BYTE

THE SMALL SYSTEMS JOURNAL

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*Run on an 8 MHz IBM AT

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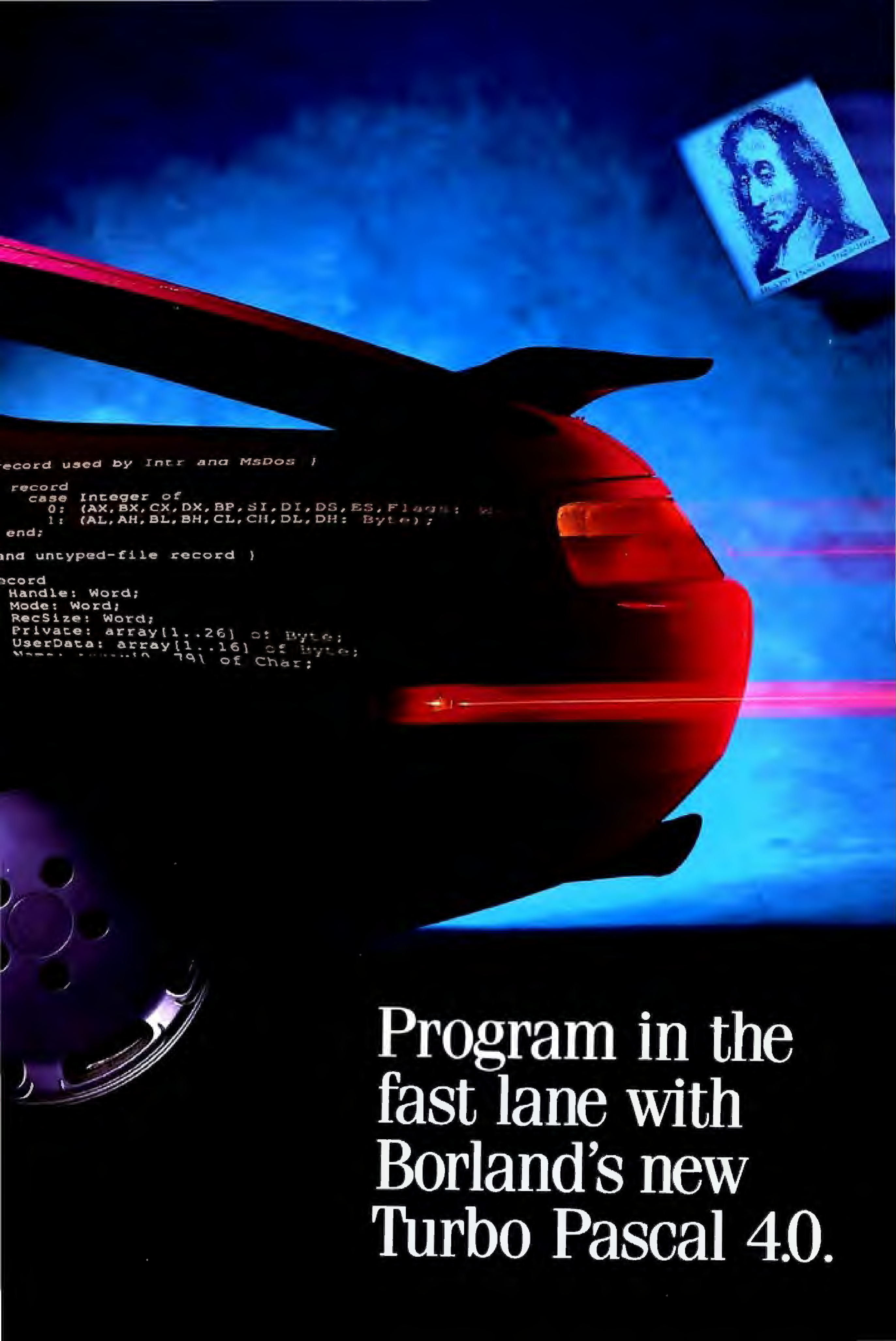

```
ecord used by Intr and MsDos }

 record
   case Integer of
     0: (AX,BX,CX,DX,BP,SI,DI,DS,ES,Flags: W
     1: (AL,AH,BL,BH,CL,CH,DL,DH: Byte);
 end;

nd untyped-file record }

ecord
  Handle: Word;
  Mode: Word;
  RecSize: Word;
  Private: array[1..26] of Byte;
  UserData: array[1..16] of Byte;
  Name: array[0..79] of Char;
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- Includes a command line version of the compiler

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Sieve (25 iterations)

	Turbo Pascal 4.0	**Turbo Pascal 3.0**
Size of Executable File	2224 bytes	11682 bytes
Execution speed	9.3 seconds	9.7 seconds

Sieve of Eratosthenes, run on an 8MHz IBM AT

Since the source file above is too small to indicate a difference in compilation speed we compiled our GOMOKU program from Turbo Gameworks to give you a true sense of how much faster 4.0 really is!

Compilation of GO.PAS (1006 lines)

	Turbo Pascal 4.0	**Turbo Pascal 3.0**
Compilation speed	2.2 seconds	3.6 seconds
Lines per minute	27,436	16,750

GO.PAS compiled on an 8 MHz IBM AT

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EDITORIAL

Show Time

Early winter is a great time for computer trade shows. Each year at this time, during a span of 60 days, we make our travel agency *very* happy by sending a steady stream of BYTE editors to shows ranging from COMDEX in Las Vegas to MacWorld Expo in San Francisco, with many smaller shows in between.

These shows yield a feast of new information. At one show, a major hardware manufacturer privately demonstrated for us hand-assembled prototypes of a new line of killer machines that will be announced shortly.

The high end of this line ranks among the most technologically advanced personal computers I've seen. We will be receiving sample units from the first production run, and we'll bring you full coverage, with detailed benchmarks, in an upcoming issue.

We also picked up a late-beta copy of Surpass, a powerful spreadsheet that enters the fray—along with new spreadsheets like Quattro, Win Excel, and PlanPerfect—against Lotus 1-2-3. Turn to this issue's Short Takes section for an early hands-on look at Surpass.

We've also seen a host of 80386 and 68020 hardware and software; tons of new equipment designed to work with—or outperform—IBM's Micro Channel PS/2s; new Mac enhancers; and more.

Embarrassment of Riches

Some of these items will show up in print right away, in the sections of BYTE with the latest deadlines: Microbytes, Short Takes, and What's New. Other items will appear later as First Impression articles and full-blown reviews.

But we gather much more raw information than we can possibly accommodate, even in a magazine the size of BYTE (e.g., our internal staff reports from COMDEX alone ran to almost 20,000 words). How can we best supply you with all this information?

Let's, for the moment, ignore BIX. Our show coverage there, usually as part of the microbytes conference, features detailed information on major product announcements and conference events posted within minutes or hours of occurrence. If you want the most up-to-date microcomputer information you can get, there's simply no better alternative.

But if you can't use BIX, what then? Senior Editor Rich Malloy had a suggestion: a paper transcript of our show coverage, mailed to interested readers right after a show.

To test the feasibility of this idea, we produced a trial transcript of our COMDEX coverage, and it went well: In a matter of just a few hours, Rich downloaded the BIX coverage, massaged the text, designed a print format, and laser-printed the whole package. It went so well, in fact, that we've forged ahead.

A New Publication

Starting immediately after the close of MacWorld Expo, we'll produce a paper transcript of our BIX coverage. We'll be glad to send you a copy for just the price of the paper, printing, and postage. Just drop a note to MacWorld Show Report, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458; please enclose a check or money order for $3, and be sure to include your name and mailing address. These new Show Reports will fill a gap in our coverage of microcomputing.

Thus, we can now offer you three alternatives for show coverage: For the most timely coverage possible, there's BIX, with its essentially zero lead time and its interactive nature (via BIX, you can ask the BYTE staff questions about the show and our coverage). Slightly slower, but fast—as fast or faster than most microcomputer news weeklies, for instance—are the new BYTE Show Reports. And finally, for thoroughgoing, in-depth analysis and selective coverage of the most important new products and technologies, there's BYTE itself.

Other Changes

Does this attention to Show Reports and BIX imply that BYTE is changing? Not at all.

Except to get better. Our New Year's resolutions for BYTE include improving the quality of our writing and editing while retaining or even enhancing the depth and authority that are BYTE's hallmarks. BYTE's technical nature guarantees we'll never be a McGuffey's reader, but we can—and will—work harder to make even our most technically rigorous articles as readable as possible.

And as attractive as possible: Nancy Rice, our able art director, is already hard at work looking at ways we can use new layouts, new line art, and new formats for tables and graphs to make the great wealth of data found in BYTE more accessible.

Other resolutions include giving more space to the print version of Microbytes in BYTE. Microbytes is already one of the finest print sources for microcomputer technology news anywhere, and as such, it has become immensely popular. As a result, we're expanding it by 33 percent, starting with the February issue.

A less welcome change: This marks the last issue with which Phil Lemmons is associated with BYTE. Phil worked here for 5 years, starting as a freelance author and ending as editorial director. In the course of his tenure, Phil enjoyed—and was largely responsible for—numerous successes, including the growth of BYTE to its current all-time-high circulation and the launching of BIX. Phil has left to pursue other career goals. We'll all miss him here, but no one more than I: Phil was, simply, the finest editor I have had the pleasure of working for. We wish him all the best.

The up side is that Phil has left BYTE marvelously positioned to continue bringing you the kind of solid, authoritative, and in-depth information you need—and that you've come to expect from BYTE. As the resolutions above indicate, we'll be building on those strengths to make BYTE even better.

We've made other resolutions—too many to talk about in this limited space—so they'll have to wait for another issue. But they all strike a similar note: Through 1988, we'll be working harder than ever to keep BYTE your premier source for expert information on personal computers. If a product or technology is at or near the cutting edge; if it's important and/or interesting; if it's aimed at sophisticated users; if it's genuinely useful or will become genuinely useful to you—folks who do the hand-holding, not those who need their hands held; then we'll cover it in BYTE. And we plan to cover it in a way that's just as authoritative, but more readable, more accessible, and more attractive than ever before.

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—Fred Langa
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Circle 63 on Reader Service Card

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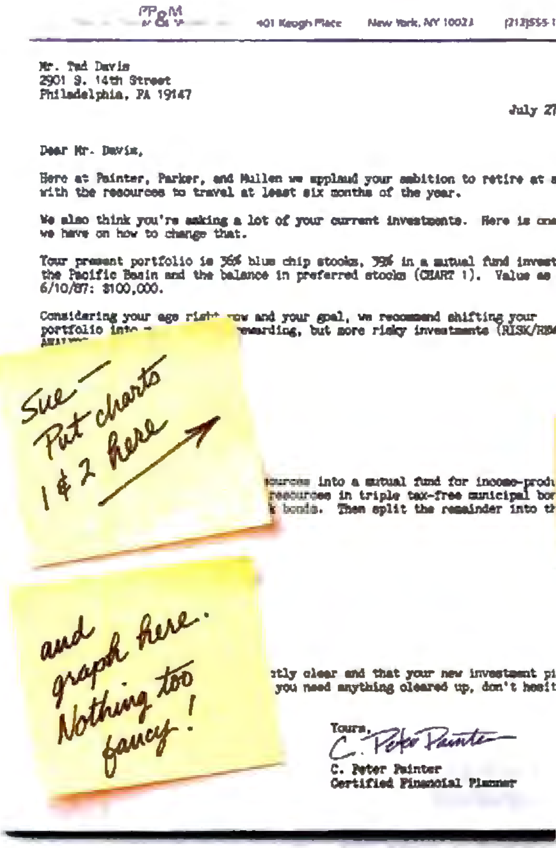

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Mr. Ted Davis
2901 S. 14th Street
Philadelphia, PA 19147

July 27, 1987

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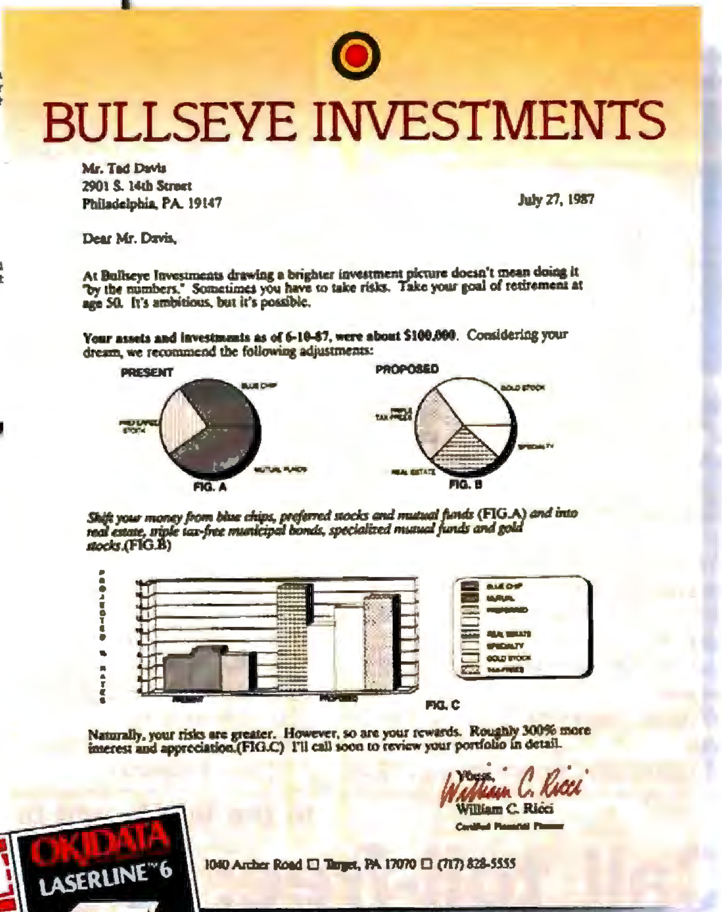

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FIG. A

FIG. B

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FIG. C

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Circle 191 on Reader Service Card

MICROBYTES

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

Price of Floppies Doesn't Guarantee Quality, Testers Say

Despite wide variations in the cost and quality of floppy disks, there's no apparent relationship between the two, according to a company that has done a comparative study of 5¼-inch floppy disks. Memory Control Technology Corp. (Omaha, NE), which manufactures disk-testing equipment and performs disk duplication services for software publishers, analyzed 18 brands of disks over the past few months. According to Jerry Korth, president of the company, the study was undertaken because of suspicions of declining quality in 5¼-inch floppies. Although many disks performed admirably, the results of the study proved those suspicions of a decline in disk quality to be true.

The company bought 10 boxes of 10 disks each at various locations throughout the country to ensure that it was using a representative sample of each brand. Prices varied tremendously, sometimes by almost 300 percent for the same brand. For example, Dysan disks were sold for both $23.90 and $8.40 for a box of 10 disks. The lowest price was $4.40 for Xidex-Precision disks.

Visual quality control also varied considerably. Disks from four manufacturers (Fuji, Kodak, Memorex, and TDK) had no visual defects. The remaining companies had disks with such defects as frayed and visible liners, jacket deformities, and contamination. One company's disks had three major defects: One disk jacket enclosed two disks, and two other disk jackets enclosed hard-sectored disks. Disks in another company's box were covered with what looked like human hair.

Memory Control Technology applied two standard ANSI recording tests to the disks. Only seven companies—BASF, JVC, Kodak, Memorex, Nashua, Sony, and 3M—had all their disks pass the "missing bit" test. Only five—BASF, Goldstar, JVC, Memorex, and TDK—had all their disks pass the "extra bit" test. No company had more than three disks fail the missing-bit test, but one company had 27 fail the extra-bit test. Other tests involved amplitude, modulation, resolution, and wear resistance. According to Korth, all disks performed outstandingly in these tests.

The final test involved formatting the disks on an IBM PC under optimal conditions. Of the 18 companies, 13 had 100 percent of their disks format without any bad sectors. Korth mentioned that this percentage is probably higher than what many people have experienced, because the PC used for the test was optimized for the lowest failure rate possible. The 13 companies whose disks passed this test were BASF, Fuji, Goldstar, JVC, Kodak, Maxell, Memorex, Nashua, Polaroid, Sentinel, Sony, Verbatim, and Xidex.

Korth said that predatory pricing policies of some disk manufacturers are having a deleterious effect on disk quality. Despite the fact that his company purchases many disks each year, Korth would prefer prices to be higher in the hope that quality would be more tightly controlled.

Optical Coprocessor Converts Raster to ASCII

While it was the hand-held optical scanner that can recognize typeset fonts that brought attention to TransImage Corp. (Sunnyvale, CA), the company's announcement that it will make its 68000-based optical-character-recognition (OCR) coprocessor board available to OEMs may have a bigger effect on image-processing applications.

At the heart of the board, which is currently an add-in card for the IBM PC, are custom gate arrays that attend to tasks such as character processing and classification. Character processing is accomplished in a chip called the Table Processor that uses proprietary microcoded "thinning" algorithms to essentially "peel away" the features of the character until an identifiable shape can be extracted. Two other chips take care of transforming the bit-level image data

continued

Nanobytes

Engineers at **Chips & Technologies** (San Jose, CA) "have become real fans" of IBM's Micro Channel Architecture, spokesperson Raj Jaswa told Microbytes Daily. "Our viewpoint is that the **Micro Channel market** will really take off," Jaswa said, predicting significant shipments of PS/2s and compatibles in the latter half of 1988. "With an average of three adapters per system, we see the market for adapters by 1990 as being in excess of 15 million units." . . . **Lotus Development Corp.** (Cambridge, MA) just says no to Windows/386. While Microsoft's Windows/386 has been hailed as a breakthrough for users wanting multitasking and a graphical interface on 80386 machines, Lotus has no plans to support it with 1-2-3. "Trying to shoehorn 1-2-3 into Windows will give sluggish performance," said Lotus spokesperson Greg Jarboe. Lotus users can get a graphical interface with the version of 1-2-3 that will run under OS/2. . . . Jim Harris, president of **Hercules** (Berkeley, CA), said the graphics-card maker expects to have a graphics board for the Mac II by next summer. The company recently said it would incorporate a **TOPS interface** to AppleTalk networks in a new version of its Graphics Card Plus. . . . **Rockwell** (Newport Beach, CA) says its R9696DP 9600-bps modem board will enable modem developers to implement the full **CCITT V.32** standard. The company claims the board, which is being sold to OEMs, represents a big step in full-duplex, dial-up modem technology. "We expect this product to lead to a new generation of high-speed stand-alone and PC-card modems," said Bill Baker, a Rockwell vice president. Until

continued

now, mass-market 9600-bps modems, such as those from Hayes and USRobotics, have only emulated a true 9600-bps transfer rate. . . . Tired of hitting keys or moving mice? **Very Vivid** (Toronto, Ontario) has come up with an alternative interface for Commodore's **Amiga** that consists of an Amiga 1000, a television camera, a digitizer board, and software. The camera is aimed at the user, and the system displays a two-color image of the user superimposed over a set of icons. The user chooses an icon by moving his or her image over that icon. The Midivision software is available now for $295. . . . The next frontier for E-mail developers, according to a speaker at a recent confab on **electronic messaging**, will be in the area of directories. "Standard directories will emerge so that you will know who is out there and how to route mail to them," said Peter Westwood of **Sydney Development Corp.** (Vancouver, B.C.). Westwood also said that problems of interconnection are not so problematic anymore. "Eighty-five percent of all systems can now be connected, and the islands of communications have disappeared." . . . The souping up of microcomputers has caused a quandary for developers of **turnkey CAD systems** whose products are dependent on a particular hardware system, says Ken Ledeen, president of CAD software house **Sigma Design** (Englewood, CO). Customers want to first choose the software they need and then buy the hardware, he said. "Turnkey CAD developers are in a difficult situation because hardware is changing so rapidly and dramatically," Ledeen said. . . . Practical **computer-aided software engineering** (CASE) tools might be a few years away, but some members of the industry are warning now that companies had better start investing in those tools if they want to be competitive. "If you consider that in about 10 years we'll be conversing with our computers, think about the enormous software development that will be required," Scott McNealy, president of **Sun Microsystems**

continued

into table image data. TransImage chairman and architect Jim Faulkerson said that prototypes of these and four other custom chips required fourteen 10- by 10-inch VME boards in a VAX development system, and it took 300 seconds to identify a single character. With the custom gate arrays and algorithms, the TransImage system can recognize 40 characters per second.

When analyzing a character, the coprocessor board operates at an image-acquisition rate of 8192 pixels every 1/100th second at a resolution of 1000 lines per inch. Faulkerson minimized the effect on performance of more powerful microprocessors, like the Motorola 68020 or the Texas Instruments TMS 34010, stating that the recognition-intensive tasks are handled by the custom gate arrays. Certainly the current high costs of other chips would not justify the performance improvements. Instead, TransImage will focus on adding new symbols to the table chips in the near future.

What may be significant to image-processing developers is that virtually any raster image stored on disk can be converted to ASCII data by "running" the image through the OCR card. Those raster images can be generated by scanning a document or by creating the images with a drawing program like MacPaint, PC Paintbrush, and others. Developers, of course, would have to write the software to the conversion, which should include operations such as character scale.

Although the initial coprocessor board is configured to work with the PC bus, a custom 8-bit bidirectional system interface chip on the board can be replaced by a chip to interface with other bus architectures—Micro Channel, SCSI, and so on. The board is currently available to OEMs at the single-quantity price of $1200 per unit.

E-Mail Growing; Users Sending Millions of Messages Monthly

Use of electronic mail systems shows no signs of tapering off, said an industry analyst at a recent Electronic Mail Association conference. According to Walter Ulrich, a partner in Coopers & Lybrand's technology consulting firm (Houston, TX), more than 150 million electronic messages are sent every month by more than 5 million E-mail users in the U.S. alone. Ulrich said 74 percent of the major corporations in the country currently have E-mail systems in place (and another 14 percent plan on installing them within the next 12 months); 80 percent of the professional staff of those companies use E-mail on a daily basis, he said.

"E-mail usage is greater than expected," Ulrich said, "and with the network infrastructure already in place and the cost per message declining, E-mail should continue to proliferate." Ulrich claimed that E-mail is the primary application large companies plan on adopting, outdistancing voice mail, electronic (desktop) publishing, and video conferencing. He added that installation of local area networks (LANs) has aided in the proliferation of E-mail systems. Ulrich said that the current 150,000 LAN sites (with 3 million nodes) is expected to increase to over 3 million sites by 1990 and that E-mail will be the major application used in those networks.

The predominant trend in the future, Ulrich said, will be the linking of multinational companies with their overseas affiliates. "We need to interconnect worldwide and focus on the international market," he said. Interconnection across competing public electronic systems remains one of the critical issues facing E-mail vendors, he cautioned, acknowledging that users will pay a premium for sending messages across systems. He predicted that by 1991, the total E-mail business will be worth nearly $3 billion, and "if that isn't incentive for interconnecting, I don't know what is."

How Do You Clone a PS/2? Very Carefully

Although it has announced board-level products that can emulate the logic chips in the IBM PS/2 Models 50 and 60, Western Digital (Irvine, CA) is proceeding very cautiously in its cloning of PS/2 systems. According to Ed Marinaro, chief operating officer at the company, it is being very careful to avoid legal entanglements with IBM over copyrights, trade secrets, or patents related to the PS/2 series.

Western Digital used three sets of engineers to design gate-array chips that emulate the IBM systems. A "forward-engineering" group was given a set of

continued

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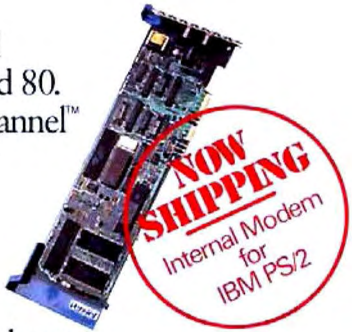

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Circle 282 on Reader Service Card

(Mountain View, CA), told a press conference at which Sun introduced its Network Software Environment. Sun cofounder **Bill Joy** was a little more aggressive in his exhortations. "It's time to recapitalize software development, **throw out those minicomputers,** and give [programmers] reasonable computers and new development tools," Joy said. . . . Joy also took a swipe at closed architectures. "When the next good idea comes along, you won't be able to use it in a closed operating system," he said. He predicted that **Unix** will grab half the market for operating systems on desktop computers. Developers who scoff at Unix will regret it, he said. "It's like all those developers who ignored the Macintosh. Now that it's starting to sell well, all they can do is stand on the sidelines and watch."

specifications and asked to design a system that would meet them. The other two groups reverse-engineered the IBM systems. The results of each group were closely compared with each other. The final design, however, most closely resembles the efforts of the forward-engineering group. According to Bill Frank, a senior vice president at Western Digital, the system has a much different architecture than IBM's and uses 63 additional devices.

As for the patents that IBM reportedly has for its Micro Channel Architecture, Western Digital says it is addressing this issue by engaging in a patent exchange with IBM.

For the job of emulating IBM's BIOS chips, Western Digital is taking a slightly different approach. Here, the company has two sets of developers, one a group of analysts and specification writers and the other a group of code developers, called "virgins." Both groups are separated by a group of managers. The developer groups cannot directly communicate with each other, but they can talk with the managers; all communications must be in writing and time-stamped.

Western Digital says it is spending $10 million on the development of PS/2-compatible systems. Although it has announced chips that can emulate almost all the functions of the PS/2 Models 50 and 60, the company says it will not announce a compatible BIOS until sometime next year.

Western Digital's Paradise Systems division says it was able to get a head start on building a VGA-compatible chip by watching certain market events. For example, IBM's large purchase last year of 31.5-kilohertz monitors from a Japanese company gave some idea as to the features of the new graphics protocol Big Blue would use. But Western Digital's Faraday division had no such hints about the features of the PS/2s; company officials say they had to wait until they could buy a machine, which they did at 12:01 in the morning of the first day the computers became available.

C&T Chip Could Mean Cheaper Controllers

A new 3270 protocol controller chip from Chips & Technologies (San Jose, CA) could drastically lower the end-user price of 3270 emulation cards used in personal computers for micro-to-mainframe connections.

Microcomputer add-in boards that are designed around the integrated CHIPSLink 82C570 microprocessor can be built with as few as seven chips, said C&T product manager Pat Chiumiento. That's far fewer than the number of chips that are on boards like the DCA IRMA card, which has approximately 45 components.

Chiumiento showed Microbytes Daily a seven-chip working card built by C&T as a development tool. He speculated that street prices for such a card will probably be in the range of $200 to $250, which is much lower than the current retail price of nearly $1200 for IRMA cards.

The C&T chip itself could be considered a microprocessor, since it has an on-chip sequence controller and arithmetic and logic unit enabling it to run at 4.7 million instructions per second. On one end, the 82C570 is compatible with both IRMA and IBM hardware and software environments; on the other end, it is compatible with the PC XT/AT bus. When it is used in conjunction with a companion chip, the 82C574, the 82C570 is also Micro Channel–compatible. The chip can be customized via external microcode for special applications or product differentiation.

