix command line, too, though it's slower since Unix has to create a DOS shell in which to run it.

There's a different mechanism for running Unix commands from DOS. The Merge 386 `on` utility takes the name of a DOS command and sends it to Unix to be processed. For example, to run the Unix program `cal`, which isn't one of the standard commands that Merge 386 makes available under DOS, you can type `on unix cal`. There's process overhead here, too; `cal` runs faster under its native Unix than it does by way of `on`. You can establish a direct link from DOS to a Unix tool by creating a new copy of ON.EXE, which lives in the DOS bin. For example, under DOS, you can issue the command `copy \usr\dbin\on.exe\usr\dbin\cal.exe`, and thereafter, you can run `cal` from DOS by simply typing in its name. The standard Unix commands that run directly from DOS are implemented this way; they live in the DOS bin and are copies of ON.EXE. Apparently, the `on` utility can feed its own name to a Unix process that runs the tool corresponding to that name.

Stream-oriented programs can communicate with one another through pipes, no matter which operating system runs them. For example, you can pipe the output of `dir` to `wc` (the Unix tool that counts lines, words, and characters) by typing `dir | wc`; this works under both DOS and Unix. Merge 386 handles conversions between Unix-style files (line-feed only) and DOS-style files (e.g., carriage-return and line-feed) automatically. The tools that perform these conversions—`dos2unix` and `unix2dos`—are available in both environments, and you can use them explicitly if you need to.

In general, you can print text files from either Unix or DOS, using each operating system's usual facilities (`pr` under Unix, `print` under DOS). Unix

continued

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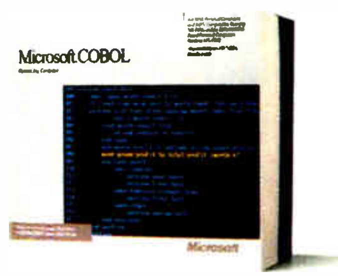

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handles spooling more efficiently than DOS does, but you can't use `pr` to print from a physical DOS device (e.g., a DOS floppy disk). The Unix spooler does handle the `Print Screen` function.

Curiouser and Curiouser

Confusion inevitably arises in a complex hybrid system like Merge 386. Unix and DOS use different symbols to separate the directories on a search path (colon versus semicolon), to separate the elements of a file specification (slash versus backslash), and to signal arguments to commands (hyphen versus slash). Under Unix, for example, you can type `dir` to get a list of files, but you can't type `dir /w` to get a wide list—you have to type `dir -w`. All these commands will work:

```
$ copy /test/foo /test/bar
$ cp /test/foo /test/bar
C>copy \test\foo test\bar
C>cp \test\foo \test\bar
```

But none of these will:

```
$ copy \test\foo \test\bar
$ cp \test\foo \test\bar
C>copy /test/foo /test/bar
C>cp /test/foo /test/bar
```

Since Unix allows longer filenames than DOS does and also allows filenames that contain characters that are illegal under DOS, Merge 386 sometimes needs to alter filenames to make them acceptable to DOS. If you run `ls` at the root, you'll see the standard Unix directory `lost+found`; `dir` displays the same directory as LOST_F'D. In general, Unix maps characters that DOS can't handle, such as +, to the underscore.

Of course, a number of commands work differently. Typing `cd` under DOS with no parameters displays the current directory, but under Unix, it changes you to the root directory; the Unix command to display the current directory is `pwd`. The `find` command in DOS searches a file for a text string, but in Unix, it searches the disk for a file. More serious is the fact that wild cards expand differently. A legal DOS operation like

```
C>copy *.* \usr\bin
```

won't work from the Unix command line; instead you must type

```
$ copy "*.* \usr\bin"
```

or precede the asterisks with backslashes:

```
$ copy \*.\* \usr\bin
```

DOS Applications

I tested a variety of DOS applications; most of the applications ran happily. I was able to log on to BIX using Procomm 2.4.2 with a Hayes 2400-bit-per-second internal modem. WordStar 5.0 worked fine, as did Lotus 1-2-3 version 2.1. There were some problems when I tried to transfer files to the system. DeskLink 2.21 repeatedly hung. I had better luck with PC Hooker 1.4—it didn't work at 115 kilobits per second, but it did fairly well at 56 kbps.

I also had some trouble getting a Microsoft Serial Mouse to work, but I eventually figured out the proper procedure. It turns out that Merge 386 runs DOS at an interrupt rate of about 1 per second, not at the standard DOS rate of about 18.2 per second. The Merge 386 command `merge set fastclk on` will increase the interrupt rate to the DOS standard. Since you can't change the interrupt rate until after you've booted DOS, I still couldn't get MOUSE.SYS to work correctly, but I was able to use the alternate scheme—running MOUSE.COM explicitly—to get the mouse to respond.

Once I'd gotten the mouse working, I tried using AutoSketch Enhanced 1.0, a CAD program. In standard EGA mode, the program's performance was atrocious. (Mouse sensitivity was also much lower than usual.) I'm accustomed to seeing the program fill areas instantaneously. Under Merge 386, I could almost see individual pixels change color.

To compensate for this poor graphics performance, Merge 386 provides a special fast EGA driver that increases performance to an acceptable level, but it precludes switching from the screen while that session is running. You can switch from the screen in standard EGA mode, but the task is suspended; CGA and monochrome screen groups do run in the background. To verify that, I ran AutoSketch in CGA mode and asked it to regenerate a drawing in the background while I ran Unix tools in the foreground. It does the job, but I wouldn't want to use CGA mode for serious graphics work.

Benchmarks for Multitasking DOS

I used the BYTE CPU benchmarks to evaluate the performance of Merge 386 as a single-user system running one or more DOS processes. Table 1 presents the results. The first row of numbers establishes the baseline—the times under raw DOS, before I installed Merge 386. The remaining groups of rows illustrate the performance of Merge 386 under varying conditions. The second group

continued

Table 1: *In single-DOS-task mode, Merge 386 ran some tests faster than pure DOS. All times are in seconds.*

	Matrix	Move byte	Move word odd	Move word even	Sieve	Sort
DOS	4.1	25.5	31.3	12.5	25.7	28.3
Merge 1:1	3.3	24.4	30.4	12.6	24.7	27.7
Merge 1:1*	4.2	26.0	32.5	13.1	26.6	29.5
Merge 1:2**	9.6	49.7	61.6	24.7	50.7	54.7
Merge 2:2	8.2	49.4	61.3	24.7	50.7	56.1
Merge 1:3**	14.5	75.1	92.6	37.6	76.8	82.9
Merge 2:3	13.5	74.8	93.2	37.9	77.1	85.5
Merge 3:3	11.9	74.8	92.6	37.9	77.1	85.5

* FASTCLK on.
** Foreground task.

compares the performance of a single DOS process (with Unix idling) running at the default Merge 386 interrupt rate and at the faster rate obtained when you enable FASTCLK. Interestingly, when you use the default interrupt rate, some of the tests run faster under Merge 386 than under DOS. When FASTCLK is on and Merge 386 is emulating the DOS interrupt rate, the tests are a little slower than under pure DOS. Under Merge 386, the faster interrupt rate slows the system by from 2 percent to 8 percent.

The third group shows the results for two concurrent DOS processes, each running a copy of each of the benchmarks; again, Unix was idling at the time. And the fourth group repeats that experiment for three DOS processes. Two points are worthy of note. First, the two- and three-process numbers are very close to integer multiples of the single-process times; the penalty for multitasking is relatively small. Second, Unix gives foreground and background tasks nearly equal priority, in contrast to OS/2, which (by default) strongly prefers the foreground task. So, under Merge 386, you should expect response time to degrade as a linear function of the number of processes you're running.

Who Needs It?

This product isn't for a casual DOS user who's curious about Unix. A two-user license costs $795, and you need an 80386-based machine with at least a 40-megabyte hard disk drive to do any serious work. Nor is it for a DOS-only user looking for a good 80386 control program. Products like VM/386 and DESQview do the job much more cheaply.

Merge 386 is really for dedicated Unix users and software developers who work mostly under Unix but would like to use DOS software in the Unix environment, or who need to port software between the two environments—for example, a telecommunications specialist who requires access to the Unix uucp facilities and also to DOS communications packages. In that context, I doubt that Unix's multiuser capability would come into play; it's more likely that the 80386 running Merge 386 would function as a single-user machine possibly communicating with larger Unix machines and DOS-oriented LANs.

Merge 386 could also function as a multiuser system. A systems integrator might use this product to create a multiuser DOS environment in which a group of users would share the use of a database package. Users accustomed to dedicated PCs would likely perceive slower response time, but the system administrator would be happier since Unix would provide uniform backup and security procedures.

I had a few problems with Merge 386. I couldn't access the physical DOS partition, timing-sensitive DOS communications programs were balky, and the mixed syntax was confusing. Overall, though, the system performed as advertised. It's not likely to convert legions of DOS users to Unix, but for those who need the capabilities of both operating systems and want them in a single box, Merge provides as good a compromise as we're likely to get. ■

Jeff Holtzman owns Publishing Concepts, a firm that specializes in evaluation, verification, and documentation of high-technology products. He lives in Ann Arbor, Michigan, and he can be reached on BIX c/o "editors."

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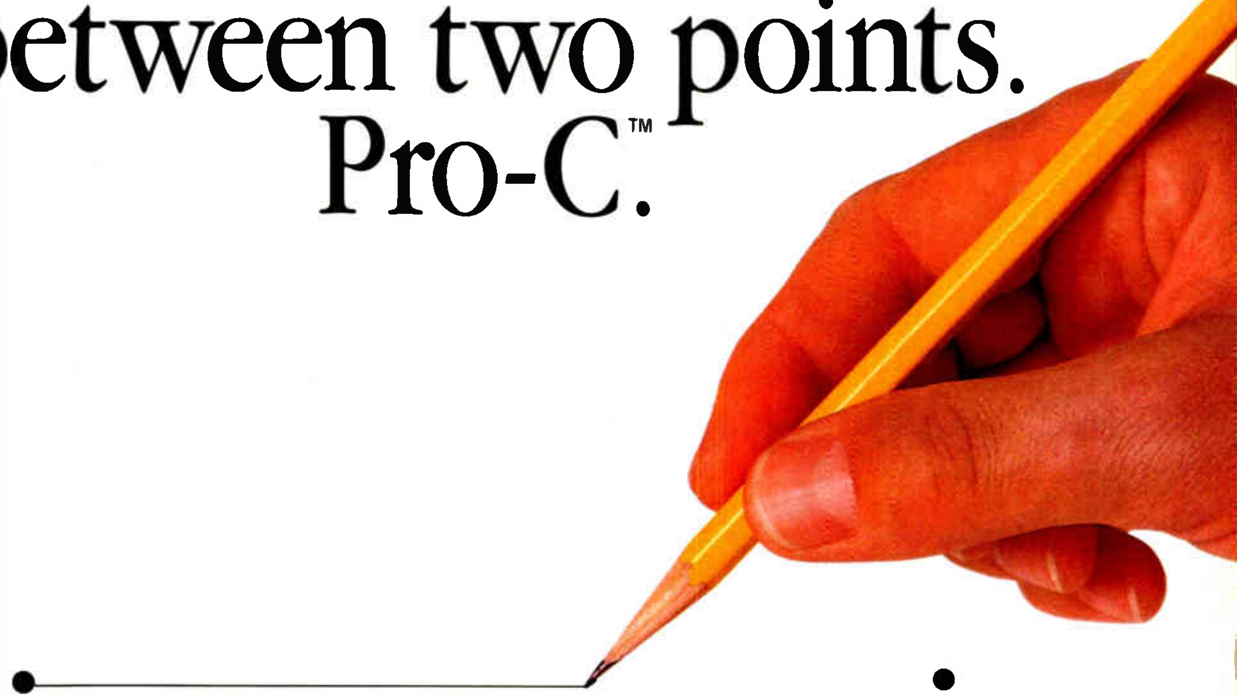

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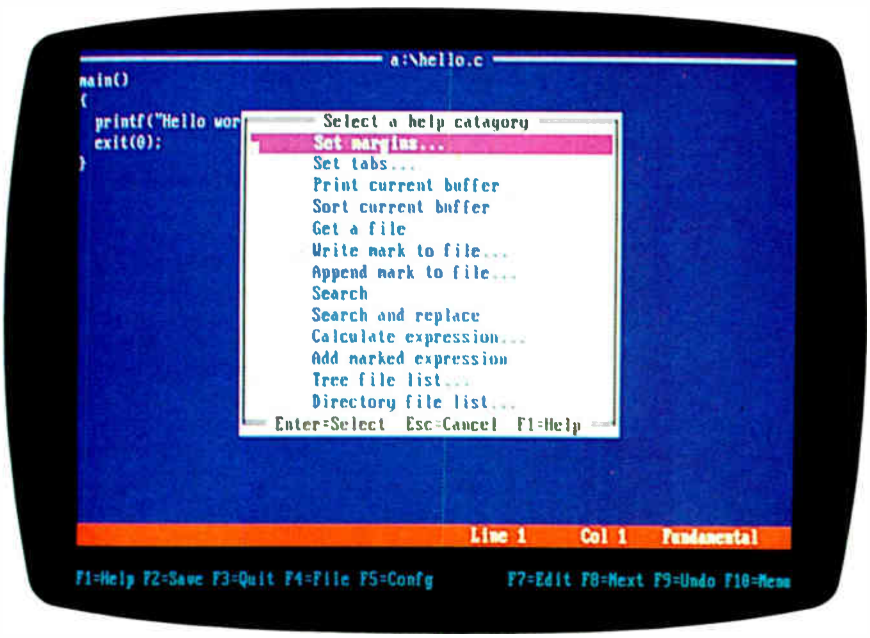
Slick



When it comes to programmer's text editors, Slick lives up to its name

Namir Clement Shammas

The investment in time and effort to select and learn a new programming editor is a nontrivial exercise. Programmers seem to become very attached to specific text editors. A newly adopted text editor must offer many new features, such as a good user interface and programmability. The latter covers many areas—macros, a command language, and reconfigurable keys, to name just a few. Slick, a $195 programmer's text editor from Micro-Edge, offers just those features.

Slick is aimed at programmers in general and at Pascal and C programmers in particular. The name "Slick" perhaps reflects on some of the interesting features, such as the file manager, the Slick programming language, a rich set of editing commands, and several enhanced and smart text-editing capabilities.

Dual Personality

The distribution disks contain two versions of Slick. The first works with DOS 2.x or higher, while the second is for OS/2 and DOS 3.x or higher. Slick requires 820K bytes of hard disk space for the DOS version and 1080K bytes for the OS/2 version. In operation, the program requires 300K bytes of RAM. The package also includes a grep utility and a Slick translator, both of which come in two versions similar to that of the Slick editor. I ran Slick using PC-DOS 3.1 and OS/2 version 1.0.

The Slick editor comes on four 360K-byte floppy disks. The manual recommends that you install the editor on your hard disk, although you can use two 360K-byte floppy disks. I easily installed Slick on a single 1.2-megabyte floppy disk and often copied the files to my 2-megabyte RAM drive to gain speed. The installation utilizes a batch file and is very straightforward.

The power and versatility of Slick first becomes evident when you examine the options involved with invoking it. For example, you can specify a list of text files for editing; the list may be based on wildcard filenames and/or a lineup of unambiguous filenames. Alternately, you can invoke the command shell. This shell prompts you for the full name of the current directory and displays the DOS error code for the last operation. You can also invoke Slick to execute a command and then exit or let it remain resident.

The Slick editor saves and updates its configuration in a "state" file. The default state file is SLICK.STA, although you can save and load other state files. When you invoke Slick, you can specify a state file other than the default. Consequently, each class of editing job you perform can have its own state file that configures Slick accordingly.

The default screen displays the edited filename (also called the buffer), the edited text, the command line, the message line, and the function-key line. You can elect to display a buffer in an entire screen or use multiple windows in view-

continued

Slick

Type
Text-editing environment

Company
MicroEdge, Inc.
P.O. Box 2367
Fairfax, VA 22031
(703) 378-4716

Format
Four 360K-byte 5¼-inch floppy disks

Language
C

Hardware Required
IBM PC, XT, AT, PS/2s, or compatibles with 300K bytes of RAM, two 360K-byte floppy disk drives or one 1.2-megabyte floppy disk drive, and one hard disk drive (recommended)

Software Required
DOS 2.x or higher, or OS/2

Documentation
304-page Editor Reference Manual

Price
$195

Inquiry 904.

ing the same file. Slick also supports the editing of multiple files and permits you to have windows viewing multiple files.

A Plethora of Commands

Slick employs a large number of commands, many of which are not mapped onto a key. Consequently, the command line is frequently invoked, with either the Escape key or the Ctrl-A key combination. Slick maintains a stack for the command lines; this lets you swiftly and conveniently execute previous commands without retyping them. You can also edit the command lines and then execute them. You use the message line to display error messages or provide help messages regarding the typed commands.

The Slick command line enables you to type many of the frequently used internal DOS commands, such as CLS, COPY, PATH, DATE, TIME, RENAME, DEL, and so on. It also has its own DIR command, so to execute the DOS DIR command, you must type DOS DIR from the command line. To invoke a copy of DOS, you type DOS. In addition, Slick passes any commands it does not recognize to DOS. The successful execution of a DOS command depends on the memory requirements to execute that particular command.

Slick provides a one-line calculator that you can activate from its command line. The calculator handles numbers and operators, including logical and bitwise operators. There are three versions of the math calculator: decimal, hexadecimal, and octal. The decimal version handles integers and floating-point numbers, while the hexadecimal and octal versions handle integers only. Each version is able to process expressions containing decimal, hexadecimal, and octal numbers—the difference is that the results are converted to the numeric base of the invoked calculator version.

The default function-key menu line displays the action task associated with each function key. Each key can obtain on-line help, save a file, edit a new file, edit the current configuration of Slick, move to the next buffer, undo line changes, and display a context-sensitive menu.

The on-line help is extensive and places help information into a buffer. The topics in question are available for you in the buffer list until you remove them explicitly. The list of general topics in the initial menu window lacks a sorted order; until you get used to them, you have to do a lot of reading. I hope that future versions present these items in a more orderly fashion. Each topic causes another help menu to pop up, displaying the exact commands or functions. When you select a function or command, the screen puts the related help information into a new buffer. Items are selected using the light bar and cursor-control keys—you cannot directly jump to a selection by typing a hot-key letter.

User Interface

The keyboard layout, the ability to reconfigure the keyboard, and the ease of doing so are major factors in establishing a good interface between a programmer and a text editor. This is Slick's weakest point. MicroEdge decided to implement its own default configuration for the keyboard layout. So, regardless of where you are coming from, your fingers need to go back to boot camp.

Slick lets you bind and unbind commands to keys in two ways. First, you can perform the command binding from the command line. The message line provides context-sensitive guidance and displays any related error messages. You are limited in that you can bind a command only to a single keystroke, with or without Shift, Control, or Alt-key combinations. The second method of binding commands to keys involves the Slick language and enables you to assign multiple keystrokes to a single command.

You can prompt Slick to display the list of default keystroke assignments. If you alter the keyboard layout, the above information becomes of little use. Alternatively, you may inquire about the function of a specific keystroke. Slick reacts in an interesting way: It displays a description of what that key does and lists any other keystrokes that perform the same function. Slick dynamically updates the list of keystrokes to reflect any changes made.

Slick supports three types of block operations: line-based, character-based, and screen blocks. The line-based blocks span entire lines. The character-based blocks mark all the text between two characters. The screen-based blocks enable you to mark screen characters by row or column, or by defining an area.

Standard text-block operations, typical of any text editor, are supported; plus, Slick throws in a few new zingers. For example, you can swiftly move a block to the left or to the right and effortlessly adjust its indentation; alter the case of the text in a block; overlay marked text; reformat marked text; sort marked text; and quickly fill a block with a single character. For example, I can mark a row-wise screen block and fill it with comment characters. I found these features to be very useful and truly timesaving.

Slick's search-and-replace capabilities include the ability to use regular expressions. Such string expressions enable you to, for example, search for text using wild-card characters. Slick supports regular expressions containing character ranges, subexpressions, ORed expressions, and reversed matching (i.e., the search fails if a match is found), to name just a few. In addition, Slick has predefined classes of character sets, such as alphanumerics, blanks, alphabets, digits, hexadecimals, integers, floating points, filenames, directory paths, quote strings, C variables, and words. These arm Slick with a powerful regular expression capability. The regular expression search engine is also integrated with a grep utility that you can invoke from the Slick command line.

Manipulating Files

Slick's file manager is a versatile add-on feature. While not directly involved with the heart of the text-editing process, the file manager provides you with a savvy way of accessing and managing files. The DIR and LIST commands are used to invoke the file manager. Basically, these two commands are identical and are implemented with different default options. The general syntax for the DIR and LIST commands are as follows: DIR {FILESPEC | [−|+ OPTIONS]} and LIST {FILESPEC | [−|+ OPTIONS]}. By default, DIR lists the file entries and the subdirectory names in the specified subdirectory path. By contrast, LIST leaves out (by default) the subdirectory names and includes the names of all matching files in the subtree of the specified subdirectory path. A number of DIR and LIST options enable you to list hidden, system, archive, and directory files. Other options enable you to turn the tree-file listing on or off (the default sets it off for DIR and on for LIST).

The tree-file listing option makes the LIST command work like the Norton FINDFILE utility. This is a valuable file management tool for PC users, not to mention programmers.

By default, the output of the DIR and LIST commands is sent to a separate buffer. Slick supports various options to select and deselect files. Using the 2 key and the 8 key, you can select individual files and move the cursor down and up, respectively. This process is reversed using the 9 and the 3 keys. You activate the file manager menu by pressing the F10 key.

When a DIR or LIST buffer is displayed, the F10 key selects the main menu for the file manager. The main options let you back up, copy, select, delete, and edit files, as well as change file attributes, select or deselect files, and update or change the list of filenames.

The copy option copies the selected files from the list into a target directory. While the original copies of the selected files may be located in different subdirectories, they end up in the same target subdirectory. The backup option copies the selected file and simultaneously creates the same subdirectory tree in the target path; this option resembles the XCOPY command. The move option moves the selected files to a target subdirectory without duplicating the source subdirectories. The delete option works by erasing files from various subdirectories without deleting the subdirectories, even if they become empty.

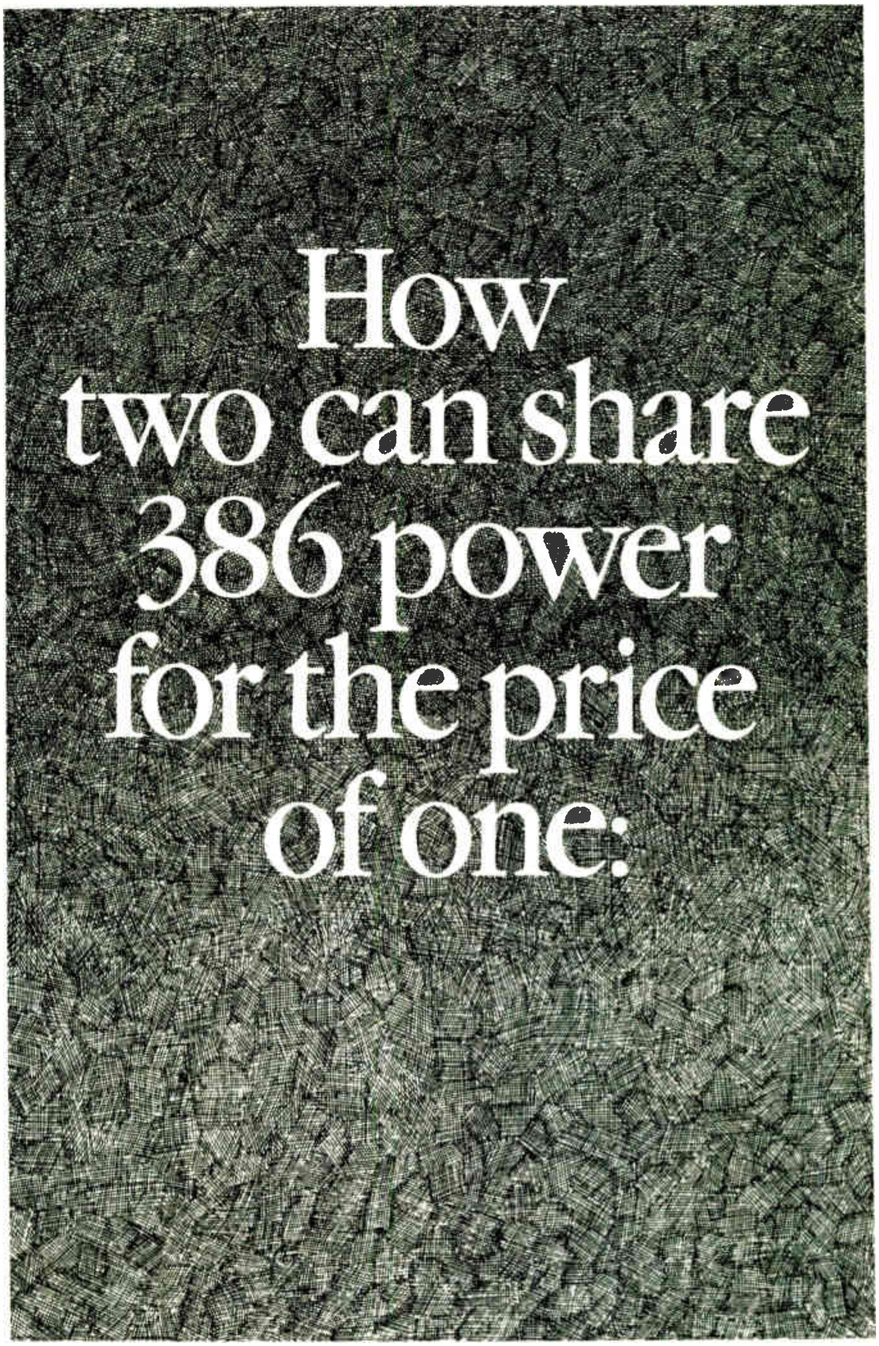
You can use the LIST command to remove from a directory files that were previously loaded from a specific set of disks. The LIST command is first applied to the source disks. Next, you edit the drive name and the path name to reflect the drive and subdirectory name where the file purge takes place. Using the edited list of filenames, you proceed to delete the undesired files.

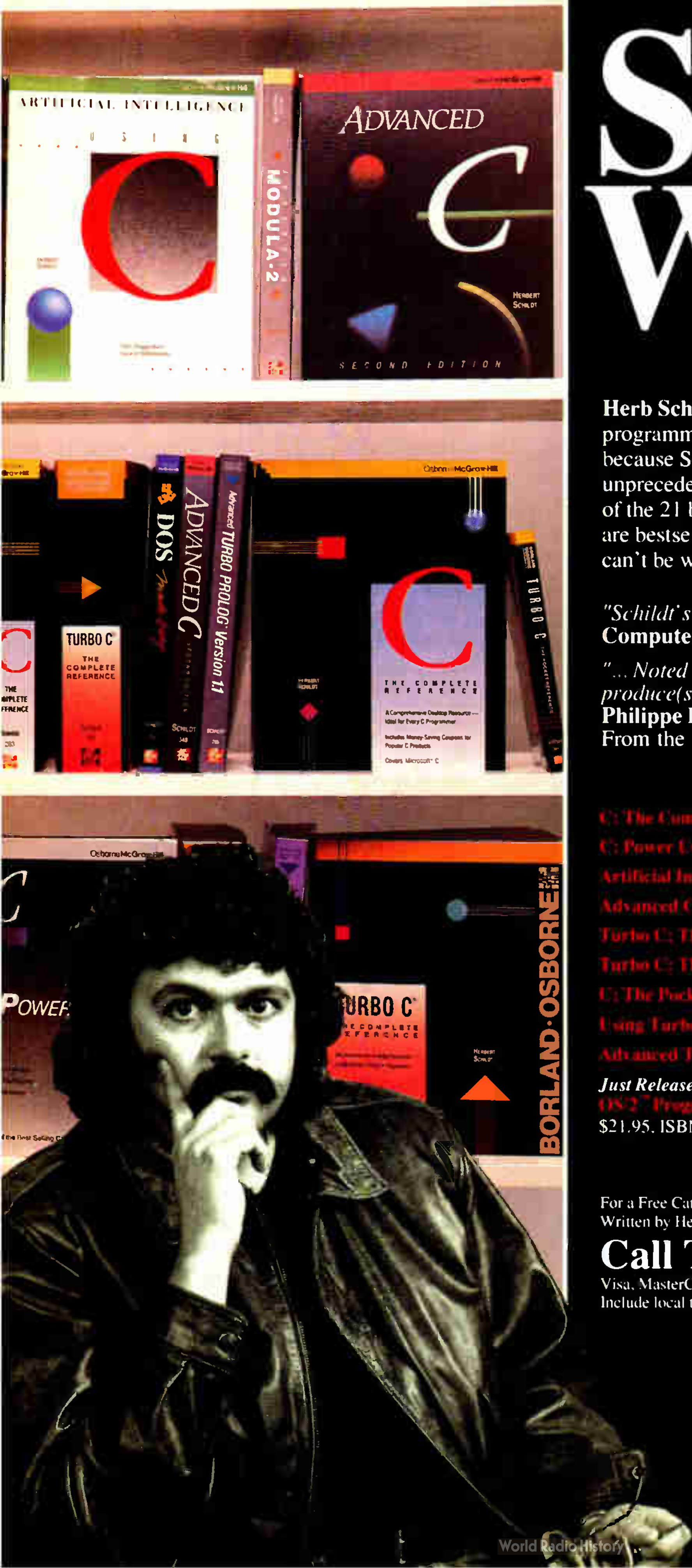
The file-attributes option enables you to toggle the hidden, system, read-only, and archive file attributes. This feature protects certain files by making them read-only or hidden files.

The file-selection option lets you append more files, unlist files, and read/write a file list to disk. You can append more files by using one of two options that perform a DIR or LIST command. The unlist options enable you to unlist all the files (by file extension name), unlist the selected files, or search for particular filenames in the list.

Slick permits you to manipulate file selection by providing you with a set of options. These options enable you to

continued





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select all files, unselect all files, reverse the selection, select by file extension name, select by file attribute, and select and deselect a block of marked files. The file manager options are translated into various forms of FOR-SELECT commands that appear on the command line.

Slick Programming Language

The Slick language was designed for batch programming and as a program extension language. The language is influenced by REXX, Modula-2, and C. String handling in the language resembles that in REXX, while Modula-2 influences scoping and calling convention.

Comments in the Slick language are handled in two ways. The first method inserts comments after a colon. The second method is patterned after REXX (and also C): The comment text is enclosed in the /* and */ character pairs. The Slick language supports string constants that are enclosed in either single or double quotes (the same type of quote must be used throughout, though).

Special characters, such as the new line, carriage return, tab, formfeed, and Backspace are represented using the C-like syntax of "\<character>." The same type of syntax is applied to other ASCII characters represented by their decimal or hexadecimal code numbers. Like REXX, Slick uses strings as the base type. Consequently, numbers are stored as string images.

The Slick language supports the declaration of constants using a Modula-2-like syntax:

```
CONST MyName = "Namir Shammas",
  MagazineName = 'BYTE'
CONST Volume_Number = 13
```

Slick supports four types of variables: universal, global, buffer, and local. The first three types must be declared. All modules can access universal variables, and all routines within a module can access global variables. Buffer variables are accessed by any module—they differ from universal variables by the fact that each buffer created receives its own copy of the buffer variables. Examples of declaring variables are shown below:

```
UNIVERSAL
  Studios = 'Hollywood'
GLOBAL
  menu_string = "F1=Help "||
                "F2=Quit "||
                "F3=Save "||
                "F4=Read"
BUFFER
  state_file = 0
```

The Slick language does not implement arrays or record structures like those found in REXX, Modula-2, and C.

Slick supports arithmetic, relational, logical, and bit-wise operators. The arithmetic operators include the integer division, modulus, and power operators. The relational operators come in two sets. The first operator set (made up of ==, <>, >>, <<, >==, and <==) performs string comparisons, treating numbers as strings. The second set (made up of =, >, <, >=, and <=) compares numbers as numbers and strings as strings. In both cases, this set of operators removes any leading and trailing spaces before comparing the expressions.

The Slick language supports the IF statement with THEN, ELSE, and ELSEIF clauses. No CASE statement is implemented. The program also supports the WHILE, OPEN, and FOR

continued

loops. The WHILE loop comes in two syntaxes:

```
WHILE (expression) DO
  <statements>
ENDWHILE
```

and

```
DO WHILE (expression)
  <statements>
END
```

The FOR loop has an optional BY clause to alter the loop control variable by a value other than 1. The REXX-like DO loop is also supported and acts just like the FOR loop.

The Slick language enables you to define commands, procedures, keys, key tables, and macros. Commands are defined using the DEFC declaration, which takes a number of arguments. You can access the arguments with the use of the predefined ARG() function, which can fetch any argument by its index. Thus, ARG(1) returns the first parameter, ARG(2) returns the second, and so on. A RETURN statement returns an error code to a universal predefined variable called RC.

Procedures are declared using the DEFPROC declaration. Appending the keyword GLOBAL after DEFPROC signals that the procedure is not universal by default. The argument list of a procedure is enclosed in parentheses and may contain up to 15 arguments. Parameters can be passed by reference using the VAR declaration. Like Slick commands, you can access procedure arguments by using the ARG functions. By default, parameters are passed by value. Procedures return values: If none are explicitly returned, a null string is the default result emitted by the procedure. Like C functions, the Slick procedures can be used as functions or procedures. A CALLed procedure causes the returned value to be discarded.

You can define keys and key tables by using the following syntax:

```
DEF [prefix][key-key],key[-key]
  = command
```

The command bound to the DEFined key must be defined by DEFC. You define keyboard macros by using the DEFMACRO command that binds a macro name to a sequence of key names.

You use the Slick translator to compile the source code file into a p-code, which the Slick editor can execute. The translator serves to catch errors in the source code. You use the LOAD command to load a module into the editor. If the source code is not compiled or up-to-date, a make utility is automatically invoked. I found that it is better to edit a Slick source code file using the editor, save the file, and then immediately load it. The make utility will be invoked, a message will identify any error, and the cursor will indicate the offending location.

Writing batch files using the Slick language requires you to use the DEFMAIN (which parallels the `main()` function in C) and the DEFINIT primitives. The Slick batch file first executes DEFINIT procedures, then DEFMAIN. Slick batch files can have the .S and .CMD (for OS/2) file extensions.

Variables and Strings

Slick comes with a rich set of predefined variables and string-handling functions. The predefined variables enable you to query and set the state of the different variables to influence or fine-tune your defined commands, procedures, keys, and macros. The string-handling functions offer additional support for text processing.

For both the C and Pascal programmer, Slick offers a special treat. It monitors what you type, looking for keywords related to loop and decision-making constucts. Whenever the editor detects such a keyword, Slick inserts a skeleton placeholder for the construct that you type. For example, while you're editing a Pascal file (with the extension PAS), typing FOR and a space causes the following to appear:

```
FOR := TO DO BEGIN
END;
```

You simply enter your variables in the appropriate locations.

Since the source code for the Pascal and C language support modules are provided, you can alter the inserted placeholders. While testing Slick, I did just that for the Pascal language support module. First, I made Slick display the Pascal keywords in uppercase rather than in lowercase (the default setting). Second, I expanded the IF statement to include a BEGIN-END block after the THEN clause and added an ELSE clause with its own BEGIN-END block. Editing the language module was easy since Slick employs verbose commands, functions, and variables.

Powerful Alternative

Slick is a sophisticated text-editing environment for programmers. This initial release can benefit from improved organization in the on-line help, easier keyboard customization, and a more detailed manual that is written for users, not just for programmers.

On the positive side, Slick combines an editor with a programmable file manager and a batch processor. The program's numerous combination of features ranges from interesting to impressive. If you are really tired of the limitations of your current text editor, Slick is worth considering. Even if you are not about to abandon your current editor, I still recommend Slick as an alternative text editor. It can make difficult editing tasks much faster and easier. ■

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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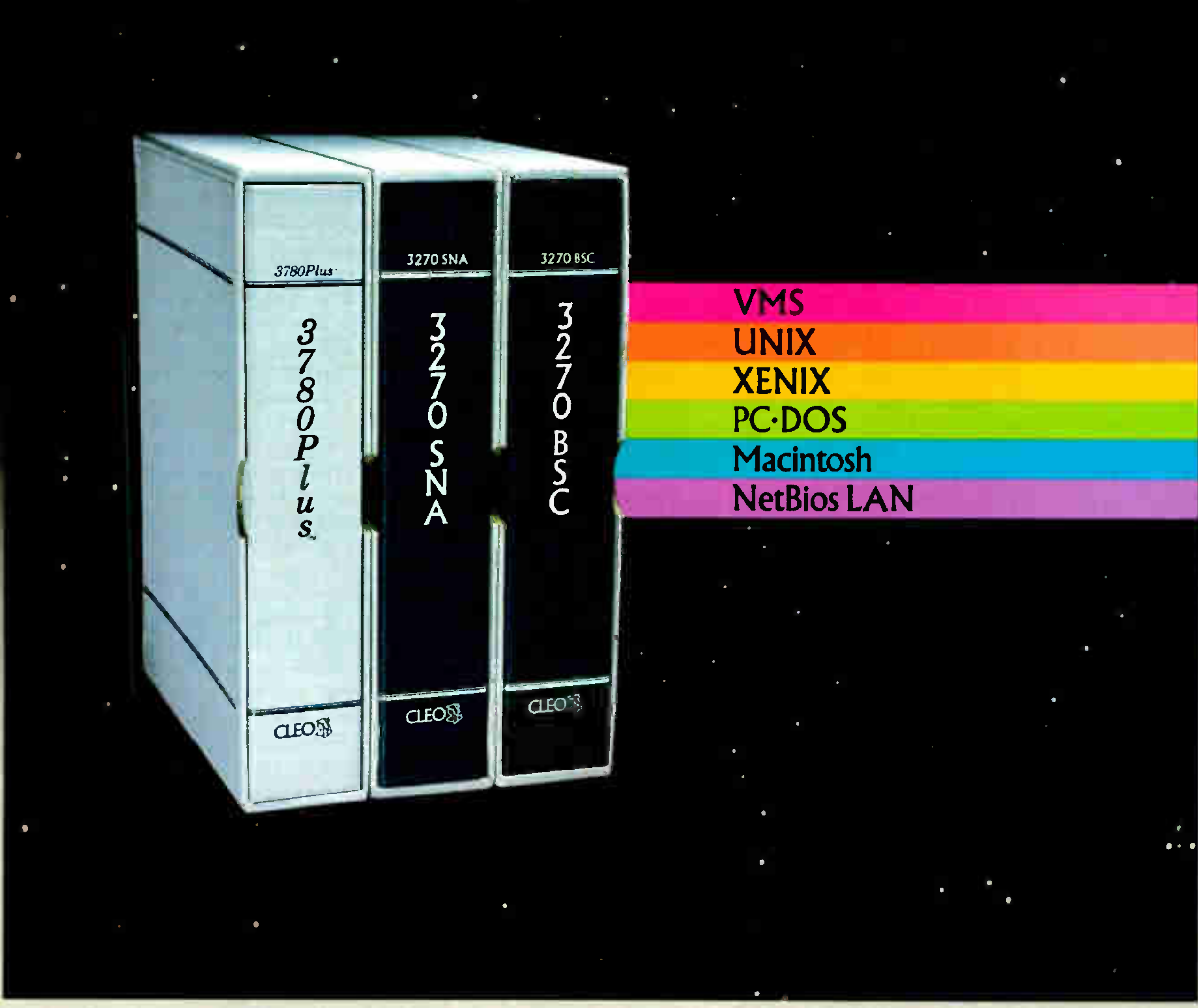

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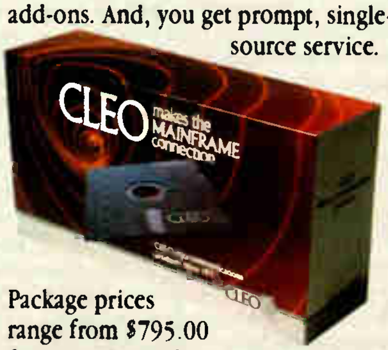

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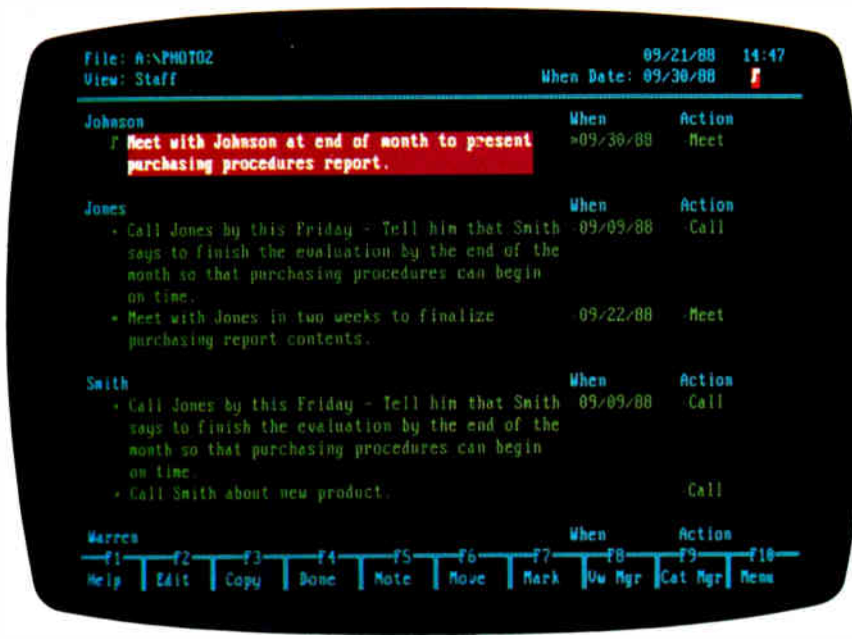

Agenda takes a flexible approach to database construction

Lamont Wood

Databases are powerful tools, but real-world information can't always be shoe-horned into the precise data formats required by most database programs. With that idea in mind, Lotus Development has developed an alternative. Agenda is a $395 information manager that attempts to organize desktop notes on your personal computer.

Lotus recommends running Agenda on an IBM PC, XT, AT, PS/2, or compatible with 512K bytes of RAM, DOS 2.0 or higher, and a hard disk drive. I ran it on a 16-MHz 80386-based AT clone with 640K bytes of RAM, a 40-megabyte hard disk drive, and one floppy disk drive.

When you first run Agenda, you see a title screen, where you can enter a name and brief description of the database you want to create. You then see a screen with a control-panel status line across the top, a list of function-key names across the bottom, and a blank work area in between. Pressing F10 replaces the status line with Agenda's main menu. Before you can start building a database, however, you'll have to master a new set of concepts and terminology.

Getting the Idea

To understand what Agenda does, suppose you find yourself jotting down the following thought: Call Jones by this Friday—tell him Smith says to finish the evaluation by the end of the month so purchasing procedures can begin on time. If you had to categorize this thought, it might go under any number of headings, including "Jones," "calls I should make," "Smith," "things to do by Friday," "the evaluation," "this month's projects," "complaints from the purchasing department," and so on.

Of course, there's no need to categorize this memo unless you've been jotting down more observations than you can track. But if you do have a lot of memos, you might want to sort them to get a list of everyone you need to call by Friday. Each memo to yourself would, in Agenda's parlance, be an *item*, the basic information element in an Agenda database. If you flipped the scrap of paper over and wrote Jones's phone number or other supportive information on the back, that secondary text would be a *note*.

In Agenda, items can be 350 characters long. Notes can be up to 10K bytes long. Notes are always associated with the item they're attached to, but they aren't treated as part of the database. In fact, a note can reside in an external text file. You enter items by pressing the Insert key, and you can attach a note to an item by highlighting it with the cursor and pressing the F5 key. A musical note symbol precedes each item that has an attached note.

All items appear under a category name. Initially, all the items you enter appear as indented, bulleted items under

continued

Agenda 1.0

Type
Information manager

Company
Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
(617) 577-8500

Format
Five 5¼-inch floppy disks and two 3½-inch floppy disks

Language
C

Hardware Needed
IBM PC, XT, AT, PS/2, or compatible with 512K bytes of RAM, DOS 2.0 or higher, a hard disk drive, and one floppy disk drive

Documentation
430-page Users Guide, 98-page Tutorial, 32-page Sample Applications Manual, 50-page Definition Files Manual

Price
$395

Inquiry 903.

the initial category Untitled. You can edit this section head to put all the items that you have entered under one category, or you can create a new category, such as Purchasing. Once you update the database by selecting Utility and Execute from the main menu, Agenda automatically scans the text of all items and assigns those containing the word "purchasing" to the new category. Some items will then belong to both the Purchasing and the Untitled categories.

A category heading and its list of items is called a *section*. A screen of information, which may contain several interrelated sections, is called a *view*. A database of items, categories, and view definitions can be about 3.5 megabytes in size, of which about 200K bytes can reside in memory.

Categorizing

If Agenda could only list items that contain a specific text string, you could save your money and get by with the DOS Find command. But Agenda's real power lies in its Category Manager. At any time, you can go to this screen to add, delete, or rearrange the list of categories and relationships that Agenda uses to sort items.

The Category Manager looks like a list of outline headings, with indented child-category headings subordinate to nonindented parent headings. For instance, you might set up a parent category called People. Indented below it, you could write a list of the people you interact with—Smith, Jones, and so on. You could then return to the initial view screen and instruct Agenda to sort the items in the People category and update the database to reflect this change. Then you could create a new view, called Staff. From the pop-up menu, you would select People as the category and indicate that child categories should be displayed.

In the Staff view, you'd see sections headed by each child category for People (i.e., each name). Under each name would be all the items associated with that category. Items containing two names would appear in two sections (see the photo). In conventional database terms, you would sort a file on the basis of fields that you defined after the fact. You could redefine, expand, and edit the fields at any time.

Suppose that you don't want to bother reading the items to see what you're supposed to do with Smith, Jones, and so on. You could go to the Category Manager screen and set up a parent category called Action, with the child categories Meet and Call. You could then go back to the staff view and add a column called Action. When you update the database, the new column will contain the words Meet or Call, or it will be blank, depending on what words appear in each item. For blank items, you must enter Call or Meet in the Action column manually. One potential problem with this automatic updating feature is that some words can have more than one meaning and might be falsely associated with a category; for example, the word "purchasing" could be used as a verb or could be a department name. In that case, you must unassign the item manually.

Agenda also lets you filter views or categories to show, for example, only those items that occur this week, or only those that pertain to a particular subject. You might include only those items that mention the evaluation, or purchasing. Or you could specify only those items that did not contain either subject.

Another interesting feature is the ability to designate some items as prerequisite and others as dependent. For example, you may not be able to meet with Joe until after Bob gives you the report results. Once item relationships are defined, you can set Agenda to display only prerequisite items. Dependent items then appear automatically when prerequisite items are done.

Category definitions can be quite complex. You can equate a list of words so that, for example, items containing the words "meeting," "seminar," or "convention" will all be assigned to the Activity category. You can impose logical operators (AND, OR, and NOT), use single-character and multiple-character wild cards, choose whether to ignore suffixes or uppercase and lowercase status, and use phrases as categories.

The Dating Game

Most people keep notebooks for personal scheduling purposes, and Lotus built some interesting date-tracking capabilities into Agenda. The program has three date categories: Entry, When, and Done. The Entry date is the date on the system clock for when you enter in the item; When is the date on which you expect an item to be finished; and Done is the date on which you actually designate an item, such as an appointment, to be finished. Entry and Done are logged in automatically. You must enter the proper date for When. You can enter the date by typing it in month/day/year format, or you can simply type "two weeks from today" or "next Tuesday." Agenda then enters the proper date for you.

You may not even have to enter a date for a new item if a date or reference is included in the item text. For example, if the item is "Call Jack this Friday," Agenda puts the correct date in the When column for you. Had the item said "every Friday," the date in the When column would change each week.

Agenda also understands "today," "tomorrow," "tonight," "fortnight," and more vague references like "end of the month," "two weeks from Friday," or "the third Tuesday."

Similar hints of artificial intelligence are shown in other functions within the program. For example, whenever you name a column heading or sort field, Agenda checks what you are typing and beeps as soon as you have entered enough characters to make a unique match with an existing category. Then the only thing you have to do is press Enter to select that category.

Whenever you have to enter an option in a dialog box (i.e., choose between Enter, When, and Done for specifying the type of date category you're creat-

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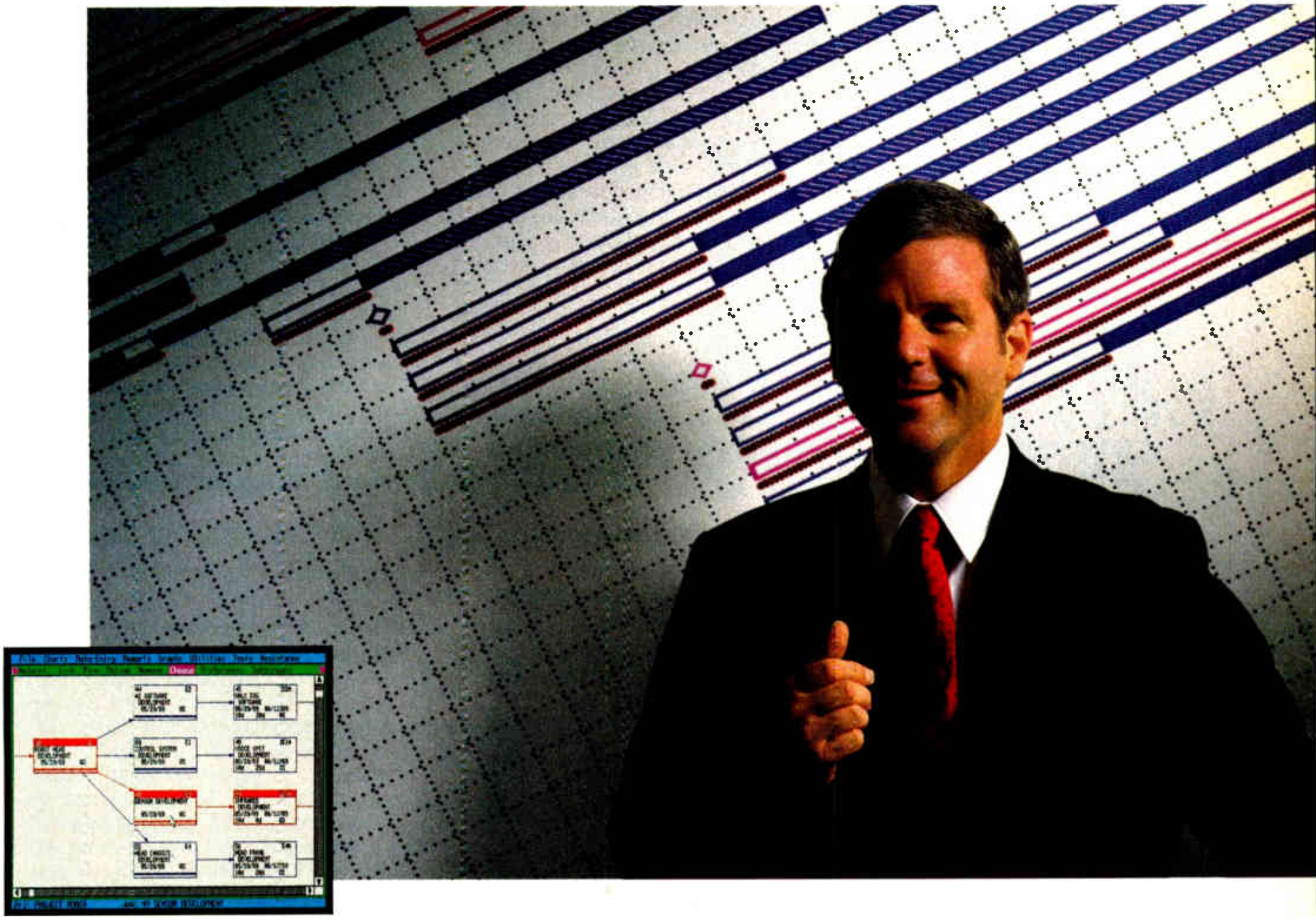

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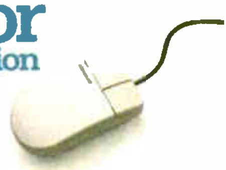

ing), you can press the space bar to display the options one at a time. Alternately, you can call up the list of possibilities in a pop-up window by pressing the Plus key on the numeric keypad. You then scroll through the list and highlight the option you want.

The function keys all have special functions that vary depending on what you are doing. Function-key descriptions are displayed along the bottom of the screen. These keys have additional functions that you invoke in combination with the Alt key, and you can view these function-key descriptions by holding down the Alt key.

The F1 key brings up contextual help screens. From one help screen, you can usually toggle to related subjects or to a central help index.

The documentation includes a tutorial that walks you through the use of several sample files. Agenda also includes several sample applications using rather sophisticated databases and category definitions. These samples are fully documented in a separate booklet.

Import Quotas

Items in Agenda don't all have to be notes jotted to yourself. You can also import existing ASCII text files, although this involves a two-step process.

First, you create a structured file out of the ASCII file by running a standalone utility called TXT2STF. It attempts to turn every block of text between blank lines into items. If the block is more than 350 characters long, it turns the leftover text into a note attached to that item. Then you go into Agenda and use the Import command to bring in the file. Once the process is finished, the program will arrange the new items within any of the categories that you have set up.

For text that's in a standard format, you can set up definition files to guide TXT2STF. For example, text following the word "To:" could be defined as a category. Agenda comes with a preset definition file to deal with text from Lotus Express electronic mail files.

Agenda also comes with two pop-up terminate-and-stay-resident (TSR) utilities, called Items and Clipboard, which you can use to import information from other applications. Both are based on Lotus Metro, Lotus's TSR desktop-management program. Items is a pop-up text editor for jotting down up to 10 new Agenda items while running other programs. You invoke Items by pressing the Shift-Alt-I keys, and you can transfer information created in Items to a structured file for importing later as items or notes in your Agenda database. You can also set Agenda to automatically import structured files each time you run the program.

Clipboard allows you to grab the contents of a screen and transfer it to an item or note in Agenda. You invoke the program by pressing the Shift-Alt-D keys. Clipboard can save an entire screen, or you can specify lines or blocks of text and format them as items or notes. Later, when you run Agenda, you can move the cursor where you want the information, call up the Clipboard, and import the data.

Lasting Impression

As a note processor, Agenda works well. After I learned all the ins and outs of categories, items, filters, views, and so on, Agenda was fun to work with. There seemed no end to adding new categories

continued

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Circle 297 on Reader Service Card

and views until the data had been squeezed dry of every conceivable relation. I could add or modify categories to settle even the most trivial, transitory question. With all this potential and power at my fingertips, the important question was where to stop. Unlike the comforting straightjacket of conventional databases, Agenda lets you face the disquiet of unending choices.

The only hitch was that, after adding or modifying categories, I had to run the Execute function to resort the database. This took several seconds and detracted from the feeling of immediate response that the rest of Agenda gives you. But the Execute requirement steers you into a routine of adding categories, sorting, examining the results, modifying categories, and resorting—thus, narrowing in on what you want.

And while the categories could have complex definitions, I found that I would start with simple definitions and add modifiers and complexity until I saw what I wanted in terms of what the data offered. Complexity is not a requirement, but the potential is there when you're ready for it.

Word Problems

Where Agenda falls down is in its 350-character limitation for items. That's only about 60 words, or about three sentences. This is particularly bothersome when importing structured files. When creating a structured file, if you separate every paragraph with a blank line, every paragraph becomes an item. But practically speaking, data you want to import isn't always in this format. When importing items such as news stories, journal entries, and text notes, I kept running afoul of paragraphs that were longer than 350 characters.

The remaining text in each paragraph becomes a note. But Agenda doesn't use the contents of notes for sorting, and meaningful information can as easily be at the end of a paragraph as at the beginning. After downloading information and handing it to Agenda for categorizing, you have to go through the list of items to see which run on into notes. The only solutions are either to divide up the material into short blocks before submitting it to Agenda or to copy the contents of each overflow note into separate items.

A Lotus spokesperson said that most people in this situation write an item-size summary (or use the headline as an item) and attach the document to it as a note. The Lotus Express import definition file that comes with Agenda uses the subject line as an item, the message date as the entry date, the "to" and "from" fields as categories, and the body of the message as a note.

Nevertheless, Agenda isn't well suited for text analysis. You couldn't, for example, download news items from BIX and have Agenda automatically filter and categorize their contents. Agenda is more of a self-sorting notebook that's tuned to one- or two-sentence personal reminders.

An additional stumbling block is that Agenda lacks numeric-processing capabilities. To Agenda, numbers are simply alphanumeric characters that it sifts and sorts. It can categorize items on the basis of any numbers they contain, but it can't add up or compare those numbers. For example, when I imported my personal finances database, Agenda was able to break out every telephone bill I had paid during the year, but it couldn't add up those bills.

Deciding Factors

Most successful programs are analogous to existing business tools. Spreadsheet programs are based on spreadsheets, word processors on the typewriter, and the database on the filing cabinet, for example. With Agenda, the concepts aren't so intuitive, although the program is easy to use once you've climbed the learning curve.

The idea of creating a self-sorting notebook is interesting, but for many people the need to organize such random notes may not be compelling enough to justify using Agenda. And as a textual database, Agenda is limited by its 350-character-maximum item size.

If Agenda's item-size limitation were taken away, it could be a powerful text processor for automated research and data analysis. Combined with math functions, the program could offer all the database power that most people would ever need—and without all the irksome constraints of database programming.

Agenda will appeal to a select group of busy managerial types who are not only experienced in using computers but have reached the point where the PC has become central to their work. If you're in the habit of doing everything on a PC, Agenda may prove seductively attractive. Otherwise, you'll probably shrug and move on. ■

Lamont Wood is a freelance writer in the computer and electronics fields and lives in San Antonio, Texas. He can be reached on BIX as "lwood."

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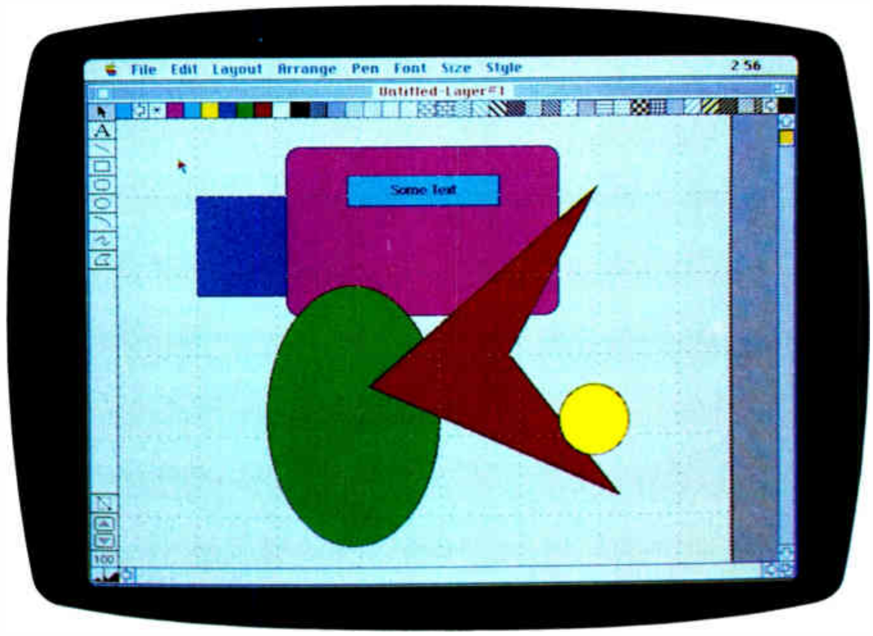

Can you teach an old drawing program new tricks?

Rusel DeMaria

MacDraw II from Claris may not set all the new standards for drawing programs, but it is a well-designed graphics tool that is much better than its predecessor. This product is entirely rewritten, and it has an exceptional user interface, a greatly improved redraw, and some very nice new features. With multiple layers, user-definable fill patterns, zooms from 3.12 percent to 3200 percent, preset views, libraries, and much more, MacDraw II is easy to use and versatile.

MacDraw II ($395) runs on a minimum configuration of a Mac 512KE. The package includes a program disk, a tutorial disk, a user's guide, and a quick reference card.

At First Sight

When you first work with MacDraw II, you can learn from a tutorial program written with VideoWorks II or follow a more detailed tutorial in the MacDraw II manual. From there, you can move to the reference section of the manual or use the handy quick reference card. The hands-on tutorial in the manual uses a pair of sample house plans to illustrate many of the drawing techniques. In particular, Floor Plan #2 includes four layers and almost 600 objects.

As good as these practice drawings are, they immediately point out one possible flaw in the program. These documents use a lot of memory when opened on a large-screen color monitor set for 256 colors. My Mac II has 5 megabytes of RAM and a 16-inch SuperMac monitor. Even with that much RAM, I was unable to open these drawings until I lowered the resolution to 16 colors—despite the fact that neither sample document uses color at all. In some cases, for instance when importing a PICT file, I was forced to change my configuration to monochrome, something of a crime when you become used to full color. MacDraw II does not support color PICT2 files but will import them in monochrome—not always with meaningful results, however, since the definition of color details in a darker-colored PICT2 file may be lost when converted to black and white.

Claris explains that MacDraw II keeps more drawing information in memory to speed up the screen redraw, and with color on, the program is ready to use color whether the drawing currently contains it or not. The company also pointed out that I was using a large-screen monitor and MultiFinder, both of which use up RAM. The company suggested that I go into MultiFinder and reallocate as much RAM as possible for MacDraw II, or that I should just run with the Finder. After following their advice, I had no trouble loading the practice drawings.

Familiar Interface

The MacDraw II interface features a host of menus, keyboard shortcuts and techniques, and the inevitable tools palette

continued

MacDraw II version 1.0

Type
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Mountain View, CA 94043
(415) 960-1500

Format
Two 800K-byte program and tutorial disks

Language
MPW Pascal

Hardware Needed
Mac 512KE, Plus, SE, or II; supports Imagewriters, LaserWriters, various plotters, and other devices

Documentation
Basic user's guide with tutorial, guided tour on disk, quick reference card

Price
$395 (upgrade for previous MacDraw owners is available at a reduced price)

Inquiry 901.

that has become a standard in Mac programs. One notable feature of MacDraw II's tool palette: Single-clicking on a tool makes it available for one use (to draw one line or circle, for instance), but double-clicking on it leaves it active until you select another tool. The basic tools include selection, text, line, rectangle, oval, rounded rectangle, arc tool, freehand drawing, and polygon tool.

One tool lets you toggle between creating, resizing, and moving objects from their center points, or from the edge when you point to and click on them once. When you double-click on this tool, you open a dialog box of preferences that lets you choose between selecting objects across layers (or in the current layer only), automatically closing polygons during creation (or closing it manually), and setting mouse constraints on object manipulation.

Arrow icons let you move up and down layers, and the appropriate icon is grayed out if no layers exist above or below the current one. Below the layer tools are the zoom icons that let you zoom in or out while displaying the current zoom level in a small box. A single click on the box returns the image to full size. MacDraw II provides exceptional accuracy when you work with zooming, and, at high magnification, it lets you edit objects with an accuracy of 2000 dots per inch.

Zoom keeps any selected object on-screen, so you can zoom on any portion of a drawing. Since MacDraw II drawings can be quite large, this is a very useful way to examine specific portions of a drawing. In fact, drawings can be up to 69 square feet in size at the largest scale. Fortunately, MacDraw II features an auto-scrolling feature and a map screen that lets you manipulate objects on drawings larger than a single screen.

The pattern palette stretches across the top of the screen. The current fill pattern is displayed on one side and the current line pattern on the other. You can choose a new pattern by clicking on the one desired. MacDraw II can support up to 16,000 patterns, and you can customize patterns at will, both in black and white and in color. Even if you don't have a color monitor, you can define color patterns and print them to a color device.

Many other aspects of the program can be customized, and these features form the basis of the product's strength. For instance, you can customize dashed line patterns, font sizes, pen sizes, line spacing, and rulers. You can measure lines in inches, centimeters, or points, and they can be as small as 0.001 points. What is especially gratifying is that you can define pen sizes, fonts (with special effects), font sizes, and even special views of a drawing and include them on the menus. You can define each of six preset rulers in inches, centimeters, feet, and miles or kilometers with scaling and divisions per unit. For instance, you could define a ruler that measured 10 miles to the inch, with 10 divisions per inch (each representing 1 mile).

CAD Features

MacDraw II has what I would call a very good set of basic features, including some that might normally be found in CAD programs. You can rotate objects or text within 0.1 degree, or you can constrain the rotation to 30, 45, or 90 degrees (or a custom setting of your choosing). You can draw lines with arrows at one or both ends (even the arrowheads are customizable) or auto-sized (showing the dimensions within the line according to the current scale as defined on the ruler). When you draw an auto-sized line, you can also stretch, rotate, or squeeze the line, and the size label varies to reflect the changes.

Another feature shows the position of the cursor in terms of distance from the zero point of the ruler (which you can reset easily by clicking anywhere on a ruler). Clicking on an object shows you its dimensions, which allows you precise control when you resize it, and moving the object automatically shows you the amount of shift from the starting point. Lines display with a starting point, an ending point, and angle information, so you can rotate them precisely.

Smoother User

Freehand drawings and polygons may be smoothed to eliminate sharp or jagged edges or corners. Specific angles may be locked, however, to prevent smoothing. Smoothing can dramatically change an object, and even if you lack artistic skills, you can produce pleasing shapes. If the original shape is not satisfactory, MacDraw II lets you reshape objects; you can even add new handles anywhere on the shape. Smoothed objects must be unsmoothed to be reshaped, but that is about the only restriction.

You can also control objects in several ways. You can group or ungroup objects, even across layers, lock objects to prevent modifications, or toggle an autogrid feature that automatically aligns objects to grid points. There are several options that let you align objects with reference to the grid. You can also distribute objects with reference to each other, either vertically—arranged by tops, centers, or bottoms, or by width—or horizontally—arranged by tops, centers, or bottoms, or by height. These alignment and distribution features help make neat, regular drawings.

You can also duplicate objects, flip them horizontally or vertically, and rotate them with precision. Objects naturally stack on each other, and you can move a selected object forward or backward in the stack, or to the front or back.

One of the most exciting features of MacDraw II is its effective use of layers—up to 500 of them in a single drawing. Many programs allow multiple layers in drawings, but few do it as smoothly and intuitively as MacDraw II. Each layer is automatically numbered, but you can give any layer a name, such as wiring, plumbing, or landscape. The current layer is displayed in the title bar of the window; so you always know where you are. You can specifically hide any layer if you don't want to view it, but ordinarily, you see all layers below the current one. You can rearrange layers to different positions in the stack, so you aren't locked into any one arrangement.

Ordinarily, you only create and edit objects on the current drawing layer, but you can set the program to let you work

continued

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on multiple layers at once. This leads to exceptional control over a drawing since you can treat all layers as a single unit or separate them as necessary. Since layers are so easily defined, selected, and moved, anyone should be able to benefit from these features, not just advanced graphic artists.

Image Libraries

MacDraw II also features some fine document-level controls. You can save a drawing as stationery, meaning that you can use it as a template for later drawings. Along the same lines, MacDraw II features a document-oriented library feature that lets you select any object and save it as a library item. You can even select several objects (or even all objects) in a drawing and then save them one after the other as library objects. Each library object has a name, and it is displayed in a dialog box with its picture and percentage of reduction. You can even paste in library objects with automatic scaling (i.e., an object created originally in one scale can be resized automatically to fit in another drawing with a different scale). This principle even applies with ordinary cut-and-paste from the Clipboard. For instance, suppose you rescale an existing drawing. The existing objects will not change in scale, but if you cut or copy them, then paste them back using Command-Shift-V, they will paste back to the document rescaled.

You can set the program to work on multiple layers at once.

Although each library is specific to a document, you can use any document's library as a source for images, so there is nothing to prevent you from sharing libraries. In fact, some documents might be designated as source libraries, and you open them whenever you require particular graphics elements.

MacDraw II has a few nice text features. You can easily create labels or multiple-line, word-wrapped text objects. In addition, you can cut, copy, and paste text to and from text objects. One example showed a newsletter created with MacDraw II. The text areas were predefined, and the text for each section was pasted in from a word processor. Pasted text automatically wraps to the text-object borders. Change the size or shape of the text object, and the text wraps to the new borders. You can even select specific sections of text and change fonts, sizes, line spacing, and color. In short, MacDraw II offers good text-control features that go beyond the capabilities of most drawing programs.

Although MacDraw II is not a PostScript-based program and won't save PostScript files, it does print to PostScript or QuickDraw printers and produces smooth and accurate results. In larger documents, you can choose the order of pages to print; with color documents, you can even print color separation layers automatically with industry-standard registration marks.

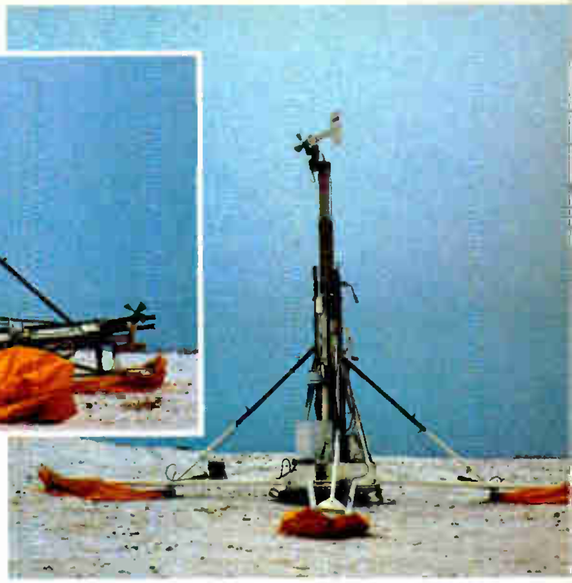
The Final Draw

My only major complaint about the product is its use of memory with color systems. There seems to be plenty of room if you set your system to monochrome (two-color) mode or allocate all RAM to MacDraw II, but memory quickly evaporates in color modes. In fact, people using Macs with 1 megabyte or less and with large system files, INITs, or other RAM eaters may not be able to load documents of any reasonable size.

MacDraw II is a basic drawing program; it doesn't have heavy-duty CAD or exotic drawing features. If you are looking for more CAD features, you might do well to look at Claris CAD. It is a superset of MacDraw II with more CAD-like features. And if you have a need for special drawing effects, such as shadowing, fountain shading, curved text, automatic stenciling, and the like, you might look at Illustrator 88, FreeHand, or Cricket Draw. Still others might prefer some combination of paint and draw programs and should look at SuperPaint, Pixel Paint, or even MacPaint to work in conjunction with MacDraw II.

I found MacDraw II to be easy to learn and use, versatile enough for many drawing tasks, and a fine program overall. It does not have many "Gee Whiz" features, but its list of basic features and its human engineering are all to its credit. If you are already a MacDraw user, you can still use your existing drawings, and, of course, MacDraw II is compatible with other Claris products. ■

Rusel DeMaria is a freelance writer living in Kula, Hawaii. He can be reached on BIX as "demaria."

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Compiled by Steve Apiki and Stanford Diehl

BYTE BENCHMARK INDEXES

Machines tested with a coprocessor (descending order, fastest overall machines first)

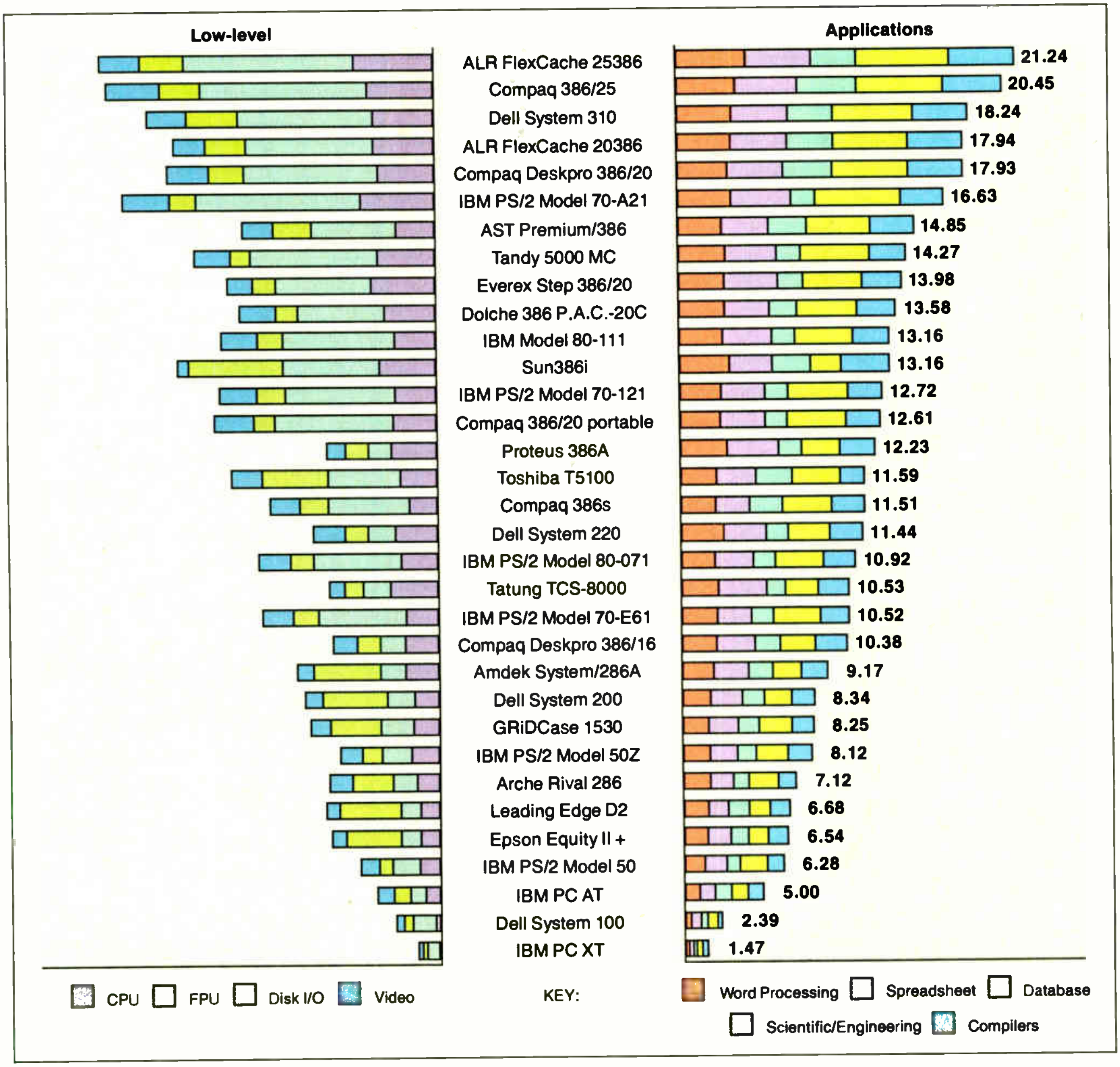
Computer	Month reviewed	FPU type	Low-level				Applications					Cum. appl. indx.
			CPU	FPU	Disk	Video	WP	SS	DB	Sci./Eng.	Cmplr.	
ALR FlexCache 25386	Nov. 88	80387	5.07	10.55	2.74	2.57	4.41	4.13	2.83	5.80	4.08	21.24
Compaq 386/25	Aug. 88*	80387	4.22	10.37	2.55	3.38	3.72	3.94	3.71	5.38	3.69	20.45
Dell System 310 (386/20)	Oct. 88	80387	3.91	8.38	3.21	2.45	3.45	3.56	2.84	4.98	3.41	18.24
ALR FlexCache 20386	Jun. 88	80387	3.92	7.93	2.50	2.01	3.44	3.51	2.88	4.66	3.44	17.94
Compaq Deskpro 386/20	Feb. 88	80387	3.61	8.34	2.23	2.54	3.20	3.51	3.09	4.67	3.45	17.93
IBM PS/2 Model 70-A21 (386/25)	Sep. 88*	80387	4.71	10.23	1.64	2.96	3.42	3.75	1.52	5.33	2.62	16.63
AST Premium/386 (386/20)	Sep. 88	80387	2.51	5.26	2.41	1.90	2.80	2.90	2.42	3.98	2.74	14.85
Tandy 5000 MC (386/20)	Sep. 88*	80387	3.71	7.91	1.25	2.26	2.97	3.23	1.50	4.35	2.23	14.27
Everex Step 386/20	Aug. 88	80287	4.11	5.96	1.41	1.59	2.94	3.37	1.55	3.67	2.46	13.98
Dolche 386 P.A.C.-20C (386/20)	Jan. 89	80387	3.30	5.35	1.41	2.23	2.96	2.78	1.68	3.79	2.37	13.58
IBM Model 80-111 (386/20)		80387	2.68	6.97	1.53	2.31	2.81	3.07	1.45	3.63	2.21	13.16
Sun386i (386/25)	Dec. 88	80387	3.61	6.02	5.87	0.70	3.24	2.66	2.36	1.94	2.96	13.16
IBM PS/2 Model 70-121 (386/20)	Jan. 89	80387	2.66	6.84	1.74	2.34	2.63	2.74	1.46	3.75	2.15	12.72
Compaq 386/20 portable	Nov. 87	80387	2.81	7.37	1.30	2.47	2.59	2.83	1.35	3.69	2.14	12.61
Proteus 386A (386/20)	Aug. 88	80287	2.94	1.42	1.44	1.18	3.02	3.20	1.45	2.34	2.22	12.23
Toshiba T5100 (386/16)	Sep. 88	80387	2.39	4.53	4.06	1.90	2.32	2.47	2.23	3.05	1.51	11.59
Compaq 386s (386SX/16)	Nov. 88	80387SX	1.86	5.03	1.78	1.87	2.24	2.15	2.06	3.01	2.05	11.51
Dell System 220 (286/20)	Dec. 88	80287	2.72	1.73	1.40	2.02	2.71	2.68	1.39	2.55	2.11	11.44
IBM PS/2 Model 80-071 (386/16)	Nov. 87	80387	2.36	5.49	1.46	1.97	2.18	2.39	1.40	3.01	1.93	10.92
Tatung TCS-8000 (386/20)	Aug. 88	80287	3.04	1.74	1.18	0.94	2.41	2.98	1.13	2.09	1.92	10.53
IBM PS/2 Model 70-E61 (386/16)	Jan. 89	80387	2.11	5.50	1.55	1.93	2.28	2.18	1.35	2.94	1.78	10.52
Compaq Deskpro 386/16	Nov. 86	80287	2.20	1.52	1.45	1.49	2.26	2.40	1.52	2.25	1.96	10.38
Amdek System/286A (286/12.5)	Jul. 88	80287	2.19	1.56	4.16	1.01	2.02	2.21	1.53	1.72	1.70	9.17
Dell System 200 (286/12.5)	Jul. 88	80287	1.60	1.72	4.05	1.09	1.83	2.01	1.31	1.74	1.46	8.34
GRiDCase 1530 (386/12.5)	Sep. 88	80387	1.68	2.09	3.12	1.25	1.67	1.91	1.29	2.03	1.36	8.25
IBM PS/2 Model 50Z (286/10)	Jan. 89	80287	1.85	1.80	1.24	1.42	1.76	1.72	1.17	2.00	1.47	8.12
Arche Rival 286 (286/12)	Jul. 88	80287	1.51	1.50	2.50	1.49	1.75	1.43	0.96	1.84	1.14	7.12
Leading Edge D2 (286/10)	Jul. 88	80287	1.27	1.25	3.86	0.79	1.63	1.24	1.32	1.28	1.21	6.68
Epson Equity II+ (286/12)	Jul. 88	80287	1.28	1.21	3.43	0.92	1.54	1.47	1.07	1.22	1.24	6.54
IBM PS/2 Model 50 (286/10)	Jul. 87	80287	1.34	1.70	0.82	1.16	1.38	1.33	0.85	1.69	1.04	6.28
IBM PC AT (286/8)		80287	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	5.00
Dell System 100 (8086/9.54)		8087-2	0.40	1.42	0.59	0.42	0.48	0.59	0.44	0.59	0.29	2.39
IBM PC XT (8086/4.7)		8087	0.22	0.71	0.32	0.25	0.33	0.28	0.22	0.35	0.29	1.47

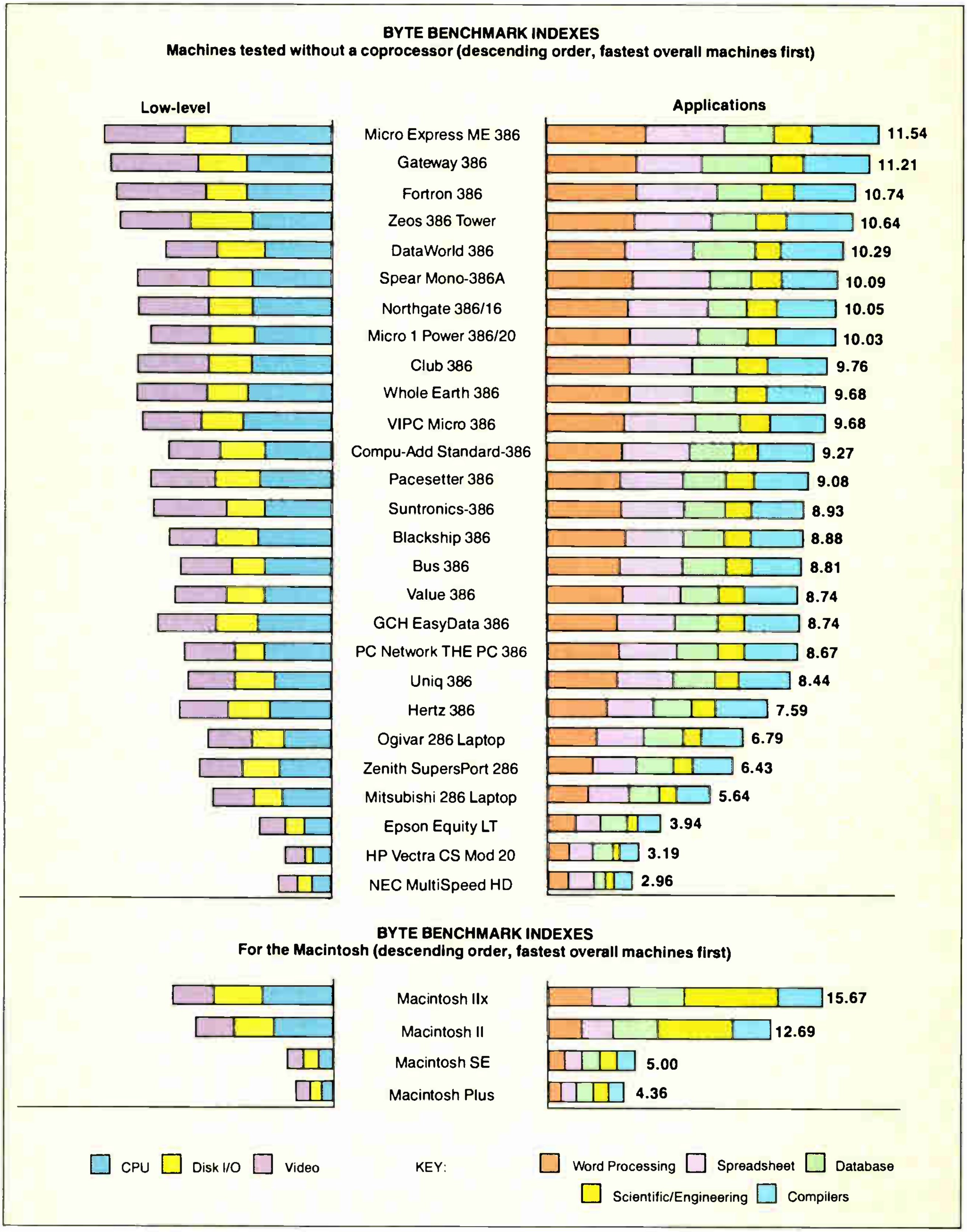
* First Impression—not a full review.