Borland Says New Debugger Signals "A New Generation"

Borland International (Scotts Valley, CA) will soon release a debugger for its Turbo C compiler that the company says will be the first of "a new generation of debuggers." What makes the upcoming package different from current debuggers, according to spokesperson David Intersimone, is that it will combine the properties of source code and data debuggers, allowing programmers to see the actual data itself, not just pointers to the data.

"Source-level data debugging is completely different from anything else," he said. "The concept of looking at the data types is really unique." Other debugger features, said Intersimone, include record-and-playback capabilities and a "log" that records what changes were made to a listing, when those changes were made, and who made them. The debugger will also provide contact-sensitive help and overlapping, multiple-source file windows.

"These are the sort of tools that came from our internal needs," Intersimone explained. "We analyzed what tools we need and what we do when developing products, and we built these tools into the debugger."

The initial implementations of the debugger will support Borland's Turbo C package, but Intersimone indicated that future versions will support Turbo Pascal and Turbo Basic.

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LETTERS

and Review Feedback

On the Epson GQ-3500

In response to the review "Laser Printer Times Four" by Wayne Rash Jr. (October 1987), I would like to clarify some incorrectly stated features regarding the Epson GQ-3500 laser printer.

Mr. Rash states, "Without emulation cards, you're stuck with Epson LQ emulation, and not all software supports it." In fact, the GQ-3500 comes with built-in code sets for the Epson Page Printer and Epson LQ printers, as well as line-printer emulation.

In addition to the built-in code sets, there are optional emulation cards for the Diablo 630 and the Hewlett-Packard LaserJet Plus. The Epson GQ-3500 is supported by leading software packages, including Framework II under either the Epson Page Printer or LQ emulation.

Mr. Rash further states, "Many printer functions must be set by software. This includes normal printer operations, plus those operations unique to laser printers, such as printing multiple copies." The fact is that, through the use of the GQ-3500's SelecType control panel, the user can select paper size, number of copies, print orientation, font, international character sets, character pitch, line pitch, and weight.

Dave Thompson
Marketing Support Engineer
Epson America Inc.
Torrance, CA

Epson may well be correct in stating that the GQ-3500 is now supported by a number of widely available software packages. That was not the case when the printer was provided to me, and the company was also not able to provide the emulation modules that are now standard with the machine. Because these capabilities were not available, they could not be tested as part of the benchmarks.
—Wayne Rash Jr.

Wayne Rash Jr.'s review of the Hewlett-Packard LaserJet Series II states that "the manual fails to mention that you have to turn the printer off and back on again for the [function and font] choices to take effect." What the manual does mention is that you must reset the printer. Pages 2 through 18 of the user's manual explain the procedure completely.

You simply take the printer off-line, then hold the Continue/Reset key down until Reset appears on the LCD panel. This also works when the printer gets confused by either software or operator problems.

John W. Sawyer
Allentown, PA

Predefined vs. Customized Formats

I read with interest Jonathan Robie's October 1987 review entitled "Three C Language Screen-Utility Packages for PCs" and must congratulate him on a job well done. But there is a point that some readers may overlook or find confusing.

Mr. Robie points out the limitations that arise from predefined formats and other vendor assumptions about the user interface. He then goes on to suggest that Vitamin C is limiting because it avoids predefined assumptions by allowing programmer-supplied routines to be inserted in key places for customized operation. He criticizes both flexibility and inflexibility, and in doing so he presents a contradiction that may leave some readers confused.

Realizing that it is virtually impossible to please all the programmers all the time, we designed Vitamin C with various standard options, behaviors, and data types. This allows typical applications to rely upon these predefined elements and be developed quickly. We also created a mechanism whereby programmer-supplied routines can be installed to customize Vitamin C for virtually any application need. This adds the flexibility to create a customized interface.

For the record, a generic version of Vitamin C is also available for Unix and Xenix environments. It will run on virtually any host machine and is not limited to XTs and ATs.

Jeff Betts
President, Creative Programming Consultants Inc.
Carrollton, TX

It is important to let users extend or modify the data-entry procedures. Very general routines offer this flexibility but require more work from the programmer than routines designed for more specific tasks. All three packages reviewed, including Vitamin C, have a robust set of general routines and use these as the basis for more specific routines. This makes it possible to have a large number of very specific routines without limiting the programmer who has special needs.
—Jonathan Robie

Just in Time

Thank you for the In Depth articles on workstations (November 1987). I work in purchasing for the New York state government, and the professors and students at our numerous state universities have been clamoring for a workstation contract. Your side-by-side comparisons and history of this field could not have been more timely.

Lynn Ellsworth
Albany, NY

Calculating Points

In reply to Jean-François Colonna (Letters, August 1987, page 16), I, too, wondered about the effect of truncating numbers in Peter B. Schroeder's "Plotting the Mandelbrot Set." I have written machine-code arithmetic for speed using 40-bit fixed-point numbers, which produces results comparable to those from other computers and programs.

The choice of pixel spacing has a much greater effect. I find it truly remarkable that although a pixel is a square of one unit side, the calculation is performed for a point of zero area situated at one corner. It is possible to calculate a greatly magnified picture that, if suitably chosen, is full of fine detail. When the same area is calculated with a coarser pixel spacing, the general form of the picture is the same even though the points of calculation fall more or less randomly against the pattern. I believe this is due to the connected nature of the set, along with the characteristic that points adjacent to the set have

continued

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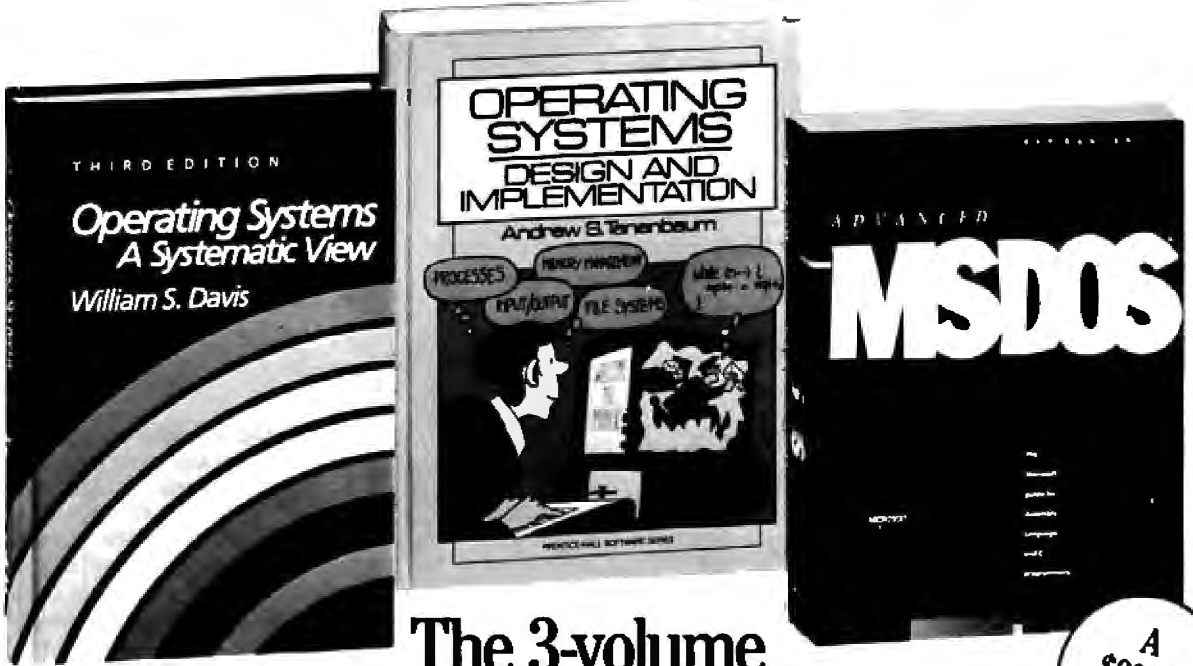

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large escape times that decrease steadily as the point is moved away. A point may miss the set, but its value will reflect the proximity or other features of the set.

I also wrote a program to run on a Z80 that can be used to calculate a single point at any level of precision up to 250 decimal digits in floating-point format. At a clock frequency of 6 MHz, it does 5 divides, or 6 products per second, at maximum precision, so it's definitely not for display work.

J. Keith Wood
Liverpool, U.K.

Satisfying the Skeptic

The heuristic algorithm Peter Wayner describes in his article "Zero-Knowledge Proofs" (October 1987) is designed to satisfy a skeptic of the identity of the prover without revealing secret knowledge to the skeptic. This condition is much stronger than that required by most of the applications where Mr. Wayner suggests it might profitably be used. For example, a program verifying the identity of a user can know the password; this information must be concealed only from all witnesses to the exchange.

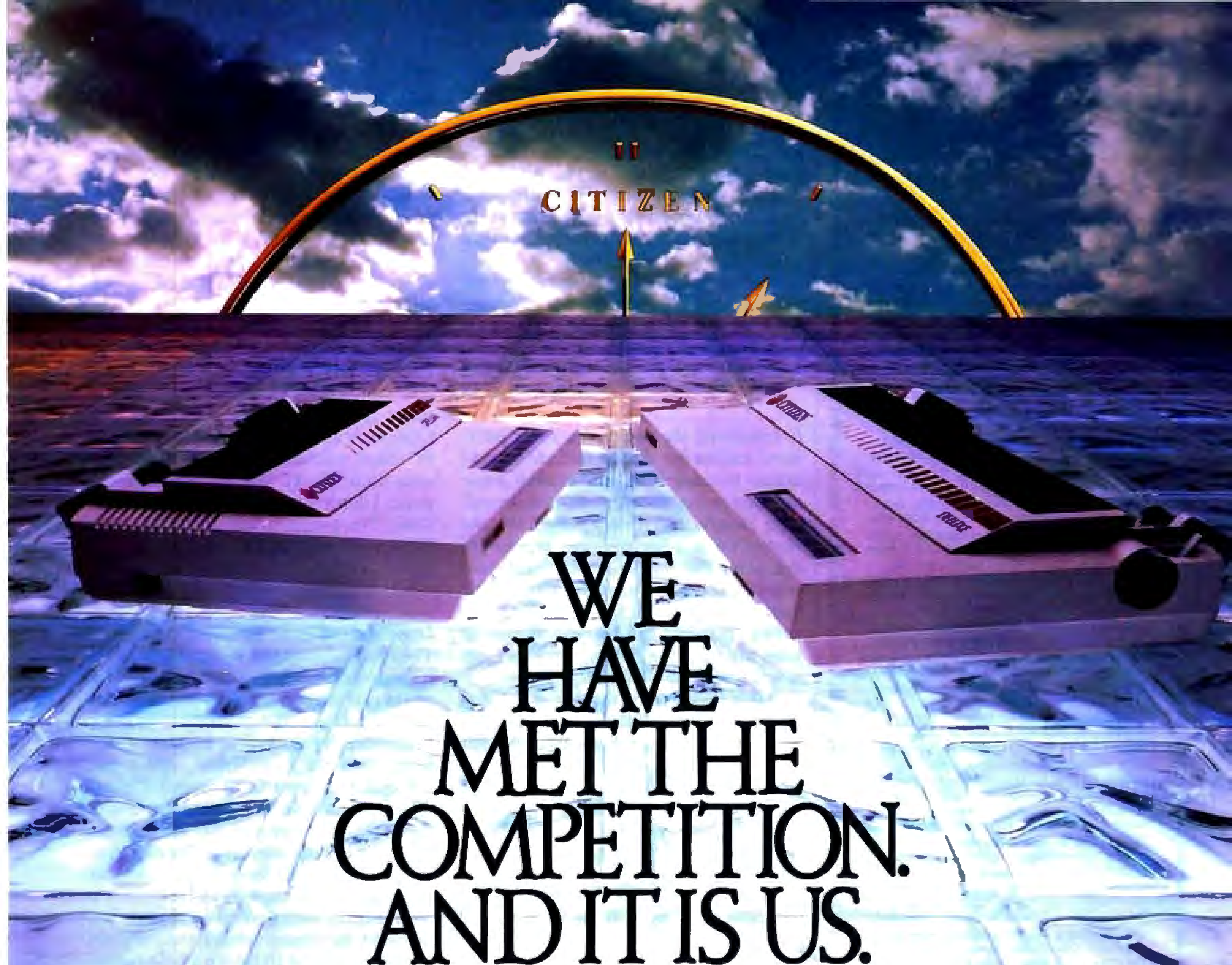
For this lesser purpose, it is not necessary to use a one-way function, just an interactive exchange. A simple algorithm would have the skeptical program display four random digits and invite the prover to reply with a single digit. The correct response would be the result of a simple computation: the sum, difference, product, and/or quotient of some of the digits displayed. This exchange could be repeated until the skeptic was satisfied.

Often in programming we must choose between implementing certain logic in data or in code. This technique is the code analog of a password: The password is a simple expression like "the product of the first and third digits mod 10" or "twice the fourth digit less the third." Since no witness would see the same four digits when he or she tried to sign on dishonestly, knowing the response to any single set of four digits would be of no help.

Peter Cyrus
New York, NY

I read Peter Wayner's "Zero-Knowledge Proofs" with interest. Another approach to this problem is to use encryption. Suppose the user and the computer agree upon an encryption standard and password. Then when the user tries to log in, the computer can present him or her with a random list of words, and the user can encrypt them using the agreed algorithm. So, for example, the computer says DOG and the user encrypts it and replies with

continued



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XER, the computer says CAT, and the computer replies XY3, and so on. An eavesdropper will not be helped by hearing this exchange, since on the next attempt to log in, the computer may present the word WHEELBARROW for encryption.

This approach is fundamentally the same as that discussed by Mr. Wayner, but I think it helps to make some of the issues involved a bit clearer.

James Hamilton
Dublin, Ireland

I considered the same idea for a password scheme but did not include it in my article because both parties must know the encryption process. In zero-knowledge proofs, the prover never lets the skeptic know what is being proven—in this case, that the prover knows the encryption-correct algorithm. The skeptic learns only that the prover couldn't be wrong. If public-key encryption systems were used in your system, however, you would have a zero-knowledge proof.

It is a handy idea, though, and I may implement it in the future.

—Peter Wayner

BASIC Windowing

I found "Windows for BASIC" by John W. Ross (*Inside the IBM PCs*, Fall 1987) interesting and instructive, but a few statements about windowing in BASIC require correction. Mr. Ross does his windows for BASIC in assembly language, claiming that windows cannot be done in BASIC itself, since they are "excruciatingly slow" in the interpreted version of the language—and that compiling "doesn't help much."

To prove the opposite, I wrote a very short BASIC program (see listing 1) named WINDOW.BAS. The program opens and closes a window in the graphic mode. It also times itself: My results for a CGA were about 0.11 seconds on an IBM PC-class machine and about 0.05 seconds on a PC AT (80286) type of computer. I don't think this can be considered slow. The program was compiled using Microsoft QuickBASIC version 3.0.

Maciej Zgorzelski
Flint, MI

Listing 1: *WINDOW.BAS.*

```
DEFINT A-Z
CLS : SCREEN 2
DIM A(600),B(600)
FOR H=300 TO 600 STEP 10:
     LINE(H,0)-(H,199): NEXT
FOR V=20 TO 180 STEP 10:
     LINE(300,V)-(600,V):
     NEXT
LINE(100,100)-(210,112),,BF
LINE(100,112)-(210,184),,B
GET(100,100)-(210,184),A
START:
LOCATE 1,1:PRINT SPC(25)
LOCATE 1,1:INPUT;"press
     return... ",A$
STARTONE!=TIMER
I=320
GET(I,I/4)-(I+110,I/4+84),B
PUT(I,I/4),A,PSET
ENDONE!=TIMER
LOCATE 1,1:INPUT;"press
     return again... ",A$
STARTTWO!=TIMER
PUT(I,I/4),B,PSET
ENDTWO!=TIMER
LOCATE 2,1
PRINT "Opening window took"
     ENDONE!-STARTONE!
     "seconds"
PRINT "Closing window took"
     ENDTWO!-STARTTWO!
     "seconds"
GOTO START
```

In Search of True Resolution

The most misused term related to printers is "resolution." If in the data sheet of a worldwide-known company you read that its 24-pin impact dot-matrix printer has a "resolution of up to 360 by 360" (i.e., better than the LaserWriter, which has 300 by 300 dots per inch), then this is not true and can never be. In the same data sheet, you can also read that the "pin diameter is 0.2 millimeters." Try to divide 25.4 mm (1 inch) by 0.2 mm, and you will find that the result is 127.

This is not even the real resolution, because in the typographical industry the line resolution of 10 lines per mm means that in a 1-mm space you have 10 positive (black) lines and 10 negative (white) lines between them, both of the same width. The term "resolution" signifies that you must be able to distinguish between the printed (black) lines.

"Page Printers" by Rick Cook (September 1987) contains an explanatory example of this true resolution in figure B on page 193—an enlargement of a 300-dpi test pattern. In the above example of 360-dpi resolution on an impact dot-matrix printer, the authors are in reality speaking of graphic point *density* of 360 dots per line—their printer can pack 350 overlapping dots into one inch.

So far, I have been unable to find in any literature an exact definition of resolution in terms of dpi that is valid for dot-matrix and other printers. It is deplorable that the manufacturers do not care. Only the lack of a real standard makes such a misleading declaration as in the above-mentioned example possible and can confuse all of us if we wish to compare the real resolution.

The September BYTE contained many extremely well written and useful articles

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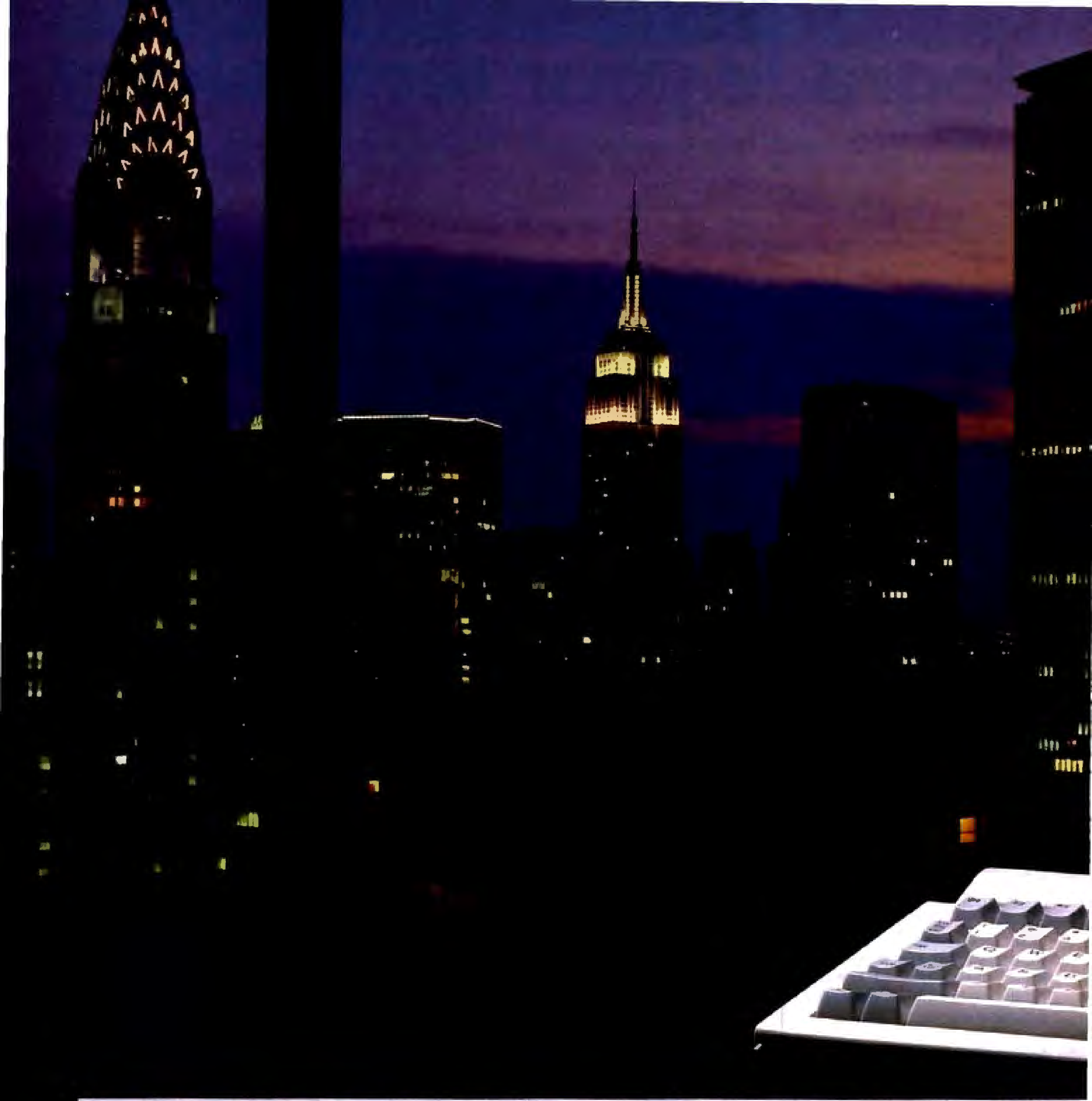

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dedicated to printer technologies. However, "resolution" was not always correctly explained.

For example, Lars Jansson's article entitled "Print Quality" states, "We find this in laser printers with a resolution of 300 by 300 dots per inch and a dot size of about 0.1 mm." Here a wrong word is used. This is not a true resolution in typographic industry terms. If we wish to compare a resolution of a photo printer (for example, Linotronic) and a laser printer, we have to use the terms "line" and "dot" in the same sense.

If this statement regarding diameter of dots is right, then such a laser printer has only about a 127-dpi resolution. For a real 300-dpi resolution, the dot diameter has to be 0.00166 inch (0.042 mm) at most.

Compare this with the proper wording in Julio Guardado's article "Color Thermal-Transfer Printing": "The ColorMaster design places up to 200 dots per linear inch, each dot with a 0.005-inch diameter." This is exactly right, because the author uses the word "places." Here the resolution would be 100 dpi.

As for impact dot-matrix printers, the best ones with a wire (pin) diameter of 0.2 mm have a true resolution (theoretically) of 63.5 dpi, and the more common 0.3-mm wire ones have a resolution of only 42.3 dpi.

Jaromir Smejc
Prague, Czechoslovakia

Calling All Macros

The members of our group are avid users of macros to aid our word-processing tasks. We define macros as prerecorded keystrokes that are fed into a program one at a time when a signal is given.

While books are available on the use of macros in spreadsheets, less attention has been paid to their best use in word processing. Accordingly, we have started a Macrobank, an exchange service for word-processing macros so that good ideas can be disseminated to others. If readers send us a 3½- or 5¼-inch MS-DOS floppy disk (any density) containing macros they use, we will incorporate those into our collection of macros and send contributors a complete set.

The macros don't have to be especially complex. We are interested in all the macros readers use, particularly the simple ones they use every day. Readers should consider anything they send us to be in the public domain, as we will make the macros available to other macro users without charge.

Rollie Cole
Paul Sommers
Macrobank
14022 23rd Ave. NE
Seattle, WA 98125

Ada's Not Complete

I have read many extreme statements about Ada, both pro and con, but never have I read a claim as far out as Mark Fowler's (Letters, October 1987, page 22): "Ada is complete; substitutions are not needed."

Ada is seriously deficient in character handling. It lacks variable-length strings, not to mention string scanning facilities. Compare Ada's string handling to PL/I, and it looks seriously incomplete; compare Ada's string handling to SNOBOL 4, SL/5, or ICON, and it looks ludicrous.

Ada is missing several important control structures. It has no mechanism for backtracking, no coroutines, and no decision tables.

Ada does not allow the programmer to define new operators, only to overload existing ones. Again, not only is something missing from Ada, but something is missing that another language (ALGOL 68) has.

Ada is not only incomplete, it is not

continued

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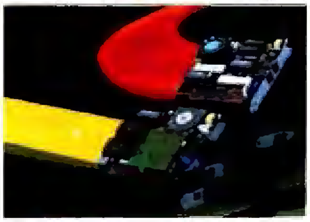

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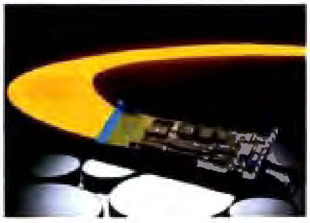

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even orthogonal. If I can have entry (task) arrays, why can't I have procedure arrays?

Of course, you could say that all these missing features, and many others, could be simulated. But the same claim could be made for any other programming language. In fact, attempting to simulate missing features in a language is likely to lead to a long string of unpleasant surprises, and any claim that, say, RPG is complete, would be specious, as is the claim for Ada.

If you tell me that the limitations of Ada are reasonable, given its restricted domain, I might buy that. But to claim that it has no limitations is dishonest, not to say absurd.

I think that Ada is a dammed good start. I just don't think it is a finished product yet. What's worse, with the Department of Defense's opposition to extentions, I doubt Ada will ever be allowed to grow into a real general-purpose language. That's a shame, because after some experimenting with extensions, I think that it would be possible to define an "Ada 89" that would be a pleasure to program in (but it's still not perfect, or even "complete").

Seymour J. Metz
Annandale, VA

Random Point Distribution

Dick Pountain's article "Spraying and Smudging" (November 1987) is an interesting introduction to some graphics techniques, but a couple of points seem worth making.

First, concerning the random points in the Euclidean plane generated by choosing a uniform [0,360] angle and a uniform $[O,R]$ random radius: Contrary to Pountain's assertion, the resulting distribution is not uniform over the circle of radius R. For any r, $0 < r < R$, the random points falling on a circle of this radius will be uniformly distributed over its $2 \times \pi \times r$ circumference. Thus, for example, the probability density of random points at radius $r = R/2$ will be twice that at radius $r = R$.

Second, concerning the random points generated by choosing x and y coordinates, within the circle of radius R, from a triangular density: The resulting density is not constant on circles. In fact, this density is constant on contours of the form

$$|x| + |y| = r,$$

which are diamond-shaped. Incidentally, the normal distribution for x and y that was first considered does produce a density over the circle that is constant on circular contours.

Richard V. Fuller
Marietta, GA

Dye-Sublimation Printing

The Printer Technologies theme (September 1987) appears to have an incredible omission—dye-sublimation printing. While similar to thermal-transfer printing, it is also somewhat different. The thermal head transfers dye only to the receiver—no binder, no wax. Further, by continuously varying the heating pulse, a variable amount of colorant is transferred so that individual pixels can have gray scale. For comparison, thermal-wax-transfer and ink-jet printers must use a group of pixels to produce a half-tone image. Even photomechanical printing uses dots of various sizes to produce gray scale with the printing density (mass/area) of colorant always fixed.