Our new benchmarks debuted in June this year, and since then, we've put dozens of new machines through their paces. Because our benchmarks are the most detailed available, we have reams of data to help you differentiate among even extremely similar machines. But the down side to having this much data is obvious: Over a period of months, it can be difficult to remember just where each machine fits into the grand scheme.

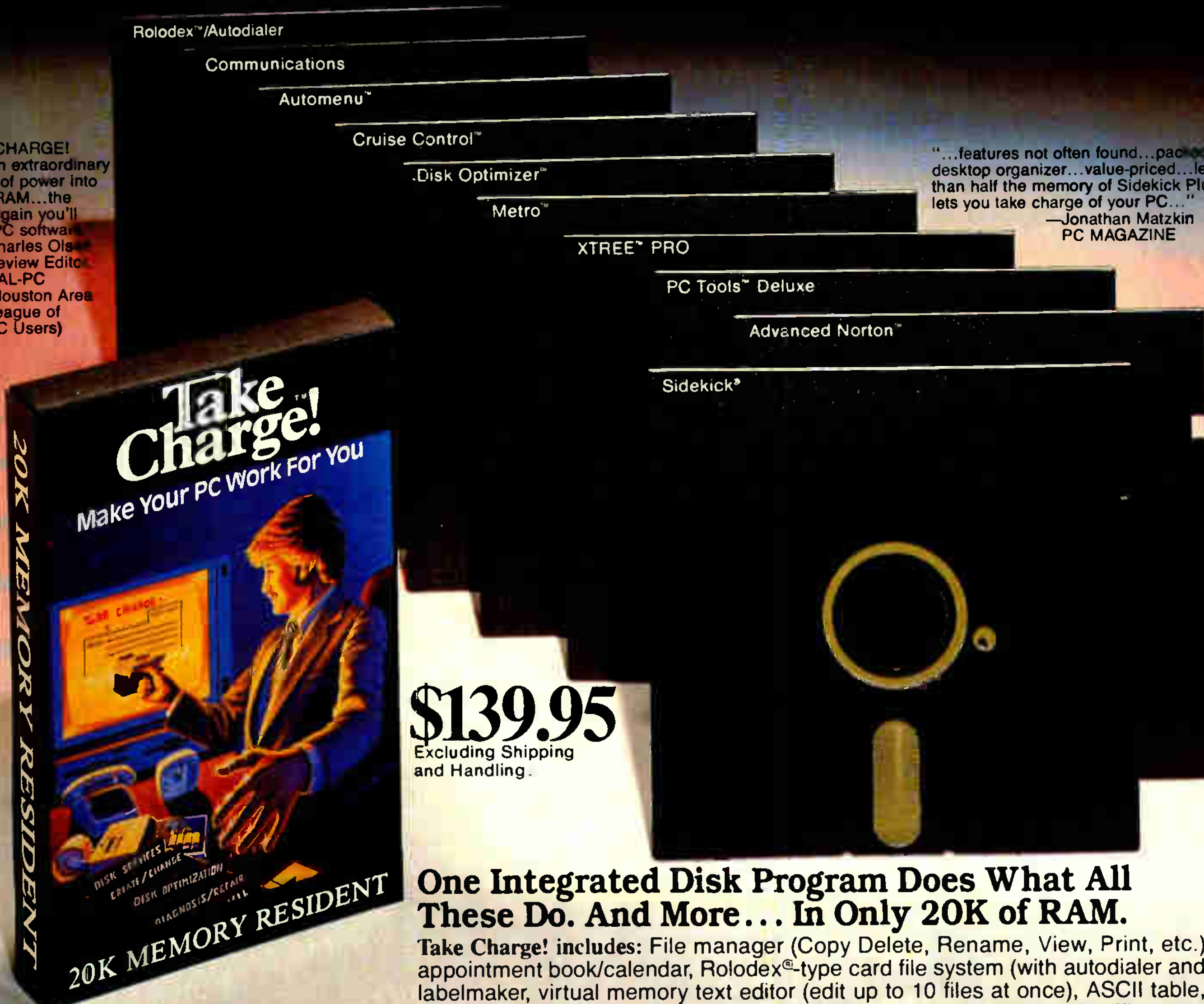
That's why we've collected 6 months' worth of system benchmarks into the graphs and charts on these pages. At a glance, you'll be able to see where each machine falls in terms of its overall performance (the cumulative applications index) and for each of nine separate measures of application-specific and subsystem performance. Whether you need first-approximation information or highly detailed data on a machine's subsys-

continued




BYTE BENCHMARK INDEXES
Machines tested without a coprocessor (descending order, fastest overall machines first)
Low-level
Applications
Micro Express ME 386 11.54
Gateway 386 11.21
Fortron 386 10.74
Zeos 386 Tower 10.64
DataWorld 386 10.29
Spear Mono-386A 10.09
Northgate 386/16 10.05
Micro 1 Power 386/20 10.03
Club 386 9.76
Whole Earth 386 9.68
VIPC Micro 386 9.68
Compu-Add Standard-386 9.27
Pacesetter 386 9.08
Suntronics-386 8.93
Blackship 386 8.88
Bus 386 8.81
Value 386 8.74
GCH EasyData 386 8.74
PC Network THE PC 386 8.67
Uniq 386 8.44
Hertz 386 7.59
Ogivar 286 Laptop 6.79
Zenith SupersPort 286 6.43
Mitsubishi 286 Laptop 5.64
Epson Equity LT 3.94
HP Vectra CS Mod 20 3.19
NEC MultiSpeed HD 2.96
BYTE BENCHMARK INDEXES
For the Macintosh (descending order, fastest overall machines first)
Macintosh IIx 15.67
Macintosh II 12.69
Macintosh SE 5.00
Macintosh Plus 4.36
CPU
Disk I/O
Video
KEY:
Word Processing
Spreadsheet
Database
Scientific/Engineering
Compilers

Memory is a terrible thing to waste



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tems, it's all here.

Of course, speed isn't everything. So we've also included a column that tells you in what issue each machine was initially reviewed. Those reviews will give the additional information you need to make a truly informed decision about any of these computers.

The machines are placed in two main groups: those tested with a math coprocessor and those tested without. Within each group, the machines are listed in order of decreasing speed. The benchmarks listed here incorporate all changes and revisions made since June.

We've also included a separate table of Mac benchmarks, including preliminary benchmarks on the new Mac IIx. ■

BYTE BENCHMARK INDEXES
Machines tested without a coprocessor (descending order, fastest overall machines first)

Computer	Month reviewed	Low-level CPU	Low-level Disk	Low-level Video	Applications WP	Applications SS	Applications DB	Applications Sci./Eng.	Applications Cmplr.	Cum. appl. indx.
Micro Express ME 386 (386/20)	Oct. 88	3.30	1.47	2.58	3.46	2.73	1.73	1.31	2.32	11.54
Gateway 386 (386/20)	Oct. 88	2.77	1.55	2.80	3.16	2.25	2.39	1.14	2.27	11.21
Fortron 386 (386/20)	Oct. 88	2.77	1.33	2.84	3.15	2.78	1.54	1.12	2.15	10.74
Zeos 386 Tower (386/16)	Oct. 88	2.61	1.97	2.25	3.08	2.67	1.54	1.05	2.30	10.64
DataWorld 386 (386/16)	Oct. 88	2.20	1.52	1.64	2.76	2.34	2.15	0.90	2.14	10.29
Spear Mono-386A (386/16)	Oct. 88	2.61	1.38	2.28	3.01	2.66	1.45	1.05	1.92	10.09
Northgate 386/16	Nov. 88	2.61	1.38	2.27	2.86	2.75	1.34	1.06	2.04	10.05
Micro 1 Power 386/20	Oct. 88	2.54	1.44	1.86	2.90	2.39	1.69	0.98	2.07	10.03
Club 386 (386/16)	Oct. 88	2.62	1.39	2.28	2.91	2.17	1.56	1.05	2.06	9.76
Whole Earth 386 (386/16)	Oct. 88	2.75	1.30	2.25	2.92	2.16	1.50	1.05	2.05	9.68
VIPC Micro 386 (386/20)	Oct. 88	2.91	1.33	1.90	2.72	2.46	1.54	1.07	1.90	9.68
Compu-Add Standard-386 (386/16)	Oct. 88	2.20	1.43	1.66	2.64	2.34	1.50	0.88	1.91	9.27
Pacesetter 386 (386/20)	Oct. 88	2.36	1.43	2.06	2.60	2.15	1.48	0.97	1.88	9.08
Suntronics-386 (386/16)	Oct. 88	2.20	1.23	2.33	2.62	2.15	1.44	0.90	1.83	8.93
Blackship 386 (386/16)	Oct. 88	2.43	1.33	1.48	2.74	2.01	1.43	0.89	1.81	8.88
Bus 386 (386/16)	Oct. 88	2.20	1.04	1.63	2.57	2.14	1.51	0.89	1.70	8.81
Value 386 (386/16)	Oct. 88	2.20	1.22	1.65	2.66	2.00	1.32	0.87	1.84	8.74
GCH EasyData 386 (386/16)	Oct. 88	2.42	1.34	1.84	2.45	2.00	1.50	0.90	1.90	8.74
PC Network THE PC 386 (386/16)	Oct. 88	2.20	0.93	1.63	2.54	1.97	1.43	0.91	1.83	8.67
Uniq 386 (386/16)	Oct. 88	1.87	1.26	1.50	2.47	1.91	1.45	0.82	1.78	8.44
Hertz 386 (386/16)	Oct. 88	2.03	1.32	1.57	2.09	1.61	1.32	0.82	1.79	7.59
Ogivar 286 Laptop (286/12.5)	Feb. 89	1.70	1.19	1.38	1.75	1.63	1.34	0.62	1.45	6.79
Zenith SupersPort 286 (286/12)	Feb. 89	1.55	1.06	1.38	1.59	1.53	1.28	0.64	1.40	6.43
Mitsubishi 286 Laptop (286/12)	Feb. 89	1.62	0.92	1.29	1.45	1.41	1.05	0.59	1.13	5.64
Epson Equity LT (NEC V30/10)	Oct. 88	0.93	0.61	0.82	1.01	0.86	0.92	0.34	0.81	3.94
HP Vectra CS Mod 20 (V30/7.16)	Jun. 88	0.64	0.26	0.62	0.77	0.84	0.68	0.25	0.65	3.19
NEC MultiSpeed HD (V30/9.54)	Jun. 88	0.68	0.47	0.59	0.74	0.89	0.41	0.27	0.64	2.96

BYTE BENCHMARK INDEXES
For the Macintosh (descending order, fastest overall machines first)

Computer	Low-level CPU	Low-level Disk	Low-level Video	Applications WP	Applications SS	Applications DB	Applications Sci./Eng.	Applications Cmplr.	Cum. appl. indx.
Macintosh IIx	4.57	3.02	2.59	2.60	2.06	3.15	5.32	2.53	15.67
Macintosh II	3.81	2.56	2.35	2.00	1.75	2.53	4.24	2.16	12.69
Macintosh SE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	5.00
Macintosh Plus	.81	.75	.91	.80	.88	.93	.91	.84	4.36

Winter 1988

BYTE

Bonus All-Mac Issue

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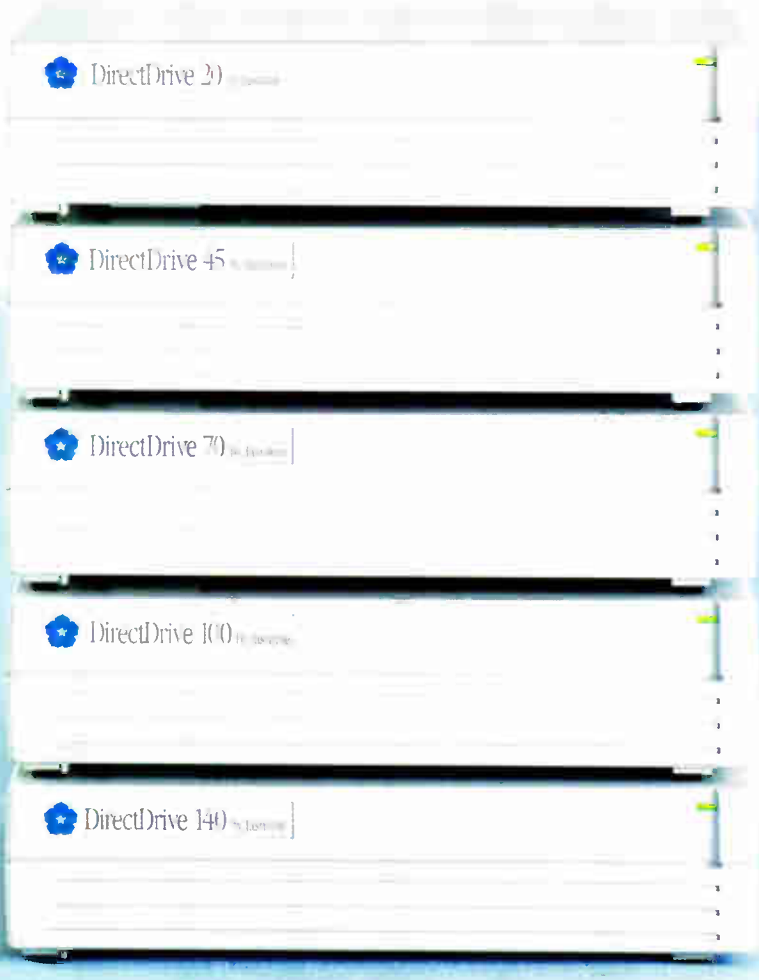

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BYTE

Macintosh Special Edition

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A Great Race

. . . in which users prove to be the big winners

Sometimes things seem to work out better when there's a little competition. It brings out the best in almost everybody. Take, for example, the two main contenders in the microcomputer race, the Macintosh and the IBM crowds.

To be sure, some strong feelings are found on both sides. Still, both have incorporated some of the other's successes into their own arsenals, benefiting users. In fact, you and I have had a hand in shaping the computing environments in which we work.

Let's Go Racing

This microcomputer business is a little weird; it's hard to come up with a metaphor that accurately represents it. In an automobile race, for example, you have backers, owners, designers, mechanics, drivers, and others, all of whom work together. All things being nearly equal, there are lots of little self-contained organizations or teams.

If a team's mechanic improves on a fuel-metering system or builds an innovative suspension system, that team might have to show it to the sanctioning body, but not to its competitors. The members of that team might win more races, claim more prize money, and chuckle to themselves, but, generally, their secrets are protected.

When a company innovates in just about any area of microcomputer technology, it might surge ahead in the race. Yet, eventually, it gives its competitors, in the form of production units, the details of its hard work.

Legalities notwithstanding, a company's secrets are available for all to digest and mimic. Most important of all, you and I can scrutinize all the entries, and if we, the "spectators," are not satisfied, we send the deficient teams back to their drawing boards. We hold a lot of power in our fingertips.

All this competition and innovation provides a great benefit, though: We spectators get to enjoy a really great race. The race cars are competitive, and we can pick a favorite based on what brand, model, or other subtlety we like. Why, sometimes we can even influence the features of the racecourse: If we are willing to pay for a certain feature, just about every competitor will add a special interpretation of it next year.

The Green Flag

In the early days of microcomputing, when the Apple II began to succeed, it founded an entirely new class in the great computing races. The prize money looked attractive to old pro IBM, and it wanted to compete. Thus, it unveiled the IBM PC, complete with expansion slots, something that Apple had shown to be attractive to spectators. Two favorites emerged, sleek versus boxy, and, followed by other contenders in all shapes and horsepowers, the race was on.

When Apple introduced the monocoque Macintosh, the race began to take on a whole new look. Though flawed with small memory, a single disk drive, *no* expansion slots, and more appearances of the system Bomb than was appreciated, the Mac's icon-based aerodynamics and Motorola power pushed the competition up a notch or two.

A Design Hiccup?

IBM's new Micro Channel Architecture (MCA) induction system was supposed to bring the next leap in performance. But racing teams and fans seemed a bit disenchanted. A new fuel (OS/2) was very expensive (memory) and difficult to obtain in a complete blend (the missing add-on Managers). Some performance was to be gained in an endurance race, but a large season-pass investment was required of the spectators.

This new design, similar but not quite equal in magnitude to the Macintosh's, has not become the darling of the racing set. In fact, some mutual competitors, after test-driving the MCA machines, decided to form their own racing consortium. They are using the proven AT-bus design and will try to take on IBM and Apple using the large numbers inherent in spectator power.

Meanwhile, Apple pulled the tarp off a boxy entry called the Macintosh II, complete with expansion slots. And while it retains the spirit behind the technology of the original Mac, physically it looks like an IBM design. Then, unexplainably, partway through the season, Apple decided it has a winner and raised the admission prices. Well, as I said, it's tough to find a really accurate metaphor.

You might argue that all this copying and trying to please all the spectators breeds a dull homogeneity. But as long as there are enough devotees to support a concept, that concept can live. The hardware and software that we see are reflections not only of the inventors but also of the environment in which they exist.

Where will the race end? We hope it never does.

What's under the Hood

The foregoing brings us to this, BYTE's second Macintosh Special Edition for 1988. You knowledgeable and skillful spectators asked for a bigger Macintosh venue, and we have responded. In 1989, four more Macintosh Special Editions are scheduled to appear, in March, June, August, and December.

As the Mac continues to evolve, BYTE will continue to provide you with practical information and theory that will help you build and maintain a personal competitive edge. See you at the races!

—Gene Smarte
Special Projects Editor
(BIX name "gsmarte")

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Modeling Made Easier

Don Crabb

Simulation modeling meets object-oriented programming

Writing simulations usually isn't considered trivial, but when you possess the proper environment and tools, you can do some pretty impressive work. In this article I would like to introduce you to a commercial software product that marries simulation modeling and object-oriented programming (OOP). Together, they make a very productive combination on the Mac. However, before I can talk about the software and how it works, we need to look at OOP in general.

Although much has been written about it in the last two years (see August 1986 BYTE), OOP can be reduced to a couple of fundamental notions. First of all, OOP looks at programming problems differently than more traditional methods. Programmers using non-OOP procedural languages such as FORTRAN or Pascal might think about creating a program as a series of black boxes, each of which solves one part of the problem at hand. In this case, they would construct a new program by first breaking the problem down into its constituent parts (the divide-and-conquer strategy), writing program segments to solve each part of the problem, and then assembling the program parts in the proper order. Blocks, structure, order of execution, and timing are critical to this kind of programming orientation.

Doing It the OOP Way

Programmers using OOP languages or tools don't need to decompose a problem in this manner, nor do they need to reassemble it in a structured way. Their concern is not with composing algorithms or specifying precise data types. Instead, OOP programmers concentrate on the objects that need to be manipulated and how they can be manipulated. OOP programming considers data and algorithms to be inseparable because they join to form the objects. OOP languages are not procedural; they are declarative. OOP emphasizes definitions.

Objects, then, form the basis for any OOP language or development environment. The agents that act upon objects are called methods (they correspond to functions or procedures in a procedural language). Objects communicate among themselves using messages, which are kind of like function or subroutine calls. All the actions that take place in an OOP system result from objects sending messages to other objects. OOP systems also support sophisticated object classification methods, called object classes, so you can assign like properties to a group of objects (individual objects in a class are called instances).

Inheritance is perhaps the most powerful construct found in OOP languages and systems. It allows instances of the same class to inherit properties or behaviors from all those classes that precede it in your overall object classification scheme. Inheritance saves you from a lot of repetitive coding, helps simplify overall application design, speeds up compilation, and allows you to concentrate on creating your application rather than concentrating on the development environment.

Now that you know a bit about what makes up an OOP language and environment, consider what happens when you combine "OOPness" with another interesting programming class, simulations. Computer simulations attempt to imitate naturally occurring processes in as much detail as possible without requiring a real-world interface. The simulation occurs strictly in the memory of the computer and in the display on the screen. Naturally, simulations can be difficult to create and program, although mainframe simulation tools have been around for a while.

Simulation on the Mac

Simulation software for the Mac has just gotten off the ground. A program called Stella was an early pioneer, and it has been updated several times since its re-

continued

ILLUSTRATION: KEVIN HAWKES © 1988

lease. The program that best typifies the happy marriage of OOP and simulation programming, however, is called Extend. Created by Bob Diamond and published by Imagine That! (I love that name!), Extend uses block diagram models to represent the essence of a simulation and to display the behavior of a complex simulation system. But it is Extend's ability to build libraries of diagram blocks, each with custom icons, dialog boxes, on-line help, and separate behaviors, that gives you some OOP power, because blocks can be manipulated in ways similar to OOP objects.

Extend's power comes from its modeling capability.

Extend includes its own modeling language, called ModL.

Extend reminds me in many ways of HyperCard. Not that it's stack-oriented, because it's not. Not because HyperTalk looks like ModL, because it doesn't. Not because they both cost $49.95; Extend costs $495. No, Extend reminds me of HyperCard for three other reasons. First, Extend works with what can be called an object-like orientation—not the true object orientation I described above, but more like the partial OOP features found in HyperCard. Second, Extend permits nonspecialists to create computer simulations in the same way that HyperCard permits nonspecialists to create their own stacks. And third, Extend's ModL language, like HyperTalk, provides for message handlers (on handlers).

As with any simulation system, Extend's power comes from its modeling capabilities. Unlike some mainframe simulation systems I've played with, Extend provides an integrated environment for the development of simulations. It includes a graphics window in which you can run existing simulations from their block diagrams (Extend includes useful samples), build new simulations from libraries of existing blocks, or create new block diagrams entirely and incorporate them into new simulations. Extend also

continued

Listing 1: *A sample simulation script from Extend. This one is called EarthQuake. Notice the similarity to the C language.*

```
constant Pspeed is 3.6;      ** miles/second
constant ratio is 0.3;  ** ratio of S to P wave speed
integer  numP, num2P, numS, num2S, iiP, iiS, jjP, jjS;
real     PArray[], SArray[];


** here is the user-defined function that calculates the
** wave propagation for the media
Real
waveCalc(integer num2, integer i, integer j, real waveArray[],
              real wavein)
{
integer  k;

** Wave propagation
k = i-1;
if (k < 0)
    k = num2-1;

** exponential decay of waves
waveArray[i] = wavein-.25*waveArray[i]-.125*waveArray[k];
return(waveArray[j]);
}


on simulate
{
integer  k;
real     SWavePart, s, p;

DistanceOut = DistanceIn+Distance;       ** sum all distances
                                         ** for final magnitude
                                         ** calculation

if (numP)      ** if more than zero elements in transmission line
    {
    ** S Wave propagation
    iiS = iiS%num2S;
    jjS = jjS%num2S;
    sWaveOut = waveCalc(num2S, iiS, jjS, Sarray, SWavein);
    iiS++;
    jjS++;

    ** P Wave propagation
    iiP = iiP%num2P;
    jjP = jjP%num2P;
    pWaveOut = waveCalc(num2p, iiP, jjP, Parray, PWavein);
    iiP++;
    jjP++;
    }
else
    {
    sWaveOut = sWaveIn;
    pWaveOut = pWaveIn;
    }
}


on endsim      ** simulation is over, throw away dynamic arrays
{
disposeArray(SArray);
disposeArray(PArray);
}
```

continued

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includes various kinds of output windows, although you might typically trace the behavior of your simulation through a plot.

Requirements for Extend are a Mac Plus, SE, or II with 1 megabyte of RAM. The program is available only on 800K-byte floppy disks, and a hard disk drive is recommended. And if you use Multifinder, you can set up your simulations to compute in the background while you continue on with other work in the foreground.

You represent blocks by icons, which are the objects of the system. Each block can be as simple or complex as your needs dictate. The actions a particular block takes are governed by its script, written in ModL, a C-like language. Blocks are connected to other blocks through lines (that represent signal paths, for example), while the lines themselves end in symbols called connectors.

Extend manages the interblock messaging that makes the process work.

Extend supports only two types of connectors, input and output. Extend signals work much like OOP messages; they are the means by which blocks communicate with each other, passing along the results of a block's processing so it can be used by the other blocks in the simulation model.

Each block supports its own dialogs, so you can query the user of the simulation for specific inputs. This dialog box support is standard Mac stuff, so the simulation you build acts much like any other Mac application. The block dialog boxes support the usual interface conventions, including such items as edit fields, push buttons, radio buttons, and check boxes.

When a simulation is running, Extend manages the interblock messaging that makes the process work, informing each block of the current state of the simulation by sending it system messages.

The ModL language won't win any awards for originality, but it does have a shallow learning curve, especially for

```
on ok    ** check for acceptable values before closing dialog
{
if (noValue(distance) || distance < 0.0)
    {
    userError("Please enter a positive value for Distance");
    abort;
    }
}

on checkdata  ** check for acceptable values before simulation
{
if (noValue(distance) || distance < 0.0)
    abort;
}


on stepsize
{
** calculate the deltaTime to give us at least 4 elements
** in the array.  Extend TM will use the minimum deltaTime
** of all the blocks, so that you may end up with more
** than 4 elements

deltatime = distance/(4.0*Pspeed);      ** minimum of 4 elements
                                        ** in array

}


on initsim
{
** here we now know the deltaTime that Extend TM is using
** so we can build the array used for our transmission
** line model

** calculate the number of elements necessary for the S wave
numS = distance/(deltaTime*Pspeed*ratio)+0.5;
num2S = numS*2;
makearray(SArray, num2S);

** initialize the array to zero
for (iiS=0; iiS<num2S; iiS++)
    SArray[iiS] = 0.0;

iiS = 0;
jjS = numS;

** calculate the number of elements necessary for the P wave
numP = distance/(deltaTime*Pspeed)+0.5;
num2P = numP*2;
makearray(PArray, num2P);

** initialize the array to zero
for (iiP=0; iiP<num2P; iiP++)
    PArray[iiP] = 0.0;
iiP = 0;
jjP = numP;
}

on help
{
showHelp();
}
```

those with C or BASIC programming experience. ModL follows C so closely that you may be able to port simulation scripts written in C on another computer to your Mac and compile them with ModL after a few minor changes. Listing 1 is a script taken from a block in the EarthQuake sample simulation on the Extend examples disk and shows this C allegiance closely.

The most important on handlers in ModL are those that appear in almost every script: `on simulate`, `on checkdata`, `on initsim`, and `on help`. With these four message handlers, you can build almost any simple block script. Despite its "C-ness," ModL supports only three data types—integer, real-numeric, and string—because it's not supposed to be a general-purpose language. These three data types, along with the rest of ModL's syntax and features, give you everything you need to create simple or complex scripts. In fact, the ModL language is so nicely self-contained, you'll begin to wonder why more Mac applications don't include their own small, dedicated languages.

A structured procedural language like ModL, working within the object-oriented simulation development environment of Extend, provides a much stronger system than would have been possible otherwise. With this hybrid system you can go to work and create some dazzling simulations without the pain normally associated with simulation programming. For my money, Extend lives up to its name. ■

Item Discussed

Extend 1.05 ....$495
Imagine That!, Inc.
7109 Via Carmela
San Jose, CA 95139
(408) 365-0305
Inquiry M170.

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Bulletin Board Software for the Mac

Brock N. Meeks

What you choose depends on what you need to do

Electronic bulletin board systems (BBSes) rode into prominence on the coattails of the information age. From the first BBS created by Ward Christensen and Randy Suess to the multinode "megaBBS" systems of today, the BBS has become a kind of grass-roots communications medium for the computer community at large. And BBS programs have been written for almost any kind of computer system you can think of. From the lowly Timex Sinclair to Tandy's briefcase Model 100 to the sleek 80386-based machines, BBSes have thrived and survived.

There is a certain minimalist charm to running a BBS that creates a communications subculture out of silicon and copper wire. Certainly there is an intangible allure that leads people to dedicate a sophisticated piece of computing equipment to being a communications workhorse. Maybe it's the fact that a BBS is a high-tech throwback to the general store: a group of people meeting in a familiar place to discuss issues and topics of common interest; the cracker barrel replaced by a CPU; the hitching post giving way to carrier tones and high-speed modems.

Given the attraction of BBSes to hundreds of thousands of computer owners, it is no surprise that BBS programs have been written for the system first touted in 24-point Madison Avenue type as "the computer for the rest of us." I'm talking, of course, about the Macintosh.

Point, Click, Oops

The Macintosh opened another world to the computing community. With advanced graphics and an icon-driven interface, the Mac's possibilities were intriguing enough to create an almost fanatical following during the computer's infancy. Naturally, the "MacReligious" set out to prove their computer could do what other systems could do—only better. But when it came to on-line communications, the Mac had no particular advantage. Early Macintosh BBS programs were slow and kludgy. Add to that the fact that dedicating a Mac as a communications center was an expensive proposition, and there was little incentive for programmers to pursue advancements in this area.

All the advantages of the Mac—the icon-driven interface, the point-and-click event loop—were lost in the ASCII-based world of on-line communications. There were some early attempts at incorporating the Mac's unique interface into the on-line world. One example was the ill-fated MacUnderground with its network of "agent" and "courier" BBSes. This network attempted to embrace menus, buttons, and dialog boxes and was a precursor to Apple's stellar AppleLink commercial network.

But the use of graphical interfaces required proprietary software, and the idea never caught on in the populist, modem-owning world. Instead, programmers were content to write BBS programs for the Mac that simply improved on those early attempts.

The Macintosh BBS community is still evolving. The programs are faster and less bug-ridden, yet Mac-based systems still offer little, if any, advantage over BBS programs written for plain-vanilla IBM-type personal computers. In spite of the drawbacks, however, Mac BBSes are increasing. There are some promising developments on the horizon, and there's even talk of a practical implementation of the Macintosh graphical interface.

Thus, today's Mac-based BBSes are a thin thread in the loosely woven fabric that constitutes this nation's network of BBSes. Programs like Echomail and Tabby have been written for Mac-based BBSes, enabling hundreds of BBSes to exchange messages electronically. These programs allow users to upload messages on their local BBS, address them to a remote system, and have them automatically transferred to the remote system in the dead of night. In this sense, those using Mac BBSes are able to emulate and participate in the well-established FidoNet network of BBS message traffic. (FidoNet operates on DOS-based machines.)

The remainder of this article examines some different kinds of BBS software available for the Macintosh. Each has its own uniqueness and special features. Choosing to run a Mac-based BBS will depend largely on what you want to do with it and how much money you want to spend in supporting the board and its users.

Red Ryder Host

Written by Scott Watson, Red Ryder Host (RRH) is perhaps the most widely used Mac BBS in operation today. The version I discuss here is up and running at limited sites under beta test version 2.0, code-named Lazarus.

The board sets up all your parameters during your first log-on. You have a line-feed test, terminal choice, clear-screen option, and the opportunity to set the system to function under the "hot menu" command structure. The hot menu simply means that any command you type is acted on immediately without your having to hit a carriage return. Although such a feature might seem a given, not everyone wants or can use a hot menu. Anyone plagued by noisy lines will want to turn off the hot menu feature, as any spurious line noise could send RRH into spasms.

The board is compatible with the

continued

Tabby store-and-forward message program. As I mentioned earlier, Tabby allows you to post a message that is sent to systems across the U.S. and, in some cases, around the world. Others can read and reply via the Tabby function on their local systems. Another function is called NetMail. This is a program that hooks into the freewheeling world of Usenet, a somewhat unwieldy electronic messaging network used by research labs, universities, and corporations all over the world. However, NetMail is an expensive option for the system operator (sysop), mainly because the host computer has to make so many long-distance phone calls in support of the store-and-forward message network.

Sysops of RRH systems are supplied with a "construction set" that gives them complete control over the appearance and operation of the entire system. The systems are built using several building-block modules to create the menus, file-transfer sections, message bases, and so on. A sysop can construct up to 20 different message bases, and there is no limit to the number of file-transfer sections that can be set up.

The file-listing section contains information about each file available for transfer, such as the name of the file and how large the file is in kilobytes, which determines how long the file will take to transfer. Also included is information about the time and date the file was uploaded, a short description of what it does or looks like, and the file type.

RRH allows up to 256 levels of clearance for each user, menu command, and download file. Each menu command can be set up to be available if its clearance level is greater than or equal to, less than or equal to, or only equal to the user's clearance level. In addition, the system supports both XMODEM-checksum and XMODEM-CRC file-transfer protocols, with full MacBinary format recognition. The program comes with over 70 pages of well-written documentation.

According to developer Watson, RRH will eventually be supporting a graphics driver protocol that allows you to make your BBS appear to users as if they were using a local Macintosh application. Watson also says that there will be graphics, menus, mouse buttons, scroll bars, and more.

Another interesting feature of RRH is the voting option. This allows a sysop to set up a series of questions that can be answered by users. Votes are tabulated, and users can peruse up-to-the-minute results of the tabulations. (However, there's no built-in safeguard against ballot-box stuffing!)

HyperBBS

When HyperCard hit the Mac world, several applications were touted as "it." Everything from self-published electronic novels to the ultimate information resource was cited as a use for HyperCard. No one gave a thought to the possibility that a HyperCard stack might be turned into a BBS. No one until Harry Chesley, that is.

Chesley wrote the HyperBBS entirely in HyperCard and uses a set of serial port XCMDs developed at Apple Computer, where he works. HyperBBS commands are invoked by typing a single letter; the BBS fills in the rest of the command and acts on it. Second, the board features automatic word wrap—both input and output, so carriage returns aren't needed except at the end of paragraphs.

According to Chesley, the BBS, from the sysop's point of view, is very "Macish and graphical." However, from the user's point of view, it is a traditional text-based BBS. Chesley claims to be working on "added features" that will enable users to "see a Macish interface such as the sysop sees." In the meantime, he says, "Consider the lack of a graphic interface for the user an incentive to become a sysop."

Uploading Files

The HyperBBS is divided into three areas: a set of menus for navigating between areas; messages sections; and a thoroughly done on-line help system. Files can be attached to any message written by a user. In this way, you can write a message describing a particular program, problem, or application and then attach a binary file to that message. After reading the text of your message, anyone can then proceed to download the attached files.

These files are uploaded as part of the message-creation process. When entering any kind of message, you must fill in several fields. The system prompts for each of these by presenting the name of the field. Messages can be made private or public, depending on your preference. Either option allows you to attach files to the message.

A nice touch in HyperBBS is the "filter" command. This allows you to select the messages you want to see by date, by sender of the message, or by keywords within the message. This command is handy for searching a message base when you can't quite remember where you read something the day before. It is essential when searching for files. To look for a particular type of file, you'll have to use the filter command in conjunction with a keyword. The board supports XMODEM and MacBinary protocols.

Two notes: The program doesn't work with the Apple 1200 modem. However, according to Chesley, it will work with the Apple Personal modem. "I spent hours trying to figure it [the Apple 1200 modem] out and failed," he says. "The modem doesn't seem to accept commands when it's ringing." Second, the board is slow. Running under HyperCard is kind of glitzy on first take, but the slow execution rate is trying at best and, if you're calling long-distance, expensive.

Nova Link

Nova Link is a port from the MS-DOS world. But developers Alex Hopmann and Mark Weaver have "really hammered on the program" to bring it into the Mac environment, says Hopmann. The board immediately sets up all your parameters before you even get to the main menu. Linefeeds, destructive backspacing, hot menus, terminal type (TTY or VT-100 only), and so on—the program asks you to set all these on your first log-on.

Nova Link is the most complex of all the Mac BBS programs available. It is also the only "multiuser" BBS available for the Mac. Currently, two users can be on-line simultaneously. Weaver wrote the multitasking program that allows the program to handle both users.

Hopmann doesn't figure that two users on a single Mac presents much of a problem. "When you think of it, most of the BBS work is interactive, and therefore you're not going to need a lot of throughput the majority of time," he says. "Interactive typing is very slow. If you are doing file transfers, then, yeah,

continued

you're going to notice a slowdown." The board utilizes both the serial and printer ports for data I/O.

Keeping the Advantage

Hopmann wouldn't reveal details of Weaver's multitasking program. "It would give away our advantage," he said. "Basically, it works like any other multitasking program: It switches between applications. You have to specify stack size, and you've got the same program running a couple of times at once. I'd like to point out that some other Mac BBSes are going for multiuser status, but they have to run under MultiFinder and that won't be half as good." Running under MultiFinder requires a lot of overhead, and the Mac would have to be switching constantly between two programs in memory.

Hopmann says that Nova Link is going to support the Epic Technologies internal Mac II modems. Each Epic modem will take up one slot. In the future, he hopes to support the Mac II's four-serial-port board.

Perhaps the biggest difference between Nova Link and other Mac BBSes is its incorporation of a tree-structured message base. This entails the nesting of messages under a "parent" topic. All subsequent responses are called "children." A comment to a message designated as a child is called a "brother." Yes, it may be confusing at first, but once you've learned how to navigate the tree structure, the information flows in a linear fashion. Navigation of the tree structure is enhanced by a command called "newscan." After entering the tree and picking a topic to read, you only have to enter N to read through the subsequent messages. To reach the top of the tree, you only have to enter MP for "move to parent" (the originating message).

If you can't handle the tree structure, there is always the "flat" message section. This is a sequential message-storage system where messages are simply stacked on top of each other in the order they were entered. It's easier to use at first, but it's much harder to read a discussion with any kind of continuity.

Any message entered on the system can have a binary file (or text file for that matter) attached to it. So, if you find the description of a program to your liking, you can go right into download mode without having to exit to a separate file section. However, Nova Link does support a separate file-storage area for storing files not attached to messages.

There is also a voting feature that enables the sysop to set up a series of questions to poll users on topics of their choosing. Users can cast votes and see the results. Nova Link also allows a chat mode between users. Although there are facilities for only two users at the present moment, Nova Link has an extensive "real-time" chat conferencing section already coded for use.

Nova Link supplies sysops with a full library of source code for writing external applications. The library is written in Lightspeed C. Using this library of code, a sysop can write applications that allow remote users to perform any number of external applications, from running programs on the remote host to remote store-and-forward message-handling programs. Nova Link is also compatible with several of the store-and-forward message-handling programs, including Tabby and NetMail.

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Items Discussed

Note: These programs require a minimum system configuration of 512K bytes of RAM and two 800K-byte floppy disk drives.

HyperBBS... Free (noncommercial use)
Harry Chesley
(415) 824-7809 (a HyperBBS system)
Inquiry M181.

Nova Link $100
Res Nova Software
54 South Meadow Lane
Barrington, RI 02806
(401) 245-5384
Inquiry M182.

Red Ryder Host $60
Freesoft Co.
150 Hickory Dr.
Beaver Falls, PA 15010
(412) 846-2700
Inquiry M183.

World War IV .... Shareware
Terry R. Teague
530 West Dana St.
Mountain View, CA 94041
(614) 385-3870 (a WWIV system)
Inquiry M184.

World War IV

A stark name for a BBS program: World War IV. However, it's an apt name. A fourth world war would likely be swift, lightning fast. And speed is the biggest advantage of this BBS program, owing to its compatibility with the Telebit Trailblazer 19.2k-bit-per-second modem.

The WWIV BBS is built like an Italian sports car: not a smooth luxury ride, but quick. The menu setup is crude, rivaling that of the earliest BBS programs of several years ago. The menu choices, however, are extensive, with more than 30 choices at the main level.

The main feature of this board is that it allows you to set up a file-transfer system operating at super-high speeds. This, of course, means that users must also have compatible modems, but for a company wanting a swift file-transfer system, this setup can't be beat (at least, not in the Macintosh environment). The board supports file transfers at up to 19.2 kbps. This accomplishment is no small programming feat. The Telebit modem is a nightmare of registers and complex protocols, and much time and effort went into making this software compatible with these high-speed modems.

Custom Macros

One intriguing feature of World War IV is that it enables you to set up custom macros. To do this, you enter the Macro section. Here you're offered the chance to create a text macro of up to 76 characters. You assign that text string a macro key (such as Control-D), and, anywhere on the system that you want to enter that particular text string, you need only hit a Control-D.

Other features include a voting feature, a global purge (to set your message markers up-to-date throughout the entire board), and the ability to run external applications.

Beyond these features, the board is pretty much a standard BBS with message bases and private electronic-mail facilities. The program is offered under the shareware system.

It's All ASCII to Me

As one skeptic asked me during my perusal of these Mac BBSes, "Who wants to run a BBS on a Mac?" A good question, but apparently a lot of people do. Clearly, the state of Mac BBSes is about 3 years behind BBSes operating under MS-DOS. But then, the Mac is still relatively young itself.

If and when these Mac BBS programmers put their graphical interfaces into use, we should see Mac BBSes become more popular. AppleLink is doing splendidly with its graphical interface, but that is a commercial system. Another thing that Mac BBS programmers will have to take into account is this: When they go to a Mac graphical interface, they will be locking out the majority of personal computer owners, thus decreasing their potential audience by a significant margin.

Perhaps it's a non-issue. Mac BBSes already have sophisticated store-and-forward message-handling programs for exchanging mail with IBM PC-based systems. The evolution of Mac-based BBSes is likely to continue unhampered by incompatibility with PC owners. As long as text can be swapped across the ether, there's no reason for undue concern. And in that vein, the network of BBSes is following the lead of its larger cousin, the commercial E-mail vendors, in a move toward global interconnectivity.

The "computer for the rest of us" continues to thrive on its own merits. And if the predicted developments for Mac-based BBSes do come about, no doubt the Macintosh will write its own chapter in the history of interactive telecommunications. ■

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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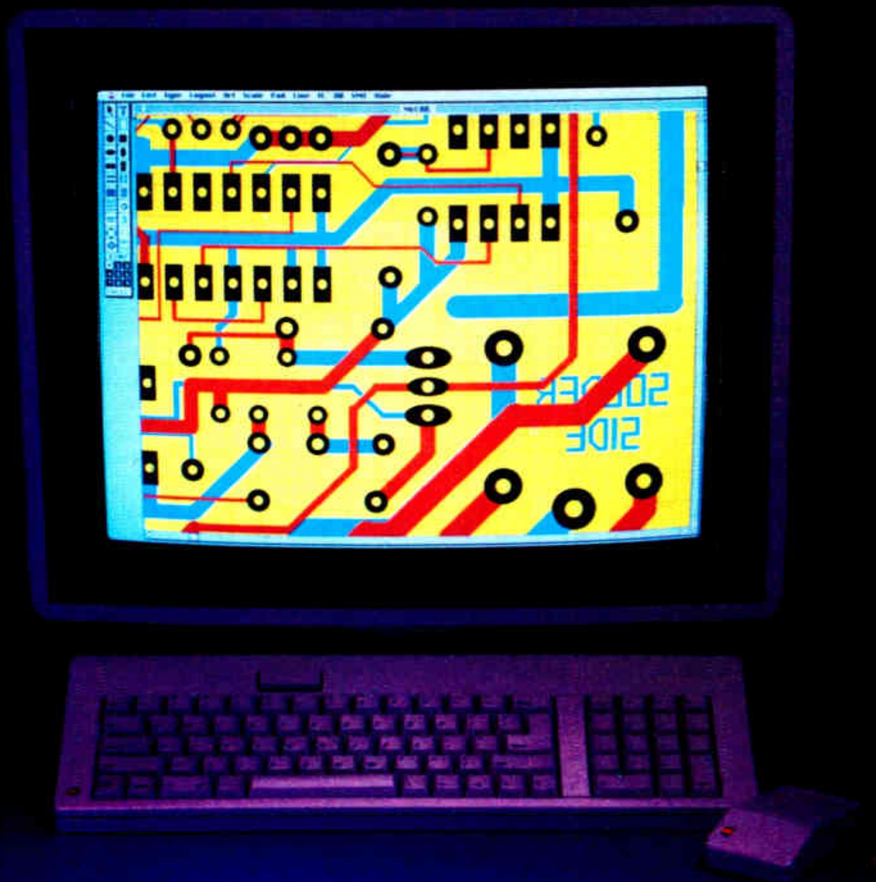

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SHORT TAKES

BYTE editors offer hands-on views of new products

MindWrite 2.1

ArchiText

Full Impact

MindWrite 2.1 Is a Word Processor for Writers

One of the most sacred decisions Macintosh users make is their choice of a word processor.

I'm a technical editor who corrects manuscripts and also writes articles. When I'm done, I insert ASCII typesetting codes into the text and send it to the copy-editing department for further work. I get many manuscripts either electronically or on an MS-DOS disk, so the application I work with has to easily import text (good-bye Write Now 1.0) and strip out gremlin characters like linefeeds or binary codes left by an MS-DOS word processor (good-bye Microsoft Word). I occasionally carry work home, so it has to work smoothly on a Mac Plus (good-bye FullWrite Professional).

Simply put, I need a word processor that can accept raw text from anywhere and in any shape. Because of my deadlines, it must be reliable—no bombs allowed. For several years, I've used MacWrite. MacWrite can handle documents with carriage returns at the end of each line, and you can cut and replace gremlin characters, making it useful for working with MS-DOS files. However, I've been writing more articles of late, and its limitation of only one document open at a time and its slow spelling checker began to really bother me.

Enter **MindWrite 2.1** from Access Technology. I examined this new version with apprehension because an earlier version (1.1) had a severe problem with screen refresh, and, worse, it crashed frequently. However, I liked its slick outliner, so I gave it a second chance. I'm glad to report that MindWrite's act has been thoroughly cleaned up. I tried MindWrite 2.1 on a Mac Plus with 2 megabytes of RAM, a Mac II with a Spectrum/24 video board and a 19-inch monitor from SuperMac Technology, and a Mac IIx with an Apple Macintosh II video board and an AppleColor 13-inch RGB monitor. It worked fine on each machine.

MindWrite 2.1's real strength lies in doing the business of writing. First, it can handle multiple documents, each in its own window. MindWrite automatically adjusts the window size to match the screen dimensions on the Mac you're using, displaying nearly a full page for you on a 19-inch screen. Better still, small icons on the document window's vertical scroll bar let you position one or more windows precisely on the Mac's screen.

This feature comes in handy in those situations where you need to consult notes in one window while typing text in another.

MindWrite's best feature is its built-in outliner. You type in an entry and terminate it with a carriage return. To build sublevels, you use keystrokes to indent the entry to the right (creating a sublevel) or to the left (to return to the previous level). Small diamond icons indicate each entry, and a darkened diamond means that sublevels are associated with it. You hide or expose sublevels by double-clicking to the left of the diamond. For those doing government work, a menu choice replaces the diamonds with properly labeled section numbers.

When you save a document, you can opt to save the outline's indented text and section numbers with your document, or to discard them. If you decide to reorganize the outline, it's just a matter of clicking and dragging the desired entry to a new location. All the sublevels associated with the parent entry are relocated along with it. Since an entry is terminated by a carriage return, you can literally write your document around your outline. At print time, a dialog box lets you print the entire document, certain levels in the outline, or only the part selected.

You can open MacWrite, text-only, ThinkTank, or Acta format files, and you can save documents in MindWrite's own format, or as MacWrite, text-only, or Acta files. The file filters provided by the add-on MindWrite Express package let you work with Microsoft Word files or export MindWrite files to PageMaker. MindWrite Express imports and exports PC word processor files like MultiMate and WordStar.

Other nice features in the new MindWrite include use of the cursor (arrow) keys, optionally saving the previous version of the document in a backup file, word counting, and a Clipboard function that lets you save the text of the last three Edit operations. The spelling checker, provided by Spellswell, is fast, but it isn't too sharp on catching possessive versions of a word.

MindWrite 2.1 isn't perfect. The display has rare minor glitches, and some of the keyboard equivalent commands, like Command-7 to show the document's rulers, are a bit baroque. And I sure wish it could print back-to-front like MacWrite, so I can simply pick up my document in the LaserWriter tray and go, without having to collate the pages. MindWrite also uses a lot of memory: 750K bytes, which leaves little room for another application if you're using MultiFinder and have 2 megabytes of RAM.

Nevertheless, this new MindWrite is practically as solid as MacWrite. It's fast, and the outliner can be a tremendous aid to your writing. If your needs run to serious writing, you work with imported text, and you don't need all the frills of page layout, check it out.

—Tom Thompson

THE FACTS

MindWrite 2.1
$195; with MindWrite Express, $295

Requirements:
Mac Plus, SE, II, or IIx (can run on a Mac 512KE) with at least 1 megabyte of RAM, System 3.2 or higher, and Finder 5.1 or higher.

Access Technology, Inc.
Access/MindWork Division
200-G Heritage Harbor
Monterey, CA 93940
(800) 367-4334
Inquiry M70.

continued

ArchiText: Hypertext Tool for Linking and Retrieving Information

THE FACTS

ArchiText
$349.95

Requirements:
Mac Plus, SE, or II with at least System 4.2 or higher and Finder 6.0 or higher. A hard disk drive is best, but it can be used with two floppy disk drives.

BrainPower, Inc.
24009 Ventura Blvd., Suite 250
Calabasas, CA 91302
(800) 345-0519;
in California, (818) 884-6911
Inquiry M71.

ArchiText reminds me of the probably apocryphal story about two guys hearing bebop for the first time. One guy says to the other, "I don't know what it is, but it sure does swing." ArchiText, like bebop, is hard to categorize—and even harder to fully explain—but it really swings if it's the kind of thing you need. BrainPower calls it a text-management and presentation package that implements the power of relational hypertext (a phrase that may or may not be redundant). I think of it as a tool for linking and retrieving megapages of information, both text and graphics, in a remarkably easy way. Well, easy once you figure the program out and if you have all the information stored on disk.

We're looking at ArchiText as a way to build a giant document (or "stack," in HyperCard-speak) of news stories we've done here at BYTE, including material from What's New, Microbytes, and Microbytes Daily (on BIX). Once the material is imported into ArchiText as ASCII files, the program lets us link all the stories on a particular subject; for example, a story (or "node," in ArchiText lingo) that refers to relational databases can be connected to every other story on that subject.

It's not a radical concept, but linking nodes in ArchiText is as easy as drawing a line, using the program's toolbox of various connectors, from one rectangle (representing a node) to another. You've got to set the nodes up before you can link them, but once you've got the files in the ArchiText document, connecting them with the program's tools is simple. I've been using the program on a 1-megabyte Macintosh SE and on an 8-megabyte Mac II and have had no significant problems.

The links, which are hypertext connections, are represented on the screen in what the program calls maps, made up of the node rectangles. Maps are the means by which you navigate the nodes, and you can have multiple maps for each set of nodes; there are really no limitations on the way you set up your information structure.

Once you've gotten all the text or images into the nodes, accessing the information held in there is easy; it's pretty much a matter of clicking on a node, and the node then opens up to show you the chunk of text or the graphic it contains. If you don't know where what you're looking for is, you can use the program's impressive search capabilities, which will let you hunt by single word or by using those fabulous Booleans, AND and OR; you can specify as many as four text strings each time. The program quickly returns results in a separate window.

This is the first text retriever I've seen that lets you change the appearance of the text it finds. Besides being able to edit the material in a node, you can alter the font, style, or size. Because the node viewing window can be pretty small, it's nice to be able to make the text bigger.

Besides letting you organize, connect, and search through tons of material, and then storing that material in a document, ArchiText provides tools for the keeper of the document—the mapper, in BrainPower dialect—to control access to the files. In the ArchiText world, you've got your mappers and your viewers, with the mappers being the ones who figure out how all the information gets linked, and the viewers being the ones who need to later use or find the information.

I'm not sure what situations would call for this sort of controlled access, but if you're working in an environment where you want certain people not to be able to see certain things, you can control that with ArchiText (once you get all the information into ArchiText documents). The mapper controls each user's viewing (read-only) privileges, even to the point of how much time a user can spend looking at a particular node; and for a really big Orwellian effect, the program will record the viewer's activity in a document. Mr. or Ms. Mapper can then verify whether or not someone looked at the information that they were supposed to look at. Each viewer, by the way, has his or her own password.

The person with mapper privileges decides how nodes are related, connects them, and draws the "driver map" that determines how the viewer will go from node to node. Mapping and map procedures comprise one of the densest areas of ArchiText. When you set up a map and connect nodes using boxes and arrows, the program interprets the graphically defined relationships as to how nodes are to be related.

BrainPower also describes ArchiText as a presentation package, because you can use it to generate something like a slide show; each node is a slide, and you can preset the length of time the node stays on the screen and the order in which each slide appears. This is a fancy little addition to an already versatile package, but this feature in itself isn't going to replace something like Cricket Presents.

ArchiText is a complicated program, and the folks at BrainPower have done a remarkable job of making it easier than it could have been. But it's still not easy to learn. I had a few odd things happen that I couldn't figure out, like ArchiText not finding files that I wanted to import from a disk, but then finding those same files when I created a new node and tried a second time to import them.

You've got to need to use this package to make the investment in learning it pay off. The manual does a good job of running you through the procedures you need (bad index, though), but it's quite a few procedures that you've got to learn. But once you understand links and nodes, connectors and frames, objects and maps, and you get the hang of traversing and combining, driving and viewing, it seems worth it because you can organize information quickly and then find it quickly when you need it.

If you want to arrange random notes and other scattered information, which is one thing ArchiText can do and do well, I'd recommend some of the less powerful programs tailored to that particular function. But if you have a big collection of information that you want to be able to thread together and search through efficiently, as well as random notes you'd like to somehow sort and store, ArchiText is a good means of doing that. It involves importing all that information into ArchiText documents, but that will pay off if you stick with the program.

In a situation like ours here at BYTE, where we get dozens of calls a week looking for help finding a particular product or development that we might or might not have covered in some issue, speedy access is essential. The program comes with some sample documents (like a guide to Boston) that illustrate the neat things you can do with ArchiText. BrainPower has devised an interesting Macintosh program that provides an environment for organizing vast quantities of information and proves the power and beauty of hypertext.

—D. Barker

Full Impact Spreadsheet Excels in Its Own Ways

I have been using Microsoft Excel on the Macintosh for more things than basic spreadsheet functions, but I was interested when Ashton-Tate got into the Mac spreadsheet business with **Full Impact**. Excel is considerable competition, but Full Impact looks like it can be a contender.

The Learning Full Impact tutorial is probably where the more experienced Mac user should start out. (There's another document for people who have no prior Mac experience, and a tutorial that seemed more a dealer demonstration than a learning experience.) The demonstration files are modified and extended to give you practice with Full Impact's features.

This is where you first get a sense of the utility of Full Impact's icon bar, which changes, as do the menu bars, depending on whether you are in spreadsheet or entry operation. The spreadsheet menu bar has two icon bars associated with it. The default icon bar groups operations having to do with manipulating files and text attributes and navigating cells; there's a handy clock in the default icon bar that displays either the time or the date. The spreadsheet's second icon bar (which replaces the default one when you click a change icon) is used when creating graphs or annotating areas of a spreadsheet.

The entry icon bar groups the most-used math functions together. The user can edit the icon bars for both spreadsheet and data entry. I found it much simpler to use the icon bar (especially when graphing) than navigating menus, the way I must in Excel.

I found it very simple to create presentation-quality

continued

documents with Full Impact. You will usually first input the spreadsheet data (up to 2048 rows by 256 columns), then make a chart of a selected range of cells. Options include bar (horizontal or vertical), pie, scatter, line, and range charts. Charting large, complicated graphs (especially on my Mac Plus) made for a noticeable lag while the program figured out how to plot the chart. During this lag, events are stored in the queue, so don't go randomly clicking around while waiting.

It's easy to create and position text paragraphs, and you can even create oval text areas complete with a line pointing to relevant cells. Pictures from the Clipboard can be pasted into the spreadsheet as well. Different "views" of a spreadsheet can also be created with little fuss.

Full Impact lets you make two different kinds of macros. Local ones are accessible only by the spreadsheet they were created on, while global ones can be accessed by any spreadsheet. A macro edit window appears during macro creation or editing, a feature I found useful in making sure the macro being created was doing exactly what I wanted.

Performance on the BYTE spreadsheet benchmarks (both 25 by 25 and 100 by 25) were just about the same for Full Impact and Excel 1.5. Whereas moving the horizontal and vertical scroll bars in Excel puts the location of the cell about to be displayed in a text box at the top of the screen, Full Impact displays the cell inside the "thumb boxes" of the scroll bar. This is a small detail, but it's useful not to have to watch one part of the screen while moving another part. I wish the program attended to such niceties of interface while opening or saving files. No progress indicator is evident during these operations. This is an admittedly small point, but it was something I missed while using A-T's new spreadsheet.

While exploring Full Impact, I found (and reported to Ashton-Tate) one bug in the program. The screen saver Pyro! will cause the program to crash during printing. Depending on the state of the system, the spreadsheet may be corrupted, and you might not be able to open it again; this happened to me. Do not have Pyro! active while using Full Impact.

An INIT called Front and Center (which draws dialog boxes at the position nearest to the current cursor position) must also be turned off during use of Full Impact, or else the display/entry icon bar will be drawn in the wrong part of the screen. Since there is no way to reposition the bar, the consequences can be awkward.

I like Full Impact. It has both the performance I want from a spreadsheet and the features I need to make data presentable. The icon bar is a useful navigational aid, not just something put in to make the program look different from Excel. The arrangement of the menus is straightforward and logically connected. Ashton-Tate has a world-class contender in Full Impact.

—Larry Loeb

THE FACTS

Full Impact
$395

Requirements:
Mac Plus with two 800K-byte floppy disk drives or one 800K-byte floppy disk drive and a hard disk drive (recommended), 1 megabyte of RAM (2 megabytes to run under MultiFinder), and System 4.1 or higher.

Ashton-Tate
20101 Hamilton Ave.
Torrance, CA 90502
(213) 329-8000
Inquiry M72.

The 68030 Mac IIx

Nicholas M. Baran and Tom Thompson

The newest Mac family member uses the latest-generation chips and can read or write PC disks

Rumors have been flying for several months that Apple would announce a product for the Macintosh II that employs Motorola's latest-generation processor, the 68030. Most speculation focused on a possible 68030 NuBus board. The speculation ended September 19th when Apple announced a new version of the Mac II, called the Mac IIx.

The Mac IIx features a 16-MHz 68030 CPU, a 16-MHz 68882 math coprocessor or floating-point unit (FPU), and a new 3½-inch floppy disk drive and controller chip that allow the Mac IIx to read and write 720K-byte and 1.44-megabyte 3½-inch PC floppy disks. The Mac IIx comes standard with 4 megabytes of 120-nanosecond RAM and costs $7769; a system with an 80-megabyte hard disk drive costs $9369.

What's New under the Hood

Looking inside the Mac IIx, you can see that its main logic board is virtually identical to the Mac II's. It has the same Apple Sound Chip and the same number of built-in I/O ports and NuBus slots. However, we also see some changes, starting with the presence of the 68030 CPU and the 68882 FPU. The location of these components' sockets has moved slightly on the Mac IIx motherboard, and the socket for the 68851 paged memory management unit (PMMU) chip is gone.

The 68030 features separate 256-byte instruction and data caches and a built-in memory management unit (MMU) that replaces either Apple's hardware memory mapper unit chip or Motorola's PMMU chip used in the Mac II. This internal MMU has a smaller address translation cache of 22 entries, versus the PMMU's 64-entry ATC, and implements a subset of the 68851 PMMU's instruction set.

Apple had to modify the Mac IIx ROMs to work with the 68030's MMU. Nevertheless, the 68030 provides the same virtual-memory and memory-protection capabilities of the PMMU it replaces, and for A/UX users, the Mac IIx is the new base system. However, A/UX 1.0—Apple's version of Unix—doesn't recognize the 68030's MMU, so a new version (1.0.1) is required for use with the Mac IIx.

The 68030 scores two big wins in terms of performance. First, its data cache, like the code cache on the 68020, improves processing throughput by reusing data if it's already in the cache. This eliminates the additional external bus cycles normally required to fetch data from the main memory. Second, with its built-in MMU to perform address translations, the additional clock cycle imposed by external MMU hardware is eliminated. The end result is that the Mac IIx accesses its memory more efficiently: The Mac IIx uses four clock cycles (of which one is a wait state) to access main memory on the motherboard, while the Mac II uses five (with two wait states).

Apple claims that the 68882 FPU in the Mac IIx is twice as fast as the 68881. This is because of its ability to execute floating-point instructions concurrently, and because of extra hardware that rapidly converts binary numbers to and from the FPU's internal extended format. Math-intensive applications that use the Mac II's FPU should run considerably faster on the Mac IIx.

Getting back to the motherboard, the four dual in-line packages and sockets that stored the Mac II's ROM code are gone. In their place is a lone single in-line memory module strip with ROM chips. This 256K-byte strip clips into a socket adjacent to the motherboard's SIMM RAM sockets. The SIMM ROM allows Apple to modify or expand the system software without causing major hardware modifications for current Mac IIx users. In addition, the replaceable ROM chips make it easy to add support for, say, a Japanese kanji font or other special applications in ROM.

Perhaps the most interesting new feature in the Mac IIx is its new 3½-inch floppy disk subsystem. The floppy disk high-density (FDHD) drive uses a new floppy disk controller chip that replaces the Integrated Woz Machine (IWM) chip now used to control the floppy disk drives. The FDHD controller chip has been in the works for some time and is commonly known as the Super Wozniak Integrated Machine (SWIM) chip. This new floppy disk subsystem allows formatting of 400K-byte, 800K-byte, and 1.44-megabyte Macintosh disks, 720K-byte and 1.44-megabyte PC disks, or 800K-byte Apple II ProDOS disks. Mac IIx users will use it to read and write data on MS-DOS- or OS/2-formatted disks, with the help of a new version (1.1) of the Apple File Exchange application. This new version of Apple File Exchange requires System 6.0.2, which is bundled with the Mac IIx's system software.

You use double-sided floppy disks for the Mac 400K-byte and 800K-byte formats and for the PC 720K-byte format. You'll need the high-density, 2-megabyte floppy disks to handle the 1.44-megabyte Mac or DOS format. This type of disk sports a second notch on the left side of its shell, opposite the write-protection notch.

Interestingly enough, the format for the 1.44-megabyte Macintosh floppy disk is identical to that of the 1.44-mega-

byte PC floppy disk: 80 tracks per side with 18 sectors per track; each sector is composed of 512 bytes.

You can only format MS-DOS floppy disks or 1.44-megabyte floppy disks from within Apple File Exchange. High-density disks can be formatted only for 1.44 megabytes. This is because formatting one at a lower density (e.g., 400K bytes) can cause data corruption, something the Apple File Exchange application prevents you from doing. Apple intends to eventually provide for seamless integration of PC or Apple II files without resorting to a special application. Current Mac II users will be able to upgrade to the FDHD drive in the first quarter of 1989.

Apple claims that virtually all Mac II software will run without modification on the Mac IIx. However, some applications that specifically look for the 68881 (e.g., Microsoft Excel) may give an error message but will still execute. Also, some NuBus Bus Master boards that directly access main memory may not operate correctly because of the new built-in data cache, requiring software modification to flush the cache of previous contents.

Putting It through Its Paces

A Mac IIx arrived at BYTE equipped with an 80-megabyte internal small-computer-system-interface (SCSI) hard disk drive, a Macintosh II video board, and an AppleColor 13-inch RGB monitor. The plastic peanuts had barely settled to the floor when we began subjecting the Mac IIx to the BYTE benchmark tests, using the 6.0.2 system software. The low-level system tests show that the Mac IIx's memory subsystem is appreciably faster than the Mac II's, thanks to the 68030. However, since the rest of the system components, such as the hard disk drive, are identical to the Mac II's, the overall improvement in performance is not as great as it was for the memory alone. See the text box "Measuring It" on page 27 for complete information.

To check for potential software compatibility problems, we tried as many Mac applications as we could get our hands on with the Mac IIx. Since an earlier release of Mac System software (6.0) has a near-legendary reputation for being bug-ridden, any discrepancies we found were cross-checked on a Mac II running System 6.0.2.

We first confirmed known software problems reported by Apple. We connected an 80-megabyte external SCSI hard disk drive with A/UX 1.0 loaded on it, made it the startup device, and rebooted. As expected, the stand-alone shell application (sash) informed us: "No PMMU—can NOT launch an A/UX kernel." Microsoft Excel 1.04 failed to detect the 68882 but worked just fine without it.

In an attempt to quickly move more than 10 megabytes of benchmark code and data from the Mac II to the Mac IIx, we tried to install AppleShare 1.0 on the Mac IIx as a server. Booting with the AppleShare Server Installer disk resulted in a bomb box with ID=1. The same disk booted normally on the lab's Mac II. We worked around the problem by using the Installer script supplied with System 6.0.2 to configure the Mac IIx as a workstation, connect it via PhoneNet to the Mac II running as a file server, and copy the files using AppleShare. This is an older version of AppleShare. Apple says AppleShare 2.0 works properly on a Mac IIx as a file server, so the moral here is to keep your software up to date.

Adobe's Illustrator 88 application, version 1.6, would display only patterns and eight colors, not the 256 colors we expected. For some reason, Illustrator 88 thinks that Color QuickDraw is not available on the Mac IIx. Although the results lacked luster on the Mac IIx display, the image as printed on the LaserWriter was identical to one printed from a Mac II. Adobe suggested that we try using System 6.0 software. We did, and at that point the application started

continued

PHOTOGRAPHY: PAUL AVIS © 1988

using color. Since Illustrator 88 functions fine on a Mac II with System 6.0.2, we suspect there's a subtle interaction with the Mac IIx involved.

The TMON 2.8.1 debugger broke on the Mac IIx, which came as no surprise since debuggers tend to be very hardware-specific. A phone call to TMON's distributors, ICOM Simulations, got us a quick and simple patch that allows TMON to work with the Mac IIx's 68030 CPU.

This is not to imply that nothing worked on the Mac IIx; far from it. We have mentioned only those applications that had problems working on the Mac IIx, and the problems described are not crippling ones. We expect that some software will have to be revised to work properly with the Mac IIx as the machine starts entering the market in large numbers.

We tried putting a 720K-byte MS-DOS floppy disk in the Mac IIx's drive and got the "Not a Macintosh disk—eject or format" alert box. We hastily ejected the disk and started Apple File Exchange. Once inside this application, we were able to read, copy, and write to the MS-DOS disk (see figure 1).

Apple File Exchange allows you to load file-translation filters that handle the chore of converting an MS-DOS file to a format readable by a Mac application, or the converse, if necessary. Simple text translation is standard, and an DCA-RFT/MacWrite filter is provided.

However, to translate such exotica as WordStar or WordPerfect files to MacWrite format, you'll need to purchase other filter programs from Apple or third-party vendors. Some software vendors also offer file-translation filters for their own word processors. Once you're through dealing with the disk, as you exit Apple File Exchange, it conveniently ejects the floppy disk to prevent you from getting the Format/Eject alert box again.

The Cost of Progress

In terms of performance, the Mac IIx is not going to leave its sire eating dust. Nevertheless, although the gain in performance is modest, it is there. The FDHD drive that comes with the Mac IIx is the real bonus: It allows you to save even more Mac files on a 1.44-megabyte floppy disk. In an office where there is a medley of different computers, the abil-

Pricing and Upgrades

Is the Mac IIx's extra features and modest increase in performance worth it? According to Apple, the Mac IIx costs about 5 percent more than an equivalent Mac II system. Let's take a look for ourselves and see what it would cost to equip a Mac II to match the capabilities of a Mac IIx:

Mac IIx

CPU with 4 megabytes of RAM:	$7769
1 megabyte of expansion RAM:	$ 499
Total:	$8268

End result: 5 megabytes of RAM and 68030 with built-in MMU, with 15 percent performance boost and standard FDHD drive.

Mac II

CPU with 1 megabyte of RAM:	$4869
4 megabytes of expansion RAM:	$2399
PMMU	$ 499
FDHD upgrade	$ 599
	$8366

End result: 5 megabytes of RAM, 68020, and PMMU with FDHD drive upgrade and no improved performance.

From the numbers, we see that the Mac IIx actually costs $98 *less* than the upgraded Mac II. Apple suggests buyers won't normally want the FDHD drive, which brings the price of the Mac II unit down to $7767—roughly 6 percent less than the cost of the Mac IIx with the same amount of RAM. Even with that reasoning, the modest increase in system performance is probably worth the additional cost.

The important thing to note here is the amount of RAM for the system: 4 megabytes or more. If you can make do with less RAM (2 megabytes or less), or without the FDHD drive or PMMU, then the Mac II is your best choice. If the applications you plan to use require lots of RAM, then the Mac IIx is the way to go.

What options do you have if you already own a Mac II? There are four. First, you can buy an FDHD upgrade kit that costs $599. This replaces your floppy disk drive, the IWM chip, and the Mac ROMs. Second, you can buy the 68851 PMMU chip for $499, which gives your system enhanced memory management capabilities. Using these first two options together gives you the basic capabilities of the Mac IIx, as outlined above.

Third, you can replace the entire Mac II motherboard with a Mac IIx motherboard for $2199. The final upgrade option is to replace both the motherboard and floppy disk drive for $2798, which effectively turns your Mac II into a Mac IIx.

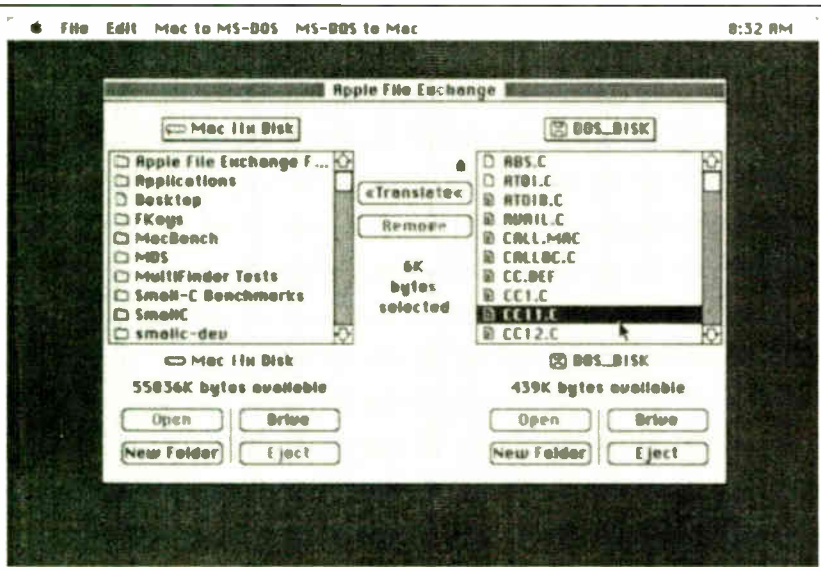

Figure 1: *The Apple File Exchange application. The menus at the top allow you to select file-translation filters that are used when copying a file from one format to another.*

Measuring It

We ran the complete suite of BYTE benchmarks on the Mac IIx. Since the Mac IIx is so similar in design to the Mac II, it serves as a unique laboratory in which we can gauge the effects of the Motorola 68030 CPU and 68882 floating-point unit (FPU) on a computer system. As described in the main article, the 68030's built-in caches and memory management unit (MMU) should boost the Mac IIx's use of its main memory. We used the BYTE Small-C low-level benchmarks to measure the performance of each subsystem, followed by the application benchmarks to evaluate real-world performance. It is a tribute to both the careful design of the benchmark code and the object-code compatibility of the 68030 with its predecessors, that all but one of the low-level benchmarks ran on the Mac IIx without modification.

Starting with the low-level memory tests, performance improvements, as compared to the Mac II's 68020 results, ranged from a low of 19 percent for the Matrix test (68000-code version) to a high of 33 percent for the Sort test. The 68030 squeezed an extra 819 Dhrystones (3680 versus 2861) out of the Mac II design. It's hard to tell whether these results are due to the 68030's caches or the one-less clock cycle per memory access. Whatever the reason, the benchmark tests indicate that the Mac IIx's memory is used more efficiently.

The BYTE math coprocessor benchmarks show a 14 percent boost across the board for the Math, Sine, and Exponential tests. Isn't the 68882 supposed to be twice as fast as its predecessor, the 68881? The reason the numbers aren't better is that Small-C accesses the FPU via Standard Apple Numerics Environment (SANE) calls. SANE's advantage is that you're safe no matter what machine you run on: If it's a standard Mac SE, software emulation libraries accomplish the floating-point processing; if you're on a Mac II or IIx, SANE routes most of the calls to the FPU. However, there's a loss in performance due to the additional code overhead when using SANE.

The LINPACK benchmarks access the 68882 directly, so we expected better results. They are. The single-precision LINPACK posted a 36 percent performance boost, and the double-precision was 30 percent faster.

What about the other subsystems? Are there major improvements there? Sadly, no. Besides the FDHD drive, the Mac IIx's only major hardware change is its CPU/FPU combination, so we expect the other components, such as the hard disk drive and video subsystems, to run at about the same speed as the Mac II. The File I/O benchmark times on the Mac IIx's 80-megabyte hard disk drive are identical to the times on a Mac II system. Both the FDHD disk and the SCSI disk sector seeks showed some improvement (12 percent and 13 percent respectively) but showed little or no gains for the larger 16K-byte sector read. The 1-megabyte write showed a 17 percent gain, but the 1-megabyte read was only 2 percent faster.

For the video subsystem, the slow Graphics test shows an 8 percent speed improvement—probably due to the amount of code in memory that's executing faster—while the Graphics test using the QuickDraw traps shows no improvement at all. The Text benchmark shows similar results: 16 percent better using code-intensive TextEdit calls, and only 11 percent when the QuickDraw `_DrawString` trap is used.

These damping effects are even more noticeable with the application-level tests, which measure the performance of the entire computer system. Most McMax database operations completed somewhat faster than normal (the Sort operation was 36 percent faster, but the Delete showed no improvement); they averaged a 19 percent improvement. This was also true for the compiler benchmarks, where a lot of disk I/O occurs. They showed a 15 percent improvement overall.

The Excel spreadsheet tests were 14 percent faster overall, but they didn't use the 68882 FPU. We can't help but wonder what the actual performance would be if they did, but the results indicate how a typical application might behave.

The exception to this trend was the MiniCad application benchmark, which makes heavy use of memory and SANE. The Redraw and the Hide and Shade operations were a whopping 50 percent faster, but the File Load took the same amount of time as on a Mac II, bringing the overall performance boost to 33 percent. Nevertheless, unless you use this type of application exclusively, we think Apple's call of a 15 percent performance improvement of the Mac IIx over the Mac II is reasonable.

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ity to read, write, and format PC disks on the FDHD drive is a big plus.

How much are you willing to pay for all this? That depends. If you're planning to buy a Mac II with lots of memory, the price of a Mac IIx is about 5 percent extra. For the additional money, you get 15 percent better performance, the 68030's MMU, and the FDHD drive. If you already own a Mac II, there are several upgrade options available to you (see the text box "Pricing and Upgrades" on page 26). Based on the sheer convenience of reading PC disks, Mac II owners should get the FDHD upgrade anyway, unless you already have PCs and Macs sharing information on a network.

Considering Apple's flair for innovation, the Mac IIx is a modest offering. It's a Mac II with a new CPU, FPU, and floppy disk drive, but little else of note. The 68030 is even clocked at 16 MHz, the same speed as the Mac II's CPU. Why is this?

The Mac IIx serves two purposes. First, you're buying into the future with the Mac IIx. Apple plans to have Macintosh computers run a multitasking operating system with hardware MMU support. This won't come overnight, but the Mac IIx, with its 68030 and SIMM ROMs, will be ready when the time comes. Of course, people who already own Mac IIs can buy into this future by adding the 68851 PMMU and plugging it into the machine. Changing the ROMs won't be as easy, but it's workable.

Second, the Mac IIx serves as a bridge machine to rumored high-performance, 68030-based Macintosh systems. Since the Mac IIx is so similar to the Mac II, it serves as a convenient way for software developers to make their software 68030-compatible without getting lost in a maze of hardware changes. ■

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Mac Expansion

Glenn Hartwig

Add-in boards are a plus with the new Macs. What are your choices?

A major advantage of the new Macintoshes is the fact that, finally, the machines don't demand that you let the company decide what kind of hardware configuration is best for you. You now have slots, and you can decide for yourself what, if any, extra capabilities you may need from your Mac and then go out and find an add-in card to help you meet those needs.

As things now stand, the major areas being developed by third-party vendors are add-ins that either expand the machines' video display or enhance their speed. With the help of a McGraw-Hill sister company, Datapro Research, we've gathered a list of Macintosh expansion cards, their manufacturers, their cost, and their capabilities.

The extensive chart we've compiled on the basis of this data should serve as a starting point for your own inquiries when and if you feel the need to go beyond the new Macs' off-the-shelf com-

continued

COMPANIES MENTIONED

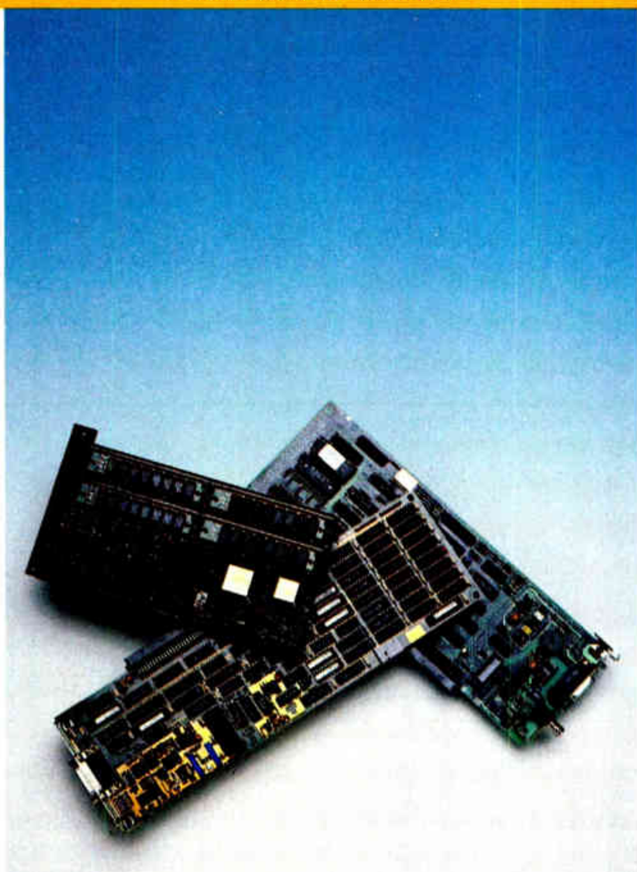
Aox, Inc.
486 Totten Pond Rd.
Waltham, MA 02154
(617) 890-4402
Inquiry M171.

Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
Inquiry M172.

Dove Computer Corp.
1200 North 23rd St.
Wilmington, NC 28405
(919) 763-7918
Inquiry M173.

E-Machines, Inc.
9305 Southwest Gemini Dr.
Beaverton, OR 97005
(503) 646-6699
Inquiry M174.

Mercury Computer Systems, Inc.
Wannalancit Technology Center
600 Suffolk St.
Lowell, MA 01854
(617) 458-3100
Inquiry M175.



Network Specialties, Inc.
296 Elizabeth St.
New York, NY 10012
(212) 995-2224
Inquiry M176.

Novy Systems
2341 South Ridgewood Ave.
Edgewater, FL 32032
(904) 427-2538
Inquiry M177.

Orchid Technology
45365 Northport Loop W
Fremont, CA 94538
(415) 683-0300
Inquiry M178.

Radius, Inc.
404 East Plumeria Dr.
San Jose, CA 95134
(408) 434-1010
Inquiry M179.

RasterOps Corp.
10161 Bubb Rd.
Cupertino, CA 95014
(408) 446-4090
Inquiry M180.

Vendor	Product	Type of peripheral: Video display	Type of peripheral: Accelerator	Display size	No. of colors displayed at one time
Aox, Inc.	DoubleTime-16	—	●	—	—
Apple Computer, Inc.	Macintosh II Video Card	●	—	640×480	16
Dove Computer Corp.	MaraThon 020	—	●	—	—
E-Machines, Inc.	DoubleColor	●	—	832×624	256
Mercury Computer Systems, Inc.	MC3200NU	—	●	—	—
Network Specialties, Inc.	Flattop	●	—	640×400	3
	Bigtop SE	●	—	1024×980	2
	Hightop	●	—	720×900	2
	Jump 020		●	—	—
Novy Systems	MAC20MX	—	●	—	—
Orchid Technology	ColorVue	●	—	640×480	16
Radius, Inc.	Full Page Display System—Mac SE	●	—	640×864	2
	Full Page Display—Mac II	●	—	640×864	2
	Two Page Display—Mac SE	●	—	1152×864	2
	Two Page Display—Mac II	●	—	1152×882	2
	Gray Scale/Color	●	—	1152×882	256
	Accelerator 16 for Mac Plus	—	●	—	—
	Accelerator 25	—	●	—	—
	Accelerator 16 for SE	—	●	—	—
RasterOps Corp.	Colorboard 100N — 8 bit NTSC	●	—	1024×768	256
	Colorboard 64 — 24 bit	●	—	640×480	307,200
	Colorboard 104 — 24 bit	●	—	1024×768	786,432
	Colorboard 108 — 8 bit	●	—	1024×768	256

puting power. The obvious extra advantage of all this is the downward pressure on prices that open competition always has. While the Mac world may still be a pricey one to enter, moving around in it afterward is probably going to be more affordable in the future. The benefits to companies and individuals are thus defined in terms of economic as well as technical flexibility.

High-speed accelerators, a somewhat wider range of display options, and a choice of basic or highly sophisticated color options all give users a greater degree of freedom. The choice of a com-

Coprocessor: Graphics	Coprocessor: Math	CPU	Clock speed (MHz)	Price	Warranty	Comments
—	68881	68000	16	$395	—	
None	—	—	—	$499	90 days	Supports Apple's monochrome and color display; produces 16 shades of gray on monochrome display; optional $149 expansion kit produces 256 colors or shades of gray.
—	68881	68020	16	$899	90 days	Custom CMOS LCA controller allows the accelerator to be reconfigured via software. $1629 MSE2 includes 1MB of memory; $1199 MSE3 includes 68881 math coprocessor; $1929 MSE4 includes 1MB of memory and math coprocessor.
None	—	—	—	$995	—	
—	Weitek XL-3132	Weitek XL-8032	10	$10,400	90 days	Includes microcoded vector and matrix algorithm library; C and FORTRAN compilers; operates at 20 MFLOPS/10 MIPS; expandable to 8MB of RAM.
None	—	—	—	$1595	90 days	
None	—	—	—	$1895	90 days	
None	—	—	—	$1595	90 days	
—	68881	68020	16	$1395	90 days	
—	68881	68020	25	$595	90 days	Includes capability for 1MB or 4MB on-board memory.
None	—	—	—	$695	2 years	Brings 16 colors and a 75 percent larger work area to the screen of the Macintosh SE 8.
None	—	—	—	$595	1 year	69-Hz refresh rate; includes system software.
None	—	—	—	$695	1 year	69-Hz refresh rate; includes system software.
None	—	—	—	$695	1 year	72-Hz refresh rate; MagicBus connector; includes system software.
None	—	—	—	$695	1 year	72-Hz refresh rate; includes system software.
None	—	—	—	$1895	1 year	72-Hz refresh rate; includes system software.
—	—	68020	15.66	$995	1 year	Full CMOS write-through logic; 32KB static RAM cache for data and instructions. Preference-panel-controlled desk accessory controls; costs $1295 with optional 68881 coprocessor.
—	—	68020	25.63	$1695	1 year	Full CMOS write-through logic; full 68000 compatibility mode; 32KB static RAM cache for data and instructions. Preference-panel-controlled desk accessory controls. MagicBus connector a second internal expansion board; costs $2195 with optional 68881 coprocessor.
—	—	68020	15.66	$995	1 year	Full CMOS write-through logic; 32KB static RAM cache for data and instructions. Preference-panel-controlled desk accessory controlls. MagicBus connector for a second internal expansion board; costs $1295 with optional 68881 coprocessor.
34061	—	—	—	$1795	3 mos.	
TMS34010	—	—	—	$2595	3 mos.	Optional daughterboard costs $995 to output to NTSC devices.
TMS34010	—	—	—	$3195	3 mos.	
34061	—	—	—	$1595	3 mos.	

puter for yourself or colleagues and coworkers is much more open if you know from the beginning of the decision-making process that your particular needs can be accommodated both by the Mac environment and by PCs, and that if the Mac doesn't arrive from the factory with all the right capabilities, cards are available that will allow you to customize the perfect configuration. ■

Glenn Hartwig is BYTE's associate managing editor, operations. He can be reached on BIX as "glenn."

about the device driver, including a queue of pending I/O operations, the driver reference number, and a handle to the driver's private data storage. The DCE also contains a reference to the actual driver; a flag bit indicates whether this reference is a pointer or a handle (Apple's ROM drivers use pointers).

How to Call a Driver

When an application opens a driver, the Device Manager first looks for it among the installed drivers in the unit table, using the name stored in the driver's header. If it doesn't find the driver installed, it looks for DRVR resources in any open resource file.

Once a driver is found, the Device Manager installs it in the unit-table entry that is the one's complement of the resource ID. This means that DRVR −41 would be installed in unit-table entry 40. _Open or OpenDriver( ) returns the −41 that the application uses to reference the open driver in all subsequent calls.

Some programmers think the OpenDriver call that most applications use opens the device drivers. It doesn't; it calls _Open. In fact, the File Manager's FSOpen and OpenDriver both call _Open to do all the work, even though FSOpen has different parameters and fills out different fields in the parameter block.

How does the system tell drivers and files apart? If the first character of the name is a null or a period, _Open looks for a driver. If it doesn't find a driver by that name, or if the first character is something else, _Open tries to open a file.

Suppose you want to install a device driver that's not in a resource. First, you allocate nonpurgeable space for the driver in the system heap. Then you allocate a relocatable DCE in the system heap and zero it out. Scan the unit table for an empty slot, and install the handle to the DCE. Finally, you fill out the dCtlDriver (with the driver's handle) and dCtlFlags (from drvrFlags) and set dCtlRefNum to the one's complement of the unit number.

Internal Details

The DCE contains a reference to the first byte of a driver as either a pointer or a handle. If the RAM-based bit in dCtlFlags is set, dCtlDriver is a handle, and the driver is automatically locked when it's opened and unlocked when it's closed. Normally, driver resources are defined as unlocked and purgeable.

The driver consists of a fixed-format header followed by the executable code required for the driver. In addition to the name of the driver, the header contains information about how the driver is used. Macintosh Programmer's Workshop (MPW) programmers should link the driver code with {Libraries}DRVRRuntime.o into a DRVW resource and then merge it with the header using Rez source (see listing 1).

The driver's header includes offsets to the five standard entry points: DRVROpen, DRVRClose, DRVRControl, DRVRStatus, and DRVRPrime. In MPW, these are resolved by Rez, the linker, and DRVRRuntime.o. Each of these entry points is called with a pointer to the application's parameter block in register A0 and the DCE pointer in A1. In MPW C, the glue expects the following calling sequence:

```
pascal short DRVRControl(pb, dCtl)
 CntrlParam *pb;
 DCtlPtr dCtl;
```

As you can see in table 1, both _Read and _Write traps go through the DRVRPrime entry point. The _KillIO trap calls DRVRControl, but it involves special processing by both the Device Manager and the driver. Although you can open and close all drivers, some may ignore _Read, _Write, _Status, or _Control calls, as indicated in the header. In this case, you should supply a do-nothing dummy routine to satisfy the linker.

Table 1: *Device Manager calls and the corresponding driver entry points. Although the access may vary, most calls go through these seven traps.*

High-level	Low-level	Trap	Entry point
OpenDriver	PBOpen	_Open	DRVROpen
CloseDriver	PBClose	_Close	DRVRClose
FSRead	PBRead	_Read	DRVRPrime
FSWrite	PBWrite	_Write	DRVRPrime
Control	PBControl	_Control	DRVRControl
Status	PBStatus	_Status	DRVRStatus
KillIO	PBKillIO	_KillIO	DRVRControl

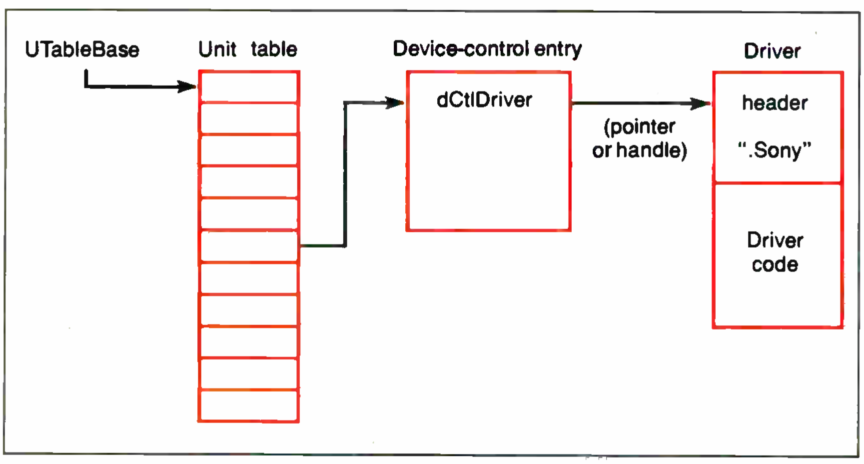


Figure 1: *Finding a driver.* UTableBase *points to the unit table that contains handles to device-control entries. The DCE references the actual driver.*

Listing 1: *MPW code to define driver resources.*

```
resource 'DRVR' (-8192,
      ".XPrint", purgeable)
{
  dontNeedLock,
  dontNeedTime,
  dontNeedGoodbye,
  statusEnable,
  ctlEnable,
  noWriteEnable,
  noReadEnable,
  0,    /* no periodic delay */
  0,    /* no events */
  0,    /* no menu */
  ".Print",
$$resource("Driver.DRVW",
          'DRVW',0)
};
```

All entry points return a status value as a function result. The DRVRRuntime.o glue places this value in D0, but DRVR-Open must place the return value in pb->ioResult instead, because the Device Manager clobbers the return code in D0.

Most device drivers require internal storage to maintain information about the device and any I/O that's in progress. The dCtlStorage field is used to store a handle allocated by DRVROpen and deallocated by DRVRClose. A driver designed to run in the application heap should set dNeedGoodbye to clean up on termination; the Device Manager calls DRVRControl with csCode = -1 before quitting the application and wiping out the heap.

Three Kinds of Traps

Each of the seven basic Device Manager traps can be made in one of three ways, distinguished by bits in the trap word, as shown in figure 2. Two of these ways—*synchronous* and *asynchronous*—go through the I/O queue, while the third, *immediate*, does not. The default and most common case is for an application to use a synchronous call. The Device Manager waits for the driver to set io-Result to noErr or to a negative value.

However, an application may not wish to wait until a driver call (usually a _Read or _Write) is completed. Each of the low-level Device Manager calls can be made asynchronously, either by passing *true* for the async parameter to PB-Read or PBWrite, or by setting the asynchronous bit on the assembly language trap. The application must pass the address of its completion routine in the parameter block. This routine has to preserve registers A2 through A6 and D3 through D7 if it uses them, and it cannot call the Memory Manager, either directly or indirectly.

Normally, the Device Manager handles an I/O request by placing the application's parameter block into the operating system queue referenced by dce->dCtlQHdr. As the driver satisfies a request, the Device Manager removes it and calls the driver with the next request. Any _KillIO call completely empties the queue; it also sets the pb->ioResult field to abortErr and then calls the application-specified completion routine.

In some cases, you may wish to bypass this queuing mechanism and let an application perform an operation directly. For example, if your application wants to find out the status of a pending I/O request, it should probably use an immediate _Status call. Since the standard Device Manager glue doesn't support

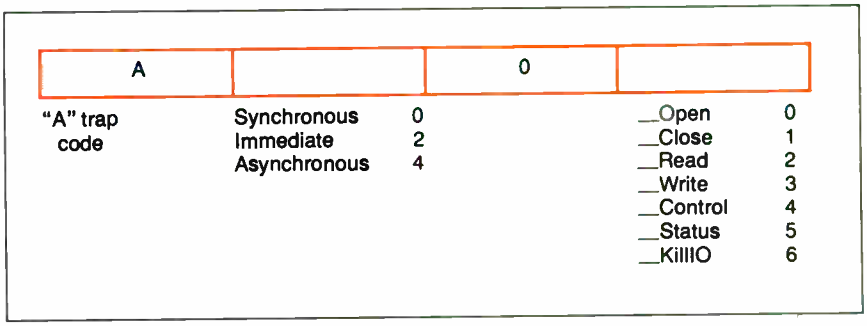


Figure 2: *Device Manager trap word. Notice the seven possible traps and the three ways—synchronous (normal), immediate, or asynchronous—in which each can occur.*

immediate calls, you need to write your own glue (see listing 2). (Note that the Device Manager always treats the _Kill-IO trap as immediate.)

Asynchronous calls are primarily intended for DRVRPrime, and immediate calls for DRVRControl and DRVRStatus. The two are mutually exclusive—that is, immediate calls are never asynchronous—and neither type of call is valid for DRVROpen or DRVRClose.

Listing 2: *The "glue" needed to support an immediate call.*

```
; pascal OSErr PBStatusImmed
                (ParamBlkPtr pb);
PBStatusImmed PROC     EXPORT
       MOVEA.L      (A7)+,A1
       MOVEA.L      (A7)+,A0
       _Status      IMMED
       MOVE.W  D0,(A7)
       JMP     (A1)
```

IODone

When a driver responds to a trap, it may need to perform some standard housekeeping tasks before returning. DRVR-Open and DRVRClose routines are the simplest, since they are always called synchronously and they always return normally.

If a DRVRPrime, DRVRControl, or DRVRStatus entry point has been called via a synchronous request, your driver should usually jump to the IODone routine, as pointed to by low-memory global JIODone (at location 0x8FC). It's up to your driver to determine how it was called, normally by checking the trap word stored in pb->ioTrap. The IODone routine removes this request from the I/O queue, executes the application-supplied completion routine (if any), and calls the driver to execute the next I/O request.

It's possible that the completion routine could start another I/O request, thus causing the size of the stack to grow. To avoid this problem, you should write each driver entry point in assembly language to jump directly to IODone with its return address on the stack. (You can also call IODone as a subroutine, via glue.)

The MPW 2.0 DRVRRuntime.o glue tries to handle this problem for the driver writer by automatically providing an IO-Done call for all DRVRPrime calls. Unfortunately, it doesn't provide the IODone calls required for control or status calls. Also, asynchronous read and write calls can't call IODone before the I/O is complete.

In actual practice, few DRVRPrime routines actually call IODone. If the driver is performing direct I/O via 68000 memory-mapped locations, it will transfer the first data byte and then return. It's up to the driver interrupt routine to transfer any additional data or to call IODone if no more data is left.

Note that the DRVRControl routine must treat any _KillIO trap (indicated by pb->csCode==1) as immediate. It should clean up its internal state, but it doesn't have to empty the queue or abort the completion routines—the Device Manager handles these. Figure 3 contains a flowchart illustrating the general algorithms for the control and status entry points, while figure 4 shows the DRVRPrime and driver-supplied interrupt routines.

A Test Drive

Let's take a functional skeleton driver, .Shadow, as an example. The driver is written primarily in MPW C, with some assembly language code and Rez resource definitions. [Editor's note: *The source code listing for the program .Shadow is available in a variety of formats. See page 3 for further details.*] The

continued

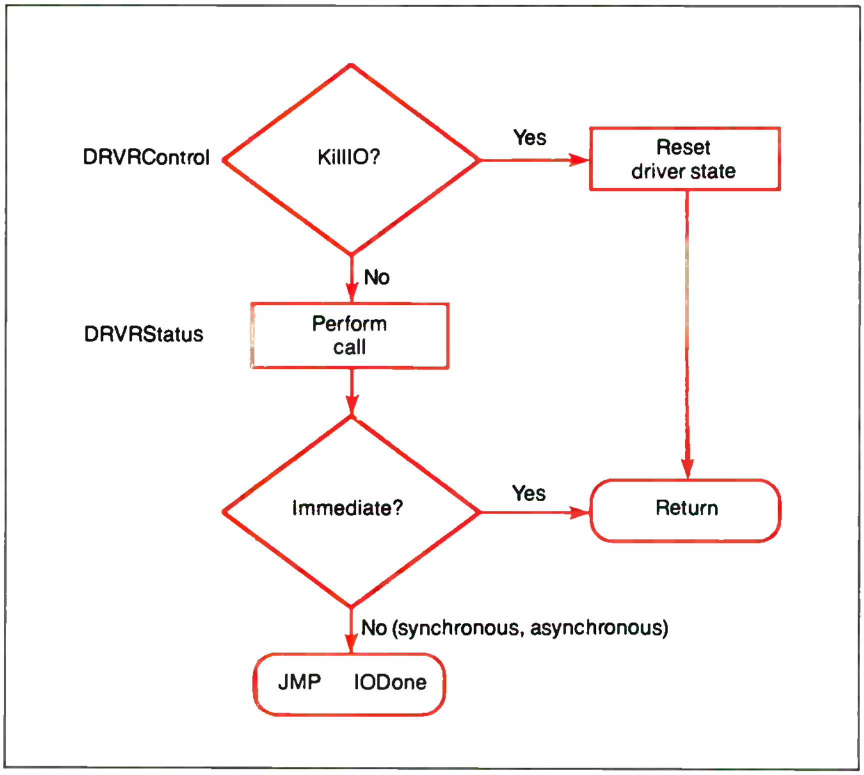


Figure 3: *Flowchart illustrating control- and status-completion logic.*

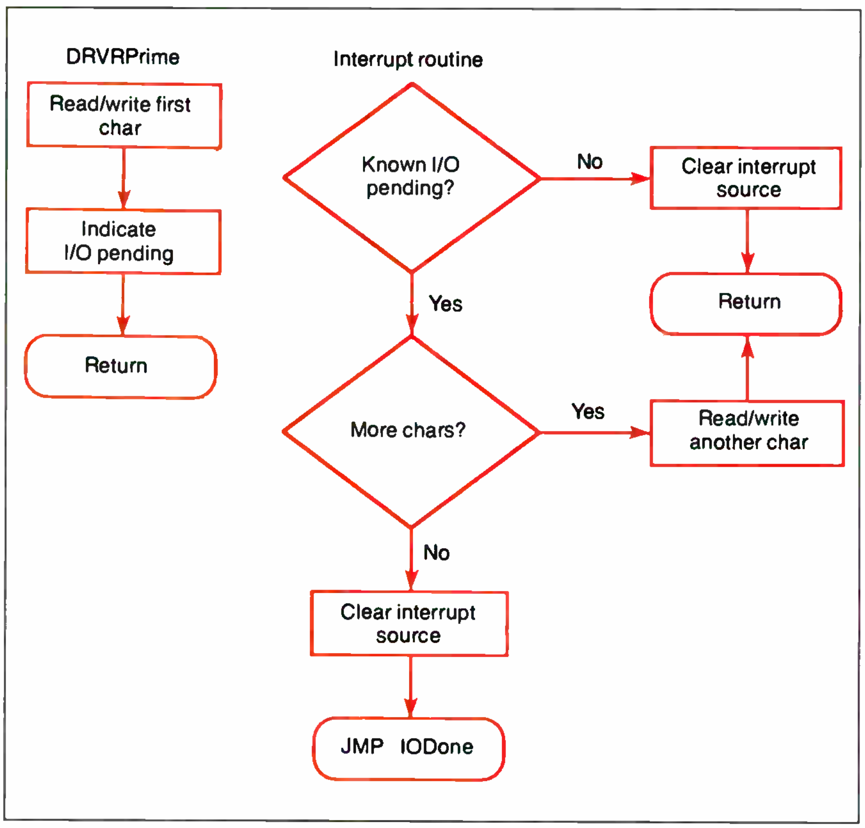


Figure 4: *Flowchart illustrating read- and write-completion logic.*

.Shadow driver sits between any application and the real driver, functioning much like a software breakout box. You could use this skeleton to log the calls to an arbitrary driver by adding code to write debugging traces to a reserved block of memory, to a serial port, or even to disk. As configured, .Shadow receives the calls for modem port .AOut and then passes them to the real .AOut driver.

.Shadow contains the five standard entry points DRVROpen, DRVRClose, DRVRPrime, DRVRControl, and DRVRStatus. The general strategy is to receive a parameter block from an application, patch the appropriate fields of that block, call the real driver, restore the parameter block, and return. The task is complicated by the various ways—synchronous, asynchronous, and immediate—in which you may call a driver routine, and by the completion mechanism of each.

How It Works

Let's start with the simplest case: immediate calls. The .Shadow driver replaces our driver's reference number in the parameter block with the reference number of the real driver. The same call is made to the real driver with our modified parameter block. Our driver then passes along the return value to our calling routine and restores the reference number.

For a synchronous call, our driver can use essentially the same method that it used for the immediate call: Install the real reference number, call the real driver, and then restore our driver's reference number. Instead of returning, however, the entry point calls the IODone routine to terminate the request to .Shadow.

For an asynchronous call, we must also call the IODone routine when the request is complete. In addition, the application may have specified an ioCompletion routine.

The problem with asynchronous calls lies in determining when we can safely call the IODone routine. We can't simply call the real driver's entry point and then call the IODone function when it returns; this would prematurely call the application's ioCompletion routine.

Instead of patching our parameter block, we have to allocate a new one and fill in the appropriate fields. We must specify our own completion routine that calls the IODone function at the correct time. Our ioCompletion routine also has to copy the returned parameters back into our original parameter block and free the allocated memory.

The task is further complicated because we can't call the Memory Manager from inside a completion routine, since such a call during interrupt processing could confuse either the Memory Manager or the application. To avoid using the memory management routines within our completion routine, our driver maintains a list of previously allocated blocks. The driver's ioCompletion routine places the block back on our list of unused blocks.

When an asynchronous call needs a new block, it checks the list of free blocks. If the list is not empty, an old block is reused. If the list is empty, a new block is allocated from the system, but not until it's safe to use the Memory Manager. When the driver terminates, all the free blocks are returned to the Memory Manager.

What to Call and When

You always call open routines synchronously and complete them with a return call. Our DRVROpen routine patches the name of the real driver into the ioNamePtr field of the parameter block (.AOut in .Shadow). If the open is successful, we allocate memory in the system heap. Then we store the reference number of the real driver in this memory and initialize our list of free blocks to zero.

Like opens, you also call close routines synchronously and complete them with a return call. Our DRVRClose routine first calls our routine ReturnMemory, which disposes of each block on our list of used blocks. Then we call CloseDriver with the reference number of the real driver and return its return value as our own.

You can call the DRVRPrime, DRVRControl, and DRVRStatus entry points as synchronous (queued), asynchronous (queued), or immediate (nonqueued). The ioTrap field of the parameter block determines the calling method: If bit 9 is set, it signifies an asynchronous call; if bit 10 is set, it signifies an immediate call. After determining the calling method, we proceed as above.

The author of a device driver meets programming obstacles that are different, if not more difficult, than those facing the application programmer.

A call to DRVRControl of csCode=1, representing _KillIO, is a special case. We have to call _KillIO on the real driver instead of just passing along the _Control call. Otherwise, the real driver's I/O queue will not be cleaned up properly.

The Challenge

In addition to device dependencies, the author of a device driver encounters programming obstacles that are different, if not more difficult, than those facing the application programmer. Debugging a program that runs at interrupt level is inherently difficult. Nonrepeatable timing errors, interactions with debuggers in interrupt routines, and differences in interrupt levels between different Macintosh models make it more difficult to find the problem. Many standard debugging techniques, such as writing information to a status window, are simply unavailable.

Each Macintosh device driver is unique, and the problems that you will encounter are different from those you may be used to. But these rules and guidelines should help you get started writing device drivers. ■

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How the Macintosh II NuBus Works

Trevor Marshall and Jim Potter

One of the nicest things about the Mac II is that most expansion boards plug into it with a minimum of fuss. That is, you don't have to tinker with switch positions or jumpers to get the board to work with the machine. Although this makes things easy on the computer user, it puts a lot of responsibility on the board designer.

Some of the information is not in the manuals

We built a coprocessor board based on the AMD 29000 reduced-instruction-set-computer microprocessor for the Mac II. In the process, we learned a lot about how Apple's implementation of the NuBus works. As we describe what we did to build an expansion board, you'll see the intricate concert of hardware and software that lets you plug a board into a Mac II and "forget about it."

The NuBus

The NuBus is a full 32-bit, multiplexed bus (i.e., the address information is multiplexed on the same lines as the data) with the ability to handle 8-, 16-, and 32-bit transfers. It is a synchronous bus, with a 100-nanosecond bus clock that ensures that all transactions occur at the correct intervals.

The NuBus was developed at MIT. Originally, it bore little resemblance to the NuBus of today. It was soon licensed by Western Digital, a company that continued its development, and a number of smaller firms began producing NuBus products. By the time NuBus was licensed to Texas Instruments for that company's range of minicomputers, it had become a synchronous bus. In 1986, the IEEE decided to form a committee to create a standard specification, the IEEE-1196 NuBus.

When Apple was looking for a 32-bit bus for the Mac II, it found the NuBus attractive because of a number of factors: It had the high performance necessary to match the 68020 processor's throughput, yet it used a low-cost, reliable, 96-pin Euro-DIN socket connector that was easily adapted for the automated assembly lines Apple was planning. The starkly simple approach to resolving a board's address mapping on the NuBus would avoid many user-installation problems. In addition, the NuBus specification was just going through the IEEE standards committee, giving Apple the opportunity to incorporate special features it wanted into the bus standard.

One modification made to the standard was the addition of a *PC form factor*. The original NuBus proposal called for a large, triple-height board (11 by approximately 14½ inches), suitable for minicomputers but not for personal computers. The PC form factor that was adopted is approximately the same size as an IBM XT card (4 by 12⅞ inches). The industry had shown that quite complex functions could be packed onto a board of that size.

The NuBus uses a single 4-gigabyte address space and supports a maximum of 16 card slots. Each slot is uniquely identified and has its own dedicated 16-megabyte *slot space* within the upper 256 megabytes of the NuBus address space (see figure 1). A NuBus board senses which slot it is in and adjusts its address mapping automatically. This prevents a board from clashing with the address spaces of other boards on the bus, and it eliminates the need for address jumpers or DIP switches to set the board's address space. Detailed operation of the NuBus can be found in *Designing Cards and Drivers* and won't be repeated here.

The current Mac II has only six slots with slot IDs from 9 to E hexadecimal. If you look inside the Mac II, you can see the slot ID silk-screened onto the motherboard alongside each NuBus connector. Apple has also defined a *superslot space* that associates an additional 256 megabytes per slot. Thus, the 256-megabyte superslot spaces for the current Mac II NuBus implementation range from 9000 0000h to EFFF FFFFh, and the 16-megabyte slot spaces range from F900 0000h to FEFF FFFFh.

It is unlikely that more slots will be made available in the near future. As figure 1 shows, additional slots can't be mapped into the 24-bit addressing mode of the Mac II, even though the hardware decode could address slots 6, 7, and 8. In addition, only the bottom megabyte of each slot space is available to programs running in the 24-bit mode (see below).

It is possible to connect an expansion chassis mapped into a Mac's unused superslot spaces. The expansion chassis then decodes the 256-megabyte superslot into extra 16-megabyte slot spaces.

Macintosh Hardware Overview

Figure 2 shows a block diagram of the Mac II's hardware system. The address-mapping unit (AMU) isolates the 68020 CPU and the 68881 math coprocessor from the memory and peripherals, which are connected directly to the 32-bit address space that the NuBus uses. The AMU may be Apple's custom hardware memory-mapper unit (HMMU), Motorola's 68851 paged memory management unit (PMMU), or the Motorola 68030 CPU itself. The I/O chips (VIA1, VIA2, SCSI, SCC, IWM, and the Apple Sound Chip) are located between addresses 5000 0000h and 5FFF FFFFh. The ROM containing the system software sits between 4000 0000h and 4FFF FFFFh. In the 32-bit addressing mode, this system layout allows for 128 megabytes of on-board RAM (from 0 to 3FFF FFFFh).

Getting more down-to-earth, when 4-megabit-density single in-line memory

continued

outside this 16-megabyte address range; therefore, it requires 32 bits of address to be accessed.

The Bus Interface Units (BIUs) that connect the NuBus to the 68020-compatible internal 32-bit buses perform a number of tasks. First, the "big-endian" byte ordering (byte 3 in a long word is least significant) of the 68020 processor must be changed to the "little-endian" format used by the NuBus (byte 3 of a long word is most significant—the same byte ordering as on Intel processors). This translation occurs in hardware by cross-wiring the bus transceivers between the 68020 and the NuBus address lines.

In addition, the BIUs support the unaligned access modes of the 68020. This allows a 68020 memory write, which can be a byte, a word, or a long word in width, and can start at any byte address, to be routed to the appropriate NuBus addresses. The most common case is a 32-bit write aligned on an even byte boundary. For this case and for single-byte writes, only one NuBus cycle is generated. The 68020 performs these translations internally for data reads.

The 24-bit Legacy

Early Macintosh computers were designed around the 68000 microprocessor, which has a 24-bit address bus that provides 16 megabytes of available linear addressing range. The Mac II's 68020 has a 32-bit address bus with a total addressing capability of 4 gigabytes—the same size as the NuBus address space. So it seemed to us that Macintosh software, using both the flat address space of the 68000 family and the flexible nature of the Mac's Memory Manager, could be easily ported to the Mac II. Unfortunately, this turned out to be a significant problem.

The Memory Manager uses items called *master pointers* to point to objects in the Mac's memory. Although master pointers are 32 bits in size, they use only the lower 24 bits as address information (remember the size of the 68000's address bus). The master pointer's upper byte holds flags that describe the object's properties: whether it is purgeable or not, or whether it is fixed ("locked") at a particular spot in memory or can be relocated.

Ideally, Apple could have quietly rewritten the Memory Manager; applications would continue to request and release memory using it, never knowing that the routines had changed. Unfortunately, Macintosh software developers, for the sake of performance and other reasons, had written their applications to modify the flags in the master pointers directly, rather than using Memory Manager calls. Thus, much of the current 68000 Macintosh software would not have been able to run on the Mac II if Apple had not implemented a 24-bit compatibility mode in its hardware. In this compatibility mode, the 32-bit addresses are truncated by the AMU back to 24 bits. This mapping is shown in table 1.

What this means is that while the 32-bit mode allows an application maximum freedom in handling boards on the NuBus, it also severely limits the application's ability to access the Mac Toolbox and ROM routines. If a peripheral board needs more than 1 megabyte of slot address range or is designed for non-Apple NuBus implementations, the operating system must be switched to the 32-bit mode prior to any access to the board.

Most 32-bit applications switch to the 32-bit mode to perform a NuBus transaction to the boards and then quickly switch back into 24-bit mode before doing any system calls. This is inefficient: The Toolbox call that performs this operation takes about 25 microseconds to switch between the two addressing modes. Apple is encouraging developers to modify their applications to normally operate in the 32-bit mode, so this problem should disappear in time.

Note particularly that the screen savers driven by timer interrupts will most likely crash and burn if an interrupt occurs while your application is in the 32-bit mode. We recommend that you remove all screen-saver-type desk accessories (DAs) while you are using the Mac's 32-bit capabilities.

In addition, compiler routines that drive the Apple video board seem to run in the 24-bit mode. While the video board itself is addressed in the 32-bit mode, most software that writes directly to the screen crashes if executed in this mode. This is true for both the TMON 2.8 and MACSbug 5.5 debuggers, making it almost impossible to debug a 32-bit NuBus board. We had to write our own simple debugger/monitor in order to even begin developing the coprocessor board.

Table 1: *The Mac II AMU's address mapping of 32-bit addresses to 24-bit addresses for the 24-bit compatibility mode.*

24-bit addresses	32-bit addresses	Description
xxNzzzzz	00Nzzzzz	On-board RAM[1]
xx8zzzzz	400zzzzz	ROM
xxSzzzzz	FS0zzzzz	Slot[2]
xxFzzzzz	500zzzzz	I/O

[1]N is 0 through 8 for a total of 8 megabytes of RAM in the 24-bit mode.
[2]S is 9 through E hexadecimal for six slots. Slot 0 is the motherboard; slot F is reserved.

Exploring with the NuBus Monitor

Our NuBus Monitor allows you to copy, display, fill, and substitute memory while the NuBus is in the 32-bit or 24-bit mode. While we wrote it to access the Apple NuBus Test Card and the coprocessor boards that we were developing, the NuBus Monitor is a convenient way to explore the NuBus address space of the Mac II. The tricks we had to use writing this Monitor are the same as those a developer will need to master to get a driver functioning in the Mac II NuBus environment. It is written in Lightspeed C 2.15.

When first invoked, the NuBus Monitor searches for the Mac II's video board. The Monitor starts in the 32-bit mode and looks for a video board occupying one of the slots. It can detect either an Apple Mac II video board or a SuperMac video board by the signature of their configuration ROM. The video board is usually located in slot 9 (the leftmost slot, looking from the front of the machine), although this is not a requirement. From this NuBus slot, the video board appears at address F900 0000h in the 32-bit mode. You should see the prompt `McCray (f9000000) >`.

The displayed address will vary depending on which slot the video board is placed in. This address points to the base address of the video board, so other Monitor commands can be issued using only the lower part of the full slot address. If the NuBus Monitor fails to detect the presence of a video board other than the two described, you can enter the address offset manually by issuing the command `o fN000000`. This sets the NuBus Monitor's operational address offset to slot *n*. Use the offset number *n* (9h to Eh) appropriate for your video board location.

The command `d fff80` dumps the block of memory starting at the top of the video board's declaration ROM. This ROM is used by the Slot Manager software in the operating system to identify the card, set its byte lanes, and allow execution of start-up code for the device. Table 2 shows the format of this ROM.

The examples given here were obtained using an Apple Macintosh II video board and an AppleColor 13-inch RGB monitor. If you are using a different video board or a larger display, your results can vary, depending on the board's resolution and the byte lanes it uses. For a Mac II video board, you will see the following at the bottom of your display:

```
f9fff80:   0        0        0        0
f9fff90:   0        0        0        0
f9fffa0:   0        0        0        0
f9fffb0:   0        ff000000
           f0000000         14000000
f9fffc0:   0        0        10000000         0
f9fffd0:   72000000         97000000
           55000000         f8000000
f9fffe0:   1000000          1000000
           5a000000         93000000
f9ffff0:   2b000000         c7000000
           0        e1000000
```

The top byte of the ROM is the word e1000000. This means that the ROM is organized with only 8 significant bits per word (byte lane 0 of the NuBus). "Word" used in this context is a NuBus word, which is 32 bits in size. Since the NuBus Monitor allows only 32-bit transfers, there is no way to isolate the bytes that the ROM uses from the unused NuBus byte lanes (the zeros). Thus, you have to manually extract 1 byte from each word in your display and piece the bytes together to form the sequential data in the declaration ROM.

The test pattern 0x5A932BC7 (which is used by the Slot Manager to verify that a valid declaration ROM is present) is visible in NuBus words e8 through f4. The ROM format is type 1, as is the revision level. You can decode the rest of the ROM using the information in *Designing Cards and Drivers*.

To obtain this ROM dump, the NuBus Monitor has switched the bus to 32-bit mode prior to each read from the NuBus address space used by the peripherals, then has switched back to 24-bit mode to use the Macintosh Toolbox routines to display the data. The BIU chips are doing simple 32-bit reads and writes.

An immediate anomaly should be apparent: Figure 1 shows that the declaration ROM is at the top of the slot space, yet we are dumping memory 1 megabyte above the bottom. The Mac II graphics card is designed with 24-bit "aliasing" (see table 1) by ignoring address lines AD20*, AD21*, AD22*, and AD23*. Thus, the ROM is visible at the same offset in both the 24- and 32-bit modes. Indeed, the ROM upgrade (to revision B) required on all the early Mac II production machines was necessary because the early Slot Manager software omitted to check for a ROM using the true 32-bit offset in addition to the aliased 24-bit configuration.

Now try `f 0 1000 ffff0000`, which fills the addresses f9000000h to f9001000h with the 32-bit word ffff0000h. You should see a series of vertical black bars at the top of your screen as you write directly to video memory. Don't worry about your display; it will return to normal either when you exit the NuBus Monitor or when a complete screen redraw is performed, usually by changing the depth of your display.

You can experiment and find out how the video board memory is displayed on the screen by carefully filling portions of video memory and then watching where and how the screen changes. Try using the `Monitors` cdev in the Control Panel DA to change the color or gray-scale aspects of your monitor screen. With the two-color mode, the same fill command yields wider and taller black bars on the screen, while in the 16-color mode the bars cover a much narrower and smaller area. This is due to the "chunked," or adjacent, positioning of data in video memory. The result is that even though you are still filling the same amount of memory, it covers more of the display when you're using fewer colors.

Now change to the 24-bit address mode by giving the `m` command to the NuBus Monitor program. This toggles the NuBus Monitor's operating mode from 32 bits to 24 bits and lets you experiment with the address offsets needed in the 24-bit compatibility mode. Typing the command `o 900000` sets up the correct standard board base address in this mode. Again dump from fff80h. You will again see the declaration ROM, mapped by the HMMU from its true 32-bit address (f9000000) to 900000. Now fill from 0 to 1000 with 0000ffffh. You'll see that the bars have offset slightly to the right on your screen, as the NuBus data word used this time reversed the position of the 00 and ff bytes.

Memory can also be substituted on a 32-bit basis by typing `s 0`. This instructs the NuBus Monitor to display 4 bytes at the current offset plus an additional displacement (in our example, zero):

```
f9000000:     ffff0000     |
```

You can enter up to eight hexadecimal digits at the vertical bar prompt. The digits are converted to a 32-bit value and written into that memory address, and the next 4 bytes are displayed. A simple carriage return without any numeric entry skips the current address and leaves the memory contents unchanged. Typing a minus character moves the current address backward, and typing a period places you back in the NuBus Monitor's command mode. You can also copy and move memory by giving the command `c 0 200 7000`, which copies the contents of addresses 0 through 200h to addresses 7000h to 7200h.

If your screen is still in the two-color mode, this command copies the menu

continued

Table 2: *The contents of a configuration ROM's format block.*

Offset from top of slot space	Contents	Description
0	Byte lanes	NuBus byte lanes to use when accessing the declaration ROM
−1	Reserved	Must be 0
−2	Test pattern	5A93 2BC7h
−6	Format	1 = Apple format
−7	Revision	Current ROM version; can be 1 through 9
−8	CRC	Checksum to verify the declaration ROM
−12	Length	Number of bytes from the start of the ROM to the start of the ROM's sResources[1]
−16	Directory offset	Signed offset from the offset itself to the sResource directory[1]

[1]Values are in byte lanes.

The Texas Instruments NuBus Chip Set

Texas Instruments recently released two chips to ease interface design for the NuBus. The first chip, the 74BCT2420, supplies NuBus-compatible address/data transceivers and registers. The second, the 74ACT2440, supplies the NuBus master-/slave-state machine logic. If we were to redesign the NuBus Test Card using these new chips, then two 74BCT2420s would replace the 74ALS651, 74LS374, and 74F521 components. One 74ACT2440 replaces the programmable array logic devices in the NTC schematic.

Figure A shows the logic diagram of the 74BCT2420. At the top of the diagram are the comparators used to determine whether the NuBus slot ID matches the current address on the bus. The detailed logic of this comparator is illustrated in figure B. Since the 74BCT2420 is only 16 bits wide, you need two to accommodate the 32-bit-wide NuBus.

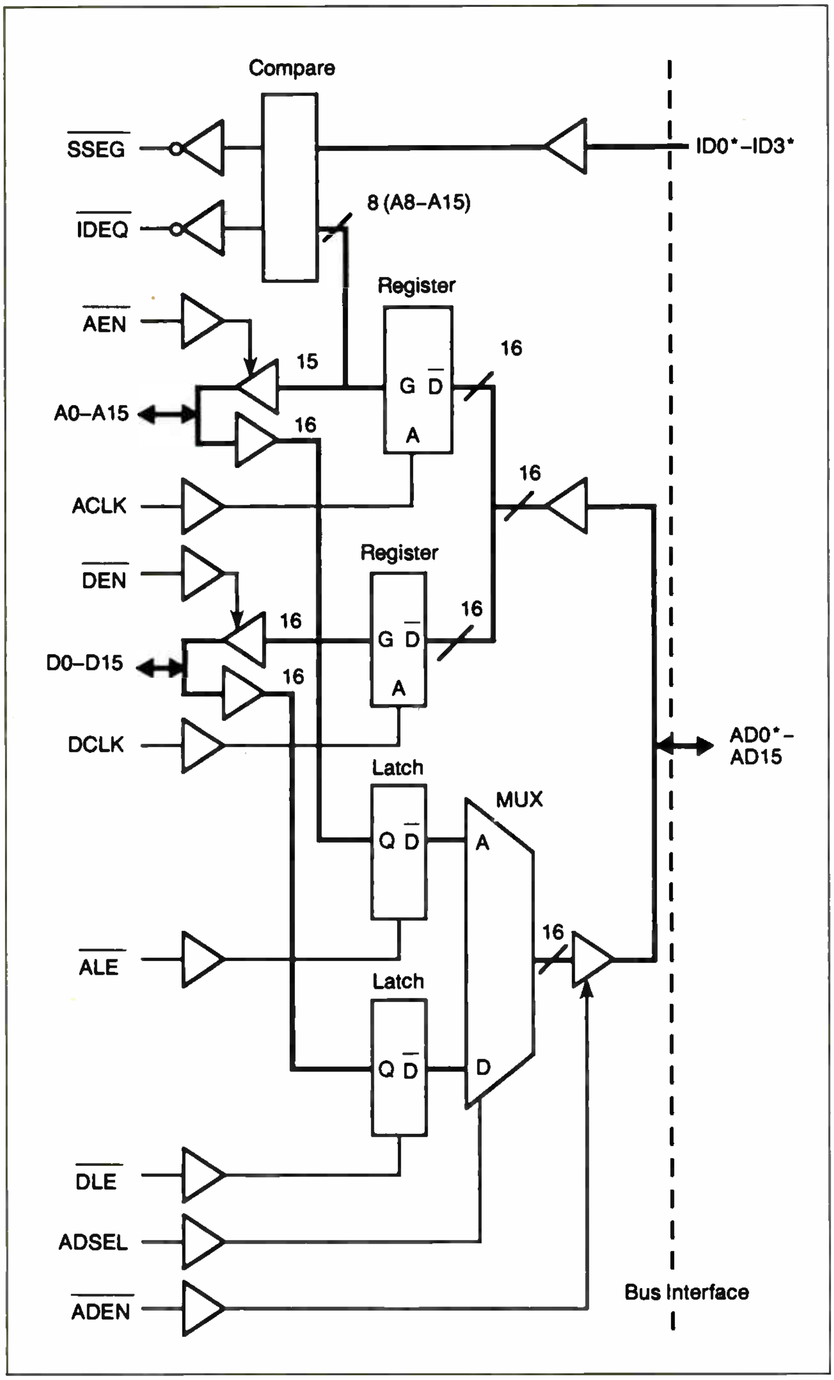


Figure A: *Block diagram of the 74BCT2420 logic.*

Both superslot and standard slotspace address allocation of the NuBus are decoded. The superslot output ($\overline{SSEQ}$) compares A12, A13, A14, and A15 with the slot ID to uniquely decode a 256-megabyte address space. The $\overline{IDEQ}$ output signals normal slot space by checking to see that the superslot is space F while also comparing A8, A9, A10, and A with the slot ID. If you're having difficulty correlating these address bits with the address map in figure 1, remember that these parts are only 16 bits wide. Thus, the address bits on the comparator diagram labeled A12–A15 would actually be A28–A31 on the 74BCT2420 connected to the upper half of the 32-bit NuBus, and A8–A11 would be A24–A27. The $\overline{SSEQ}$ and $\overline{IDEQ}$ outputs from the 74BCT2420 connected to the lower half of the NuBus would not be used.

The maximum delay time between address clock and decoded outputs of this part is 20 nanoseconds, slightly slower than a 74F521 but probably acceptable unless you are trying to design a board that operates with zero NuBus wait states (one cycle for the address and one cycle for the data). The companion controller does not sample these decodes until the cycle following the address cycle, which seems to preclude any possibility of zero-wait operation with this chip set.

The chip set is intended to operate in both NuBus master and slave modes. The operation of the buffers and latches in the slave mode is fairly conventional. Data present at the AD0*–AD15* bus pins is buffered and fed to two 16-bit registers, one for the address and one for the data. During the address cycle (START* is asserted), the control circuitry activates ACLK on the sampling edge of the NuBus clock (see figure C). If the $\overline{AEN}$ signal is active, then this address data will appear at the A0–A15 pins and remain latched for the whole NuBus transaction. Similarly, during the final data cycle, when the ACK* has been asserted, the control circuitry will activate $\overline{DCLK}$ and $\overline{DEN}$ to allow the latched valid data to be presented at the D0–D15 pins.

In the master mode, $\overline{AEN}$ and $\overline{DEN}$ are disabled and $\overline{ADEN}$ is asserted. When the valid address has been set up on A0 to A15, then $\overline{ALE}$ is activated to latch it, so it can be fed to the NuBus through the multiplexer (MUX). This is the first significant functional difference from the 74ALS651 approach.

The address in the master mode is fed to the NuBus through a transparent latch, allowing valid data to be set up long before the sampling edge of the NuBus clock. Using the 74ALS651, all internal registers are edge-triggered, forcing a master to keep address and data stable throughout the requisite portions of the NuBus transaction. In the case of our coprocessor, after a master transaction has commenced, the READY signal is not returned to the CPU until the NuBus has totally finished the cycle, so the CPU holds both the data and address valid during the whole transaction. The 74ALS651 parts can thus be used in their transceiver mode, and no latching function is necessary. The master data cycle is controlled similarly, with the MUX steering signal ADSEL kept at logic high.

The 74ACT2440 NuBus Controller executes only a subset of the IEEE 1196 standard functions, because external logic is needed to implement the high-speed burst mode of data transfer (which, in any case, is not used in the Mac II). It will operate in master only, slave only, or master/slave applications, and it generates signals intended to drive two 74BCT2420 parts. It directly generates the ARB0*–ARB3* and RQST* arbitration control signals, as well as the TM0*, TM1* (transfer mode), ACK*, and START* signals.

This controller does correctly perform the locked bus transactions that the NTC PALs fail, but many of its other functions are very similar to those of the NTC PALs.

The introduction of these NuBus interface chips considerably eases NuBus interface design. The chips reduce the NuBus interface to the level of a "black box" that the designer really does not have to be unduly concerned with.

Conversely, however, some flexibility is lost, especially if the ultimate in speed is needed. The chips offer little additional functionality over the discrete approach used in the NTC. If you use a socket to hold the 68-pin PLCC packages, there is little savings in printed circuit board space over the discrete alternatives. In addition, the current pricing of the chip set is higher.

Nevertheless, as the price drops and application support improves, this chip set will help NuBus peripherals proliferate and ensure the success of the bus both in the Mac II and in other NuBus computers.

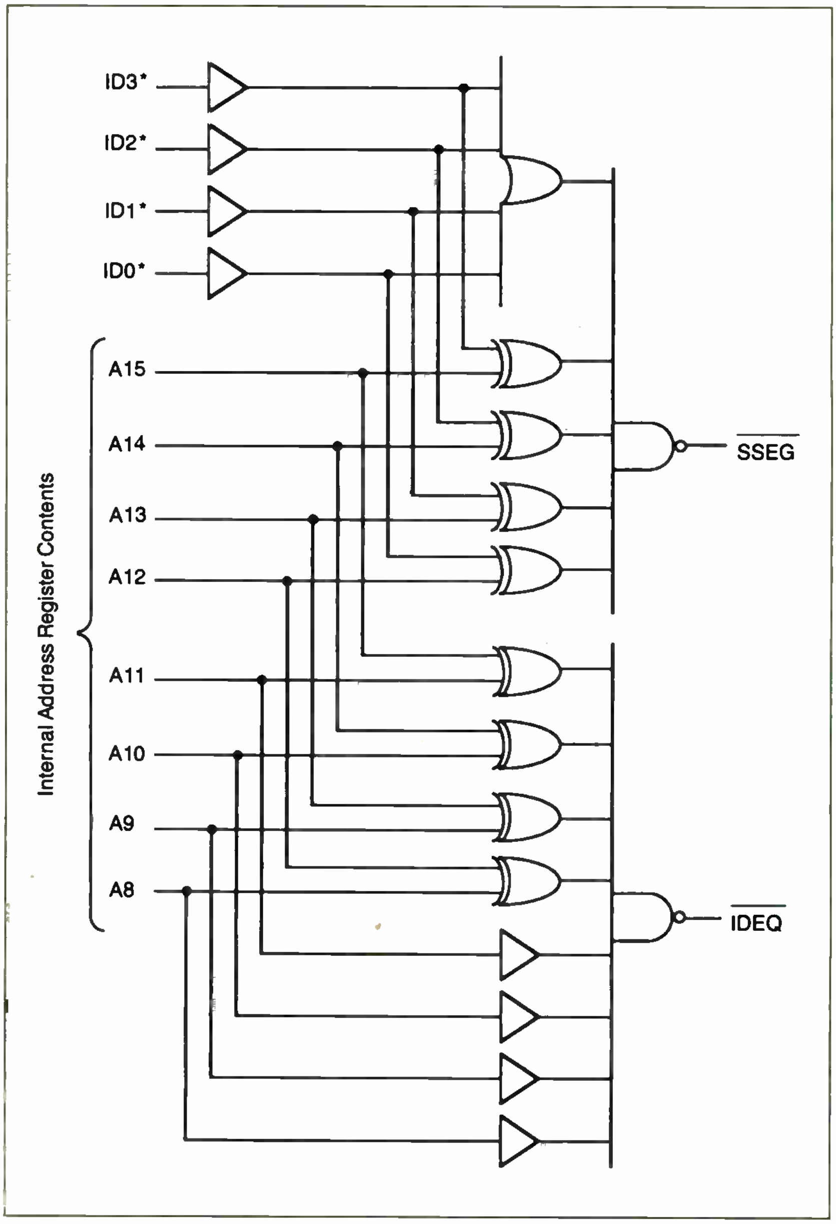


Figure B: *Logic diagram of the 74BCT2420's comparator.*

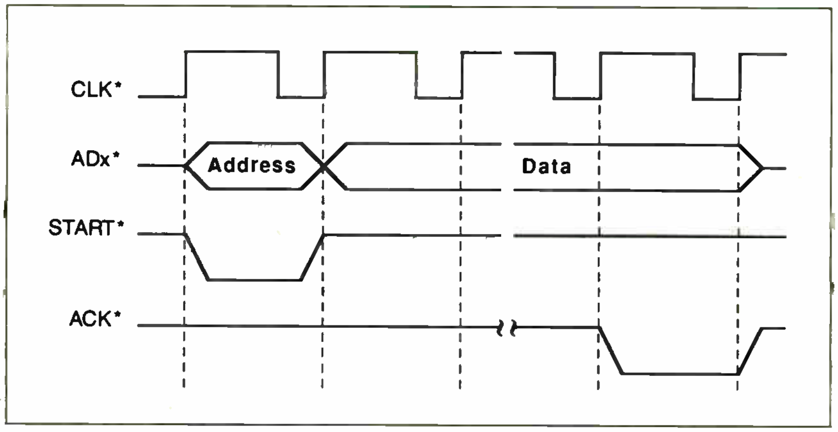


Figure C: *A NuBus write cycle.*

bar to about the middle of the screen. Notice also that when the window scrolls up, it carries the new screen pattern along with it, while the portion of the image that lies outside the NuBus Monitor window remains in place.

When you quit the NuBus Monitor, all the changes you made to the video memory disappear, and the screen returns to its original state. This is because the Finder refreshes the screen memory with its best guess as to what the screen looked like. If the NuBus Monitor went through some QuickDraw calls to write to the screen, the Finder "remembers" those portions when it redraws the screen.

With careful experimentation, you can now determine the inner workings of the Mac II. However, a word of caution is in order here. Since all the NuBus Monitor operations consist of reading and writing directly to NuBus memory, the system software doesn't have any idea what we're doing to its memory; thus, care must be taken while exploring it. We have not crashed a system by modifying the video board memory, but you have to be careful when examining other address spaces, such as the address space where the small-computer-system-interface port and other I/O devices reside.

Filling or copying to the Mac II's main memory can yield fatal results. You should not write to low memory where the CPU vectors and the Macintosh global variables reside unless you really know what you're doing. It's a good idea to back up your file system before you experiment with the Mac II's memory, even if it belongs to just the video board.

Bus Errors

The NuBus has a time-out feature. If the 68020 addresses a slot in which no board is present, then no response or acknowledgment signal (ACK*) will be generated. (We'll use SIGNAL (overlined) to indicate an active low signal on the board, and SIGNAL* to indicate a NuBus signal.) This situation normally causes a bus to freeze, since either the processor or a board will wait for a response signal that it will never get. To prevent this, after 25.6 microseconds a bus timer generates the ACK* signal automatically for the NuBus and supplies a bus error code to the 68020 processor. The 68020 uses this value to locate the address of a "handler" (procedure code) in an exception vector table. This handler is executed in response to this error. Unless the software supplies a handler and the vector table address to it, the 68020 has nothing but nonsense to execute when this type of error occurs, and the Mac II hangs.

Listing 1 shows code to support the bus error code. It is a short fragment of in-line assembly language written for the Lightspeed C compiler. At the commencement of program execution, the MySwap routine locates the bus error vector in low RAM and replaces it with a pointer to our error handler, MyBerr.

When a bus error trap occurs, the 68020 execution is vectored to the MyBerr routine, which calculates the address (from the stack) at which the error occurred, increments it past the instruction that gave the error, and returns execution to that point. Note that this routine will work only if the bus error is generated by a 2-byte memory reference instruction. This is the case with Lightspeed C, but other languages may behave differently, requiring that you modify the code in listing 1.

At the end of the program, the routine CleanUp must be called. This reinstalls the original bus error vector to point back to the Finder. Apple frowns on direct replacement of such vectors, yet there seems to be no alternative for trapping the bus errors at this time.

The NuBus Test Card

Apple designed the NuBus Test Card so Mac II motherboards could be fully exercised during burn-in with both slave- and master-mode transfers. The design of the NTC has been made available to developers. It has also been published in *Designing Cards and Drivers*, complete with all the programmable array logic equations. The NTC gives designers an excellent opportunity to evaluate NuBus operation without first having to complete and debug their own designs. In addition, the

Listing 1: *Software to install a custom bus error routine* (MyBerr) *for use with debugging NuBus hardware and software.*

```
;
; Routines to allow NuBus exploration without Mac system
; errors.
;
; MySwap must be called BEFORE any questionable accesses are
; made to the NuBus. It swaps out the regular Macintosh
; BusError handler vector and substitutes a handler that is
; more forgiving, and won't bomb the whole system if you
; look in the wrong place at the wrong time.
;
; MyBerr is the routine that handles the actual NuBus Bus
; errors that might be encountered. It does nothing but
; bounce back to the user's program, but skipping the actual
; instruction that caused the bus error.
;
; CleanUp MUST be called by the user's program after
; fiddling with the NuBus; It returns the original Macintosh
; bus error handler to the vector area so that the Mac works
; the same way as before the user's program started.
;
;
MySwap:
    move     sr, -(sp)      ; Save the current status register
                            ; on the stack.
                            ; We need to turn off the interrupts
                            ; and get into supervisor mode for
                            ; this replacement operation.
    move     #$2700, sr     ; This puts us into Supervisor mode,
                            ; and turns off interrupts while we
                            ; are in here doing this.
    move.l   $8, a0         ; Get BusError vector from address
                            ; hex $8 in the vector table, move it
                            ; into address register zero.  We
                            ; performed a "move long" because we
                            ; want the whole four byte vector.
    move.l   a0, vect       ; Save the vector into a previously
                            ; set up variable called 'vect'.
    lea      MyBerr, a0     ; Load the Effective Address of our
                            ; new Bus Error handling routine.
    move.l   a0, $8         ; Put our routine's address into the
                            ; Bus Error Vector at address hex $8.
```

continued

PAL equations are easily modified to form the basis of a slave, master, or composite design. The PAL listings are available in *Designing Cards and Drivers.*

YARC Systems built its NTC on a wire-wrap prototype card. Except for giving a lot of trouble due to short circuits between the card gridding and the IC pins, it worked fine and provided a shortcut to understanding multimaster operation on the NuBus. From this basis, we quickly evolved our final master and slave control PALs for the McCray.

Figure 3 shows the NTC's schematic diagram. U1 through U4 are 74ALS651 bidirectional latches with bus drivers. These chips can look like either two 74ALS374 latches or 74ALS245 transceivers, as determined by control signals applied to them. The CAB and CBA signals are equivalent to the clocks of a 74ALS374, and the GAB and GBA signals determine which side of the part is the output and which is the input. The SAB and SBA signals determine whether the outputs are driven from the internal transceivers or from the latches. U5 through U12 are the 74ALS374 latches used to store the address and data that are used to generate the master-mode cycles.

The NTC powers up as a slave on the NuBus. In addition to providing slave read/write capabilities, it can be programmed to automatically take control of the NuBus in a master mode and perform a read or write as the bus master.

When data is written to NuBus address Fss0 0000h, it is stored in latches U5 through U8. It can be read back from the same location. This is the address that the NTC uses during the master cycles it generates. Note that the address data must be scrambled to account for the byte-lane positioning. The data to be used in the master cycles is written to address Fss4 0000h. Finally, the control word is written to address Fss8 0000h. This control word determines whether the master cycle is a read or a write and whether a locked or normal transaction is generated; it also sets an 8-bit value that determines the delay between the write to this register initiating the master cycle and the actual master cycle itself.

U14 is a 74F521 8-bit comparator used to compare the NuBus slot ID with address lines AD24* through AD31* and thus generate a $\overline{\text{mySLOT}}$ signal. The slave PAL uses $\overline{\text{mySLOT}}$ to detect a NuBus start cycle to the board.

U23 and U24 are 74LS161 counters. They are programmed with the delay value, and they produce the signal MASTERD after they have counted the requisite number of NuBus clock pulses. When both MASTER and MASTERD are valid, the master PAL (U18) initiates a master NuBus transaction. The slave PAL (U16) generates signals to indicate whether the NTC is operating in the master or slave modes, as well as the ROM control signals $\overline{\text{ACKCY}}$, A19D11L, and A18D11L. The latter two signals determine the mode of operation and usually will be replaced by terms more applicable to the environment of your design.

The master PAL generates the timing control signals corresponding to NuBus arbitration, address, and data cycles. The busy signal indicates that the NuBus is in the midst of either a master or slave transaction. The $\overline{\text{LOCKED}}$ signal is generated during a locked NuBus transaction. Unfortunately, the NTC PALs do not allow locked transactions of more than one cycle in length, limiting the usefulness of the feature of the NuBus.

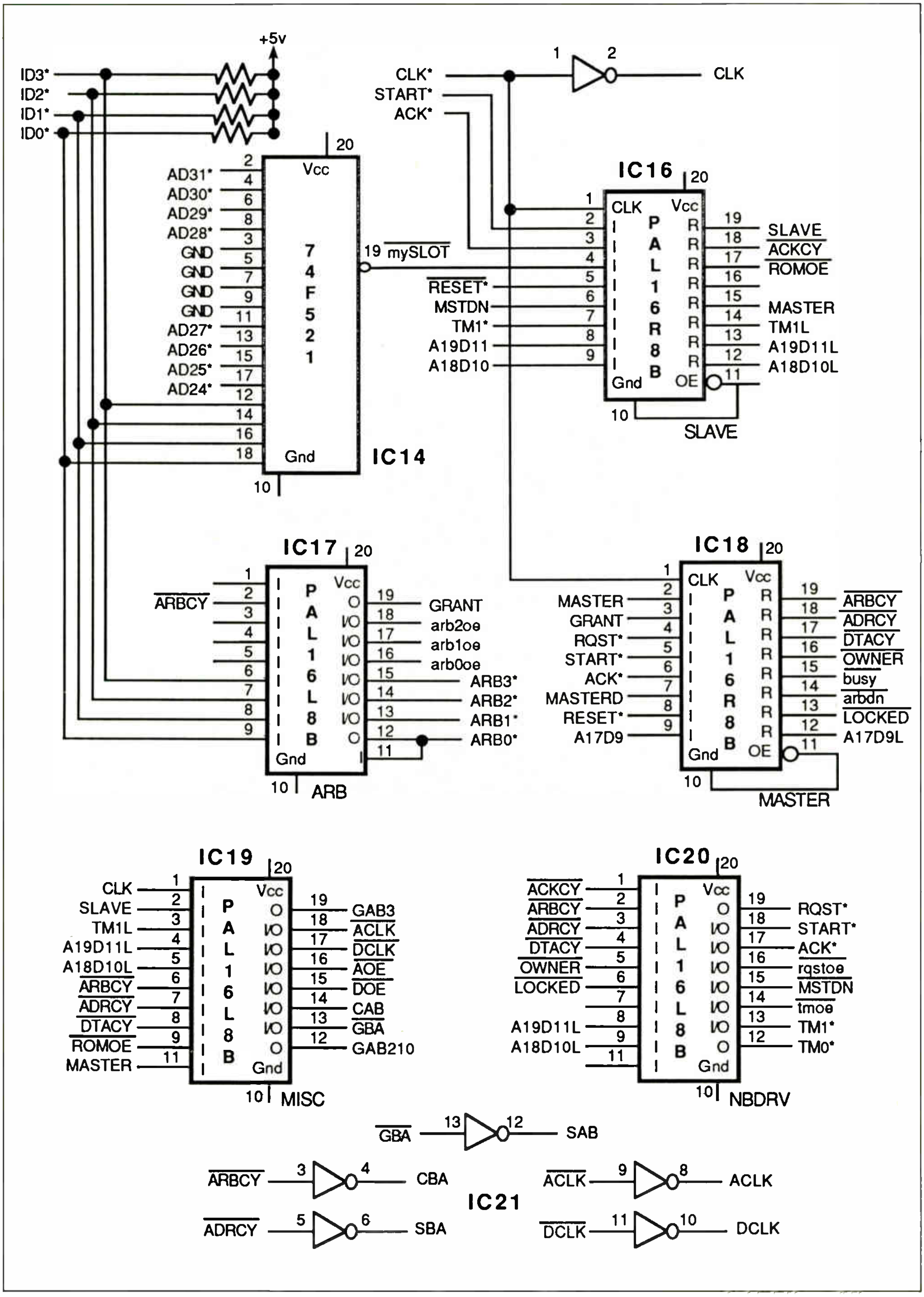
The ARB PAL arbitrates for bus access by placing the card's NuBus ID on ARB0* through ARB3* and sensing whether a higher priority value is present. If not, then GRANT is asserted.

The NBDRVR PAL generates the RQST* signal during the arbitration phase of a master transaction. It also drives the NuBus control lines START*, ACK*, TM0*, and TM1* during both master and slave cycles. Note that in the listing for the NuBus driver PAL on page A-2 of *Designing Cards and Drivers* (nbdrvr2) PAL has a misprint in the pinlist. The pin labeled START should be /START.

The MISC PAL drives the NTC clock and buffer enable signals. This is the PAL that will need the most customiza-

continued

```
        move    (sp)+, sr       ; Recover the original status
                                ; register value off of the stack,
                                ; and return it to the sr.
        rts                     ; scram.
;
; Now comes the routine that pops up every time that we
; explore the NuBus in a place when there isn't anything
; there.
;
MyBerr:
        move.b  $a(sp), d0      ; Get the first byte of the 68020's
                                ; Special Status Word. This is hex $a
                                ; (ten) bytes up on the stack.
        bclr    #0, d0          ; Clear the "Rerun Flag" bit
                                ; so that the 68020 won't continue on
                                ; and re-run the instruction that
                                ; started the Bus Error.
        move.b  d0, $a(sp)      ; Move the adjusted value back onto
                                ; the stack.
        move.l  2(sp), d0       ; Get the Program Counter of routine
                                ; that caused the error, it's a four
                                ; byte value (long) that's two bytes
                                ; up on the stack.
        addq.l  #2, d0          ; Add two to the Program Counter, to
                                ; make the user's program return
                                ; to the instruction after the one that
                                ; caused the offending Bus Error.
        move.l  d0, 2(sp)       ; Move the adjusted Program Counter
                                ; back onto the stack, in the same
                                ; place where we found it.
        rte                     ; Return from Exception, get back to
                                ; the user's program.
;
; This routine sets back the Mac Bus Error handler's vector.
;
CleanUp:
        move    sr, -(sp)       ; Save 68020 Status Register, and
                                ; turn interrupts off again for a
                                ; moment.
        move    #$2700, sr      ; Again, go to Supervisor mode and turn
                                ; off any interrupts.
        move.l  vect, a0        ; Restore the original Bus Error Vector.
        move.l  a0, $8          ; And move it back to the Vector Table.
        move    (sp)+, sr       ; Restore interrupts, etc..
        rts                     ; and return.
```



+5v
ID3*
ID2*
ID1*
ID0*
AD31*
AD30*
AD29*
AD28*
GND
AD27*
AD26*
AD25*
AD24*
Vcc
74F521
Gnd
IC14
19 mySLOT
CLK*
START*
ACK*
CLK
RESET*
MSTDN
TM1*
A19D11
A18D10
IC16
PAL16R8B
SLAVE
ACKCY
ROMOE
MASTER
TM1L
A19D11L
A18D10L
OE
IC17
ARBCY
PAL16L8B
GRANT
arb2oe
arb1oe
arb0oe
ARB3*
ARB2*
ARB1*
ARB0*
ARB
IC18
GRANT
RQST*
START*
ACK*
MASTERD
RESET*
A17D9
PAL16R8B
ARBCY
ADRCY
DTACY
OWNER
busy
arbdn
LOCKED
A17D9L
IC19
CLK
SLAVE
TM1L
A19D11L
A18D10L
ARBCY
ADRCY
DTACY
ROMOE
MASTER
GAB3
ACLK
DCLK
AOE
DOE
CAB
GBA
GAB210
MISC
IC20
ACKCY
ARBCY
ADRCY
DTACY
OWNER
LOCKED
A19D11L
A18D10L
RQST*
START*
ACK*
rqstoe
MSTDN
tmoe
TM1*
TM0*
NBDRV
GBA
SAB
ARBCY
CBA
ADRCY
SBA
IC21
ACLK
DCLK

tion for your particular hardware.

If this all seems a bit complicated, remember that the NuBus, while simple in design, is sophisticated in its operation, including master/slave functions and bus arbitration. Texas Instruments has recently introduced a set of chips that implement most of the NuBus functions in two chips that should greatly ease the construction of new peripheral boards (see the text box "The Texas Instruments NuBus Chip Set" on page 44).

The NTC's ROM can be programmed with data (such as that in table 2) to more fully exploit the capabilities of the Slot Manager software and the byte-lane capabilities of the Macintosh. Normally, a board's driver software will be located in this ROM. The Slot Manager installs this driver code into the Mac II's main memory when the computer boots.

What We've Learned

The NuBus used in the Mac II is a powerful bus with speed and capability matching the power of the 68020 CPU. Design of boards and peripherals for the NuBus is fairly straightforward, thanks to the clean logic of the NuBus and the technical support provided by Apple. We encountered some problems during the construction of our board; some will go away as Mac II software evolves toward a 32-bit addressing mode, but a mechanism where a developer can cleanly replace the bus-error vector should be looked into.

Despite these incidents, we did succeed in constructing our board, which means the problems encountered were not insurmountable. We hope that the information provided here and our NuBus Monitor will make future developers' jobs a little easier. ■

Editor's note: *The source code and executable code for the NuBus Monitor described in this article are available in a variety of formats. See page 3 for details. They are also available on the Thousand Oaks Technical Database, (805) 492-5472 and (805) 493-1495. The NTC schematic and PAL listings are also available on BIX.*

ACKNOWLEDGMENT
The authors wish to thank Ron Hochsprung at Apple for his patience and support while helping us become acquainted with the NuBus quirks.

Trevor Marshall is the chief engineer at YARC Systems Corp. in Thousand Oaks, California. He can be reached on BIX as "tmarshall." Jim Potter is the 29000 software team leader at YARC. You can reach him on BIX c/o "editors."

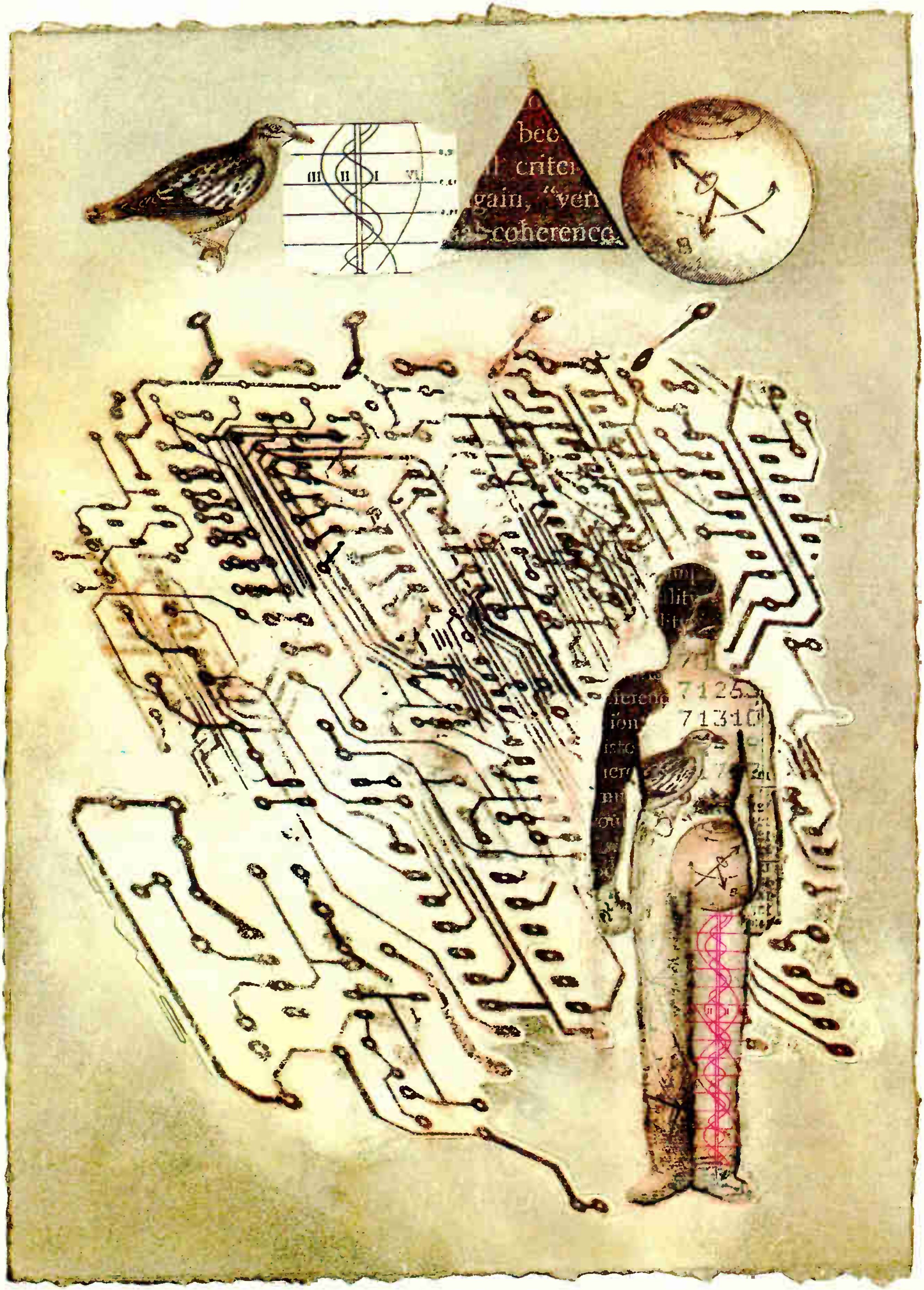


ILLUSTRATION: JOHN STEWART © 1988

Program Extenders

Laurence H. Loeb

Specialized tools make it easier to jump into Mac programming

Lately I seem to be getting a lot of letters on BIX (where I comoderate the macintosh conference) that are disturbingly similar. Always polite, the writer will say something like "Hi! My company just got some Mac IIs (finally!), and I've got a lot of ideas about the programs I want to do. What's a good start on how to program the Mac? Can I just use the non-Mac C code subroutines I've got already? I said I'd be able to show them something in a few weeks, so I'd appreciate any help on this."

I tend to look at the screen for a while, mumbling, wondering where to start. I feel for the programmer who has to show some results quickly, but I usually write back that it isn't that easy. And it's not. The paucity of *experienced* Mac programmers has caused something of a minor bidding war for their services as more companies enter the Mac software market. Supply and demand are in the driver's seat again.

But what of the unfilled demand when the supply runs out? Simple. Programmers who have worked on other machines start in on the Mac. And write me letters on BIX, hoping for a quick technofix. So what I'm going to do for the rest of this article is write a letter of reply to all you folks out there. If you want more details on the nit-and-grit of code calls, the selected bibliography that ends this piece will be useful. I'm going to point out the general terrain here and offer some specifics on useful stuff to get you up and running.

Some Starting Points

If you have never seen a Mac program before, you might want to consult Apple Computer's *Programmer's Introduction to the Macintosh Family*. It covers a lot of things that a programmer approaching the Mac for the first time would find useful. It's hard to program the events for a GoAway box if you don't understand what it is, right? As befits an introductory tome, its breadth is greater than its depth. Depth is where *Inside Macintosh* (all five volumes *and* its separate *X-Ref* [cross-reference] volume) comes in. If you get seriously into Mac programming, you'll need *Inside Macintosh*. Your first Mac program, however, may not require you to go out and buy it—especially if you use one of the language extenders I'll be discussing. Some of the extenders may have a necessary subset of the *Inside Macintosh* information available as part of their manuals. Some other introductory books (especially Chernikoff's and Knaster's) show how to use the information far better than *Inside Macintosh*, which is an encyclopedia, not a tutorial.

Shift That Paradigm

One of the steepest parts of the Mac learning curve occurs smack dab in the beginning. You can't design a Mac program (it used to be called flowcharting) in the pre-Mac manner. That's because the way a program works (its paradigm or technique, if you will) has to change. Generic programs (the ones you may have done in, say, COBOL) will get information from the user, go away to process it, and come back when some outputting is needed. The means of putting in the data may be an on-screen menu choice or cards in a deck or something else, but the overall process remains the same. An action is specified (the mode), and then the program performs that action on data. With a Mac, the sequence of this process is turned inside out. One must specify the data first and then the action.

As an example, a word processor will have a delete mode to remove specified text while in that specific mode. In a Mac word processor, you would specify the text by selecting it, then tell the program the action to be performed. A Mac program tries for a "modeless" environment. This is both the foundation of the Macintosh interface and a reason neophyte Mac programmers get lost at the beginning.

I think that Macs will make the computing history books because of the popularization and refinement of this concept, not for the elegant hardware, neat as it is. The first time you use a machine that does things this way can be a transcendent experience. You gain control of computing in ways that had not been possible before. Doing things this way removes a layer of abstraction between the worker and the work. (You don't have to remember the name of the file you want to open because you select the file *first* from a list of choices, then open it.)

The style of feeding information back to you (e.g., when you press a button its color inverts) is the heart of the Macintosh implementation of this concept (a.k.a. "being Macish"). To allow for this complex "human interface," the major executing time of most Mac programs is spent waiting for the user to do something: to create an event that is then handled. An event is usually a keystroke or a mouse movement or some other physical user/machine interaction. The offshoot of event handling is that the user gains control of the program's logical flow. It may not be the 1-2-3 you envision. It may be 2-3-1 once and 3-2-1 the next time.

Once you fully appreciate this shift in paradigms, the programming tools available on a Mac become less opaque and more systematically interrelated. They are there to do the repetitive tasks that

continued

this interface requires of a program, so you don't have to code them yourself.

Why Do I Need the Toolbox?
The Mac operating system software uses a 68000-family assembly-level feature called "interception of unimplemented A traps" when a program makes a call for external code. Instead of specifying the exact address at which the external code will be found, a program instead generates an A-trap exception 4 bytes long. The processor then fobs off to the operating system the job of dealing with this exception. The operating system, in turn, has a patch table where it finds the physical address of the code to be executed. (When Mac programmers talk about a "handle" to some data, it is this doubly indirect method of generating actual addresses that they are referring to.)

You pass the handle to your data or event when calling one of the operating system's Managers, not the data's address. Doing things this way lets your code reference logical objects without worrying about where in memory those objects will be at execution. The operating system takes care of that. Using the code routines that Apple has already written and actively supports (collectively called the Mac Toolbox) in your software helps it be more bulletproof in execution. The actual Toolbox code is usually solid and optimized. If it's not, the operating system can patch it easily when Apple finally gets it right. (Don't laugh. This is what happened with the SCSI Manager between 1985 and 1986.) It also gives you a much better shot at upward compatibility as the operating system and the hardware of the Mac change over time. The Toolbox is something to embrace in your code, not to ignore.

Debuggers
The macintosh conference on BIX has shown me that the debate on the choice of a debugger can grow very heated, very fast. I really don't want to fan those flames. But I have used Apple's MacsBug 6.0 for the last six months and am very happy with it. It is a *vast* improvement over its predecessors, which were based on the Motorola 68000 debugger. Information is now presented in a much more logical manner, and the on-line help has been invaluable. While not as full-featured as TMON (especially with the Extended User Areas that have been developed), it does the things that I need to do almost all the time. And it's always there just waiting for something to happen, because the operating system is set to install it upon boot-up (which, to be fair about it, TMON can also do).

Another useful tool in my bug-catching armamentarium is Steve Jasik's program, Debugger. It might overwhelm beginners, but it can provide a whale of a lot of information about an application through a multiwindow display of what is going on inside it. It is a unique program, providing me with a complete low-level analysis. It hasn't let me down yet.

Cranking Something Out Fast
Suppose your jump into Mac programming requires fast turnaround. You have to get something up on a Mac screen, but it doesn't require blazing performance. You want some buttons for the user to press or some other simple sort of interaction, and you want it quick. How about using HyperCard? HyperTalk (the language that controls HyperCard's actions) is close enough to English syntax that it's

possible to get up to speed in a few days, especially if you have one of the better-written HyperCard introductions at your side. (Danny Goodman's *Complete HyperCard Book*, the first one out, still shines in the rapidly crowding field.)

Using HyperTalk is sort of an extension of the concept of letting the Toolbox handle the events. Event handling is done on a logical scale in HyperTalk, instead of on an assembly-language microscale. You tell HyperTalk to "answer `MyQuestion` with 'OK' and 'Cancel'" rather than calling the individual Managers necessary to put up a dialog box with two buttons, waiting for the mouse click to happen, and finding out from a Manager which button was pressed.

HyperTalk will just get the value of the response for you. The programmer (or "stack scripter," in Apple parlance) concentrates on the logical relationships of the user's actions rather than the actual generation of the interface necessary to elicit the action.

In the August BYTE Macintosh Supplement (page 75), I wrote about how I used HyperCard to solve one of my specific work problems. More can be found in that article on using HyperCard. However, I think it's important not to get dazzled by HyperCard's accessibility. There are drawbacks. For one, users can get to your underlying script code and change it. This may pose a security/maintenance problem. Second, it's a little too easy to reintroduce modal operation in HyperCard. Because of the lack of HyperTalk verbs for every occasion, it's rather tempting in the logical operation of a stack to restrict what users can do and when they can do it. This is one way to break a large problem into smaller, more manageable tasks—but try really hard not to, even if you're itching to take an IBM PC program and put the "screens" you have onto "cards." It may even require you to be somewhat clever in how you approach and script what it is you need to do.