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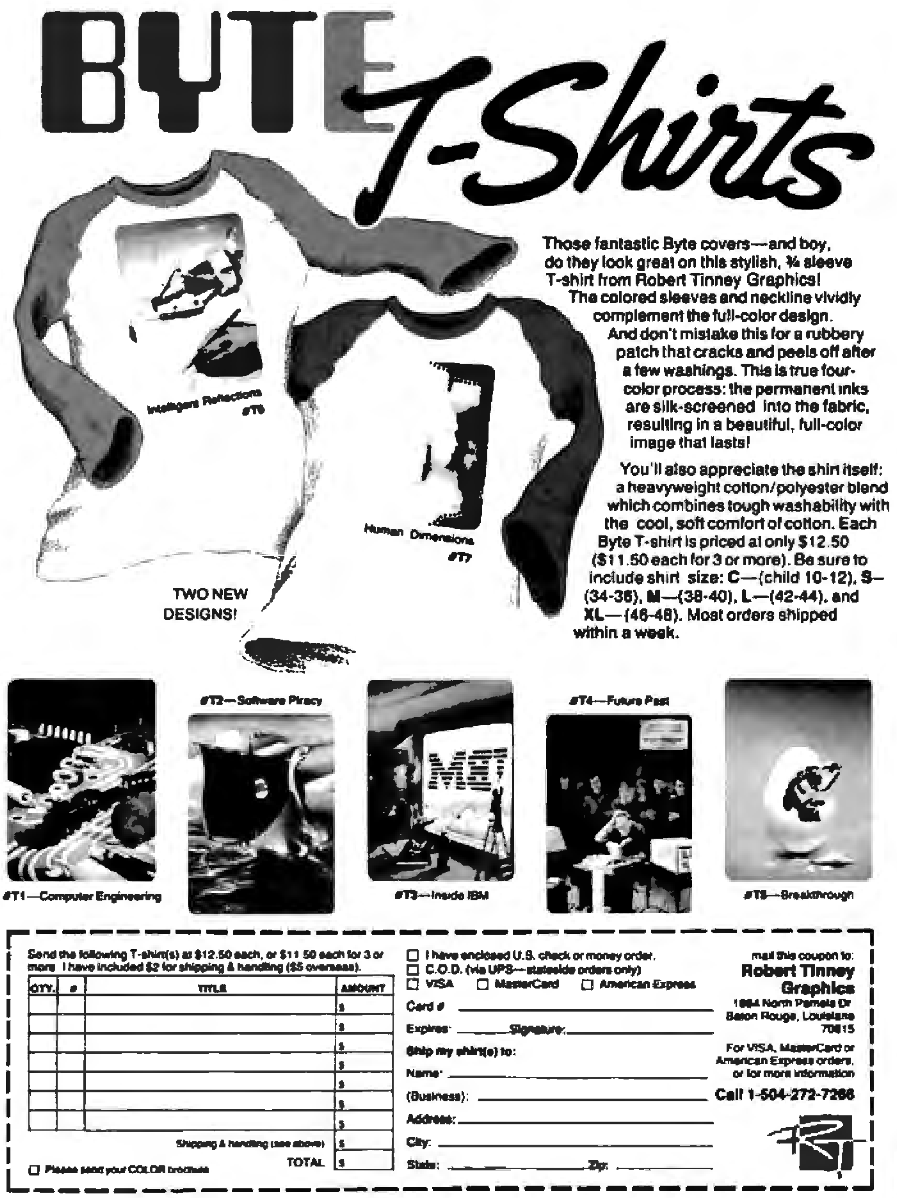

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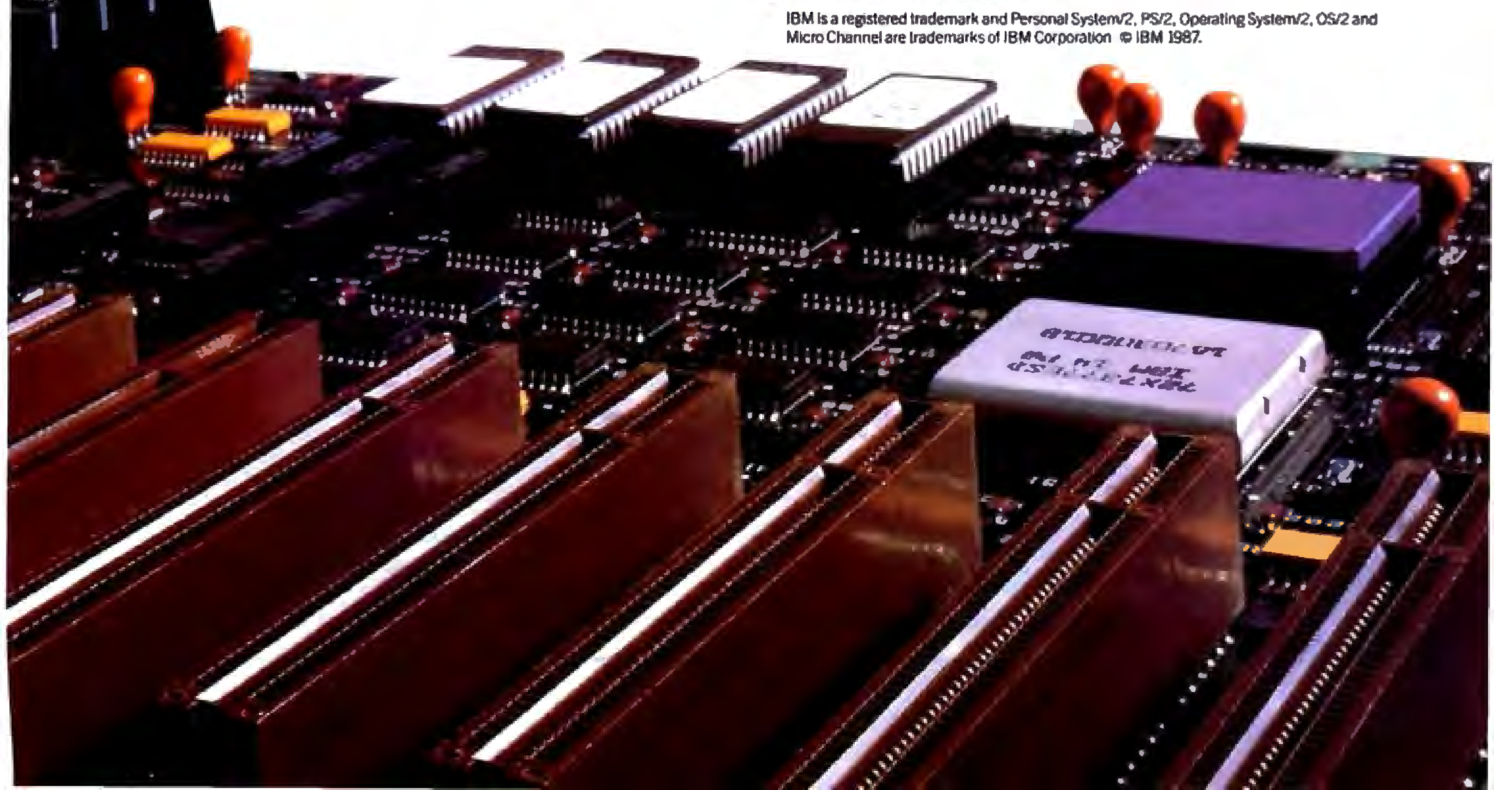


step is just that this process makes "soft" dots, and printed pixels may be in 1-to-1 correspondence with color video monitor/storage systems. Companies with prototypes or products already on the market include Hitachi, Sony, Fuji, and Kodak, and we can probably expect full-page (8½- by 11-inch) printers about a year from now. Smaller-format (4- by 6-inch) printers are available now. You haven't appreciated a high-resolution screen dump in color until you have seen it in this media.

L. M. Marks
Mississauga, Ontario, Canada

False Claim

Roman A. Dyba (Letters, October 1987, page 12) says that a claim in my and Brian Wichmann's article "Building a Random-Number Generator" (March 1987) is untrue. Specifically, Mr. Dyba says that if $x1$ and $x2$ are independent and uniformly distributed over the range (0,1), then the combination of $x1$ and $x2$ will also be uniformly distributed over (0,1). He is wrong.

We are well aware that the sum of $x1$ and $x2$ is not uniformly distributed, but we had defined "the combination" to mean the *fractional part* of the sum, not the sum itself. Of this, the statement is true.

David Hill
Harrow, Middlesex, U.K.

AI Limits

I read with interest George Beinhorn's book review of *Intelligence: The Eye, the Brain, and the Computer* by Martin A. Fischler and Oscar Firschein (August 1987). One question Mr. Beinhorn posed interests me: "What are the inherent limitations of artificial intelligence?" Obviously, we should not waste our efforts attempting to do the impossible. It is unfortunate that the field of AI seems so unaware of the fact that this question has been given thorough treatment in the past by writers from other disciplines.

The subject of human intelligence and how it relates to nonhuman entities is treated thoroughly in a book called *The Difference of Man and the Difference It Makes* by Mortimer J. Adler. Written in 1967, the book clearly explains intelligence and how it is qualitatively different between humans and animals. Adler also addresses the subject of machine intelligence, and he issues specific challenges to the field of AI. People working with AI should read this book to understand the problems they are confronting and learn about what a machine can and cannot do.

Marin David Condic
Parsippany, NJ

Thanks for the Accelerators

Thank you for "80286 Accelerators" by Raymond GA Cote (November 1987). I have tried, without success, to talk with accelerator manufacturers about their products—do they work, how do they work, when do they not work, and with what are they compatible or incompatible? All I could get out of them was the promise that if it didn't work, I would get my money back.

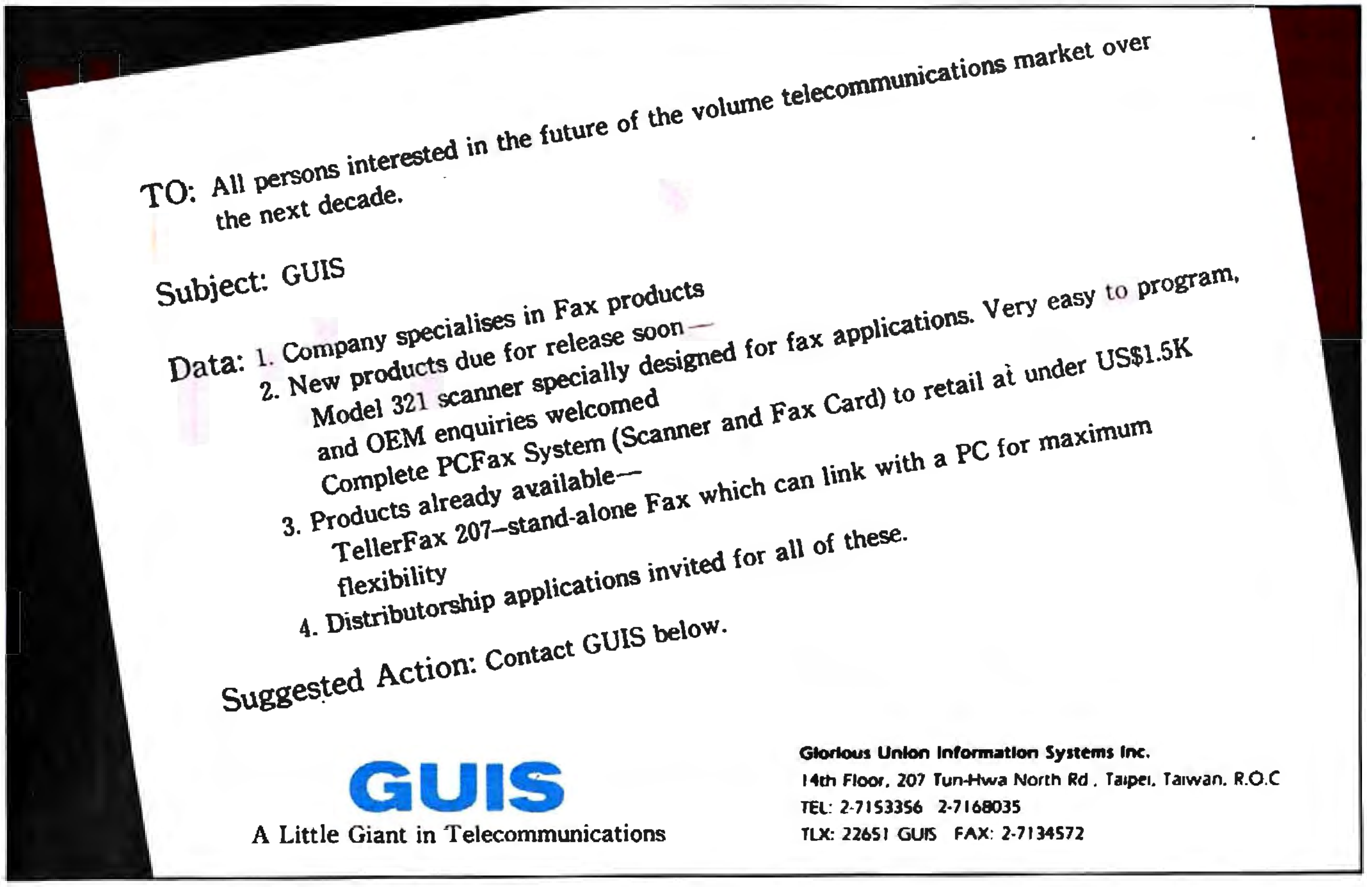
Now I'm glad I didn't do anything at all. The secret was to hold out for a faster system, not to junk up my existing one. If I really do need more speed, I ought to be able to justify it. If I cannot, then I should not try to justify a chancy second-best.

Sid Phillips
LaGrange, GA

Acer vs. Compaq DOS

I am writing in response to Ed McNierney's review of the Acer 1100 80386 clone ("Acer 1100 and Micro 1 386+," November 1987). I have an 1100 at work.

continued



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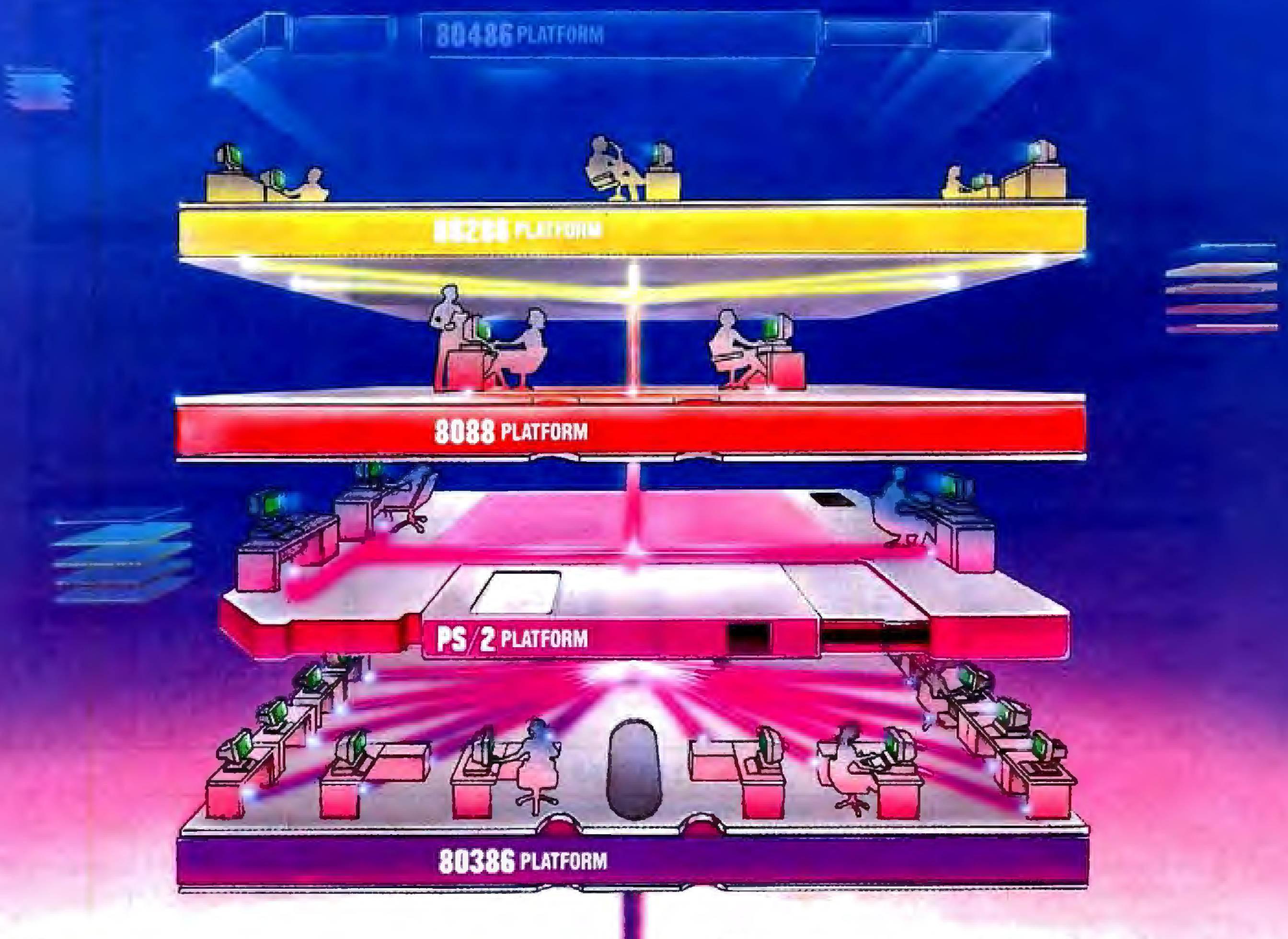

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LETTERS

The hardware seems solid, but the version of DOS provided with it (3.20) has some serious bugs. Most notably, certain programs that redirect LPT1 to COM1 fail miserably unless you slow the machine down to 4.77 MHz. These problems don't occur if you boot the machine with Compaq DOS version 3.1.

Additionally, Microsoft Windows/386 will not run whatsoever under Acer's DOS. The machine blurts out `Error: Unsupported Intel 80386 CPU version` or `Error: Incorrect DOS version`. Yet, again, if you boot off a Compaq DOS (version 3.1) floppy disk, Windows/386 comes up and runs just fine (on the machine that gave the `Incorrect DOS version` error—the machine that gave the `Unsupported Intel 80386 CPU version` error still would not run Windows/386).

John Roberts
Portland, OR

Reader Request

I normally work in a Unix environment, but I use an IBM PC under MS-DOS 2.x frequently enough to warrant pursuing the following task: Is it possible to have the shell (via a batch file) read an ASCII file and return the contents on one line of that file in the context of $1, $2, $3, and so on, so that I can branch to different parts of the .BAT file depending on the state of some routine?

One application could be to determine if the communications port is configured for printer *x* or printer *y*. The only way I can think of to automate this feature in a .BAT file is to be able to pass the information from an ASCII file to the shell in some way. Can that be done without coding in assembly language? Perhaps through Turbo C? Do readers have any suggestions?

Jacques Cazier
Houston, TX

FIXES

Pricing Error

In the Items Discussed box for Computing at Chaos Manor for September 1987, we incorrectly reported the price of Definicon's 68020 boards for the IBM PC. Prices for the boards begin at $1094 for a 12.5-MHz board with 1 megabyte of RAM (not upgradable). Models with faster CPUs and more RAM are also available, such as the DSI-785/4, which costs $6610 and includes a 25-MHz CPU and 4 megabytes of RAM (upgradable to 16 megabytes).

How Much Is That Pup?

SK Data alerted us to a pricing error in the announcement of its Golden Retriever Pup on page 18 of our Fall 1987 *Inside the IBM PCs* issue. The Pup sells for $5, and Golden Retriever sells for $99.

VCR Technology Tape Backup

On page 70 in the November 1987 What's New section, we incorrectly stated the name of the company that makes the VAST device. It should be Emerald Systems Corp. The item also states that the VAST device will back up data from a CD-ROM. It will not.

HYPERchannel Fix

We would like to clarify a statement in "A Look at Apple's Cray Simulation Engine" (Microbytes, September 1987). HYPERchannel is not the I/O channel on the Cray supercomputer but is a separate piece of hardware sold by Network Systems Corp. for networking computers of various manufacturers. HYPERchannel is the registered trademark of Network Systems Corp. for use with Network Systems' network adapters. ■

CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics.

Still Speedy After All These Years

Dear Jerry,

I was very interested in your August column about benchmarking two BASIC compilers—so interested, in fact, that I dug out my dusty old Sinclair QL and fished around for my copy of the SuperBASIC compiler SuperCharge.

After entering the benchmark test and compiling, I was rather pleased with the results. Remember, this is the very slowest configuration of the 68008 QL (some RAM expansions increase speed by more than 50 percent), using a very old version of a now much-enhanced compiler, compiling a very powerful version of BASIC (more so than QuickBASIC, at least, and I have used both extensively). The times I—or rather the computer, since I used its clock for accuracy—got were:

	Time	Code size	Data size
Slow	3:58	8006 bytes	51,200 bytes
Fast	2:52	9796 bytes	51,200 bytes

The fast version of the benchmark used the compiler in-line code option—hence the larger code size. These results raise some questions. What would the results have been with the latest compiler and a fast RAM expansion? We could easily expect times in the 1-minute range for the Fast benchmark—and not an 80286, 80287, 80386, or 80387 in sight! What rubs in the point even more is that the benchmarks were, of course, running under QDOS and were therefore multitasking with BASIC (which is more than MS-DOS can do).

Perhaps more people should pay attention to this long-forgotten machine. And its price in England? The QL is £99, the compiler £80 (for the new, faster, more powerful program called Turbo).

Danny Ross
Basingstoke, Hampshire, U.K.

Fascinating. I knew the 68000 chip was good, but that's little short of amazing.

The Sinclair was one of the most frustrating machines ever constructed. The basic computer engineering was excellent, but the user interface and video were just plain horrible. Sir Clive Sinclair took the trouble to show me his new "notebook" machine a few months before it came out, and it seemed to me to have the same pattern: really excellent design and concept, but little appreciation for the small things that help market a system. I wish him well; he's done a lot for the computer revolution.—Jerry

How to Publish?

Dear Jerry,

This letter is a request for advice. If you are not in an advisory mood, please feel free to use file 13. My ego won't survive, but that's all right.

Back in the dark ages, as a graduate student, I developed a set of FORTRAN II multivariate statistical programs for use on my research project. In the ensuing years, every time I used one of the programs, I promised myself that I really would get busy and develop them as a coherent system. Twenty years ago they actually did get translated to the new, superpowerful FORTRAN IV.

Two years ago, several things happened nearly simultaneously. First, I involuntarily became a former geologist. Second, Albert the Compaq homesteaded my dining room. And third, I fell in love with C.

To while away the time between nonexistent interviews, I began work on my system, which consists of factor analysis, stepwise multiple regression, distance-based cluster analysis with dendrogram, multigroup discriminant analysis, multigroup canonical analysis, and a standard data-file construction program—all with dynamic dimensioning.

Much to my surprise and the relief of my friends, the Thélème system is now complete. During my thrashing about with translation and development, I discovered that there is no publication on number crunching in C; if mentioned at all, it is discussed as an afterthought. Also, source code for multivariate statistics, in any language, does not exist at a price below absurd.

Now for my request. I believe there is a market for my system as a book. Numerical procedures in C would be illustrated by the source code statistical system. This

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.

will, I hope, be possible at a price even poor starving students can afford. I am electing the book route because practitioners of any art balk at invariable canned products. In addition, a book would be more useful as a reference than a disk would be.

My experience in publishing is limited to company reports, where the manuscript is handed to the secretary and the author heads for the field until the furor abates. I also have some experience with journal publication, where the manuscript is mailed off and the author cowers in a corner under the slings and arrows of outraged referees. I have no idea how publication is accomplished in the "real world."

Any advice you may care to offer will be gratefully received.

P.S. Thanks for *Footfall*. Because most of my recreational reading is pure escape, I thoroughly enjoy a good blood-and-thunder space opera unencumbered with an intrusive moral or philosophy. By the way, what relationship does the biker in *Footfall* bear to a similar character in *Lucifer's Hammer*? They read like the same character with different names.

Fred E. Fisher
Katy, TX

The best advice I can give you is to join the writers conference on BIX; a number of professional writers give advice to newcomers.

The long answer is, you haunt bookstores until you find a company that publishes books like yours—Addison-Wesley, Que, John Wiley and Sons, and Osborne/McGraw-Hill come to mind. Decide which of those appeals to you, and write a good letter of inquiry. If you have the manuscript completed, send it; if not, send in at least one good sample chapter and an outline of what the book will contain.

The cover letter shouldn't try to tell the publisher its business, which is marketing books. But it won't hurt at all to include your thoughts on the target market. A cover letter isn't strictly required, but it can help a lot. It can also hurt; if it is arrogant, ignorant, or both, your manuscript is not likely to be read, or at least it won't be read soon. A good cover letter (and your letter to me indicates that you can write one) can get the editor eager to look at what it covers. If you find a publisher, have someone send me a review copy.

As to Footfall: *A writer I much admire told me that you can put all the morals and philosophy you like in a book as long as the characters don't know it. Harry Reddington, a.k.a. Mark Czescu, never knew what he illustrated.*—Jerry ■

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ASK BYTE

Steve Ciarcia answers your questions on microcomputing.

A Simple Problem

Dear Steve,

All three expansion slots in my Tandy 1000 are full. I have seen expansion chassis for additional slots and a power supply that cost from about $500 to $1200. These prices seem too high for what appears to be a simple add-on. Is there an easy way to build an expansion chassis with, say, four to six slots?

I would like to add a hard disk drive, a memory board (above 640K bytes), and a speedup board (if one exists for the Tandy 1000). Since I have three slots filled, I would need four more slots, assuming the expansion unit requires a slot in the main unit.

Am I wishing for the impossible? After all, for between $500 and $1200, I could buy a faster IBM PC AT clone or equivalent unit. (My wife wouldn't balk at "add-ons," but I think I'd have a problem buying an entire computer.)

Chris Bonney
St. Louis, MO

The prices for expansion boxes do seem a little extravagant, but they also show no sign of coming down (which is a bad sign). It turns out that those boxes have some interesting design problems, and there are no simple answers.

When you sit down to design a bus, you need to know how many circuits will connect to each line. That gives you the maximum steady-state current the bus drivers will have to supply. Next, you figure out the capacitance on the bus, which determines the transient current. The more loads or the greater the capacitance, the bigger the drivers you need to do the job. Remember that those drivers are on each card, not just the system board.