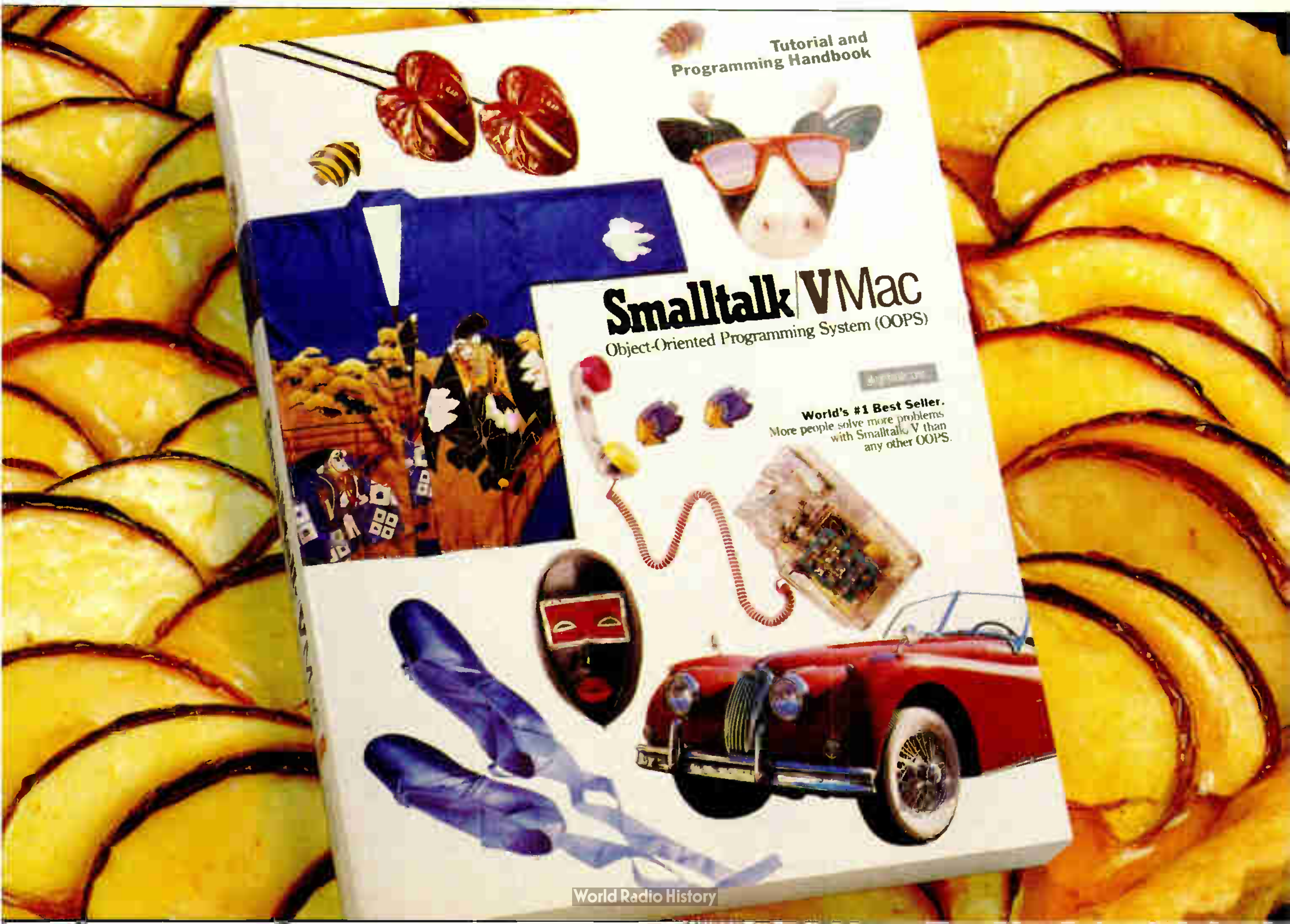
On the other hand, the extra effort required to maintain the "modeless" approach is worth the trouble. Without it, you will lose one of the things that users have come to expect and demand from Mac programs. But if the tasks are just too complex for HyperCard to handle (say, complicated printing) or HyperCard performance in that particular area is not acceptable (say, complex database searches), be prepared to do it another way.

ZBasic

Before HyperCard, there was BASIC. Lacking the satanic bracing conventions of C, it shares with HyperCard scripts a quasi-English readability. Some say this makes for easier maintenance of a program. I only know that one of my consulting clients demanded BASIC as the language for an application so he could maintain it on his own should I be—uhh—hit by a truck. So I wrote this Mac-to-Wang-terminal program that communicated at 19.2 kilobits per second. I compiled it and produced a double-clickable application. All in ZBasic from Zedcor. ZBasic got me paid for the job. The major part of the code from that terminal program is shown in listing 1. While this is the main loop of code, you miss in it the simple way ZBasic can handle events. The Init procedure (listing 2) illustrates more, and listing 3 shows the event handlers the program will branch to.

There is also a "construction set" for

continued



Listing 1: *Some primary code for a Mac-to-Wang-terminal program emphasizes simplicity.*

```
00010 WINDOW OFF:REM Compiler directive
      (turn off default TTY window)
00020 DEFINT A-Z:XON$=CHR$(67):XOF$=CHR$(72):
      REM constants and types
00030 GOSUB "Init" :REM Do initialization stuff,
      like open the serial port "C"
00040 REM Then display characters from C and
      send keystrokes to C
00050 BL=2000:DIM 6 STUFF$(2000):REM ZBasic's array
      setup syntax here
00060 "Loop":REM Logical branch labels instead of
      line numbers are used
00070 Q=0
00080 MENU ON:DIALOG ON:REM That's all you have do
      to check for most events! If an event occurs
      (or gets loaded into the event queue and gets
      checked here) the program branches to the
      event handler
00090 JFLAG =0:TRY=0:QFLAG =0:REM Reset my flags
00100 DIALOG OFF:MENU OFF :REM Shut off event traps
      (so execution speed of the program is increased
      without the event trapping overhead)
00110 "TimeoutTrap":
00120 IF TRY > 50 THEN GOTO "SerialTimed":REM Timed out
      on serial port
00130 "ReadPort":
00140 READ #-1,L$;0 :REM Read the modem port
00150 IF L$="" THEN TRY=TRY+1:GOTO "TimeoutTrap":
      REM Nothing there? Increment and do again
00160 Q=Q+1 :REM Read returned something (L$ isn't empty)
00170 DUM= BL - 1:REM Syntax dummy since IF statements
      can't compute
00180 IF Q > DUM THEN STUFF$(Q)=L$:GOTO "ConvertBuffer":
      REM Overflow buffer check here; the goto will execute
      if true since it's on the same line
00190 STUFF$(Q)=L$ :REM Put character into buffer array
00200 TRY = 0 :REM Reinitialize loop breaker for events
00210 GOTO "ReadPort": REM Go back and read the serial port
```

Listing 2: *An Init procedure in ZBasic.*

```
01080 "Init":
01082 WINDOW 1,"McWang by PBC",(2,38)-(510,335),5:
      REM Set up my window here
01084 WINDOW OUTPUT #1:CALL OBSCURECURSOR:COORDINATE WINDOW
01090 ON MENU GOSUB "HandleMenu":REM  On a menu event
      go to my handler
01100 ON DIALOG GOSUB "HandleDialog":REM Go to my
      handler for others
01110 TEXT 4,9,0,0:REM Style of text to be used
      in my window
01120 REM Set up menus for my window
01130 MENU 1,0,1,"File"
01140 MENU 1,1,1,"Quit"
01150 REM Open Communications port with 1K-byte
      input buffer
01160 OPEN "C", -1,19200,1,0,1,1000
01162 BUTTON #1,1,"Load/Run", (10,280)-(80,295),1:
      REM Specify a button
01170 RETURN
```

ZBasic, called Generator, that automatically puts out source code. You place buttons, menus, and "edit fields" (areas in ZBasic where text is entered or displayed) where you want them on the Mac screen. Generator then produces source code automatically. The handlers you devise are added to this outline (or skeleton) code to make the complete program. This combination can significantly shorten ZBasic programming time for novices. In particular, the syntax of placing event handlers within a program is the thing that most ZBasic first-timers seem to have trouble grasping. Generator puts the event skeleton code into the program in the correct manner, based on the events you show it you want to trap.

I consider Generator an intelligent program extender; that is, it takes care of the code syntax for you and frees you to concentrate on what it is you want the Mac to do. ZBasic 5.0 (promised by Zedcor to be out by the time you read this) will have a command that allows any new Toolbox calls (say, from a 68030-based Mac) to be inserted into ZBasic code through the use of a Font/DA Mover-like utility. This should enhance the ability of ZBasic programmers to use the newest system features, as well. It's on my Hot List, anyway.

Oh Say, Can You C?

I think that "MacJumpers" who have to plunge into a C (or Pascal) programming effort their first (or second) time out should seriously think about using some sort of program extender written specifically for the Mac. Using the prewritten (and hopefully debugged) functions that such an extender provides is a great way to get up and running without having to offer up the hair of one's head in ritual sacrifice to the programming gods.

The specifics of which extender is best for you to use can admittedly be a problem. Some have had their core source routines written in a manner that does not allow much in the way of eventual user modification. However, Invention Software's Professional Programmer's Extender fulfills all the criteria I can set for such a product. The over 800 pages of documentation are clear, crisp, and copiously illustrated with examples of source code. Invention Software makes the extenders for Lightspeed C, Lightspeed Pascal, TML Pascal, Turbo Pascal, Aztec C, and Macintosh Programmer's Workshop (MPW), so just about anyone's choice of compiler should be covered. Invention Software also offers the extender in two volumes to lessen ini-

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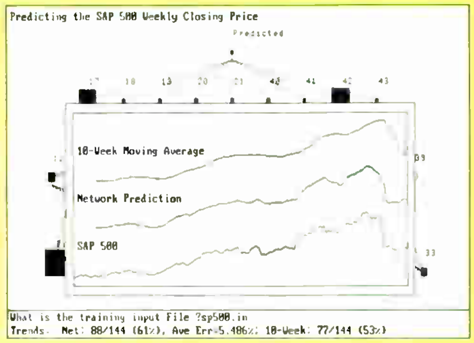

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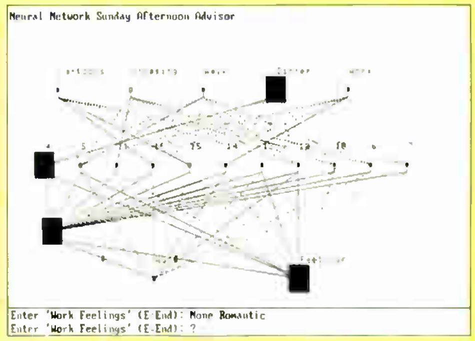

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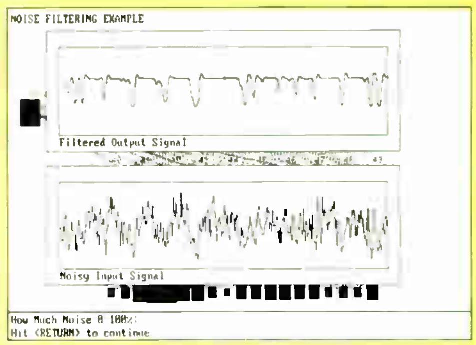
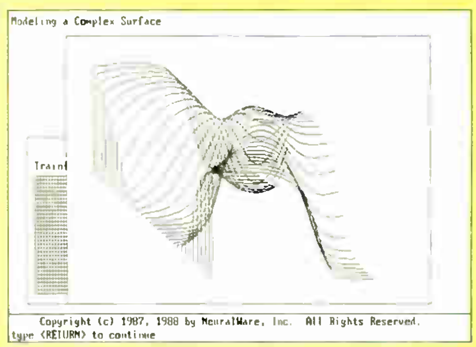


Noise Filtering



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Listing 3: *Examples of event handlers coded in ZBasic.*

```
01180 "HandleMenu":
01190 DIALOG OFF:REM Stop trapping so current event
      can be handled
01195 MENU :REM Invert the active menu like the
      "Human Interface Guidelines" suggest
01200 IF MENU(0)<>1 THEN RETURN:REM Only one menu
      in my application
01210 IF MENU (1) =1 THEN "Endit" :REM Quit has been
      selected from menu
01220 RETURN: REM Go back and wait for serial
      port/keyboard events
01230 "HandleDialog":
01240 DIALOG OFF:MENU
01250 DZ= DIALOG (0):DWON =DIALOG (1):REM Figure out
      what kind of event
01260 IF DZ = 0 THEN RETURN
01270 IF DZ = 1 THEN GOSUB "DoButton":REM Button event
01272 IF DZ =16 THEN PRINT #-1,CHR$(DIALOG(16)) :
      REM Keyboard event
01280 RETURN:REM Back to where the handler was called
01282 "DoButton":
01283 IF DWON =1 THEN BUTTON     #1,1,"Load/Run",(10,280)-
      (80,295),2:PRINT#-1,"LOADRUN";:PRINT #-1,
      CHR$(13);:BUTTON #1,1,"Load/Run",(10,280)-
      (80,295),1:REM Button actions to perform
      invert of button, sending the button message to C,
      and "deinverting" the button
01288 CALL OBSCURECURSOR: REM Direct toolbox call here
01289 RETURN
```

Listing 4: *"Extended" source code shows greater functional orientation of the program.*

```
#include <extender>/* get the extender headers and equates*/

/* tell the program what the local variables are*/
EventRecord    event;
/* event record structure instance  */
EventStuff     whatHappened;
/* event detail structure instance  */
WindowRecord   WR1,WR2;
/* window record structure instances*/
WindowPtr      window1,window2;
/* window record structure pointers */
Rect           myRect;
/* rectangle data structure instance*/
MenuHandle     appleMenu,fileMenu,editMenu;
/* handles for standard menus*/
MenuHandle   hideItMenu,showItMenu,selectItMenu;

/*start of the program proper*/
main()
{
   XTendInit();   /* Extender initialization routine
                     must always be first statement*/

/* do the menu and window setups*/
   StdMenus(&appleMenu,&fileMenu,&editMenu);
                        /* set up standard menus */
/* set up custom menus, with Pascal-formatted
       (\P) text used for  literals*/
   hideItMenu = BuildMenu(20,"\PHide It",
                             "\PHide Window1;Hide Window2");
```

continued

tial cash outlay, but only the "professional" package comes with all the source code.

What does extender code actually look like? I mostly filed off the serial numbers on the program in listing 4 (which will post two windows and select/show/hide one of them based on menu choices) and added some commentary. The idea here is to show how "extended" source code reads compared with normal C coding.

The program flow is remarkably readable for a C program. You may notice that the event flow is, in fact, similar to that of the previous ZBasic example. Most of the program is just waiting for an event, with event handlers providing the bulk of the code. With Extender calls such as `XTGetNextEvent` and `HandleEvent` available, the program becomes far more functionally oriented. Just as ZBasic gives BASIC the verbs necessary to avoid confusing "spaghetti" code, Invention's Extender does much the same for C. All C programmers I know (myself included) seem to have their own routine libraries of things that work. The Invention Extender is like having a prebuilt collection of those routines. The Lightspeed C 3.0 version of the Extender greatly impressed me for both the variety of routines included and the clarity of the documentation that explains how to use them. Another tool for my Hot List.

MPW/MacApp

I haven't mentioned MacApp thus far. MacApp is the "Official Programmer's Extender of Apple Computer" because the company has put a fair amount of both time and money into it. In 1985 or so, there was a hue and cry from the programming community trying to get up to speed on the Mac. Apple realized it had to provide some way to allow coders who were not used to the intricate Mac way of doing things to participate in Mac development. If there wasn't a way for companies to assign teams to a software project, a lot of commercial development would never even be undertaken. In response, Apple came up with an upgrade to the Lisa Programmer's Workshop that ran on the Mac, not the Lisa (which was the recommended development machine at that time). Called Macintosh Programmer's Workshop, its shell runs "tools" as well as compilers. MacApp is such a tool. It uses Object Pascal (a spin-off of the Lisa Clascal) to let you do inheritance-based object-oriented programming. MacApp has things like windows already built in. You select the "view" of an object to be worked with

continued

```
   showItMenu = BuildMenu(21,"\PShow It",
                        "\PShow Window1;Show Window2");
   selectItMenu = BuildMenu(22,"\PSelect It",
                     "\PSelect Window1;Select Window2");

   SetRect(&myRect,100,100,350,250);
                     /* set window boundary rect */
/* next make the window*/
   window1 = CreateWindow(&WR1,&myRect,"\PWindow1",0,
                     TRUE,TRUE,TRUE,TRUE,TRUE);
   SetRect(&myRect,150,150,400,300);
                    /* do it for window 2*/
   window2 = CreateWindow(&WR2,&myRect,"\PWindow2",0,
                     TRUE,TRUE,TRUE,TRUE,TRUE);
/* All set up, so now let's do something!*/
do {
   do {
  /* the following three lines are the crux of any Mac
     program and show the extender's syntax.  It only
     requires 4 calls to do all event intercepts! */

        SystemTask();         /* allow for DA handling */
    } while (!XTGetNextEvent(everyEvent,&event));
                              /* until event occurs */
    HandleEvent(&event,&whatHappened);
                              /* get event info */

    if (whatHappened.MenuNum > 0)
                        /* if user selected a menu item */
        DoWindMenu(&whatHappened);
                        /* handle the menu item selection */
 /* note that ONLY menu events are handled by this program;
    other handers would be called at this point. */
    } while (ExitRequest(&whatHappened) == FALSE);
                       /* if close box hit or
                          quit from std menu*/

    KillWindow(window1);  /* dispose of windows and exit */
    KillWindow(window2);
}
/*end of program, now follow up with its subroutines*/

void DoWindMenu(ES)    /* handles menu item selections */
EventStuff   *ES;
{
switch(ES->MenuNum) { /* Extender gives case numbers
                         from &whatHappened event record*/
  case 20:              /* 'Hide It' menu is selected */
     switch(ES->ItemNum) {
        case 1:         /* 'Hide Window1' is selected */
           HideWindow(window1);
           break;
        case 2:         /* 'Hide Window2' is selected */
           HideWindow(window2);
           break;
     }
     break;

  case 21:               /* 'Show It' menu is selected */
     switch(ES->ItemNum) {
        case 1:          /* 'Show Window1' is selected */
           ShowWindow(window1);
           break;
        case 2:          /* 'Show Window2' is selected */
           ShowWindow(window2);
           break;
     }
     break;
```

continued

```
        case 22:                /* 'Select It' menu is selected */
           switch(ES->ItemNum) {
              case 1:           /* 'Select Window1' is selected */
                 SelectWindow(window1);
                 break;
              case 2:           /* 'Select Window2' is selected */
                 SelectWindow(window2);
                 break;
           }
           break;
    }
  }
```

and add local "methods" to it.

If the time and labor assigned to a first Mac programming effort are both going to be significant, MPW and MacApp may be one way to allow many people to work on the same project and have the code all work together. Both MacApp and MPW have steep learning curves, but the payoff is the "industrial-strength" programming environment. Joel West's excellent *Programming with Macintosh Programmer's Workshop* is both a tutorial and a reference I would recommend to anyone trying to learn MPW. Since Apple supports MacApp and MPW, upward compatibility to new hardware platforms or software features is virtually guaranteed. If you like Pascal, you'll feel at home with MacApp. MPW 3.0 will introduce a source-level debugger running under MultiFinder, which will be a very welcome addition to the environment.

LabView

LabView is a specialized development tool from National Instruments that creates "virtual instruments" that actually do something. If you want to make a data-acquisition or measurement system out of your Mac, I strongly suggest you look at this product. Version 2.0 (promised by the company to be out before the end of the year) will compile the now-interpreted "v.i." This should give users execution speeds comparable to a special-purpose program written in C. NI also has a good record of user support, having gone through two major upgrades of the program since it shipped.

LabView is a "graphical" extender that lets you design the features and the output of your "v.i." on the Mac's screen rather than having to specify them for execution by the underlying code (as you do in SPICE on a mainframe). It is a good example, in my eyes, of a program removing an intruding and annoying layer of abstraction between users and their work, albeit specialized work in this case. The company sells hardware boards for doing measurements, but you can use any instrument that is capable of understanding GPIB commands to generate usable data.

Wrap It Up!

I think that if you can program, you can program the Mac. The recent evolution of extenders has simply made it easier to jump into the field. No extender tools will replace a programmer's ingenuity, but they make it a lot easier to get results while you're learning the lessons that give the basis for that ingenuity. Yes, Real Programmers do use extenders. Especially if they have to get work out the door in a reasonable time. ■

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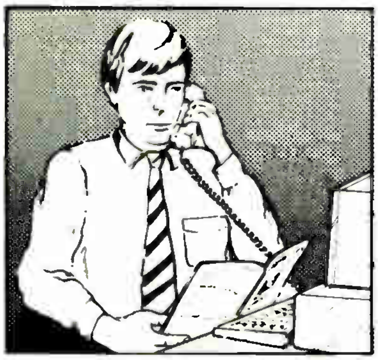

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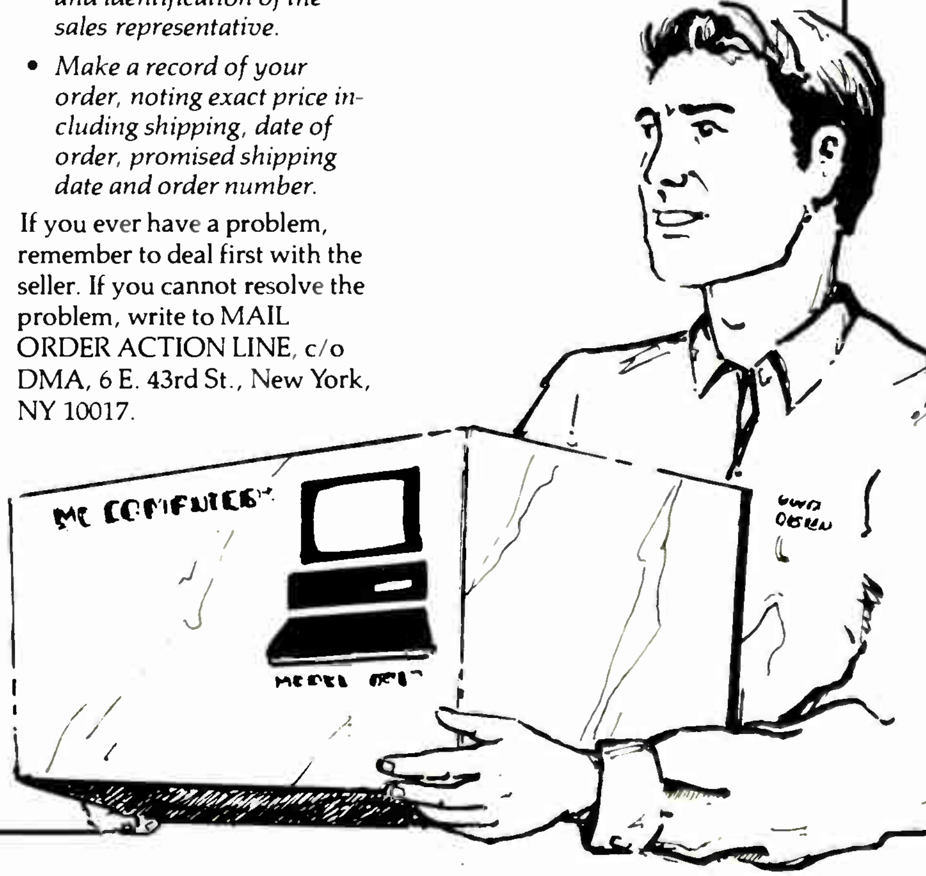

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already-learned behaviors.

I also like the Mac's ability to run smaller programs, called desk accessories, while other applications are in memory. I can increase my productivity as a result of the ready availability of these applications. They give me the ability to work on the Mac in the nonlinear way I do things on a desk. I may do one task in my main application, another task in a desk accessory, and then go back to the main application. These are different from PC terminate-and-stay-resident programs. I can just load a collection of them into the Mac system without worrying if they will conflict or which must be loaded first. It's easy to use them, so they're sure to be used.

I have a choice of Mac hardware platforms on which to run my software, ranging from the very adequate Mac Plus to the powerful Mac IIx. Because of the discipline Apple insists on for programmers, its software will run on any Mac. A few programs require a Mac II to run, but very few. There is a consistency of operation with the hardware as well as the software—a flexibility that allows you to operate with a variety of configurations.

For example, some programs take advantage of the extra function keys on my Mac SE to simplify the operations. But I don't have to have an extended keyboard, because Mac programs will adjust to my existing hardware. I don't have to configure hardware cards or flip the DIP switches on a Mac. Cards added to a Mac II's NuBus will configure themselves. The hardware is designed to take care of itself, so I don't have to.

Another thing about the hardware that I like is the networking support that has been part of the standard Mac hardware since Day One. Called LocalTalk (née AppleTalk), it allows easy networking of peripherals like the LaserWriter. This standard protocol has now blossomed to the point where I can choose from many network implementations, all of which keep the Mac metaphors constant across the network. So the skills I learned on a single-user Mac do not have to be relearned or rethought when I use a Mac in a network environment.

My Mac makes my work easier for me. That's the bottom line. I don't have to fight my machine to get things done. Rather than describe the cell I want in a spreadsheet, I point to it and select it with a mouse-click. I am telling the Mac what I want done in a way that is intuitive to me, rather than having to remember how to tell it in a way the Mac will understand. The intervening layer of abstraction is gone.

While other machines may imitate the Mac's way of doing things, I haven't seen any with the Mac's sophistication and attention to detail. Until I see something better, I'm sticking with the Mac. ■

Harry Conover is CEO of Computer Simulated Sports, a Boston-based sports database company. He can be reached on BIX c/o "editors."

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But you're up the creek unless you can find a friendly dealer who still has the parts and pieces you need and who is willing to part with them without charging an arm and a leg.

Compatibility and RAM Requirements

Although there are parallels to this incompatibility situation in the PC AT world, they're nowhere near as severe. With few exceptions, I can take any contemporary MS-DOS software package off the shelf and have it run just fine on a circa-1983 IBM PC or compatible. I might need to beef up the memory a bit and add a more contemporary version of MS-DOS or PC-DOS, but, with a minimum of hassle, I can run the latest and greatest software on a 6-year-old PC. Of course, the situation will get more complicated when (and if) OS/2 becomes an industry standard, because I won't be able to run OS/2 applications without an 80286-based system and plenty of memory. But I already have an AT clone with 3 megabytes of RAM.

Another pet peeve I have with the Macintosh is the ever-increasing amount of RAM needed to do anything useful. A friend of mine uses a Mac Plus for desktop publishing. Although he had it upgraded, even his 2 megabytes just isn't enough. The latest models of the Macintosh II are coming with 4 megabytes of RAM, an amount that's quickly becoming a standard. With today's memory prices, though, it adds quite a few bucks to the price. And many Macintosh applications I've looked at require huge amounts of RAM while delivering virtually the identical functionality of DOS applications that need half the memory.

Interface and Architecture Trade-offs

There's no denying that the Macintosh graphical interface offers distinct advantages for nontechnical types who are learning to use computers. But in my opinion, it, too, has limitations. As naive users develop into power users, they often find that they want alternate means of performing common procedures. And, as I see it, those alternatives, such as an optional or switchable command-line interface, just aren't there.

In my view, the Mac interface, though slightly improved, still shoehorns you into one set way of interacting with your system. Some commonly required operations become a real trial. But PCs give you a *choice*. And if you really want that Mac-like interface, there's Microsoft Windows and Presentation Manager.

I'm also unhappy with Apple's grudging reluctance to open up the Macintosh architecture. To a degree, Apple made a stab at doing so in the Mac SE and II. But even nearly 2 years later, the add-in choices are limited compared to the thousands of boards and peripherals available for PCs. And what's available almost always comes at wallet-clearing prices.

The last straw for individual users came when Apple made an all-out push to go after that ever-lucrative "Fortune 1000" market. Suddenly, the rest of us were out on the street. Those without deep pockets need not apply. As I write this, Apple has just raised its prices for the Macintosh SE and II. Though the company cited increasing RAM prices and heavy demand for the increase, I don't buy it. The Macintosh is now out of my reach and, I'd guess, out of the reach of the vast majority of individual or small-business users who were the Mac's first enthusiastic buyers.

It's all more than a little ironic in a number of ways. Apple, a company that got its start with a definite counterculture thrust, has turned into a typical corporate giant. Had it played its cards differently, there might be a Mac on nearly every office desk and in every home in the U.S. Meanwhile, IBM has established the real standard by opening up the architecture and making PCs truly ubiquitous. ■

Stan Miastkowski is a BYTE contributing editor, director of K+S Concepts (a documentation and consulting firm), and editor of the "OS Report" newsletter. He can be reached on BIX as "stanm."

Why I Like the Macintosh

Harry Conover

Welcome to Macintosh! That simple three-word salutation is the very essence of why I continue to use the Macintosh line of personal computers as my "tool of choice." In that cheerfully disarming greeting, you realize the significance of the concept advanced by Apple Computer: Computer use should be a seamless extension of the user's expression.

I remember my initial Macintosh experience at the 1984 rollout in Boston. The expressions of hundreds of people sitting in front of Macintoshes turned from puzzlement to appreciation as they changed from observer to participant. Five years later, the Macintosh is still evolving. The core ideas at the root of the Macintosh experience are being maintained while this evolution is opening the door for users to migrate to higher-performance platforms.

Those are the global reasons I continue to use the Macintosh. They are supported by my real-world considerations: ease of use of both the machine and its software, hardware reliability and extensibility, and consistency across the board in terms of Apple's commitment to the machine and to increased productivity.

Let's talk about consistency, since it's the springboard from which all Macintosh tasks are launched. Apple has prescribed some very high standards for Macintosh developers—some may say some very rigid ones as well. Although they force a certain amount of constraint on a developer, these standards provide users with long-term benefits. By abandoning the archaic command line interface used in pre-Mac days and creating the desktop metaphor environment, Apple has set up an atmosphere in which you will enjoy the experience of truly interacting with a Macintosh.

You can easily see this verb-object type of processing when you want to obtain a file or start an application. Instead of typing in a name and/or a path in which to find a file, you visually identify the object and initiate an action (click on it). You could call this a primitive way of "transaction" processing: Select object. Do Object.

This commonality is extended across the range of Macintosh applications so that the skills you learn in one application are transferable to another. Thus, the Macintosh's learning curve can be thought of as "soft," a feature that makes it easier to train Mac users and reinforce

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Why I Still Don't Use a Macintosh

Stan Miastkowski

One of those "no-name" IBM PC AT clones sits on my desk. I use it daily, and it does everything I need. Why isn't a Mac sharing the space, or occupying the place of honor? There are a variety of reasons. Heaven knows, I've been tempted to buy one.

But since I make my living with a computer, I quickly came to the conclusion that the first Mac was a crippled machine. Because there wasn't much software for it and it had only 128K bytes of RAM, it simply wouldn't do the things I needed. So I waited.

An Arm and a Leg

The Mac 512 came soon thereafter, but the software still wasn't there for me. And as it began to appear, Apple threw me a curve again with the Macintosh Plus. At last, a powerful machine with the then-unheard-of full megabyte of RAM and the first implementation of a small computer system interface (SCSI). The Mac Plus was innovative. It was exciting. But it was also ridiculously expensive, especially since it appeared at the same time that low-cost IBM PC clones were becoming widely available.

The Macintosh Plus fostered an avalanche of useful software and peripherals. But the fact remained that outfitting a Macintosh to make it really useful (e.g., extra RAM, a second floppy disk drive, and a hard disk drive) brought the price into the $3500 to $4000 range. It cost easily three times as much as a comparably equipped PC clone, and twice the price of an AT clone.

When Apple rolled out the Macintosh SE and II, I was tempted again. But I still couldn't afford a Mac.

Another thing that bothers me about the Mac's evolution is Apple's propensity for leaving loyal users behind in the dust. To my mind, if you don't own the latest and greatest Macintosh, you have problems. Case in point: Models prior to the Mac Plus had 64K-byte system ROMs. But it wasn't long before lots of the most useful software required 128K-byte ROMs, along with at least a megabyte of RAM.

If you own a 512K-byte Mac or (heaven forbid) a 128K-byte model, you've got problems. Not to mention the fact that these "oldies but goodies" have 400K-byte floppy disk drives. Since 800K-byte drives have been standard issue from the Mac Plus on, most software is shipped on 800K-byte disks. Usually, manufacturers will send you 400K-byte disks if you return the 800K-byte versions. But it's a pain, and many companies charge extra for it.

Sure, you could upgrade your system ROMs, memory, and floppy disk drives.

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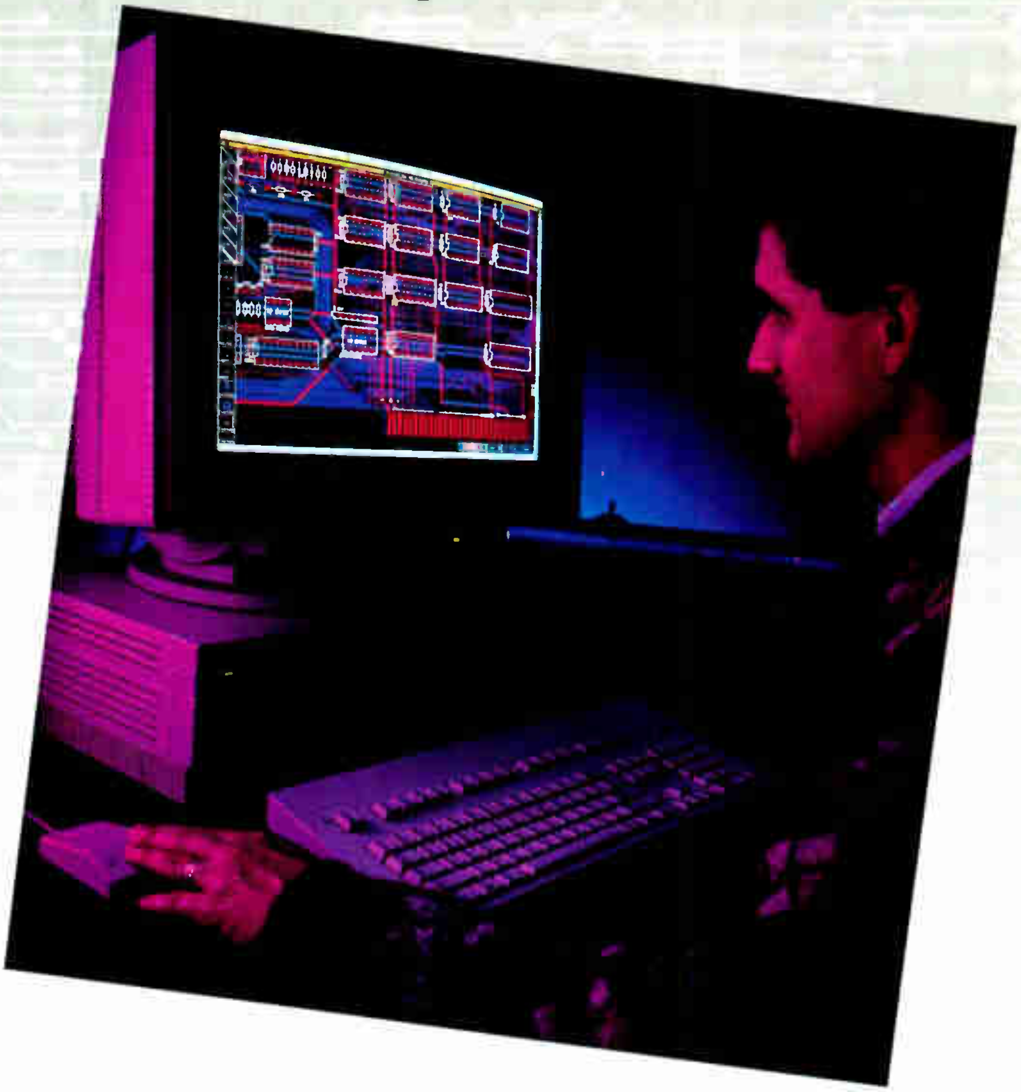

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IN DEPTH

Groupware

Working together is not a new idea. We've been doing it since the days of the hunters and gatherers. And we've done lots of it at our various workplaces. In fact, sometimes coordinating the different parts of a workgroup so that they can work together takes more time and effort than the job we're trying to accomplish.

That's where groupware comes in. The purpose of groupware is to provide both structure and support to aid us in working together. One definition for it might be "software for a group." Another is "computer-supported cooperative work."

We are pleased to begin our In Depth section with "Working Together" by Douglas Engelbart and Harvey Lehtman. Some of the earliest work in collaborative work systems was done by Douglas Engelbart, and this article defines the elements involved in groupware and discusses the importance of both the tool and the human elements.

In "Where the Action Is," Terry Winograd looks at the specifics of one type of groupware system, an action-coordination system. One part of working in a group is, quite naturally, coordinating the actions of its various members. It's interesting to see how a groupware system can actually help you do that.

"Perils and Pitfalls" by Jonathan Grudin provides insight into the problems, many of them people problems, that you can encounter in trying to create groupware or in converting a product aimed at individuals to one for a group.

In "Intelligent Software Agents," Kevin Crowston and Thomas W. Malone discuss the various research efforts under way in using the techniques of artificial intelligence to enhance the capabilities of groupware.

And then, in "A Groupware Toolbox," Susanna Opper takes a look at a variety of microcomputer groupware products. This article, in effect, contains this month's resource guide and more. It's not just a product listing; it includes explanations of each product as well.

While the concepts behind groupware may not be new, the application of those concepts in the microcomputer world certainly is. With all the research under way, groupware can only grow and expand. Perhaps we'll eventually learn to place cooperation above competition after all.

—Jane Morrill Tazelaar
Senior Technical Editor, In Depth

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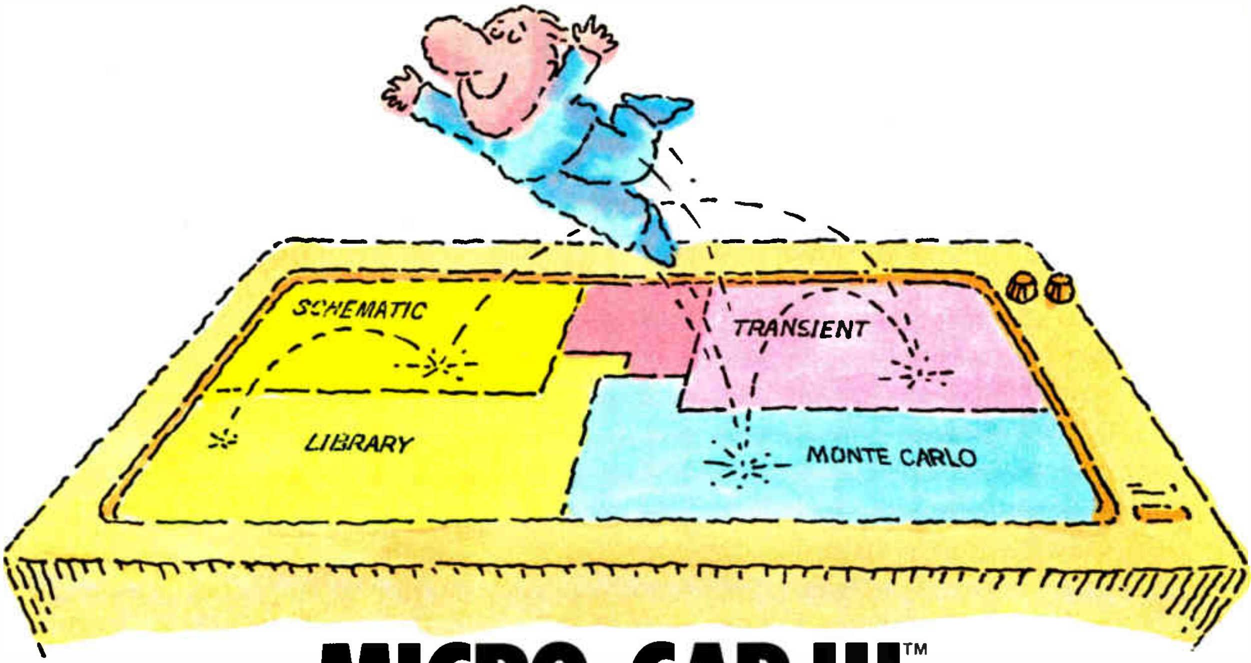

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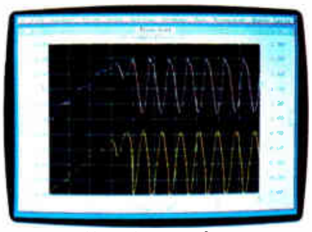

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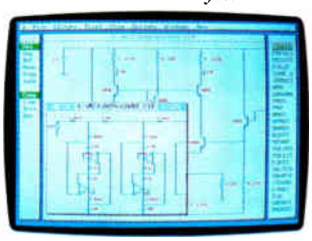

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Working Together

The "human system" and the "tool system" are equally important in computer-supported cooperative work

Douglas Engelbart and Harvey Lehtman

The emergence of the personal computer as a major presence in the 1970s and 1980s led to tremendous increases in personal productivity and creativity. It also caused setbacks in the development of tools aimed at increasing organizational effectiveness—tools developed on the older timesharing systems.

To some extent, the personal computer was a reaction to the overloaded and frustrating timesharing systems of the day. In emphasizing the power of the individual, the personal computer revolution turned its back on those tools that led to the empowering of both co-located and distributed work groups collaborating simultaneously and over time on common knowledge work.

The introduction of local- and wide-area networks into the personal computer environment and the development of mail systems are leading toward some of the directions explored on the earlier systems. However, some of the experiences of those earlier pioneering systems should be considered anew in evolving newer collaborative environments.

Computer Supported Cooperative Work (CSCW) deals with the study and development of systems that encourage organizational collaboration. Most groupware products fall under this classification. CSCW projects can be classified into three categories: tools for augmenting collaboration and problem solving within a group geographically co-located in real time (e.g., CoLab at Xerox Palo Alto Research Center); real-time tools for collaboration among people who are geographically distributed; and tools for asynchronous collaboration among teams distributed geographically.

In our work at the Augmentation Research Center (ARC) at the Stanford Research Institute (SRI) International beginning in the mid-1960s, we developed a system called NLS (On-Line System) and tools that supported these forms of collaboration. However, we placed the greatest emphasis on collaboration among people doing their work in an asynchronous, geographically distributed manner.

Our original goal at ARC was to "augment" individuals doing knowledge work. (See the text box "The NLS/Augment Architecture" on page 247.) In fact, some of the tools, techniques, and artifacts we developed then have become widely used in personal computer environments. These include full-screen windowed editing systems, mouse-controlled cursors, hypertextual linking of documents, and consistent user interactions across all aspects of a system. As timesharing systems and then wide-area networks (such

continued

as the ARPANET) were introduced, the domain we attempted to augment widened to include groups collaborating in the same place, as well as over distances bridged by the networks and over time bridged by tools for creating a recorded dialogue among the collaborators.

One of the key strategies at ARC was the notion of bootstrapping: making use of available technology to create tools, techniques, and methodologies for knowledge workers in general, and the ARC group in particular, to use in further development of the tools. We served as the developers of the technologies, as well as the subjects for the analysis and evaluation of the augmentation system we had been developing. Many of the surface features of the system appeared in fancier dress as bit-mapped graphical hardware that became available first at Xerox, then later, much more widely, at Apple.

While it was exciting to see bits and pieces of the original NLS, now called the Augment system, appear commercially over the years, many elements of the system's conceptual core have only recently been recognized: outline editors (for easy manipulation of ideas); hypertextual linking capabilities fully integrated into the system; a system of recorded group dialogue that transcends most mail systems; user programmability and customizability of the system; and, most important, tools for augmenting not just individual knowledge workers but also teams of people both coresident and distributed over the world interacting through a networked environment.

We thought that success in creating tools for collaborative knowledge work was essential to the necessary evolution of work groups in increasingly knowledge-rich societies and to increasing organizational effectiveness. Until the recent growing interest in CSCW, most developers limited their analyses to technical issues and ignored the social and organizational implications of the introduction of their tools; such considerations were, however, key to our work.

There is growing recognition that some of the barriers to acceptance of fully integrated systems for augmenting groups of knowledge workers may be more significantly social, not solely technical. The availability of rapidly evolving new technologies implies the need for concomitant evolution in the ways in which work is done in local and geographically distributed groups.

ARC experienced this phenomenon continuously. The bootstrapping approach, so important to the continuing evolution of the system, caused us to constantly undercut our world: As soon as we became used to ways of doing things, we replaced platforms to which we were just becoming accustomed. We needed to learn new roles, change attitudes, and adopt different methods because of growth in the technological system we ourselves produced.

We brought in psychologists and social scientists to serve as observers and facilitators. They were as important to our team as the hardware and software developers. The resistance to change, which we soon realized was an essential part of introducing new technologies into established organizational settings, and the psychological and organizational tensions created by that resistance were apparent in ourselves. We were required to observe ourselves in order to create appropriate methodologies and procedures to go along with our evolving computer technologies.

We brought in psychologists and sociologists to serve as observers.

Our lab was concerned with *augmentation*, not automation. The choice of this term was significant. Aspects other than introducing new technological tools into the workspace (e.g., conventions, methods, and roles) are at least as important to the success of any CSCW system. The elegant tools available now and in the future—superlative graphics, artificial intelligence services, and so on—only make sense in an integrated workshop of tools in which information may be exchanged. The tools in such an integrated workshop need to be conceptually and procedurally consistent.

We expect that as tools are introduced and used, a co-evolution will occur between the tools and the people using them. Thus, WYSIWYG systems eased the acceptance of computer systems by nontechnically oriented users; however, these systems produce a map of what you would see on paper as opposed to a hyperdocument with structural links evolving over time. We are now seeing the increasing acceptance of other presentation metaphors (such as Apple's HyperCard and Owl International's Guide) incorporating some of the nonlinear linking capabilities that were present in Augment.

The architecture and character of Augment were directly oriented toward augmenting the capability of humans to deal with tough knowledge work and to process effectively the large volumes of information with which knowledge workers must deal. A subgoal was to support active collaboration among groups of workers. To gain experience with the issues and needs associated with this support, we developed and operated the Network Information Center (NIC) for the original ARPANET user and researcher community.

Creating a Collaborative System

The following elements are necessary ingredients in a system designed to support collaboration in a community of knowledge workers. The sequence represents an explicit progression that begins with tested techniques whose "cultural shock" and financial investment are relatively low; it proceeds through paced, open-ended evolution with time, experience, and perceived payoff toward tools and techniques that involve a greater investment in both financial and social areas.

• *Collaborative dialogue*. Computer tools for the composition of messages and for their subsequent reviewing, cross-referencing, modification, transmission, storage, indexing, and full-text retrieval are a necessary part of a CSCW system. A "message" in such a system can be of any length. It can contain formalized citations pointing to specific passages in prior messages, so that a group of related messages becomes a network of recorded-dialogue contributions.

There should also be automatic message delivery; full cataloging and indexing; on-line accessibility both to message notification and to the full text of all messages; and open-ended storage of the dialogue records. These services enable a community of people who are distributed in space and time to maintain effective, recorded, collaborative dialogue in a manner that qualitatively differs from most ordinary electronic-mail systems.

With Augment, real-time remote dialogue (teleconferencing) was supported by a "shared screen" facility through which users could "link up" their displays; each party to the link sees a common display view. Any party to the link is able to point to or control or execute

continued

The NLS/Augment Architecture

The On-Line System, or NLS, was designed to support members working in varied disciplines, including software engineers, managers, and social scientists. There were core tools used by all these knowledge workers, as well as specialized tools developed for particular requirements. All the tools shared the commonality of design principles that we thought essential to the success of what we termed a knowledge workshop. Early development began in 1963 and proceeded until 1976. (See photo A.)

The physical environment on which Augmentation Research Center (ARC) members (and collaborators across the country) worked evolved along with our system and externally available technologies. Back when the project started, display technologies were extremely primitive: Most people were still using punched cards and paper tape. Few computer users had direct access to a computer.

A Revolutionary Console

In that context, the NLS terminals were especially revolutionary. The display consoles were equipped with typewriter-like keyboards, a five-finger keyset for one-handed character input, and a mouse, invented in our lab, for cursor control (see photo B).

The keyset was useful for most members of ARC, as commands were generally recognizable by single-character mnemonics, with appropriate feedback provided by the system. Most team members became proficient at one-hand text input, leaving the other hand available for cursor control by means of the mouse as they moved through the information space on their terminal screens.

Initially, screens were generated on small CRTs in our machine room and transmitted via closed-circuit television to the ARC workstations. Later on, as character-based displays became commercially available, we created external boxes to those terminals for attaching mice and keysets and controlling the cursor and screen updates in the manner required by our essentially nonlinear system devices, which were developed principally as "glass teletypewriters."

Those boxes, or line processors, were eventually made available to users over the ARPANET so they could experience the display-based version of NLS. However, because of the initially limited availability of displays, we also created a typewriter version of the system (TNLS), which had a complete mapping of the display NLS (DNLS) interface and permitted ready access to information across the country through the then more cost-effective typewriter terminals.

NLS was the core workshop software application system. It centered around the composition, modification, and study of structured textual material. Graphics were available in a primitive manner on the early terminals; the later line-processor-based systems made graphics available on additional, external graphics displays.

The type of bit-mapped graphics systems and hard-copy printers readily available today were not available to us at the time, although later evolutions of our file-system content architecture could accommodate graphical entities as data nodes. Moreover, there were important areas associated with the text domain that needed exploration.

A Hierarchical Structure

The underlying NLS document architecture was hierarchically structured; the structure of a file was separated from its content. Originally, content nodes were strictly textual in nature; eventually, each structural node referred to a property list of content nodes of varying types, including other hierarchies (i.e., text, graphics, code, and so on).

The structure made for rapid navigation through the information space created by a file or collection of files. Its complexity was hidden from novice users (who didn't need to know about its implementation and, in fact, could ignore the hierarchy if they wished as they created linear documents in the NLS editor).

However, more sophisticated users

continued

Photo A: *A 1985 augmented meeting. This configuration is similar to more current systems, such as Xerox PARC's CoLab.*

• *Meetings and conferences.* At ARC, we made extensive use of augmentation tools in our local and distributed meetings. Projected display images, video overlays, and split-screen image superimposition were first used to great effect by Engelbart in the 1968 IFIP Fall Joint Computer Conference in San Francisco.

Dynamic control of the agenda and the collaborative creation of position papers are some typical uses of these services.

• *Community management and organization.* Conventional project-management operations can be augmented through the use of computer-based project-management tools with the enriching services of dialogue support, document development, and the handbook, which would include plans, commitments, schedules, and specifications.

• *Special knowledge work by individuals and teams.* The tools supporting a collaborating community should be available to the team members in their roles as individuals and members of other teams. A user-programming facility in Augment made it possible for individual users to customize parts of the system according to their needs and abilities. Some of these specialized extensions became part of the more widely available tools for the entire workshop community.

A Formula for Success

As Augment evolved, we realized some assumptions that we think are applicable to any successful CSCW system:

• *Coordinated set of user-interface principles.* There should be a common set of principles over the many application areas. This does not mean that the user interface itself is necessarily the same across all domains. It does mean that a common underlying style of communication is present. While each domain within the core workshop area or specialized application system may have a vocabulary unique to its area, this vocabulary should be used within language and control structures common throughout the tool environment. Users learn new functions by increasing vocabularies, not by learning separate "foreign" languages. When in trouble, they will invoke help or tutorial functions in a standard way.

This point has become apparent in the Apple Macintosh environment. Users of different applications have a common method of interacting with each application. This makes it easier to learn new applications and to move between systems.

A single interface metaphor is neither required nor ideal. Interaction styles suitable for a particular application domain and user group may differ from those for other domains and users. Apple's HyperCard provides an example of an environment that offers interaction metaphors different from the original Apple Desktop with minimal confusion to users.

• *Grades of user proficiency.* Users who are not experienced in using the system are part of the community; they will want to be able to get at least a few straightforward things done with a minimum of learning. Even an expert user in certain domains of the collaborative workshop environment will be a novice in less frequently used domains. Attention to novice-oriented "easy to use" features is required.

However, users should be rewarded for their increasing proficiency with a rich tool environment that offers advanced vocabularies and the opportunity

continued

for individual customization in every specialized domain.

• *Ease of communication among, and addition of, workshop domains.* We think that there will be many different parts of an augmented-knowledge workshop, each with its own tools. You should never be bound to isolated areas of the workshop. It should be possible to move and communicate information between domains easily. It should also be possible to install new tools as needed.

• *User-programming capability.* Users must be able, with various levels of ease, to add or interface new tools and extend the language to meet their needs. They should be able to do this in a variety of programming languages in which they may have training, or in the basic user-level language of the workshop itself (e.g., through a macro facility.)

> *We can't ignore the social implications of our technical progress.*

• *People-support services.* The computer-based tools will be insufficient by themselves. The CSCW technologies will create opportunities and needs for highly specialized professional services, such as database design and administration, training, cataloging, and retrieval formulation.

• *Recognition of standards for information interchange and ranges of hardware.* We should not have to assume the presence of a particular type of machine in a user's work environment. It should be possible to exchange information and get a reasonable representation of the information shared across system environments.

• *Careful development of methodologies.* The elements involved in augmenting communities of knowledge workers include the development of both "tool systems" and "human systems" (the set of skills, methods, languages, customs, procedures, training, and organization structures needed for effective use of tools). New technologies, even those such as CSCW that aim at improving group interaction, contribute directly only to the tool system. The cultural evolution that led to the current state of the human system took place with a very primitive tool system.

As much care and attention needs to be paid to developing the procedures and methodologies associated with the people-support services and the organizational and societal effects of introducing new technologies as is spent on developing the technologies themselves.

• *Co-evolution of roles and organizational structures and technologies.* The widespread availability of successful CSCW services will create the need for new organizational structures and roles. These structures and roles need to co-evolve with the technologies. For example, we found there was a need for what we called knowledge-workshop architects who served as "change agents" in introducing new technologies into their organizations.

To take advantage of the radical, emerging tool-system inventions associated with CSCW, it is inevitable that the evolution of the human system will begin to accelerate. The optimum design for either a tool system or a human system is dependent on the match it must make with the other. The high degree of mutual dependence implies that a balanced co-evolution of both is necessary. The bind we are in is that our society encourages and rewards progress in the technological and material sense and often ignores the human and social implications of that progress. ■

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Douglas Engelbart, a senior scientist at McDonnell Douglas, recently created the Bootstrap Institute to further CSCW research. Harvey Lehtman is manager of the New Media Group at Apple Computer. They can be reached on BIX c/o "editors."

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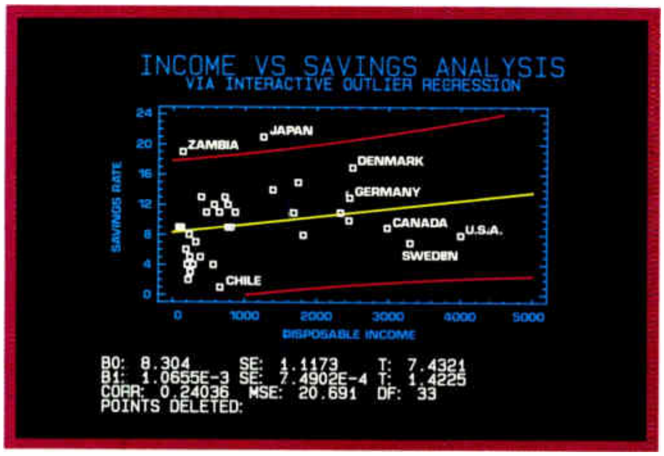

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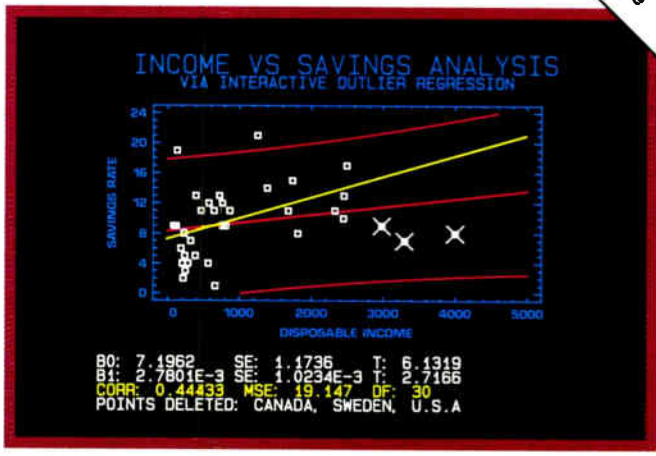

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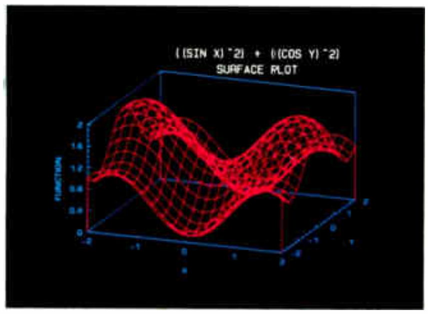

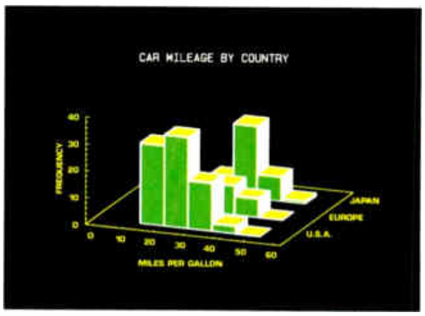

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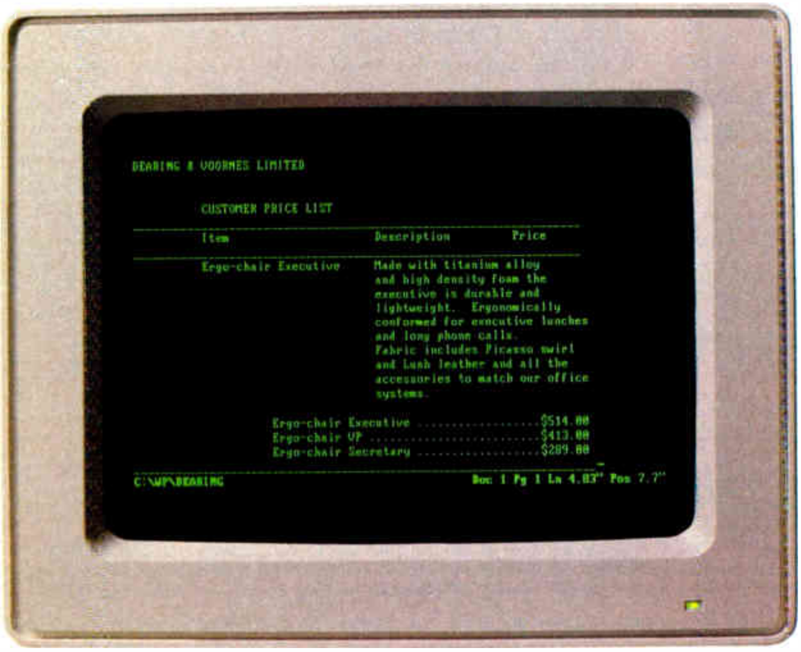

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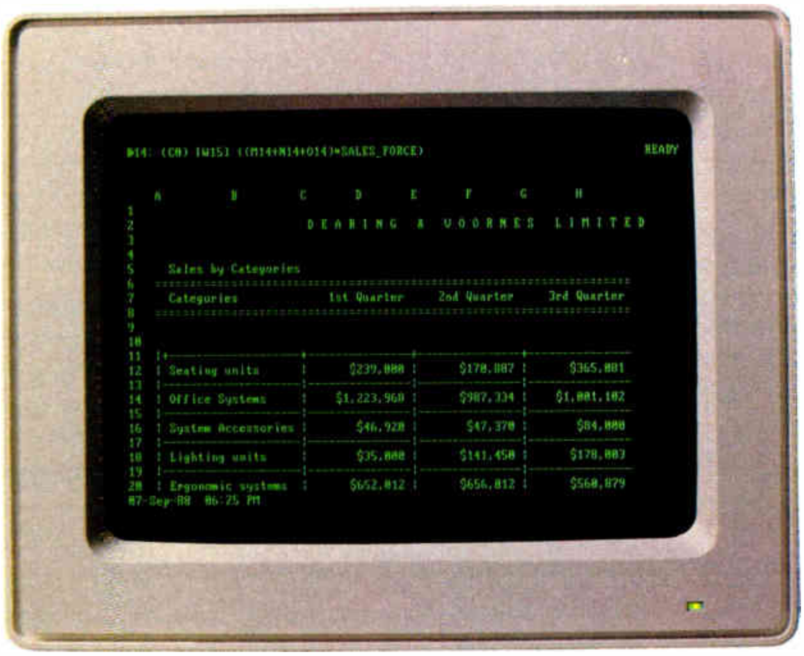

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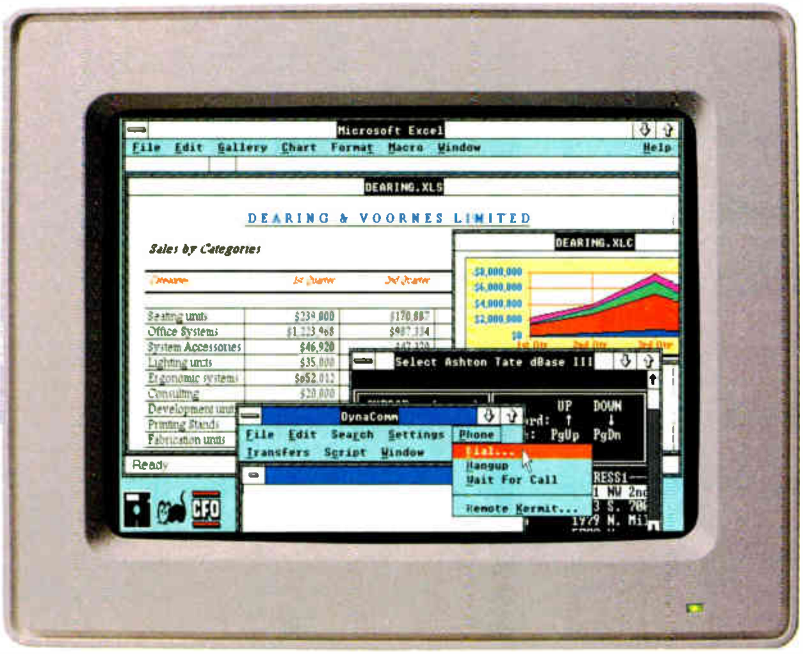

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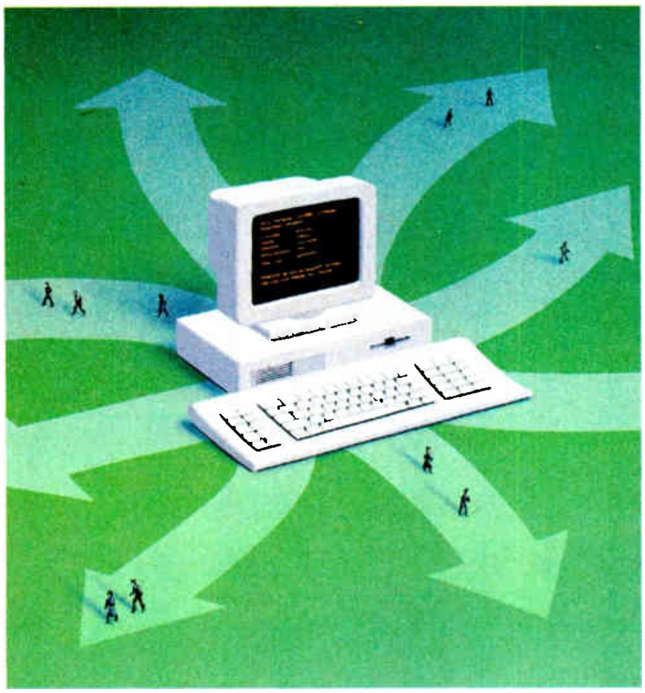
Circle 244 on Reader Service Card

Where the Action Is

Groupware brings clarity and simplicity to the coordination of human action

Terry Winograd

The lifeblood of an organization is not data or computation, but *interaction*. People working with computers get things done by placing orders, requesting and producing reports, and releasing products, not by processing information. Work is organized as a network of interlinked actions—actions that are embodied in language. The ability to affect and anticipate the behavior of others through language is an important condition of human action.



Current research on the design of computer-supported cooperative work reveals the importance of this linguistic dimension. But there is a common-sense tradition that hampers looking at the essential structure of language. In this tradition, language is a system for representing the world and for conveying thoughts and information. Although this perspective is useful in many ways, it leaves out the fundamental dimension of language as *commitment*, as a construction that shapes the world in which we act.

A traditional linguist would analyze the utterance "The cat is on the mat" as conveying information, describing a particular state of affairs. But if you imagine a setting where someone really might say that, something more is happening. Perhaps an action is being called for: It's my cat, and my friend's precious mat is in danger of being unraveled. Or maybe a request has been fulfilled: My cat-training assistant has finally gotten the cat into the appropriate starting place for a trick. Whenever you convey information, you are embedded in a context that makes it relevant to something getting done. The meaning of the words serves as a starting point for interpretation that leads to networks of interconnected actions.

By directly addressing this universal dimension of human communication, we are beginning to develop groupware that offers a new simplicity of design and effectiveness of management. This article looks at a class of systems called *action-coordination systems*, which apply principles of *conversation management* to help people keep track of what is going on and what needs to be done. Systems of this kind will be the central framework for the integrated office systems of the future.

The Architecture of Conversations

Action-coordination systems are based on a theory of language developed by Flores and Winograd (see bibliography), growing out of earlier work on "speech acts" in the philosophy of language. This theory holds that when you utter or write sentences, you are performing speech acts that have consequences for your own

continued

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future action and for the actions of the people you are addressing. Traditional language theories look at the way in which words convey information. Speech-act theory looks at the ways in which utterances are connected to future possibilities and consequences.

The basic *conversation for action* grows out of a request or offer that one person makes to another. The exact words may differ greatly, ranging from highly formalized statements like "I hereby request that you grant my petition . . ." to everyday utterances like "How about a movie?"

A conversation can be viewed as a kind of dance, in which particular linguistic steps move toward completion: If an action was requested of you, you promise or decline; if you promised to complete the action, you report completion or revoke your promise; if you requested an action, you cancel your request, ask for a progress report, or declare that your conditions have been fulfilled and the action completed.

The state-transition diagram in figure 1 illustrates the possible moves in a conversation for action that is initiated by a request. Each circle represents a state of the conversation, and the arcs are the language acts that the participants (labeled A and B) can take. Each act has a name, such as Decline or Counter (counteroffer). After A makes an initial request, three basic moves are open to B: *promising* to do what is requested, *declining* the request (thereby closing the conversation), or *counteroffering* (suggesting an alternative). Each act leads to a different state, with its own possibilities for further acts by B and for responses by A.

Having promised to do something, B's next standard move in the conversation is to report that the request has been fulfilled. A can accept this report or declare that the completion was not satisfactory (according to A's interpretation of the promise). A conversation moves toward a state of completion in which no further moves are anticipated. This can result either from a successful completion (marked by the requestor's positive declaration), or from acts, such as withdrawing the original request or canceling the promise.

The state-transition diagram is universal in that it generates the range of possible speech-act sequences regardless of the topic, the language in which the acts are expressed (computerized or natural), and the intentions and plans of the conversants. This structure of possibilities is used in action-coordination systems to organize records of what has been done and present them to the conversants as possibilities for further action. In the general action-coordination systems of the future, this structure will be the basis for declaring and automating practices specific to the work of a particular individual or group.

A Network of Practices

Organizations are structures for the social coordination of action, generated in conversations based on requests and promises. You might say that conversations and actions are the bricks and girders of which the organizational structure is built. They are crucial to building technology for organization and management, and they are universal with respect to time and culture. So long as people live and work together, they will coordinate their actions in requests and promises and the expectations derived from those requests and promises.

But there is a larger structuring that is particular to the practices of the organization. (By *practice*, I mean a recurrent pattern in which conversations are generated and related to one another.)

As a simple example, we find some standard practices in the menus of the Coordinator (for more detailed information, see the text box "Coordinating Conversations" on page 256D). The item "Delegate it" in the menu of photo C is not a simple conversational move. When I delegate a request from you to a third party, I am really entering into a new conversation with that party, with its own conditions and dates. Although the interface makes this a simple menu item, it is really a way of linking two distinct conversations.

Conversations dealing with the new design specification (in the text box) involve another kind of practice. On completing the specification, I initiate standard conversations to make sure that the documentation is kept up-to-date and that the programming is done. This same pattern is followed again and again for different design projects. The Coordinator makes it possible to generate the individual conversations, but it doesn't provide for capturing the regularity of conversations—how certain conversations follow others in a standard way. This regularity includes the types of conversations, the people they are with (e.g., the documentation editor and the programming manager), and some of the content (e.g., the documentation that needs updating is related in a systematic way to the code being written).

Group work is organized around collections of practices. Some are on a small scale, linking only a few conversations. Others are larger and include many conversations, such as those required for managing a software development effort or those involved in materials acquisition or payments and accounts. If conversations and actions are the bricks and girders, then these practices are the larger architectural elements that make up the design of the organization.

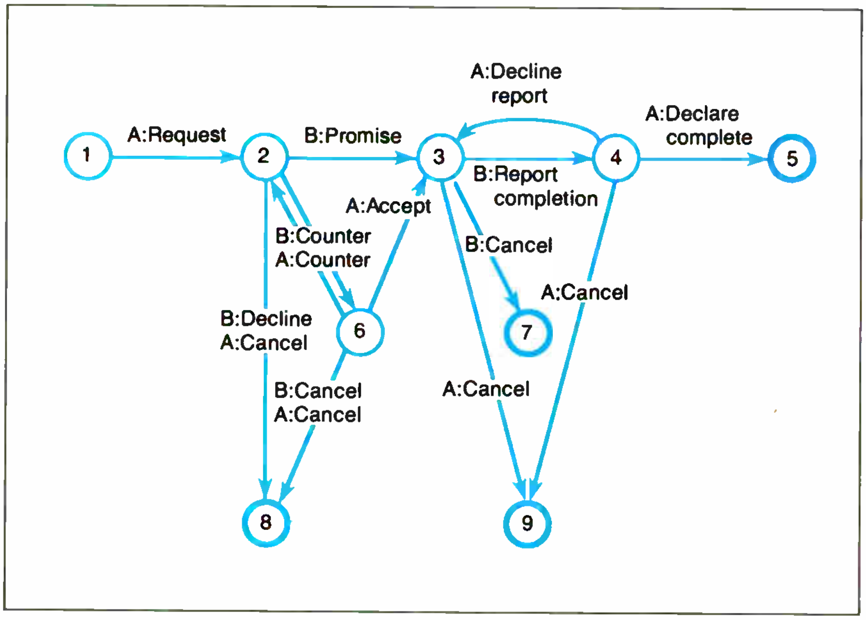

Figure 1: *Basic conversation diagram. The heavier circles represent states of completion. (Adapted from Winograd and Flores, 1986, page 65.)*

continued

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Coordinating Conversations

The first commercial product to provide the functionality of an action-coordination system was the Coordinator, introduced by Action Technologies in 1985 (version 2 is now out). The following brief scenario introduces the basic concepts of conversation management as exemplified in the Coordinator.

What Is There to Do?

Photo A shows the screen that faces me when I begin work for the day. It includes my schedule, reminders I have set for the day, a list of conversations that need attention, and a list of new mail that has arrived. Much of this will be familiar if you use message systems and computer desk utilities, but the structure is different. My work is organized around the collection of *conversations* in which I am currently engaged, and I operate by taking *actions* in those conversations.

Today I choose to look first at the new message dealing with "article on reliability." It comes up on my screen as shown in photo B. All messages in the Coordinator are identified as expressing a conversational action, in this case "Chapman@cpsr requested..." In addition to specifying that it is a request, the sender has included explicit dates by which she wants a reply and completion of what she requested. This message also includes an enclosure, a file that I can examine and store on my own system for later use with whatever application is appropriate to it.

Making a Response

Having read the message, I call up the response menu, as shown in photo C, and select from the different kinds of responses shown.

The primary responses are those indicated in the network of conversational moves. I can say "Yes," *promising* to do as requested; I can say "No" to *decline*, or I can *counteroffer* with either "OK, except..." (indicating I'm willing but not exactly as specified) or "No, however..." (indicating that I want to suggest an alternative). I can also select "This is done," jumping directly to a state indicating that I have *reported* completion of what was asked.

In each case, a new composition window will appear on my screen with a brief standard message for the selected action, which I can edit or expand as the text of my response. In many instances (e.g., "I'll do it" is the text for "Yes"), no more text is necessary, and I immediately activate the Send command. In others, I may type in something like "I can't do it by the 10th, how about the 15th?" (in a counteroffer) or "The original hardback was published by Ablex and the paperback by Addison-Wesley" (in response to a question).

The system is guiding me in the steps of the conversational dance. At any point, certain moves are possible and others aren't. The menus are designed to provide only the set of possibilities that make sense, and to distinguish them so that the recipient can see my intent and be guided in the next move.

In addition, I have menu options for several standard practices, such as acknowledging the receipt of the message, postponing action to a specific date, and delegating the matter to someone else. Or I can just send a comment (equivalent to ordinary electronic mail).

In this example, I select "Yes," and with a tap on the function key for "Send," a return message is on the way to Susan, and the promised completion date is recorded in my calendar.

Keeping Track of Completion

Returning to my schedule (see photo A), I note three conversations listed as requiring action by today. Macken has made a request concerning the research catalog and asked for a response by today. Since I have not yet responded in that conversation, it shows up on my calendar. I have promised Cbell to do a design task by today and have not yet reported it complete, and I have requested that Hartley get back to me about travel requests and have not received a reply.

The inclusion of reply and complete dates is optional when an action is taken. Experienced users almost always include one or more of them. Explicit dates associated with conversations identify potential breakdowns in the progress toward completion. Their use in organizing what is brought to the attention of the user each day plays a surprisingly large role in producing effective conversations. In fact, this is the essential core of "time management," as embodied in many of the standard practices of organizations, such as project plans, tickler files, reminder systems, and much of what goes into a daily calendar. The explicit use of conversation theory makes it possible to integrate these into a unified approach to the question of "What do I need to pay attention to now?"

The distinction between *open* and

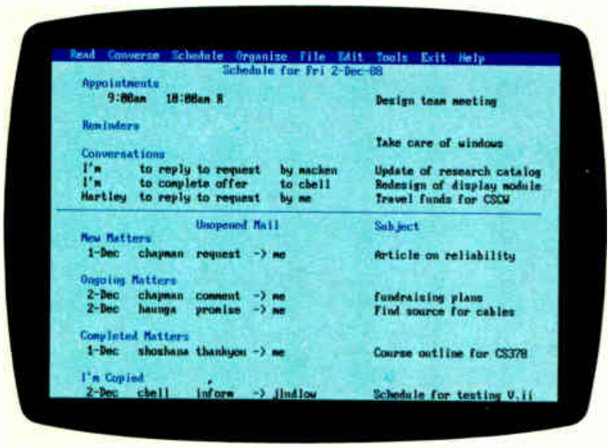

Photo A: *The screen that faces me when I begin work for the day. Notice that my work is organized around the conversations in which I am currently engaged.*

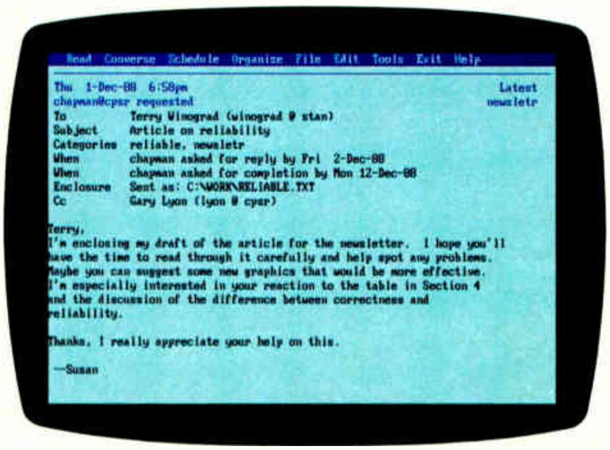

Photo B: *A new message. Notice the expressed conversational action, in this case, "Chapman@cpsr requested..." and explicit dates for completion or reply.*

completed conversations is fundamental to keeping track of where things stand. Certain acts (marked with asterisks in the menus) move the conversation to a state in which nothing more is expected, although further comments can always be added. Completed conversations do not normally appear in schedules and conversation lists, unless specifically requested. The list of open conversations is a map of what still needs to be done. The structure and status of conversations are the primary basis for organizing retrieval and review in the system. To put it simply, the structure is organized to provide straightforward and relevant answers to "What's next?"

Table A: *Menu items for initiating a new conversation.*

Request	Sender wants receiver to do something.
Offer	Sender offers to do something, pending acceptance.
Promise	Sender promises to do something (request is implicit).
What if	Opens a joint exploration of a space of possibilities.
Inform	Sender provides information.
Question	A request for information.
Note	A simple exchange of messages (as in ordinary E-mail).

Keeping Records

I decide to look more carefully at the conversation with Cbell, selecting it and selecting the menu operation to produce a status report (see photo D). The conversation was initiated by my offer in September. Cbell made a counteroffer, and I accepted it. This acceptance was the last communication in which the state of the conversation advanced toward completion. Then, there was an exchange of comments between Cbell and Avra (who was copied in the original request), and a follow-up from Cbell. I also set a reminder for myself, which noted this conversation on my calendar on November 1, with a comment about reading the specs. By selecting any of these lines, I could go back and read the specifics of the message.

Much of what is recorded in conversation records is already part of standard practices, but with a different organizing structure. Records (including the files that appear as *enclosures*) are organized around distinct conversations, providing quick access to the history that provides the context for the action I am considering at the moment.

Openings

I report to Cbell that the design is complete by selecting "It's done" from the response menu and enclosing the file containing my new specs. I then want to inform the editor of the manual that the corresponding section needs to be updated, and to start people going on the programming. I bring up the menu for new conversations, which includes the items listed in table A.

I choose "Inform," type in the details about the section I have rewritten, and send it. I then choose "Request," type in my instructions for the programming team, and send that as well. Although occasionally an unstructured exchange of notes is called for, one of the explicit conversation types is usually more appropriate. In fact, there is often a benefit in being asked to think about which one it is.

Everyone makes requests and promises, but we often cause confusion by not being clear about what we expect. On getting a message, the conversational types provide a clear guide to what is being called for in response, without a lot of words. They also set into motion the conversation-management mechanisms that provide options and bring things up on the schedule.

The Coordinator has no magic to coerce people to come through with what they promise, but it provides a straightforward structure in which they can review the status of their commitments, alter commitments they are no longer in a position to fulfill, anticipate coming breakdowns, make new commitments to take care of breakdowns and opportunities appearing in their conversations, and generally be clear (with themselves and others) about the state of their work.

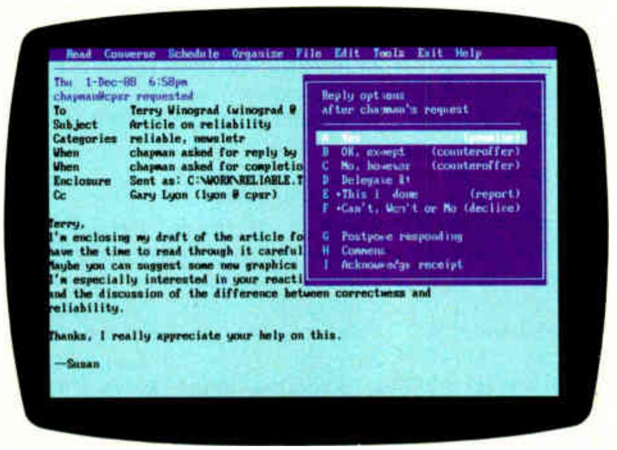

Photo C: *The response menu. This contains the different kinds of responses I may select. Notice that they include promise, counteroffer, report, and decline responses.*

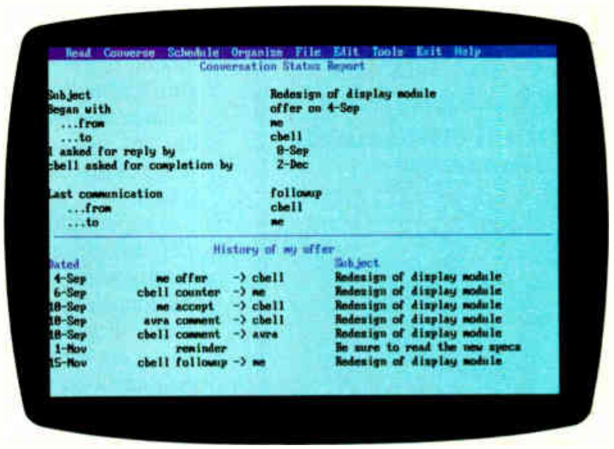

Photo D: *A status report. It contains the details of my conversation with Cbell, followed by the history of all activity related to that conversation.*

Current computer systems provide two distinct worlds for dealing with practices. On one side are the elementary facilities provided by connectivity and compatibility: shared files and electronic messaging. These are totally general, but offer almost no structure to build with. On the other side are conventional data-processing systems for practices such as order entry, airline reservations, and integrated CAD/CAM. In these, a particular collection of practices is fossilized in the design of the information structures and operations. Although such systems can be very efficient and effective for the practices designed into them, they tend to be difficult to build, inflexible in use, and poorly adapted to change.

Computers offer tremendous potential for improving our interactions with one another.

The challenge for groupware is to provide an effective way of designing and continually *evolving* the collections of practices that constitute an organization. Action-coordination systems offer a promising approach. In a generalization of systems like the Coordinator, you can provide mechanisms that let people in organizations design the appropriate architectural elements—the patterns of interrelated conversations. In doing so, they aren't being asked to provide a set of procedures that would let the machine make the decisions; they are constructing a range of possibilities for effective human action.

As a simple example, I might find it difficult or impossible to make rules for exactly when I should send a design off to the documentation people, or which programming team I want to handle it. These decisions may depend on factors that aren't captured in the computer system at all. But what the system *can* do is provide me with a menu of appropriate possibilities. On sending the "This is done" action in a conversation about a design, I could be shown a menu with special items for "Inform documenters" and "Initiate programming." When I choose one of these items, the initial text in the message I compose would not be the generic text for an inform or request, but a text I have designed for this specific conversation, with data filled in automatically from the conversation I just completed (e.g., the identity of the relevant files).