You can add an expansion box in one of two ways: by direct wiring or adding buffers. The former is simply a set of wires that runs between the original system board and the expansion board, so the bus drivers have to handle the added loads and capacitance. If you add buffers to drive the expansion board, the original drivers don't have to contend with an additional load (the buffers are located on a card that plugs into the original bus, just as you expected).

In fact, buffered designs have bus drivers at each end, so neither bus is connected directly to the cable. Each bus has a card connected to the cable, so you lose one slot in each. In some designs the circuitry is on the expansion chassis board. Such designs don't need a separate card in that box, but they still use a card slot in the computer.

Obviously, a double-buffered expansion bus is a better way to do things. But here's the catch: There's no way to tell in which direction those new drivers must send the signals. For example, suppose you have a video card in the expansion box and a hard disk controller in the original system. When the processor reads data from the disk, the buffers in the expansion box should be inactive to avoid conflicts with the disk card. A read from the video card requires that the buffers drive data from the expansion box onto the original bus. But you can't tell which is which by any logic based on the bus signals alone.

A similar problem comes up with I/O ports and control lines. It turns out that the true-blue IBM expansion box, which was recently discontinued, used a bizarre scheme: It waited to see which bus was active, then turned on the drivers to send data in the other direction. Perforce, it also added a wait state or two to all data transfers to cover the indecision. Ugly, but it worked fairly well.

Another problem is radio-frequency interference (RFI). The cable between the two units contains a large number of lines all switching at the same time, and it is just about the right length to serve as an antenna. You wind up with a very nice TV and radio jammer.

What to do? If you're up for a little soldering, you might want to try the brute-force approach. Get a PC system board (from the back pages of BYTE) without any components at all. Use some ribbon cable to connect it directly to your Tandy 1000 and see if it works. I'd suggest wiring the cable with ground lines alternating with signals to keep the RFI down and making it a foot or so long to keep the capacitance down.

You'll need to add a power supply for the expansion board, but do not connect the power supply lines between the two systems (only the ground lines—two supplies connected together don't work at all). Fitting the thing into a case should be straightforward, but you'll wind up with a rather funny-looking 1000.

I can assure you that a speedup card won't work, simply because the longer bus won't tolerate any higher speeds.

Given the rather low prices for AT clones, it may be worth your while to invest in a bigger, better, faster, more expensive system that will almost certainly work when you take it out of the box. One problem with trying to exceed the designer's specs is that you're likely to wind up with a pile of hardware that doesn't quite work anymore.—Steve

Get in Touch

Dear Steve,

I am trying to locate a place to purchase some conductive, transmissive Mylar that is used to make touch-screen input systems. It is similar to the indium-/tin-/oxide-coated glass used in capacitive touch-oven controllers. I have called some of the thin-film deposition companies, but I haven't received any of the promised literature. Do you know a source for this product?

Also, what is the preferred method to connect to this material? Several years ago I had a sheet of this material, and I used zebra strips and edge connectors.

Mike Kerr
Johnson City, TN

I don't know about any conductive Mylar, but I have tinkered with some Kynar film. It has some amazing properties: It's piezoelectric, pyroelectric, transparent (with the right electrodes), and durable. It's made by Kynar Piezo

continued

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

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Circle 77 on Reader Service Card

Parallel port		Speech chip	
Signal	Pin #	Pin #	Signal
strobe	*1	20	ALD
data 0	2	18	A1
data 1	3	17	A2
data 2	4	16	A3
data 3	5	15	A4
data 4	6	14	A5
data 5	7	13	A6
data 6	8	No connection	
data 7	9	No connection	
BUSY	11	9	LRQ

Figure 1: *Diagram for connecting an Atari 1040ST's parallel port to an SP0256 speech-synthesis chip. You should also wire the parallel port's ground (pins 18 to 25) to the ground of whatever circuit board the SP0256 is on.*

Film Group, Pennwalt Corp., 900 First Ave., King of Prussia, PA 19406, (215) 337-6710. The company was selling a $45 experimenter's kit a while ago. The film had aluminum electrodes, so it wasn't transparent. Pennwalt makes it with transparent electrodes, but that costs more.

The nice thing about Kynar is that it generates a voltage when you touch it. A few suggested circuits let you pin down where the touch occurred. You can either zebra or pattern the connections right in the film.

If you're buying the stuff by the acre, the company will do anything you want. In sample sizes, you're stuck with whatever they've got. Depending on your application, Pennwalt may have some standard film that will be close enough.
—Steve

Little Orphan Softcard

Dear Steve,

After recently purchasing an Apple IIGS computer, I was disappointed to learn from Microsoft that my Softcard (which I used previously on my Apple II Plus) is incompatible with the IIGS. I have heard conflicting reasons for this incompatibility. Some say all I need is a software upgrade, while others—including Microsoft—say the situation is hopeless. Can you tell me the cause for this incompatibility and how I can go about solving this problem?

Steven Park
Baltimore, MD

One of the unfortunate happenings in the microcomputer industry is the occasional creation of an orphan interface that is unable to follow along when a major equipment upgrade is performed. If your Z80 board is the original Microsoft Softcard, it has indeed been orphaned because of uncorrectable (sans hardware changes) timing problems. If you have the newer Softcard II (with 64K bytes of on-board RAM), a software update is available from Microsoft that accommodates the differences between the II Plus and the IIGS.

If you have the older card, it looks like your only option is to get a newer Z80 card with appropriate software for the new computer.—Steve

Parallel Talk

Dear Steve,

I am building a speech synthesizer for my Atari 1040ST. The circuit is based on a diagram I found for Commodore 64 and Radio Shack computers, and it uses an SP0256-AL2 chip. How do I connect the chip to my Atari's serial or parallel port?

Kairi Yousif
El Cajon, CA

The SP0256 speech-synthesis chip you are trying to interface was designed to be driven easily from a Centronics-compatible parallel printer port. The Atari 1040ST parallel port meets that requirement.

Look at the pin connection diagram in figure 1. You'll also need a low-pass filter and audio amplifier stage, but I assume those are shown on the schematic from which you are working.—Steve

CIRCUIT CELLAR FEEDBACK

More Talk

Dear Steve,

Recently, I came across your article on ADPCM (adaptive differential pulse-code modulation) for speech synthesis (June 1983 Circuit Cellar).

I am starting a small project on the statistical analysis of speech at the allophone level. Do you know of any source that could supply a set of the allophones in a digitized form? It would be of great help

continued

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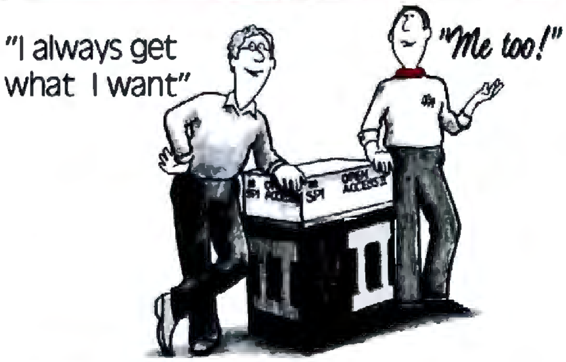

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Circle 168 on Reader Service Card

in getting my project started. A PCM-coded set readable on an IBM PC would be easiest to use.

Lawrence M. Politzer
Engineering Technology Dept.
Youngstown State University, OH

One of the problems facing anybody building speech-recognition hardware or software is that there's no standard speech against which to measure the results. This allows anyone to define a test set that makes the answers come out very well for whatever's just been developed, but it tends to breed suspicion in the users, who find that it doesn't work well in real life.

Since you're not developing a commercial system, you might be able to pry some samples out of manufacturers who build such hardware. There might be some strings attached, but they'd surely be less onerous than having to do the sampling yourself.

The IEEE Acoustics, Speech, and Signal Processing Society may also have contacts that can help. I recall that there were some tapes available with digitized speech samples, but my memory fails after that point. Get in touch with the IEEE, perhaps through your campus chapter, and see what they've got.
—Steve

Home Control

Dear Steve,
I would like to put a system for controlling a hi-fi and perhaps other things from any of several locations (upstairs and downstairs) in my two-story home. I'm not ready to design and build the system, but because of some remodeling projects, it is an ideal time to string cables through the walls. Hence, my question: What kind of cables? If they have lots of wires, they will be expensive but will permit relatively cheap and dumb terminals. On the other hand, if I am willing to build several smarter terminals, then perhaps very simple cables will suffice. What do you recommend?

Benjamin G. Cooper
Minneapolis, MN

You're fortunate to have the opportunity to lay your own wire. Most people have no option but to resort to AC power carriers like the X-10 system.

As for the type of wire you should use, the best trade-off between cost, flexibility, and performance is probably shielded dual twisted pair, which is just a more expensive variant of phone wire. As apparent from the name, it combines four wires with a shield connection that you can use for ground.

Four wires give you lots of options: full-duplex RS-232C plus RTS and CTS handshaking; RS-422, single-ended or differential; and so on. RS-232C is the best bet for keeping costs down; nearly every gadget you might want to hook up will adapt to an RS-232C.

Wiring topology is another issue. Bus, star, and ring networks have their own advantages and disadvantages. A bus topology is probably best, but it needs fancy software and chips. A ring is good, but it requires active nodes (i.e., everything on-line for any communication to take place) unless you bypass unused nodes with a switch. A star is simple, but it needs lots of wire and a central controller. Check out a book on local-area networks (LANs) and see which one is best for you.

The shielding really helps protect your data from noise spikes. Though it might be convenient, I wouldn't route the data cable next to the AC power lines and outlets—better be safe than sorry. Of course, it goes without saying that you have to make sure your setup meets all building codes. Safety first.—Steve

Just the Facts

Dear Steve,
I have a few questions for you. First, what is a real-time operating system? Second, is MS-DOS a real-time operating system? Finally, how are Unix and Xenix related?

Hugh Roth
New York, NY

MS-DOS was originally designed to handle just one task at a time. When a program is loaded, DOS gives it all available memory with no restrictions on its accessing that memory. DOS was also written with nonreentrant code, which means that trying to run two or more programs concurrently is more difficult than it has to be.

You usually find real-time operating systems in scientific and process-control environments. For example, a computer may be controlling an industrial process where, for the most part, very little raw computing power is needed. The computer monitors temperatures, pressures, valve openings and closings, and so on. However, in an emergency, it may be vital that the computer shut down processes quickly.

The computer must assess certain information—say, that a critical temperature or pressure has been reached. It may be that if a high pressure isn't relieved immediately, some damage may occur. Suppose also that as a result of this high pressure, a critically high temperature has been created elsewhere. The computer must analyze this information and

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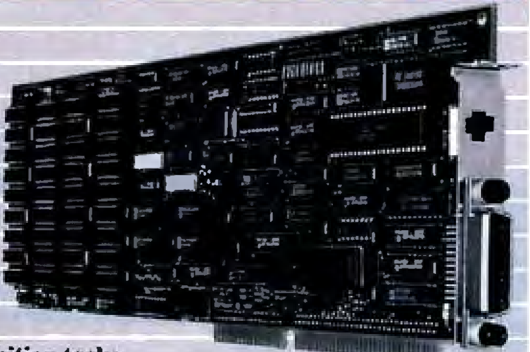

enable equipment to relieve the critical temperatures and pressures. This scenario demands a real-time operating system, one that can respond to independent and possibly simultaneous events and do so without the computer's losing track of what it is working on at the time.

DOS is not the operating system for handling environments as described above. Some attempts at providing multitasking for DOS are available: Digital Research's Concurrent PC DOS, DESQview by Quarterdeck Systems, Windows by Microsoft, and The Software Link's PC-MOS are a few examples. These solutions use some form of time-slicing algorithm. They intercept the system-clock interrupt, suspend the currently executing program and store its operating status, and pass control to another process. Usually, the operating system gives each program equal slices of execution time, assigned in round-robin fashion. In our process-control example, this task-assignment technique may be unacceptable, since it could be a relatively long time before a critical task is given its execution time slice.

Real-time operating systems can give variable amounts of execution time to processes. They can also assign priorities to processes, thus enabling the computer to recognize emergencies and devote more time to an important program. (I have used a process-control application as an example, but the control of scientific experiments can be similar.) While Unix is a multiuser, multitasking operating system, its design is such that, like MS-DOS, it is not suitable for real-time operations.

Unix is a trademark of AT&T. Other vendors, such as Microsoft, license Unix from AT&T but are prohibited from advertising it as Unix. They adapt it to various machines and market it under their own names (Xenix is Microsoft's Unix offering). Thus, anyone who is familiar with Unix on a minicomputer will find it almost identical to Xenix on an IBM PC.
—Steve

I Miss the Megabytes

Dear Steve,

I recently acquired an NEC MultiSpeed laptop computer; I've owned a Compaq "luggable" for several years. I got the NEC because I needed a lightweight computer that I could carry from office to office. Now, although I enjoy the speed of my laptop, its two 720K-byte floppy disk drives still seem small after my Compaq's 30-megabyte hard disk drive.

I know that at least one manufacturer makes hard disk drives for the NEC (I saw an NEC with a hard disk drive at

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spring COMDEX), but I have lost information on the company.

Also, I have been thinking about building a battery-backed RAM disk with storage capabilities on the order of 10 megabytes. I would like it to be able to plug into the slot vacated by one of the disk drives and include a connector for an external power supply for when I change its battery. Can you give me any pointers about its construction?

Finally, I am considering changing some boards in my Compaq and replacing them with some of the newer multifunction cards. I am pretty sure that all of the slots in my Compaq are IBM-compatible, but I would like to be assured of this. I recently replaced the machine's keyboard (through my local dealer) and ended up paying considerably for the replacement, since the Compaq's keyboard requires 12 volts instead of the 5 V that most other keyboards require. I've sent Compaq a letter concerning slot compatibility, but the company has not answered so far.

David Ferguson
Winter Haven, FL

Premier Technologies (1890 McGaw Ave., Irvine, CA 92714, (714) 261-1184) and Axonix Corp. (417 Wakara Way, Salt Lake City, UT 84108, (801) 365-9521) both offer a 10-megabyte hard disk drive for the NEC MultiSpeed.

It may be technically possible to build a 10-megabyte RAM disk drive for your NEC, but it may not make sense when you take everything into consideration. For example, if you were to use 1-megabit chips, you would need 90 of them for a 10-megabyte RAM disk.

Ninety chips take up a fair amount of space and produce a fair amount of heat. Even at bargain prices of $25 each, that would be $2250 for the chips alone. Power requirements would probably mean either a permanent AC adapter (limiting portability) or an additional battery pack to lug around. All in all, one of the above hard disk drives would be a better choice.

Compaq makes some nice computers, but it has fallen short in technical support for the end user, refusing to answer even simple questions. The company requires that the end user be serviced by a dealer and does not make its technical manuals available. Since I have not had much access to Compaq's computers, I can't comment on the keyboard question.

As far as replacing some boards, they should be compatible, but you should either try out the board before you buy it or make a prior arrangement with the vendor for a refund if it doesn't work.
—Steve ■

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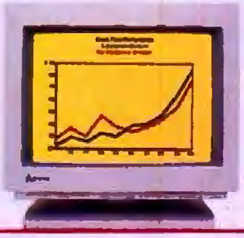

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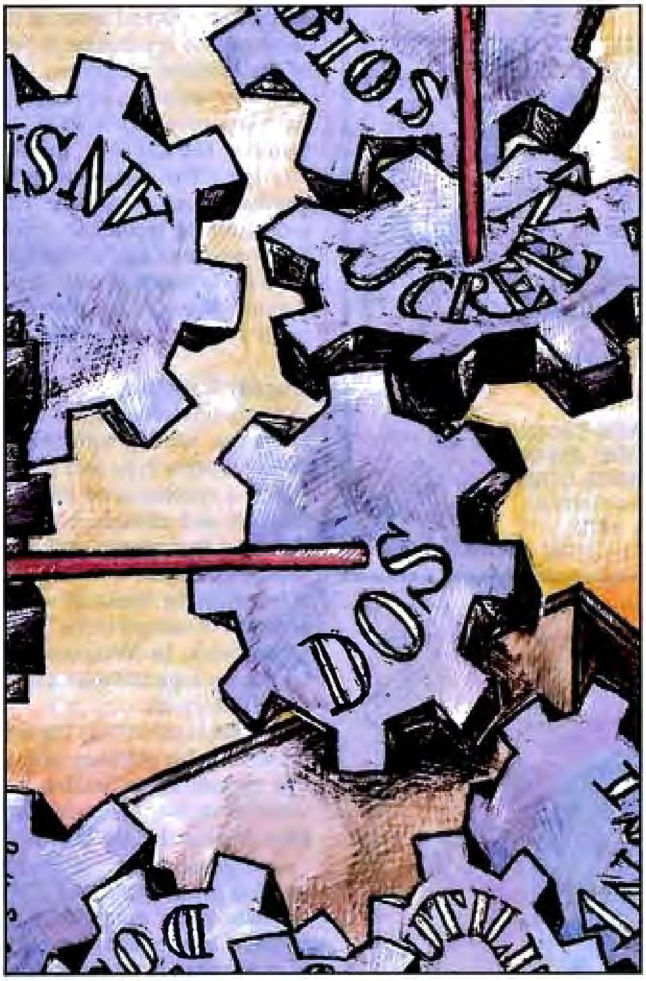
BOOK REVIEWS

PROFICIENT C
Augie Hansen
Microsoft Press
Redmond, WA: 1987
ISBN 1-55615-007-5
512 pages, $22.95

THE COMPLETE GUIDE
TO MIDI SOFTWARE
Howard Massey and
the staff of PASS
Amsco Publications
New York: 1987
ISBN 0-8256-1088-5
252 pages, $19.95

A LITTLE SMALLTALK
Timothy Budd
Addison-Wesley
Reading, MA: 1987
ISBN 0-201-10698-1
280 pages, $25.95



PROFICIENT C
Reviewed by Alex Lane

Augie Hansen wrote *Proficient C* for DOS programmers who are interested in applying structured programming techniques to develop libraries of reusable, professional routines. Along the way, he presents a number of interesting and useful utility programs.

Hansen assumes that the reader has a "modest" level of experience with some high-level language or assembly language and a working knowledge of C. With nearly 8000 lines of source code in the book, I would amend the latter to a "good" working knowledge. And since the software uses DOS 2.0 or higher and Microsoft C version 4.0, it wouldn't hurt to be familiar with the product, including support tools like `MAKE`. In one of the appendixes, Hansen comments briefly on the comparison of Microsoft C to C86, the Mark Williams C Programming System, and Lattice C. The author developed and tested all the programs and routines on both an AT&T 6300 computer running MS-DOS and an IBM PC AT running PC-DOS.

If you shudder at the prospect of keying in several thousand lines of source code or are interested only in the executable files, two companion disks—one with source code and `MAKE` files, the other with stand-alone, executable programs and precompiled function libraries—are available from the publisher for under $20 each.

The book is divided into four major sections and a group of appendixes. Section I contains three chapters describing the workings of the Microsoft C compiler (along with a quick rundown on memory models and support tools like the Microsoft `LINK`, `LIB`, and `MAKE` programs), thoughts on program development, and a discussion of the interaction between C and the DOS environment.

Hansen's kickoff discussion of program development has a tendency to dissolve into generic bromides like "The consistent and careful application of structured design and the incremental development of both programs and the documents that describe them are critical factors in the success of programming projects." Fortunately, the tone soon improves as attention turns to nuts-and-bolts C programming.

Standard Libraries

Section II describes standard libraries, the user interface, and automatic program configuration. In addressing the subject of portability, Hansen strives to avoid what he calls the "religious debate" surrounding this issue. Since the software being developed here is intended for use in a DOS environment, Hansen concentrates on building code that can be moved among various implementations of MS-DOS and PC-DOS. The chapter on libraries is by no means comprehensive; it does little more than provide a quick survey of exception handling, time, and file and character I/O functions.

Although I don't know how the author could have done a better job, I couldn't help wondering why he selected these particular functions for discussion. On the other hand, the ensuing discussion of the operating system interface lays a solid foundation of both facts and source code for subsequent programming. All of this is brought somewhat loudly together in a demonstration program designed to let the user control the appearance of the screen cursor. This choice of sample program takes some of the bite out of the author's laudable intent not to "waste any time solving Fibonacci series or calculating factorials." While I was impressed with the techniques that were used to construct the program, I found the program disappointing.

The text quickly gets back on track with a discussion of command-line processing. Here, Hansen drops a gem of a C function in the reader's lap: `getopt()`, which scans the command

continued

Illustration by Lynne Buschman

line and extracts option flags and arguments (Microsoft C apparently has no facility to do this). He puts the function to good use in a sample program called Timer, which performs a number of timing and sound functions inside the IBM PC. Starting with the Timer program, Hansen puts his programming methodology into practice by providing both pseudocode descriptions and manual pages for his programs.

File-oriented Utilities

Many concepts and much of the code developed in the first two sections find application in Section III, which is devoted to a set of file-oriented programs, including several Unix-like file and directory utilities. Although some of the programs duplicate functions provided by DOS, they generally exhibit some added features. The LS utility, for example, is a general-purpose directory lister that outperforms the `DIR` command by affording a number of output options. The subsequent chapter extends the programming technique developed thus far to the methodical development of `PR`, a Unix-like program designed to display or print the contents of text files either with or without formatting options. Between the author's clear explanations and the program's intrinsic usefulness, this chapter is pure gold.

Display Functions

In Section IV, the author turns his attention to screen-oriented programs, starting with brief discussions about determining the display system type and methods of updating displays. He develops a synchronized block-copy routine to address the latter problem and extends it in the following chapter into a set of functions that interact with a screen buffer.

Hansen begins a separate chapter on the ANSI.SYS device driver with the basics of what it is, how it's used, and the pros and cons of using it in the IBM PC environment. Having laid the groundwork, he then presents the source code for an ANSI interface package and uses it to implement a program that controls screen attributes.

In what is effectively the final chapter in the book, the author presents a file-viewing utility and discusses its construction. The appendixes in Section V cover, among other things, overviews of various C implementations and a summary of the routines presented in the book.

One gauge of the usefulness of a technical book, especially one that presents a series of working examples to the reader, is the value of the examples in relation to the cover price. For example, I have bought books that were hardly worth the trouble to read, despite a plethora of nattily formatted source code. Others have provided one or two gems that made buying the book a break-even proposition. On rare occasions, I run across a book from which you get your money's worth and more; *Proficient C* is such a book.

Alex Lane (1873 Bartram Rd., Jacksonville, FL 32207) is a registered professional engineer with a strong interest in artificial intelligence. The moderator of the prolog conference on BIX, he can be contacted there as "a.lane."

THE COMPLETE GUIDE TO MIDI SOFTWARE

Reviewed by Donald Swearingen

Any book that claims to be the complete guide to any subject even loosely related to computer software must inevitably fall short of that claim. In a field where programmers are often hard at work on a program's next revision even as the current release is being shipped, it is practically impossible to provide a truly up-to-date compendium of available software.

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Not unpredictably, *The Complete Guide to MIDI Software*, written by Howard Massey and the staff of New York's Public Access Synthesizer Studio (PASS), provides something less than a complete overview of this new and rapidly expanding area of software development. What it does provide, according to its authors, is an unbiased survey of some 60 musical instrument digital interface (MIDI) software packages available at the time of the book's publication. As you shall see, even this more circumscribed objective proves difficult to fulfill.

Real-World Perspective

PASS, which has been reorganized as the Center for Electronic Music, is a nonprofit organization devoted to making available state-of-the-art facilities for audio production and synthesis, along with various related services, including workshops, seminars, and individual instruction. As such, the members of PASS are in the position of having had hands-on experience with all the software described. This reservoir of expertise gives the book its strongest voice; the comments and observations reflect a real-world perspective rather than the detached or tendentious attitudes that are often present in critical reviews.

However, while a great deal of specific and quite useful information is communicated within its pages, the book fails to define any general criteria by which readers might objectively compare one program with others of its class.

Only 8 of the book's 250 pages are devoted to introductory and background material. The remaining pages consist of actual reviews of individual MIDI software packages. The authors skimp on more general information that might have been most useful to a reader attempting to get his or her bearings in an often confusing world of hype and promotion.

The authors suggest that you "buy the hardware to run the software." While this may represent a good basic strategy, it fails to address a broader context where functional overlap, the relative price-to-performance ratio, life expectancy (will the manufacturer even be in business in 2 years?), and usability for other tasks often cloud the picture, making choices far less clear-cut than such a simple approach might suggest.

The allocation of a short descriptive paragraph to each of the computers for which MIDI software is reviewed simply does not provide sufficient enlightenment for making informed choices. Also missing is a discussion of available MIDI interfaces and their prices for each computer, an important factor in the decision of which computer to buy.

The MIDI software reviews constitute the bulk of the book. They are organized into seven sections, each covering MIDI software for a particular computer. Included are the IBM PC and compatibles, the Apple Macintosh, the Apple II, the Atari ST, the Commodore 64, and, with a single entry for each, the Commodore 128 and the Texas Instruments 99/4A. Amiga owners will be disappointed to find no entries for their computer, even though a number of MIDI applications are now available for the Amiga. Even for the computers covered, there are a number of puzzling omissions. For example, the Steinberg Pro-24 sequencer for the Atari ST has been available since the fall of 1986, but it somehow failed to make the book, despite its 1987 publication date. Once again, however, any software book calling itself "complete" must have an omniscient viewpoint and almost no lead time.

Review Format

A standard format is applied to the review of each MIDI program surveyed. Each review begins with a "box score" describing the program name, function, author, MIDI interface requirements, price, and a list of the program's special features and limitations. This is followed by a "guided tour" discussion

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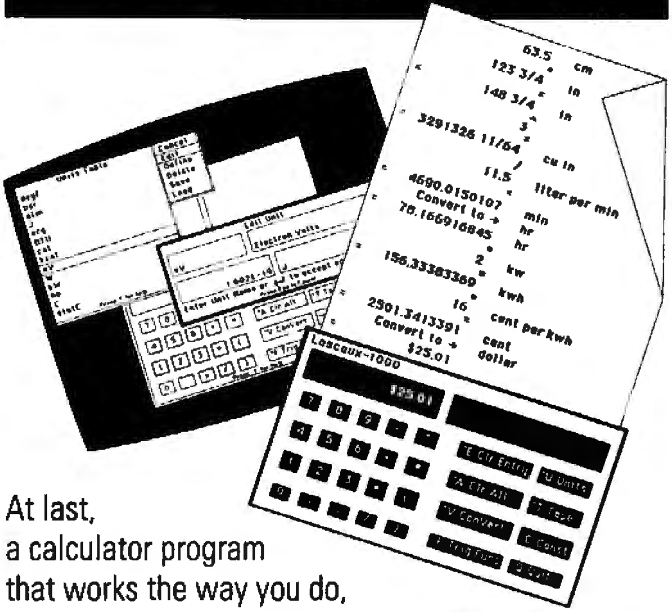

of the program's use from start-up to shutdown, usually encompassing several pages and providing a good feel for the program's basic operations. The book makes extensive use of screen images, reproduced poorly but legibly, to illustrate each program's layout and use. Each review ends with a short "final word" section that summarizes the program's general characteristics.