As a further step, I can encode rules for those parts of the practice that are standard enough for a program (either a conventional algorithm or a rule-based system) to determine. As opposed to the artificial-intelligence approach, which tries to simulate the user's thinking process, the action-coordination framework focuses on providing an appropriate tailored set of actions to choose from. Thus, it provides a framework for incremental user-driven automation.

The Office of the Future

At first, computers were seen as number machines to be used in scientific quantitative applications. Today, you hear a lot about how they are really symbol machines or knowledge machines. This is all true; however, computers are also "action machines"—machines with which you take linguistic action. They offer tremendous potential for improving our capacity to interact with one another. This potential is just being touched on by networking, electronic messaging, teleconferencing, and the like. But it will really come to fruition when these are integrated into a deeper understanding of how language serves as a medium in which people bring forth their own actions and those of others.

The development of conversation-action systems will make possible a new level of integration—not just of computer networks or standards, but of what people do. As we move from software to groupware, we will be able to create people-centered systems that bring new clarity and simplicity to the coordination of human action. ■

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Perils and Pitfalls

To succeed with groupware, you must first clear these hurdles

Jonathan Grudin

Groupware development has not always been either profitable or successful. This failure hasn't been because the products were dull or unoriginal or the companies were poorly run, but because the products attempted to change the way in which people interact in a work environment. Sound simple? It isn't.

Group interaction is a complex web of political, motivational, economic, and social currents. Our knowledge in these areas is largely unconscious, so tutoring computers to help us collaborate can be slow and difficult—that is, until product designers and purchasers alike acknowledge the stumbling blocks to user acceptance.

The obstacles described here are not unsolvable, and they are not intended to devalue groupware's goal. You can implement useful groupware applications if you invest sufficient resources to solve the problems, develop the appropriate research and development methodologies, and find niches where the problems don't arise or where applications will succeed in spite of them, and if you adequately prepare users for the new applications.

A Collective Benefit?

An application can fail if it requires that some people do additional work, especially if they are not the ones who perceive a direct benefit from using it.

Groupware supports people who work in different roles, such as an author and an editor, a manager and individual contributors, or a professional and a secretary. To succeed, a groupware application must be used by all the relevant people. But often some will benefit more than others, while others will have to do extra work.

Doing the extra work cannot be left to individual discretion. Nor will each groupware application be important enough to mandate that reluctant individuals take on the extra work; in many cases, the cost will outweigh the benefit. If it can be determined that the application really does provide a collective benefit to the group, education and leadership may be critical in convincing people to do the required work.

The best solution is to ensure that everyone benefits directly from using the application by building in additional features, eliminating or minimizing the extra work required of anyone, or rewarding people for doing it. User interfaces must be provided that are matched with user backgrounds, jobs, and preferences. This is a substantial undertaking, but there may be no other option.

Fact vs. Tact

Applications can fail if, through ignorance, they violate social taboos, threat-

continued

en existing political structures, or otherwise demotivate some users.

The computer is happiest in the world of information—explicit, concrete facts or images. Accessing and manipulating information is central to the tasks for which individual users rely on their computers. Central to the dynamics of groups, however, are much less explicit social, motivational, political, and economic factors. Often without thinking about it, we rely on social conventions and our knowledge of the personalities of those around us to guide our actions.

It will be difficult to make these conventions, personal agendas, and so forth available to the computer. Even trying to make these things explicit may be a problem in itself: Often we tactfully keep our motivations and agendas (and our views of other people) to ourselves. Yet unless this information is made explicit, groupware will be insensitive to it.

Allowing for Error

Applications can also fail if they do not allow for the wide range of error, exception handling, and improvisation characteristic of much group activity.

Software may be developed to support group activities or procedures as they are "supposed to" happen. But our descriptions of "typical" procedures may be misleading. Close examination may reveal that group activity is particularly variable and that strict adherence to a standard procedure is more the exception than the rule.

Designer's Intuition

The design process sometimes fails because our intuitions are poor for multiuser applications—no one person's intuition is likely to foresee the full range of user reactions in a complex social situation involving the simultaneous participation of people with different backgrounds, preferences, and jobs.

Decision makers rely heavily on intuition. The track record of a development manager considering a groupware project is generally based on single-user applications, where intuition may be a far more reliable guide—a manager with good intuition may quickly get a feel for the user's experience with a word processor, spreadsheet, and so forth. Not surprisingly, the decision maker may be drawn to groupware applications that selectively benefit one subset of the user population: managers. Managers may see the potential benefit for people similar to themselves, but may not see that extra work may be required of others, that social conventions important to others may be violated, or that the actual work activity of others may in practice vary from the prescribed procedures the manager sets out to automate.

Evaluation Difficulties

Groupware applications can be difficult to analyze and evaluate. Task analysis, design, and evaluation are never easy, but they are considerably more difficult for groupware than for single-user applications. An individual's success with a particular spreadsheet or word processor is not likely to be affected by the backgrounds of other group members or by the administrative or personality dynamics within the group.

But in a group, motivational, social, and political factors come to the fore, and these factors do play an important role in the success of groupware.

Many applications will fail if, through ignorance, they violate social taboos.

Evaluating groupware "in the field" is complex due to the number of people to observe at each site, the wide variability in group composition, the time over which group processes unfold, and the range of factors that play a role in determining acceptance, such as user training, management buy-in, and vendor follow-through. In fact, you may have to fully implement a groupware application to really evaluate its potential.

Groupware's Heritage

The two historical influences on groupware are single-user applications written for minicomputers and microcomputers, and multiuser systems written for mainframes. Each brings with it certain assumptions that, because they don't hold for groupware, contribute to our failure to recognize the problems we face in designing and evaluating groupware.

A groupware application can be a logical extension of a single-user application, such as a coauthorship application that goes beyond word processing. Word processing does not become groupware by virtue of permitting different users to access and edit the same document sequentially. But a coauthorship application supports document preparation as a group activity if it allows coauthors to work simultaneously, if it identifies edits by the user making them, or if it interacts with users according to their role—principal author, coauthor, editor.

Similarly, providing sequential, multiuser access to a database isn't enough: Database products such as Paradox, Ingres for PCs, or Professional Oracle do allow multiuser access but don't distinguish among users beyond password access. Multiuser databases are a foundation on which groupware will be built; for example, a groupware application might monitor changes in such a database and alert different people to specific changes according to their job. (Of course, a group could use a word processor or a database as a kind of electronic mail system, leaving notes for one another, thus turning what wasn't designed to be groupware into something that does support group activity.)

Whether we are designers, implementers, users, or managers, our computer experience has generally been with single-user applications. Our intuitions are based on this experience. As a result, we are not accustomed to thinking in terms of the needs and preferences of different users. The single-user application does not train us to consider users of the same product who have a crucial but entirely different engagement with it.

At times we may think about novice, casual, and power users, but rarely about the different roles people play in relation to one application: author and editor, sender and receiver, enterer and monitor, and so forth. Intuitions formed around single-user applications do not prepare us to consider the complex social and political context that applications are used in, yet this context is critical for groupware, which influences the way communication and coordination occur. Experience with single-user applications does not prepare us for the difficult job of evaluating the more complex work patterns and longer time intervals that mark group activity.

The Mainframe Legacy

Groupware designed for users linked by minicomputers or networked microcomputers can also be based on larger, mainframe-based systems. Corporate information systems centered on multiuser databases are common. Experience with these multiuser mainframe systems molds our intuitions regarding groupware. They have similarities, but there

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are critical differences, particularly at the time of introduction. A mainframe system has a much higher cost, greater visibility, and stronger commitment from upper management. As a result, a new system brings with it the expectation of organizational change. The far less expensive groupware application will not carry the same visibility, commitment, or expectation of change.

The strong management commitment to ensuring the success of a new mainframe system means that the collective benefit of the system is recognized to be high; the organization may create new jobs to achieve success, if necessary; ways will be found to work around a few important individuals who will not use the system (the manager who won't use a terminal, for example); and pressure from management to try the system may be high. Even with these forces working to the advantage of the mainframe system, successful implementation is difficult. Introducing groupware applications without this backing will be more difficult, all else being equal.

The much less expensive application program may provide a smaller or less certain collective benefit and won't have the same degree of management commitment. The organization cannot restructure itself around each new groupware application, nor will management work as hard to ensure full participation. To a greater degree, groupware must fit more smoothly into existing work patterns and appeal to all the people needed to support it. In general, the organization may adapt to a mainframe system, but a groupware application program must adapt to the organization. A large system may support several editors to choose among, for example, but all authors working together must use the same coauthoring application. Groupware must be more "group-friendly" than previous software has been.

Learning from Failures

Digitized voice, as in voice annotation or voice mail, has some advantages as a computer-based communication medium. But despite 25 years of research, voice technology has been highly unprofitable, and projected sales of voice products continue to be revised downward. Why? The advantages of digitized voice over typed input are almost all advantages for the speaker. The disadvantages to digitized voice, however, are mostly problems for the listener. It is harder to understand, slower to take in, not easily scanned or reviewed, and more likely to contain errors.

The speaker benefits from voice applications, and the listener does additional work. When will it be acceptable for speakers to thus burden listeners? Sometimes there is little alternative: A sales force on the road, for example, may have no E-mail option. A disparity may be acceptable when the speaker is of higher status than the listener, as with dictation machines, or when all users are speakers and listeners in roughly equal measure, sharing the burdens and benefits.

Group decision support is another groupware area that hasn't yet caught on. The appeal to improving the efficiency and effectiveness of decision making in meetings or groups is obvious, but writing software that can do it will be tricky. The decision-making process is often complex and subtle, with participants holding partially hidden agendas, relying on knowledge of the personalities of the others involved, and so forth. Such factors may be difficult or impossible to represent explicitly in the system, and thus the computer may participate at a great disadvantage.

In addition, group decision-support systems are expressly designed to benefit decision makers. But others may need to take time to learn and use the system. The system may encounter resistance if significant learning is required, if much effort to put information on-line to make it publicly available is necessary, if the system records information that a participant would prefer not to spread outside the meeting, if it blocks other means to influence decision making (such as private lobbying), or if it undermines management authority.

Automatic meeting scheduling is my last example of a faltering groupware area. For automatic meeting scheduling to work efficiently, all involved must maintain personal calendars and be willing to let the computer schedule their free time. These requirements are not met. Electronic calendars are not electronic versions of paper calendars. They serve communication functions, primarily for managers and executives with personal secretaries who maintain the calendars. Most individual contributors get by fine with portable, compact paper calendars.

This has dire consequences for automatic meeting scheduling. If a manager wants to meet with nonmanagement subordinates, few of the latter are likely to maintain their electronic calendars. The scheduling program will find all times open and schedule a meeting, and conflicts will ensue. The one who benefits from the feature is the person who calls meetings—the manager. Those who have to do additional work to make the application succeed are the individual contributors, who would have to maintain electronic calendars that they would not otherwise use.

Analysis of a Success: E-Mail

How have E-mail and bulletin boards avoided these pitfalls to become the clear groupware success story? To begin with, there is an equitable division between who does the work and who gets the benefit. In some situations, everyone takes equal turns sending and receiving; in other cases, the person with a message to communicate does a little more work to type it, while the receiver can easily read or ignore it. The basic conversation format fits in readily with our social conventions (although the differences lead to potential problems, such as "flaming" and "junk E-mail").

But E-mail is peculiarly anomalous in some interesting respects. It is coming into wide use less through a normal product-development and marketing process than by spreading from academic and public sources. Unlike many groupware products, the obvious beneficiaries are not managers or decision makers. Its asynchronous nature may even bother managers whose time is tightly budgeted: The ability for anyone to rapidly disseminate information (including rumors) can create new and not always welcome challenges for managers, whose jobs often involve managing and controlling communication. Because it is so different from most groupware, it may be a mistake to look at E-mail as a model for groupware development.

In fact, for groupware to succeed, it must be less technology-driven than it has been. We must start with a better understanding of how groups and organizations function and evolve, and we must be more systematic in evaluating the effects of introducing technology into groups. We also need a better understanding of our own decision-making processes. The intuitions that guided us in the past are breaking down as we move from single-user applications and mainframe systems to the new world of networked minicomputers and microcomputers that will support groups. We need better science and better intuitions in this area, because failure is so expensive and time-consuming. ■

Jonathan Grudin is a member of MCC's Human Interface Laboratory in Austin, Texas. He can be reached on BIX c/o "editors."

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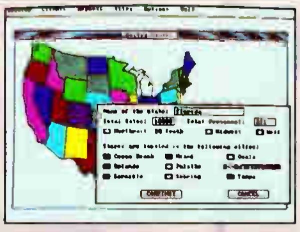

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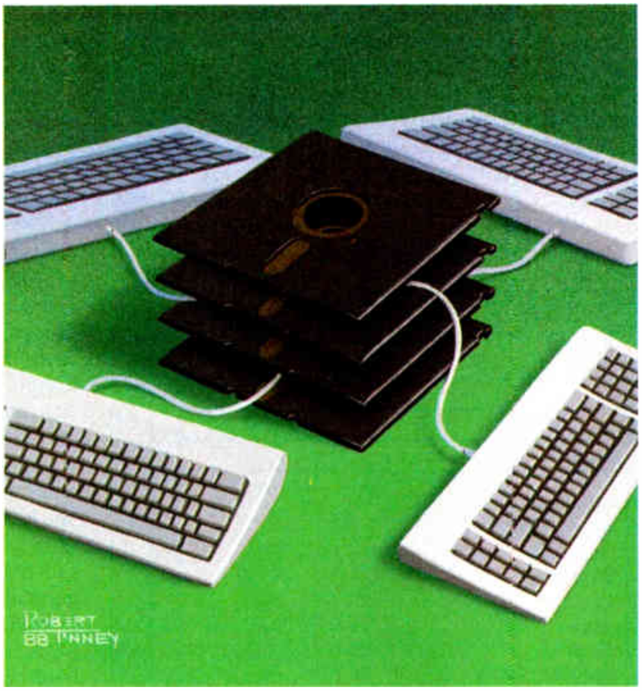
Intelligent Software Agents

Using AI techniques in groupware has the potential to dramatically alter the way we organize our work

Kevin Crowston and Thomas W. Malone



Although people often work together in groups, computers, so far, usually don't. Computer systems have been designed either to automate an entire process, such as calculating a payroll, or to support an individual, such as a decision-support system for a decision maker or a word processor for a writer. Recently, however, researchers have begun to experiment with software that is specifically designed for groups—a type of software often called *groupware*.

Artificial intelligence, a field almost as old as computers themselves, is no exception. Many expert systems, for example, embody the know-how of an individual expert working alone on a task. AI techniques can be equally useful, however, in supporting group work, and such applications are now being used in research labs.

Designing Intelligent Groupware

Most of the designers of intelligent groupware systems have concentrated primarily on the underlying "intelligent" functionality of the systems, not on their user interfaces. This focus is understandable, since most of the systems were explorations of the technology and not intended for use in a real setting. We think, however, that the design philosophy for presenting intelligent functionality to end users is much more important than simple "user interface" questions would imply; in fact, it's critical to the success of these systems.

Our work on the Information Lens, an intelligent information-sharing system developed at the Sloan School of Management at MIT, has helped to crystallize in our minds some of the principles that we find useful in designing intelligent groupware. These principles follow primarily from the observation that most cooperative work involves more knowledge than we can completely formalize in computer programs. Furthermore, there are some kinds of interactions that humans should always handle themselves rather than delegate to computerized assistants.

We believe that computer systems can be more useful if they follow two basic rules: (1) Expose incomplete knowledge and (2) make it easy to include informal knowledge and processing. For instance, instead of trying to depend on complex, hidden (and necessarily imperfect) reasoning about what you, as a user, want to do with your messages, the system should expose all its rules in such a way that you can both see and modify them. Thus, you can understand and compensate for the system's incomplete knowledge.

In addition, unlike traditional forms-

continued

processing systems, the system should not restrict the type of information in most fields of messages; it should let you put whatever unstructured text you want in a message. Thus, if the message types included in the system are incomplete or inappropriate for a given situation, you can always take care of the situation informally.

Information Lens

The Information Lens system uses ideas from AI research to enhance the most common kind of groupware: electronic mail. In mature computer-based messaging communities, it's common to feel flooded with large quantities of electronic "junk mail." At the same time, it's also common to be unaware of facts that would make your work easier, facts that are known elsewhere in your organization. The Information Lens helps you solve both these problems. It helps you filter, sort, and prioritize messages that are already addressed to you, and it also helps you find useful messages you would not otherwise have received. Furthermore, it lets you choose for yourself how much of your mail you want to process automatically.

A key idea in the Information Lens is that information in messages can be partially represented in frames. For example, "meeting announcement" messages include fields for date, time, place, organizer, and topic, as well as additional unstructured information. Senders can compose their messages using frames that suggest the kinds of information to be included in the message and likely alternatives for each kind of information (see figure 1).

Receivers can conveniently specify rules to automatically filter and classify incoming messages into folders based on the same dimensions used by senders in constructing messages (see figure 2). When necessary or desirable, however, the receiver can still process messages by hand. For example, if a sender put "we don't know yet" in the time field of a meeting announcement, the rules of most automated calendars would not be helpful, but a person can easily make sense of the sender's intentions.

Information in messages can be partially represented in frames.

In addition, messages can be sent to a special mailbox (currently named "Anyone") to indicate that the sender is willing to have this message automatically redistributed to anyone else who might be interested. Receivers can specify rules that find and show messages addressed to "Anyone" that the receiver would not otherwise have seen. Messages can thus be selectively disseminated only to people who are likely to be interested in them. This framework supports many kinds of information sharing in addition to straightforward E-mail. For example, automobile designers could ask to receive just those engineering-change notices that affect their parts of the car instead of manually sorting through the paper announcements of all changes.

When senders don't use any special message types in composing their messages, receivers can still process these messages with rules based on the fields present in all messages (e.g., "to," "from," "subject," "date," and "text"). As natural-language parsers become more powerful and accurate, however, they could be used to parse more and more kinds of unstructured documents. For example, as a demonstration of possible extensions to the Information Lens, we developed a parser that reads unstructured seminar announcements and creates meeting-announcement messages. Rules like these could be used to process a much wider range of documents.

Semi-structured messages are also useful, not only for information sharing but also for supporting a variety of other coordination processes in organizations (see Malone, Grant, Lai, Rao, and Rosenblitt in the bibliography). For example, when the system knows the types of messages it is receiving, it can take automatic actions on receiving certain kinds of messages and suggest actions that its users might take on receiving others. Simple examples of using these capabilities include setting up rules to automatically forward meeting announcements to a secretary who keeps a calendar or to enter the meeting in an on-line calendar, and having the system automatically present its users with an option of loading the patch files specified in "bug-fix announcements."

We have also recently used these ideas to implement demonstration systems that help you schedule meetings, engage in computer conferences, and keep track of tasks you have agreed to do. For instance, we created a system to help schedule meetings simply by creating several new types of messages (e.g., "meeting proposal" and "meeting acceptance") and by adding several new kinds of rule actions and response options (e.g., "accept meeting" and "add to calendar") to the system.

Computer conferencing requires a

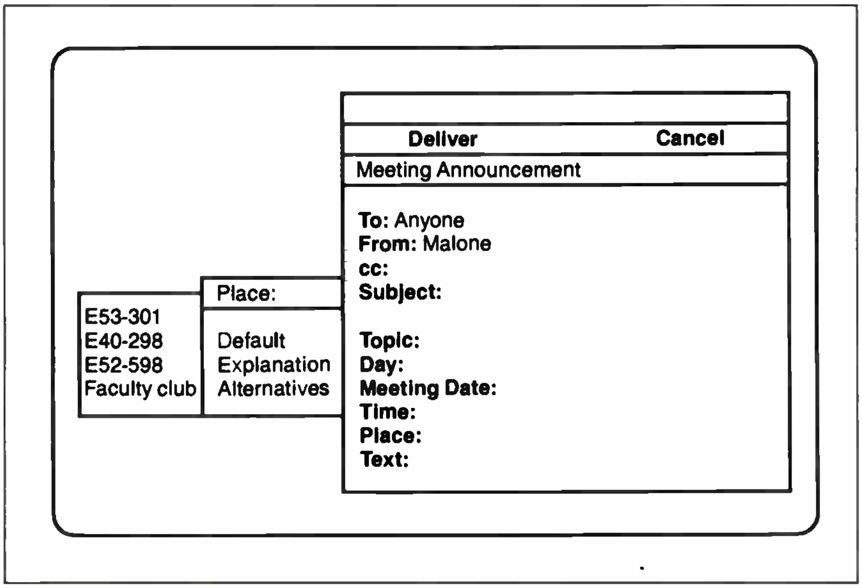


Figure 1: *The format of the message screen from the Information Lens. Messages are composed with a display-oriented editor and templates that have pop-up menus associated with the template fields.*

new message type to announce a conference, and a new action, "join conference," that creates the following: a new folder for conference messages, an "Anyone" rule to forward the messages sent to the conference, and a rule to put the messages in the folder. To send a message to a conference, you simply mark the message with the conference name and send it to "Anyone." To read a conference, you simply open the appropriate folder.

Object Lens

We are currently working on a successor to the Information Lens system, called Object Lens that applies these principles to a much wider domain than just messages. This system provides a user interface that integrates many of the capabilities of electronic messaging, rule-based "intelligent" agents, object-oriented databases, and hypertext.

The design of Object Lens is based on the Information Lens system, and it also uses frames to represent the information in messages and rules to process E-mail. Object Lens extends the use of frames, however, by using them to represent many other objects as well. For example, "person" objects have fields for name, phone number, and job title; "tasks" have requestor, performer, and deadline. These fields can contain text, as in the Information Lens, or links to other frames, as in hypertext systems. For example, you can find the phone number of a person doing something for you by examining the phone number field of the "person" object in the performer field of the "task" object.

Object Lens also extends the scope of rules beyond messages. As a user, you can create agents to do some tasks automatically, such as sorting new mail into folders when it arrives. Agents can also be triggered by other events; for example, an agent could be set up to remind you when a deadline passes. You can also create an agent to find all the objects that match some criteria, much like running a query in an object-oriented database.

We hope that Object Lens will provide an infrastructure in which many other applications for intelligent groupware can be easily implemented by developers and easily understood and modified by users. For example, Object Lens could be used for task tracking by adding message types for "action request" and "commitment." You could then organize these messages in different ways—for example, sorted by deadline or by the name

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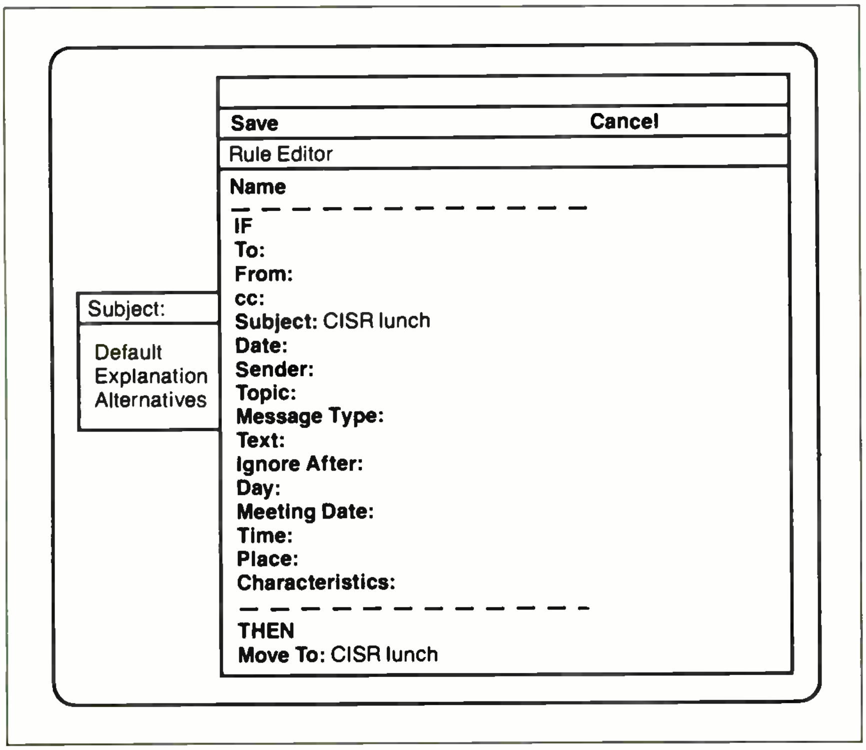

Figure 2: *The format of the rule screen from the Information Lens. Rules for processing messages are composed using the same kind of editor and the same templates as those used for composing messages in the first place.*

Experimental Groupware Systems

Name	Developer	Focus	Language and system	AI techniques
System Development Support Environment	Beverly Kedzierski, University of Southwestern Louisiana	Software development	CHI and V	Frames, rules
Callisto	Arvind Sathi, Thomas E. Morton, and Steven F. Roth, Digital Equipment Corporation	Project management	SRL; recent work in Knowledge Craft expert-system shell from the Carnegie Group	Planning
Carleton Office Knowledge Expert System (COKES)	A. Roger Kaye and Gerald M. Karam, Carleton University	Office work	Prolog	Frames, rules
Omega	Gerald Barber, MIT	Office work	Lisp on an MIT Lisp Machine	Non-monotonic reasoning
Polymer	W. B. Croft and L. S. Lefkowitz, University of Massachusetts at Amherst	Office work	KEE expert-system shell from IntelliCorp	Planning
Argnoter	Mark Stefik, Gregg Foster, Daniel G. Bobrow, Kenneth Kahn, Stan Lanning, and Lucy Suchman, Xerox Palo Alto Research Center	Group decision making	Interlisp-D and LOOPS on Xerox 1132 workstations	Non-monotonic reasoning
Information Lens	Thomas Malone, Ken Grant, Franklyn Turbak, Kum-Yew Lai, Ramana Rao, Kevin Crowston, and David Rosenblitt, MIT, Sloan School of Management	E-mail	Interlisp-D and LOOPS on Xerox 1100 series workstations	Frames, rules
Object Lens	Kum-Yew Lai, Thomas Malone, and Keh-Chiang Yao, MIT, Sloan School of Management	Office work	Interlisp-D and LOOPS on Xerox 1100 series workstations	Frames, rules

of the person doing the task. Managers could display the status of all tasks being done by people in their group.

Experimental AI Systems

Six other groupware systems that use AI techniques are also summarized in the text box. The first three help people working together by being "experts" on how the group interacts.

• *System Development Support Environment* contains knowledge about the kinds of things people often say to each other when developing software, and it uses this knowledge to automatically carry out parts of the conversation. For example, if you want to complain about a bug, the system can ensure that all relevant information is recorded; identify the person responsible for the program and forward the report; warn other users of the bug; and collect the information in an easily accessible form for further analysis.

• *Callisto* is a distributed system for engineering project management. Group managers each use a copy of the program to help schedule resources and activities for their own groups. The individual systems are connected and can communicate when necessary. When one group needs something from another, such as access to a facility controlled by that group, the relevant systems can automatically negotiate, using a variety of techniques.

• *COKES* is a distributed system to support office work. Each individual has an "assistant" that can provide details about office procedures, other staff members, or available resources. Other servers store shared organizational knowledge. These systems can communicate with each other, for example, to request or supply information. New managers could use the system to find which reports they need to write, when they are due, and who should get a copy. The "assistant" could then help collect the information necessary for each report.

The other three systems use knowledge-representation techniques to store information the group is working on. This in itself can be seen as a benefit, because it requires people to be more explicit, thus reducing disagreements caused by conflicting but unstated assumptions. Moreover, once the knowledge is in a form that can be handled by computer, the system can provide further support.

• *Omega* embeds knowledge about the effects of the actions a worker can take. When you state a goal (e.g., finding a new assignment for a Navy officer), the system checks that the goal can be achieved. If it finds a problem (e.g., not enough money budgeted to pay moving expenses), the system can identify the cause, allowing you to restate the goal or change the underlying constraints (e.g., delaying the move until money becomes available).

• *Polymer* uses planning ideas to help carry out the steps in a complex office procedure. When you state a goal, the system creates a plan—that is, a sequence of actions to achieve the goal. As each action is carried out (e.g., by assigning it to someone to do), the system checks to see if it worked as expected. If something goes wrong, the system can reevaluate the situation and, if necessary, make a new plan. For example, a journal editor could use the system to control the review process. As each paper is received, the

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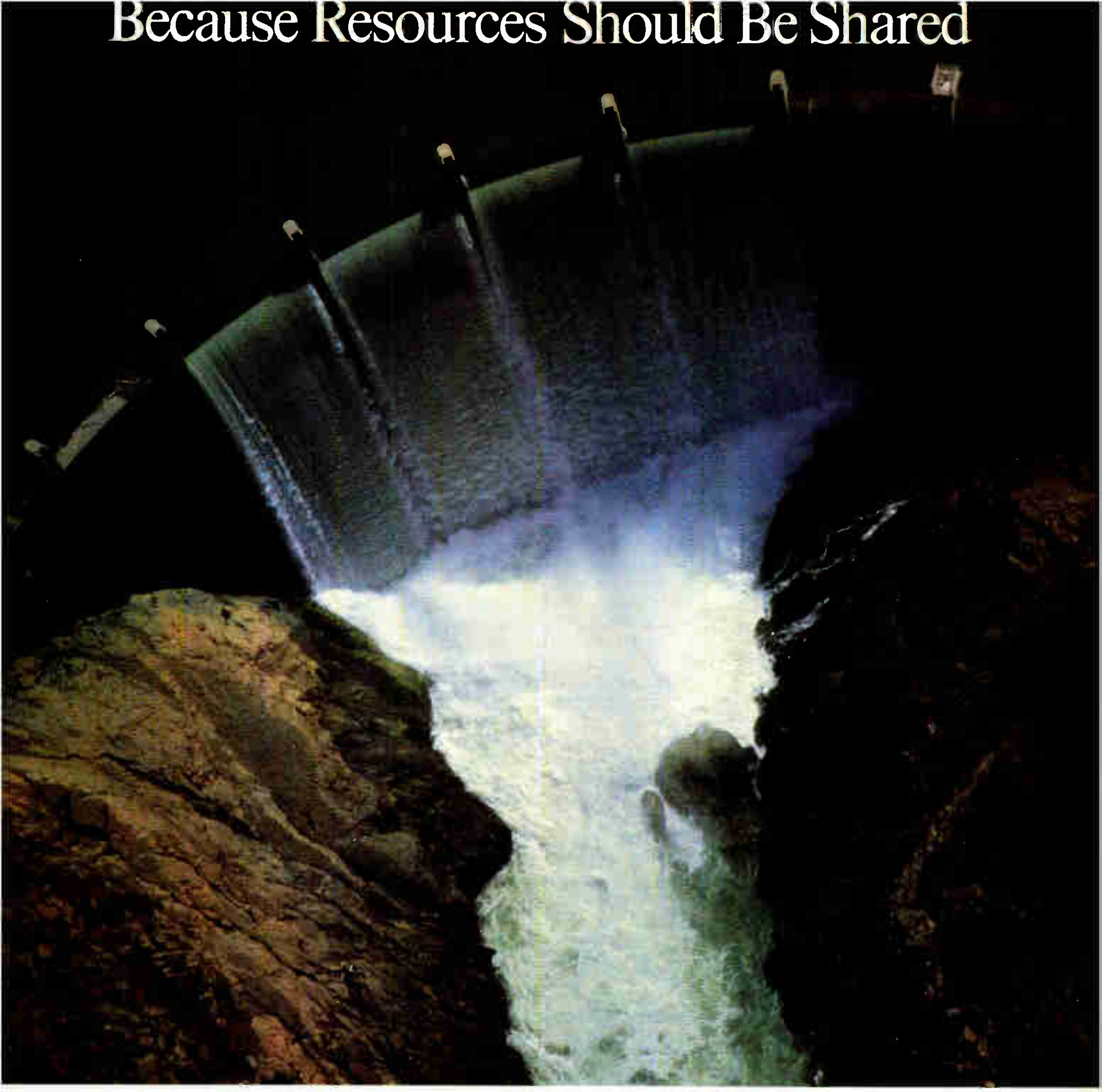

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system would ask for the names of reviewers, request their recommendations, and get the editor's final decision on the paper.

• *Argnoter* will be part of the CoLab, a face-to-face meeting-support system. Argnoter is designed to support a group evaluating proposals—for example, for the design of a piece of software. Individuals suggest arguments for or against each proposal and compare proposals, using the system to prepare summaries of the arguments. As participants discuss the arguments, they can state their underlying assumptions and evaluation criteria and have the system quickly evaluate proposals under different sets of assumptions.

Just the Beginning

At present, AI techniques for group work are still in their infancy. These techniques, however, have the potential to dramatically alter the way we choose to organize our work. For instance, imagine a future in which you work at a workstation connected to many others on a corporate network. Vast amounts of knowledge are stored on-line. Your workstation contains most of the letters, reports, calendars, business cards, drawings, and other papers that clutter your office today. It also "knows" what tasks you are working on, what products your company makes, and who has different roles in your organization. Other computers on the network know how the components in new products fit together, which outside firms can supply them, and why the major design decisions were made as they were.

Imagine further that you are the master of dozens of "intelligent agents." These automated servants tirelessly do your bidding, searching for meeting announcements, news stories, engineering-change notices, and other information that might interest you. They also sort, prioritize, and keep track of all the information you receive. Sometimes these servants schedule meetings for you (according to your own priorities); at other times, they suggest how you may want to handle a message you have just received. Often they advise you about how to get things done: who to ask, what procedures you need to follow, what you haven't done yet. These servants sometimes act as your representatives in answering other people's questions, in negotiating project schedules, and even in buying parts from outside suppliers.

Of course, no system today can perform all this magic. But researchers are making significant progress in using techniques from AI to help solve some of these problems. ■

Kevin Crowston is a doctoral student and Thomas W. Malone is a professor at the MIT Sloan School of Management. They can be reached on BIX c/o "editors."

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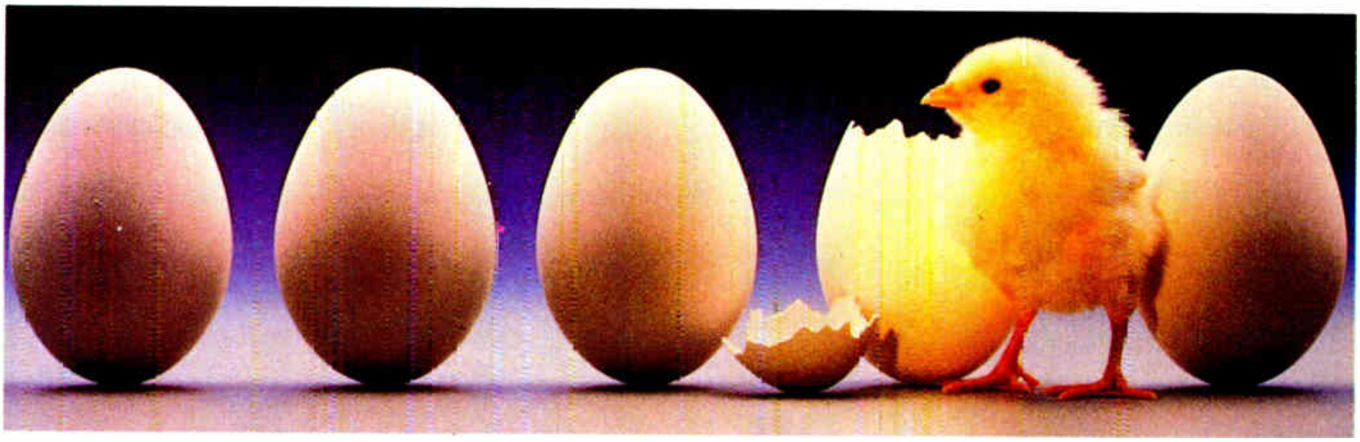

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A Groupware Toolbox

These products prove that personal computer groupware is real

Susanna Opper

The population of groupware products increases each week. And there's no doubt that a virtual baby boom of entries will blossom with OS/2 and the Presentation Manager.

Even though many personal computer groupware products are still in their infancy, some are young adults. The products mentioned here are a sampling of the more popular and promising programs available.

The Toolbox

It's useful to think of groupware as a class of products—similar to a toolbox containing tools for diverse tasks. Like the tools in the box, various groupware products are suited to different jobs or workgroup missions. Here are some emerging categories:

- *Document editing.* This software automates the process of capturing and tracking editorial comments on a document by several people. Proposals, legal documents, and sales literature are examples of work in this category.
- *Forms centered.* These systems are designed to coordinate routine transactions through a standard cycle. The processing of order forms, insurance claims, and customer complaints are examples.
- *Team development.* This is an emerging category that includes products designed to assess and provide feedback to groups about individual styles and team makeup.
- *Workgroup communication management.* This includes structured and semistructured electronic mail-based systems that enable groups to have discussions, take messages, coordinate calendars, track projects, and follow up on details.

Some observations hold true for many or all of the products I'll discuss. The first is residence. Where your groupware product resides makes a big difference. If you've bought a program to enable anyone in your workgroup to take phone messages for anyone else, but message takers must quit another program each time the phone rings, you'll have a lot of unanswered calls. Some programs that don't have this drawback are noted below. Otherwise, investigate a multitasking environment such as DESQview from Quarterdeck Office Systems.

You should also consider your resources. You need to know up front that many of the products on the following pages are "hogs." Whether a groupware product will strain your resources and whether it's worth the cost of adding memory or bumping other applications are questions you may need to bear in mind.

Connectivity is your next concern.

continued

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Local-area networks are gaining great popularity. But some managers recognize danger in having a LAN here, an incompatible LAN there, and a third elsewhere. Few workgroups in companies work in isolation. Manufacturing needs to talk to sales; everyone needs to talk to personnel; the controller needs to talk to everyone. This means groupware in one department must connect to the same product or another groupware product elsewhere in the company—often at a different location. Furthermore, many organizations require links to the corporate mainframe.

Who connects to whom is a lengthy, complicated, and ever-changing discussion, and I'll not list connectivity for individual products here. But before you settle on your short list for groupware, check to be sure the product makes the connections you need.

And finally, you should consider standards. While CCITT's X.400 will probably be the interconnection standard, its implementation today is neither consistent nor universal. Some groupware products will provide an X.400 gateway via Action Technologies' Message Handling System, which was included with Novell's software starting in January. MHS is a store-and-forward message-handling service that allows program-to-program transfer of data. The Coordinator, Higgins, and WordPerfect Office support MHS.

Familiar Faces

The following products have all been around for a while, typically 2 or 3 years, and most have been upgraded at least once. Each has an installed base and loyal user support.

• *ForComment*. Ever since the Founding Fathers framed the Constitution, collaborative writing has been the American way of putting ideas into print. By 1984, in spite of computerization, group writing hadn't improved much. This bothered university professors Mark Edwards and Jim Levine, who spent their lives writing research grants, commenting on colleagues' papers, reviewing student writing, and preparing manuscripts for print. Both programmers on the side, they figured there had to be a better way. They began to sketch out the characteristics of what the ideal product would look like. Not long after that, they brought in Midian Kurland, another scholar cum programmer whose speciality was cognitive psychology.

The result of their efforts, ForComment, now marketed by Broderbund Software, is a document-editing package that supports up to 16 users. It's now available for the IBM PC or compatibles with 384K bytes of RAM, a word processor, and DOS 2.0 or higher.

ForComment allows multiple reviewers to comment on a document, seeing and adding to each other's remarks without actually altering the original version. That privilege rests with the designated author, who alone can choose to incorporate someone else's comments into the document. Each of up to 16 commentors' contributions is automatically initialed in the document, which can be printed with the annotations. A "cover page" tracks reviewers' activities. Menus and context-sensitive help screens give users support during the process.

ForComment is compatible with most popular word processing programs. Although it works much better in a LAN environment, it can be used as a standalone product also.

• *Higgins*. Conetic Systems' Higgins is the granddaddy of traditional LAN-based workgroup productivity software. It's built around a relational database that gives each user keyword access to group calendars, shared project information, and a personal filing system. It includes standard features like E-mail, scheduling, and project tracking, as well as expense reporting plus accessories—calculator, notepad, and telephone dialer. Two levels of password and full encryption of all text files keep data secure.

The product requires an IBM PC Network-compatible LAN, including 3Com's 3+, Novell's Advanced NetWare, Banyan's Vines, IBM's Token Ring, and AT&T's StarLAN.

The latest Higgins feature is a transparent, menu-driven facsimile delivery for E-mail. This means users can select a name from their previously specified personal directory, and recipients who aren't on E-mail will receive the message as a fax. Higgins even creates a cover page indicating the sender, recipient, subject, number of pages, and date. Incoming fax messages are stored until printed. The add-on costs $995.

Currently, the Higgins scheduler doesn't automatically notify meeting attendees of get-togethers or add dates to the calendar as tentative until confirmed. Howard Case, marketing vice president at Conetic Systems, says an upgrade is in the works.

• *The Coordinator*. This LAN-based product from Action Technologies is designed to allow organized information exchange between members of an electronic workgroup. More than just E-mail, the product helps those who send messages to clarify their requests, and it helps those who receive messages to respond to requests made of them by either accepting the request, rejecting it, or proposing alternatives. The Coordinator also keeps track of all interaction.

continued

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Data Access Corp.
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Perfect Timing
Workgroup communication.
Imagine Software
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Fairfax, CA 94930
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Inquiry 966.

SuperSync
Team development.
SwixTech USA
2102 Business Center Dr., Suite 130
Irvine, CA 92715
(714) 253-5715
$295.
Inquiry 964.

WordPerfect Office
Workgroup communication.
WordPerfect Corp.
1555 North Technology Way
Orem, UT 84057
(801) 225-5000
$495 for file server; $150 for each additional station.
Inquiry 963.

The product requires a LAN server with 640K bytes of RAM, Novell's Advanced NetWare (version 2.0 or higher), or a LAN operating system that fully supports DOS 3.1 or higher.

The Coordinator differs from other groupware in two important ways—one technical, one philosophical. Technically, the Coordinator's server is like a post office (a major metaphor in the system's design). When the recipient picks up a message, it moves to the user's PC and is no longer in the server. Thus, group members have their own unique Coordinator files right in their PCs. The good news is ease of access; the Coordinator is the place where work is done. The bad news is that if you travel, you must take your computer with you everywhere. And if you lose your files, you can't count on the server for a backup.

Philosophically, the Coordinator is designed to change the way people work. It's based on the concept of records providing a context or history for each conversation. It includes a mechanism for people to make commitments to action and a calendar system designed to track those commitments. This theory led the original Coordinator to a structured dialogue of "conversations for action" and "conversations for possibility," which included such "canned" messages as "I decline your offer." (For more information, see the text box "Coordinating Conversations" on page 256D.) The Coordinator Version II provides clearer menus, revised language, and greatly reduced learning time.

• *Caucus*. This system, from Metasystems Design Group (MDG), is the most versatile of a handful of computer conferencing products that run on small systems. Computer conferencing allows communication across organizational and geographic boundaries on many subjects at any time of the day or night. Caucus, running on an 80386-based machine with multiple serial ports, can handle up to 16 simultaneous users, which equates to a population of several hundred occasional callers. It's this capability and the ability to separate discussions by topic that set real conferencing systems apart from bulletin board systems, with which they are often confused.

The system's minimum requirements are an IBM PC or 100 percent-compatible machine running MS-DOS 2.0 or higher, complete with a 20-megabyte hard disk drive.

Not only does Caucus run on everything from a PC to a mainframe, but its built-in dictionaries give system administrators a powerful tool with which to customize commands. User interfaces can easily be translated into foreign languages or industry-specific jargon.

The Defense and Space Systems Integration Group at Boeing Computer Services in Seattle is one of more than 100

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sites using Caucus for on-line meetings. With the system's special macro commands, each conference is linked to a database that provides users with background technical information and other data appropriate to the topic. The same programming tool has been customized by Caucus's distributor, MDG, to keep track of prospects. If anyone in MDG's six-person office gets a lead, they begin a conference on the subject by invoking a macro-triggered program that interactively prompts for basic data on the prospect. Caucus's indexing feature enables MDG to generate lists of prospects for review and follow-up by the more than 20 associates and affiliates located around the world.

MDG holds electronic meetings for all prospects with existing clients who meet on-line to share common challenges of running a conferencing system and to let developers know where they think the program is lacking. These support groups are essential in computer conferencing, because the technology usually meets resistance when first installed in organizations where familiar in-person exchanges are replaced by lines on a screen.

Using the dictionary capability, developer Charles Roth is working on a Japanese version of Caucus. The development team—the members of which have never been able to meet in person—are working together on-line.

New Introductions

The next four products were introduced in the past year, have generally received good press, and have some loyal users.

• *Office Works*. This product from Data Access is designed to automate what people do in offices every day. The software's phone message slip, for example, looks like the standard paper form. The product promotes efficient message handling and calendar planning.

For example, Access Graphic Technologies in Piscataway, New Jersey, uses Office Works for all phone messages routed throughout the company. Suppose a call comes in to Joe McCaffrey, technical service manager for AGT, when he isn't at his desk. The receptionist would take the message and assign it a priority. If the priority is high enough, it would beep its presence for McCaffrey when he gets back to his office. Once he returned the call automatically through the program using his modem, he would file the message on the system and add his newfound contact to a database. He could send the message to someone else in the office if desired, since all 15 workers in the graphic-distributors organization, from the president to the receptionist, use Office Works.

While Office Works can handle a lot of phone messages, it also provides a sophisticated graphically presented calendaring feature. The program's scheduler, unlike some others, is very complete. If you want to set up a meeting, you indicate the time and desired attendees, and Office Works takes you through the whole process, from showing conflicts to placing the meeting tentatively on the targeted attendees' calendars and sending E-mail notification messages. If you don't get a confirmation, you know to follow up by other means.

Office Works also includes a completely searchable name, address, phone, and company-information database for clients, vendors, and business contacts. Unfortunately, the first release was not compatible with other DataFlex databases, causing some users double work. The company plans to correct that and introduce a multi-site version soon. The product handles traditional E-mail, including forwarding and future-delivery options, and it includes automatic routing for fax and telex messages. Its document-control feature lets you find any indexed items by ownership, author, recipient, date, or user-provided keyword.

The system requires an IBM PC, XT, AT, or compatible with 640K bytes of RAM and 2.5 megabytes of disk storage. Support is provided for multiuser-compatible operating systems, including Novell Advanced NetWare 2.0 and higher, 3Com 3+ version 1.1 and higher, IBM PC Network/LAN Program 1.12 and higher, IBM Token Ring/LAN Program 1.12 and higher, and other NetBIOS-compatible networks.

• *WordPerfect Office*. At Lugenbuhl, Burke, Wheaton, Peck, and Rankin, a New Orleans law firm, WordPerfect Office is used by a dozen secretaries and several adventurous attorneys with personal computers. The firm uses the product's calendar in conjunction with the scheduler for controlling the docket and scheduling appointments, meetings, and resources, such as conference rooms and court runners.

With WordPerfect Office, unlike some other programs, if the phone rings while you're in the middle of typing, you can pull up your calendar without leaving your word processing program. That's because WordPerfect Office has a shell program that directs traffic among WordPerfect applications and even allows easy access to third-party databases and other software. This module also has a "clipboard" that makes it easy to move text from one place to another.

The program includes a notebook that makes it easy to organize information into separate records (e.g., a telephone directory). Other features are a file manager that helps organize program and data files on both local and network directories, four different calculators, macro and program editors, and, of course, E-mail.

WordPerfect Office grew from user demands—specifically, requests by the U.S. Department of Justice, which was interested in an enhanced version of WordPerfect Library for use with its Data General hardware. That, coupled with continued user requests for a multiuser version of WordPerfect Library, led to the current personal computer version. Future versions will have greater connectivity capabilities.

This LAN application can run on most network systems that support DOS file-locking features. DOS 3.0 is required for the WordPerfect Office document-locking feature. Each workstation requires 384K bytes of RAM.

• *SuperSync*. You could argue that SuperSync, from SwixTech USA, isn't a groupware product at all, but rather a stand-alone package designed to analyze group behavior. The "groupware" part comes in feeding back to the group the results of their electronic sociograms. Sociograms are pictures of how members view the group, and with SuperSync, developer Tony Adams has automated the process of discovering in advance how individuals are likely to function as a group. Adams spent many years as a manager in the U.S. and Switzerland and found group formation a major headache, so he developed this program.

According to Stein Roaldset, who heads Scandinavian Management Development in Madison, Connecticut, SuperSync is the most exciting product in the training and development field in many years. He uses it in his business, consulting and training in small-group formation. As a test of the program's accuracy and effectiveness, he and a colleague experimented. The colleague took 4 days of traditional individual interviews before forming a group. Roaldset spent just 30 minutes with the same population using SuperSync and came up with similar results, but in more detail.

The software requires an IBM PC, XT, AT, PS/2, or 100 percent–compatible computer with 512K bytes of RAM and DOS 2.0 or higher. To use Super-

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Sync, you list team members and select questions they will each answer. Then you can create your own questions or use those included in the program—for instance, "You will most probably obtain the best advice from whom?" The program prints a questionnaire that group members answer with the name of another person or persons. Then the data is entered back into the computer, and you can see a bar chart showing centers of influence and the individual having the most influence in each center. It's not that simple, of course. In fact, the program is mostly being used by consultants with considerable group-behavior experience.

• *LIfE.* These products from Motorola Computer Systems are short for Linked Information Environment. Four modules are available: LIfE•Forms produces electronic forms that look like paper ones already in use. It facilitates paperwork, such as purchase orders, billing, employee forms, and tax records. LIfE•Works provides high-end data entry for back-office activities. LIfE•Plans offers high-speed, high-capacity workgroup spreadsheets.

In addition, LIfE•Lines is a workgroup E-mail system. The products are designed to be easy for end users, and results from one application can be used directly by another application.

Note, however, that all these products require Motorola hardware and the Unix operating system.

In Development

Soon to arrive is Perfect Timing from Imagine Software. Because it's a Macintosh desk accessory, it's only a mouse-pull away from any task you are involved in. The program provides the standard functionality—calendaring, to-do lists, scheduling, reminders—with the ease of Macintosh graphics. Want to extend the meeting time? Just grab that section of the calendar and stretch it. Want to change a task from Wednesday to Thursday? Just highlight it and move it.

Imagine Software's other offerings—Smart Alarms and Appointment Diary—have been popular products for the Mac. But Perfect Timing was created from scratch—taking two programmers 14 months to develop. The software requires an Apple Macintosh network via AppleTalk over LocalTalk or equivalent cabling; it requires no additional software. It is compatible with AppleShare, TOPS, and other networking packages.

Groupware Is Real

Macro trends in business portend well for the future of groupware. These trends say companies will be trying to do more work faster with fewer people, that the "time to decision" will be shorter, and that small groups rather than individuals or large committees will be the agents getting things done.

But groupware has a long way to go. While it saves time to automate message-taking and meeting scheduling, this isn't the stuff of breakthroughs. Groupware will reach a level of heightened utility when it enables people to do work they were never able to do before. SuperSync hints at what this could look like—programs that actually enhance the way a group works together, that improve group decision-making, and that increase group synergy. Those products have yet to appear. ■

Susanna Opper is a New York City-based consultant in workgroup communication and productivity. She can be reached on BIX c/o "editors."

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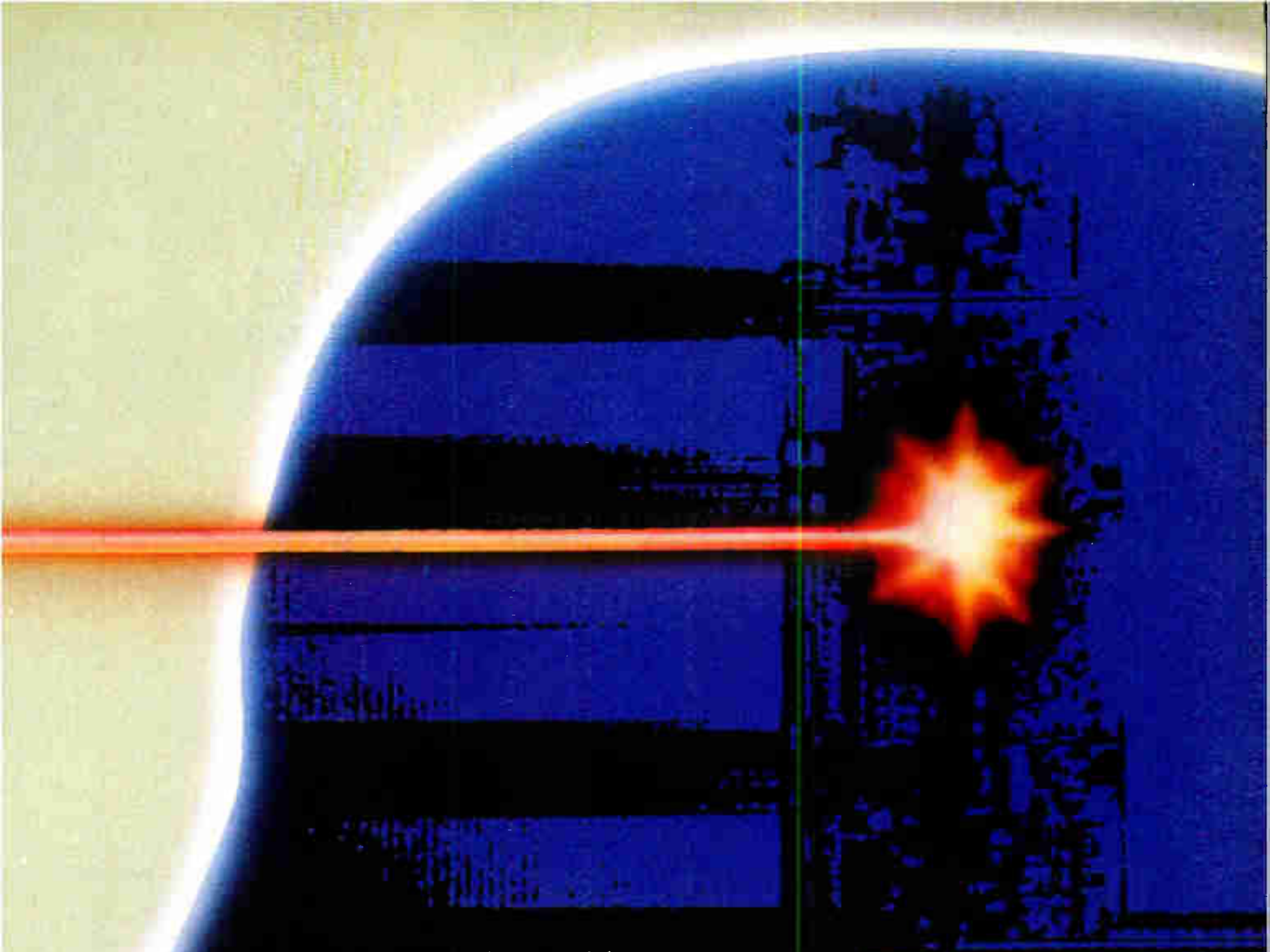

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FACE TO FACE WITH OPEN LOOK

Can a new graphical interface make Unix friendly after all these years?

Tony Hoeber

For years now, the Unix operating system has been like an athlete with potential—it has great talent but somehow has never lived up to expectations on the playing field.

While Unix is one of the most capable and powerful operating systems available, it still has a very small installed base (about 350,000 licenses and some 1 million users) compared to the MS-DOS operating system (more than 10 million users) or even the Macintosh Finder (close to 2 million). Many industry observers would agree that the main problem with Unix has been its lack of an accessible, easy-to-use interface.

In April 1988, AT&T announced a new graphical user interface called Open Look, destined to be the user interface for Unix System V version 4.0, the converged version of the three most popular variants of Unix: System V, Berkeley (BSD) 4.2, and Xenix. Designed for AT&T by Sun Microsystems, and based on technology licensed from Xerox, Open Look was designed to be independent of the hardware and software on which it runs; as such, it can be used with operating systems other than Unix.

The Graphical Interface Story

The development of graphical user interfaces can be traced to commercial products such as the Xerox Star, Smalltalk, and the Macintosh; to academic projects such as the Andrew system from Carnegie-Mellon; to research systems such as Diamond and Sapphire; and to many applications in areas like CAD and desktop publishing.

The roots of all these systems go back to work done at Xerox's Palo Alto Research Center (PARC) in the 1970s. Among the more influential of the Xerox systems are Smalltalk, the Star (and its successor ViewPoint), the Bravo Editor, and the Cedar development environment. These systems introduced many of the ideas that have come to be taken for granted as the basic elements of graphical user interfaces: windows, icons, menus, the desktop metaphor, and direct manipulation of objects on the screen by the user. The designers of the Star, in particular, placed great emphasis on the consistency of the user interface.

In the early 1980s, the designers of the Apple Macintosh took those ideas and combined them in a design tuned for a specific machine, market, and price point. The Macintosh had a single-process operating system and a small screen. This led to a user interface based on a single top-of-the-screen menu bar used by whatever program was currently active. The designers envisioned an interface that was simple and accessible to nontechnical people. This emphasis on simplicity also led to the choice of a single-button mouse.

The Open Look user interface for Unix builds on and enhances both of these traditions—the consistency of the Star and the simplicity of the Macintosh. Beyond specific features, however, the major significance of Open Look is that it is not tied to a particular computer or operating system.

The "Open" in Open Look

The Xerox Star was a tightly integrated, closed system. The hardware, operating system, windowing system, user interface, and applications were all built by the same company, so consistency was ensured.

Similarly, the Macintosh was a closed system, though Apple broke the applications out of the bundle. As independent software developers began to supply applications for the Macintosh, consistency across applications emerged as a crucial issue. Apple addressed this issue by publishing user-interface guidelines and creating a culture that encouraged application developers to follow the conventions.

With the advent of open systems like the Mac II, hardware as well as software is now available from companies other than Apple. Meanwhile, a variety of graphics-oriented system software (e.g., Windows and the Presentation Manager) is now available for 8086/80286/80386 machines.

In graphics-based systems, the trend from tightly integrated,

continued

ILLUSTRATION: CARY HENRIE © 1988

single-vendor systems toward loosely integrated, multivendor systems has important consequences for user interfaces. The designers of the Star took the position that the hardware should be designed specifically to fit the software. The designers of the Macintosh also designed their look and feel with reference to a particular operating system, display, and mouse.

Open Look takes this evolution to the next step. It was designed from the start to accommodate different keyboards, mice, and screen resolutions. The interface is not tied to a particular piece of hardware, operating system, or windowing system, so it is possible for applications to have a consistent look and feel, regardless of what hardware or operating system they happen to be running on.

First Look at Open Look

In Open Look, the display screen is called the *workspace*. The workspace contains windows and icons representing application programs. An application typically consists of one main window (in which the application's data is displayed) and several pop-up windows that you use to manipulate the data.

Figure 1 shows a typical Open Look screen with sample applications called Draw and Write. Notice the L-shaped corners on the applications' windows, suggesting picture mounts from a photo album. By clicking and dragging these mounts, you can resize a window from any corner.

At the top of each application window is the *header*, which contains the name of the application and a window mark that closes the application when you click it.

Below the header is the application's *control area*, which provides access to the application's main functions, such as opening and closing files. The control area typically consists of a single row of buttons. You "push" these buttons by moving the mouse pointer over it and clicking the Select mouse button. (For an explanation of Open Look's approach to mice, see the text box "Open Season for Mice.")

As you can see in figure 1, there are two styles of buttons: Those with a single, heavy shadow are simple buttons, representing a single command. Those with a double shadow are *button stacks*, representing several related commands.

To perform the default action on a button stack, you click the Select mouse button. Pressing the Menu mouse button calls up the menu associated with the stack. The Edit button's menu in figure 1 has been opened up in this way. Notice that the menu itself contains buttons and button stacks. By using the two types of buttons in combination, an application can support far more commands than it could display on the control panel.

Below the control area is the *pane*, in which the application displays its data. The form that data takes is up to the application; usually it is text, a drawing, or a spreadsheet.

To the right of the pane is a scroll bar that lets you move the contents of a document within the pane. As you can see in figure 1, the Open Look scroll bar resembles an elevator riding on a cable that is anchored at either end. Clicking on the top arrow moves you one line toward the top of the document; clicking on the bottom arrow moves you one line toward the bottom. Because the arrow buttons are located next to each other on the elevator instead of at either end of the scroll bar, you need only move the mouse a short distance to reverse directions.

To jump directly to the beginning or end of the file, click on the top or bottom cable anchors, respectively. Finally, you can move to any part of the document by pressing in the middle of the elevator and dragging.

Property Windows

Open Look's debt to the Xerox Star is evident in its use of *property windows* that let you view and modify the properties of any object you can see on the screen.

To change an object's properties, you first select the object of interest. Then choose Properties from the appropriate menu (which will change depending on the application and the object you select). This will bring up a window with controls that you

continued

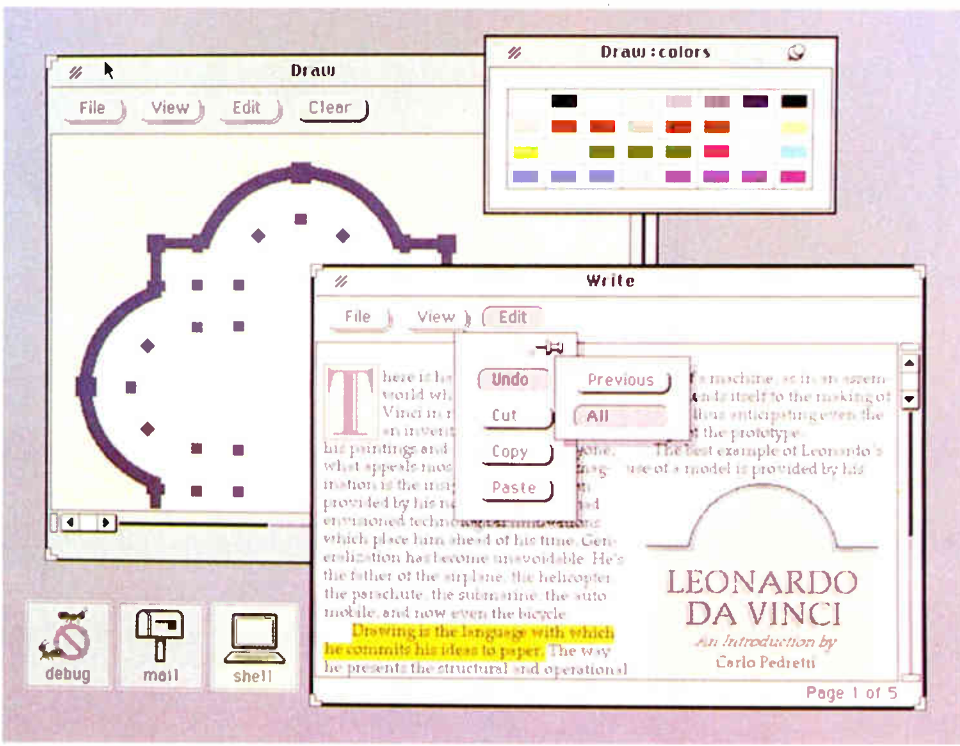

Figure 1: *A typical Open Look screen with edit and draw applications. Each application consists of one main menu (which you can resize using the L-shaped corners) and several pop-up windows that you use to manipulate the data.*

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Open Season for Mice

Open Look was designed to work with a one-, two-, or three-button mouse. The interface provides for three mouse functions called *Select*, *Adjust*, and *Menu*. Select lets you select and drag objects and manipulate controls such as buttons. Adjust lets you adjust a selection (such as selecting more text). Menu lets you display and choose among pop-up menus.

On a one-button mouse, the unmodified button is Select, with modifier keys (such as Alt or Option) required for the Adjust and Menu functions. On a two-button mouse, you use the left button for Select, the right button for Menu, and the Select button plus the keyboard Shift key for Adjust. On a three-button mouse, the default assignments of the buttons are, from left to right, Select, Adjust, and Menu. Again, these are the default assignments; regardless of the type of mouse, you can change them if you want. For example, on a two-button mouse, you could assign Adjust to the unmodified right mouse button and require a modifier key for Menu.

can use to modify the properties of the object. All property windows work in exactly the same way, regardless of which object you are changing. For example, you could select a word in a word processing program and change its font, select the main window of an application and change the application's background color, or select the screen background and change a global property such as the volume of the system bell. Figure 2 shows a typical property window for a word processing application.

The first two lines in the property window of figure 2 are examples of settings that let you choose among predefined choices. When you select a setting, its border becomes outlined in bold. Settings whose borders touch are exclusive—only one choice may be on at a given time. Settings whose borders do not touch are nonexclusive—you can toggle each choice on and off independently of the others. Below the settings is a text-entry field, and below that is a sliding control that lets you choose quickly from a range of values.

All property windows have a special control, known as the *pushpin*, at the right of the window header. When the pin is on its side, as in figure 2, the window will disappear when you click the OK button. If you click on a pushpin, it pops into the hole next to it. The window will remain until you dismiss it by clicking on the window mark in the header. Using the pushpin lets you perform multiple operations (such as changing font characteristics of various words throughout a document) without having the window disappear after each action.

An application may also have pushpins on menus, thus allowing the menu to be pinned up for repeated use. Figure 1 shows examples of both pinned and unpinned menus.

Additional Pop-ups

A special type of pop-up window is the *notice*, which asks you to confirm operations that would result in the loss of data. Notices appear to project from the button that prompted their appearance, as shown in figure 3. This "projection" acts as a visual prompt.

Open Look provides help through a standard help window (see figure 4) that appears when you point at an object on the screen and press the Help key on your keyboard (which will vary from system to system).

Next to the help message is the *help lens*, a magnifying glass that contains a snapshot of the object for which you have requested help. As you move the mouse pointer from object to object and press the Help key, both the image in the lens and the help text are updated.

Design Goals

The main goals of the Open Look design were to provide the following: good visual design; balance among simplicity, consistency, and efficiency; device independence; and interoperability with other widely used interfaces.

One of the most challenging aspects of visual design is the use of color. The problem is to use color so it emphasizes useful distinctions and adds interest to the visual scene without producing a neon "Las Vegas" effect.

Some user interfaces show each visual element—buttons, scroll bars, window headers, and so on—in a different color, resulting in a random clutter of bright colors. In contrast, Open Look allows you to choose the colors for the three areas of the user

continued

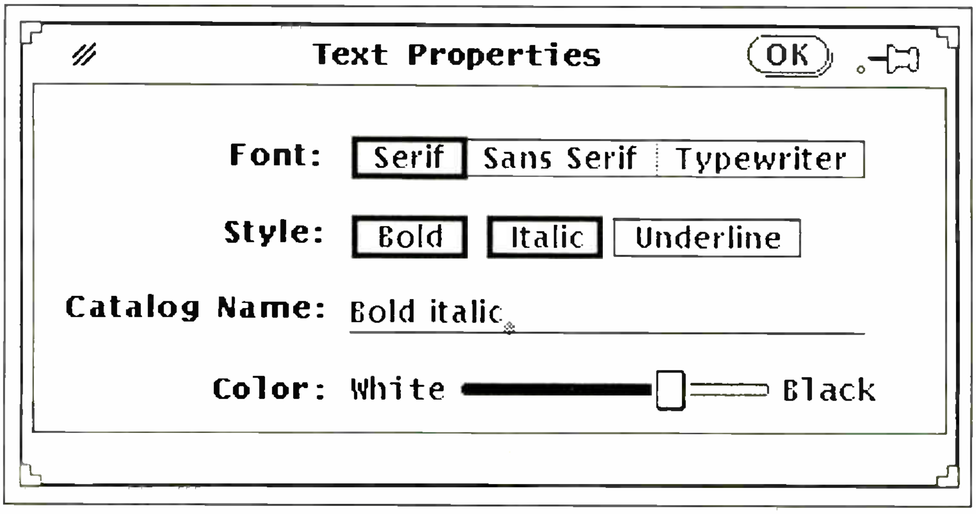

Figure 2: *A typical Open Look property window for a word processing application. Settings whose boxes are closed together are exclusive—you can only choose one at a time. With settings whose boxes are separated, you can choose as many as you want.*

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interface: the background of the screen, the background of each window, and the currently selected object. This use of color serves several purposes. The backgrounds of the windows are colored with neutral tones so that they will not overwhelm whatever information the application is displaying. Also, since a single background color is used for all the windows of a given application, you can tell at a glance which pop-up window goes with which application.

Against this neutral background, the eye is naturally drawn to the brightly colored selection (e.g., the block of yellow text in figure 1), which is the focus of the user's attention.

Open Look provides several palettes from which you can choose the colors of the screen background, window backgrounds, and the current selection. The colors in each palette have been chosen by the graphic designer so that they go well together. This approach accommodates individual tastes while ensuring that the overall effect will be pleasing and the text will still be readable.

Simplicity, consistency, and efficiency are the basic principles that guided the Open Look design. When you're doing a new task, you want the interface to be simple. If the interface is similar to that of a task with which you are already familiar, learning will be easier. And when you are doing a task over and over, you want the interface to be as efficient as possible.

It is hard to overemphasize the importance of consistency. Consistency lets you learn many applications and switch easily among them.

Several aspects of the Open Look design reflect this emphasis on consistency. Throughout the system and across applications, a given mouse button is used for only one function. We aimed for visual consistency in the design of controls: Buttons and settings look the same, regardless of whether they appear in a pop-up menu or in a window. The help window is another example of consistency: You can point to any object on the screen and get help, regardless of whether it is a standard element of the system (such as the pushpin) or an application-specific object such as a particular button.

Open Look has taken many other well-established conventions of graphical user interfaces and applied them in a more consistent way. For example, in Open Look, we extended the familiar selection paradigm to include the screen background, so you can select multiple windows and move or close them in a single operation. Another example: While earlier interfaces let you manipulate graphics objects directly, Open Look lets you select and drag arbitrary pieces of text as well (see figure 5).

Efficiency is easier to measure than simplicity or consistency. The fewer moves needed to perform a task, the more ef-

continued

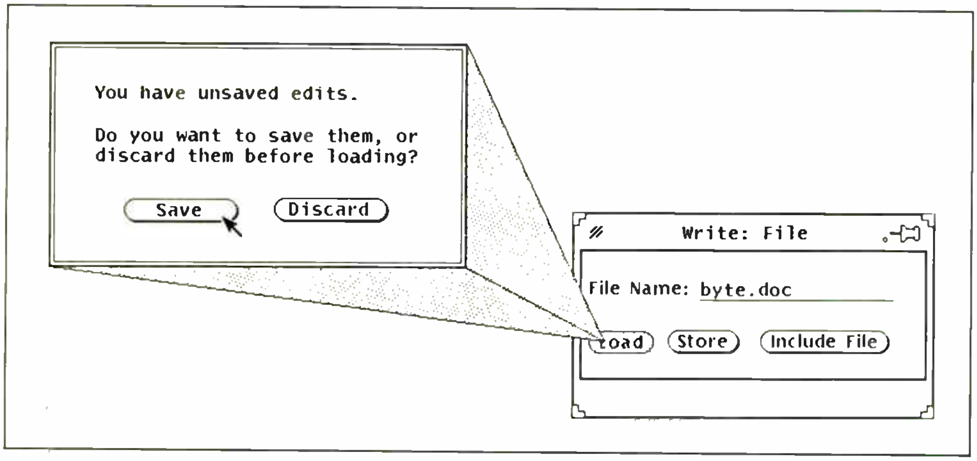

Figure 3: *Open Look's three-dimensional notice windows alert you to actions that could result in loss of data.*

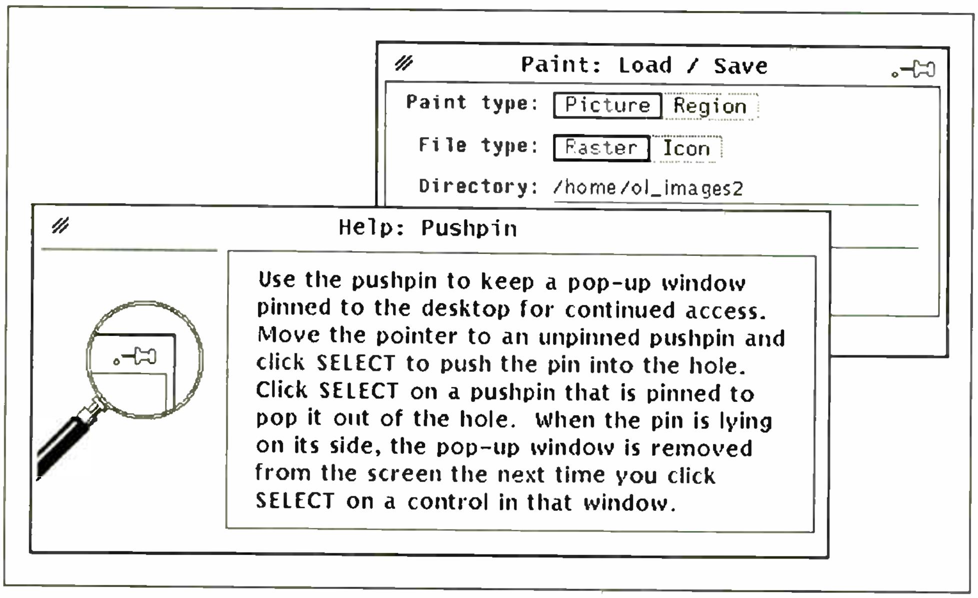

Figure 4: *The Open Look help window, called by pointing to an object on the screen and pressing a Help key, contains a help message and a help lens, with a snapshot of the object for which you have requested help.*

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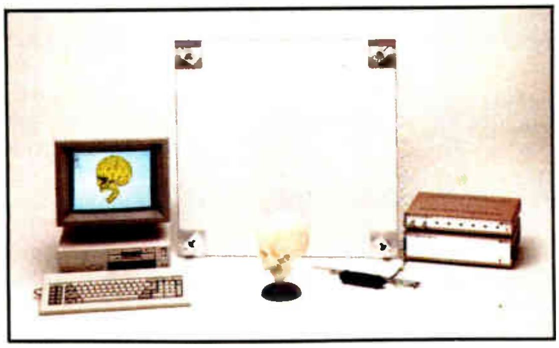

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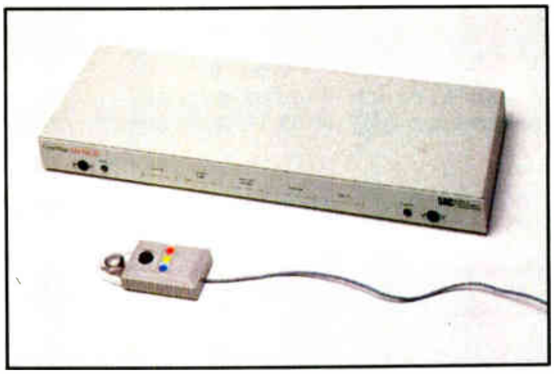

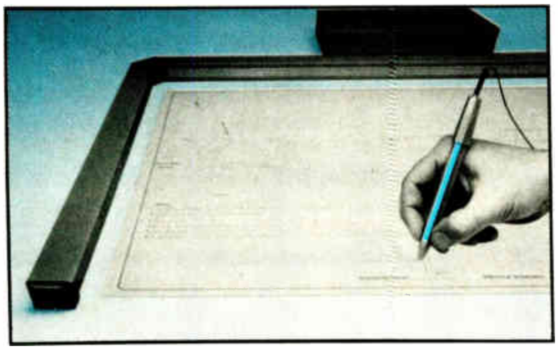

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Design is never done in a vacuum. The user will always approach a new interface with a background of experience with existing interfaces. Every change comes at the price of a learning effort for the user.

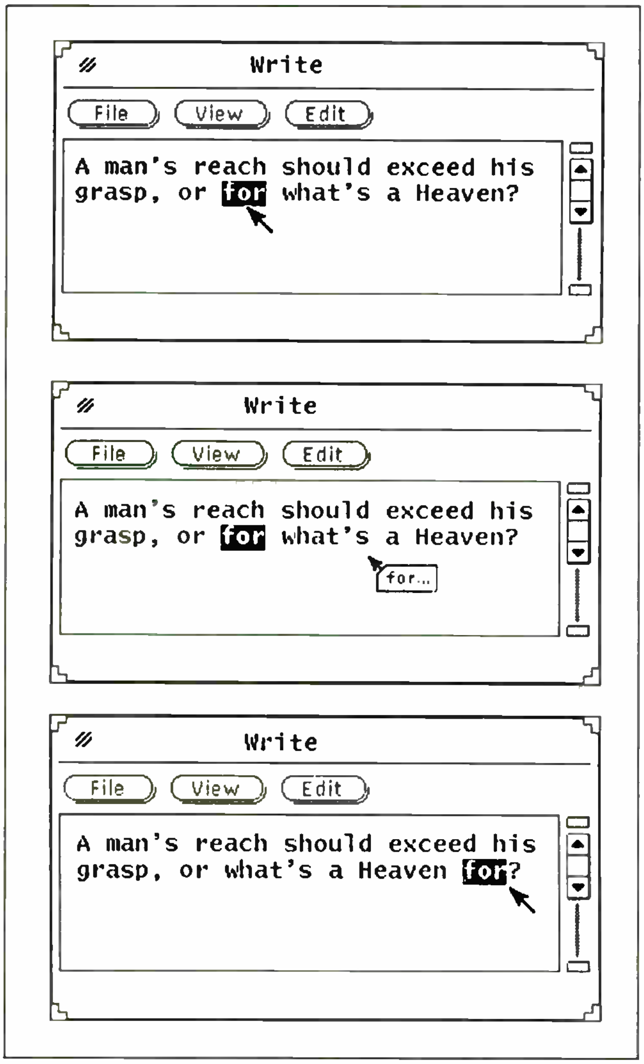

Figure 5: *While earlier graphical interfaces pioneered the direct manipulation of graphics objects, Open Look extends this, allowing you to select and drag arbitrary pieces of text as well.*

ficient the interface. This means minimizing keystrokes, mouse travel, and the need to switch back and forth between the keyboard and the mouse.

Minimizing mouse travel becomes more important as more systems use large screens. One way to reduce mouse motion is by using pop-up menus. In Open Look, each region of the screen—the workspace, the window background, scroll bars, and each application pane—has its own pop-up menu with relevant buttons. Instead of having to move all the way to the control area, you simply press the Menu mouse button, which effectively brings a control area to wherever the pointer happens to be.

Another way that Open Look minimizes mouse travel is by jumping the mouse pointer to a default button when a pop-up window (such as a notice) appears. If you click on the default button in the window, the pointer jumps back to its original position—saving two mouse motions.

A more subtle aspect of efficiency is allowing users to take advantage of the multitasking capability of an operating system like Unix. Take the problem of how to indicate that a window is busy and will not respond to input. Most systems change the mouse pointer into an hourglass or timer. In a single-tasking system such as the Macintosh, this is appropriate, since you can't do anything else until the active window is finished. In multitasking systems, however, the hourglass is only visible when the pointer is over the window that is busy. This approach requires you to keep the pointer in the busy window so you can see when it becomes responsive again. In contrast, when an Open Look window is busy, the window header (or icon, if the window is closed) turns gray. Thus, you can move the pointer out of the window and work on something else, and still tell at a glance when the window is again responsive.

Device Independence

Open Look was designed specifically to be used across a wide range of hardware. This requirement means that the visuals must work well on displays of various resolutions and sizes and on both monochrome and color. It also means that all the details of the look—each graphical element and the amount of white space between elements—must be specified in device-independent terms rather than as bit maps.

continued

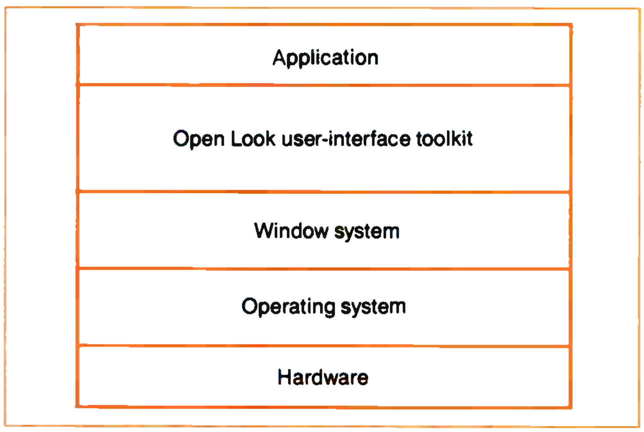

Figure 6: *Toolkits for the Open Look user interface will allow software developers to develop applications for a variety of windowing systems running on widely disparate hardware and operating systems. The first toolkits available will be for Unix systems.*

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Hardware differences on the input side are also significant. The number of modifier keys (e.g., Alt, Option, and Control) varies on different keyboards, as does the number of buttons on different mice. As far as possible, Open Look insulates you from such variations by allowing a great deal of flexibility in mapping mouse buttons and modifier keys to functions.

Changing Horses

Design is never done in a vacuum. The user of a new interface will always approach it with a background of experience with existing interfaces. This means that every change comes at the price of increased learning effort on the part of the user.

The Open Look design team envisioned a typical user who wants to switch easily between Open Look, the Mac Finder, and the Presentation Manager. We therefore ruled out design possibilities that would make this switch too difficult.

Take the example of scroll bars. There are endless variations on the scroll bar concept, and many other possible ways to scroll that don't even involve scroll bars. After considering many of these possibilities, we became convinced that Open Look's scrolling mechanism had to be similar enough to what people were used to so they could use it successfully right away. The design task, then, was to refine the familiar scroll bars, making them more visually attractive and more efficient.

An Open Look at the Future

The Open Look Functional Specification—a thick book addressed to the developers of user-interface toolkits and describing the look and feel in great detail—was distributed to over 1000 firms for review in July 1988 and will be published this month. (A toolkit is a set of system-specific libraries containing the standard building blocks—such as windows, menus, and scroll bars—that an application developer uses in creating an application. Figure 6 shows where a toolkit fits into the overall software architecture.)

The Open Look Application Style Guide, a somewhat thinner book addressed to application developers, gives guidelines for how to use the various building blocks that Open Look provides. The Style Guide will be published in early 1989.

Since the Functional Specification does not specify a particular hardware or software platform, it leaves room for different toolkits to implement the Open Look user interface on different systems. The first two Open Look toolkits—available in the first quarter of 1989—will be XT+ from AT&T and View2 from Sun, both based on MIT's X-Windows, a windowing system for Unix.

Sun is also developing an Open Look toolkit called NDE (for NeWS Development Environment) based on the NeWS window system. NeWS is a portable, PostScript-based window system that is commercially available for many platforms, including Unix, OS/2, and the Macintosh. Thus, when NDE becomes available in the second quarter of 1989, Open Look will be able to provide a common look and feel across a wide variety of computers and operating systems. ■

Tony Hoeber is the leader of the Open Look design team for Sun Microsystems (Mountain View, California). He can be reached on BIX c/o "editors."

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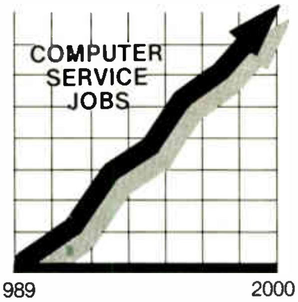

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LIES, DAMNED LIES, AND SPREADSHEETS

Lend credibility to your computations by using these five simple validity tests

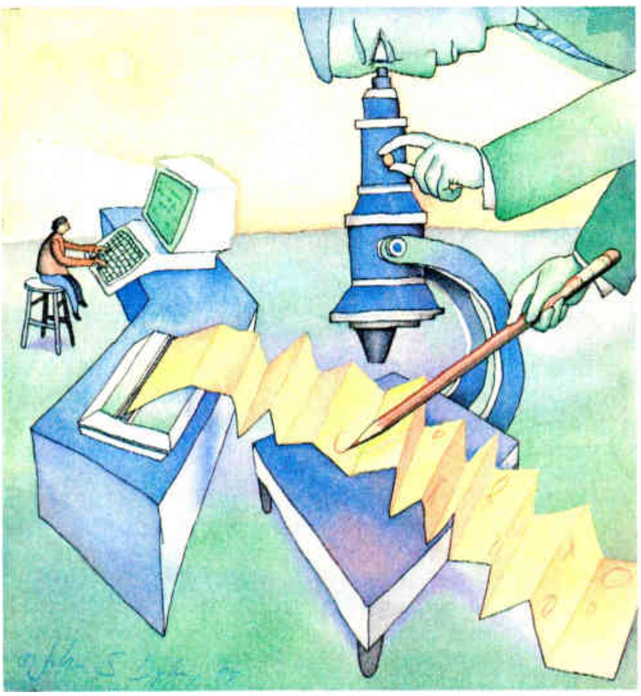
Ronald Pearson

Mark Twain, in his autobiography, credits Benjamin Disraeli with identifying the three kinds of lies as "lies, damned lies, and statistics." While statisticians are professionally obligated to take umbrage at this remark, it does neatly summarize the level of public trust in a lot of numerical data-analysis procedures, statistical or otherwise. Careless application of these procedures to great piles of incomprehensible data can lead to some real problems. What appears on your display as output is not necessarily truth, as the following tale of statistical woe illustrates.

The Case of the Conflicting Counts

A large professional organization once surveyed its members on a variety of topics. One of the questions on the poll was "Did you vote in the last society election?" When the responses to this question were compared with the actual voting records, the pollsters noted a large discrepancy—the percentage of respondents who said they had voted was significantly larger than the percentage of society members who actually had voted. After careful examination of the data, the survey team advanced an awkward explanation for the difference.

Most opinion polls attempt to reach as many members of the group being surveyed as possible so the conclusions will accurately reflect the group's opinion. In this case, the analyzing statistician claimed that the number of surveys returned was large enough to yield statistically significant results. One pertinent issue, however, was whether or not this collection of members was representative. It may not have been.



One variable that may have influenced the results was that ballots had been mailed to all society members with stamped, self-addressed envelopes included. In contrast, the survey questionnaires were placed at the back of the monthly society newspaper that is mailed to all members.

Those who took the trouble to fill out the questionnaire were probably more involved in society activities (and, therefore, more likely to have voted in the election) than those who did not fill it out. This kind of analytical faux pas is more common than most would like to admit.

There is a way you can steer clear of these kinds of problems and see to it that when awkward explanations are called for, somebody else is making them ("Well, sir, according to my financial forecasts, we were expecting a profit of $6 trillion from the new electric shoelaces we introduced this quarter, but there seems to be a bug in the program or something. . . ."). You can apply five simple va-

continued

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lidity tests to your data immediately after you evaluate your information. These tests are based on the fact that most data-analysis procedures take a large set of relatively uninformative numbers (the raw data) and boil them down to a small set of much more useful numbers (final results).

The Five Validity Tests

• *Are the results impossible or unreasonable?* Sometimes, raw data is so corrupted with measurement errors or missing data points that your data-analysis package generates suspiciously unreasonable numbers. Similarly, if you use a computational method outside its range of validity (e.g., curve fitting with only one data point), bizarre numbers can result. Generally, however, these results do not warn you that there is a problem (e.g., "Caution: The following results are numerical drivel and have no basis in fact. Ignore them.").

If the analysis is complicated enough, faulty results will not necessarily be "intuitively obvious even to the most casual observer." By Murphy's Law, however, they will come to light at the worst possible time. Then you may find yourself explaining to the founder and CEO of your firm why the percentage of total sales broken down by market segments totals 312 percent, or why the total number of widgets sold in the previous month is less than zero. Mistakes of this sort are easy enough to make by hand, but they are much more memorable after they have been turned into multicolor presentation charts by your integrated spreadsheet/word processor/slide-maker package.

Sometimes, raw data is so corrupted with errors that your data-analysis package generates suspiciously unreasonable numbers.

• *If possible, estimate your results by some other method—then check to see if both answers are in reasonable agreement.* Often, you can estimate some or all of the results you are calculating by another, possibly cruder, method. Typically, these secondary estimates are only approximate, but frequently they can provide at least order-of-magnitude figures as checks on your primary results. If the primary estimates are wildly different from these secondary estimates, a careful reexamination of both results is probably in order. While such disagreements do not necessarily mean that your computations are in error, they do suggest that you should seek a reason for the discrepancy before you stake your career on either estimate.

• *Do small changes in your raw data values cause enormous changes in your results?* Extreme sensitivity to small changes in the starting data may indicate difficulties with either the problem itself or the computational method you are using to solve it. While both of these difficulties can result in hypersensitivity, their implications are quite different.

A problem is said to be ill-conditioned if small changes in the starting data cause large (albeit accurate) changes in the results.

However, a numerically unstable computational method could also cause this sensitivity to small changes. The difference is that here, the results are probably wrong. Change to a more stable method.

• *Do large changes in the raw data cause little or no change in the results?* If you see no change in the results when you change your raw data, you probably have trouble. As in the case of overly sensitive computations, it could be that the problem you are trying to solve really is highly insensitive to changes to the raw data; but in most problems, that's not the case. Thus, as in the case of extreme sensitivity to small changes, extreme insensitivity to large changes should be investigated.

It is more likely that such insensitivity means that some intermediate result has underflowed or overflowed, or has been erroneously multiplied by 0 or subtracted from itself. Such problems could arise either from bugs in the computational software or from using a particular computational method outside its range of validity. In any event, the end result is that, no matter what raw data you feed it, you are getting the same (wrong) answer every time you do the calculation. Be especially suspicious if your computations consistently yield the same magic number, like 0, π, or a power of 2.

• *Examine the raw data graphically and numerically—do any of the data points look suspicious?* An annoying feature of real data is that it sometimes contains outliers—bogus data points. In manually entered data, this problem can arise from transposition errors or other simple human mistakes in recording the information. In computer-collected data, the problem can still arise if the input range of the sensors collecting the data is momentarily exceeded.

The point is that any collection of data from the real world—no matter how it was acquired—can contain one or more bad observations. Typically, these bad observations represent large (rather than small) deviations from what the real data should be. Since some common computational techniques (i.e., least-squares curve fitting) are fairly sensitive to the presence of outliers, it is important to check for the presence of outliers in the raw data. This analysis can often be done graphically: When almost all the data points conform to some pattern (especially a pattern you are expecting), the few that stick out like a small ensemble of sore thumbs may well be outliers.

The best procedure for confirming that a suspicious data point is indeed an outlier is to go back to the source of the data and double-check to see if there was some error in data collection. If this is not possible, or if the results of the check are inconclusive, it would probably be best to recompute the results either with a more reasonable estimate of the suspicious data point or without it altogether.

You should be careful here, however. Don't discard a significant portion of your data as outliers. Ideally, an outlier should be a single, isolated observation in the middle of 20 or more good observations. If the data point really is valid, removing it and redoing the calculations shouldn't change the results much; large changes suggest that the point in question is an outlier. However, if one point, even a good one, is removed from a set of only three or four, large changes are apt to occur.

A Hypothetical Case Study

Let's use these validity tests in an example. Suppose your boss asks you to find a reasonable approach to forecasting your company's monthly widget inventory in dollars. Your general im-

	A	B	C	D	E
1	Example 1		Inventory	Forecasting	Absolute
2	Month	Inventory	Trend	Error	Error
3					
4	1	23700	18524.1026	-5175.8974	5175.89744
5	2	25400	21352.1445	-4047.8555	4047.85548
6	3	2940	24180.1865	21240.1865	21240.1865
7	4	31300	27008.2284	-4291.7716	4291.77156
8	5	33700	29836.2704	-3863.7296	3863.7296
9	6	35000	32664.3124	-2335.6876	2335.68765
10	7	38100	35492.3543	-2607.6457	2607.64569
11	8	39800	38320.3963	-1479.6037	1479.60373
12	9	41700	41148.4382	-551.56177	551.561772
13	10	43200	43976.4802	776.480186	776.480186
14	11	46100	46804.5221	704.522145	704.522145
15	12	48000	49632.5641	1632.5641	1632.5641
16					
17	Average:	34078.3333	34078.3333	-6.063E-13	4058.95882
18		Test 4:		Test 1:	Test 2:
19		Change month 3		Unreasonable	New method
20		29400	(no real	6.0633E-13	480.06993
21		vs. 2940	change)	-6.063E-13	4058.95882
22				"Zero"	"Reasonable"

Figure 1: *In this hypothetical Excel spreadsheet example, columns A and B show the dollar inventory amounts for the preceding 12 months.*

pression is that this inventory has been steadily growing, so it could probably be predicted fairly reasonably by extrapolating from the last few months' numbers.

To test this hypothesis, you set up the Excel spreadsheet shown in figure 1 and enter the dollar inventory amounts for the 12 months of last year (columns A and B). With Excel, you can fit a straight line to this data using the built-in Trend function. The results of this fit are listed in column C. A colleague has suggested that you evaluate the quality of this fit by computing the prediction errors (i.e., the value predicted by the Trend function minus the true value from column B) and averaging them to get an average prediction error. Column D contains these forecasting errors, and the average value of all the columns is listed at the bottom of each column.

Applying validity test 1, "Are the results unreasonable?", it's clear that something is wrong. Specifically, the dollar amounts in the actual and predicted inventory columns (B and C) are in the tens of thousands of dollars, while the average forecasting error at the bottom of column D is $-6.063E-13$, or zero for all practical purposes.

Because the average prediction error is zero, it looks as if the results indicate the Trend function has predicted the inventory values perfectly. The difficulty is that the Trend function generates a least-squares linear fit that exactly splits the difference, trading off positive prediction errors on some points for negative prediction errors on others. Consequently, regardless of how well the line actually fits the data, the average prediction error computed here is always zero. Thus, the small number computed by the spreadsheet is just round-off error.

A more reasonable indicator of the caliber of the Trend function fit is the average of the absolute values of the prediction errors, tabulated in column E. This average is just a little over $4000, a figure that represents about 8.5 percent of the average inventory for the year, suggesting Trend fits the data reasonably well but not perfectly. Comparing this average with the average error computed from column D, the second validity test again suggests that the average error in column D is not representative.

Skipping ahead to the test for outliers, figure 2 shows an *x,y* plot of the monthly inventory data. Note that all the points except the third lie fairly well on a straight line. The third point, however, clearly is much too low, a discrepancy that suggests it may be an outlier. Rechecking this number, 2940, against the others in column B, we become even more suspicious—all the other numbers are in the tens of thousands of dollars and are expressed as even 100s.

The simplest possibility is that a trailing zero has been dropped. Perhaps this entry should read 29,400 instead of 2940. Inserting the larger number for the third month yields the *x,y* plot shown in figure 3, clearly a much better straight line. This revised calculation can also be viewed as the fourth validity test: "Make a large change in the data and look for extreme insensitivity."

As expected, this change in the data improves the average magnitude of the prediction error (column E), reducing it from about $4000 to just under $500. In terms of the average monthly inventory, this replacement of point 3 with a more reasonable

continued

number has reduced the average absolute prediction error from about 8.5 percent to just under 1 percent. The average prediction error computed in column D, however, remains effectively zero, changing from −6.063E−13 to +6.0633E−13, a result that again suggests that this quantity is independent of the data and thus not useful.

While examples failing the third validity test (i.e., extreme sensitivity to small changes in the data) do not arise as commonly, they do appear often enough to be worth checking for. To illustrate this point, consider the spreadsheet shown in figure 4. Here, warehouse storage charges are given for 12 months (column C), together with the dollar value of the widget inventory stored there (column B). Suppose you assume that these two quantities are related, and your boss wants a number he or she can quote as to how many cents per dollar of inventory it costs to store your gizmos.

Using Excel's built-in Linest function, you calculate the first set of numbers shown for slope and intercept of the best-fit straight line through the data. From there, you can easily generate your boss's desired number. But first, just to be on the safe side, you apply test 3 to the data, adjusting the last storage cost by 1 percent. Your results show that this insignificant change in one of 12 numbers changes your final result by 454 percent.

Even worse, you change that number back and make a 1 percent change in the first month's storage fee, and the *sign* of your number changes—apparently you would save money by storing

continued

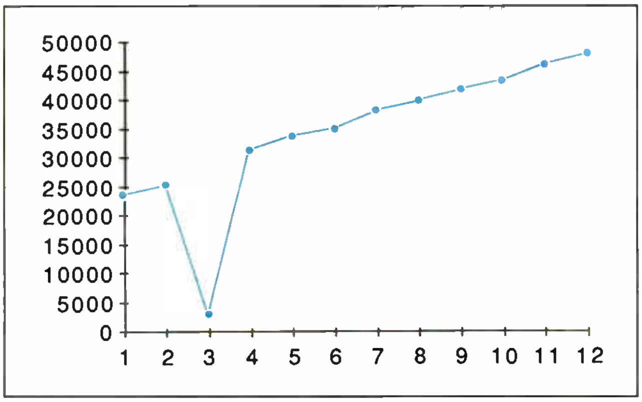

Figure 2: *The third point of the* x,y *plot of the monthly inventory data is out of sync with the rest and thus may be an outlier.*

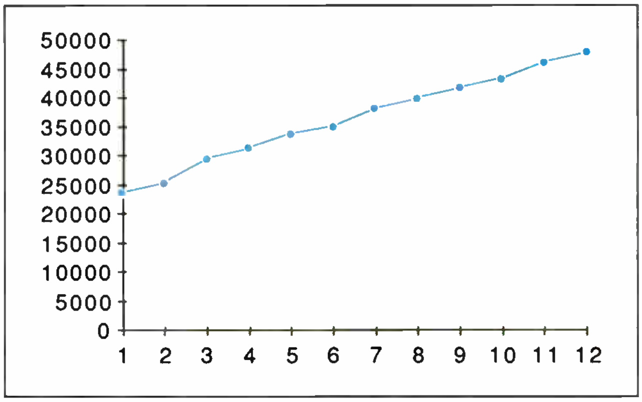

Figure 3: *Inserting the correct figure for the third month yields an* x,y *plot with a much straighter line.*

	A	B	C	D	E	F
1						
2		Example of Extreme Sensitivity:				
3			1% Change in C18 Causes 454% Change in Answer			
4						
5	Month	Inventory	Storage Fee			Perturbed Fee
6						
7	1	10300	101			101
8	2	12400	103	Linear fit with original data		103
9	3	14500	98			98
10	4	15700	105	4.3409E-06	101.741848	105
11	5	19000	104			104
12	6	20400	100	Linear fit with perturbed data		100
13	7	22500	100			100
14	8	23900	105	2.4068E-05	101.409433	105
15	9	25800	100			100
16	10	27700	104	Percent changes		104
17	11	29400	100			100
18	12	31300	102	454.444444	-0.3267243	103
19				Slope	y-axis intercept	

Figure 4: *Column C shows the warehouse storage charges for 12 months, while dollar values of the stored inventory are shown in column B.*

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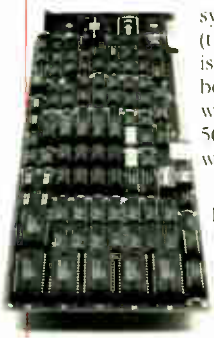

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more goods. Either you have discovered some hitherto unknown loophole in the physics of warehouse management or, more likely, you have discovered a problem with your calculations.

The problem is that, regardless of the value of the widget inventory you are storing, it seems to cost about $100 per month to store them. Thus, the linear connection you are trying to make between the inventory dollar value and storage fees simply does not exist. The small numbers you are computing for the slope of the best-fit straight line through the data are really trying to tell you that no such relationship exists—the slope of the line is about zero. The apparent extreme sensitivity is due to the fact that almost any change in something that is about zero is going to amount to a large percentage of that something.

Keep in mind that the results of any computation are only as good as its most questionable step.

Caveat Emptor

The tests I've described for unearthing analytical blunders are only a few of many possibilities and, sadly, are not guaranteed to turn up all your potential computation flaws. That is, significant errors can exist in computations that pass all these tests. Conversely, even some perfectly valid results would look suspicious under one or more of these tests. There will even be some cases where all these tests either are inapplicable or return inconclusive results. Overall, however, if you can apply them, testing your results is a lot better than the alternative of doing nothing and hoping for the best.

While it could be argued that the actual spreadsheet examples described here illustrate blunders that were intuitively obvious to the most casual observer, such errors often appear that way only after they have been discovered. I deliberately simplified these examples to illustrate what was going wrong and how these five validity tests can alert you to the problems. In more real-world examples with huge spreadsheets, obvious inconsistencies between the entries in cells A1 and ZZ312 may not be all that easy to spot.

Keep in mind that the results of any computation are only as good as its most questionable step. This point is neatly illustrated by "Burns' Hog-Weighing Method," generally attributed to Scottish poet Robert Burns:

1. Select a well-balanced board and place it symmetrically on a fulcrum.
2. Place the hog to be weighed on one end of the board.
3. Pile rocks on the other end of the board until they exactly balance the weight of the hog.
4. Carefully guess the weight of the rocks. ■

Ronald Pearson holds a Ph.D. in electrical engineering and is employed by a Fortune 500 company. He can be reached on BIX c/o "editors."

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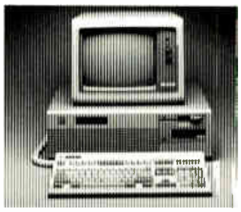

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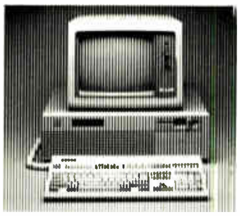

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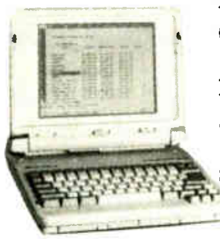

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UNTANGLING PASCAL STRINGS

Here's a set of functions that provides Pascal with neat, efficient string handling

Dick Pountain

Maybe it's because I write words for a living, but I find that much of the programming I do involves string handling. Certainly many of the programs I write are file filters to process text files, but even in the most numerically intensive programs, the user interface section, error handling, and help all involve a lot of string manipulation, and nowadays these areas tend to be the largest parts of a program.

The Pascal Bonds

I write many of my programs in Turbo Pascal. Standard Pascal is poorly equipped to handle strings, regarding them simply as packed arrays of characters. All commercial implementations of Pascal have had to introduce more sophisticated string handling as nonstandard extensions to make it a viable language. The extensions introduced in UCSD Pascal seem to have caught on and become a de facto standard; at any rate, Borland adopted them for Turbo Pascal as well, which gives them a sizable user base. In case you're not familiar with the string-handling facilities of UCSD/Turbo Pascal, I'll recap them briefly, but a language manual is the obvious place to look for a fuller account.

You can use the built-in type called `STRING` to represent semidynamic character strings, whose maximum storage size is static and must be declared at compile time but whose actual size can be varied dynamically at run time (up to the maximum). You can think of them as being a compromise between the totally static character arrays of standard Pascal and the fully dynamic strings of interpreted BASIC, whose actual storage size can be altered at run time. You can declare a variable like

```
VAR Mystring: STRING[80];
```

and then assign a string of any length up to 80 characters to it using, for example:

```
Mystring := 'short string';
```

If you assign a 90-character string to `Mystring`, it would be accepted but truncated to 80 characters and the excess 10 characters thrown away. The maximum size of a string is 255 characters, determined by the single-byte count that is stored in the first byte of a string variable and records its current length.

You can manipulate strings using a number of built-in string functions. The function `Length()` returns the current length of a string. The function `Pos(target,source)` finds out whether the substring `target` exists in the string `source`. If so, `Pos()` returns the position of its first character; if not, it returns zero. The function `Copy(source, start, size)` returns a new string formed by copying `size` characters from `source` beginning at the position `start`. You'll often see `Pos()` used to find the `start` position for a `Copy()`. `Concat(s1,s2)` returns a new string formed by joining `s1` and `s2` together, an operation you can also perform in a string expression with the binary operator + (e.g., `s1+s2`). Finally, the two functions `Insert()` and `Delete ()` insert or remove, respectively, a substring from a target string. These functions are quite efficient and well chosen in the sense that almost any string operation you can imagine can be performed by using them in some combination.

I had begun to feel that for many of my purposes these string functions were too low-level and often led to opaque and unreadable code when I used them in their raw state. For example, I often found myself writing expressions like

```
copy(paramSTR(1),1,pos('.',paramSTR(1)))+'PAG';
```

and worse. So I resolved to try to discover a small set of higher-level string functions that would do most of what I needed to do to strings in a tidier and more readable way—and with reasonable efficiency.

In deciding what functions to include in my set, I scoured around some other languages of my acquaintance for hints. The first port of call was BASIC because everyone remembers BASIC as being good for handling strings. In fact, to my mild

continued

surprise, I discovered that the string functions in BASIC are almost identical to Turbo Pascal's and not really any more expressive. `MID$( )` is effectively the same as `Copy( )` when used as a function, and `INSTR( )` is the same as `Pos( )`. BASIC has the extra functions `LEFT$( )` and `RIGHT$( )`, but they contribute little to readability and you can easily simulate them by using `Copy( )`. A quick look at some of my old BASIC programs confirmed the impression that I should look elsewhere for beauty and elegance:

```
5247 LOCATE I*3+1,11:COLOR 11,2:
PRINT "$";RIGHT$(STR$(M(I,9)+STAKE1),
 LEN(STR$(M(I,9)+STAKE1))-1);"     ":
COLOR 0,2
```

I moved on to look at functional languages like Lisp and POP-11, but the solution didn't dawn on me until I was examining the string functions in SNOBOL4, the best string-handling language ever invented (rivaled only by its more modern offspring, Icon [see "An Icon Tutorial" by Ralph E. Griswold and Madge T. Griswold, October 1986 BYTE, page 167]). The Turbo Pascal and BASIC string functions are index-oriented; that is, they want you to tell them which numeric position in a string you're interested in. But my problems tended to be pattern-oriented: replacing the extension on a filename, for example, which involves looking for the period that separates name and extension but whose actual location in the filename string is of no interest at all.

I therefore decided to start with two pattern-oriented primitive functions that I call `Before( )` and `After( )`. You can easily implement them using `Copy( )`, `Pos( )`, and `Length( )`, but if you are more concerned with efficiency than I am, you might want to rewrite them in assembly language or in-line code. I've reproduced their definitions in listing 1. Both functions look for a target string in their source string. If the target is found, `Before( )` returns all the source string up to but not including the first occurrence of the target string, while `After( )` returns all the source string that follows (but does not include) the first occurrence of the target string. If the target is not found, `Before( )` returns the whole source string while `After( )` returns a null string.

Listing 1: *Source code for the author's pattern-oriented string-handling functions,* `Before( )` *and* `After( )`.

```
function Before(Source, Target: String):
                                 String;
begin
  if pos(Target,Source) = 0
    then Before := Source
    else Before := Copy(Source,1,pos
                    (Target,Source)-1)
end;

function After(Source, Target: String):
                                String;
begin
  if pos(Target,Source) = 0
    then After := ''
    else After := Copy(Source,pos
       (Target,Source),length(Target),
          length(Source))
end;
```

A Working Example

To illustrate their effects, `Before('potomac','to')` would return `po` while `After('potomac','to')` would return `mac`. These two simple operations, together with a third that I'll describe later, turn out to be of surprisingly wide application. To illustrate with an example, I'll use my old favorite of replacing the extension part of a filename with a new one. I do this frequently as a way of distinguishing the output file produced by a file filter from its input file; for example, my page-making program changes the input filename to end in .PAG. The code I used to use to perform this chore looks like this:

```
if pos('.',paramSTR(1)) = 0
then OutputFileName := paramSTR(1)+'.PAG'
else OutputFileName :=
 copy(paramSTR(1),1,pos('.',paramSTR(1)))+'PAG';
```

Using `Before( )` reduces this to

```
OutputFileName := Before(paramSTR(1),'.')+'.PAG';
```

which to me is a lot more readable as well as prettier. Using `Before( )` and `After( )` in combination, it's possible to perform quite complex manipulations in very little code. For example, to transpose two sentences:

```
Textstring := 'This is sentence 1. This is sentence 2.';
Textstring := After(Textstring,'. ')+'.'
    +Before(Textstring,'.')+'.';
```

It's possible to emulate the effects of `Insert( )` and `Delete( )` using only `Before( )` and `After( )`, as the following two code fragments show. The task is the replacement of one substring by

continued

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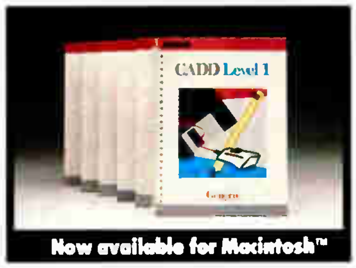

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another in a piece of text, for example, in the search-and-replace function of a text editor. Using `Insert()` and `Delete()`,

```
posn := pos(oldstring,textstring);
delete(textstring,posn,length(oldstring));
insert(newstring,textstring,posn);
```

Using `Before()` and `After()`,

```
Textstring := Before(textstring,oldstring)
           + newstring + After(Textstring,oldstring);
```

There is more to this example than meets the eye. In a real application you would very likely want to replace *all* the occurrences of `oldstring` in the text, and so you would iterate the above routines until all were replaced. But the `Before()` and `After()` solution is inefficient in such a case because it will unnecessarily copy the same parts of `textstring` repeatedly, whereas `Insert()` and `Delete()` simply scan down the string. Benchmarking shows that the second routine using `Before()` is in fact some 80 percent slower than the first. This, then, is not a happy application for the new functions.

An application that demonstrates their virtues much more clearly is parsing command strings. Suppose you have a file of commands to control some program, say a style sheet for a word processor. The commands are all strings of the form <command name>:<parameter1>,<parameter2>, and they are stored in the file one to a line, separated by new lines. An instance of a command string might look like `page-size:72,66`. My program reads in one line at a time and extracts the components of the command using `Before()` and `After()` (see listing 2).

Freeing Up Memory

Notice that the use of pattern-oriented functions avoids placing any restrictions at all on the size of the fields in the command, which may be of varying size from one line to the next. In the interests of memory economy, you would probably want to declare `commandcode` and the rest to be of some reasonable size—`string[12]`, perhaps—so that only the first 12 characters of a command name were significant. On this subject, note that these functions also reduce the amount of memory that is per-

continued

Listing 2: *Using* `Before()` *and* `After()` *to parse a command line.*

```
while not eof(commandfile) do
begin
  readln(commandfile, commandstring);
  commandname :=
      Before(commandstring,':');
  parm1 :=
      Before(After(commandstring,':'),',');
  parm2 :=
      After(After(commandstring,':'),',');
  more processing.......
```

manently tied up in temporary variables; one attraction of this style of programming by function composition, or nested application, is that all the space used while extracting the substrings is allocated on the stack and reclaimed after the functions finish evaluating. However, there is a limit to the degree of nesting that is desirable. Looking at a new command file with command strings of the form `window:10,10,20,40`, my problem is how to extract that last 40 from the string.

The statement required is

```
parm4 := After(After
  (After(After(commandstring,':'),
     ','),','),',');
```

Now how about a command with 12 parameters? It's clear that a third function is needed to deal with unlimited runs of substrings separated by the same symbol.

Listing 3: *Improved command-line parsing action.*

```
function Parse(VAR Source: String; Separator:
                               String): String;
begin
  Parse  := Before(Source,Separator);
  Source := After(Source,Separator)
end;
```

Listing 4: `Parse()` *in action.*

```
while not eof(commandfile) do
begin
  readln(commandfile, commandstring);
  commandname := Before(commandstring,':');
  parms := After(commandstring,':');
  parm1 := Parse(parms,',');
  parm2 := Parse(parms,',');
  parm3 := Parse(parms,',');
  parm4 := Parse(parms,',');
  more processing........
```

Listing 5: *Using* `Parse()` *to extract an unknown number of command-line arguments.*

```
while not eof(commandfile) do
begin
  readln(commandfile, commandstring);
  commandname := Before(commandstring,':');
  parms := After(commandstring,':');
  count := 0;
  while parms <> '' do
  begin
    val(Parse(parms,','), ParmArray[count],
                                   Error);
    if Error <> 0 then write('Bad parameter
                          number ',count);
    count := count + 1;
    more processing........
```

Listing 6: `Noblanks()` *strips all leading and trailing blanks from a string.*

```
function Noblanks(s: String): String;
var lead, trail: Integer;
begin
  lead := 1;
  while s[lead] = ' ' do lead := lead + 1;
  trail := length(s);
  while s[trail] = ' ' do trail := trail - 1;
  noblanks := copy(s, lead, trail - lead + 1)
end;
```

A Happy Answer

`Parse()`, defined in listing 3 solely in terms of `Before()` and `After()`, solves the problems I mentioned above. `Parse()` takes a string and treats it as a stream of tokens, separated by a string that forms its second argument. Each time you call `Parse()`, it returns a single new token from the stream. When the tokens are all used up, it continues to return null strings. If you are familiar with C, there is a C library function often called `strtok()` that does something similar, except that on all but the first call it must be given a null argument.

Parse has some slightly unsavory characteristics that distinguish it from `Before()` and `After()`. The latter are "pure" functions in that they do not modify their arguments in any way and have no side effects. `Parse()` is not, as it consumes its source string argument and leaves it empty. `Parse()` is also an odd kind of function in that it returns different values on different occasions when given the same arguments; in mathematical terms, it lacks the property of *idempotency*. Nevertheless, it is quite easy and obvious to use in practice. Also, unlike `Before()` and `After()`, `Parse()` has a `VAR` parameter for its first argument that restricts the sort of object it can be given as a first argument. In particular, you may not use a literal string constant, an expression, or `paramstr()` as a first argument; only string variables are allowed. It also means that in Turbo Pascal you must compile `Parse()` using the `{$V-}` compiler switch to disable strict type checking of string parameters.

The second command-parsing example above, `window:10, 10,20,40`, can now be accomplished far more tidily using `Parse()`, as shown in listing 4. In fact, by using `Parse()` you can easily parse command strings that have a variable and unknown number of items in their parameter lists so long as you know the maximum number there can be. In listing 5, I convert the parameters to numbers and then store them in an array. The array `ParmArray` clearly has to be declared to be as large as the maximum number of parameters expected.

When using functions like `Before()`, `After()`, and `Parse()` to parse strings, the question of leading and trailing spaces is bound to crop up. For example, if the user of the program chooses to insert spaces in the command string `window : 10, 10, 20, 40`, what is to happen? The bad old answer would be to make it a syntax error, preferably announced by a short, brutal message such as FATAL ERROR IN CMDFL-3456:8950. In the civilized world it would make the program easier to use if you allowed arbitrarily placed spaces between (but not within) tokens. The problem is that our functions, say `Parse(parms,',')`, will return any leading or trailing spaces along with the parameter, for example, ' 40'. It so happens that the Turbo Pascal procedure `Val()` is quite happy with number strings that contain leading blanks, but it hates them with trailing blanks and spits them out. Clearly I ought to strip out all leading and trailing blanks for safety. After some agonizing, I concluded that this should not be the duty of `Before()`, `After()`, and `Parse()`. I believe they should remain primitive

continued

Listing 7: `Spaces()` *simply returns a string of* `Num` *blanks.* `NStr()` *provides conversion from number to string in the form of a function rather than a Pascal procedure.*

```
function Spaces(Num: Integer): String;
const Blanks = '
                              ';
begin
  Spaces := Copy(Blanks,1,Num)
end;
function NStr(Num: Real;
              Len, Places: Integer): String;
var Temp: String[20];
begin
  Str(Num:Len:Places,Temp);
  NStr := Temp
end;
```

Listing 8: *Parsing header information to yield the format shown in figure 1.*

```
function ExpandHeader(template: String):
                                 String;
  var  a,b: integer;
       left,mid: String[80];
  begin
    if pos('$$$',template) <> 0
    then template := Before(template,'$$$')
                + NStr(Pagenumber,0,0)
                + After(template,'$$$');
    left := Parse(template,'/');
    mid  := Parse(template,'/');
    a := (Pagewidth - length(mid)) div 2 -
                              length(left);
    b := Pagewidth - (length(left) + a +
         length(mid) + length(template));
    Expand := left + Spaces(a) + mid +
                       Spaces(b) + template
  end;
```

Listing 9: *The author's great contribution to ergonomics: proper pluralization in system messages.*

```
function Plural(Num: integer; Thing: String):
                                   String;
var Temp: String[10];
begin
  Str(Num,Temp);
  case Num of
  0: Plural := 'No ' + Thing + 's';
  1: Plural := Temp + Thing;
  else Plural := Temp + Thing + 's';
  end
end;
```

```
Dick Pountain    page <14>    Byte September
```

Figure 1: *The heading for the author's correspondence, as printed by PC-Write.*

operations and that any stripping of blanks should be done explicitly at the point of use of the parsed tokens. I've included a function called `Noblanks()` (see listing 6) that does this job, though such a routine really ought to be written in assembly language or in-line code for efficiency.

For a more substantial example of the use of these functions, I'll write a function that expands word processor header templates into strings ready for the printer. I'll borrow the syntax for the header template from a real program, PC-Write, which is the word processor I use every day. In PC-Write, you specify headers using a dot command like this:

```
.H:Dick Pountain/page <$$$>/Byte September
```

The header template is divided into up to three parts by the "/" symbol, and these parts are correspondingly left-justified, centered, and right-justified when the header is printed (figure 1).

The optional $$$ symbol gets translated into the current page number, if present. However, the $$$ can occur anywhere at all in the header, and any of the three parts can be omitted altogether, so the syntax is actually more complex than it at first appears. In order to write a function `ExpandHeader()` that parses and expands such templates, I intend to call on two more special string functions. One is `Spaces()`, which I have published before (see March BYTE, page 255), when the typesetters lost the end of the string constant `Blanks` and caused no end of fun. (Just in case it happens again, `Blanks` is supposed to be just 80 space characters in single quotes.) `Spaces()` returns a string of spaces equal in length to its argument. The other new function is `NStr()`, which converts a number into a string. Turbo Pascal already has a perfectly good routine to do this, called `Str()`, but it is a procedure, not a function, and so it returns no value and cannot be used in expressions. I prefer, for consistency, to redefine it as a proper function. My version exploits Turbo Pascal's implicit typecasting to work with all numeric types, and it takes extra arguments to specify the write format; you might prefer to define separate functions for each type in Modula-2 style. Both functions are defined in listing 7. I can now define `ExpandHeader()`, as shown in listing 8.

Suppose that you have just read the above dot-command line into a variable called `dotline` and ascertained that it is indeed a header command by examining `Before(dotline,':')`. Then a call to `ExpandHeader(After(dotline,':'))` will return a full header string justified to the current `Pagewidth` and numbered with the current value of `Pagenumber`, the latter being two global variables.

Final Indulgence

The last of the chosen string functions is a piece of total indulgence on my part. For years I've been irritated by programs that announce that there is "1 bytes of memory free." Even the compromise "1 byte(s) of memory free" cannot console me. I finally swore a solemn oath that I would never write such a program again, and hence the function `Plural()` (see listing 9). Try it out with:

```
for i := 0 to 10 do
write(Plural(i,' green bottle'));
```

Please don't bother to write in and point out that it doesn't work with "little piggy"; I have to draw the line somewhere. ■

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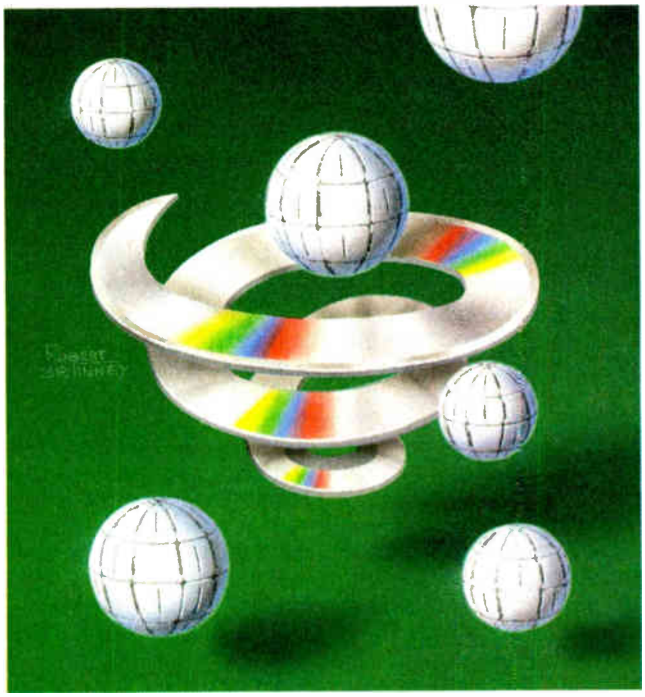
THE CD-ROM CONNECTION

Compact disks may unlock hypertext's potential, but a tightly structured database is a necessity

Tim Oren

The CD-ROM provides inexpensive storage for massive amounts of information. However, getting at all that information can be a problem. Also, since you can't write to CD-ROMs, they are good for distributing databases, but not for storing your personal files.

These properties of CD-ROM make it a natural as a storage medium for hypertext. The fact that CD-ROM is static (i.e., it can't be altered) is a selling point, because large, editable hypertext systems can be difficult to update. Every time you edit, move, or delete a document, links connected to that node may have to be changed. Although suitable data structures do this, it can place quite a computational load on your microcomputer if you're dealing with a database consisting of hundreds or thousands of nodes. You compound the problem when you distribute a hypertext database across machines or let multiple users update the database simultaneously.



With CD-ROM, you can't remove or alter the basic document. You can add annotations or new nodes via magnetic disk, but the node structure on CD-ROM doesn't change. This relieves the update problem.

Capacity is the other major attraction. A single CD-ROM can store a hypertext equivalent of about 100 printed volumes. A CD-ROM hypertext system can also store links for fast retrieval. The pointers can be stored within the document itself, rather than in a disjointed database. Also, duplicate tables of incoming and outgoing links for each document can be placed on the disk, eliminating the need for multiple accesses to the CD-ROM when you request these summaries.

Where to Begin

Before CD-ROM and hypertext can truly fit, a few database design problems have to be resolved. What we need are, in Alan Kay's words, "conventions that work." These conventions should support the hypertext paradigm of augmenting human thinking, while including some of the familiar information-organization techniques found in existing printed media.

CD-ROM hypertext is inherently different from Ted Nelson's Xanadu environment. Where dynamic hypertext is a tool for cooperative writing and on-line publishing, hypertext on CD-ROM is a stored medium that transmits human communication without feedback from reader to author. In this situation, you can't hope for hypertext's desirable properties to emerge through use; you must design them into the product.

The first design task worth solving is to alleviate those

continued

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CD-ROM problems already discovered. One such problem is that documents stored electronically, like those stored on CD-ROM, lose the desirable qualities of information stored on paper. Paper documents use location, closure, unity of type, and state preservation as visual and tactile reader cues.

Another problem with CD-ROM databases is that they use full-text, Boolean-algorithm searches. These search methods are flawed because they make trade-offs between retrieval precision and recall, and between inconsistent human selection and automatic choice of indexing terms.

A larger design problem is how to improve communication between the hypertext author and user.

Recovering the Benefits of Print

A valuable attribute of printed documents is *state preservation*. A printed volume stays the same when you aren't looking at it. You can put bookmarks or your finger between pages to save locations or write notes in the margins and underline items. All these will stay put until you remove them. A hypertext browser should have similar properties.

In fact, an electronic equivalent of a finger in a book is a browser that remembers its previous positions when following a link. One way to accomplish this would be to generate a new view window at each jump, leaving the previous document, scroll point, and selection in the old window. Multiple windows let you compare documents side by side and specify new links by direct manipulation. They can, however, clutter a small microcomputer display. As a compromise device, a browser window could jump to the target document but preserve the state of the previous document and restore it upon return. Then, you could request a new window to restore the side-by-side viewing benefits.

Hypertext bookmarks are simply links to a document, generated at the user's request and stored with some associated comment or picture. For easy access, bookmarks should be collected as a full-fledged hypertext document that can be searched and targeted by a link.

To simulate writing in a book's margins or otherwise making notes, CD-ROM hypertext systems require some form of document versioning. Since neither margin notes nor highlighting delete information or change a document's structure, you can store them as an increment file associated with the document. Making full copies of changed documents can quickly fill up a magnetic disk if you annotate a large CD-ROM database frequently.

You can also construct the equivalent of Post-its or paper-clipped notes by placing a link in the increment file targeted to a new notepad document stored on magnetic disk. Again, you should be able to search notes and marginalia. If one notepad document or bookmark set is allowed to link to another, the hypertext update problem is reintroduced. When this happens, you must choose between the benefits of such links and the difficulties of implementing them.

Unity of Type

Books have an *interface unity* seldom achieved in software, simply because everything is printed on the same paper. In a hypertext system, you should avoid needless multiplication of data types. For example, a document's storage medium should be transparent to the user. Links, bookmarks, and document references generated through searches should be of one type. Hypertext documents, user notes, bookmark sets, search result lists, and tours should also form one type.

Of course, some of hypertext's dynamic elements have no print equivalent: animated graphics and video and sound sequences. In some applications, you can bury these complexities within the scope of a document. The onus is on the hypertext system browser to determine the correct type of display for a document or object within a document.

Serendipity

Printed books encourage *serendipity*. They can fall open at an unintended place. Interesting pictures may draw your eye into articles that you would otherwise miss. A passage that you read may adjoin another that catches your eye.

Unfortunately, the perennial shortage of computer screen space often forces the removal of just this sort of "irrelevant" information. You must try to return serendipity without intruding on the main retrieval task.

You can do this by inserting links in a hypertext system to simulate the physical proximity of page layout. These links don't need to obey conventional topology; they can lead anywhere in the database. They don't need to be strongly relevant to the subject matter, either. They can be links that might interest the kind of person who's likely to be reading a particular node or article. For this feature to be used, however, the cost to explore a link must be very low—a single mouse-click or keystroke with almost no pause on the jump and return.

Because pictures are gestalts, they are another effective way to draw attention to documents otherwise missed. Many printed publications, such as *The Whole Earth Catalog*, have deliberately used this technique to promote discovery.

Truly random jumps have limited appeal in hypertext systems, because a document you find this way might already be familiar. If it isn't familiar, it might be difficult to understand because it appears out of context. To make random jumps useful, you must have strong location cues and tools available. This aspect may be better handled by tours.

The Importance of Closure

Closure tells you when you are done or how far you have to go. In a conventional book, the end is obvious; in hypertext, it isn't.

But you can simulate closure if you set up the hypertext system to remember user actions—which documents have been viewed and which links followed, and in what order. The system can then generate simple statistics that tell the users what fraction of the database has been read or, more important, which portion of the database is undiscovered. "Show me something new" or "Show me a new path to something I've seen before" are now meaningful requests.

Any such request can be filled without a deep understanding of the contents of documents. The idea does suggest, however, that document and link objects should be able to record requests made of them, and that a global record of features used will be more than an interface designer tool.

Location

A well-designed book uses print conventions to give you a sense of *location*. Chapter titles, section headings, type styles, and indentation situate the current passage in the work's hierarchical or narrative structure. Positioning of images and tables reinforces the topic under discussion. Many print conventions are lost in electronic media because they are designed as peripheral cues that you only occasionally bring into focus. When you remove the physical proximity of information and constrain layouts because of the computer's small screen, it's easy to abandon these cues. Hypertext systems exacerbate the problem by encouraging the proliferation of small nodes.

Achieving a sense of location in a hypertext system is not

continued

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Circle 325 on Reader Service Card (DEALERS: 326)

It's easier to jump around in hypertext than it is to thumb through a book, so it encourages investigation.

easy. You can adopt or convert some print conventions, such as running titles and headings, into hierarchical or linear links among documents. But these won't work in a complex database with thousands of nodes.

Hypertext designers usually approach this problem by providing a tool so users can "view" the neighborhood. These browsing tools show you a "zoom out" or "road map" schematic view of adjoining nodes. Such views can be generated automatically at the time of request, built manually during the editorial process, or defined by the user.

Neighborhood views can take many forms, all in the general class of contiguity maps. Any of these views can be overwhelmed by heavy branching at a node or by attempts to view at a distance of several links from the current document. As the number of nodes in sight grows, the view either becomes cluttered or is forced to multiple screens, defeating the purpose of synopsis. Filtering methods and focused or distorted views help overcome this problem.

Filtering removes documents from the view based on simple criteria. If the documents are typed, a subset of these types can be displayed. If links are typed, the view can be generated by moving along a subset of link types. Users must manipulate filtering criteria.

Distorted views use more complex criteria to determine whether nodes are rejected or included in the view. Choice is determined usually by global or regional properties of the database. For instance, the fish-eye viewing technique developed by George Furnas shows samples from the database in relation to their distance from the viewing point.

Clusters are another type of distorted view. Here each document is assigned to one or more clusters, which means the view from a node shows adjoining clusters rather than single documents. One document can be chosen to stand for the cluster, or a separate designator can be generated.

As with other views, you can deliberately create clusters as part of the editorial process, perhaps as an extension of the regular hierarchical outlining process. You can also assign documents to self-defined clusters upon retrieval.

Other, less intrusive, ways to provide hypertext location are through subliminal or periodic cues not explicitly requested. For example, movement between documents might include a sequence in which the browser zooms back to a cluster view, pans to a cluster of the new document, and zooms into the text level. You can also use colors, background patterns, or icons to indicate a document's topic or its level in a hierarchy. In a multimedia system, you can use sound as a peripheral cue to location.

When Searches Need Help

Boolean full-text search is the de facto CD-ROM retrieval method for a number of reasons. First, users, implementers, and data providers experienced in on-line retrieval are accustomed to Boolean search, so they carried their experience to CD-ROM. Second, it's easy to precompute the inversion tables required in Boolean search and to optimize their layout on the CD-ROM. And third, the technique makes modest demands on microcomputer processing power.

Unfortunately, Boolean searches have well-known flaws: the search trade-off between precision (i.e, the portion of retrieved items actually of interest) and recall (i.e., the fraction of truly relevant items that the search finds). You can attribute these failings to users who choose imprecise or incomplete search terms, the lack of semantic analysis of the documents, and the difficulty of determining a node's relevance through a binary decision. Whatever the reason, unaugmented Boolean search techniques shouldn't be used unless you realize the trade-offs involved and are willing to formulate complex queries. A false sense of completeness or a plethora of irrelevant document references is particularly dangerous with sensitive databases, such as those used in law or medicine.

Probabilistic and weighted Boolean full-text searches offer substantial improvements, but they have been slow to appear on CD-ROM because they impose a higher processing load and are more difficult to implement. In the interim, the network structure of hypertext databases may improve the apparent performance of Boolean searches.

Failing Gracefully

If you build links between nodes into the CD-ROM database, it's no longer so important if searches fail to find every relevant document. If the target is documents that have related semantics, it should suffice for the search to retrieve a subset of these documents, leaving the remainder to be found by browsing.

You can also use the hypertext network as a direct component of a search. Bibliographic and cocitation analysis can dramatically increase search performance in hypertext, presumably because the links directly trace the evolution of ideas. When appropriate, you can use these techniques to augment CD-ROM hypertext searches.

Even when the links are not explicitly bibliographic, the hypertext network can be used in relevance feedback. Spreading activation along links from user-marked nodes can be used to generate document weights. Marking could be explicit, or the browser could simply record the nodes visited by the user since the last search, with an option to forget a document that was a false path.

Regardless, it's the hypertext designer's responsibility to ensure that these techniques work. Links must be true reflections of semantic relevance, if not exact bibliographic relationships.

Improving Communication

For hypertext to succeed, it must have advantages not offered by printed or isolated electronic documents. One such advantage of CD-ROM hypertext is that it can support the iterative communication of ideas.

For example, ideas exist in the mind as a dense web of entities and relations. Hypertext honors these connections by making relations explicit; you can explore them until the idea is clear. Because it's easier to jump about in hypertext than it is to thumb through a book or return to the shelves, investigation is encouraged. Therefore, hypertext communicates ideas, as opposed to transmitting disconnected bits of information.

You can store many inquiry paths on CD-ROM. The problem CD-ROM hypertext architects face, however, is how to anticipate and build the most useful paths, given that it is impractical to provide all paths due to production costs and time.

Beyond the economic limits, there may be a cognitive limit to the optimum and maximum number of useful links per document. A small hypertext constructed in Xerox's NoteCards system has an average of slightly greater than 2 links per card. Other experimenters with constructed hypertexts report ranges of 4 to 8 and 2 to 10 links per screen. Interestingly, these figures are close to the number of items considered optimal for menu selection: 7 ± 2.

Do these numbers represent a fundamental limit on the number of competing items humans can simultaneously consider? If so, the consequences of exceeding this number in hypertext documents should be obvious. You could expect choosing a path from such documents to take longer because of the need to reload links while reaching a decision.

A related question is, what is the optimum size of a document in a hypertext system? Documents created in a hypertext system tend to express one idea and tend to be smaller than traditional print documents or text files. This fits well with the notion that links capture relations between ideas.

If these suggestions are true, the burden on the author and editor of a CD-ROM hypertext is clearer. As yet, there are no automatic tools to extract idea-size chunks from linear text. The need for parsimony of linkage suggests that, as in print, what is not said is as important as what is represented. The burden of expression and selection is on the human creator.

Contiguity and Similarity

When you are trying to decide which types of links to include in a CD-ROM hypertext, two associative principles, similarity and contiguity, will help.

Objects in a similarity relation share properties but no further association; they are members of a set or class. On the other hand, contiguity puts objects and events into a spatial or temporal relation. The relation may be simple, as in a time line, or complex, as in an organized scene or script. Contiguity relations are more readily learned and recalled than abstract concepts of hierarchies. This is not surprising, since contiguity is the rule in our everyday life.

Printed media show contiguity relationships with time lines, maps, or narrative. Computer scientists have represented contiguity relations as frames, scripts, and schemata. When you attempt to understand stories with these tools, you'll find that the information transferred is not enough for understanding. The text assumes a certain amount of underlying knowledge on your part. It is a narrative convention that expected behavior is not mentioned. You might say that the value of a narrative is precisely in its novelty, its deviation from the expected script.

This narrative convention causes communication breakdown when the reader doesn't have the appropriate abstraction in mind or can't extract it from the story. This type of failure means that the experience cannot be generalized and reapplied.

You use similarity relations to codify and retrieve knowledge and build classification hierarchies that exhibit the common elements of experiences, objects, and concepts. Similarity relations capture the generalizations deduced from narrative and experience. Similarity enables metaphorical and analogical reasoning by highlighting the common features among the related elements.

continued

Printed documents show similarity relations via outlines, tables of contents, formal taxonomies, and encyclopedic classifications. In electronic media, key-term indexes define similarity classes, and structured documents and outline processors emulate print conventions for classification.

It's difficult to communicate similarity relations because they are very general. You must have some common experiences between you, the author, and the reader to ground the argument, or the concepts abstracted become meaningless buzzwords. Thus, the reader can't learn the similarity relation because it can't be restated in familiar terms. Printed textbooks try to overcome this problem by providing examples that the student reads to overcome limited experience. Unfortunately, there is a practical limit in breadth and depth of coverage in textbooks. Some level of prior experience must be assumed.

Happy Trails

The value of hypertext is that it gives access to multiple classification hierarchies and many trails of narration and experience. When you find a narrative unclear because of a missed concept, you can examine other documents in a similarity class. If an explanation of similarity becomes murky, you can follow a trail of examples. The user who retrieves desired facts can move smoothly into the learning experience.

Because hypertext can represent multiple hierarchies (and printed outlines can't), it lets you explore multiple points of classification, which provides a greater chance of discovering analogies and metaphors. Different hierarchies can also embody competing views of the same experiences.

Multiple hypertext narratives correspond to Vannevar Bush's concept of memex *trails*. They are also called *tours* or *paths*. Since hypertext is a multivoice medium, tours can embody differing pedagogical approaches to material, or different points of view.

For instance, the same generalized material on ecology can be illustrated with different examples, depending on the viewer's bioregion. A tour can simply determine the next document presented by default, or it can be a dynamic presentation with real-time sound, video, and animation components.

Building structure into CD-ROM hypertext databases is very important. It's analogous to the production value added to printed works by editors, designers, and publishers. Successful products in the new medium require just as much creative effort, though it may take different form.

CD-ROM has already won a position as an archival system for existing data. To go further, opening new markets and competing with other media, databases and retrieval systems must be specifically crafted for CD-ROM and the new audiences it can reach. This will happen if technologists and publishers ally in a conscious search for new forms. The hypertext technique is a good place to start. ■

Editor's note: *Adapted from the Hypertext '87 conference proceedings.*

Tim Oren is a senior engineer at Apple Computer in Cupertino, California. He can be reached on BIX c/o "editors."

LIGHT, BRIGHT, AND WHITE

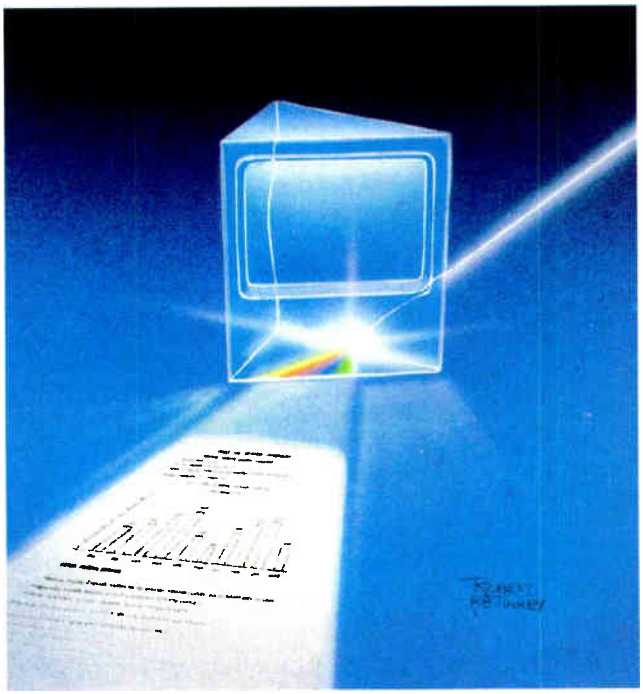
Laptop screens have been getting more readable lately, thanks to a new look at fluorescents

Wayne Rash Jr.

Finding the proper display for portable computers has always been a challenge. These peripatetic machines need a screen that is light and easy to read, and consumes little power. From the beginning, the liquid-crystal display (LCD) has been an obvious answer, but developing one that provides adequate performance takes careful engineering and precision manufacturing. As the demand for screens grew and the demand that their quality improve became clear, new techniques for producing such displays were needed.

LCD screen development has continued apace. In the last few years, we have gone from bare displays to displays with backlighting, and then to supertwist LCDs. At this writing, the state of the art resides with Zenith Data Systems' fluorescent-backlit, dual-layer, supertwist LCD.

Zenith calls its display "page white." This means that the background areas are white rather than light blue, and the dark areas are black or gray rather than dark blue. In addition, the new Zenith display demonstrates a contrast ratio of about 20 to 1, while its predecessors operated at a ratio of about 12 to 1.



Taking Apart the Zenith Display

Zenith's new version of its LCD, used in its new 80386-based laptop computer, gets its clarity and lack of color through a new backlight and an additional layer in the LCD panel itself (see figure 1). In addition, some engineering changes were required to realize the screen's potential clarity.

The rear of the typical backlit display differs from the familiar reflective LCDs by having a light source instead of a reflector. While this reduces the ability of the display to work with available room light, the significantly greater amount of light shining out from the screen results in a brighter display. The only exception to this is viewing the screen in direct sunlight, which can overwhelm most light sources. Even in direct sunlight, however, the limited reflective capability of the backlight is adequate for viewing.

In the past, the backlight has been an electroluminescent panel. This panel generated white light, which was transmitted through the LCD's polarizing layers, emerging as blue-tinged light. The light areas normally appeared as light blue, and the dark areas looked dark blue. In their most recent implementations, these screens were clear and visible, demonstrating a contrast ratio of about 12 to 1.

The Backlight

The differences in the newest Zenith display begin with the way in which the light is gen-

continued

ILLUSTRATION: ROBERT TINNEY © 1988

erated. To produce a brighter light source, Zenith chose fluorescent tubes in place of the electroluminescent display used in its (and other companies') laptop computer designs. The fluorescent tubes produce a much brighter, but much less consistent, light.

The problem with making the light even was solved by creating a reflector and diffuser that blocked most of the light directly in front of the tubes. Essentially, the diffuser was made partially reflective in front of the tubes. The level of reflectivity was reduced farther away from the tubes. This reduced the level of light directly in front of the tubes to keep them from showing through the display, while not wasting the light they generated.

The light comes from a pair of 2.5-watt tubes designed for this application. The differences from standard tubes include a more constant light level, the ability to handle more than 10,000 on-off cycles, the ability to have a variable light level, and the ability to start instantly.

Polarization and Blue

The light emerges from the diffuser as white, nonpolarized light. Immediately in front of the diffuser is the rear polarizer, which passes only vertically polarized light. This readies the light for the next stage, the supertwist LCD.

The LCD material is a super-rotator: It will rotate light through several thousand degrees per millimeter. According to Kevin Menkin, Zenith's material will rotate light through about 30,000 degrees per millimeter, compared with quartz, which rotates light only about 20 degrees per millimeter.

This high rotation allows an extremely thin layer of LCD material to be used. The light gets a net rotation of 90 degrees from the material, although the actual rotation is likely to be a multiple of 360 degrees, plus 90. While this high rotation allows for extremely thin liquid crystals, it also causes some serious engineering problems. The glass facing the liquid crystal must be manufactured with extreme precision so that the thickness is uniform. Even very slight differences can result in areas where the light gets twisted more or less than is desired. In a display, this appears as a blotchy area.

When power is applied to the LCD material, the normally twisted crystals untwist. This allows the polarized light to pass through unchanged. If the light was vertically polarized when it went in, it will stay that way when it emerges.

The problem with the liquid-crystal polarizing material is that it treats blue light differently from the other components of white light. Depending on the material, it can rotate blue light either slightly more than other light or slightly less. In either

continued

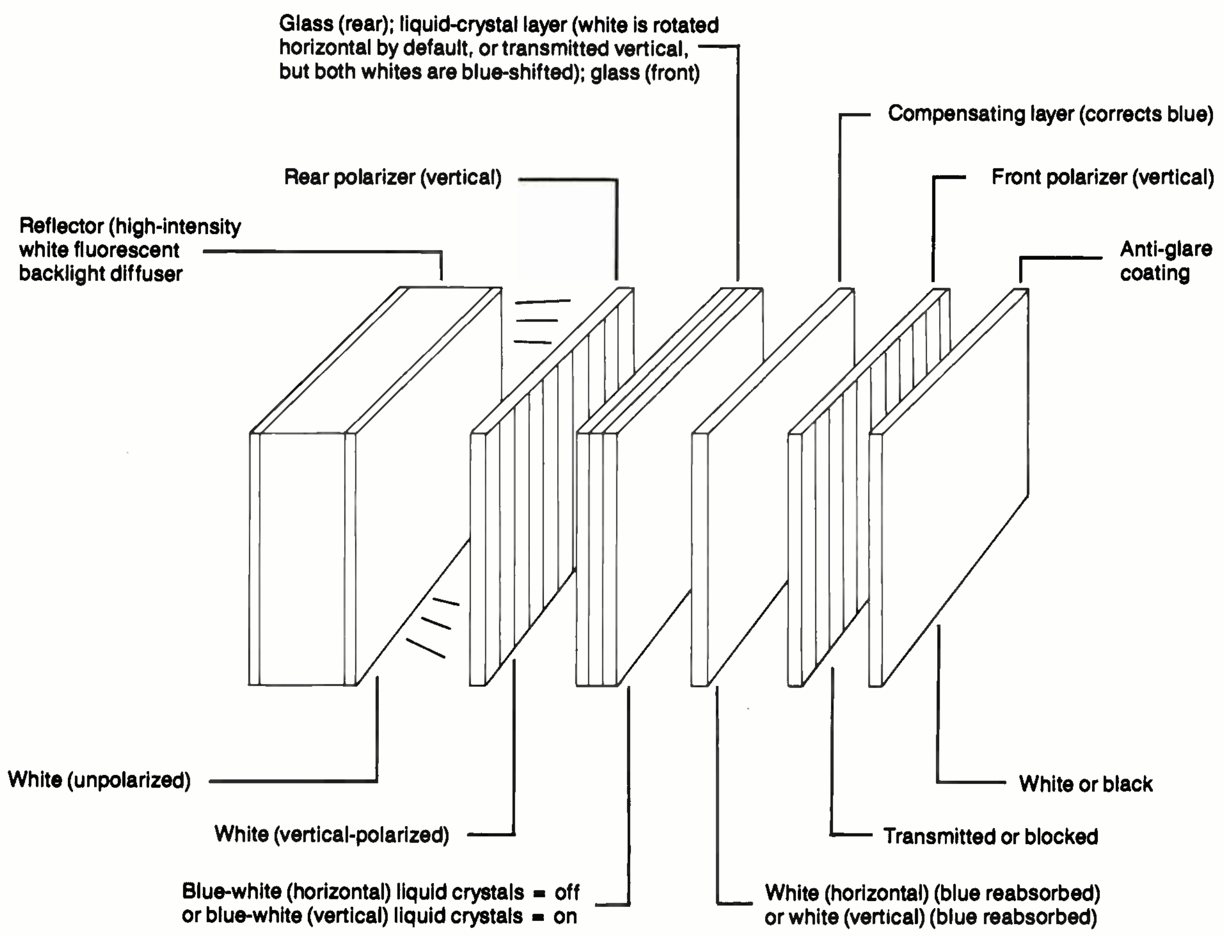


Figure 1: *Structure of the Zenith supertwist LCD, showing two unusual features—the diffuser layer and the compensating layer.*

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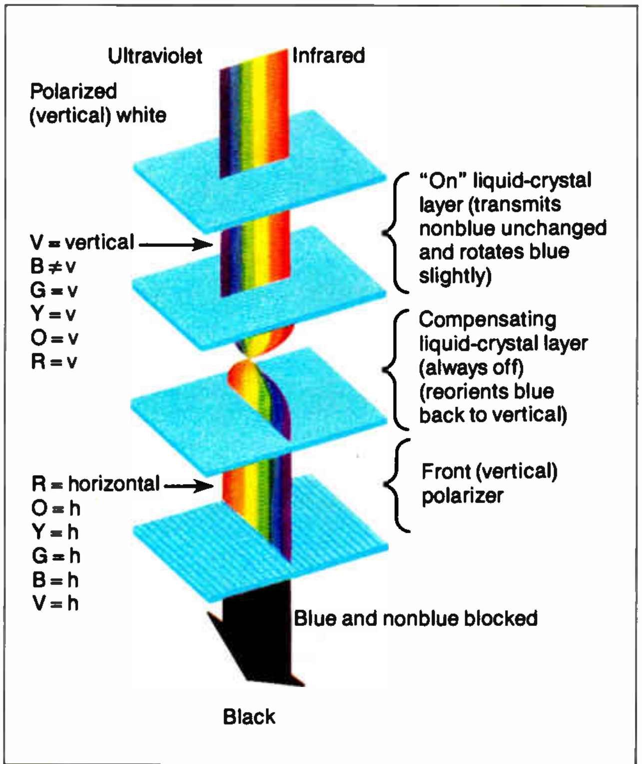

Figure 2: *An "on" pixel polarizes light, which is then blocked by the front polarizer and appears as a black pixel on the white background.*

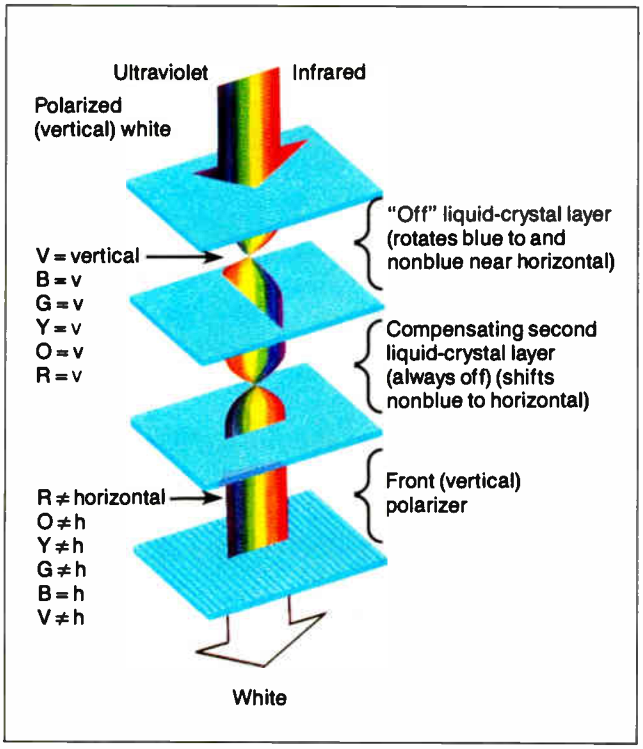

Figure 3: *Light passing through an "off" pixel is not blocked by the front polarizer and appears as white.*

case, a relatively greater amount of blue light emerges from the liquid crystal. Zenith counteracts this by adding an additional optically active layer after the liquid crystal. This layer over- or under-rotates the blue light in the opposite amount that the liquid crystal did. The net result is that the blue component of the light is in proper proportion with the rest of the light passing through the display.

Once the light emerges from the color-compensating layer, it passes through the final polarizing layer. This layer, which is also vertically polarized like the first layer, blocks out light with horizontal polarization. This means that when the light passes through the liquid crystal that is turned on, it picks up an additional 90 degrees of polarization, won't pass through the front polarizer, and shows up as a dark area (see figure 2). Light that passes through a pixel that is off will remain vertically polarized and will show up as a light area (see figure 3).

The result of the compensation is an LCD that appears black and white. In reality, there is still a slight blue tinge, but it tends to be *very* slight. One advantage of having the brighter light source is that the contrast gets higher. This happens because more light can be blocked out by the polarizing layers and still have acceptable brightness.

The higher contrast ratio also produces a better gray scale. Zenith's Kevin Menkin explained that the wider range of contrast also gives a wider range of grays. The gray scales are produced by turning the LCD material in each pixel on and off quickly. The ratio of on versus off determines the gray level.

Capabilities and Problems

Zenith clearly has high hopes for this display technology. The company says that this LCD can be made to be faster than a CRT. In addition, there are strong indications that the company is planning a color version of this display.

From the user's standpoint, there are a few problems with the fluorescent-backlit LCD. It is, of course, expensive, which explains why the company has it only on its top-of-the-line 80386-based laptop. In addition, the diffusing panel is less than perfect from some vantage points. In fact, at some angles you can see a faint indication of the fluorescent tubes.

Otherwise, this display limits its problems to engineering. According to Menkin, most of the display development problems relate to engineering rather than technology. The high level of precision required for the glass in the LCD was the thorniest, but it was eventually solved.

The other problems relate to the backlight. Without the great quantity of light produced by the fluorescent tubes, the compensated supertwist display would not work. Zenith tested this on traditional backlighting and created a screen that no one could read. The fluorescent backlit display is as readable as a CRT because of the light levels. In fact, it is so bright that it puts out more light at its lowest setting than traditional Zenith laptops do at their highest.

Bright Future

The compensated, fluorescent-lit LCD is clearly the next step in the evolution of flat, portable display technology. It consumes less power than gas plasma displays and is more readable. It is also brighter and clearer than traditional LCDs, and once it becomes possible to engineer this form of display into more traditional laptops, we should see plenty of them. ■

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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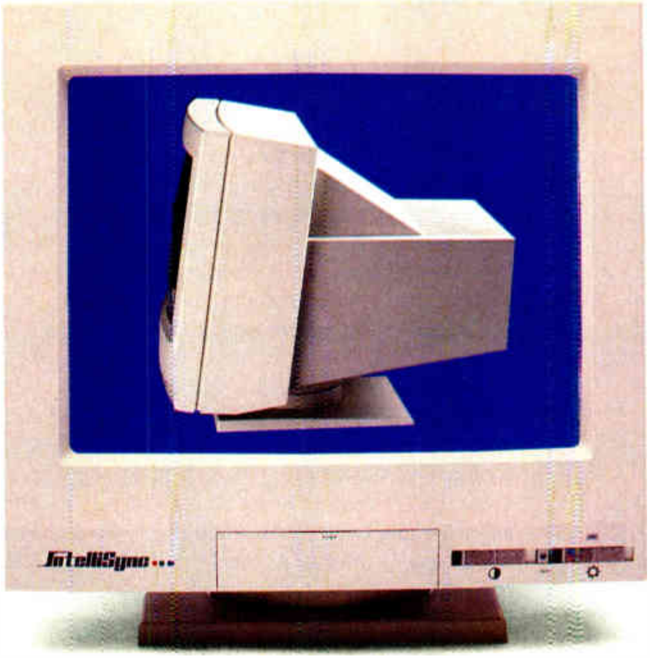

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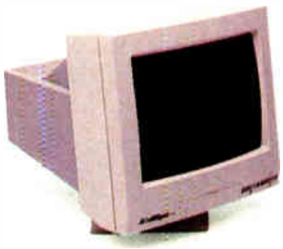

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Part 3

A SUPERCOMPUTER

This final part looks at hardware nuts and bolts and also at the driver program

The first two parts of this article gave you a background in multiprocessor architectures and described the basic algorithms used in the Circuit Cellar Mandelbrot engine. In this part, I'll go into the nuts and bolts of the engine's hardware and explain how the driver program in the IBM PC AT controls the engine.

Many Processors

A multiprocessor system is made up of perhaps hundreds or thousands of separate computers. The overall cost of the system is largely determined by the cost of each individual computer, so there is a strong motivation to keep costs under control. If a system uses 256 processors that each cost $1000, few people can afford the full system.

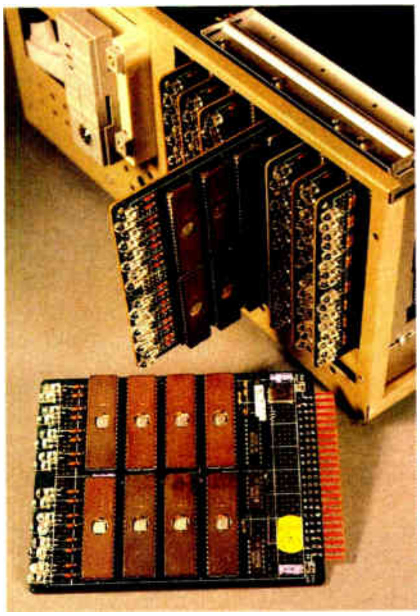
As I explained in Part 1, the multiprocessor's hardware architecture must match the problems that it will solve. If the problems require extensive communication between processors, the hardware must provide high-bandwidth intercomputer channels. The fact that those links are expensive simply means that's the price of solving the problem in the fastest way possible.

The iterative formula that produces Mandelbrot-set images is ideal for a multiprocessor implementation. The calculations require high-precision arithmetic but need little communication to set up the processors and report the results. A simple processor with low-cost communications can handle the problem adequately.

The Mandelbrot engine uses the Intel 8751 single-chip microcontroller as its basic building block. Figure 1 shows all the circuitry associated with a single processor. The hardware is deceptively simple, because the 8751 is a complete computer on a chip—there's a lot of hardware behind those pins!

I've long believed that something was lost when computers stopped sporting front panels with blinking lights, so there are two LEDs for each processor. The program turns on one LED when it's computing and the other when it's done. A glance at the front panel indicates the state of every processor in the engine. The LEDs also assist in program and hardware debugging, because the program blinks them in specific patterns when it's waiting in various loops.

The 8751 receives data and setup information through its serial input port, which is driven by a buffer that is shared by all the chips on a single card. The results of the Mandelbrot set calculations, as well as ID and version information, are sent over the 8751's serial output port. Each chip has a separate output buffer that drives the single serial output line leaving the card.



The chain-in and chain-out lines provide control and timing information during the calculations. When the program finishes evaluating the iterative formula for its current point, it waits for a pulse on the chain-in line before transmitting its result. After the final stop bit of the result message is finished, the chip pulses its chain-out line to signal the next processor in line that the serial output is available.

With those simple connections, each processor can receive data and send results in an orderly manner. The next step is to connect 256 of these processors into a single system.

It's in the Cards

Although I could have designed a single card with 256 40-pin DIP sockets and 512 LEDs, I figured that it made more sense to build the engine from smaller units. After all, a single-card computer would occupy about 5½ square feet and cost a small fortune.

Each 8751 is rated at no more than 250 milliamperes of current from the 5-volt power supply. While ¼ ampere doesn't sound like much, a full-bore engine with 256 processors will draw about 64 A! The two LEDs at each processor add another ampere or so to the bill. Obviously, there would be some problems getting enough power onto that single board.

After worrying about the problem for a while, I decided that a board with eight 8751s made a nice unit. Photo 1 on page 332 shows a hand-wired prototype with all eight processors installed and 16 LEDs peeking over the edge of the card. The card draws about 2 A of current, low enough not to pose a problem for the edge connectors.

Figure 2 shows the connections for a single card. To reduce the complexity of the drawing, I've shown the eight processors as blocks with I/O connections

continued

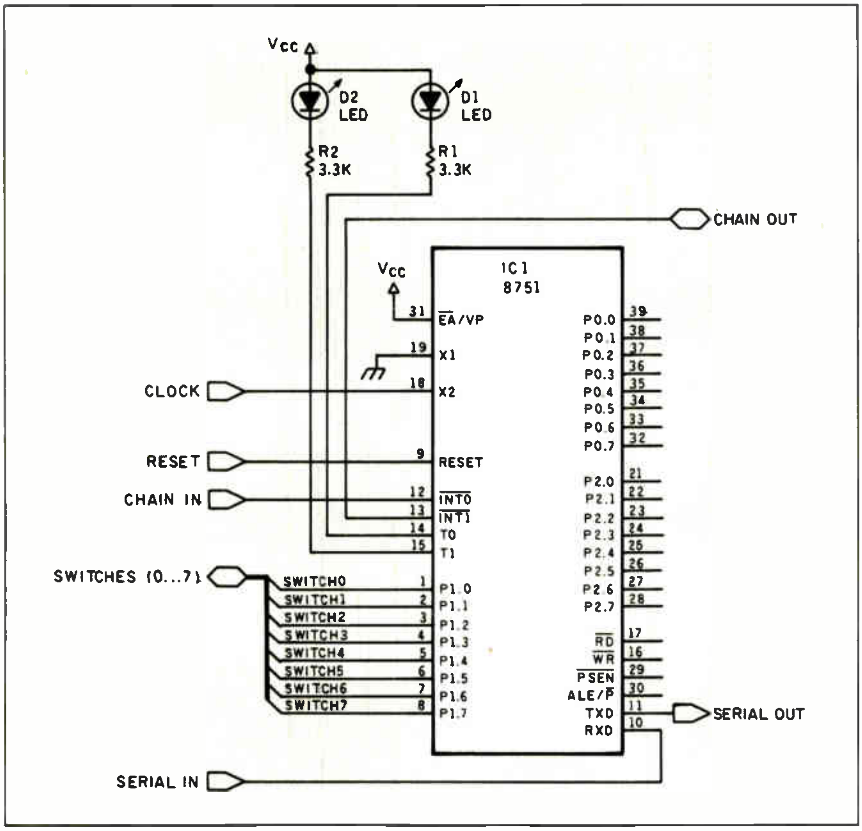


Figure 1: *The schematic for one processing element of the Mandelbrot engine.*

rather than as separate chips. Notice how the serial I/O ports are connected in common to all chips, while the chain-in and chain-out lines snake throughout the card.

The LEDs are connected to output-port pins on the 8751 through 3.3-kilohm resistors that limit the current to about 1 mA. Normally, a transistor buffer providing 10 mA or 20 mA drives the indicator LEDs, but I didn't think the additional hardware was worth it. Instead, I used high-efficiency red LEDs that are surprisingly bright at 1 mA.

The 8751, like all computers, requires a clock signal to sequence its internal registers and buses. Normally, a crystal connected directly to the 8751 provides that clock signal; each 8751 would then use a separate crystal. In this application, it didn't make much sense to have eight crystals on one board, so I included some circuitry to buffer the clock signal from one 8751 to the other seven. The few parts needed for the buffer cost much less than seven more crystals.

Because all the processors are driven by a common clock signal, their internal bus activity is synchronized. This can produce awesome current spikes on the 5-V supply, a situation that demands 100-nanofarad bypass capacitors across every IC on the board. These capacitors supply the transient current needed by each processor and reduce the spikes on the rest of the card. In addition, the cards have a ground plane on the top surface and heavy power-bus lines on the bottom, so there is a relatively low impedance connection to the 5-V supply.

One port of the 8751 is dedicated to switches that provide setup and test information. Rather than put a separate DIP switch on each card and risk having one switch in the wrong position, I used a single DIP switch for all the cards. Figure 2 shows port P1 connected to eight card-edge pins that provide the switch information.

Since the software can handle any number of processors, it made sense to design the hardware the same way. A jumper block on the card connects the chain-out line from each processor to the card's chain-out line. The first processor must be installed in socket IC1, and all processors must be contiguous, but by setting the jumper correctly, you can install any number of 8751s on the card.

Notice that, since I stored the Mandelbrot engine program in EPROM in each processor, there is no boot sequence before the program is ready to run. Unlike IBM PCs and other common computers, the Mandelbrot engine is easily and quickly reset. In fact, all the 8751 reset lines are connected together and driven by the DTR line from the AT's serial port (through a level converter and buffer, of course), so that the AT can reset the engine at the start of calculations. This ensures that the engine is in a known state and ready to receive setup information.

Cards on the Rack

A complete Circuit Cellar Mandelbrot engine consists of 32 cards with 8 processors on each card (256 processors). Since that would require a card rack about 1¾ feet long and involve distributing 64 A of power supply equitably along the rack, I decided to take a more modest approach—only 64 processors.

Photo 2 shows a prototype rack that holds eight Mandelbrot engine cards. The power requirement for this rack is about 15 A, which is reasonable for a single power supply. (One point that bears mentioning is that a failure in the power supply can crisp 64 processors in one shot, so the rack also includes an overvoltage crowbar protector.

Figure 3 shows the connections for one rack, with each card shown in place. One of the cards, the Rack Master, has a socket for the DIP switch needed to tell the 64 processors what serial-port rate to use, and so forth. The switches in each rack are identical.

A full Mandelbrot engine requires four racks. Figure 3 also shows the PC serial-port connections required to control the whole multiprocessor. As is indicated, you need relatively few wires for a computer with 256 processors. (The 64-processor engine we put together at the Circuit Cellar has about $6000 in hardware and 250 hours of wiring. Using a conservative $40-per-hour technician rate, our 64-processor Mandelbrot engine cost about $16,000.)

I've glossed over one small complexity up to this point: The serial-port connections from the PC use the standard RS-232C voltage levels, while the connections within the Mandelbrot engine are strictly TTL. One card, the Array Mas-

continued

ter, includes an MC145406 level converter (IC5) that handles the translations between the two standards. That card is also the Rack Master for the first rack, so it also has a DIP switch.

Skipping Jumpers

From reading the description of the Mandelbrot engine, you'd think that there are three different types of cards: a single Array Master, three Rack Masters, and 28 ordinary cards. While I could have designed three cards with three layouts, it made a lot more sense to design a single card that could serve in all applications.