Based as they are on the personal experiences of the PASS staff, the guided tours represent by far the most extensive and useful material in the book. But the format also reveals the subtle personal biases and presumptions each of the reviewers inevitably brings to the task at hand. Also, the "forms" are not filled in consistently. One review for an IBM PC program states that the program requires an expansion slot for the MIDI interface. But this is not listed as a requirement for the other PC programs, even though all of them will require a MIDI interface and an associated slot.

In a review of a MIDI sequencer program, the ability to record real-time MIDI notes and events is listed as a special feature when this is what a sequencer is supposed to do in the first place, a fact readers would have been aware of with better introductory material. One of the "limitations" listed for a MIDI voice librarian on the Macintosh is that "Mac Plus users must have a separately powered MIDI interface." This is, of course, a limitation of the Macintosh and the MIDI interface rather than of the MIDI software. It seems that the review standards, whatever they may be, are not applied evenly and that the reviewers don't want to say anything too negative about any of the programs.

Take Your Chances

This is not the "complete" guide to MIDI software that it claims to be. Can you still gain something from this treatise, incomplete as it is? I think so, though it will cost you $20 to find out if you agree. Even with all its shortcomings, you just may find within its pages that one tidbit of information that will galvanize your decision as to which MIDI software package is best for you. And if you make the right decision, the book will have been worth its price.

Donald Swearingen (2261 Market St., Box 289, San Francisco, CA 94114) is a freelance programmer, musician, and author.

A LITTLE SMALLTALK

Reviewed by Joel West

Three years ago, Timothy Budd was faced with the challenge of teaching object-oriented programming to students at the University of Arizona. Budd took the resources available—a group of 12 graduate students and a Unix-based time-sharing system—to develop a version of Smalltalk for his teaching. The result was Little Smalltalk.

A Little Smalltalk is geared to two types of readers: the introductory student learning the language, and the more advanced student modifying the system. The book is a readable teaching text for a one-semester introductory course and a concise companion to hands-on exercises using the Little Smalltalk system.

The System

Little Smalltalk is written in C and runs under Unix systems. The author, now at Oregon State University, distributes the public domain source code for the system as a nine-track Unix tape image.

Little Smalltalk is a dialect of Smalltalk and nearly a proper subset of Smalltalk-80, which was developed at the Xerox Palo Alto Research Center (PARC) and documented by the original Smalltalk books. Although the dialects are different—Smalltalk-80 is the original and seminal dialect—Little Smalltalk *is*

continued

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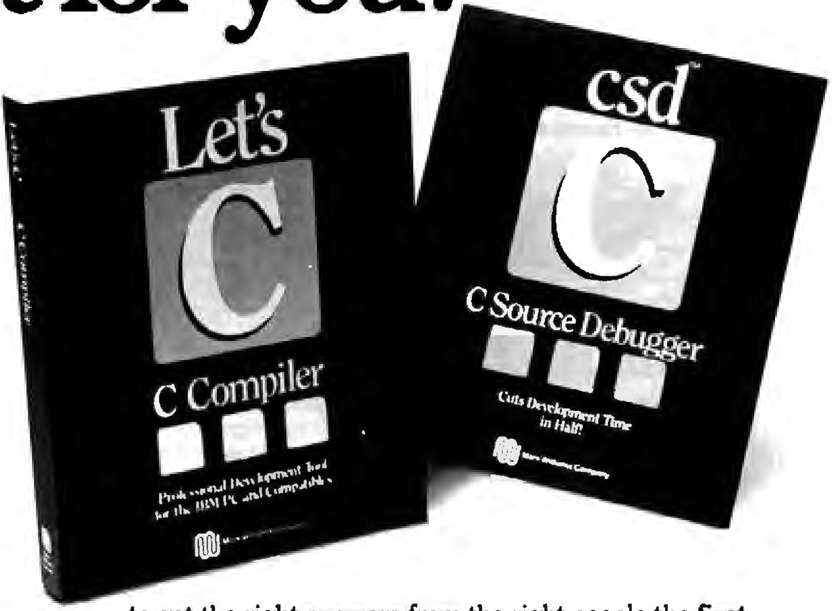

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Smalltalk: It treats everything as an object, including numbers. It includes the unary, binary, and keyword messages of Smalltalk, with single-path method inheritance. The differences between Little Smalltalk and Smalltalk-80 are clearly spelled out in an appendix.

Given its nature as a simple implementation of Smalltalk, it should not be surprising that Little Smalltalk does not emulate the Smalltalk-80 programming environment. Little Smalltalk requires only line-oriented terminals to develop and run programs, but it also supports the cursor character graphics system of 4.1 BSD (Berkeley Standard Distribution) Unix, as well as the specialized Unix plot libraries for terminals such as the Tektronix 4014.

The Book

Inevitably, *A Little Smalltalk* will be compared to the three-volume PARC series also published by Addison-Wesley, particularly *Smalltalk-80: The Language and Its Implementation*. The three volumes are a comprehensive specification of Smalltalk-80, and, in their depth and style, they are most suitable for advanced readers. They have also been used as textbooks for courses on learning Smalltalk. In contrast, *A Little Smalltalk* is an intermediate-level text that attempts to cover the breadth of the language quickly. It is not a step-by-step tutorial. In the space of the first 40 pages, it attempts to give the reader the fundamental concepts and syntax of the language.

The remainder of the first section of the book is devoted to reinforcing language principles and introducing language subtleties through four topics: simulation, generators, graphics, and processes. The examples in this section were well chosen for teaching (rather than the author's amusement), and many include the output, a boon for those who don't have the software. Budd solves several classic problems using Little Smalltalk, including those of the eight queens and the dining philosophers. The end of each chapter includes a series of student exercises and references to further reading.

The final third of the book covers the internals of the Little Smalltalk implementation. It seems to be a good road map for modifying the system, although the feasibility of such modifications depends heavily on the style (or lack thereof) in the actual source code, which is not included. Still, this section offers insight into implementation considerations in moderate doses.

The book's bibliography is eclectic and a bit arcane. It includes a few obvious references, notably PARC's three Smalltalk-80 books. It also includes references that, while important, are inaccessible to the average reader, such as internal PARC reports and Alan Kay's Ph.D. thesis. It also includes items that are a bit tangential to the main thrust of the book, such as references to the Alphard, CLU, Act 1, Snobol, and GPSS programming languages.

A Little Is a Lot

Budd seems to have fulfilled the goals he set out to achieve; as a companion to the software, *A Little Smalltalk* is ideally suited to a one-term course on object-oriented programming, and it would be my first choice if I were offering such a class.

For those readers who are not in a classroom, the exercises at the end of each chapter are somewhat frustrating. As someone learning from a book rather than a class, I would like to have the answers to the exercises available.

Overall, *A Little Smalltalk* is clearly written and edited and is an inexpensive way to learn Smalltalk. ■

Joel West (P.O. Box 2733, Vista, CA 92083) is president of Western Software Technology. He recently completed the design of an object-oriented language for discrete simulation based on Modula-2.

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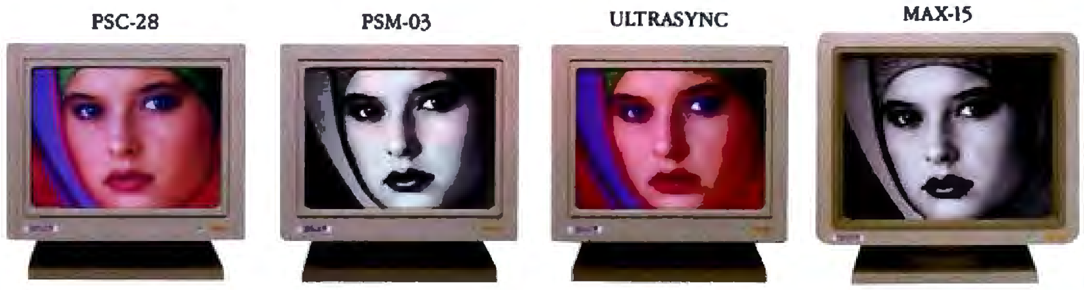

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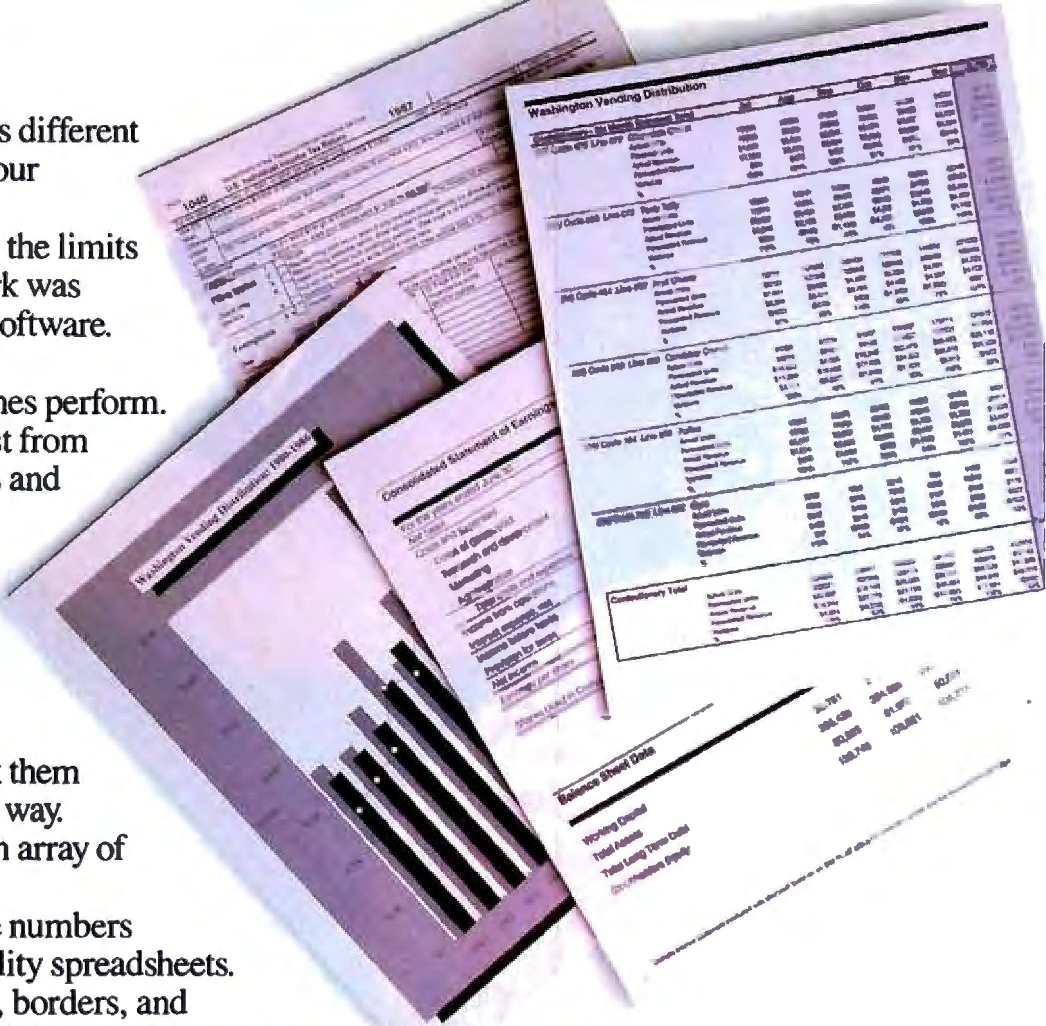


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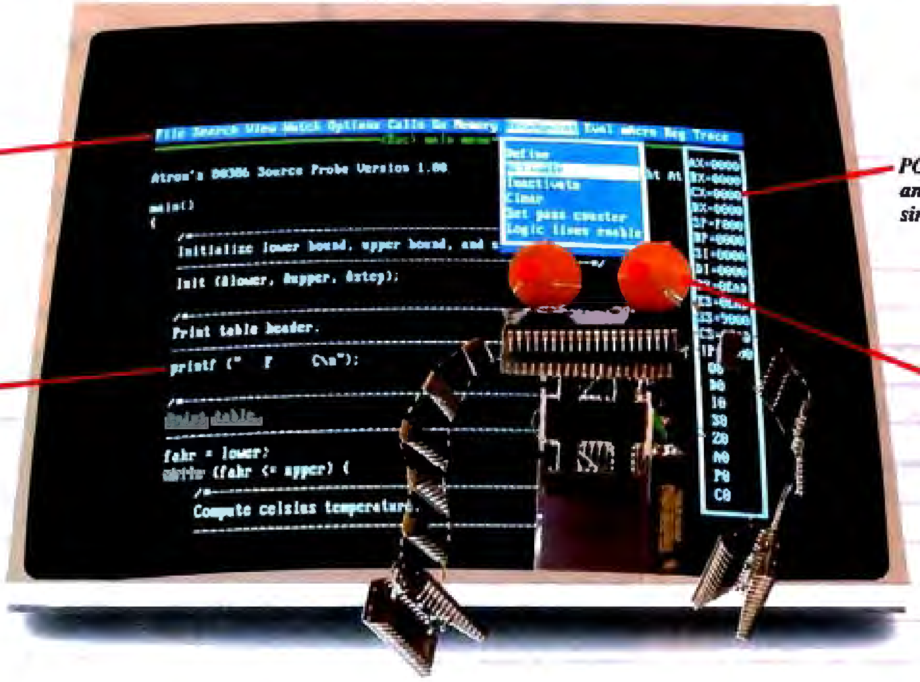

```
Atron's 80386 Source Probe Version 1.00

main()
{
    /*
    Initialize lower bound, upper bound, and
    init (&lower, &upper, &step);
    /*
    Print table header.
    printf ("   F      C\n");
    /*
    Print table.
    fahr = lower;
    while (fahr <= upper) {
        /*
        Compute celsius temperature.
```

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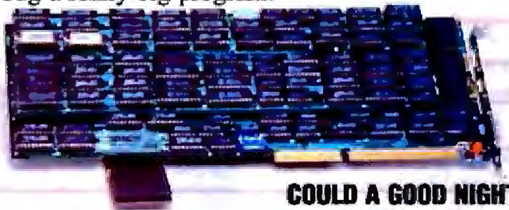

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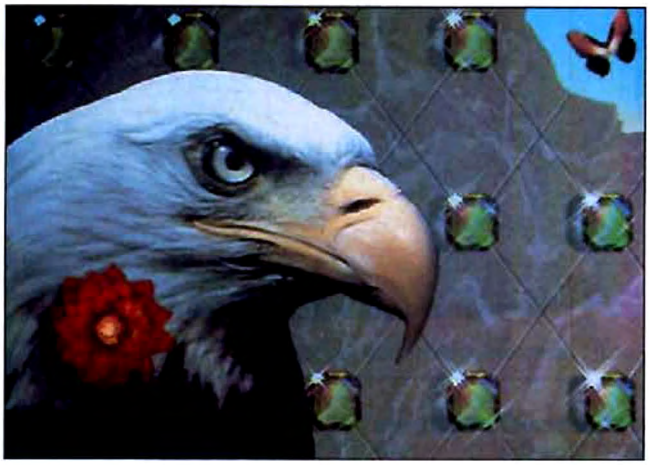

The Personal Hardcopy System creates hi-res images on film.

Unique-Looking Laptop from Amstrad

London-based Amstrad (with a U.S. subsidiary in Irving, Texas) has introduced its PPC 640 and PPC 512 PC-compatible portables. Unlike most of the current laptops, where the screen pivots up from the keyboard, the Amstrads are long and thin, with a full-size 101-key keyboard that folds down from the system unit. The supertwist liquid-crystal screen—which has a true "television-style" aspect ratio—then pops up from inside the system unit.

Weighing 11¾ pounds, the PPC 640 and PPC 512 are both based on an 8086 running at 8 MHz. As their names imply, they're shipped with 640K bytes and 512K bytes of RAM, respectively. The PPC 640 also has a built-in 2400-bit-per-second Hayes-compatible modem and comes with either single or dual 3½-inch 720K-byte floppy disk drives. Software shipped with the system includes MS-DOS 3.3 and SoftKlone's Mirror II telecommunications package. The PPC 512 comes with a single drive, MS-DOS 3.3, and no modem.

Both models have five power options. They'll run on AC, a car cigarette lighter, a rechargeable battery pack, or even on 10 standard C-cell flashlight batteries. Serial, parallel, and RGB video ports are standard.

Price: PPC 640 with single drive, $999; with dual drives, $1099; PPC 512, $799.

Contact: Amstrad Inc., 1915 Westridge Dr., Irving, TX 75038, (214) 518-0668.

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To install Desk-Link, you run an install program on both computers and connect the cable. A pop-up menu lists the auxiliary devices including local or remote hard disks, floppies, and printers. You can select or change the devices by popping up a menu and pressing a key. Talk Box is a feature that you can pop up when you want to use another computer's printer or disk.

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Delta Technology's memory manager Extra gives you control over your memory-resident programs by letting you set up a menu and access up to 26 programs while using the RAM of only one. It operates by transferring each terminate-and-stay-resident (TSR) program from memory to disk. The program organizes your TSRs in a menu that you can define.

The program is menu-driven and offers hot-key operation, mouse support, and customizable screens.

Extra runs on the IBM PC, XT, AT, and compatibles, including the PS/2s. You'll need at least 256K bytes of RAM, a hard disk drive, either a 3½- or 5¼-inch floppy disk drive, and DOS 2.0 or higher. Extra runs with a color or monochrome monitor and is not copy-protected.

Price: $99.

Contact: Delta Technology International, 1621 Westgate Rd., Eau Claire, WI 54703, (800) 242-6368; in Wisconsin, (715) 832-7575.

Inquiry 754.

continued

SEND US YOUR NEW PRODUCT RELEASE

We'd like to consider your product for publication. Send us full information about it, 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 does not represent itself as having formally reviewed each product mentioned.

Lotus Agenda

Agenda, a personal information manager from Lotus, lets you enter a series of thoughts or items, which you can then categorize and view in various ways. Agenda also automatically categorizes items. It will run on the IBM PC and compatibles and on the PS/2 family of computers, with versions for both DOS and OS/2.

Lotus calls Agenda an "item/category database." It allows you to type in a free-form series of items. Each item can be up to 350 characters long; you can attach "notes" up to 10K bytes long to each item. After you enter an item, you have the option of placing it in one or more categories.

An interesting thing about Agenda is that it can match category names with the contents of an item. If it finds a match, Agenda can automatically group that item under a matching category.

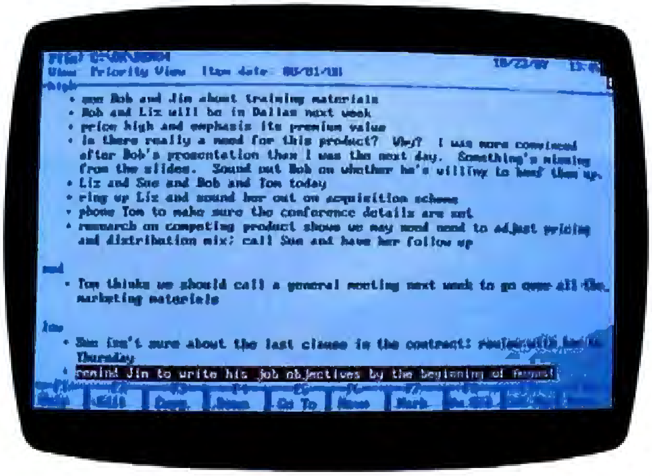
You can control how tight the match must be, and you can designate synonyms for category names. You can also enter rules pertaining to the categorization.

You can check the items you've entered by using a feature called a "view," which is analogous to a report in a standard database. You can construct a view by arranging the items and categories into a row-and-column format. You can set up a view showing each item you've entered, along with each company category (if any) that you've assigned to that category. You can also set up another view showing each company name, with all the associated items below it.

Price: $395.

Contact: Lotus Development Corp., 55 Cambridge Parkway, Cambridge, MA 02142, (617) 577-8500.

Inquiry 755.



```
View: Priority View  Item date: [illegible]                    10/23/87
high
  • see Bob and Jim about training materials
  • Bob and Liz will be in Dallas next week
  • price high and emphasize its premium value
  • Is there really a need for this product?  Why?  I was more convinced
    after Bob's presentation than I was the next day.  Something's missing
    from the slides.  Sound out Bob on whether he's willing to beef them up.
  • Liz and Sue and Bob and Tom today
  • ring up Liz and sound her out on acquisition scheme
  • phone Tom to make sure the conference details are set
  • research on competing product shows we may need need to adjust pricing
    and distribution mix; call Sue and have her follow up

med
  • Tom thinks we should call a general meeting next week to go over all the
    marketing materials

low
  • Sue isn't sure about the last clause in the contract; [illegible]
    Thursday
  • remind Jim to write his job objectives by the beginning of August
```

Lotus' personal information manager.

Hardware-Compatible VGA Board

Everex Systems says its EVGA graphics adapter for the IBM PC and compatibles—using a custom application-specific integrated circuit—is fully compatible with all 17 VGA modes at the hardware-register level, not just at the BIOS level. The board hooks up to any PS/2-compatible analog monitor.

The EVGA will also support EGA, RGB, and monochrome monitors and their respective software drivers. The board comes with both 9-pin (digital) and 15-pin (analog) monitor connectors.

Price: $399.

Contact: Everex, 48431 Milmont Dr., Fremont, CA 94538, (800) 821-0806; in California, (800) 821-0807.

Inquiry 756.

Microsoft's Pageview

Pageview, from Microsoft, is a WYSIWYG (what you see is what you get) page-preview and graphics-integration program that runs with Word in a windows environment. To use Pageview's graphics capabilities, you need Windows 2.0 or Windows/386. You can insert graphics from other applications programs and move, resize, and preview them onscreen.

Pageview runs on the IBM PC and compatibles and on the PS/2s. You need 512K bytes of RAM (640K bytes is recommended), DOS 3.0 or higher, and Word 3.0 or higher.

Price: $49.95.

Contact: Microsoft Corp., 16011 Northeast 36th Way, P.O. Box 97017, Redmond, WA 98073-9717, (206) 882-8080.

Inquiry 757.

Ultra-Res Graphics from Texas

The Genesis 1280 is the latest incarnation of National Design's ultra-high-resolution graphics board. It uses Texas Instruments' high-powered TMS34010 graphics processor, handles resolutions of up to 1280 by 1024 pixels by 8 colors, and fits into a full-length slot in any PC AT or compatible.

Fully compatible with the Genesis 1024 graphics card, you can program the Genesis 1280 for virtually any analog RGB monitor up to the monitor's maximum resolution. The 1280 comes with 4 megabytes of on-board RAM (expandable to 32 megabytes on the card).

Graphics interfaces available for the board include the Texas Instruments Development Toolkit, Metagraphics' MetaWindows, Nova Graphics International's Nova CGI, and GSS' DGIS and CGI interfaces. EGA emulation is optional.

Price: $2995.

Contact: National Design Inc., 9171 Capital of Texas Highway N, Austin Bldg., Suite 230, Austin, TX 78759, (512) 343-5031.

Inquiry 758.

A Nonemmissive Monitor

For those who still have doubts about the long-term safety of standard personal-computer monitors, even with lead-impregnated glass filters, a company named ASK LCD has a new liquid-crystal flat-screen monitor.

Because it uses a blue supertwist LCD, the Flat-Screen doesn't emit any radiation. The screen measures 12 inches diagonally. Its low weight (3 pounds) and low volume (5 percent of a standard monitor) are additional advantages.

The CGA-compatible Flat-Screen comes mounted on an "ergo-arm," a flexible arm that mounts the screen above your desk and lets you swivel the Flat-Screen up to 180 degrees and tilt it up to 120 degrees. An optional wall-mounting bracket is also available.

ASK LCD says that besides its lack of radiation, the screen is much easier on the eyes than standard monitors. For security-conscious organizations, its display can't be picked up by sophisticated RF surveillance devices.

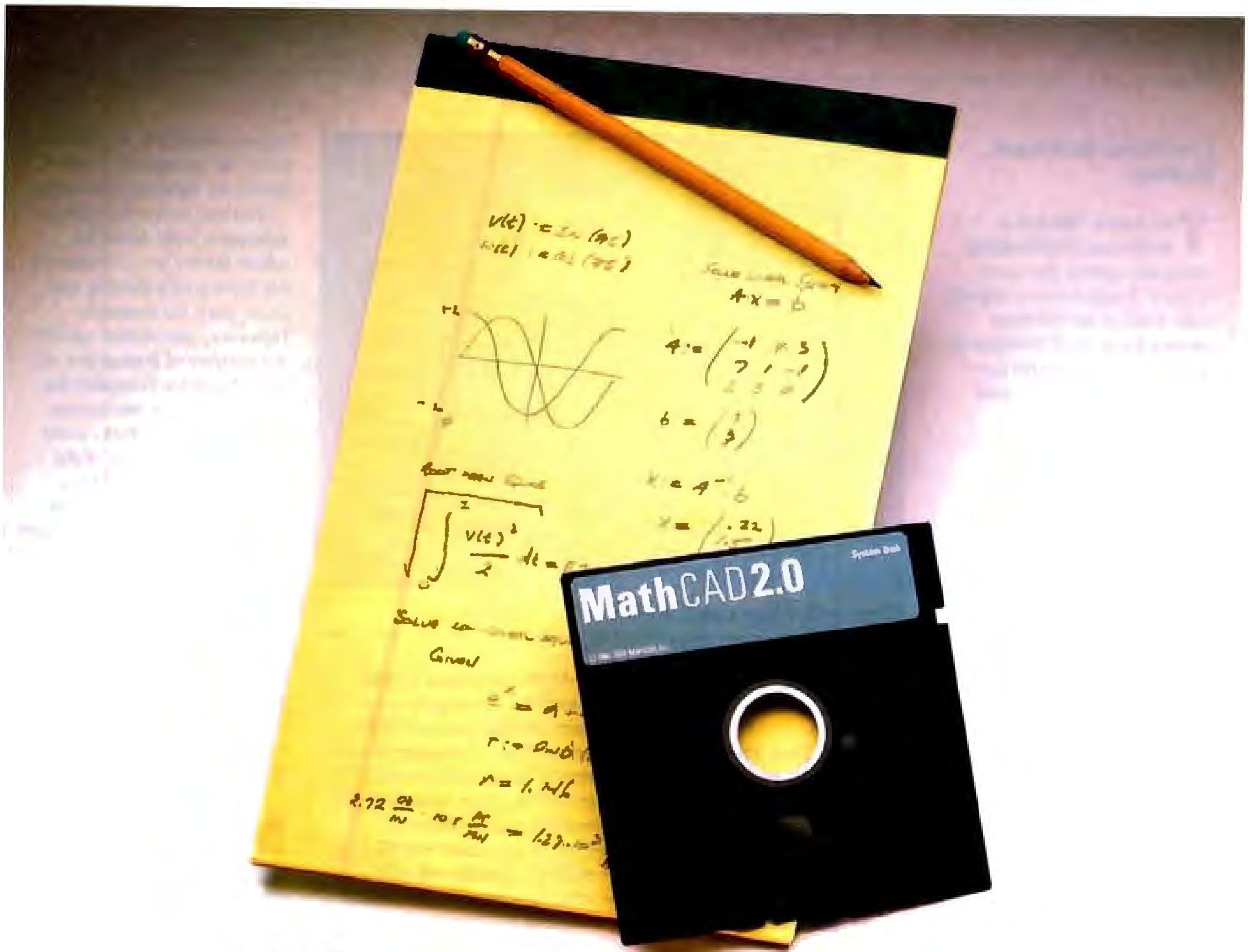
The Flat-Screen comes in two different configurations: one for the IBM PC and compatibles, and another that works with several laptops including the Toshiba T1100 Plus, Olivetti M15, and Zenith Z-181.