The ordinary way to do that would use a set of jumpers on the card to select various I/O configurations and route signals to the appropriate places on the card. You could then select the "personality" of the card by the various jumper locations.

In this application, I decided that using personality jumpers was a bad idea. With up to 32 cards in a full Mandelbrot engine, it was almost certain that one or two jumpers would be misplaced, and it could take hours to track down the offending card. So the ideal goal was to eliminate jumpers entirely, except for the single jumper that designates a card with fewer than eight 8751s.

If you refer back to figure 2, you'll see the schematic for the Array Master card. The three Rack Master cards omit the MC145406 level converter and the LS21 chip that combines the serial data from the racks. All the cards can be identical, with the appropriate chips omitted from cards that don't need them.

It turns out that all the connections normally made through jumpers can be made by back-panel wiring between the cards. This explains the odd connections shown in figure 3.

For example, the AT's serial port connects to the serial data-in line on pin A7. The MC145406 converter translates the RS-232C signal into TTL voltages and drives four gates in the 74LS241 buffer. One of these connects to all the serial-port inputs on the card, and when the card operates as the Array Master, it also drives the seven other cards in the rack through pin B15.

The other three gates drive the remaining three racks through pins B14, B13, and B12. Because only the Array Master card has the 74LS241 buffer, each line from the Array Master to a rack connects to pin B15 on all the cards in that rack. If you trace the circuitry, you will see that pin connected to all the processors on the card; the pin doesn't care which way the electrons are flowing.

continued

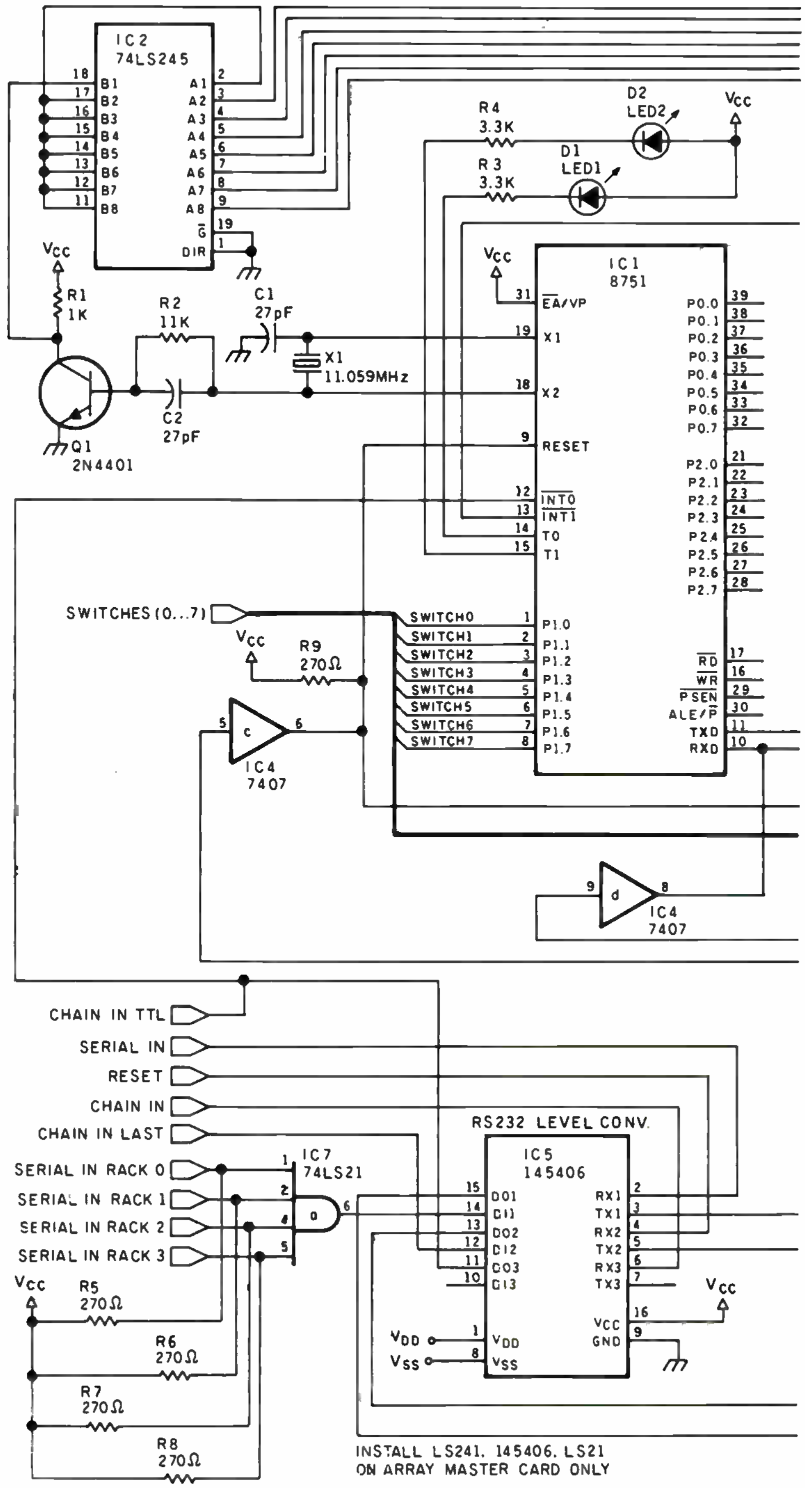
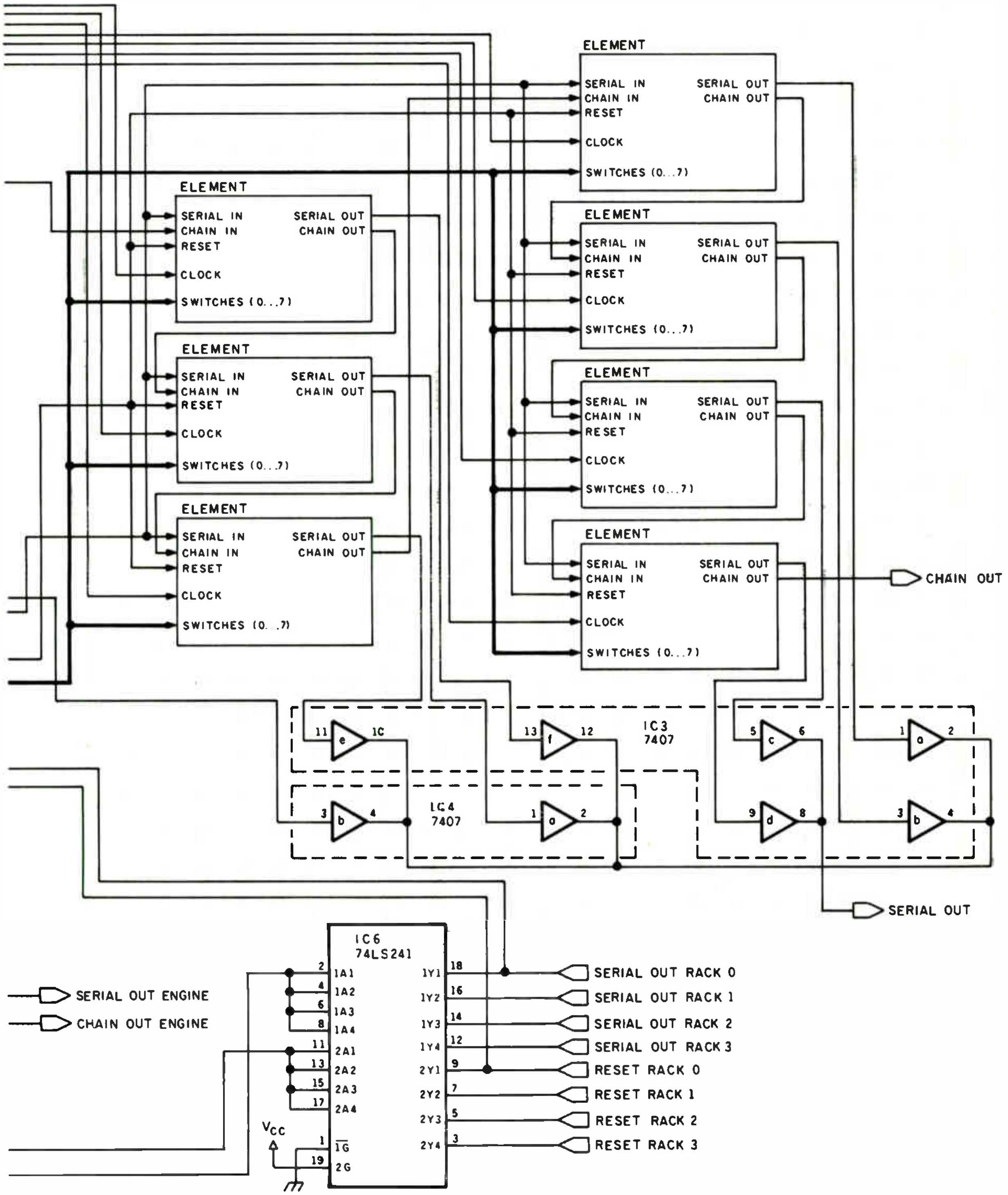


Figure 2: *The schematic of a Mandelbrot engine card.*



ELEMENT
SERIAL IN
CHAIN IN
RESET
CLOCK
SWITCHES (0...7)
SERIAL OUT
CHAIN OUT
IC3
7407
IC4
7407
IC6
74LS241
CHAIN OUT
SERIAL OUT
SERIAL OUT ENGINE
CHAIN OUT ENGINE
SERIAL OUT RACK 0
SERIAL OUT RACK 1
SERIAL OUT RACK 2
SERIAL OUT RACK 3
RESET RACK 0
RESET RACK 1
RESET RACK 2
RESET RACK 3
VCC

Each card has a single serial output line from all the processors on the card. All eight outputs in a rack are connected in common, so 64 open collector gates are tied together. Because I didn't think connecting 256 gates in four racks together made much sense, the Array Master card has a 74LS21 gate to combine the four signals into one. Remember that only one 8751 will be transmitting data on the serial line at a time, so only one of the 256 gates will be active.

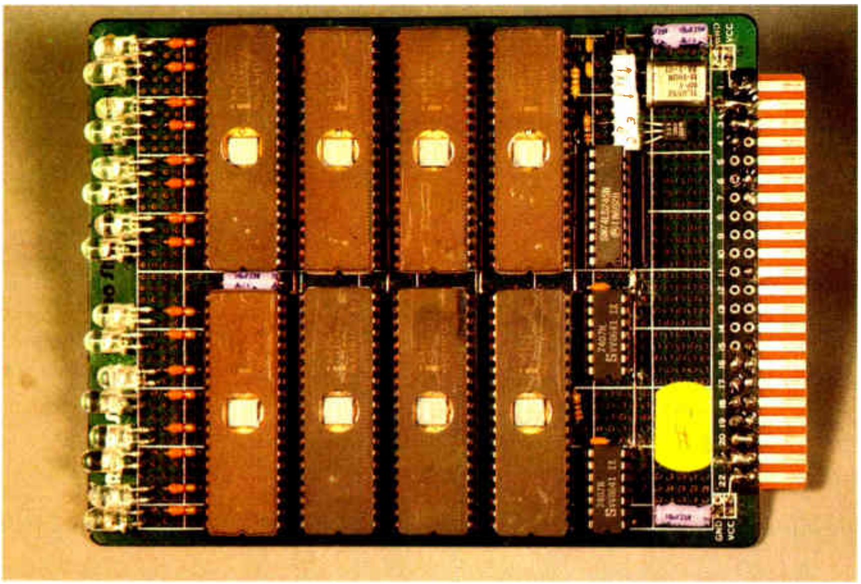


Photo 1: *A prototype of one eight-processor card from the Mandelbrot engine. High-efficiency LEDs are along the left of the board, and notice the windows on each CPU for programming the on-chip EPROM.*

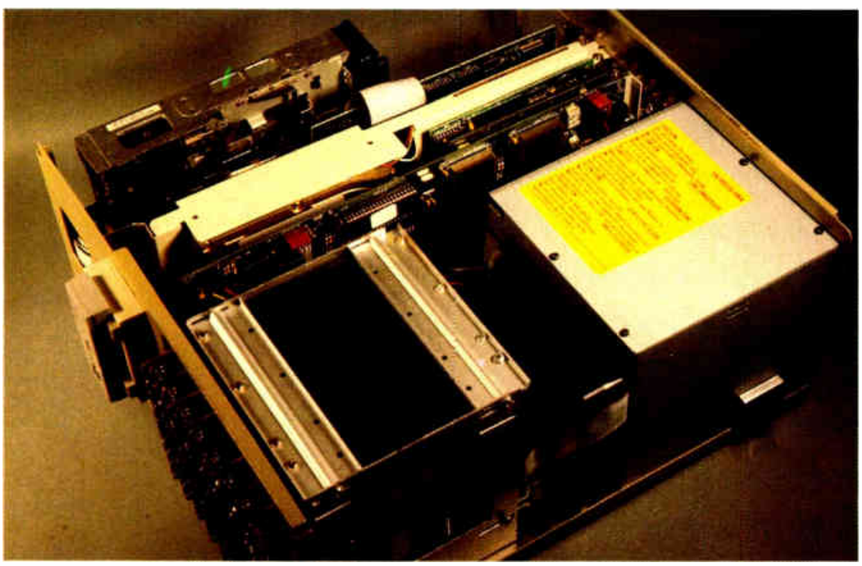


Photo 2: *A prototype rack chassis, designed to hold eight cards (for a total of 64 processors). Note that this chassis also houses a Circuit Cellar AT, complete with a hard disk drive.*

Engine Software

Because the Mandelbrot engine is dedicated to computing one formula, the program structure is simple. Figure 4 shows the block diagram of the code, which is written in 8051 assembly language.

Immediately after a hardware reset, the program examines the switches to figure out the bit rate for the serial port. Timer 1 in the 8751 controls the bit rate, but the timer period is set by the processor's clock input. Various members of the 8051 family can run with clocks up to 16 MHz, so the switch settings must also tell the program what the clock frequency is. There's no way to figure it out from within the 8751.

The Mandelbrot engine can have up to 256 identical processors. The data for each processor depends on the particular part of the complex plane under scrutiny, as well as the section of the plane assigned to that processor. If all the processors run the same program and they all receive the same serial data, how can the control program tell them apart, and how do they know which one they are?

The chain-in signal provides a way to assign each processor a unique address. When the AT begins assigning the addresses, it toggles the chain-in line connected to the first processor and sends the first address. The 8751 program waits until it sees an address immediately following a pulse on its chain-in line, grabs that address as its own, and transmits an inverted copy on its serial-out port. When the transmission is complete, it toggles its chain-out line to signal the next processor.

The AT sends addresses starting with 0, so the first address is 00 hexadecimal and should be returned as FF hexadecimal. When all the processors have grabbed their unique addresses, the AT will see a pulse on the chain-out line coming back from the array. At that point, the AT knows how many processors are installed in the engine, and each processor knows its unique address.

The processor addresses will remain set until the next hardware reset, so there's no need to go through the address assignment loop again. The AT must keep track of whether the array has been initialized, so that it doesn't perform the address assignment at the wrong time.

Each processor is responsible for a group of points in the complex plane. The AT must download the location of those points before the processor can start computing, so the entire engine waits for the initial data after the address assignment is finished.

The AT assigns data in two passes, *common* and *individual*. Common data applies to all processors, and it sets items like maximum number of iterations and point size. Individual data varies according to the processor; it controls the point location in the complex plane.

Each processor begins computing as soon as it has all the command and individual data. There's no reason to wait for all the processors to be started in unison, so you'll see the LEDs flicker into action

continued

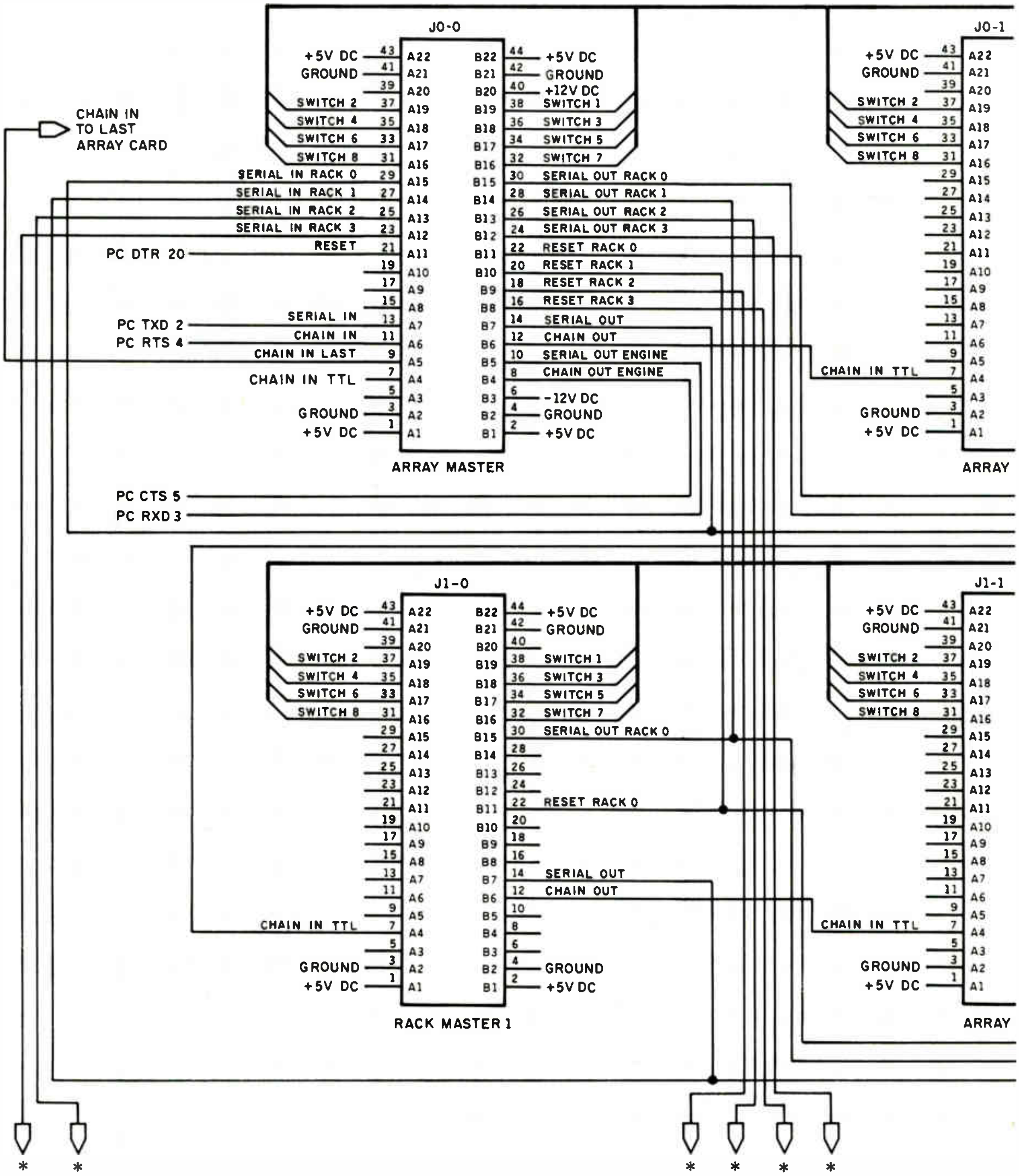
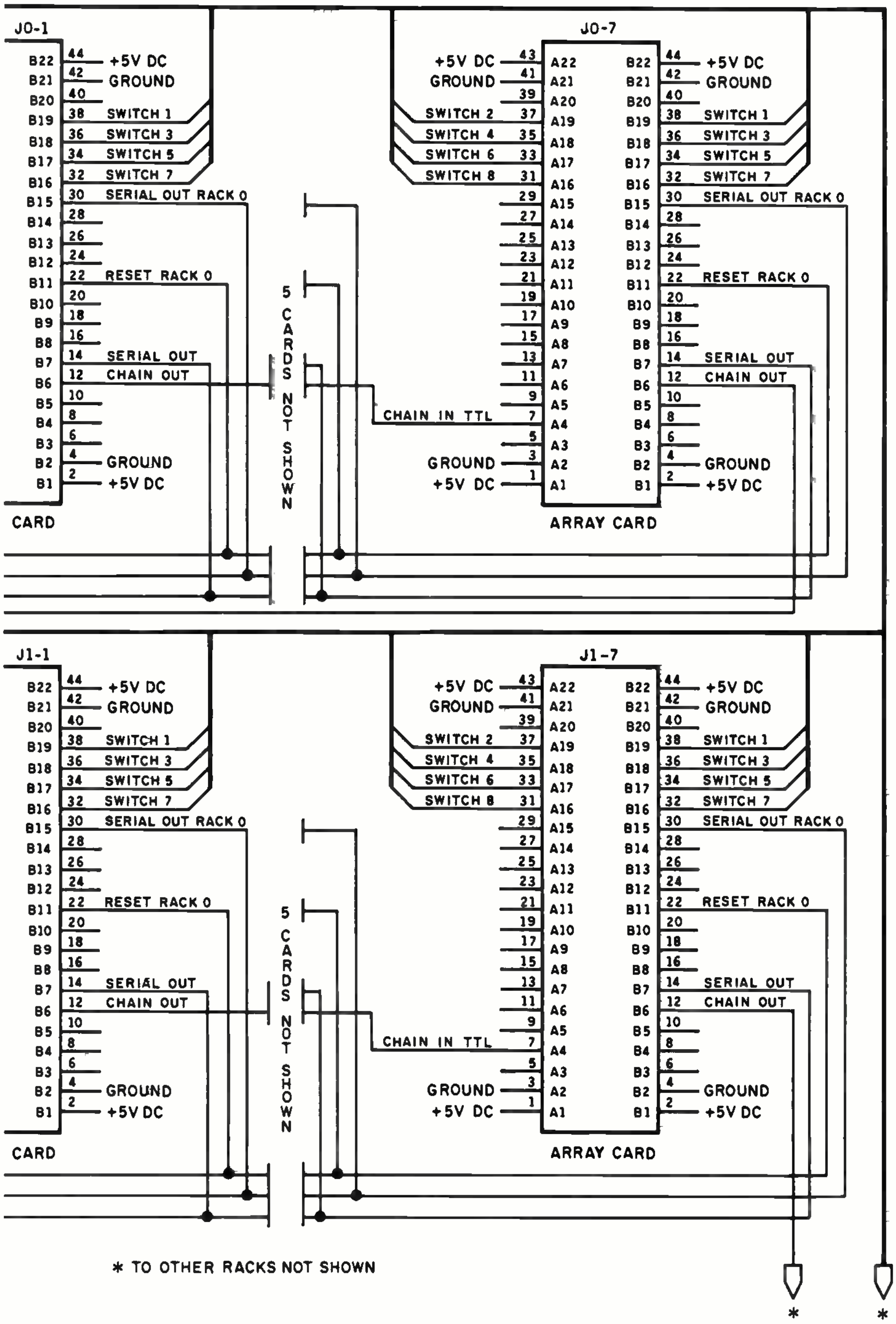


Figure 3: *The complete schematic (sans buffers and support chips) for the Mandelbrot engine, detailing how the processors are chained together.*


J0-1
B22 44 +5V DC
B21 42 GROUND
B20 40
B19 38 SWITCH 1
B18 36 SWITCH 3
B17 34 SWITCH 5
B16 32 SWITCH 7
B15 30 SERIAL OUT RACK 0
B14 28
B13 26
B12 24
B11 22 RESET RACK 0
B10 20
B9 18
B8 16
B7 14 SERIAL OUT
B6 12 CHAIN OUT
B5 10
B4 8
B3 6
B2 4 GROUND
B1 2 +5V DC
CARD
5 CARDS NOT SHOWN
J0-7
+5V DC 43 A22
GROUND 41 A21
39 A20
SWITCH 2 37 A19
SWITCH 4 35 A18
SWITCH 6 33 A17
SWITCH 8 31 A16
29 A15
27 A14
25 A13
23 A12
21 A11
19 A10
17 A9
15 A8
13 A7
11 A6
9 A5
CHAIN IN TTL 7 A4
5 A3
GROUND 3 A2
+5V DC 1 A1
B22 44 +5V DC
B21 42 GROUND
B20 40
B19 38 SWITCH 1
B18 36 SWITCH 3
B17 34 SWITCH 5
B16 32 SWITCH 7
B15 30 SERIAL OUT RACK 0
B14 28
B13 26
B12 24
B11 22 RESET RACK 0
B10 20
B9 18
B8 16
B7 14 SERIAL OUT
B6 12 CHAIN OUT
B5 10
B4 8
B3 6
B2 4 GROUND
B1 2 +5V DC
ARRAY CARD
J1-1
B22 44 +5V DC
B21 42 GROUND
B20 40
B19 38 SWITCH 1
B18 36 SWITCH 3
B17 34 SWITCH 5
B16 32 SWITCH 7
B15 30 SERIAL OUT RACK 0
B14 28
B13 26
B12 24
B11 22 RESET RACK 0
B10 20
B9 18
B8 16
B7 14 SERIAL OUT
B6 12 CHAIN OUT
B5 10
B4 8
B3 6
B2 4 GROUND
B1 2 +5V DC
CARD
5 CARDS NOT SHOWN
J1-7
+5V DC 43 A22
GROUND 41 A21
39 A20
SWITCH 2 37 A19
SWITCH 4 35 A18
SWITCH 6 33 A17
SWITCH 8 31 A16
29 A15
27 A14
25 A13
23 A12
21 A11
19 A10
17 A9
15 A8
13 A7
11 A6
9 A5
CHAIN IN TTL 7 A4
5 A3
GROUND 3 A2
+5V DC 1 A1
B22 44 +5V DC
B21 42 GROUND
B20 40
B19 38 SWITCH 1
B18 36 SWITCH 3
B17 34 SWITCH 5
B16 32 SWITCH 7
B15 30 SERIAL OUT RACK 0
B14 28
B13 26
B12 24
B11 22 RESET RACK 0
B10 20
B9 18
B8 16
B7 14 SERIAL OUT
B6 12 CHAIN OUT
B5 10
B4 8
B3 6
B2 4 GROUND
B1 2 +5V DC
ARRAY CARD
* TO OTHER RACKS NOT SHOWN
*
*

in a wave as the AT assigns data to each processor.

I described last month how the AT reads data out of the array. To summarize, it toggles the chain-in line to the first processor, which responds with the results of its calculations on the first point and toggles the chain-in line for the next processor. Once each processor has responded, the AT formats the data into dots on the screen and then repeats the process.

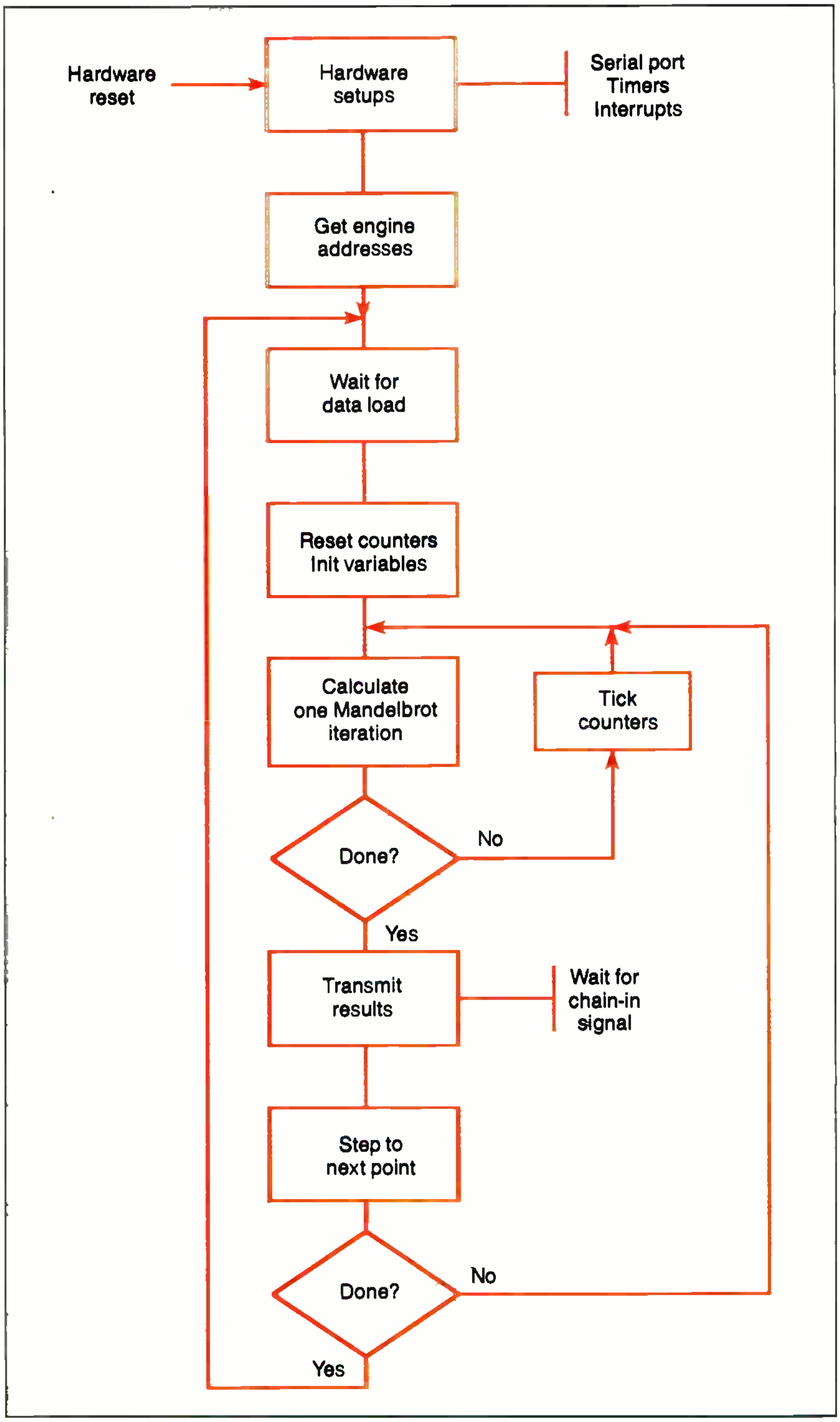


Figure 4: *The flowchart for the program executed by each processor of the Mandelbrot engine.*

The AT program divides the number of points on the screen by the number of processors in the engine, to decide how many points each processor must handle. For example, an EGA display has 224,000 pixels, so a four-processor engine will have 56,000 (224,000÷4) points assigned to each processor.

Figure 5 illustrates how those 224,000 pixels are divided among the four processors. Each processor is responsible for every fourth pixel across the line, and the assignments repeat on each line. The common setup data tells every processor that it must compute 160 pixels along the real axis before stepping the complex axis value. After 350 complex steps, the processor has finished its 56,000 points; it simply returns to the top of the loop and waits for the next set of data.

The sequence of events follows the classic "set up, read data, compute, write data, repeat forever" loop. In this case, though, the processors have only two LEDs and a serial port for communication, which is quite different from most computers you've seen before.

Although the AT program can handle engines of any size, it picks a line length that is the largest multiple of the actual number of processors. If it finds 9 processors installed (one full card and one lonely 8751 on another), the line length will be 639 (9 × 71). Six full cards with 48 processors will give a 624-pixel line (48 × 13), and so on. Installing a number of processors that "fits" into 640 pixels is best.

All the processors in the engine will cease computing after the complete Mandelbrot set is finished, at which time the AT can reload new common and individual data without having to reassign processor addresses. If the AT needs to interrupt a calculation in progress, it sends a single command to all processors that forces them into the idle state. If all else fails, of course, the AT can simply toggle the reset line and start from scratch.

Images On-Screen

The results of the Mandelbrot engine's calculations could be presented as a printed listing of the 224,000 counts needed to fill an EGA display, but it makes a lot more sense to view them directly. The program should also let you specify coordinates and areas by simply indicating a section of the screen. After all, typing in 19-digit numbers is no fun! Function and cursor keys control all the AT program's actions, so little typing is needed to make it work.

The EGA has more capabilities than most people realize, so we took the opportunity to show off a few of them in the Mandelbrot engine driver program (known simply as DRIVER). It's written in Microsoft C 5.1, with a few routines in Macro Assembler 5.1 to handle the video interrupts and some ugly machine details. (This code is available on the Circuit Cellar bulletin board system.)

All current EGA cards come equipped with 256K bytes of video memory, and DRIVER uses it all. To run DRIVER, you will need a 256K-byte EGA card and a display similar to an IBM Enhanced Color Display or an NEC MultiSync that can show 640 by 350 pixels in 16 colors. It does not support CGA cards, Hercules adapters of any sort, or (of course) the nongraphics IBM monochrome display.

At this point, DRIVER treats a VGA card just like an EGA, but we may at some time in the future add more capability to get better images using the VGA 320- by 200-pixel 256-color mode. We did a few sample VGA screens (sorry, the code isn't in distributable form yet), and once you've seen Mandelbrot-set images in full color, you'll never want to go back to 16 colors again. (Those of you with old true-blue 64K-byte IBM EGAs are out of luck. You are overdue to add the memory daughterboard and RAM chips. Given the current price of memory, you may need to shop around, but the expansion will be worth the price.)

Figure 6 shows how DRIVER uses the 256K bytes of video buffer. The EGA hardware supports smooth horizontal panning and vertical scrolling, so the buffer is laid out with 546 scan lines of 960 pixels each. The first 21 scan lines are dedicated to a hardware split screen that shows status messages and prompts, so the area available for graphics is actually 960 by 525 pixels. The 640 by 350 pixels visible on the screen can be scanned smoothly over the background using the cursor keys.

The results from the Mandelbrot engine can fill either the screen area or the whole video buffer. If DRIVER is in full-buffer mode, you can tour the complex plane while the image is being drawn. The scrolling and panning is controlled by an interrupt routine driven by the vertical interrupt from the EGA card.

Because that video interrupt is so critical, DRIVER will not work if you have a true-blue IBM VGA Display Adapter card for your PC, XT, or AT. For whatever reason, IBM did not implement the vertical interrupt signal on the PC version of the VGA card. DRIVER cannot update the screen at the right times without the vertical interrupt signal. Real VGAs work just fine, however, because the PS/2 system board includes the interrupt signal. Nice move, IBM.

I've had trouble with "super EGA" boards that automatically switch between various graphics modes. DRIVER is badly behaved in that it directly manipulates the hardware, so make sure that your board switches are set to disable all the super features if it doesn't run on your hardware. Successfully running DRIVER is a good test of your board's compatibility with a genuine IBM EGA.

Messages and prompts appear on a split-screen line that appears only when the messages are needed. At all other times, the full 350 scan lines are filled with Mandelbrot-set graphics. The vertical interrupt routine scrolls the split screen up and down, while the rest of the program continues about its business.

DRIVER can save images on disk, but it dumps the complete contents of the buffer with no compression. A single Mandelbrot image requires 252,512 bytes of disk space, so a hard disk drive is essential. The prototype engine with the AT controller that I built sports a 32-megabyte hard disk drive, which filled up surprisingly quickly.

DRIVER's main purpose is to control the engine, but it also includes functions that get the engine running and that measure its performance. Various function keys pop up statistics describing the current image, and a summary line appears after an image is finished.

The Problem with Benchmarks

Benchmarks can be misleading under the best of circumstances. When it comes to evaluating a multiprocessor system, benchmarks can be downright dangerous. There's more to it than just running a program between stopwatch clicks.

The ordinary benchmark sequence for a new computer seems to involve running the Sieve program at least once, along with a few other programs that exercise memory, disk accesses, and floating-point math. The problem, of course, is that the Mandelbrot engine can't run any of those programs: It's designed to solve one problem very well, and it can't handle any other task.

So a more appropriate benchmark

continued

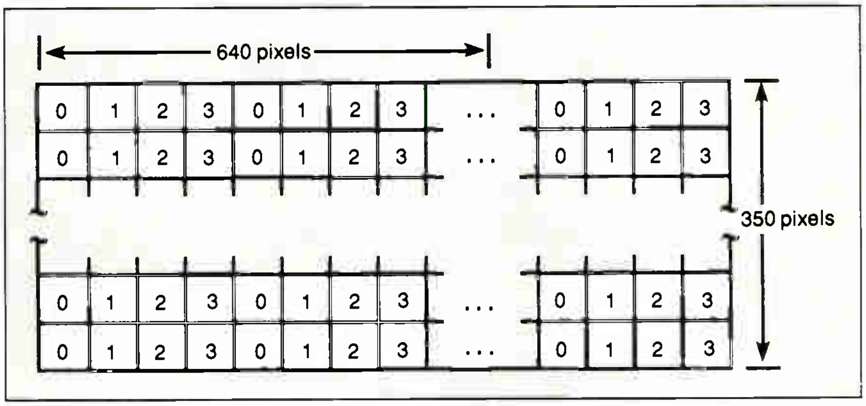


Figure 5: *Assigning pixels to processors. If you're running a four-processor engine, the control program assigns pixels to successive processors by moving through the screen buffer horizontally left to right, then down.*

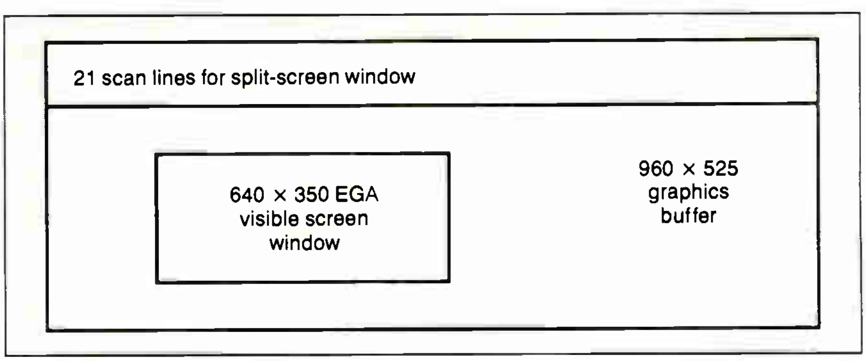


Figure 6: *A map of the EGA video buffer (256K bytes), as used by the Mandelbrot driver program.*

might compare the Mandelbrot engine against other Mandelbrot-set programs that run strictly on a PC. The problem here is that the programs on the two machines are totally different, so it's not clear what "performance" the benchmarks would measure: hardware, software, or firmware.

Worse, the Mandelbrot engine requires a driver program running on a PC to handle all its setup and I/O. Obviously, a faster PC will run the driver program faster, so the performance will increase, even though the engine itself remains unchanged. Should the benchmarks include testing on various PCs to isolate the effects of the driver?

I decided that the only reasonable way to benchmark the Mandelbrot engine was to add code to DRIVER that simulated the engine's calculations. The comparisons could then take DRIVER as a constant and concentrate on the differences between the engine and the PC simulation. This also ensured that any hardware differences on the PC would affect the engine and the PC simulation equally.

DRIVER can handle three levels of simulation. You can run it to plot the Mandelbrot set directly without the Mandelbrot engine. Entering the command-line switch `-FAKE:1` invokes double-precision floating-point calculations with about 52 bits of precision.

The `-FAKE:2` switch uses single-precision floating-point math with about 24 bits of precision. The `-FAKE:3` switch triggers a precise emulation with fixed-point numbers identical to those used in the engine.

The two floating-point simulations (as well as the rest of the code) take advantage of a math coprocessor if the PC has one available. The fixed-point simulation is written in C rather than tightly optimized assembly language, so the performance is excruciatingly slow. The comparisons shown below use only the `-FAKE:1` simulation mode.

The AT is slower than the Mandelbrot engine by a factor of 22.

Figure 7 summarizes a head-to-head competition between an 8-MHz IBM PC AT and a Mandelbrot engine with 64 processors. The AT takes 85 minutes to generate the same image that a 64-processor engine knocks off in 3.9 minutes. Adding a 10-MHz 80287 to the AT improves its performance to 9.7 minutes, while the engine drops to 2.8 minutes because of the improved speed in DRIVER.

Those numbers are worth examining in more detail. The AT is slower than the engine by a factor of 22! Adding an 80287 improves the AT by a factor of 8.8, but the engine is 3.5 times faster than that. Not bad for a bunch of single-chip microcontrollers.

Remember that engine calculations use more precise numbers to derive the results, so the Mandelbrot-set images will be slightly different. I suspect that the engine results are more "correct," but I don't have any way to prove it (I'm certainly not going to run the calculations by hand).

The engine's performance depends on how many processors are sharing the work load, as with any multiprocessor system. Figure 7 plots the total elapsed time for each calculation against the number of processors, using log-log axes to show equal percentage changes as equal distances (I ran the tests with a maximum iteration limit of 64 to provide a better load on the processors, but the image area is the same as on the previous test). With the exception of the 64-processor engine, the results fall on a nearly perfectly straight line, which indicates that the additional processors are sharing the work load equally—the more processors, the better it runs.

The AT (with an 80287) takes 21.7 minutes to generate the test image, which is equivalent to a engine with only 13 processors. Although I didn't try it without the 80287, the factor of 8.8 found in the previous test indicates that it would take about 191 minutes. A Mandelbrot engine with 2 or 3 processors will do better than that!

The 64-processor engine is slower than the trend line for the other six configurations would indicate. Recall that each processor delivers its results in strict order, so any processors that get done calculating "early" must wait their turn on the serial link. This contention will increase as more processors share the link. We considered changing the 8751 program to buffer the results of one or two calculations so that the program can continue even if the link isn't ready, but there's no room left on the 8751 for even a tiny buffer.

It's worth noting that serial-link transmission time doesn't slow down the results by a significant amount. A byte on the link takes about 450 microseconds at 28,800 bits per second, so a complete Mandelbrot set with 224,000 points will

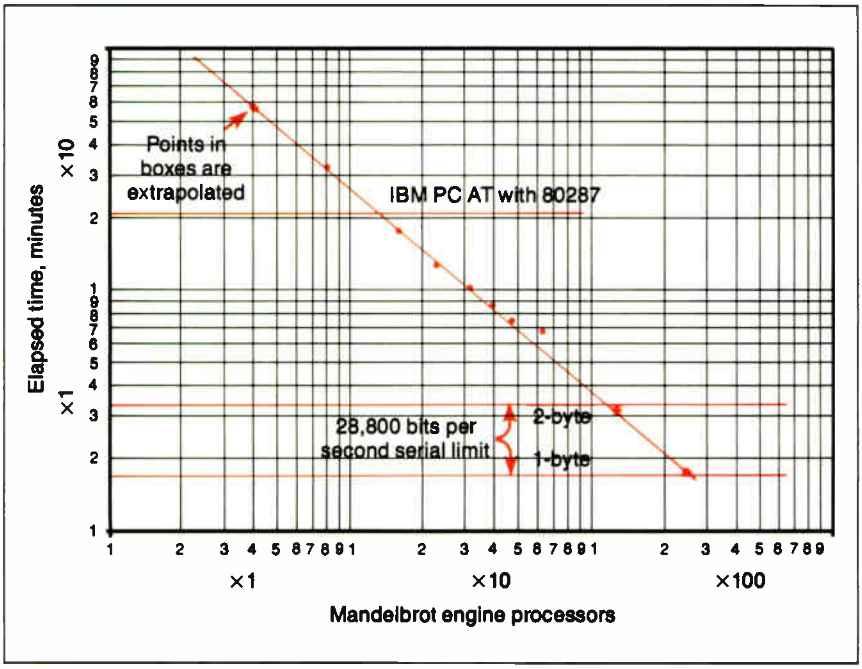


Figure 7: *The log-log plot of elapsed time to calculate a given portion of the set versus number of processors. Also shown is the time for an AT to plot the same image.*

take 1.7 minutes to transfer if every processor is ready on time. Iteration limits above 255 require 2-byte counts, so the transfer time would double to 3.4 minutes. You can see that the serial link is not the limiting factor for "serious" calculations.

Conclusion

During this three-part article, I've explained why single-processor computer systems suffer from performance limitations that can't be wished away and how multiprocessor systems are able to "get around" some of those limits. The Circuit Cellar Mandelbrot engine demonstrates some of the design issues that arise in a multiprocessor computer and shows how you can get high performance from very simple computing elements. ■

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.

There is a multiline Circuit Cellar bulletin board system (running TBBS 2.0M) that supports past and present projects in BYTE and Ink. You are invited to call and exchange ideas and comments with other Circuit Cellar supporters. The 300-/1200-/2400-bps BBS is online 24 hours a day at (203) 871-1988.

To receive information about the Circuit Cellar Ink publication for hardware designers and developers, please circle 100 on the Reader Service inquiry card at the back of the magazine.

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

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AN OVERVIEW OF OVERLAYS

Often the only option for large programs, overlays permit memory to do double duty

Sometimes, as I sit nearly comatose before my CRT waiting for a compilation to finish, I dream of a world of limitless RAM, 64-bit microprocessors with flat address spaces, and multiplatter optical disk drives. In a world like that, I might not have written this column, because we wouldn't need overlays—hardware and software schemes that swap portions of large programs into and out of memory.

But in the real world, we do need overlays, and we'll probably need them for some time to come. As long as people dream up programs bigger than memory will allow, overlays offer the means to give a program breathing room that is tied to disk space, not RAM space. And with RAM prices still climbing (at least as I write this), who knows how important that may be in the future?

When I Was Your Age: BASIC

A good—well, easy, at least—place to start in a discussion of overlays is BASIC. That's right, old reliable interpreted BASIC (the example I'll give uses GW-BASIC) supports overlays. Listing 1 shows a simple overlay system.

Right off, you can see the components common to all the overlay techniques I'll discuss: the root (listing 1a) and the overlays (listings 1b and 1c). The root program is the core (or kernel) of the system and acts as a switching center, calling the proper disk-stored overlay code into memory. The overlay processes are independent of one another; for example, the root might call in one overlay to sort the contents of a file, then call in a file-maintenance overlay when—the sort having been completed—the user needs to move the file to another directory. The two overlays execute in the same memory area (though at different times), so the effect is that you've doubled the capabilities of a single block of memory.

The steps are as follows:

1. Execute the root.
2. The root loads an overlay into the overlay region.
3. The root transfers control to the overlay.
4. The overlay does its work, then returns control to the root.
5. The root does whatever housekeeping it needs to do.
6. Return to step 2 as many times as you like.

The command that BASIC uses to load the overlay is CHAIN MERGE, which is a souped-up version of the MERGE command. CHAIN MERGE reads a BASIC source file (which must be stored in ASCII form) into the program area—preserving the program already there, namely, ROOT.BAS—and transfers control to the overlay. You can specify the overlay's entry point in the second argument of CHAIN MERGE; in my example, the entry point (and the start of the overlay region) is line 500.

There are some problems with using CHAIN MERGE. First, since the overlay files must be in ASCII, the loading process is slower than if the files were in compressed form. (That's all you need: something in interpreted BASIC to go slower, right?) Also, the CHAIN command resets the subroutine stack; if you try to CHAIN MERGE from within a subroutine, you get a RETURN WITHOUT GOSUB error when your program encounters the associated RETURN statement. This means that an overlay must return to the root via a GOTO statement that uses an explicit line number—not a very flexible approach.

As usual, when a piece of software doesn't do exactly what you want, you write a piece that does—no matter how daunting.

Handcrafted Overlays: Forth

Constructing your own overlay system for a high-level language is not that difficult, provided you have a clear picture of the memory configuration that an appli-

continued

Listing 1: *Overlays in GWBASIC:* **(a)** *the root,* **(b)** *the first overlay, and* **(c)** *the second overlay.*

(a)

```
100 REM ** OVERLAYS IN BASIC
108 DEFINT A-Z
110 PRINT "This is the Root."
120 PRINT "Loading overlay 1..."
129 REM ** CALL OVERLAY 1
130 CHAIN MERGE "OVERLAY1.BAS",
          500,ALL
140 PRINT "The Root is back."
150 PRINT "Loading overlay 2..."
159 REM ** CALL OVERLAY 2
160 CHAIN MERGE "OVERLAY2.BAS",
          500,ALL
170 PRINT "The Root is back."
180 STOP
```

(b)

```
500 REM ** FIRST OVERLAY
510 PRINT "...Overlay 1..."
519 REM RETURN TO ROOT
520 GOTO 140
```

(c)

```
500 REM ** SECOND OVERLAY
510 PRINT "...Overlay 2..."
519 REM RETURN TO ROOT
520 GOTO 170
```

Listing 2: *A Forth overlay system. Forth lends itself to easy installation of an overlay handler, thanks to that language's clearly defined in-memory structure.*

```
( ** SMART READ-WRITE AND OVERLAY ROUTINES ** )

0 VARIABLE NBYTES     ( NUMBER OF BYTES FOR SR/W )
0 VARIABLE SOFF       ( OFFSET INTO SCREEN )

( SMART READ/WRITE ROUTINE )
( READS OR WRITES nbytes BYTES TO/FROM SCREEN # STORED IN  )
( SCR AT OFFSET STORED IN SOFF.  addr IS ADDRESS OF BUFFER )
( IN MEMORY TO READ/WRITE. IF f=0, READ ELSE WRITE.        )
: SR/W          ( addr nbytes f -- )
  >R            ( SAVE FLAG )
  BEGIN
   SCR @ BLOCK SOFF @ + SWAP DUP B/BUF SOFF @ - MIN
   SWAP OVER - SOFF ! >R >R DUP R> R>
   R
   IF >R SWAP R> CMOVE          ( READ )
   ELSE CMOVE UPDATE            ( WRITE )
   ENDIF
   SOFF @ -DUP                  ( DONE? )
  WHILE
   + SOFF @ 0 SOFF ! 1 SCR +!   ( NEXT SCREEN )
  REPEAT
  DROP R> DROP FLUSH            ( WRITE IT OUT )
;

 ( STORING THE OVERLAY -- YOU SHOULD DO THIS IN INTERPRETIVE )
 ( MODE SO AS NOT TO WASTE DICTIONARY SPACE.                 )
 ( FIRST, GET THE WORDS YOU'RE GOING TO STORE INTO THE       )
 ( OVERLAY LOADED, SET SCR TO STARTING SCREEN #, THEN ENTER: )
 ( 0 SOFF ! CURRENT @ 2 0 SR/W           \ SAVE CURRENT      )
 ( 2 SOFF ! ' <name> NFA SP@ 2 0 SR/W    \ SAVE OVERLAY START )
 ( DUP HERE SWAP - NBYTES !              \ CALC # OF BYTES   )
 ( 4 SOFF ! NBYTES 2 0 SR/W              \ SAVE OVERLAY SIZE )
 ( 6 SOFF ! NBYTES @ 0 SR/W              \ SAVE OVERLAY      )
 (                                                           )
 ( NOTE: <name> IS THE FIRST -- I.E., LOWEST IN MEMORY --    )
 (       WORD IN THE OVERLAY.  WHEN 'OLOAD' [NEXT SCREEN]    )
 (       LOADS THE OVERLAY, CONTROL TRANSFERS TO THE TOPMOST )
 (       [I.E., LATEST] WORD IN THE OVERLAY.                 )

 ( OVERLAY LOAD ROUTINE )
: OLOAD          ( READS FROM CURRENTLY ACTIVE SCREEN FILE )
  0 SOFF ! CURRENT @ 2 1 SR/W       ( RESTORE CURRENT )
  2 SOFF ! 0 SP@ 2 1 SR/W           ( GET START ADDR ON STACK )
  DUP                               ( DUP START ADDR FOR LATER )
  4 SOFF ! NBYTES 2 1 SR/W          ( READ # OF BYTES )
  6 SOFF ! NBYTES @ 1 SR/W          ( READ IN OVERLAY )
  NBYTES @ + DP !                   ( FIX DICT. POINTER )
  LATEST PFA CFA EXECUTE            ( VECTOR TO TOP WORD )
;
```

cation created by that language will exhibit at run time. In the case of Forth, the run-time environment is well documented and, thanks to the structure of Forth's dictionary, easily accommodates a workable overlay scheme. (I'll be using the PC version of FIGForth as distributed by the Forth Interest Group.)

I won't go into a complete description of Forth; there are scads of books on the shelves with plenty of room to talk about the language. Forth's primary data structure is its dictionary, an upward-growing region in memory onto which the programmer adds the definitions of the executable code, variables, constants, and other more elaborate structures that ultimately make up a program. All definitions, whether they refer to data items or executable items, are called *words*. How words are attached to the dictionary is, of course, under the control of the language.

The simple overlay handler that I've built (see listing 2) assumes that you've created a root program that resides at the top of the dictionary and above which is the overlay region. To create an overlay, you simply add words to the dictionary (above the root) and save those words in overlay form. You can then FORGET (Forth's term for erasing words from the top of the dictionary) the words of the first overlay, define a new set of words for a second overlay, save the second overlay, and so on, until you've created all the overlays your application needs or until your disk runs out of space. Each overlay is stored on disk starting on a screen boundary, and you select which screen an overlay is saved on by storing the screen value in the system variable SCR.

Once you've saved the overlays on disk, you can call them up at run time using the OLOAD word. Simply store the screen number corresponding to the overlay to load in SCR and execute OLOAD. OLOAD reads the overlay into the overlay region, attaches it to the dictionary, and then transfers control to the overlay's topmost word (which has become the dictionary's topmost word). Each overlay is copied into memory at the same location from which it was saved, so the dictionary must be in the same state at load time as when you originally built the overlays.

In all fairness, the example I've given is not the final word in overlays for Forth. Several commercial products have refined the technique beyond what I've shown. MicroMotion (8726 South Sepulveda Blvd., Suite A-171, Los Angeles, CA 90045) sells a complete line of Forth packages for a variety of microcomputers and offers an optional relocating loader utility. The utility's net effect is similar to the method I've presented in that it allows your program to load a memory image into the dictionary, thus bypassing Forth's time-consuming interpretive phase. However, the MicroMotion scheme allows relocatable overlays—that is, the overlay region need not be fixed in memory—and is therefore more flexible than my example. It also has a friendlier user interface; you don't have to remember screens and offsets.

The preceding examples are overlay schemes tied intimately to languages, not to a particular piece of hardware or operating system; therefore, the overlay management occurs at a higher level. Higher, that is, than the assembly language level, where the machine's total resources are at your beck and call. Until it crashes.

On the Metal 1: Macintosh

On the Macintosh, when an application program is loaded, there's no telling where it will end up in physical memory; the application heap's location depends on the size of the system heap, which depends on the number of INITs you've set up on your Mac. This means applications on the Macintosh must be relocatable. In other words, all instructions that make address references—branches and subroutine calls—have to use program-counter-relative addressing; the effective address is calculated by adding a 16-bit offset to the program counter. The exclusive use of this addressing mode restricts code size to 32K bytes, since a 16-bit offset allows an address reference within a window of ±32,726 bytes. But Macintosh programs are *not* restricted to 32K bytes. The secret to this magic is the Mac's segment loader, which is, in many ways, a transparent overlay system.

Overlay management can happen at a high level, or at the hardware or OS level.

Macintosh application programs are divided into segments of up to 32K bytes each. Associated with every segment is a jump table, a collection of 8-byte elements. This jump table is referenced off the processor's A5 register. For a given segment, there is one element for each externally referenced entry point in that segment. The content of a jump-table element is dependent on whether or not the segment containing the associated entry point is loaded in memory.

Figure 1a shows an entry for an entry point whose segment is not currently loaded. When the application program performs a subroutine call (or a branch) to that entry point, program control first passes to the MOVE.W instruction that pushes the segment number onto the stack. Next, the LoadSeg trap is executed. LoadSeg reads the associated segment into memory (in the application heap) and scans through that segment's jump table, altering the jump-table elements to the loaded state, as shown in figure 1b. Finally, LoadSeg jumps back to the modified jump-table element (now containing a JMP instruction), which passes control to the routine the program was trying to get to in the first place.

Since all jump-table entries for the loaded segment have been modified to

continued

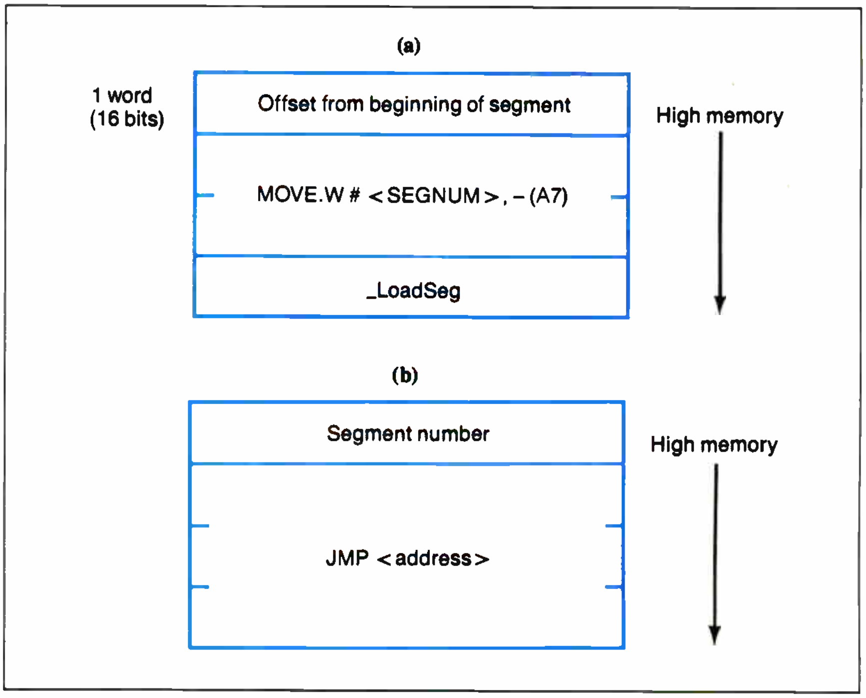

Figure 1: *A Macintosh jump-table element for* **(a)** *an entry point whose segment is not currently loaded and* **(b)** *an entry point whose segment is loaded.*

include JMP instructions, any future jumps or calls to a routine in that segment simply cause it to perform an extra branch on the way to its final destination. The operating system has loaded the segment transparently to the program.

Once the segment is in the application heap, the system locks it; that is, the segment is unpurgeable and unrelocatable. In most cases, the segment simply hangs around until the application shuts down. But if loading a segment was all that the Mac allowed, not only would this scheme be prone to system lockups under large programs, but Macintosh segments would not truly be overlays (since they couldn't be overlaid!).

You can unload a Macintosh segment using the `UnloadSeg` system trap. You call `UnloadSeg` by pushing the address of any routine in the target segment onto the stack and executing the trap. `UnloadSeg` just undoes the work of `LoadSeg`, changing the jump-table entries back to their unloaded state and marking the block of memory used by the segment as purgeable. The freed memory is now available for some future segment.

The beauty of this system is its transparency. The executing application is completely unaware of the activities of `LoadSeg`. The only work you have to do is keep your code modularized to the degree that no routine grows larger than 32K bytes. You don't have to worry about segments while you're creating the source code. If you call a subroutine in another segment using a JSR (jump to subroutine) instruction with an absolute destination, the Macintosh Development System (MDS) assembler automatically changes the JSR instruction's destination to the routine's jump-table entry.

If you're creating an application program large enough to require multiple segments, and it's time to link object modules together using the MDS linker, you indicate the start of a new segment using the "<" symbol in the link-control file. (Typically, you'll only have to worry about this if you're working in assembly language. Most high-level languages automate the process of dividing the application into segments.) Listing 3 shows a sample link-control file. Object modules Module1 and Module2 are in one segment, Module3 is in a second segment, and Module4 is in a third. The linker handles the job of building the jump tables; once again, the Mac's Toolbox does much of the work that you would have to do by hand on the PC.

The Macintosh Toolbox does much of the work that you have to do by hand on the PC.

On the Metal 2: MS-DOS

MS-DOS's EXEC function (INT 21h, function 4Bh) lets an executing program load another program, transfer control to it, and then regain control when the loaded program terminates (the first program is often referred to as the *parent*, and the second is called the *child*). This is the way many programs let you "drop into DOS": They transfer control to the COMMAND.COM program via function 4Bh. In fact, EXEC is the mechanism by which MS-DOS loads and executes programs (.EXE and .COM files).

Though you could certainly use this function to manage overlays, with the parent as the root and the child as the overlay, this doesn't create an overlay structure in the same spirit as what I've discussed so far. Specifically, the child process is more or less an independent program, not a collection of routines that the parent can call over and over again. So I've chosen to use the MS-DOS memory allocation capabilities to implement a modest overlay system.

Figure 2 shows the overlay system's memory map and segment register assignments. You'll find a template program in listing 4. When the root program is loaded, EXEC allots space for the program's code, data, and stack segments. Unfortunately, EXEC gets carried away with its allocation and gives *all* available memory to the program, starting with that program's PSP (program segment prefix, which is a 256-byte area that MS-DOS loads at the base of any executing program; it holds system data associated with that program). In figure 2, the PSP would appear below the root code segment. So the root program's first job is to return any unused memory back to the operating system. It does this using the DOS INT 21h function 4Ah ("shrink allocated memory block").

Referring to listing 4, you can see that I've defined a dummy segment called ZSEGMENT. Furthermore, I've used the .ALPHA directive, which tells the assembler and linker to load segments into memory in alphabetical order. This means that ZSEGMENT will load highest into physical memory, and since EXEC always puts the PSP beneath the executing program, I can determine how much memory my root program is actually using by subtracting the PSP's segment offset from ZSEGMENT's segment offset. Fortunately, EXEC also loads up the ES register with the PSP's segment, so calculating the program's memory is just some easy math that appears at the front of the listing.

Now that the program has returned its unused memory to the operating system, it's time to ask for some back so there is a place to load the overlay. DOS INT 21h, function 48h allocates a block of memory; you store the number of paragraphs (16-byte blocks) you want in the BX register, and function 48h returns an initial segment offset in the AX register. The program in listing 1 saves the initial segment offset in OVSEG (which it uses later as an indirect pointer) and the ES register. The memory map now looks like the diagram in figure 2a.

Memory is now set to accept the over-

Listing 3: *A link-control file for the MDS linker, illustrating the commands used to instruct the linker on how modules are grouped into segments. (This particular example produces an executable with three segments.)*

```
; Linking multiple modules
; on the Macintosh
!Start      ;Program start location
]           ;Listing off

Module1     ;First code module
Module2     ;Second code module
<           ;Start a new segment
Module3     :Third code module
<           ;Yet another segment
Module4     ;Fourth code module
$           ;End of link
```

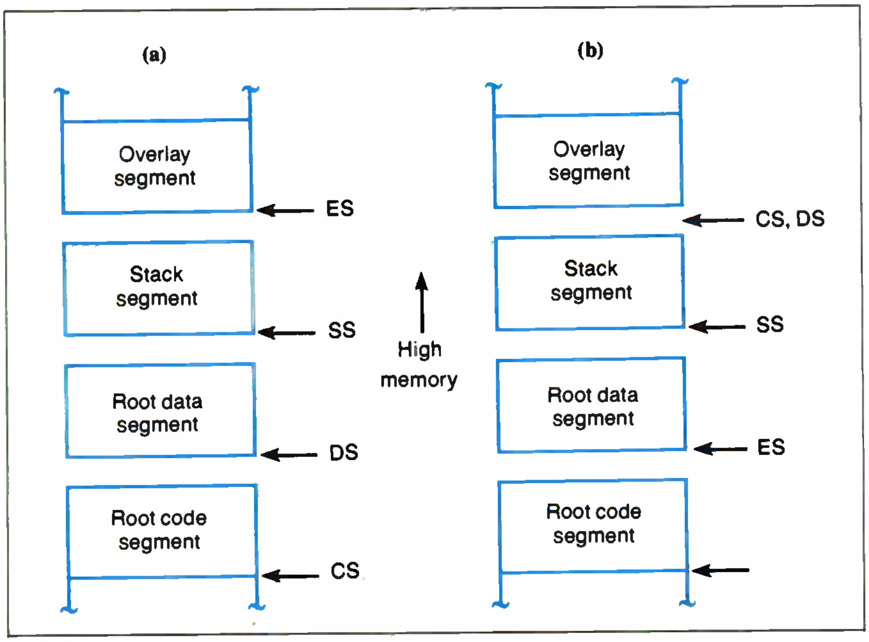

Figure 2: *Memory map for an overlay system under MS-DOS.* **(a)** *This part shows the segment register assignments while the root program is executing. When the root calls a routine in the overlay segment* **(b)**, *the DS and ES segment registers are swapped so that the overlay can access its local memory without having to perform segment overrides (of course, since the overlay is executing, the CS register points to the overlay segment as well). Also, since overlays and the root have access to the root data segment, that area could be used as a communications area for messages larger than the stack can comfortably handle.*

Listing 4: *Template source code for performing overlays under MS-DOS.*

```
;
; Turn on alpha ordering of segments so
; ZSEGMENT loads highest in memory.
    .ALPHA
ZSEGMENT SEGMENT PARA PUBLIC
ZSEGMENT ENDS

DATASEG SEGMENT PARA PUBLIC 'DATA'

 ... Root program's data segment ...

; Overlay files pathnames
OV1NAM  DB  'OVERLAY1.OVY',0
OV2NAM  DB  'OVERLAY2.OVY',0

; Pointer for indirect call. OVOFF
; is the offset of the first instruction
; in the overlay to execute.
OVOFF   DW  0
OVSEG   DW  0

; Overlay size in paragraphs.
OVSIZE  EQU    100

DATASEG     ENDS

STAKSEG     SEGMENT PARA STACK 'STACK'
        DW     80 DUP (?)
STAKSEG     ENDS
```

continued

```
CODESEG    SEGMENT PARA PUBLIC 'CODE'
     ASSUME  CS:CODESEG,DS:DATASEG
     ASSUME  SS:STAKSEG,ES:NOTHING

START:
; Set up data segment register
     MOV     AX,DATASEG
     MOV     DS,AX
; Deallocate any memory the root is not
; using.
     MOV     AX,ES
     MOV     BX,ZSEGMENT
     SUB     BX,AX
     MOV     AH,4AH
     INT     21H
; Get memory for the overlay.
     MOV     BX,OVSIZE
     MOV     AH,48H
     INT     21H
     JNC     L01
; Allocation failed
 ... If control comes here, there was
 ... either some error or not enough
 ... memory for the allocation.
 ... Error code is in AX
; Allocation worked - segment is in AX.
; Save AX in ES and in jump pointer.
L01:
     MOV     WORD PTR OVSEG,AX
     MOV     ES,AX
; Load in first overlay
     MOV     DX,OFFSET OV1NAM
     CALL    LOAD_OVLAY
     OR  AX,AX  ;Ok?
     JZ  L03
; Overlay load failed
 ... If control comes here, the first
 ... overlay failed to load.
; Overlay succeeded - jump to overlay
; Note: We assume the first executable
; instruction in the overlay is at offset
; 0, so we don't load OVOFF.
L03:
     MOV     BX,OFFSET OVOFF
     CALL    DWORD PTR [BX]
; Overlay returns here.
 ... Root can do what it wants to
 ... here.
; Load in second overlay
     MOV     DX,OFFSET OV2NAM
     CALL    LOAD_OVLAY
     OR  AX,AX  ;Ok?
     JNZ     L04
; Overlay load failed.
 ... If control comes here, the second
 ... overlay failed to load.
; Overlay succeeded - jump to overlay
     MOV     BX,OFFSET OVOFF
     CALL    DWORD PTR [BX]
; Second overlay returns here.
 ... Root can do what it wants to here.
; Release the memory we got with ALLOC_MEM.
; Note: ES must contain the segment of the
; memory to be released -- in this case it
; already does.
     MOV     AH,49H
     INT     21H
```

```
     XOR     AL,AL        ;Clear return code
; Return to DOS
LXX:
     MOV     AH,4CH
     INT     21H          ;Bye
;
; LOAD_OVLAY - Load the overlay file into
; memory.
;  ENTRY:
;    DS:DX: Pathname of file to open.
;    ES: Segment to load overlay into.
;  EXIT:
;    AX = 0 if OK
;    AX = errorcode if failure
;
LOAD_OVLAY:
     MOV     AX,3D00H     ;Open file for reading
     INT     21H
     JNC     LD01
;Open failed
     RET               ;Return with error code
;Determine the file length
LD01:
     MOV     BX,AX        ;File handle in BX
     XOR     CX,CX        ;Offset is 0
     XOR     DX,DX
     MOV     AX,4202H     ;Position to EOF
     INT     21H
     JNC     LD02
;Position failed
     RET
;Number of bytes in file is in AX (# of bytes is actually
;AX+1 since AX is an offset).
;Note that this assumes the file we're loading is less
;than 64K big.
LD02:
     PUSH    AX        ;Save filesize
     XOR     CX,CX        ;Offset is 0 again
     XOR     DX,DX
     MOV     AX,4200H     ;Rewind the file
     INT     21H
     POP     CX        ;Get filesize
     JNC     LD03
;Rewind failed
     RET
;Now read the file into the segment pointed to by ES
LD03:
     INC     CX        ;Make it proper
     PUSH    DS        ;Save our data segment
     MOV     AX,ES
     MOV     DS,AX        ;DS is ES
     MOV     AH,3FH           ;Read file
     INT     21H
     POP     DS        ;Restore DS
     JNC     LD04
;Read failed
     RET
;Close the file and go home
LD04:
     MOV     AH,3EH           ;Close
     INT     21H
     XOR     AX,AX        ;All's well
     RET
;
CODESEG      ENDS
     END     START
```

lays. Subroutine LOAD_OVLAY reads an overlay file into the overlay segment, and since the overlay segment has been stored into OVSEG, it's a simple matter to execute a far subroutine call into the overlay code.

You'll notice that the example I've given assumes that location 0 is the overlay's execution entry point. This is simply a requirement that I've imposed for this example—nothing you have to adhere to. You can get as elaborate as you want with how your root program transfers control to overlays; for example, you might have a jump table at the beginning of the overlay for multiple entry points.

Listing 5 is the source code for a possible overlay. It looks a lot like a .COM program—one segment, no apparent stack—and, indeed, you build it as you would a .COM program. That is, after you assemble and link the program, you pass it through EXE2BIN to create a core image file. But this program has no ORG 100H, as a .COM program would have at its beginning. This is because .COM programs require the ORG 100H to make room for the PSP, and since the program in listing 5 is not a stand-alone program, it needs no PSP.

Overlays are more or less a kludge, a way around a problem.

Finally, notice that the overlay's first job is to swap the DS and ES registers. This sets the DS register to the overlay segment so the overlay can access its local memory (see figure 2b). And since the ES register now points to the root's data segment, the root and the overlay can agree on a communication area in that segment for data exchange. Of course, before the overlay exits, it has to swap DS and ES back.

You can make as many overlays as your disk drive can hold. This scheme should be particularly handy for a terminate-and-stay-resident program that you want to hang a passle of features on with minimum memory expense. You could create a root program that sets up an overlay block and simply plays menu manager, loading in one overlay for an editor, another overlay for a terminal emulator, and yet another for a spelling checker.

Listing 5: *Sample for an overlay that can be loaded by the program described in listing 4.*

```
;
; Overlay file
;
OVSEG   SEGMENT PARA PUBLIC 'CODE'
        ASSUME CS:OVSEG,DS:OVSEG
        ASSUME ES:NOTHING,SS:NOTHING
;
;First, swap the contents of ES and
;DS so that our segment is in DS and
;the ROOT program's data segment is
;in ES.
  CALL SWAPDSES
;Tell everyone we're here.
  MOV  DX,OFFSET OVHELLO
  MOV  AH,9
  INT  21H
;Put DS and ES back.
  CALL SWAPDSES
;Return to root.
  RETF
;
;Swap DS and ES register.
;Uses AX and BX.
;
SWAPDSES:
  MOV  AX,DS
  MOV  BX,ES
  MOV  DS,BX
  MOV  ES,AX
  RET
;
; Data follows
;
CR  EQU 0DH
LF  EQU 0AH
OVHELLO DB 'Hello from overlay 1!',CR,LF,'$'

OVSEG ENDS
      END
```

Overlay Exit

Although this column hasn't been the final word on overlays, I hope it has given you some idea of their utility. Keep in mind that overlays are more or less a kludge—a way around the problem of large (or numerous) programs trying to survive in memory limited either by size or by processor architecture. More sophisticated operating systems—Unix, for example—sport virtual memory management that handles overlays *beneath* the application program; users don't have to worry about overlays at all. And when the day comes that we all have 32-bit CPUs and memory management units and virtual memory operating systems in the microcomputers on our desks, that paradise I spoke of will be a reality and we can leave worrying about overlays to the system programmers.

But until then. . . .

Next Month

I'll look at a keyed-file system: rapid data retrieval for those monster hard disk drives coming down the pike. ■

[Editor's note: *Listings to accompany this article are available in a variety of formats. See page 3 for details.*]

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74F04	.25	74F157	.59
74F08	.25	74F193	2.95
74F10	.25	74F240	.69
74F32	.25	74F244	.69
74F74	.29	74F253	.59
74F86	.39	74F373	.79
74F138	.59	74F374	.79

CD—CMOS

CD4001	.19	CD4076	.59
CD4008	.59	CD4081	.22
CD4011	.19	CD4082	.22
CD4013	.29	CD4093	.35
CD4016	.29	CD4094	.89
CD4017	.49	CD40103	1.49
CD4018	.59	CD40107	.49
CD4020	.59	CD4510	.69
CD4024	.45	CD4511	.69
CD4027	.35	CD4520	.75
CD4030	.35	CD4522	.79
CD4040	.65	CD4538	.79
CD4049	.29	CD4541	.89
CD4050	.29	CD4543	.79
CD4051	.59	CD4553	3.95
CD4052	.59	CD4555	.79
CD4053	.59	CD4559	7.95
CD4063	1.49	CD4566	1.95
CD4066	.29	CD4583	.59
CD4067	1.49	CD4584	.49
CD4069	.19	CD4585	.69
CD4070	.25	MC14411P	7.95
CD4071	.22	MC14490P	4.49
CD4072	.22		

MICROPROCESSOR COMPONENTS

MISCELLANEOUS CHIPS

Part No.	Price
D765AC	3.95
WD9216	3.95

Z80, Z80A, Z80B SERIES

Part No.	Price
Z80	1.19
Z80-CTC	1.29
Z80-PIO	1.29
Z80A	1.29
Z80A-CTC	1.65
Z80A-DART	4.95
Z80A-PIO	1.89
Z80A-SIO/0	3.95
Z80B	2.75
Z80B-CTC	3.95
Z80B-PIO	3.95

6500/6800/68000 SER.

Part No.	Price
6502	2.65
65C02(CMOS)	7.75
6520	1.95
6522	2.95
6532	5.49
6551	2.95
65C802 (CMOS)	15.95
6800	1.95
6802	2.95
6810	1.25
6821	1.75
6840	3.49

6500/6800/68000 Cont.