Price: IBM PC–compatible version, $1150; portable computer version, $1050.

Contact: ASK LCD Inc., 5 Dunwoody Park, Suite 116, Atlanta, GA 30338, (404) 399-5208.

Inquiry 759.

continued



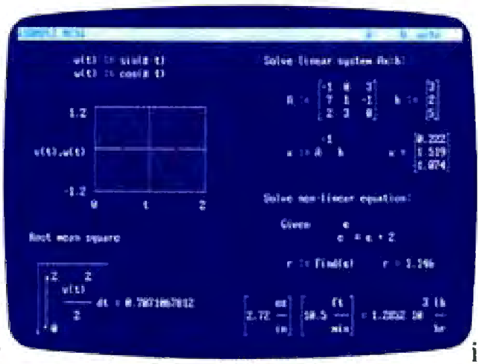
Your pad or ours?

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.

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MathCAD® MathSoft, Inc.

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Circle 154 on Reader Service Card

Low-Cost Multiuser System

The Kowin Three is a multiuser, multitasking computer system that runs Unix V.3 and comes complete with most of the software needed for a small business to get started in computerization. The combination host computer/workstation is based on a 68020 processor, with dual 68000 processors providing peripheral processing. It has a 12-inch monochrome display and an integrated telephone handset and built-in modem.

Internally, there's a 40-megabyte hard disk, a 1.2-megabyte 5¼-inch floppy disk drive, 4.5 megabytes of RAM, a network controller, four network ports, three RS-232C ports, and an ST-506 port.

Because the system is designed for business users with limited computer expertise, the Unix V.3 system is hidden by an interface shell. There are four template levels for the 15 function keys on the 101-key keyboard, giving a total of 60 preprogrammed function keys. Applications software shipped with the system includes voice/data communications, electronic mail, word processing, networking, forms management, graphics, calendar/scheduling, a calculator, a notepad, and a phone directory/dialer.

Each host/workstation can accommodate up to 32 workstations. Each workstation includes a 12-inch monochrome monitor, a telephone with autodialer, 64K bytes of display memory, a network port, and two RS-232C ports.

Price: Host/workstation, $11,990; workstation, $1190.

Contact: Kowin Computer Corp., Kowin Bldg., 830 North Wilcox, Montebello, CA 90640, (800) 445-6946; in California, (800) 225-6946.

Inquiry 760.

The Kowin Three uses a 68020 and dual 68000s.

Zenith Upgrades Laptop

Zenith Data Systems now has a 20-megabyte hard disk version of its popular laptop. And the twist in this model has nothing to do with the supertwist LCD display. Zenith is using a new CMOS-based hard disk controller along with run-length-limited (RLL) encoding on the hard disk.

The low-power consumption of the CMOS controller (70 percent less than a standard NMOS-based board), coupled with the efficient coding of RLL has resulted in, according to Zenith, the longest battery life for a hard disk laptop in the industry. Zenith is claiming the Z-183 will run up to 3 hours with the standard 2.5-ampere-hour rechargeable battery. An optional 4-ampere-hour battery ($129) extends the running time to 5 hours, according to Zenith.

The running times are based on the company's own benchmark with a 20 percent disk-access frequency, and with both continuous backlighting and hard disk power on. You can extend the running time even further by turning the backlighting off, and you can set the hard disk to automatically power down after from 1 second to 5 minutes of non-use.

At the same time it introduced the 20-megabyte version, Zenith reduced the list price of the 10-megabyte version of the Z-183 from $3499 to $3199. (The 10-megabyte version uses neither the CMOS controller nor RLL encoding.) Zenith will also offer an upgrade kit that will upgrade current 10-megabyte Z-183s to 20 megabytes with the new controller. A company spokesperson says a price on the upgrade hasn't been set yet.

Price: $3599.

Contact: Zenith Data Systems, 1000 Milwaukee Ave., Glenview, IL 60025, (800) 842-9000.

Inquiry 761.

Animation Program for AutoCAD

AutoFlex, an animation program from Autodesk, generates animation sequences of AutoCAD drawings and AutoShade renderings. The program will be available in the first quarter of 1988 and will be priced at under $500, according to Autodesk.

AutoFlex generates a series of user-defined "camera positions" into a set of frames, which can be replayed as an animated movie. You can define camera positions, focal points, and other geometric properties of the viewing orientation.

You can also create kinetic animation with AutoFlex, which allows you to represent the motion of a moving machine part, for example. However, you cannot specify the number of frames per second. AutoFlex compiles the frame sequence into a compressed file structure, using only about 5 percent of the original file space of each stored frame. The initial release of AutoFlex will support only the EGA graphics standard.

Price: Under $500.

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

Inquiry 762.

Mite-E.Mail

Mite-E.Mail, a data communications program that allows access to Telex, electronic mail, and on-line systems, runs with EIT's Fax modem. The program uses EIT's graphics windows software environment, automatically dialing asynchronous modems. The program includes auto-log-on and command sequences to a variety of services. It also includes a terminal mode for direct, interactive transmissions.

Mite-E.Mail supports Mite, XMODEM, YMODEM, and Kermit file-transfer protocols. It includes a command-line operating mode and a programming language that automates common communications procedures.

The program runs on the IBM PC, XT, AT, and compatibles with a 300-, 1200-, or 2400-bps asynchronous modem; an EIT Fax modem; and a graphics display adapter. It requires 640K bytes of RAM and DOS 3.0 or higher.

Price: $179.

Contact: Electronic Information Technology, 25 Just Rd., Fairfield, NJ 07006, (201) 227-1447.

Inquiry 763.

continued

A GEM of a Deal

Free Software from Genoa! For a limited time only, every SuperEGA HiRes+™ card comes with a FREE copy of GEM Graph™—the popular business graphics package that normally retails for $249!

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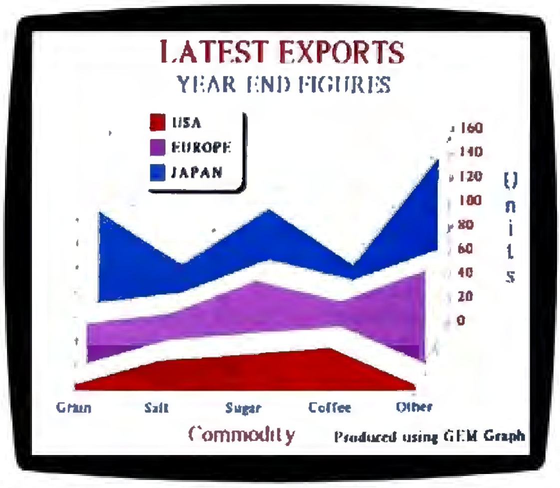

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Circle 101 on Reader Service Card

Presentation Graphics Package for Windows 2.0

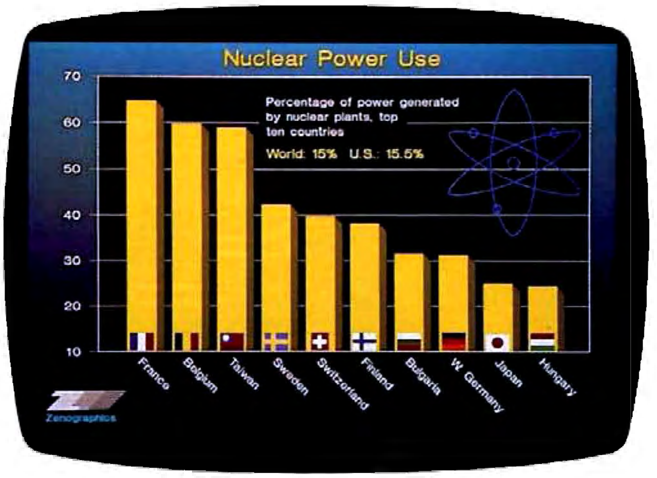
Pixie is a low-cost presentation graphics program from Zenographics that runs under Windows 2.0. The package features interactive editing of graph values and attributes directly on the graph. Working with a bar graph, for example, you can change a value on either axis, and the graph is automatically rescaled. You can also alter the size of a bar or curve using the mouse; the new value of the curve is displayed in a window in the corner of the screen.

Another interesting feature of Pixie is the use of "modeless" dialog boxes, which reflect object selections in the dialog box simultaneously on the graph. Pixie also uses the Windows 2.0 clipboard, letting you cut and paste images that conform to data structures supported by Windows 2.0. This means that you can use Pixie to dress up clip art or to add text and charts to other graphic images. Pixie includes a built-in text processor and font library and a standard palette of 98 colors (user-definable colors of up to 16 million).

Pixie will ship this month. It represents the low end of Zenographics' line of presentation-quality business graphics software, according to the company. The program is compatible with Mirage .IMA files and supports a device driver for sending data to slide-making service bureaus.
Price: $195.
Contact: Zenographics, 19752 MacArthur Blvd., Suite 250, Irvine, CA 92715-9976, (714) 851-6352.
Inquiry 764.

A Faster Clipper

Clipper Summer '87, a new version of the dBASE compiler, is significantly faster in compilation and execution times than the original and contains many new commands and functions along with entirely rewritten documentation.



Pixie running under Windows 2.0.

The new version also includes low-level file access, expanded string-handling capabilities, a rewritten debugger, and new utilities. It can use the DOS 3.3 capability to open 250 files per process. Clipper Summer '87 runs on the IBM PC, XT, AT, and compatibles with 256K bytes of RAM, a hard disk drive or dual floppy disk drives, and DOS 2.2 or higher.
Price: $695.
Contact: Nantucket Corp., 12555 West Jefferson Blvd., Suite 300, Los Angeles, CA 90066, (213) 390-7923.
Inquiry 765.

68000-based Single-Board Computer

The MS68K Single Board Computer is a complete 68000-based system on a 5¼-by 8-inch board. Besides its 8-MHz processor, the system has 256K bytes of RAM (expandable to 512K bytes), and up to 128K bytes of EPROM. There are also two serial ports, a parallel port, and a floppy disk controller.

Also on the board is a socket for a SCSI protocol controller, as well as an expansion bus. The MS68K requires only +5 VDC power, and it comes with ROM-based monitor software that contains a line assembler, disassembler, and a debugger.
Price: $249.95.
Contact: Marion Systems Corp., 1317 Fifth St., Suite 301, Santa Monica, CA 90401, (213) 451-8910.
Inquiry 766.

Mac II Data Acquisition

GW Instruments has a new line of hardware and software to handle all aspects of data acquisition, data analysis, and external control applications on the Macintosh II. The MacADIOS II (which stands for Macintosh analog/digital input/output system) is a 10-board set that connects the Mac II to the outside world through a number of analog and digital channels.

The master MacADIOS II card can sample 12-bit data through one channel at 142,000 samples per second. Conversion time is 5 microseconds with +/− 0.02 percent accuracy. The software-programmable instrumentation amplifier has three gain settings: 1, 10, and 100 V/V. The AM9513A counter/timer chip has five 16-bit event counters.

You can attach nine daughterboards, which provide a variety of I/O functions, to the master board. Available software includes MacADIOS Manager II for nonprogrammers. If you're a more experienced bit jockey, you can program MacADIOS through any of half a dozen programming languages.
Price: $1500 to $10,000.
Contact: GW Instruments Inc., P.O. Box 2145, Cambridge, MA 02141, (617) 625-4096.
Inquiry 767.

Multifeature Laser

The price of midrange laser printers, usually packed with standard features, continues to fall. A case in point is Kyocera Unison's F-1000A printer. This 10-page-per-minute printer has 79 resident fonts, including 8 foreign-language character sets.

Included with the printer are 512K bytes of RAM (expandable to 1.5 megabytes) and both parallel and serial ports. The F-1000A emulates seven printers, including the Diablo 630, Qume Sprint II, NEC Spinwriter, IBM Graphics Printer, Epson FX-80, Hewlett-Packard LaserJet II, and a generic line printer.

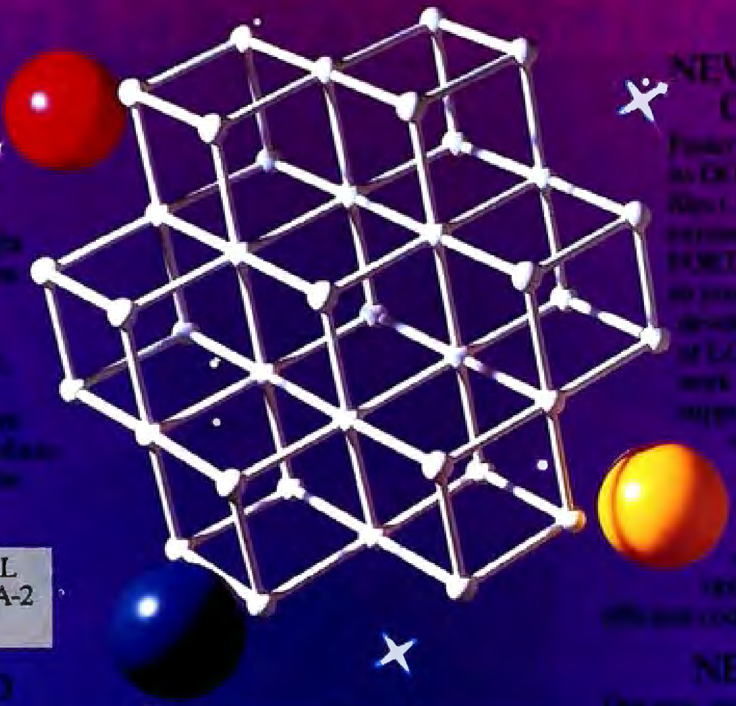
The printer has two card slots that accept customized IC cards, each of which store personalized logos, business forms, and even signatures. If you want to prepare cards, you'll need the optional Font/Logo Master software ($300) and the IC Card Burner Kit ($500). Blank IC cards are $55 each.

Like other Kyocera laser printers, the F-1000A includes the Prescribe printer-command language, which accepts commands in straight ASCII. The printer has a 250-sheet feed cassette.
Price: $2895.
Contact: Kyocera Unison Inc., 3165 Adeline St., Berkeley, CA 94703, (415) 848-6680.
Inquiry 768.

continued

SOFTWARE ENGINEERING COMES OF AGE.

ANNOUNCING LOGITECH MODULA-2 VERSION 3.0



Modula-2 is the language of choice for modern software engineering, and LOGITECH Modula-2 is the most powerful implementation available for the PC. The right language and the right tools have come together in one superior product. Whether you're working on a small program or a complex project, with LOGITECH Modula-2 Version 3.0 you can write more reliable, maintainable, better documented code in a fraction of the time at a fraction of the cost.

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TRANSLATOR

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Circle 147 on Reader Service Card (DEALERS: 148)


Who do you think of as the world's largest manufacturer of mice?

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In our short history, we've manufactured over 750,000 mice. More than any other company in the world.

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Our new mouse is 100% compatible with IBM. Plus Software includes driver, programmable pop-up menu system, Point and Click Shell for 1-2-3,™ and Point, the mouse-based text editor.

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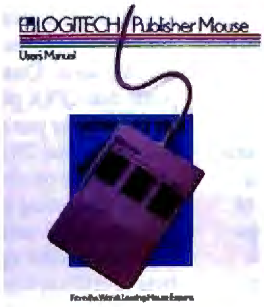
LOGITECH MOUSE with Plus Software $119
Consistently the reviewers' favorites, our Bus and Serial mouse products come complete with our Plus Software, which includes driver, Logimenu programmable pop-up menu system, Point and Click Shell for Lotus 1-2-3,™ and Point, the mouse-based text editor.



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Mouse, Plus Software and PUBLISHER software. Produces high-impact, professional looking documents. Design templates make page layout easy. For beginner and advanced.

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LOGITECH'S COMPLETE CADD SOLUTION $189
For beginner to advanced, it's a complete solution for dimensioned line drawing and CADD. Package includes Mouse, Plus Software, and LOGICADD.

Circle 149 on Reader Service Card
(DEALERS: 150)

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GRID Adds High-Powered Laptops

GRiD Systems has broadened its product line with laptops based on the 80286 and 80386 processors. The GRiDCase 1500 Series computers weigh about 12 pounds apiece. GRiD claims that the units are the only battery-powered 286 and 386 laptops.

Standard features of the AT-compatible 1500 series include a 10-inch diagonal supertwist backlit LCD screen, 1 megabyte of RAM (expandable to 8 megabytes), two 1.44-megabyte 3½-inch internal floppy disk drives, and up to 512K-byte ROM packs.

Options for the 1500 series include two different gas-plasma displays, 10-, 20-, or 40-megabyte internal hard drives, a math coprocessor, an internal modem, and a rechargeable battery pack.

The Model 1520 uses an 80C286 processor running at 10 MHz, while the Model 1530 has an 80C386 processor running at 12.5 MHz.

Price: 1520, $3495; 1530, $4695.

Contact: GRiD Systems Corp., 47211 Lakeview Blvd., Fremont, CA 94538, (415) 656-4700.

Inquiry 769.

PS/2 External 525 Drive

Delkin Devices' 525 Extra is a compact, low-cost external 5¼-inch floppy disk drive for all models of the IBM PS/2 series. The drive simply plugs into an existing connector inside the PS/2; it gets its power from the computer.

Measuring 9 by 6 by 2¼ inches, the 525 Extra installs in about 5 minutes with a standard screwdriver. It allows the PS/2 machines to read, write, and format standard 360K-byte floppy disks.

Price: $325.

Contact: Delkin Devices U.S.A., 4655 Cass St., Suite 306, San Diego, CA 92109, (619) 273-8086.

Inquiry 770.

The GRiDCase 1500 comes with an 80286 or an 80386.

Datavue has 386 Transportable

And yet another entry in the growing list of 80386-based transportable systems comes from Datavue. Adding to its extensive line of laptop, portable, and transportable computers, its power-user system—called the Smoke386—will be available in both a 16-MHz system with a 40-megabyte hard disk drive and a 20-MHz version with a 100-megabyte hard disk drive. A company spokesperson says both will be available by the end of March.

The Smoke386 will run on AC power only. The unit's appearance is similar to the Datavue 25—the company's first portable. It has a vertical configuration and an appearance that some have compared with an electric toaster. Departing from screen types of previous Datavue portables, the unit uses a backlit twisted nematic LCD display with a 1-to-1 aspect ratio and a black-on-white (or inverse) VGA-type display featuring a resolution of 640 by 480 pixels.

The Smoke386 will come standard with 2 megabytes of RAM, expandable to 8 megabytes. Besides the hard disk drives mentioned above, several different floppy disk drive configurations are available, including single or dual 1.44-megabyte 3½-inch floppy disk drives, as well a 1.2-megabyte 5¼-inch floppy disk drive.

Weighing about 16 pounds, the Smoke386 can handle two full-size IBM PC or AT expansion cards with an optional expansion chassis that mounts on the bottom of the unit. The box does add to the size, but the computer remains easily transportable.

Price: 16-MHz version, $4995; 20-MHz version, price not yet available.

Contact: Datavue, One Meca Way, Norcross, GA 30093-2919, (404) 564-5555.

Inquiry 771.

Operating System for PS/2s

Quantum has a version of its QNX operating system for the IBM PS/2 family. The program provides 150 concurrent tasks in a protected-mode environment and 64 tasks in real mode. Quantum reports that QNX performs 3800 task switches per second in real mode and 2816 in protected mode on the Model 50.

The operating system provides up to 32 serial ports and can handle files up to 1 terabyte (a trillion bytes), according to Quantum. Running Quantum's DOS-emulator program, QDOS II, provides DOS compatibility.

Price: $450.

Contact: Quantum Software Systems Ltd., 175 Terrence Matthews Crescent, Kanata South Business Park, Kanata, Ontario, Canada K2M 1W8, (613) 591-0931.

Inquiry 772.

NEC MultiSync in Monochrome

NEC Home Electronics, whose MultiSync color monitors started a minor revolution in color graphics, has introduced a monochrome version. The "GS" in MultiSync GS stands for gray scale, and that's how it displays colors—in up to 64 shades of gray. It's available in green, amber, and paper-white phosphor models.

The MultiSync GS has a 13-inch diagonal screen and is NEC's first monochrome monitor. The unit works with all IBM PC–compatible graphics adapters, and the monitor's input is switchable between analog and digital. MDA and Hercules inputs are displayed as 3 levels of gray, CGA as 13 levels, EGA and EGA-plus as 64 levels, and MCGA and VGA depend on the mode.

The monitor's maximum resolution is 720 by 480 pixels. The scan rate, which automatically adjusts to the graphics adapter being used, is 15.7 to 31.5 KHz horizontal and 49.6 to 70 KHz vertical. Its screen is nonglare, with a flat CRT and square corners.

Why a monochrome MultiSync? An NEC spokesperson says the company's market research showed a need for MultiSync features in many business environments, but the cost of the color monitors coupled with often-tight budgets meant that workers who needed MultiSync features often didn't get them.

Price: $279.

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

Inquiry 773.

continued

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PageMaker 3.0

Among other features, PageMaker 3.0 will provide automatic text flow throughout a document, automatic text wraparound of irregularly shaped graphics, support for color, image controls for scanned photographs and bit-mapped illustrations, user-definable style sheets, and 20 page-design templates.

The image-control feature lets you control brightness, adjust contrast between an object and its background, define the angle and density of an image's lines and dots to create special effects, and easily modify images.

With version 3.0, new pages are automatically created for text overflow, and a `Snap to Rulers` command for precise alignment has been added. You can also import tagged formats from word-processing, database, and spreadsheet applications.

The new version of PageMaker will require a Windows-compatible PC AT or PS/2 that has at least a 10-megabyte hard disk drive.

Price: $795.

Contact: Aldus Corp., 411 First Ave. S, Suite 200, Seattle, WA 98104, (206) 628-2375.

Inquiry 774.

80386 Computer Kit

In one or two evenings of simple assembly work, you can build yourself a high-powered computer system with Heath's H-386 kit. Based on an 80386 processor running at 16 MHz, the standard H-386 kit also includes a 1.2-megabyte 5¼-inch floppy disk drive, a combination floppy/hard disk controller, serial and parallel ports, ROM-based diagnostics, and a 101-key keyboard.

The Heath Z-449 video board that comes with it is EGA-, CGA-, and MDA-compatible. Software includes Zenith's MS-DOS 3.2+ and Integrated 7+, an integrated software package that includes a spreadsheet, word processor, database manager, graphics, and communications.

You don't need any special tools or skills to put the H-386 together. No soldering is required, and the completed system has five full-length open slots. Options include hard disk drives, additional floppy disk drives, and monochrome or color monitors.

Price: $3349.95.

Contact: To obtain kit, write to the Heath Company, Dept. 350-010, Hilltop Rd., Benton Harbor, MI 49022.

Inquiry 775.

Lotus 1-2-3 Add-on Relational Database

Windjammer Software believes that its product, NexView, is the first relational spreadsheet program. The Lotus 1-2-3 add-on gives you access to data in spreadsheets without having to write any special formulas. You can consolidate a number of spreadsheets into one and work on up to 10 windows simultaneously. The program formats reports and lets you bring entries from one spreadsheet to another.

NexView runs on the IBM PC XT and compatibles with 640K bytes of RAM, a monochrome or color monitor, and a hard disk drive.

Price: $595.

Contact: Windjammer Software Inc., 567 Park Ave., Scotch Plains, NJ 07076, (201) 322-6363.

Inquiry 776.

Transportable Wide-Carriage Printer

Diconix, a subsidiary of Eastman Kodak, now has a wide-carriage version of its transportable printer. The Diconix 300W takes paper up to 14.8 inches wide, measures 3 by 9 by 19 inches, and weighs just 12 pounds.

The printer uses ink-jet technology and has a rated noise level of only 48 decibels. Draft print speeds are 310 cps (elite) and 258 cps (pica); near-letter-quality mode prints at 73 cps (elite) and 61 cps (pica); and letter-quality mode prints at 48 cps (elite) and 40 cps (pica). A condensed draft-quality mode is also available, and the printer can print full-size graphics at 192 by 192 dots per inch.

Emulating the IBM Proprinter, IBM Quietwriter, and the Epson FX-85/100 printers, the Diconix 300W is available in both parallel and serial models.

Price: $749.

Contact: Diconix Inc., 3100 Research Blvd., Dayton, OH 45420, (800) 342-6649.

Inquiry 777.

Skok Announces CAD Programs

Skok Systems began shipping four new drawing programs in December. The first, Drawbase HLR, is a hidden line-removal program that works with other Drawbase software.

Drawbase 2000 is a two-dimensional program that includes construction geometry, interrupt command structure, and DXF import/export capability. Drawbase 3000 is a two- and three-dimensional program that features two- and three-point views, as well as orthographic and wire-frame views. The last program in the series, Drawbase 4000, includes a database package and the program Space Accounting, which tracks area and perimeter values of any graphic object.

Skok reports that all the Drawbase programs are integrated, enabling you to move drawings back and forth between them without a translation procedure. None of the announced products is copy-protected.

Price: Drawbase HLR, $495; Drawbase 2000, $1995; Drawbase 3000, $2995; Drawbase 4000, $3995.

Contact: Skok Systems Inc., 222 Third St., Cambridge, MA 02142, (617) 868-6003.

Inquiry 778.

Forget-Me-Not

The programmable message system Forget-Me-Not tells your system to execute batch-file applications unattended and can be used for sending and receiving electronic mail in a LAN environment.

The program reads SideKick calendar programs as well as six other files you create. You can pop up a message window using the SideKick notepad, EDLIN, WordStar, or other ASCII text editors. You can program the window to appear at a certain time or place, and the message can contain multiple windows.

Forget-Me-Not is file-driven and written in assembly language. It requires 25K bytes of RAM, one disk drive, and MS-DOS or PC-DOS 2.0 or higher.

Price: $59.

Contact: Sterling Castle Software, 702 Washington St., Suite 174, Marina del Rey, CA 90292, (800) 722-7853; in California, (800) 323-6406.

Inquiry 779.

FORTRAN Compiler with GEM Documentation

Prospero Software's program development environment, Prospero FORTRAN for GEM, runs on the Atari ST and the IBM PC. An enhanced version of Pro FORTRAN-77, the new compiler offers a four-window source editor, a development environment, a symbolic debugger, and an improved linker.

The package is a complete validated ANSI-standard FORTRAN-77-level compiler, Prospero reports. The IBM PC version lets ST programmers recompile source programs to run on the PC and compatibles under GEM.

Price: $199.

Contact: Prospero Software Inc., 100 Commercial St., Suite 306, Portland, ME 04101, (800) 327-6730.

Inquiry 780.

continued

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Mainframe Runs MS-DOS

The Centaur II Mainframe is an MS-DOS-compatible, multiuser, multiprocessing system that runs under the Novell NetWare operating system. It can be expanded to handle up to 100 simultaneous terminal users or up to 500 occasional switched terminal users. Each user's terminal is connected to a circuit card that incorporates an NEC V40 processor running at 8 MHz, 786K bytes of RAM (640K bytes is user-accessible), and two COM ports: one for attaching the terminal, the other for a printer or modem.

The main file processor for the mainframe is either 80286- or 80386-based and includes 2 megabytes of RAM (expandable up to 16 megabytes). The peripheral controller included can handle up to six floppy/hard disk systems and a tape backup unit.

The Mainframe itself consists of a standard 19-inch computer cabinet and from one to six rack-mounted Centaur II chassis. Each chassis houses from 1 to 14 application processors. A full range of storage peripherals is available. Centaur II supports most ASCII terminals, including DEC VT-100s and compatibles, as well as standard PC-type terminals such as those available from DVSC, Link, Kimtron, TeleVideo, and WYSE.

Price: Starting at $50,000 (30 to 40 users).

Contact: Data/Voice Solutions Corp., One Newport Place, Mail Stop 800, Newport Beach, CA 92660, (714) 752-8181.

Inquiry 781.

The Centaur II is MS-DOS-compatible.

Toshiba's 386 Portable

Toshiba's T5100 portable computer gets its power from a 16-MHz 80386 (switchable to 8 MHz). There's also a socket for an 80387 coprocessor. Other standard internals of the portable are 2 megabytes of RAM (expandable to 4 megabytes), a single 1.44-megabyte 3½-inch floppy disk drive that Toshiba says is fully compatible with IBM PS/2 drives, and a 40-megabyte hard disk drive with an average access time of 29 milliseconds. The T5100 requires AC; it will not operate on battery power.

On the outside, the T5100 measures 12¼ inches wide by 14¼ inches deep by 3½ inches high. Like other Toshiba portables, the screen flips up. Like the Toshiba T3100, the screen has a gas-plasma display. With a resolution of 640 by 400 pixels (equal to the EGA standard), it displays graphics using four shades of gray. There's also a port for an external EGA-compatible monitor.

The unit has an RS-232C serial port, a parallel port, a port for connecting an external 5¼-inch floppy disk drive, and a Toshiba standard internal expansion slot. Software includes MS-DOS 3.2 and Lotus Metro, the memory-resident desktop manager from the 1-2-3 mavens.

Options for the T5100 include a 2-megabyte memory expansion board (price not yet announced). There's also an internal 1200-bps modem ($399), an external 5¼-inch floppy disk drive ($499), and Floppy Link, a $199 package that lets you connect the T5100 to a desktop PC. A carrying case is also optional.

Price: $6499.

Contact: Toshiba America Inc., Information Systems Division, 9740 Irvine Blvd., Irvine, CA 92718, (800) 457-7777.

Inquiry 782.

Toshiba's new portable is 80386-powered.

PageLink Merges Text and Graphics

Qume's PageLink is a self-contained hardware/software system that merges text and graphics from existing word-processing and spreadsheet programs to produce typeset-quality documents. It's available in two versions: PageLink has 1.2 megabytes of internal memory to combine text with partial-page graphics. PageLink Plus has 2 megabytes of memory, enough to combine text with full-page bit-mapped graphics.

The PageLink system has 111 built-in fonts, and software enhancers allow automatic kerning, optimized character spacing, and true typesetting functions such as italics. You can create page frames, shades, and patterns. You can also integrate scanned images into documents.

PageLink operates in two basic modes. In the PageLink mode, the controller outputs video directly into the imaging unit of your laser printer. In native mode, PageLink acts only as a buffering multiplexer to the standard laser-printer controller. The system lets you connect up to nine microcomputers to a single laser printer, and it operates with pop-up software.

Price: $3795; PageLink Plus, $3995.

Contact: Qume, 2350 Qume Dr., San Jose, CA 95131-1893, (408) 432-4000.

Inquiry 783.

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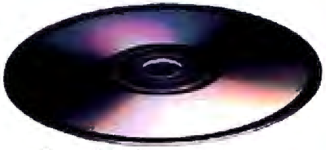

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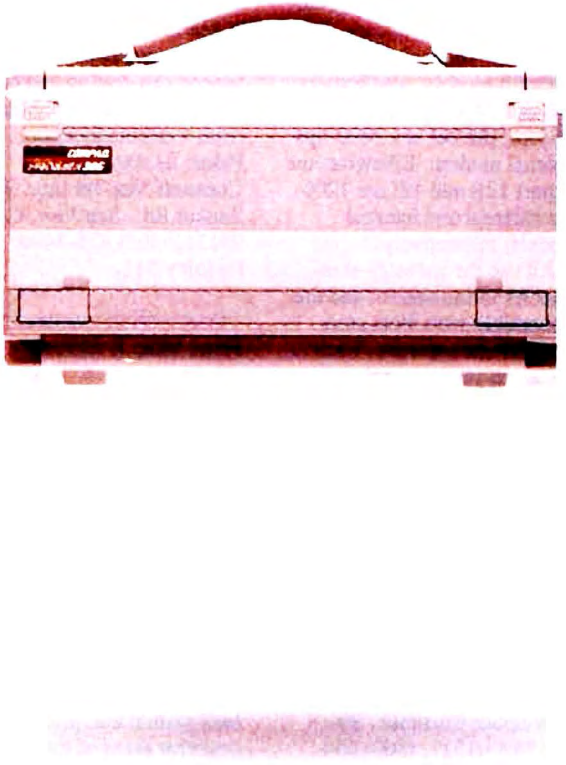

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Citizen Speeds Low End

Citizen America now has a faster version of its popular low-cost 120D printer. The 180D is, as its name implies, a 180-cps (draft) dot-matrix printer. It also has three additional modes: data processing at 150 cps, high-speed NLQ at 31 cps, and NLQ at 29 cps.

The 180D uses a nine-wire print head and is compatible with both Epson and IBM printers. You can also print graphics in seven resolutions up to 240 dots per inch. The unit can generate over 200 type styles, including compressed and expanded characters.

You can feed paper into the 180D through either the rear or the bottom of the unit. A parallel interface is standard; a serial interface is optional.

Price: $259.

Contact: Citizen America, 2401 Colorado Ave, Suite 190, Santa Monica, CA 90404, (213) 453-0614.

Inquiry 784.

High-Speed AT Hard Disk

Micro Systems Group has a new series of hard disk drives for the IBM PC AT and compatibles that feature ultra-fast access times and are designed to take advantage of the 16-bit bus and faster clock speeds of 80286-based computers. The fastest of the lot is the MSG-HS40, a 40-megabyte unit with an average access time of 8.2 milliseconds.

The drives are also available in capacities of 82, 120, and 150 megabytes, each with an average access time of 16 ms. All models are full-height 5¼-inch drives and come complete with an ESDI controller with proprietary firmware for maximum data transfer.

Price: From $3495 to $5495.

Contact: Micro Systems Group Inc., 2117 Stonington, Hoffman Estates, IL 60195, (312) 882-5666.

Inquiry 785.

Low-Cost Modems

A new series of modems for the IBM PC and compatibles from Advanced Computer Technology has four different models. The Expert 24E is a 2400-bps external modem; the 24I is a 2400-bps internal modem. Likewise, the Expert 12E and 12I are 1200-bps external and internal models, respectively.

All use the industry-standard AT command set and are compatible with most communications software. Each has a two-year warranty and includes auto-dialing, on-screen help menus, multiple-number storage, automatic speed adjustment for noisy lines, and extensive self-testing and diagnostics. A built-in speaker and dual telephone jacks are also standard.

Price: 24E and 24I, $199; 12E and 12I, $109.

Contact: Advanced Computer Technology, Worcester-Providence Turnpike, Sutton, MA 01527, (800) 654-6464; in Massachusetts, (617) 865-3304.

Inquiry 786.

High-Speed Modem for Normal Lines

Ven-Tel's EC18K-34 is a very high-speed 18,000-bps asynchronous modem with integral data compression that the company claims can boost throughput up to 19,200 bps, even on poor lines.

The modem automatically corrects errors using 16-bit CRC in high-speed mode and MNP error correction at 1200 bps and 2400 bps. It can also dynamically adjust itself to changing phone-line conditions. Unlike many competing high-speed modems, the EC18K-34 can fall back in speed by 100-bps increments if the line degrades.

At high speed, the modem uses PEP (Packetized Ensemble Protocol) multicarrier modulation. At lower speeds, it is Hayes-compatible and automatically adjusts itself to the highest speed supported by the modem on the other end. The EC18K-34 has advanced self-testing and can be configured via telephone line from a remote location.

Price: $1300.

Contact: Ven-Tel Inc., 2121 Zanker Rd., San Jose, CA 95131, (408) 436-7400.

Inquiry 811.

Fast Mac II Drive

With a data transfer rate that's faster than the transfer rate of the Macintosh II, the PRO 140 II/i is a 140-megabyte internal hard disk drive that's designed especially for Apple's top-of-the-line model.

The disk has an average access time of 26 ms and features automatic head parking. There's also a dynamic brake-lock system that protects sensitive areas of the disk while it's being transported. The PRO 140 II/i comes with the CMS SCSI Utilities program that helps you format, initialize, and install the drive.

Price: $2695.

Contact: CMS Enhancements Inc., 1372 Valencia Ave., Tustin, CA 92684, (714) 259-9555.

Inquiry 787.

Fingerprint Your Computer

ThumbScan is a "biometric identification system" that analyzes fingerprints to make sure that only authorized users get access to a computer equipped with the unit. The system consists of a small fingerprint-scanning device that connects to your system, as well as software.

The software initializes your fingerprint by requesting that you place a thumb or finger on the scanner's image area. The ThumbScan then digitizes and encrypts the fingerprint. Later on, it will compare your fingerprint with the encrypted image. If it matches, you can access the system. It takes about 5 minutes to initialize a user, and thereafter about 5 seconds to check if the user is authorized.

ThumbScan is compatible with MS-DOS systems, as well as DEC VAXes and IBM mainframes, which require additional software.

Price: $995.

Contact: ThumbScan Inc., Two Mid-America Plaza, Suite 800, Oakbrook Terrace, IL 60181, (312) 954-2336.

Inquiry 788.

Heavy-Duty Laser

With a target volume of 10,000 pages per month and a rated print-engine life of 600,000 pages, the Facit P7080-A laser printer is designed for heavy use in a busy environment. The printer comes with six fonts in two sizes; plug-in cartridges are available to provide additional fonts, PostScript and HPGL emulation, and bar-code printing.

Rated at 8 pages per minute, the P7080-A emulates the Diablo 630, Hewlett-Packard LaserJet Plus, and Epson FX printers. It has both parallel and serial interfaces, and it comes standard with 512K bytes of RAM, expandable to 2 megabytes. The feeder and output trays both handle 250 pages, and the output is collated face-down.

Price: $5895.

Contact: Facit Inc., 9 Executive Dr., Merrimack, NH 03054, (603) 424-8000.

Inquiry 789.

continued

UDS is chipping away at V.32 prices!

Full duplex 9600 bps communication over dial-up telephone lines becomes more cost-effective than ever, as UDS announces a 36% price cut for the popular V.32 modem.

A unique echo cancellation technique (patent pending) permits reliable performance over all types of surface and satellite links. Set-up and operation are greatly simplified by a 3-key system of responses to menu prompts on an integral LCD screen. The same screen displays results from the modem's extensive self-test regime.

New Quantity One Price

The unit also features auto dial, auto answer, call progress detection and adaptive line equalization. If degraded line quality prevents 9600 bps communication, a 4800 bps fallback mode is available.

If modem cost is the reason you haven't upgraded your dial-up system to V.32, the rules have just changed. For detailed specifications and quantity prices, contact Universal Data Systems, 5000 Bradford Drive, Huntsville, AL 35805. Telephone 800-451-2369; Telex 752602 UDS HTV.

Universal Data Systems
MOTOROLA INC.
Information Systems Group

Circle 279 on Reader Service Card

Created by Dayner/Hall, Inc., Winter Park, Florida

High-Speed EGA/VGA

Ahead Systems has two new video cards for the IBM PC and compatibles that feature both EGA and BIOS-level VGA compatibility. The EGA Wizard and EGA Wizard Deluxe have maximum resolutions of 640 by 480 pixels and 800 by 600 pixels, respectively.

Both cards display CGA and EGA colors as 16 shades of gray on monochrome monitors and support 132-column modes. Both also have a proprietary turbo mode, which the company claims improves video display speed by up to 300 percent by reducing the number of wait states to less than half that of standard EGA cards.

The cards are shipped with a number of custom software drivers for such popular applications as Lotus 1-2-3, AutoCAD, PageMaker, Ventura Publisher, Generic CAD, Dr. HALO III, Framework, and FastCAD. Both also support extensive PC-to-mainframe and PC-to-minicomputer communications with emulation support for the IBM 3278/3279, S3G, VT-100/VT-220, HP, and Tektronix 4005/4010/4015.

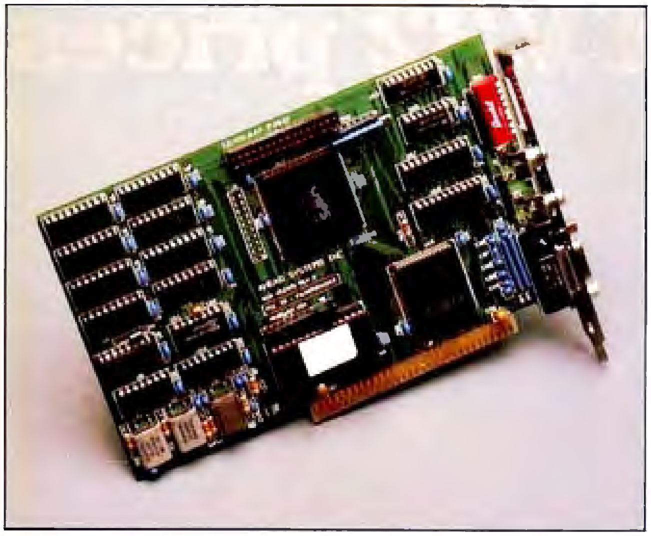
Price: Wizard, $249; Wizard Deluxe, $349.

Contact: Ahead Systems Inc., 1977 O'Toole Ave., Suite B105, San Jose, CA 95131, (408) 435-0707.

Inquiry 790.

Cableless 386 Upgrade

If you want to upgrade your AT or compatible to an 80386, the Master 386 from Aox lets you do it easily, without removing chips or installing cables. Installation is a simple matter of plugging in the board and installing software. The Master 386 is available in both 16-MHz and 20-MHz versions, with high-speed cache memory and a socket for an optional 80387 coprocessor.



The EGA Wizard series is VGA-BIOS-level-compatible.

The Master 386 includes special circuitry that the company claims will prevent problems caused by the recently announced bug in the 80386. The company claims the Master 386 will run flawlessly in protected mode with an 80387 as required by Unix, PC-MOS/386, and Windows/386.

Using its on-board connectors, you can equip the Master 386 with true 32-bit memory using Aox's optional memory-expansion board. A 2-megabyte card (expandable to 10 megabytes) is $1250; a 4-megabyte card (expandable to 16 megabytes) is $1995.

Price: 16-MHz version, $1595; 20-MHz version, $2195.

Contact: Aox Inc., 486 Totten Pond Rd., Waltham, MA 02154, (617) 890-4402.

Inquiry 791.

SCSI for the PS/2

The MCS-350 SCSI host adapter from Future Domain is an add-in for the IBM PS/2 Models 50, 60, and 80. It interfaces the computers with any of the wide variety of SCSI peripherals.

The MCS-350's transfer rate is 1.67 megabytes per second, and it offers full Micro Channel compatibility with an IBM-assigned ID number. It also has all the features you need to run advanced operating systems such as OS/2, Xenix, and Novell.

Price: $390.

Contact: Future Domain Corp., 1582 Parkway Loop, Suite A, Tustin, CA 92680, (714) 259-0400.

Inquiry 792.

Acquire Data for the PS/2 50, 60, and 80

The MDL-16 is a real-time and event-based data acquisition system for the PS/2 Models 50, 60, and 80. It includes a multifunction Micro Channel data acquisition board with both RS-232C and RS-422/485 comunications ports.

The system comes with the TransParent Interface, a real-time background data collection program. Its features include interfaces for Borland's Turbo Pascal, Turbo Basic, and Turbo C, as well as Microsoft's GWBASIC and C. Language variables are updated in real time and directly interfaced with analog and digital inputs and outputs.

Hardware features include 16 13-bit analog inputs, 16 TTL-level digital inputs, 16 TTL-level digital outputs, 96 alarms, a battery-backed real-time clock, and stand-alone data logging with time and date stamping. Options include a 1200-bps modem, a temperature sensor board, I/O rack adapter cards, and isolation modules.

Price: $499.

Contact: The Automation Group Inc., 848-R Nandino Blvd., Lexington, KY 40511, (606) 254-6916.

Inquiry 793.

Your Computer Speaks

The Heath HV-2000 is an expansion card for the IBM PC and compatibles that gives your computer a wide variety of voices. It's a half-size plug-in card that, according to the company, translates ASCII data as well as high- or low-level languages into intelligible speech.

This add-in consists of a speech synthesizer on a circuit board, an audio amplifier, and an external speaker. A Speak utility program lets you add vocal prompts to batch files. It will also read ASCII text files, as well as ASCII data received through a serial port. The board has XON/XOFF handshaking and a 60K-byte buffer. There's also terminal-emulator software that adds speech to modem communications.

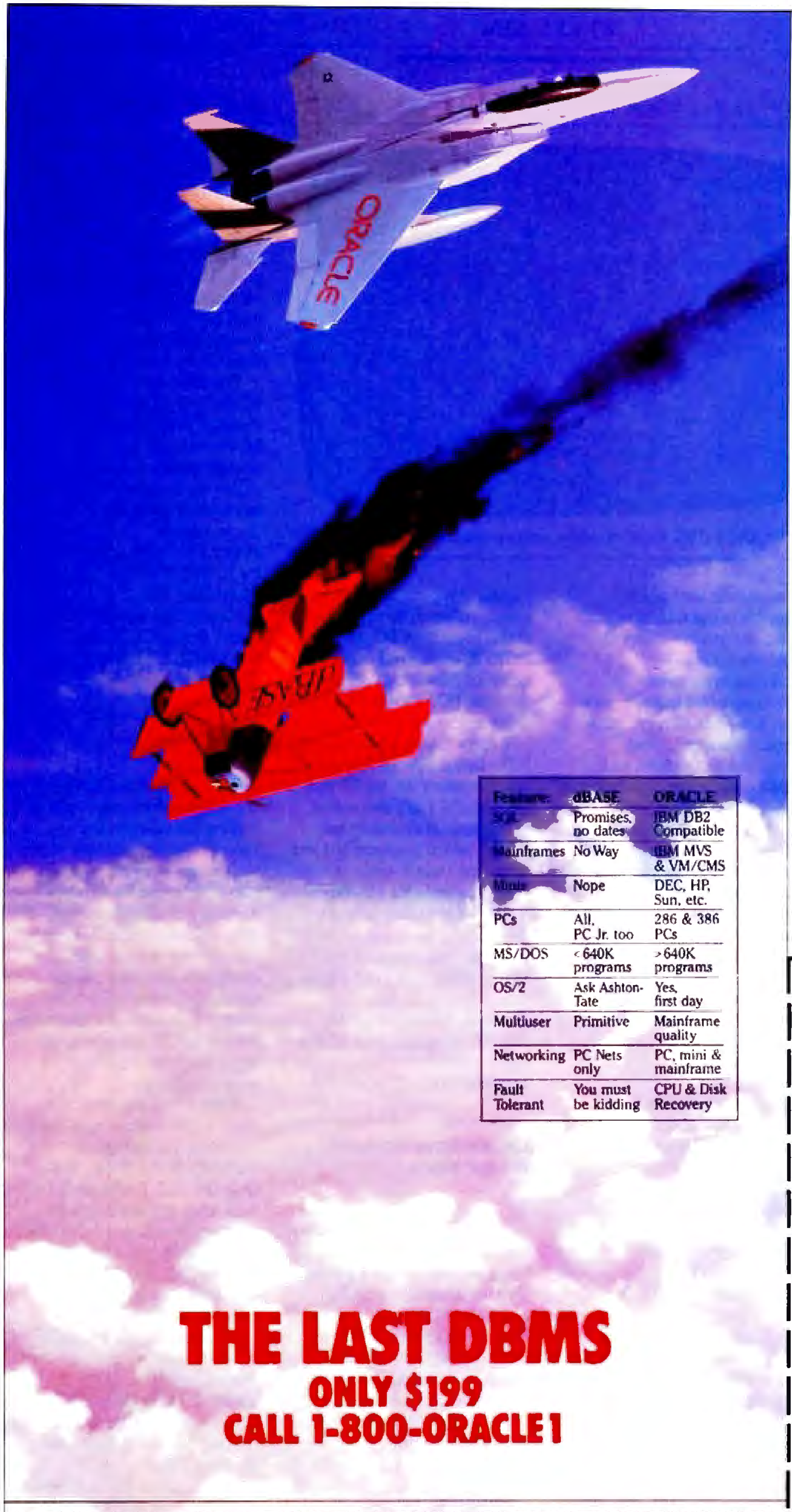
The HV-2000 uses 64 phonemes to create words, phrases, and sentences. Other attributes include four durations, 16 rates, 4096 inflection levels, 32 transition levels, eight transition rates, eight articulation rates, and 49 musical notes. The audio output has 16 amplitude settings.

Price: $89.95.

Contact: To obtain kit, write to the Heath Company, Dept. 350-020, Hilltop Rd., Benton Harbor, MI 49022.

Inquiry 794.

continued



Feature	dBASE	ORACLE
SQL	Promises, no dates	IBM DB2 Compatible
Mainframes	No Way	IBM MVS & VM/CMS
Minis	Nope	DEC, HP, Sun, etc.
PCs	All, PC Jr. too	286 & 386 PCs
MS/DOS	<640K programs	>640K programs
OS/2	Ask Ashton-Tate	Yes, first day
Multiuser	Primitive	Mainframe quality
Networking	PC Nets only	PC, mini & mainframe
Fault Tolerant	You must be kidding	CPU & Disk Recovery

Oracle Corporation, the world's fastest growing software company,[1] has just climbed past Ashton-Tate to become the world's largest supplier of database management software and services.[2]

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- Because ORACLE® runs on PCs, plus mainframes and minicomputers from IBM, DEC, DG, HP, Prime, Wang, Apollo, Sun, etc. — virtually every computer you have now or ever will have. Ashton-Tate's dBASE runs only on PCs.
- Because ORACLE is a true distributed DBMS that connects all your computers — PCs, minicomputers and mainframes — into a single, unified computing and information resource. dBASE supports only primitive PC networking.
- Because Oracle has supported the industry standard SQL language since 1979. Ashton-Tate promises to put SQL into dBASE sometime in the indefinite future.
- Because ORACLE takes advantage of modern 286/386 PCs by letting you build larger-than-640K PC applications on MS/DOS today, and run them unchanged on OS/2, once OS/2 is available. dBASE treats today's 286/386 PCs and PS/2s like the now obsolete, original PC.

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Title
Company
Street *(P.O. Box numbers not acceptable)*
City
State Zip
Phone
Credit Card Number
Card Expiration Date
Signature BYTE
I am a value-added reseller (VAR) ☐ YES ☐ NO

---

[1] Revenue doubled in 9 of Oracle's 10 years. [2] Sales rate over $200 million in current fiscal year. [3] For PC development use only. Requires a 286/386 PC plus 1-MByte extended memory. Offer valid only in US & Canada. © 1987 by Oracle Corp. ORACLE® is a reg. trademark of Oracle Corp. dBASE is a reg. trademark of Ashton-Tate. Microsoft & IBM own numerous reg. trademarks. TRBA

SOFTWARE • PROGRAMMING LANGUAGES AND AIDS

Programmer's Calculator

The XACT-16C is a RAM-resident calculator that emulates the Hewlett-Packard 16-C. It has decimal, hexadecimal, binary, octal, and floating-point modes with words from 2 to 64 bits. If you wish, you can run the calculator as a stand-alone DOS program. The XACT-16C also has advanced algebraic, logical, base-conversion, and bit-manipulation functions.

The calculator is programmable, with up to 203 program lines. It has a simulated paper-tape feature, and you can print the tape, save it to disk, or stamp it with messages. It also includes a built-in ASCII table.

To run XACT-16C, you need an IBM PC or compatible with at least 128K bytes of RAM, one floppy disk drive, and PC-DOS or MS-DOS 2.0 or higher.
Price: $49.95.
Contact: CalcTech Inc., 13629 Bellevue-Redmond Rd., Suite 202, Bellevue, WA 98005, (206) 643-1682.
Inquiry 795.

The XACT-16C RAM-resident programmable calculator.