Part No.	Price
6845	2.75
6850	1.95
6852	.75
6854	1.19
MC68000L8	9.95
MC68000L10	11.95
MC68010L10	49.95
MC68020RC12B	99.95

8000 SERIES

Part No.	Price
8031	3.95
80C31	9.95
8035	1.49
8073	6.95
8080A	2.25
8085A	2.49
8086	3.95
8086-2	6.95
8087(5MHz)	99.95
8087-1(10MHz)	229.95
8087-2(8MHz)	159.95
8088	4.95
8088-2	6.95
8116	4.95
8155	2.49
8155-2	3.49
8156	2.95
8203	6.95
8212	2.29
8224	2.25

8000 SERIES Cont.

Part No.	Price
8228	1.95
8237-5	4.25
8243	1.75
8250A	4.95
8250B (For IBM)	5.95
8251A	1.69
8253-5	1.95
8254	3.95
8255A-5	2.95
8259-5	2.25
8272	3.95
8279-5	2.95
8741	9.95
8742	19.95
8748 (25V)	7.95
8748H (HMOS) (21V)	9.95
8749	9.95
8751 (3.5-8MHz)	39.95
8751H (3.5-12MHz)	44.95
8755	13.95

DATA ACQUISITION

Part No.	Price
ADC0804LCN	2.79
ADC0808CCN	5.95
ADC0809CCN	3.69
ADC1205CCJ-1	19.95
DAC0808LCN	1.75
DAC1008LCN	5.95
AY-3-1015D	4.95
AY-5-1013A	1.95

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Part No.		Price
8052AHBASIC	CPU w/BASIC Interpreter	$24.95
MC68000P12	16-Bit MPU (12MHz)	$12.95
MC68701	8-Bit EPROM Microcomputer	$14.95
MC68705P3S	8-Bit EPROM Microcomputer	$9.95
MC68705U3S	8-Bit EPROM Microcomputer	$10.95
80286-10	16-Bit Hi Performance MPU	$69.95
80287-8	Math Co-processor (8MHz)	$244.95
80287-10	Math Co-processor (10MHz)	$309.95
80387-16	Math Co-proc. (16MHz) GRID ARRAY	$474.95
80387-20	Math Co-proc. (20MHz) GRID ARRAY	$749.95

DYNAMIC RAMS

Part No.			Price
*4116-15	16,384 x 1	(150ns)	1.39
4128-20	131,072 x 1	(200ns) (Piggyback)	3.25
*4164-100	65,536 x 1	(100ns)	3.49
*4164-120	65,536 x 1	(120ns)	2.95
*4164-150	65,536 x 1	(150ns)	2.59
*4164-200	65,536 x 1	(200ns)	1.75
*TMS4416-12	16,384 x 4	(120ns)	7.75
*41256-80	262,144 x 1	(80ns)	13.49
*41256-100	262,144 x 1	(100ns)	12.49
*41256-120	262,144 x 1	(120ns)	11.95
*41256-150	262,144 x 1	(150ns)	11.49
*41464-15	65,536 x 4	(150ns) (4464)	14.75
*511000P-10	1,048,576 x 1	(100ns) 1 Meg	39.95
*514256P-10	262,144 x 4	(100ns) 1 Meg	59.95

STATIC RAMS

Part No.			Price
*2016-12	2048 x 8	(120ns)	4.49
2018-45	2048 x 8	(45ns)	6.95
2102	1024 x 1	(350ns)	.89
2114N	1024 x 4	(450ns)	.99
2114N-2L	1024 x 4	(200ns) Low Power	1.49
21C14	1024 x 4	(200ns) (CMOS)	.49
5101	256 x 4	(450ns) (CMOS)	2.95
*6116P-3	2048 x 8	(150ns) (CMOS)	4.95
*6116LP-3	2048 x 8	(150ns) LP CMOS	5.99
*6264LP-12	8192 x 8	(120ns) LP CMOS	10.49
*6264P-15	8192 x 8	(150ns) (CMOS)	9.95
*6264LP-15	8192 x 8	(150ns) LP CMOS	10.25
6514	1024 x 4	(350ns) (CMOS)	3.75
*43256-15L	32,768 x 8	(150ns) Low Power	15.25
*62256LP-12	32,768 x 8	(120ns) LP CMOS	16.95

EPROMS

Part No.			Price
TMS2516	2048 x 8	(450ns) 25V	6.95
TMS2532	4096 x 8	(450ns) 25V	5.95
TMS2532A	4096 x 8	(450ns) 21V	4.49
TMS2564	8192 x 8	(450ns) 25V	6.95
TMS2716	2048 x 8	(450ns) 3 Voltage	6.95
1702A	256 x 8	(1μs)	4.95
2708	1024 x 8	(450ns)	6.95
2716	2048 x 8	(450ns) 25V	3.75
2716-1	2048 x 8	(350ns) 25V	4.25
27C16	2048 x 8	(450ns) 25V (CMOS)	4.25
2732	4096 x 8	(450ns) 25V	3.95
2732A-20	4096 x 8	(200ns) 21V	4.25
2732A-25	4096 x 8	(250ns) 21V	3.95
27C32	4096 x 8	(450ns) 25V (CMOS)	4.95
2764-20	8192 x 8	(200ns) 21V	4.25
2764-25	8192 x 8	(250ns) 21V	3.59
2764A-25	8192 x 8	(250ns) 12.5V	3.69
2764-45	8192 x 8	(450ns) 21V	3.39
27C64-15	8192 x 8	(150ns) 12.5V (CMOS)	5.95
27128-20	16,384 x 8	(200ns) 21V	6.95
27128-25	16,384 x 8	(250ns) 21V	5.95
27128A-25	16,384 x 8	(250ns) 12.5V	5.25
27C128-25	16,384 x 8	(250ns) 21V (CMOS)	5.95
27256-20	32,768 x 8	(200ns) 12.5V	6.95
27256-25	32,768 x 8	(250ns) 12.5V	5.49
27C256-25	32,768 x 8	(250ns) 12.5V (CMOS)	6.25
27512-20	65,536 x 8	(200ns) 12.5V	10.95
27512-25	65,536 x 8	(250ns) 12.5V	9.95

EEPROMS

Part No.			Price
2816A-25	2048 x 8	(250ns) 5V Read/Write	6.25
2817A	2048 x 8	(350ns) 5V Read/Write	7.95
2865A-30	8192 x 8	(300ns) 5V Read/Write	9.95
52B13 (21V)	2048 x 8	(350ns) 5V Read Only	1.49

COMMODORE CHIPS

Part No.	Price
LAG570	9.95
WD1770	8.95
SI3052P	1.25
6504A	1.19
6507	2.95
6510	12.95
6522	2.95
6525	4.95
6526	14.95
6532	5.49
6545-1	3.95
6560	10.95
6567	24.95
6569	15.95
6572	10.95
6581 (12V)	12.95
6582 (9V)	14.95
8502	7.95
8564	4.95
8566	9.95
8701	9.95
8721	14.95
8722	13.95
*251104-04	12.95
310654-05	9.95
318018-03	12.95
318019-03	12.95
318020-04	12.95
325302-01	14.95
325572-01	17.95
*82S100PLA**	15.95
901225-01	15.95
901226-01	15.95
901227-03	15.95
901229-05	15.95

*No specs. available
**Note: 82S100PLA = U17 (C-64)

74C/CMOS

74C00	.29	74C174	.49
74C02	.29	74C175	.49
74C04	.29	74C221	1.79
74C08	.29	74C240	1.19
74C10	.19	74C244	1.79
74C14	.49	74C373	1.95
74C32	.29	74C374	1.95
74C74	.49	74C912	7.95
74C85	1.49	74C915	1.39
74C86	.29	74C920	4.95
74C89	3.95	74C921	4.95
74C90	.99	74C922	3.95
74C154	2.95	74C923	3.95
74C173	.59	74C925	5.49

MISC. COMPONENTS

TANTALUM CAPACITORS

TM1/35 1μf @ 35V	.19	TM4.7/35 4.7μf @ 35V	.45
TM1/35 1μf @ 35V	.19	TM6.8/35 6.8μf @ 35V	.49
TM2.2/35 2.2μf @ 35V	.25	TM10/35 10μf @ 35V	.59

POTENTIOMETERS

Values available (insert ohms into space marked "XX"): 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 1MEG

43PXX ¾ Watt, 15 Turn .99 | 63PXX ½ Watt, 1 Turn .89

TRANSISTORS AND DIODES

PN2222	.13	PN2907	.13	1N4004	.12
2N2222A	.29	2N4401	.12	1N4148	.07
2N3055	.65	1N270	.25	1N4735	.29
2N3904	.12	1N751	.15	C106B1	.49

SWITCHES

JMT123 SPDT, On-On 1.19 | 206-8 SPDT, 16-pin DIP 1.25

MPC121 SPDT, On-Off-On 1.19 | MS102 SPST, Momentary .39

D-SUB CONNECTORS

DB25P Male, 25-pin .69 | DB25S Female, 25-pin .75

LEDS

XC556R T1¾, Red	.13	XC556Y T1¾, Yellow	.17
XC556G T1¾, Green	.17	XC556C T1¾, Clear/Red	.17

IC SOCKETS

Low Profile		Wire Wrap (Gold) Level #2	
8LP	.11	8WW	.59
14LP	.12	14WW	.65
16LP	.13	16WW	.69
24LP	.25	24WW	1.19
28LP	.27	28WW	1.39
40LP	.29	40WW	1.89

Soldertail Standard (Gold & Tin) & Header Plug Sockets Also Available

74HC HI-SPEED CMOS

Part No.	Price	Part No.	Price
74HC00	.19	74HC175	.59
74HC02	.19	74HC221	.89
74HC04	.19	74HC240	.69
74HC08	.19	74HC244	.79
74HC10	.25	74HC245	.79
74HC14	.29	74HC253	.49
74HC30	.25	74HC259	.49
74HC32	.29	74HC273	.59
74HC74	.29	74HC373	.69
74HC75	.35	74HC374	.69
74HC76	.35	74HC595	1.29
74HC85	.55	74HC688	1.49
74HC86	.35	74HC943	8.95
74HC123	.69	74HC4040	.89
74HC125	.49	74HC4049	.39
74HC132	.49	74HC4050	.39
74HC138	.45	74HC4060	.99
74HC139	.45	74HC4511	1.19
74HC154	1.49	74HC4514	1.79
74HC163	.49	74HC4538	1.19
74HC174	.59	74HC4543	1.19

74HCT — CMOS TTL

74HCT00	.17	74HCT139	.39
74HCT02	.17	74HCT157	.29
74HCT04	.19	74HCT174	.35
74HCT08	.17	74HCT175	.39
74HCT10	.17	74HCT240	.69
74HCT32	.19	74HCT244	.59
74HCT74	.29	74HCT245	.69
74HCT86	.25	74HCT373	.49
74HCT138	.39	74HCT374	.49

LINEAR

DS0026CN	1.95	LM1458N	.35
TL074CN	.99	LM1488N	.45
TL084CN	.89	DS14C88N (CMOS)	1.19
AF100-1CN	8.95	LM1489N	.45
LM307N	.39	DS14C89N (CMOS)	1.19
LM309K	1.25	LM1496N	.69
LM311N	.39	MC1648P	2.95
LM317T	.65	LM1871N	1.95
LM318N	.99	LM1872N	1.95
LM319N	1.29	LM1896N-1	1.49
LM323K	3.49	ULN2003A	.75
LM324N	.35	XR2206	3.95
LM338K	4.49	XR2211	2.95
LM339N	.39	XR2243	1.95
LF347N	1.49	26LS29	2.95
LM348N	.69	26LS31	.99
LM350T	2.95	26LS32	.99
LF351N	.39	26LS33	1.49
LF353N	.49	LM2901N	.25
LF355N	.79	LM2907N	1.29
LF356N	.79	LM2917N (8 pin)	1.79
LF357N	.89	MC3419CL	3.95
LM358N	.49	MC3446N	.99
LM360N	1.95	MC3450P	.49
LM361N	1.49	MC3470P	1.19
LM380N-8	.89	MC3471P	.99
LM386N-3	.89	MC3479P	3.95
LM387N	1.09	MC3486P	1.19
LM393N	.39	MC3487P	.99
LM399H	3.49	LM3900N	.49
LF411CN	.79	LM3905N	1.25
TL497ACN	1.49	LM3909N	.89
NE540H (C540H)	.99	LM3914N	1.79
NE555V	.29	LM3916N	1.49
XRL555	.59	NE5532	.69
LM556N	.45	NE5534	.69
NE558N	.79	7805K (LM340K-5)	1.39
LM565N	.89	7812K (LM340K-12)	1.39
LM567V	.75	7815K (LM340K-15)	1.59
NE592N	.75	7805T (LM340T-5)	.45
LM741CN	.29	7812T (LM340T-12)	.45
LM747CN	.49	7815T (LM340T-15)	.45
MC1350P	.89	7905K (LM320K-5)	1.49
MC1377P	2.29	7905T (LM320T-5)	.49
MC1398P	4.95	75472	.49
LM1414N	.99	75477	1.29
		MC145106P	1.95
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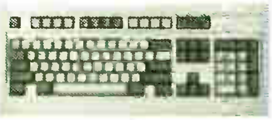

JE1016 Pictured

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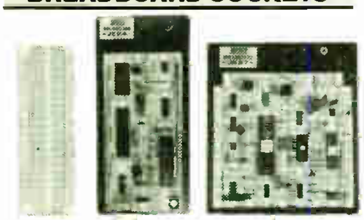

JE23 JE24 JE27

Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price
JE20	6½ x ¾	200	0	$ 2.95
JE21	3¼ x 2⅛	400	0	$ 4.95
JE22	6½ x 1⅜	630	0	$ 5.95
JE23	6½ x 2⅛	830	0	$ 7.95
JE24	6½ x 3⅛	1,360	2	$14.95
JE25	6½ x 4¼	1,660	3	$22.95
JE26	6⅞ x 5¾	2,390	4	$27.95
JE27	7¼ x 7½	3,220	4	$37.95

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400041	NSC Linear Data Book-Vol. I (88)	$14.95
400042	NSC Linear Data Book-Vol. II (88)	$ 9.95
400043	NSC Linear Data Book-Vol. III (88)	$ 9.95
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JE1001	4.77/8MHz Turbo Motherboard (Zero-K RAM — includes AMI BIOS ROM)	$89.95
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JE1040	360K Floppy Controller	29.95
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AMBER	12" Monochrome Amber Monitor	99.95
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JE1044	360K Floppy/Hard Disk Controller Card (PC/XT)	$129.95
JE1045	360K/720K/1.2MB/1.44MB Floppy/Hard Disk Controller Card (AT)	$149.95

COMPUTER PERIPHERALS

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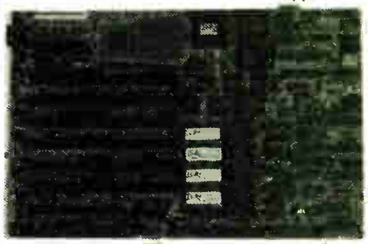

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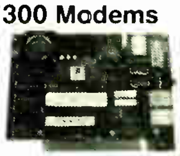

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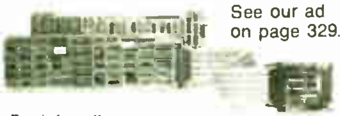

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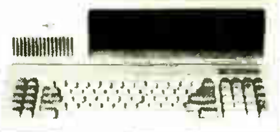

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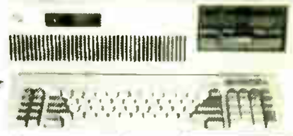

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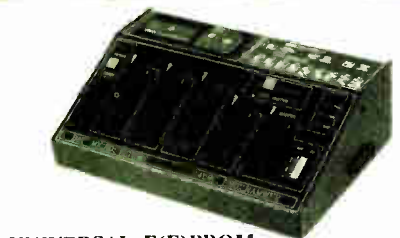

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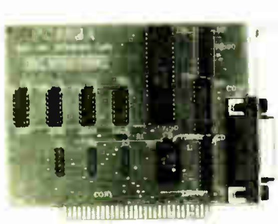

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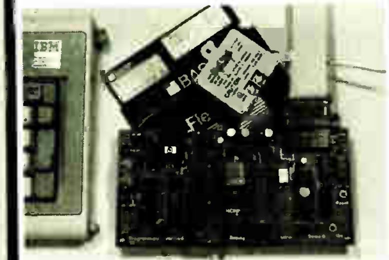

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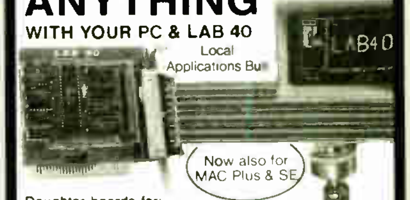

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C Everex EMS 3MB	$ 95	D Everex POCKET 1200 B Modem	$129
E Everex Super EGA (800 x 600)	$189	F Vega VGA card	$289
G Genoa Super EGA (800 x 600)	$219	H Panasonic 1080i printer	$199

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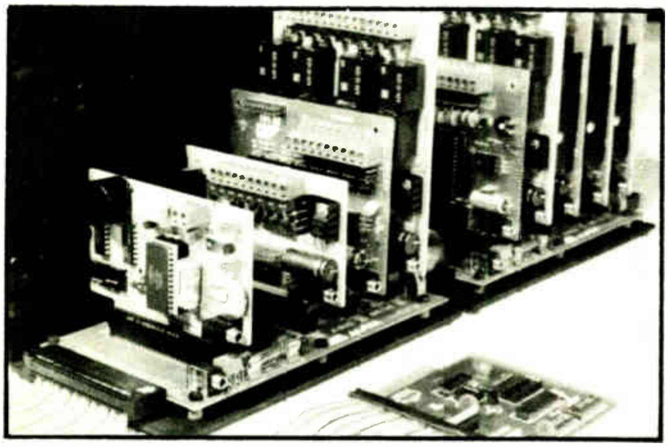
Circle 322 on Reader Service Card

The Amazing A-BUS

NEW



An A-BUS system with two Motherboards
A-BUS adapter (IBM) in foreground

Plug into the future

With the A-BUS you can plug your PC (IBM, Apple, TRS-80) into a future of exciting new applications in the fields of control, monitoring, automation, sensing, robotics, etc.

Alpha's modular A-BUS offers a proven method to build your "custom" system today. Tomorrow, when you are ready to take another step, you will be able to add more functions. This is ideal for first time experimenting and teaching.

A-BUS control can be entirely done in simple BASIC or Pascal, and no knowledge of electronics is required!

An A-BUS system consists of the A-BUS adapter plugged into your computer and a cable to connect the Adapter to 1 or 2 A-BUS cards. The same cable will also fit an A-BUS Motherboard for expansion up to 25 cards in any combination.

The A-BUS is backed by Alpha's continuing support (our 11th year, 50000 customers in over 60 countries).

The complete set of A-BUS User's Manuals is available for $10.

About the A-BUS:

- All the A-BUS cards are very easy to use with any language that can read or write to a Port or Memory. In BASIC, use INP and OUT (or PEEK and POKE with Apples and Tandy Color Computers)
- They are all compatible with each other. You can mix and match up to 25 cards to fit your application. Card addresses are easily set with jumpers.
- A-BUS cards are shipped with power supplies (except PD-123) and detailed manuals (including schematics and programming examples).

Relay Card — RE-140: $129
Includes eight industrial relays, (3 amp contacts, SPST) individually controlled and latched. 8 LED's show status. Easy to use (OUT or POKE in BASIC). Card address is jumper selectable.

Reed Relay Card — RE-156: $99
Same features as above, but uses 8 Reed Relays to switch low level signals (20mA max). Use as a channel selector, solid state relay driver, etc.

Analog Input Card — AD-142: $129
Eight analog inputs. 0 to +5V range can be expanded to 100V by adding a resistor. 8 bit resolution (20mV). Conversion time 120us. Perfect to measure voltage, temperature, light levels, pressure, etc. Very easy to use.

12 Bit A/D Converter — AN-146: $139
This analog to digital converter is accurate to .025%. Input range is −4V to +4V. Resolution: 1 millivolt. The on board amplifier boosts signals up to 50 times to read microvolts. Conversion time is 130ms. Ideal for thermocouple, strain gauge, etc. 1 channel. (Expand to 8 channels using the RE-156 card).

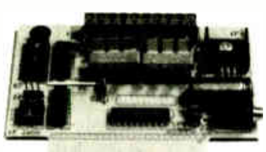
Digital Input Card — IN-141: $59
The eight inputs are optically isolated, so it's safe and easy to connect any "on/off" devices, such as switches, thermostats, alarm loops, etc. to your computer. To read the eight inputs, simply use BASIC INP (or PEEK).

24 Line TTL I/O — DG-148: $65
Connect 24 input or output signals (switches or any TTL device) to your computer. The card can be set for: input, latched output, strobed output, strobed input, and/or bidirectional strobed I/O. Uses the 8255A chip.

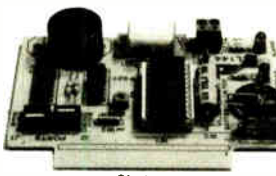
Clock with Alarm — CL-144: $89
Powerful clock/calendar with: battery backup for Time, Date and Alarm setting (time and date); built in alarm relay, led and buzzer; timing to 1/100 second. Easy to use decimal format. Lithium battery included.

Touch Tone® Decoder — PH-145: $79
Each tone is converted into a number which is stored on the board. Simply read the number with INP or POKE. Use for remote control projects, etc.

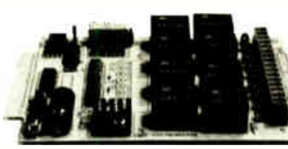
A-BUS Prototyping Card — PR-152: $15
3½ by 4½ in. with power and ground bus. Fits up to 10 I.C.s



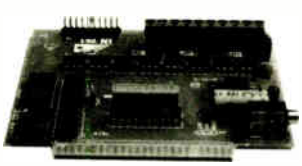
ST-143



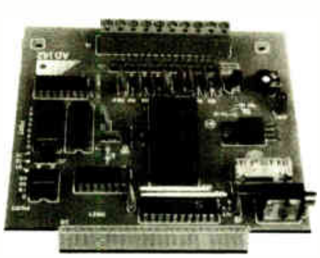
CL-144



RE-140



IN-141



AD-142

Smart Stepper Controller — SC-149: $299
World's finest stepper controller. On board microprocessor controls 4 motors simultaneously. Incredibly, it accepts plain English commands like "Move arm 10.2 inches left". Many complex sequences can be defined as "macros" and stored in the on board memory. For each axis, you can control: coordinate (relative or absolute), ramping, speed, step type (half, full, wave), scale factor, units, holding power, etc. Many inputs: 8 limit & "wait until" switches, panic button, etc. On the fly reporting of position, speed, etc. On board drivers (350mA) for small steppers (MO-103). Send for SC-149 flyer.

Remote Control Keypad Option — RC-121: $49
To control the 4 motors directly, and "teach" sequences of motions.

Power Driver Board Option — PD-123: $89
Boost controller drive to 5 amps per phase. For two motors (eight drivers).

Breakout Board Option — BB-122: $19
For easy connection of 2 motors. 3 ft. cable ends with screw terminal board.

Stepper Motor Driver — ST-143: $79
Stepper motors are the ultimate in motion control. The special package (below) includes everything you need to get familiar with them. Each card drives two stepper motors (12V, bidirectional, 4 phase, 350mA per phase).
Special Package: 2 motors (MO-103) + ST-143: **PA-181: $99**

Stepper Motors — MO-103: $15 or 4 for $39
Pancake type, 2¼" dia, ¼" shaft, 7.5°/step, 4 phase bidirectional, 300 step/sec, 12V, 36 ohm, bipolar, 5 oz-in torque, same as Airpax K82701-P2.

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Intelligent Voice Synthesizer, 14 Bit Analog to Digital converter, 4 Channel Digital to Analog converter, Counter Timer, Voice Recognition.

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TRS-80 Model 102, 200 Plugs into 40 pin "system bus"	AR-136 ..$69
Model 100. Uses 40 pin socket (Socket is duplicated on adapter)	AR-135 ..$69
TRS-80 Mod 3,4,4D. Fits 50 pin bus. (With hard disk, use Y-cable)	AR-132 ..$49
TRS-80 Model 4P. Includes extra cable. (50 pin bus is recessed)	AR-137 ..$62
TRS-80 Model I. Plugs into 40 pin I/O bus on KB or E/I	AR-131 ..$39
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A-BUS Cable (3 ft, 50 cond.) — CA-163: $24
Connects the A-BUS adapter to one A-BUS card or to first Motherboard.
Special cable for two A-BUS cards: CA-162: $34

A-BUS Motherboard — MB-120: $99
Each Motherboard holds five A-BUS cards. A sixth connector allows a second Motherboard to be added to the first (with connecting cable CA-161: $12). Up to five Motherboards can be joined this way to a single A-BUS adapter. Sturdy aluminum frame and card guides included.

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Comparable monitor and card packages retail at over $1095. California Digital has made a special purchase and is able to offer the CD/240 and 132 column VGA/EGA graphic card for only $389

NEC/890 Laser Printer

$3295

PC Magazine has chosen the NEC-890 best laser printer of the year. (Jan. 12, 1988). And its obvious why... the printer is Postscript, Hewlett Packard, and Apple compatible, and comes standard with three megabytes of memory. The 890 accepts data from parallel, serial and Apple-Talk devices.
NEC has also incorporated 40 built-in fonts along with two paper trays into this industrial quality laser printer.

Hewlett Packard Laser II, 8 pages per minute	$1659
QMS PS/810 2 Meg., 35 fonts, Postscript 8 pgs	3879
Apple Laser Writter II	1899
Texas Instruments 2115 Postscript 15 pgs.	5426
Quadram Quadlaser with 5 megabytes	2995

PRINTRONIX 4160 CAD Printer

$1495 $5995

The 4160 is a bond paper printer that emulates the Versatec model V 80 1200A and 3200A plotters. This is the ideal heavy duty printer for CAD CAM applications. The perfect printer for high speed CAD proofs, bar codes, schematics or anywhere that fast graphic output is required.
Other Printronix available: P300....$3795; • P600....$5795.

Texas Instruments ProCalc 95

$200 **$85**

The ProCalc 95 Scientific features a full alphanumeric keyboard along with a two line dot matrix LCD display. Complete with hard carrying case.
Texas Instruments original price $200. Now available from California Digital for only $85. Printers & software cartridges available

20" Analog Color

$1895 **$659**

Ever try gathering a classroom of students around a 12 inch monitor? This 20 inch analog RGB monitor is the ideal solution. High screen resolution of 1200 pixels by 950 lines allow extra fine detail without the dots looking like golf balls. 256 colors and VGA compatible.
Super value originally sold for over $2000. Only 350 available.

Hitachi CD-ROM

$495

Compact disk is a relatively new medium for storage of read-only digital data. One removable disk is capable of storing over 500 megabyte of data on a disk the same size as an audio CD.
The CDR-3500 will install in a PC in the space of one 5¼" drive.
Other CD/ROM Products Available: Sony 510 internal $539. Amdek Laserdrive/1 system $679. Hitachi CDR-1503SUY external with IBM host adapter and MS ext. DOS $699. Panasonic WORM drive $1895.

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$359

Turn your PC into a FAX Machine!
The FaxCard 200 gives you the capability of sending and receiving World wide FAX transmissions. Preprogram your computer to send FAX messages to all your branch offices at a specific time.
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40 Meg. Tape Back-up

$239 $659

Head Crash, Power Spikes or just poor disk maintenance...
Don't loose data because you didn't back up. The All/40 is an inexpensive way to save and restore files in the event that your data has been distroyed.
This 40 megabyte half height tape back is manufactured by North Americas largest producer of data retrieval equipment.
No need to purchase a separate tape controller... the ALL/40 attaches directly to your existing floppy disk controller. Supplied software allows your computer to back up any time **Day or Night.** Come back in the morning and 40 megabytes of irreplacable data has been stored on one Scotch DC/2000 data cassette. Back up entire hard disk, modified files only, or by file name. Loss of data is inevitable but when you are backed up on an ALL/40 its not a catastrophe.

Murata 1200 FAX

$759 $899

The Murata 1200 is a medium duty desktop copier and facsimile machine. Automatic record keeping of transmit and receive reports. CCITT group II and group III compatible. Capable of scanning 10 documents. LCD display.
Other FAX Equipment available: Canon Faxphone 20 $1259. Panasonic 120[illegible] Sharp 80 (flat copier) $895
Also: R[illegible], Toshiba, Brother, Cobra, NEC, Xerox, PacTel

$119 2400 Baud Modem

2400 baud with forward error correcting make the Moxon MAX/2400 an unbelievable value at only $119.
Fully compatible with the Hayes command set and CCITT V 22 standards. Error correcting, autobauding and "adaptive equalization" allow the MAX 2400 to maintain reliable data transmission over marginal phone lines.
Manufactured by Maxon Systems, one of the Worlds largest producers of consumer electronics. Orginally priced at $295. While supplies last California Digital is offering the MAX 2400 at only $119

	One	Two	Ten
TEC501 ½ height sgl.side	49	39	35
TANDON 101/4 full ht. 96 TPI.	99	89	79
FUJITSU 5¼" half height	65	63	57
MITSUBISHI new 501 half ht.	119	109	105
MITSUBISHI 504A AT comp.	149	139	135
TEAC FD55BV half height	89	85	79
TEAC FD55FV 96 TPI, half ht.	119	109	105
TEAC FD55GF for IBM AT	109	105	99
PANASONIC 455 Half Height	109	99	89
PANASONIC 475 1.2 Meg./96	119	115	109
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SONY MP-53W 720K/Byte	129	125	119
SONY MP-73W, 2 Meg.	159	149	call
TEAC 35FN 720 K/Byte	129	119	115
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QUME 841 single sided	119	109	99
SHUGART 851R dbl. sided	319	309	299
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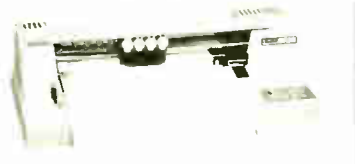
OLIVETTI 851	189	179	165

Hitachi 11 by 17 Plotter

$895 **$695**



The Hitachi 672/XD is a four color 11 by 17 (B size) plotter with superior accuracy and repeatability (.3mm). The 672 accepts HPGL 7475 commands and is both Centronics parallel and RS232C compatible.
The 672 plots at a fast eight inches per second in axial direction and eleven inches at an angle of 45 degrees. The plotter also features a self contained digitizing function that allows data to be entered into your computer from printed graphs and blue prints. Four different color pens are supplied with the plotter but a wide variety of technical pens are available.

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. Word processing and communication software included.

40 Megabyte Hard Disk Kit

$397

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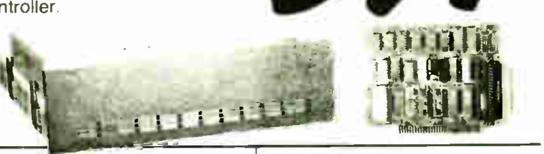

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ICM7208	15.95

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74LS00	.16	74LS112	.29	74LS241	.69
74LS01	.18	74LS122	.45	74LS242	.69
74LS02	.17	74LS123	.49	74LS243	.69
74LS03	.18	74LS124	2.75	74LS244	.69
74LS04	.16	74LS125	.39	74LS245	.79
74LS05	.18	74LS126	.39	74LS251	.49
74LS08	.18	74LS132	.39	74LS253	.49
74LS09	.18	74LS133	.49	74LS257	.39
74LS10	.16	74LS136	.39	74LS258	.49
74LS11	.22	74LS138	.39	74LS259	1.29
74LS12	.22	74LS139	.39	74LS260	.49
74LS13	.26	74LS145	.99	74LS266	.39
74LS14	.39	74LS147	.99	74LS273	.79
74LS15	.26	74LS148	.99	74LS279	.39
74LS20	.17	74LS151	.39	74LS280	1.98
74LS21	.22	74LS153	.39	74LS283	.59
74LS22	.22	74LS154	1.49	74LS290	.89
74LS27	.23	74LS155	.59	74LS293	.89
74LS28	.26	74LS156	.49	74LS299	1.49
74LS30	.17	74LS157	.35	74LS322	3.95
74LS32	.18	74LS158	.29	74LS323	2.49
74LS33	.28	74LS160	.29	74LS365	.39
74LS37	.26	74LS161	.39	74LS367	.39
74LS38	.26	74LS162	.49	74LS368	.39
74LS42	.39	74LS163	.39	74LS373	.79
74LS47	.75	74LS164	.49	74LS374	.79
74LS48	.85	74LS165	.65	74LS375	.95
74LS51	.17	74LS166	.95	74LS377	.79
74LS73	.29	74LS169	.95	74LS390	1.19
74LS74	.24	74LS173	.49	74LS393	.79
74LS75	.29	74LS174	.39	74LS541	1.49
74LS76	.29	74LS175	.39	74LS624	1.95
74LS83	.49	74LS191	.49	74LS640	.99
74LS85	.49	74LS192	.69	74LS645	.99
74LS86	.22	74LS193	.69	74LS670	.89
74LS90	.39	74LS194	.69	74LS682	3.20
74LS92	.49	74LS195	.69	74LS688	2.40
74LS93	.39	74LS196	.59	74LS783	22.95
74LS95	.49	74LS197	.59	25LS2521	2.80
74LS107	.34	74LS221	.59	26LS31	1.95
74LS109	.36	74LS240	.69	26LS32	1.95

LINEAR COMPONENTS

TL071	.69	LM380	.89	XR2206	3.95
TL072	1.09	LM383	1.95	XR2211	2.95
TL074	1.95	LM386	.89	LM2917	1.95
TL081	.59	LM393	.45	CA3046	.89
TL082	.99	LM394H	5.95	CA3146	1.29
TL084	1.49	LM399H	5.95	MC3373	1.29
LM301	.34	TL494	4.20	MC3470	1.95
LM309K	1.25	TL497	3.25	MC3480	8.95
LM310	1.75	NE555	.29	MC3487	2.95
LM311	.59	NE556	.49	LM3900	.49
LM311H	.89	NE558	.79	LM3909	.98
LM311K	3.49	NE564	1.95	LM3911	2.25
LM312H	1.75	LM565	.95	LM3914	1.89
LM317T	.69	LM566	1.49	LM3915	1.89
LM318	1.49	LM567	.79	MC4024	3.49
LM319	1.25	NE570	2.95	MC4044	3.99
LM323K	3.49	NE590	2.50	RC4136	1.25
LM324	.34	NE592	.98	RC4558	.69
LM331	3.95	LM723	.49	LM1360	1.49
LM334	1.19	LM733	.98	75107	1.49
LM335	1.79	LM741	.29	75108	1.49
LM336	1.75	LM747	.69	75110	1.95
LM338K	4.49	MC1330	1.69	75150	1.95
LM339	.59	MC1350	1.19	75154	1.95
LF347	2.19	LM1458	.35	75188	1.25
LF353	.59	LM1488	.49	75189	1.25
LF356	.99	LM1489	.49	75451	.39
LF357	.99	LM1496	.85	75452	.39
LM358	.59	ULN2003	.79	75477	1.29

HIGH SPEED CMOS LOGIC

74HC00	.21	74HC244	.85	74HCT138	.35
74HC04	.25	74HC245	.85	74HCT139	.55
74HC08	.25	74HC273	.69	74HCT157	.59
74HC14	.35	74HC367	.69	74HCT161	.79
74HC32	.35	74HC373	.69	74HCT240	.89
74HC74	.35	74HC390	.79	74HCT244	.89
74HC138	.45	74HC374	.69	74HCT245	.99
74HC139	.45	74HC4040	.89	74HCT273	.99
74HC154	1.09	74HCT00	.25	74HCT373	.99
74HC157	.55	74HCT04	.27	74HCT374	.99
74HC161	.65	74HCT08	.25	74HCT393	.99
74HC164	.65	74HCT32	.27	74HCT4040	.99
74HC175	.59	74HCT74	.45	74HCT4060	1.49

STANDARD CMOS LOGIC

4001	.19	4028	.65	4069	.19
4011	.19	4040	.69	4070	.29
4013	.35	4042	.59	4081	.22
4015	.29	4044	.69	4093	.49
4016	.29	4046	.69	14411	9.95
4017	.49	4047	.69	14433	14.95
4018	.69	4049	.29	14497	6.95
4020	.59	4050	.29	4503	.49
4021	.69	4051	.69	4511	.69
4023	.25	4052	.69	4518	.85
4024	.49	4053	.69	4528	.79
4025	.25	4060	.69	4538	.95
4027	.39	4066	.29	4702	9.95

7400 SERIES LOGIC

7400					
7400	.19	74121	.29	74F240	1.29
7402	.19	74123	.49	74S00	.29
7404	.19	74125	.45	74S02	.29
7406	.29	74150	1.35	74S04	.29
7407	.29	74151	.55	74S08	.35
7408	.24	74153	.55	74S10	.29
7410	.19	74154	1.49	74S32	.35
7411	.25	74157	.55	74S74	.49
7414	.49	74159	1.65	74S86	.35
7416	.25	74161	.69	74S112	.50
7417	.25	74164	.85	74S124	2.75
7420	.19	74166	1.00	74S138	.79
7430	.19	74175	.89	74S153	.79
7432	.29	74367	.65	74S157	.79
7438	.29			74S158	.95
7442	.49	**74F/74S**		74S163	1.29
7445	.69	74F00	.35	74S175	.79
7447	.89	74F02	.35	74S195	1.49
7473	.34	74F04	.35	74S240	1.49
7474	.33	74F08	.35	74S241	1.49
7475	.45	74F10	.35	74S244	1.49
7476	.35	74F32	.35	74S280	1.95
7483	.50	74F64	.55	74S287	1.69
7485	.59	74F74	.39	74S288	1.69
7586	.35	74F86	.55	74S299	2.95
7489	2.15	74F138	.79	74S373	1.69
7490	.39	74F139	.79	74S374	1.69
7493	.35	74F253	.89	74S471	4.95
		74F157	.89	74S571	2.95

Circle 153 on Reader Service Card

CRYSTALS

32.768 KHz	.95
1.0 MHz	2.95
1.8432	2.95
2.0	1.95
2.4576	1.95
3.579545	1.95
4.0	1.95
5.0	1.95
5.0688	1.95
6.0	1.95
6.144	1.95
8.0	1.95
10.0	1.95
10.738635	1.95
12.0	1.95
14.31818	1.95
16.0	1.95
18.0	1.95
18.432	1.95
20.0	1.95
22.1184	1.95

OSCILLATORS

1.0MHz	5.95
1.8432	5.95
2.0	5.95
2.4576	5.95
2.5	5.95
4.0	4.95
5.0	4.95
5.0688	4.95
6.0	4.95
6.144	4.95
8.0	4.95
10.0	4.95
12.0	4.95
14.31818	1.95
15.0	1.95
16.0	4.95
18.432	4.95
20.0	4.95
24.0	4.95

DISCRETE

1N751	.49	2N4403	.25
IN5402	.25	2N6045	1.75
IN4004	10/1.00	MPS-A13	.40
IN4148	25/1.00	TIP31	.49
KBP02	.55	4N26	.69
PN2222	.10	4N27	.69
2N2222	.10	4N28	.69
2N2907	.25	4N33	.89
2N3055	.79	4N37	1.19
2N3904	.10	MCT-2	.59
2N3906	.10	MCT-6	1.29
2N4401	.25	TIL-111	.99

SOLDER STATION

UL APPROVED

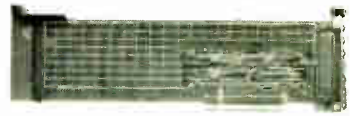
- ADJUSTABLE HEAT SETTING
- TIP TEMPERATURE READOUT
- REPLACEMENT TIPS AVAILABLE $2.95

168-2C

$49.95

WIREWRAP PROTOTYPE CARDS

FR-4 EPOXY GLASS LAMINATE WITH GOLD PLATED EDGE-CARD FINGERS AND SILK SCREENED LEGENDS.



FOR PS/2

JDR-PR32	32 BIT PROTOTYPE CARD	69.95
JDR-PR16	16 BIT WITH I/O DECODING LAYOUT	49.95
JDR-PR16PK	PARTS KIT FOR JDR-PR16 ABOVE	15.95
JDR-PR16V	16 BIT FOR VIDEO APPLICATIONS	39.95

FOR AT

JDR-PR10	16BIT WITH I/O DECODING LAYOUT	34.95
JDR-PR10PK	PARTS KIT FOR JDR-PR10 ABOVE	12.95

FOR XT

IBM-PR1	WITH +5V AND GROUND PLANE	27.95
IBM-PR2	AS ABOVE WITH I/O DECODING LAYOUT	29.95

CAPACITORS

TANTALUM

1.0µf	15V	.12
6.8	15V	.42
10	15V	.45
22	15V	.99
1.0µf	35V	.45
2.2	35V	.19
4.7	35V	.39
10	35V	.69

DISC

10pf	50V	.05
22	50V	.05
33	50V	.05
47	50V	.05
100	50V	.05
220	50V	.05
.001µf	50V	.05
.005	50V	.05
.01	50V	.07
.05	50V	.07
.1	12V	.10
.1	50V	.12

ELECTROLYTIC

RADIAL

1µf	50V	.14
4.7	50V	.11
10	50V	.11
47	35V	.13
100	16V	.15
100	50V	.23
220	35V	.20
470	25V	.30
2200	16V	.70
4700	25V	1.45

AXIAL

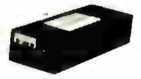
1µf	50V	.14
10	16V	.14
10	50V	.16
22	16V	.14
47	50V	.19
100	35V	.19
470	50V	.29
1000	16V	.29
2200	16V	.70
4700	16V	1.25

FULL 1 YEAR WARRANTY ON EVERY PRODUCT!

POWER SUPPLIES

APPLE TYPE SUPPLY
- APPLE CONNECTOR
- +5V @ 6A, +12V @ 3A, -5V @ 1A, -12V @ 1A

PS-A $49.95



FLOPPY DRIVE SUPPLY
- +5V @ 2.5A, +12V @ 2A, -12V @ 1A
- +5V @ 5A, IF +12 NOT USED

PS-ASTEC $24.95

75 WATT SUPPLY
- UL APPROVED
- +5V @ 7A, +12V @ 3A, -5V @ 300MA, -12V @ 250MA

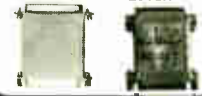
PS-1558 $34.95

MICRO SUPPLY
- UL APPROVED, 144 WATTS
- +5V @ 18A, +12V @ 4A, -12V @ 500MA

PS-1554 $29.95

GENDER CHANGERS

GENDER-FF	FEMALE-FEMALE	7.95
GENDER-MM	MALE-MALE	7.95
GENDER-MF	MALE-FEMALE	7.95
GENDER-NM	NULL MODEM	8.95
GENDER-JB	JUMPER BOX	8.95
GENDER-MT	MINITESTER	14.95



BIT RATE GENERATORS

MC14411	9.95
BR1941	4.95
4702	9.95
COM5016	16.95
COM8116	8.95
MM5307	4.95

BYPASS CAPACITORS

.01xx	CERAMIC DISC	100/5.00
.01xx	MONOLITHIC	100/10.00
.1xx	CERAMIC DISC	100/6.50
.1xx	MONOLITHIC	100/12.50

CLOCK CIRCUITS

MC146818	5.95	MM58174	9.95
MM58167	9.95	MSM5832	2.95

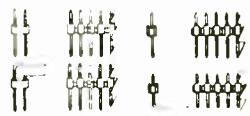
DISK CONTROLLERS

1771	4.95	2797	29.95
1791	9.95	8272	4.39
1793	9.95	UPD765	4.39
1795	12.95	MB8876	12.95
1797	12.95	MB8877	12.95
2791	19.95	1691	6.95
2793	19.95	2143	6.95

"SNAPABLE" HEADERS

CAN BE SNAPPED APART TO MAKE ANY SIZE HEADER, ALL WITH .1" CENTERS

1x40	STRAIGHT LEAD	.99
1x40	RIGHT ANGLE LEAD	.49
2x40	2 STRAIGHT LEADS	2.49
2x40	2 RIGHT ANGLE LEADS	2.99

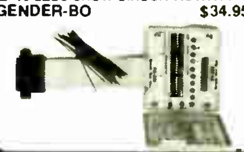


RS-232 BREAKOUT BOX

FOR TROUBLESHOOTING SERIAL COMMUNICATIONS

- OPEN/CLOSE INDIVIDUAL CIRCUITS
- 20 JUMPERS CROSS-CONNECT ANY TWO CIRCUITS
- 10 LEDS SHOW CIRCUIT ACTIVITY

GENDER-BO $34.95



IDC CONNECTORS/RIBBON CABLE

DESCRIPTION	ORDER BY	CONTACTS					
		10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WIREWRAP HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WIREWRAP HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.63	.89	.95	1.29	1.49	1.69
RIBBON HEADER	IDMxx	–	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	.85	1.25	1.35	1.75	2.05	2.45
10' PLASTIC RIBBON CABLE	RCxx	1.60	3.20	4.10	5.40	6.40	7.50

FOR ORDERING INSTRUCTIONS, SEE D-SUBMINIATURE CONNECTORS BELOW

D-SUBMINIATURE CONNECTORS

DESCRIPTION		ORDER BY	CONTACTS					
			9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.45	.59	.69	.69	1.35	1.85
	FEMALE	DBxxS	.49	.69	.75	.75	1.39	2.29
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	.49	.69	–	.79	2.27	–
	FEMALE	DBxxSR	.55	.75	–	.85	2.49	–
WIREWRAP	MALE	DBxxPWW	1.69	2.56	–	3.89	5.60	–
	FEMALE	DBxxSWW	2.76	4.27	–	6.84	9.95	–
IDC RIBBON CABLE	MALE	IDBxxP	1.39	1.99	–	2.25	4.25	–
	FEMALE	IDBxxS	1.45	2.05	–	2.35	4.49	–
HOODS	METAL	MHOODxx	1.05	1.15	1.25	1.25	–	–
	PLASTIC	HOODxx	.39	.39	–	.39	.69	.75

ORDERING INSTRUCTIONS:
INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED. EXAMPLE : A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR.

MOUNTING HARDWARE 59¢

EPROM ERASERS

SPECTRONICS CORPORATION

Model	Timer	# of Chips	Intensity (uW/Cm²)	Unit Cost
PE-140	NO	9	8,000	$ 89
PE-140T	YES	9	8,000	$139
PE-240T	YES	12	9,600	$189

DATARASE **$34.95**

- ERASES 2 EPROMS IN 10 MINUTES
- VERY COMPACT, NO DRAWER
- METAL SHUTTER PREVENTS UV LIGHT FROM ESCAPING

- 30 DAY MONEY BACK GUARANTEE
- 1 YEAR WARRANTY ON ALL PRODUCTS
- TOLL-FREE TECHNICAL SUPPORT
- COMPLETE CUSTOMER SATISFACTION
- KNOWLEDGEABLE SALES STAFF

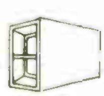
IC SOCKETS/DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS								
		8	14	16	18	20	22	24	28	40
SOLDERTAIL SOCKETS	xxST	.11	.11	.12	.15	.18	.15	.20	.22	.30
WIREWRAP SOCKETS	xxWW	.59	.69	.69	.99	1.09	1.39	1.49	1.69	1.99
ZIF SOCKETS	ZIFxx	–	4.95	4.95	–	5.95	–	5.95	6.95	9.95
TOOLED SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
TOOLED WW SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIERS	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
DIP PLUGS (IDC)	IDPxx	.95	.49	.59	1.29	1.49	–	.85	1.49	1.59

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE CONNECTORS ABOVE

SHORTING BLOCKS

5/$1.00



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- 6.8V FOR 286/386 COMPUTERS
- MOTHERBOARD CONNECTOR
- ADHESIVE VELCRO STRIP FOR EASY MOUNTING

LITHIUM 6.8V $11.95

LITHIUM-3V	3V COIN TYPE LITHIUM BATTERY	$1.95
3V-MHW	BATTERY HOLDER	$1.49

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JDR Microdevices®

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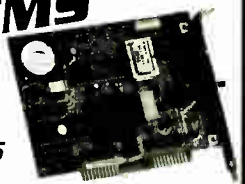
• COMPLETE CUSTOMER SATISFACTION • SUPERIOR SERVICE • FRIENDLY, KNOWLEDGEABLE SALES STAFF

2400 BAUD MODEMS



$129.95

$169.95

PROMETHEUS

SAVE TIME AND TELEPHONE CHARGES WITH A HIGH SPEED 2400 BAUD MODEM FROM JDR.

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- AUTO DIAL ANSWER
- SELF TEST ON POWER-UP
- TOUCHTONE OR PULSE DIALING
- HAYES & BELL SYSTEMS COMPATIBLE
- FULL OR HALF DUPLEX
- MIRROR II COMMUNICATIONS SOFTWARE INCLUDED

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PRO-12I	1200 BAUD 1/2 CARD	$69.95
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EXTERNAL 2400 BAUD

- 2400/1200/300 HAYES COMPATIBLE
- 8 EASY-TO-READ STATUS LED'S
- CALL PROGRESS MONITORING & ADJUSTABLE VOLUME
- 2ND PHONE JACK FOR VOICE COMMUNICATIONS
- REQUIRES SERIAL PORT & CABLE (OPTIONAL)

PRO-24E		$169.95
PRO-12E	1200 BAUD EXTERNAL	$99.95

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MACINTOSH 2400 BAUD EXTERNAL AS ABOVE WITH CABLE AND PROCOM-M SOFTWARE.

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PRO-24A	APPLE II 2400 BAUD MODEM	$179.95
PRO-12A	APPLE II 1200 BAUD MODEM	$139.95

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- B&W AND 3 HALF-TONE MODES
- 32 LEVELS OF GRAY SCALE
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HS-3000

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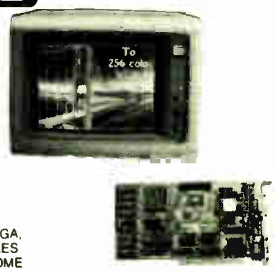

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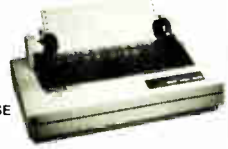

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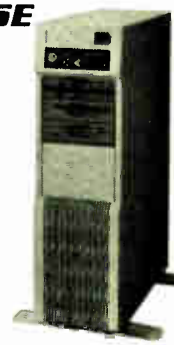

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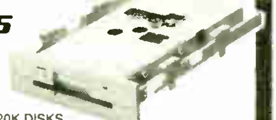

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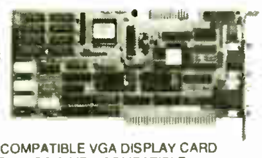

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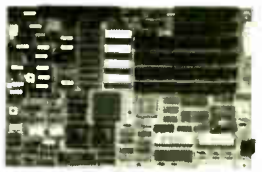

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Editorial Index by Company

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:

The subject of January's **Product Focus** will be the graphics tablet, an input device for both the IBM PC and the Macintosh that's steadily growing in popularity. Graphics tablets can come with a drawing device that lets you translate a drawing more accurately into digitized data. This makes them useful for CAD, paint programs, business graphics, desktop publishing, and other applications that rely on drawing or tracing.

Graphics tablets come in a wide range of sizes. Some of the smallest have a drawing area of about 6 by 8 inches, while the largest freestanding units give you a drawing area of about 44 by 60 inches. Our Product Focus will compare the features and capabilities of IBM PC–compatible graphics tablets in 12- by 12-inch and 12- by 18-inch formats, two of the most popular sizes for use on desktop computers.

Last summer, IBM introduced a slew of new PS/2 computers. Among the seven new systems are the 16-MHz and 20-MHz Model 70s, the first desktop 80386-based systems from IBM. Also new is the Model 50Z, which IBM claims is 35 percent faster than the older Model 50 and faster than any 80286 machine from competitors. In January, we'll look at all three in **system reviews**.

The Dolch P.A.C. from Dolch Computer Systems is an 80386-based portable that's designed to serve a dual role as both a high-powered portable and a desktop system.

We'll also have **reviews of add-ins and peripherals**. Intel's Connection CoProcessor is an add-in board for IBM PC compatibles that's geared strictly for communications. This "intelligent" board is equipped with its own microprocessor, and it can carry on communication tasks in the background. Our review will examine how well the board manages your communication tasks.

High-resolution graphics for PS/2 systems has been slow in coming. Next month, we compare two high-resolution graphics boards, IBM's own 8514/A graphics adapter and Control Systems' Artist 10 MC, both of which offer a resolution of 1024 by 768 pixels.

Language reviews: Microsoft's QuickBASIC compiler for the IBM PC world received an enthusiastic welcome from BASIC programmers. Now that the company has released its Macintosh version of QuickBASIC, we're anxious to see if Macintosh programmers will be as excited. In addition, we'll be looking at IntegrAda, an Ada programming support environment from Aetech.

Our lineup for **application reviews** includes Mathematica from Wolfram Research. Mathematica solves algebraic and calculus problems in symbolic form and will be bundled with the NeXT computer. Opus 1 is a combination of a database manager and a user-designed graphical interface.

IN DEPTH:

January will see the first Expanded In-Depth section in BYTE. This is a new opportunity to provide significantly expanded coverage of major growth technologies in our industry. This expanded section will recur from time to time, as warranted by industry trends and interest.

Next month's subject will be **communications**, an area that has grown at a phenomenal rate. Our regular In-Depth section would be too short to adequately cover a field that includes both point-to-point communications and networks. This expanded coverage includes a variety of articles on local-area networks, their operating systems, standards, and protocols. It also deals with various issues involved in designing and managing LANs. The section is not confined to LANs, but they are its largest component, as indeed they are the major part of the microcomputer world's current focus on communications.

FEATURES:

Features for January will provide, as usual, a glimpse at the constant variety of microcomputing. For example, Dick Pountain has written an authoritative article on **the inner workings of XWindows**. A panel of world-renowned experts has been polled for their views on **what we can look forward to in the next 12 months**. Rick Grehan continues his exploration of language subjects in Some Assembly Required with a look at a **keyed-file database**. A new feature, Under the Hood, introduces Brett Glass, who offers penetrating and informed commentary on the hardware side of microcomputing, this month on **token rings**. Finally, BYTE begins a new tradition with its **first Excellence Awards**. BYTE editors and contributors have surveyed the field of products first introduced or that rose to prominence in 1988 and have come up with those that have the greatest potential for affecting microcomputer usage.

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Seagate

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buy a controller with a hard disk for extra savings!

Size	Model #	Size	Avg. Speed	Drive Alone	Packaged with MCT Controller			
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30MbRLL	ST-138	3-1/2"	40MS	$289	----	$339	----	$429
20Mb	ST-225	5-1/4"	65MS	$225	$269	----	$339	----
30Mb RLL	ST-238	5-1/4"	65MS	$249	----	$299	----	$389
40Mb	ST-251	5-1/4"	40MS	$379	$419	----	$489	----
40Mb	ST-251-1	5-1/4"	28MS	$469	$509	----	$579	----
60Mb RLL	ST-277	5-1/4"	40MS	$449	----	$499	----	$589
80Mb	ST-4096	5-1/4"	28MS	$629	----	----	$739	----

Floppy/hard controller

This 16-bit controller card for AT compatible computers supports up to two floppy drives (5-1/4" or 3-1/2" floppy, 360K, 720K, 1.2Mb or 1.44Mb) and two hard disks. It has a high speed (16 bit) bus to take advantage of the fast 80286 microprocessor. Includes support for disk activity LEDs.

MCT-AFH $149.95

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Increase hard disk performance and free up an expansion slot at the same time! This controller card combines functions normally requiring two expansion cards. Supports up to two RLL hard drives (such as the ST-238 or ST-277) for better hard disk performance, and two floppy drives (5-1/4" or 3-1/2" floppy, 360K, 720K, 1.2Mb or 1.44Mb). Its non-interleaved operation provides faster controller/hard drive performance. Designed for AT compatibles.

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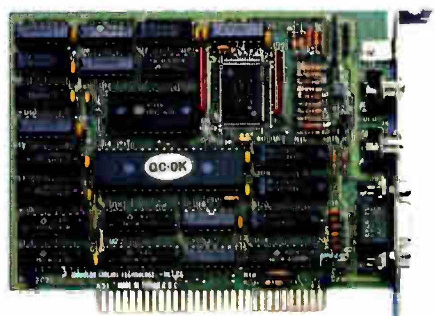

RLL controller

RLL controller

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Before adding an item to our product line we perform rigorous tests for compatibility and performance, plus we provide clear, understandable and detailed documentation and **toll-free** technical support.

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Louise Morley,
Fort Lauderdale, Fl

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PC File+ - Faster than most databases and easier to learn.

PC Calc - A "business-strength" spreadsheet that's suitable for home or office.

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"Shareware" is software based on the honor sytem. Try the program out at your own pace. If you continue to use the program you pay the manufacturer and become a registered user. These programs are from "Buttonware", a leading publisher of shareware.

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JDR-BETA	**$4.95** with motherboard	**$19.95** alone

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DOS-VIDEO **$79.95**

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MS-DOS is the industry standard operating system that you'll need to run most software. DOS 3.3 supports the latest high-density 3.5" drives (see our cover) and 17 new commands for quicker, more efficient computing. The extensive, well-written manual helps you to get the most out of this time-proven DOS.

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HS-3000 $249.95

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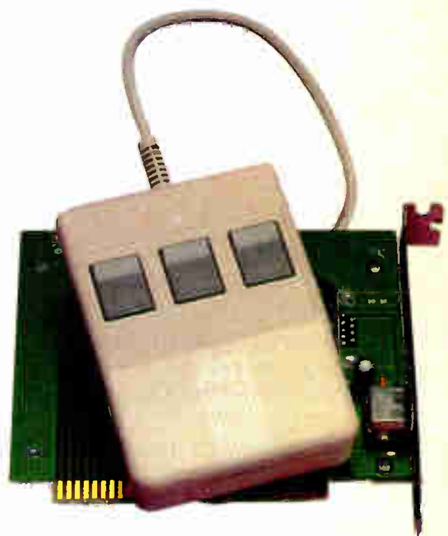

Logitech Hirez mouse

2-button mouse

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- Connects to standard serial port
- Reliable, accurate opto-mechanical design

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LOGITECH

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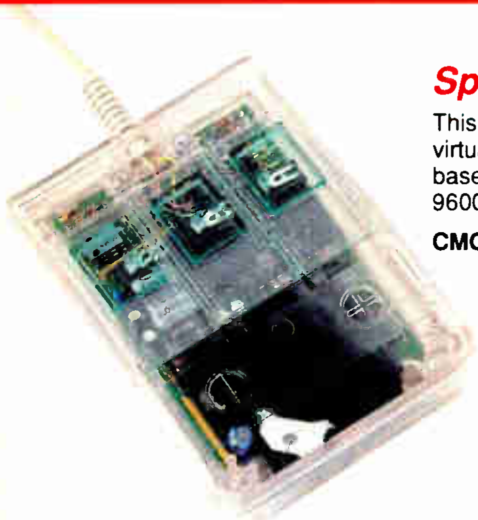

Special Edition: see-through mouse

This serial mouse is clearly a conversation piece and more! It's compatible with virtually all mouse-based programs, and programmable to adapt any keyboard based application. High resolution, adjustable cursor control. Programmable 9600 baud rate. Includes LOGIPAINT and a 9 to 25 pin adaptor.

CMOUSE-P **$109.95**

Logitech bus mouse

Logitech 3-button mouse

Our best selling mouse! Voted PC Magazine's "Editor's Choice" and now the standard in the industry. This all-purpose opto-mechanical mouse is fully compatible with with most any software that supports a mouse. All versions support the following features:

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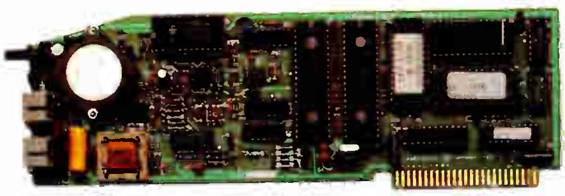
Modems



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An internal 2400/1200/300 baud intelligent card modem for the Apple II family, now at a great price!

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- Auto redial on busy
- Includes ProCom-A Communications & Word Processing software

PRO-24A **$179.95**
PRO-12A 1200 baud version **$139.95**

2400 baud external modem

A 2400/1200/300 baud Hayes compatible modem packed with features you'd expect to find only in higher priced models. An excellent value!

- 8 easy-to-read status LED's
- Adjustable volume control
- Call progress monitoring
- 2nd phone jack for voice communications
- Comprehensive user documentation
- Requires one serial port & cable (optional)

PRO-24E **$169.95**

Macintosh 2400 baud external modem

Includes ProCom-M communications software and cable for Mac Plus, Macintosh SE and Macintosh II.

PRO-24EM **$199.95**

Call home from anywhere with the pocket modem

This take-everywhere modem is great for laptops and portables and has all the power you'd expect from a full size model. Now wherever you are, you're just a phone call away from your data. Quality design in a small package.

- Operates off one 9 volt battery (included)
- AC power pack & phone line cord included
- Switchable Bell/International protocol
- Serial interface (DB25 connector)
- 1200/300 baud operation
- 4 status indicators
- Weighs only 6 ounces

PRO-12P **$99.95**

Call our 24-hour BBS
(408) 374-2171
For technical support, conferencing, tips and more

Hayes compatible 2400 baud internal modem

This well designed and solidly built IBM compatible modem offers 2400bps performance at an incredibly low price . Made in the U.S.A and packed with features, this modem is an exceptional value.

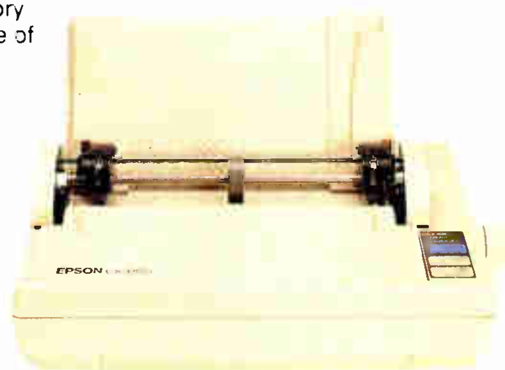
- 2400/1200/300bps operation
- Includes Mirror II communications software
- Automatic answer/dial/redial
- Call progress monitoring
- Can be configured as COM1, COM2 or COM3
- Second phone jack for voice communications

PRO-24I **$129.95**

PROMETHEUS

Epson printers

Epson LX-800

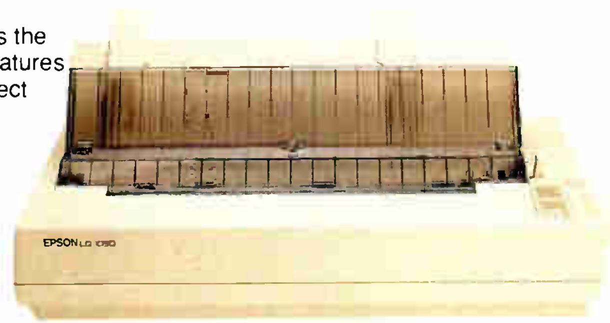


Affordable high performance! With its quick printing speed, built-in memory buffer and convenient paper-handling features, the LX-800 represents one of the finest printer values in its class.

- 180 CPS draft, 30 CPS NLQ mode
- 3K memory buffer
- Friction feed and tractor feed
- Auto-load for single sheets
- 3 fonts: Draft, Roman & Sans Serif
- Fonts & print mode are selectable from front control panel
- 9-pin dot matrix print head
- Parallel interface (serial optional)

LX-800 $199.00

Epson LQ-1050



Built for heavy workloads! This wide-carriage model handles the toughest print job with ease. It's very fast, very quiet, and features push-button paper handling. Simply press one button to select between fan-fold, single sheet, forms or envelopes.

- 24-pin dot matrix print head
- 264 CPS draft, 88 CPS letter quality
- 6K memory buffer
- Prints up to 132 columns
- 3 fonts: Draft, Roman, & Sans Seriff
- Tractor feed & friction feed
- Auto load for single sheets
- Parallel and serial interfaces
- Options include font modules, a sheet feeder & a 32K print buffer

LQ-1050 $999.00

Visit our retail store:

1256 S. BASCOM AVE, SAN JOSE, CA
(408) 947-8881 M-F 9-7, SAT 9-5, SUN 12-4

Epson LQ-500

An exceptional value! Using a 24-pin print head and bidirectional text and graphics printing, the LQ-500 is able to print even letter quality documents at a high rate of speed. Ideal for business, home and student use.

- 24-pin print head
- 180 CPS draft, 60 CPS letter quality
- 8K memory buffer
- Tractor feed & friction feed
- Auto-load for single sheets
- Parallel interface (serial optional)
- 3 fonts: Draft, Roman, & Sans Seriff
- Optional font modules & sheet feeder available

LQ-500 $399.00

Epson LQ-850

Lightning fast! Every office could use one of these printers. The LQ-850 has an extremely fast print speed of 264 CPS — just what you need for high volume work. And it does all this at a very quiet 55 decibels.

- 24-pin dot matrix printer
- 264 CPS draft, 88 CPS letter quality
- 6K memory buffer
- 3 fonts: Draft, Roman, & Sans Seriff
- Pushbutton selection of font & pitch
- Bidirectional in text & graphics mode
- Tractor feed & friction feed
- Auto load for single sheets
- Parallel and serial interfaces
- Options include font modules, sheet feeder & 32K printer buffer

LQ-850 $699.00

Epson EX-800

This is one of the fastest 9-pin printers available! It prints at 300 CPS in draft mode, and in letter quality mode, the EX-800 is more than twice as fast as a daisywheel printer. This printer is built for performance!

- 300 CPS draft, 50 CPS NLQ
- 8K memory buffer
- 3 fonts: Draft, Roman, & Sans Serif
- Bidirectional in text mode
- Tractor feed & friction feed
- Auto load for single sheets
- Parallel & Serial interfaces
- Emulates Epson or IBM Proprinter
- Options include image scanner, sheet feeder & 32K print buffer

EX-800 $579.00

Order Toll Free: 800-538-5000 LOCAL (408) 866-6200 FAX (408) 378-8927

Stocking Stuffers

Binder for your manuals

One binder for all of your manuals! Designed to hold JDR, MCT and other product manuals, this binder features the JDR Microdevices logo. Durable vinyl cover wipes clean easily.

- Attractive vinyl binder and slip-cover
- Accepts 8.5" x 5.5" paper (standard manual format)
- 1 1/2" binder rings
- Durable spine-riveted rings
- Includes 5 labelled dividers

JDR-BINDER **$9.95**

Supercharge your XT

Replacing the 8088 microprocessor in your XT or compatible with the more efficient NEC V-20 can improve performance up to 30%. The V-20 is functionally identical to the 8088.

- Pin compatible with 8088
- Uses superset of 8088 instructions
- High speed address calculation in hardware
- CMOS design requires less power

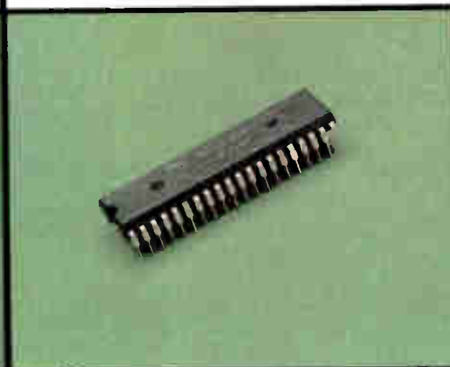
V20	4.77 Mhz	**$8.95**
V20-8	8 Mhz	**$10.95**
V20-10	10 Mhz	**$12.95**

Soldering station

With precise temperature controls and accurate heat sensing for fine PCB work, this soldering tool is suitable for the hobbyist or professional technician.

- UL approved
- Thermostatically controlled heat
- Adjustable temperature setting
- Range 200º - 900ºF
- Quick heating & recovery
- Power-on & Heater-on LEDs
- Replaceable solder tip

168-2C **$49.95**
168-TIP Replacement tips **$2.95**



8-bit prototype card

Decode support for a wide range of applications! The PR2 provides decode & buffering circuitry. Use as designed, or modify to suit your application.

- XT compatible
- Buffering & decode circuitry
- Silk screened labels on both sides
- Labelled component & test points
- +5V and ground planes,
- All holes plated through
- Projects & instructions for beginners

JDR-PR2 **$29.95**

PC accelerator

The Nickel Express improves the performance of your PC! By installing this inexpensive device you can make your PC, XT or clone run up to 67% faster. Requires no slot and is easy to install within a few minutes.

- 3 different operating speeds for maximum compatibility
- Super-fast NEC V20-8 processor
- Turbo switch
- Speed-change software
- Includes mounting bracket & cable

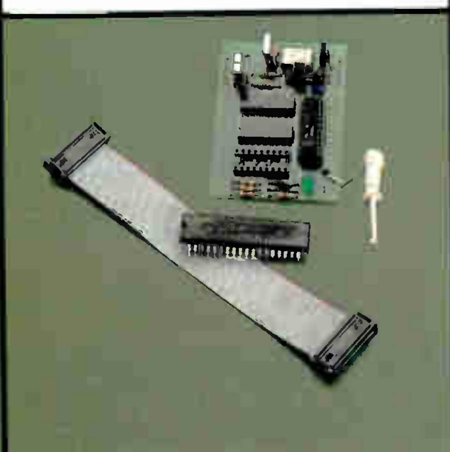
NICKEL-X **$69.95**

Computer Floor Stand

A great way to reduce desk clutter! This floor-mount stand enables you to move your computer from your desktop, freeing valuable desk space. It has a wide, sturdy base, and fits virtually every standard PC case.

- Attractive beige design
- Fits PC/XT and PC/AT CPU cases
- Designed for 4 to 7-1/2" case widths
- Rugged plastic construction
- Easy to assemble/disassemble

CASE-STAND **$19.95**



Smart solutions

Monitor Stand

Compute in comfort! This swivel-tilt stand lets you position your monitor at just the right angle for you. No more sore muscles and eye strain due to bad viewing angles. A great gift idea.

- Sturdy ABS plastic construction
- Adjustable tilt and swivel base
- Can be locked in one position or allowed to swivel
- Padded base protects your monitor
- Base dimensions: 11" x 10"

MS-100 $12.95

Stand & Power Station

Centralized power for your whole system! This stand provides one location for all the power outlets you need. Control your computer, printer, monitor and other peripherals with individual outlet switches, or simply use the master switch for everything.

- Adjustable tilt-swivel base
- Five individually controlled sockets
- 15-amp circuit breaker and line protection circuitry
- UL approved

MS-200 $39.95

Surge protector

This sturdy power strip has six outlets for your computer and peripherals. If you plug it into your computer power supply using the CBL-PS-MNTR cable, you can control your computer, monitor, printer, and other peripherals with your computer's power switch.

- UL approved
- 15 Amp circuit breaker
- Surge protection circuitry
- 5-foot power cord

POWER-SURGE $12.95
CBL-PS-MNTR $3.95

Long life battery

Install this long-lasting lithium battery in your AT compatible or 386 computer! It has a longer life than ordinary batteries and is much more reliable. Plus, it's small enough to be installed virtually anywhere in your computer.

- 6.8 volts
- Lithium for longer life
- Adhesive/velcro mounting strip
- Includes wiring & connector for motherboard battery pins

LITHIUM 6.8V $11.95

Printer Stand

You'll want two of these—one for home, one for your office! This stylish printer stand helps reduce the clutter around your desk. It provides a raised surface for your printer, so you can put your fan-fold printer paper directly (and neatly!) beneath the printer.

- Large enough for wide-carriage printers
- Attractive smoky brown acrylic
- 4 rubber pads protect desk surfaces
- Approx. 23-1/2" x 11-3/4" x 3-7/8" H

YU-S22B $49.95

Keyboard Drawer

Increase your desk space! This clever keyboard storage drawer fits under your computer and allows you to simply slide your keyboard out of the way when not in use.

- Sturdy metal housing with slide-out drawer
- Drawer fits all standard keyboards
- Provides a large base for computer & monitor
- 15-1/2" x 24" x 4" H

YU-E21B $49.95

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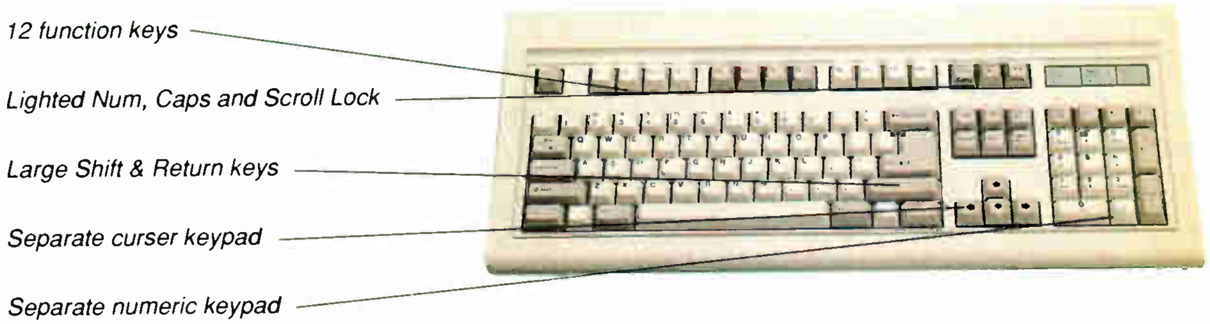
Keyboards



New! Enhanced keyboard with a "click"

Sounds and feels like a typewriter! This "key-click" keyboard is designed for those who miss their old typewriter keyboard. Each key makes a clicking sound upon the completion of a keystroke. XT and AT compatible.

K103-A **$84.95**

BTC enhanced keyboard

A keyboard for the power user! This 101 key keyboard is designed for maximum efficiency. It has separate cursor and numeric keypads for more convenient cursor movement and number entry.

- XT and AT compatible
- New enhanced layout
- Separate cursor & number keypads
- 12 function keys
- Large shift and return keys
- LED indicators for scroll, caps, and number lock.
- Automatically adjusts to XT or AT
- Auto-repeat feature

BTC-5339 **$79.95**

BTC standard keyboard

Just like IBM's original AT keyboard! This 84-key keyboard has the same compact layout as the IBM AT keyboard. This makes it ideal for the many software programs that were designed for this keyboard.

- XT and AT compatible
- Automatically adjusts to XT or AT
- 84-key AT style layout
- 10 function keys
- Extra large Shift & Return keys
- LED indicators for Scroll, Caps & Number lock
- Auto-repeat feature

BTC-5060 **$59.95**

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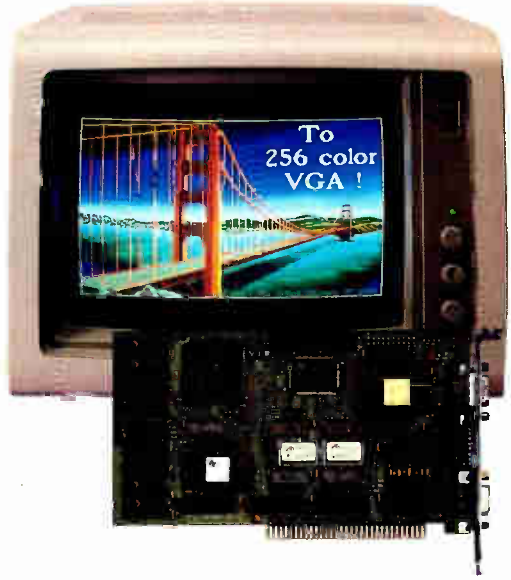
Graphics

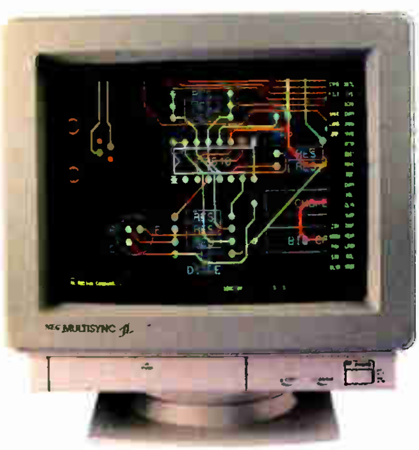
VGA Compatible Package

This VGA display system offers an unbeatable combination of color and clarity—with it, you can display a vivid array of up to 256 colors simultaneously! Other modes support 800 x 560 or the standard 640 x 480 in 16 colors from a palette of 64 colors. In addition to its color and clarity, this VGA system offers full compatibility with IBM's VGA. Consisting of a fully compatible VGA card from ATI, and a professional graphics analog monitor, the VGA system offered by JDR Microdevices is now available at a price comparable to EGA display systems.

- 640 x 480 in sixteen colors for VGA compatibility
- 320 x 200 with 256 colors from a palette of 262,000
- SoftSense Automatic Mode switching for transparent downward capability with EGA, CGA, Monochrome & Hercules graphics
- Comes with support & drivers for 1-2-3, Symphony, Windows, GEM & AutoCad
- User friendly manual with step-by-step instructions
- Includes Mode Switching, Screen Saver & Diagnostics software

VGA-PKG $649.95





NEC multisync II monitor

Breathtaking color display! You'll be hard pressed to find a better monitor—at any price. The Multisync has a remarkably clear display with crisp, distinct colors and is ideal for graphics-intensive applications like CAD, CAM, & windows.

- Super-sharp resolution (800 x 600 max)
- Compatible with VGA, MCGA, PGC, EGA, Hercules, CGA & other display adapters
- Automatically adjusts to any standard display adapter
- Front-mounted power, brightness & contrast switches
- Monochrome text mode & text color switches (green, amber & white)
- 9-15 pin adapter for PS/2 computers

NEC-MULTI $599.95

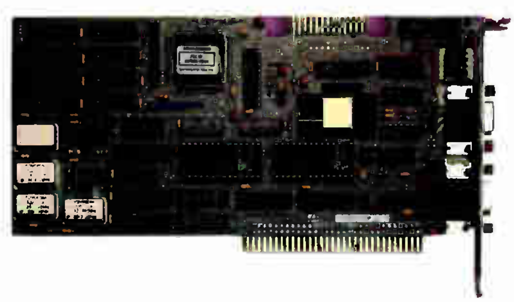
Sigma VGA Board

Here's an intelligent graphics card that offers a universal solution to the multiple PC display standards. It supports nearly all the current IBM PC and PS/2 display modes and monitors, and it's 100% hardware compatible in all modes. The SIGMA VGA is ideal for the NEC Multisync II.

- 100% register compatible
- VGA, EGA, CGA, HGC & MDA compatible
- 320 x 200 in 256 colors
- 640 x 480, 800 x 600 in 16 colors
- 80 x 25, 132 x 44 text modes
- Supports all standard digital & analog monitors (9 &15 pin)

SIGMA-VGA $297.50

"...if I were in the market today for a VGA board, the Sigma VGA would be my choice."
— Curtis Franklin Jr., BYTE, March 1988



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Peripheral cards

Supports 2 floppy drives—360K or 720K (includes cables)

Parallel, serial, & game ports with socket for optional 2nd serial port

Clock-calendar, battery, & RAM disk software

Hercules compatible monographics High resolution (720 x 348 pixels)

MODULAR CIRCUIT TECHNOLOGY

Graphics, floppy control and I/O in one card!

The only card your XT compatible computer needs! This card is almost a computer in itself: it provides monochrome graphics, support for two floppy drives, a clock-calendar, a parallel port, a serial port, and a game port. All you need is this card and a motherboard for a fully functional computer.

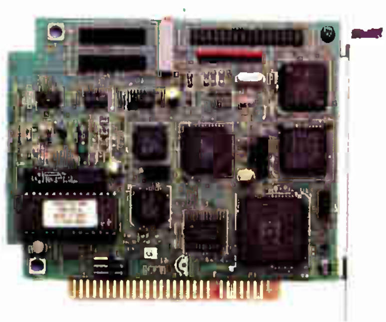
MCT-MGMIO **$119.95**

286/386 display and I/O control using one slot!

Create a complete system using only two cards! Use this "do everything" card to hook up a monochrome monitor, parallel printer, modem, and game joystick at the same time. The only other card your system needs is a floppy// hard controller.

- AT compatible
- Hercules compatible monographics
- High resolution display (720 x 348 pixels)
- 80 & 132 column text modes
- Serial port (w/ optional 2nd serial port)
- Parallel port & game port
- Includes software for running color graphics programs on a monochrome monitor

MCT-MGAIO **$99.95**



Add inexpensive color to your computer!

Great for home computing! This card has the versatility you need-- it works with monochrome or color monitors (RGB), displays a medium resolution for graphics or a higher resolution for text, plus it displays up to 4 colors for computer games.

- Two display modes: monochrome (640 x 200) and color (320 x 200)
- Works with monochrome or RGB monitors
- Light pen interface
- XT and AT compatible

MCT-CG **$49.95**

Inexpensive Hercules compatibility!

Great for word processing! Our monochrome graphics card has true Hercules compatibility and uses VLSI chips for reliability. The software driver allows most color graphics programs to run on a monochrome monitor.

- 720 x 348 resolution in graphics mode, 80 x 25 in text mode
- Includes parallel printer port configured as LPT1 or LPT2
- Lotus 1-2-3 compatible

MCT-MGP **$59.95**

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(408) 947-8881 M-F 9-7, SAT 9-5, SUN 12-4

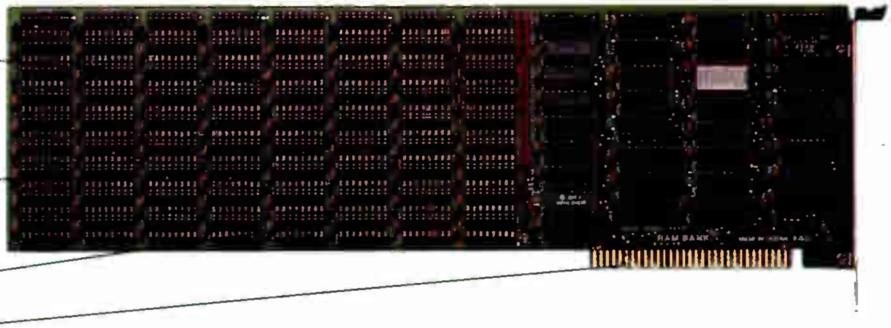
Modular Circuit Technology

2MB RAM capacity (ØK installed) for expanded or part expanded/part conventional memory. Accepts 64K or 256K DRAM chips

Conforms to LIM EMS version 3.2 Software for EMS drivers, RAM disk & more

Compatible with Lotus 1 2 3

XT compatible



Add memory to your XT compatible!

Go beyond the limits of 640K! This card provides additional RAM for improved performance. It allows you to add up to 2 megabytes of RAM (ØK installed) — ideal for the fast RAM disks and disk caches you need to speed up your computer's operation.

MCT-EMS		**$129.95**
MCT-AEMS	286/386 version	**$139.95**

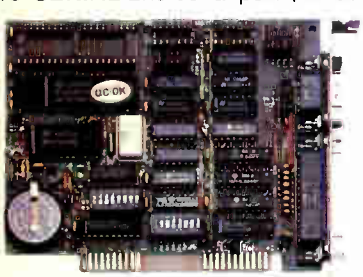
MODULAR CIRCUIT TECHNOLOGY

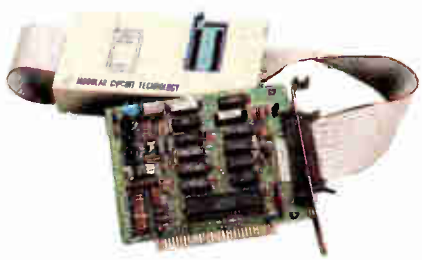
Serial/parallel ports plus clock/calendar

Combines I/O ports with a clock-calendar! The MCT-IO adds parallel and serial ports to your XT compatible system, and a clock-calendar that keeps the right time and date—even when your computer is turned off.

- Parallel port is addressable as LPT1 or LPT2
- Serial port is addressable as COM1, COM2, COM3, COM4
- Socketed for optional 2nd serial port
- Selectable port addresses
- Real time clock/calendar & battery
- Includes software for RAM disk and clock

MCT-IO **$59.95**
IO-SERIAL 2nd serial port **$24.95**





Easily program your own EPROM's

Our best selling EPROM programmer supports various manufacturers' formats with 12.5, 21 and 25 volt programming. The menu-driven software allows you to easily manipulate data files, split or combine the contents of several EPROMS and perform many functions with just a single keystroke.

- Read, Write, Copy, Erase, Check & Verify with one easy key selection
- Includes software for standard Hex and Intel Hex formats
- Programs 27xx & 27xxx series EPROMS up to 27512

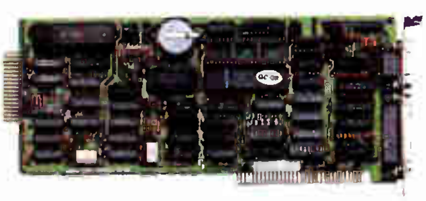
MCT-EPROM **$129.95**

I/O and floppy control in one card!

Combines controller & I/O functions! This card does a lot of things at once: it controls your floppy drives, provides parallel, serial & game ports for your printers, modems, mice & joysticks; and it even has a clock-calendar to help your computer keep the right time.

- XT compatible
- Supports two floppy drives
- Parallel port
- Serial port (2nd serial port optional)
- Game port
- Includes floppy drive cables and DB9-DB25 converter
- Clock-calendar with battery
- Includes software for RAM disk and more

MCT-MIO **$79.95**
MIO-SERIAL 2nd serial port **$15.95**



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Test equipment

The ultimate hand-held multitester

This full function 3.5 digit DMM offers highly accurate performance and a host of added features like audible continuity, capacitance, transistor, temperature, and conductance to help you do the job— fast. Temperature probe, test leads and battery included.

DMM-300 $79.95

2 YEAR
REPLACEMENT WARRANTY ON ALL JDR INSTRUMENTS PRODUCTS!

Fully overload protected

Transistor Tester: 0º - 2000ºF

9 functions, 34 ranges

Conductance Tester: 200ns range

Temperature Tester: 0º -2000º F

Basic DC accuracy: plus/minus 0.25%

DC Voltage: 200mv - 1000v, 5 ranges

AC voltage: 200mv - 750v, 5 ranges

Resistance: 200 ohms - 20M ohms, 6 ranges

Capacitance: 2000pf - 20 uf, 3 ranges

Input impedance: 10M ohm.

Full function DMM

Get highly accurate performance from this 3.5 digit full function DMM at a very affordable price. Rugged construction, 20 amp current capability and 22 ranges make it a perfect choice for serious field or benchwork. Low battery indicator and tilt-stand, Probes and 2000 hour battery.

- Basic DC accuracy: ± 0.25%
- DC voltage: 200mv - 1000V, 5 ranges
- AC voltage: 200mv - 750V , 5 ranges
- Resistance: 200 ohms - 20M ohms,6 ranges
- AC/DC current: 200uA - 20A,6 ranges
- Input impedance: 10M ohm
- Fully overload protected
- Approx. 7" x 3-1/2" x 1-1/2" Wt. 11 ozs.

DMM-200 $49.95

Pocket size DMM

Perfect for the field service technician. Shirt pocket size doesn't compromise features or accuracy. Large, easy to read 1/2" LCD display. Fully overload protected for safety. 2000 hour battery life with standard 9V cell. Probes and battery included.

- Basic DC accuracy: plus/minus 0.5%
- DC voltage: 2V - 1000V, 4 ranges
- AC voltage: 200V - 750V, 2 ranges
- Resistance: 2k ohms - 2M ohms, 4 ranges
- DC current: 2mA - 2A, 4 ranges
- Input impedance: 10M ohm
- Fully overload protected
- Approx. 5" x 3" x 1". Under 7 ozs.

DMM-100 $29.95

3.5 digit probe DMM

Custom 80 pin LSI chip provides accuracy and reliability in a very compact size. Autoranging, audible continuity and data hold features help you pinpoint the problem quickly. Case and batteries included.

- Basic DC accuracy :± 1%
- DC voltage: 2V - 500V, autoranging
- AC voltage: 2V - 500V, autoranging
- Resistance: 2K ohms - 2M ohms,autoranging
- Fully over-load protected
- Input impedance: 11M ohm
- Approx 6 1/2" x 1" x 3/4"
- Weighs under 3 ozs.

DPM-1000 $54.95

Order Toll Free: 800-538-5000 LOCAL (408) 866-6200 FAX (408) 378-8927