Language Combines Prolog, Pascal, and dBASE

Complete Logic Systems calls it the first commercially available logic programming language based on constraints. As the name suggests, Trilogy has three levels of programming within the framework of predicate logic: procedural, database, and logic.

The company reports that the blind backtracking of Prolog is replaced with constraint satisfaction, resulting in faster logic solutions. The Pascal-like notation makes use of data constructors and destructors. But the file system, unlike Pascal, offers variable-size records and records with arbitrary values. You can insert, delete, and modify records in the middle of a file, and you can query them like predicates.

Trilogy has its own environment that includes an editor, a module library, an interactive compiler that produces native 8086 and 8087 code, an on-line linker, a loader, and help screens. The four modules (Math, Strings, Files, and Windows) export routines for transcendental functions, string/date/time manipulation, file access, and windowing functions.

The language runs on the IBM PC, XT, AT, and compatibles with MS-DOS or PC-DOS 2.0 or higher and 512K bytes of RAM. It is not copy-protected.
Price: $99.95.
Contact: Complete Logic Systems Inc., 741 Blueridge Ave., North Vancouver, B.C., Canada V7R 2J5, (604) 986-3234.
Inquiry 796.

386 FORTRAN Compiler

NDP Fortran-386 is a globally optimizing compiler that generates native 386 code that runs in protected mode under MS-DOS or Unix V. With NDP and MicroWay's mW1167 numeric coprocessor board, the company reports speed increases of up to 60 times the speed of an IBM PC. NDP's FORTRAN is a full implementation of FORTRAN-77 and includes FORTRAN-66 and other extensions.

Coprocessors supported by NDP include the in-line transcendentals of the 80387 and the full mW1167 instruction set. Output is assembly language, which is assembled and linked by Unix V tools or Phar Lap tools for MS-DOS.

The addressable memory available in the linear address mode is 4 gigabytes.
Price: $595; mW1167 coprocessor board, $1495.
Contact: MicroWay, P.O. Box 79, Kingston, MA 02364, (617) 746-7341.
Inquiry 797.

Cross-Development Kit for Macs

Memocom's cross-development kit for the Macintosh includes a table-driven cross assembler and a Memulator II or Memulator 16 in-circuit EPROM emulator. Memocom reports that you can assemble and test source programs for almost any microprocessor/controller with a maximum of 24 address bits.

Instead of burning EPROMs during an application's development cycle, you can download the output of your assembler or compiler directly into the target EPROM socket via the Mac's modem port. The Memulators II and 16 emulate the JEDEC standard 2716- through 27256-type devices and have an access time of 150 nanoseconds.

The cross assembler and Memulators II and 16 support standard Intel hexadecimal, Motorola S-record, and straight binary formats, which are compatible with most serial EPROM programmers.
Price: $725 with a Memulator II; $1275 with a Memulator 16.
Contact: Memocom, 1920 Arbor Creek Dr., Carrollton, TX 75010, (214) 446-9906.
Inquiry 798.

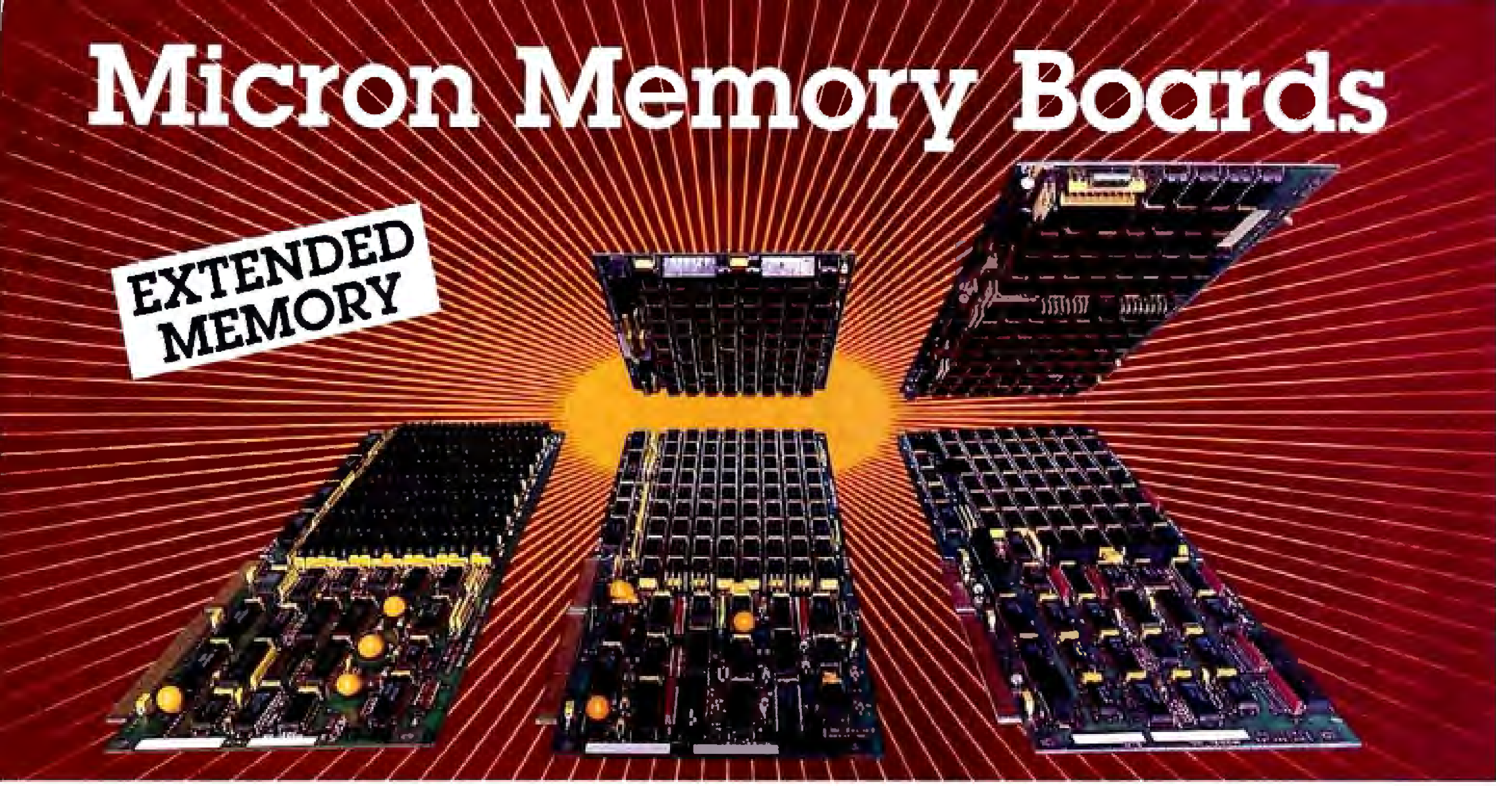
Pop-Up Pal

Pop up XO-Shell to do cross-referencing without leaving the editor; view any file and transfer sections of it to your editor or printer; view, copy, and erase files from a directory display; retrieve, edit, and re-execute DOS commands; and insert graphics characters into your source code. The memory-resident program also lets you insert extended ASCII characters and input them into your applications programs.

Wyte Corp. says that XO-Shell works with most editors, including Turbo Pascal, Turbo C, Turbo Basic, and QuickBASIC. It also works with most applications software, such as Lotus 1-2-3. To run the shell, you need an IBM PC, XT, AT, or compatible, or a PS/2. It takes up about 88K bytes of RAM and requires MS-DOS or PC-DOS 2.0 or higher.
Price: $49.
Contact: Wyte Corp., 701 Concord Ave., Cambridge, MA 02138, (617) 868-7704.
Inquiry 799.

continued

Micron Memory Boards



4 Meg AT ZIP Board

- EMS emulation software included
- Fully populated and tested with 4 MB of Micron memory on a single PC board!
- Designed to work with 80286 and 80386 based systems
- Compatible with OS/2, DOS, UNIX and XENIX
- Operating speeds up to 8 MHz zero wait-state and 12 MHz with one wait-state
- Backfills conventional memory
- Switch selectable on 4 MB boundaries at 1 MB or 2 MB starting address
- RAM diagnostics, RAM disk and print spooler software included
- All boards are tested under a wide range of environmental conditions to insure high reliability and quality
- Warranted for 2 years to registered users
- Made in the USA

Operating Speeds	Order Number	
	Standard Board	Board with 384 KB Offset*
Up to 6 MHz w/no wait-state Up to 10 MHz w/1 wait-state	MB-46-1Z	MB-46-3Z
Up to 8 MHz w/no wait-state Up to 12 MHz w/1 wait-state	MB-48-1Z	MB-48-3Z

*For systems with a 1 MB or 2 MB motherboard

2/4 Meg AT DIP Board

- EMS emulation software included
- Purchase 2 MB mothercard and 2 MB daughtercard separately or together to fit in a single slot!
- Designed to work with 80286 and 80386 based systems
- Compatible with OS/2, DOS, UNIX and XENIX
- Operating speeds up to 8 MHz zero wait-state and 12 MHz with one wait-state
- Backfills conventional memory
- Switch selectable on ½ MB boundaries starting at 1024K or 1408K
- RAM diagnostics, RAM disk and print spooler software included
- All boards are tested under a wide range of environmental conditions to insure high reliability and quality
- Warranted for 2 years to registered users
- Made in the USA

Operating Speeds	Order Number	
	2 MB	4 MB
Up to 6 MHz w/no wait-state Up to 10 MHz w/1 wait-state	MB-26-D	MB-46-D
Daughtercard for MB-26-D	MB-26-DD	
Up to 8 MHz w/no wait-state Up to 12 MHz w/1 wait-state	MB-28-D	MB-48-D
Daughtercard for MB-28-D	MB-28-DD	

16 Meg AT DIP Board

- EMS emulation software included
- Purchase 6 MB mothercard and 2, 4, 6 or 10 MB daughtercard separately or together to fit in a single slot!
- Fully populated and tested with Micron's own 1 megabit CMOS Dynamic RAMs
- Designed to work with 80286 and 80386 based systems
- Compatible with OS/2, DOS, UNIX and XENIX
- Operating speeds up to 8 MHz with zero wait-state and 12 MHz with one wait-state
- Backfills conventional memory
- Switch selectable on 128KB boundaries
- RAM diagnostics, RAM disk and print spooler software included
- All boards are tested under a wide range of environmental conditions to insure high reliability and quality
- Warranted for 2 years to registered users
- Made in the USA

Memory Capacity	Order Number	
	10MHz**	12MHz***
6 MB	MB-66-D	MB-68-D
8 MB	MB-86-D	MB-88-D
10 MB.	MB-106-D	MB-108-D
12 MB.	MB-126-D	MB-128-D
16 MB.	MB-166-D	MB-168-D

**Up to 6 MHz w/no wait-state up to 10 MHz w/1 wait-state
***Up to 10 MHz w/no wait-state up to 12 MHz w/1 wait-state

Micron Technology, Inc.
Systems Group
2805 East Columbia Road
Boise, Idaho 83706
1-800-642-7661
(208) 386-3800

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TECHNOLOGY, INC.

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Circle 165 on Reader Service Card

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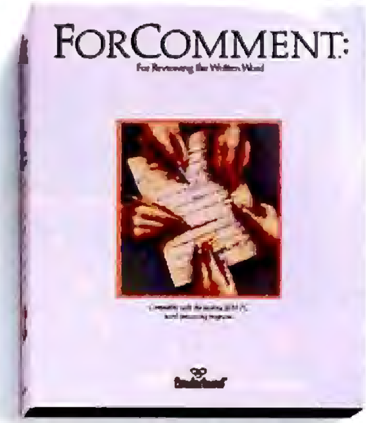
Best Reasons for

123 Ver. 2.x
Display more data with no loss of speed; pop up graphs on same screen as spreadsheet.

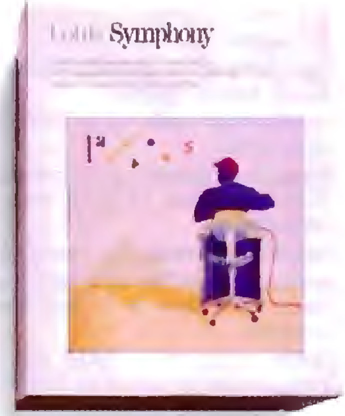
Wordstar 2000 Plus Ver. 3
Display sub/superscripts, italics, boldface, strikethrough.



For Comment
Display more text with no loss of speed.

WordMARC
Display foreign characters at text mode speeds.

Microsoft Multiplan
Display more data with no loss of speed.



Symphony
Display more data with no loss of speed.

Now, Here's

It's hard to find a business application that can't run better with RamFont.™

Spreadsheets show nearly twice the data. Word processors display foreign, technical and other special characters. All with no loss of scrolling speed–in fact, it often improves.

Now for a real look at what RamFont does, there's Write On! This unique RamFont word processor from Hercules displays several type styles and sizes at text-mode speeds, complete with headline-size type, custom and foreign characters, underscore and true boldface. See them on-screen like they'll appear in print, brightening memos, overheads and prompt cards.

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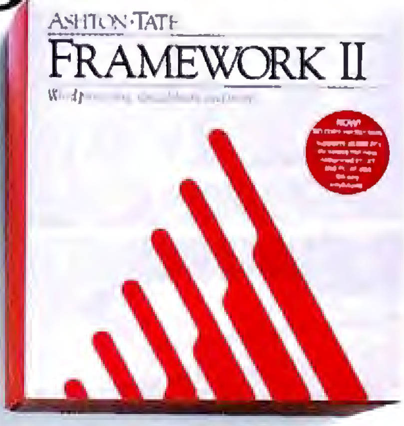
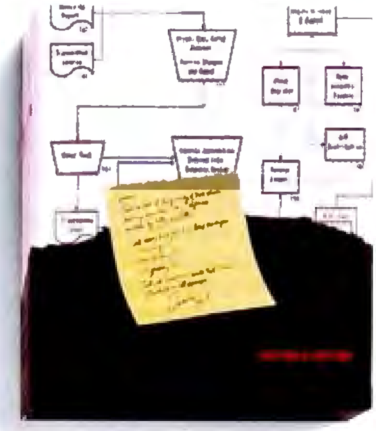
ow Some of the Having RamFont.

Brief
Display more text with no loss of speed.



Framework II
Display more data with no loss of speed; display boldface and italics in the word processor.



Flow Charting II
Display special symbols at text mode speeds.

Nota Bene
Display foreign character sets at text mode speeds.

Microsoft Word 4.0
Scroll much faster than in graphics mode, retaining all on-screen fonts and attributes.

Manuscript
Display sub/superscripts, italics, boldface and strikethrough.

One More.

Create new documents with Write On! or import any ASCII text file. You get full editing functions plus pull-down menus and mouse support for easy font changes. You'll turn plain text files created with other word processors into dazzling communications in seconds!

For a limited time, you get a *free* copy of Write On! with every Hercules Graphics Card Plus or Hercules InColor Card.*

Both are at your Hercules dealer, complete with our exclusive RamFont mode that makes it all possible.

There have never been so many reasons for RamFont. But as any software publisher will tell you, there will soon be a whole lot more.

Hercules.

RamFont by Hercules.
Exclusively in the Graphics Card Plus and InColor Card.

**If you already own a Hercules Graphics Card Plus or InColor Card, call us toll-free at 800-532-0600. We'll tell you how to get your copy of Write On!*

Circle 109 on Reader Service Card (DEALERS: 110)

SOFTWARE • SCIENTIFIC AND ENGINEERING

CAD/CAM on the Mac

The Professional System from Douglas Electronics now supports the Macintosh II as well as color and unlimited layers. The program is made up of three parts—Schematic Capture, a layout program, and an Autorouter.

To run the program, you need at least 512K bytes of RAM on a Mac or a Mac II. Input is via a mouse; you will need no additional hardware. You begin by designing a schematic with the Schematic Capture program; then you draw an outline with the layout software. Using the Parts Placement facility, you position the components on the grid. The Autorouter completes the process by automatically routing the circuit connections.

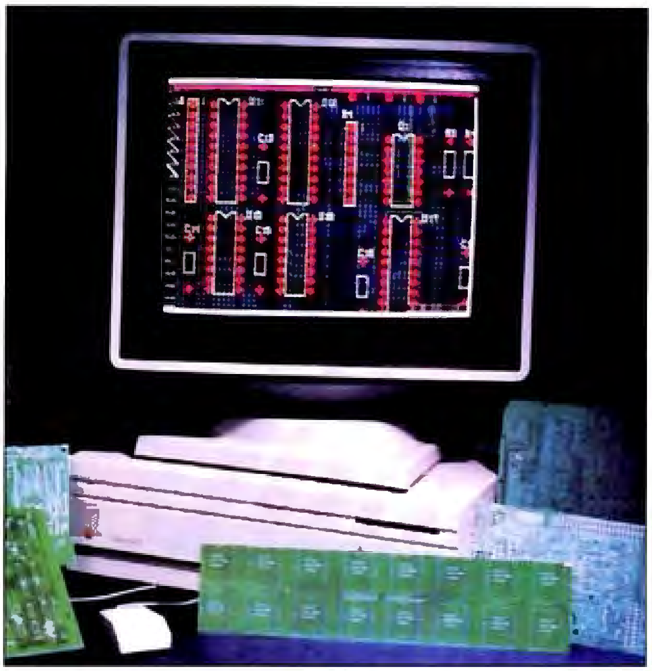
The Schematic Capture module features interactive circuit logic simulation that you define; and large TTL, CMOS, and discrete parts libraries. You can use symbols from the library or design your own.

The layout system features board designs of up to 32 by 32 inches, an unlimited number of layers, and 50 levels of magnification. You can view the layers separately or all at once, and, choosing from eight colors, you can assign a color to each layer.

The routing parameters are controlled via a command file, which provides options for grids, line widths, and maximum trace length. Douglas reports that the router is based on a maze router algorithm. A text file lists unroutable connections and shows them on the layout as rat's-nest lines.

Output options include dot-matrix, LaserWriter, pen plots, and Gerber files. Douglas will also provide you with artwork or finished circuit boards if you send the layout files via modem or mail.

Price: Professional Layout, $1500; Schematic Capture, $700; Autorouter, $700.



Douglas Electronics' Professional System offers schematic capture, a layout program, and an autorouter.

Contact: Douglas Electronics, 718 Marina Blvd., San Leandro, CA 94577, (415) 483-8770.

Inquiry 800.

CAMSmith

CAMSmith, based on the Graphics Entity and Operation Unification theory (GEOU) technology, offers advanced CAD and manufacturing capabilities. These include drafted walls, variable drafted walls, compound planes, intersection of any combination or arbitrary and regular surfaces, and interactive viewing of cutter path with dynamic scaling, rotation, and translation.

GEOU is based on research being conducted at 3D Science Laboratories. The company explains that in a typical CAD system, if you have *n* curve/shape types and *m* possible operations to perform between curves, then you must code $n \times n \times m$ procedures. The resulting program is large, so GEOU unifies all possible shapes into one, reducing the number and variety of operations you would need to perform. GEOU's implementation in CAMSmith simplifies the user interface.

CAMSmith is a menu-driven system that lets you create three-dimensional surfaces and three-axis simultaneous NC code to cut the surface. You can view both the surface and the three-dimensional tool path graphically. The program is compatible with CAD systems and two-dimensional CAM systems, and it supports file formats such as IGES.

CAMSmith runs on the IBM PC AT or compatibles with at least 640K bytes of RAM, a math coprocessor, a hard disk drive, and an EGA card.

Price: 3D machining system with 3D graphics will sell for about $8750; the machining system plus 2D CAD/CAM with 3D graphics will sell for about $9350; and the 3D CAD system will sell for between $600 and $3500.

Contact: 3D Science Laboratories, 3090 Avon St., Burbank, CA 91504, (818) 841-2121.

Inquiry 801.

Compute Air and Water Vapor in Four Units

Psychrometry is a program for use in engineering, physics, and meteorology. You can compute 10 properties of air and water vapor mixtures in four-unit systems including MKS, SI, English, and English (grains).

The program's algorithms are based on thermophysical properties: specific heat, specific heat of air, heat of vaporization, and vapor pressure of water vapor.

You begin by selecting two properties followed by inputting the magnitudes. The program computes the remaining eight and tabulates dry bulb temperature, adiabatic saturation temperature, dew-point temperature, relative humidity, humidity ratio, enthalpy, entropy, density, humidity ratio at adiabatic saturation, and enthalpy at dew point. You can repeat the process 12 times, or you can opt to transfer a specified property over some or all repetitions.

The temperature range of the program is −105° C to 255° C (−157° F to 491° F).

You can run the program at standard pressure, standard pressure corrected for elevation, or at any pressure from a few hundredths of an atmosphere to a maximum of 10 atmospheres of partial pressure.

Psychrometry runs on the IBM PC with DOS 2.0 or higher and on the Mac with at least 512K bytes of RAM.

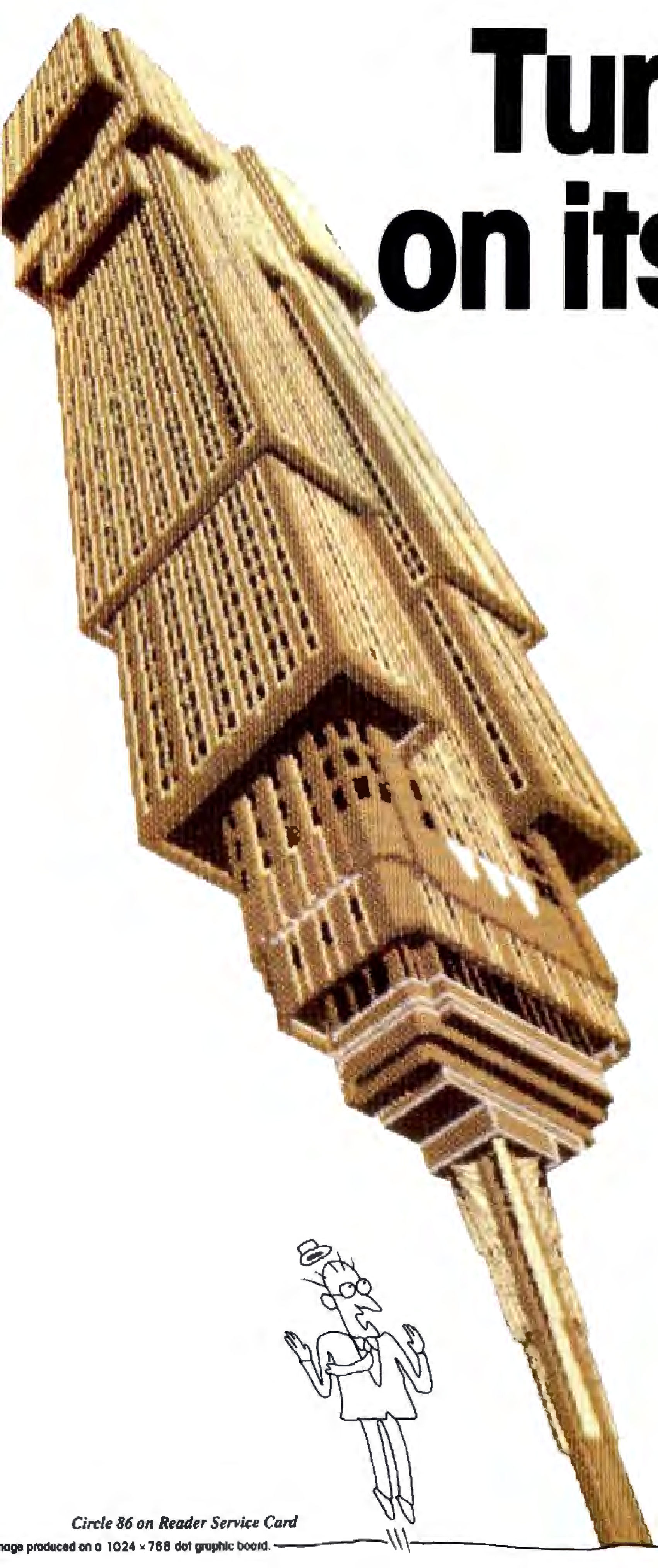
Price: $37.60.

Contact: Jim Lang, P.O. Box 307, Oneida, WI 54155, (414) 869-2691.

Inquiry 802.

continued

Turn N.Y. on its head!



You don't need the power of a mainframe to turn N.Y. on its head — just your own creativity and DynaPerspective™ from Dynaware. Perfect for conceptual design, visual analysis and presentations, DynaPerspective™ lets you easily zoom in and out, change the declination, elevation, compass direction, and rotate your model through 360° for a full walk-around effect. Advanced hidden-surface functions free you from the time-consuming line deletion typical of wire-frame line drawings. This powerful software package also gives you full surface color and light-source shading for unsurpassed solid surface modelling.

DynaPerspective™ does away with computerese. User-friendly screen icons and pull-down menus eliminate the need for remembering complicated commands. And DynaPerspective™ is fast as well as powerful. After initial compilation, even major changes are reflected in the model in seconds. A variety of powerful time-saving features have also been incorporated, such as a large parts library file for frequently used components. Conceptual design and visual analysis have never been easier. Whether you're an architect, graphic artist, urban designer, or one of the new wave of multidisciplinary professionals, DynaPerspective™ will save you valuable time and make your job easier.

DynaPerspective™ also allows you to network, since it can communicate with other DXF compatible PC CAD systems. No wonder it's been called the most powerful user-friendly 3-D solid modeling design software ever created for a personal computer.

Already available for the IBM® PC, AT and compatibles, Dynaware will soon release versions for the HP-9000™ and Macintosh II™. For your added convenience we have established a brand new headquarters in San Francisco to handle all inquiries.

A powerful tool that lets you maximize your time, DynaPerspective™ is priced at only $975. Take the opportunity to turn N.Y. on its head, and have the city at your feet…

Try a new perspective—a DynaPerspective™

■ System Requirements
Computers: IBM® PC, AT and compatibles
(Minimum 640K RAM)
Hard disk recommended but not required.
Graphic card
Input: Tablet or mouse
Output: Plotter or printer

Suggested Retail Price **$975**

DYNAPERSPECTIVE™
3D Modeling Design and Presentation Software

Please send me more information.

Name ______________ Computer ______________

Address ______________

City ______ State ______ Zip ______

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Circle 86 on Reader Service Card

nage produced on a 1024 × 768 dot graphic board.

SOFTWARE • BUSINESS

Silverado

Computer Associates describes Silverado as a database that operates as a window inside a spreadsheet. It lets you import multiple databases for analysis and reporting and to link databases together. You can import and analyze Lotus 1-2-3, SuperCalc4, dBASE III, and ASCII text files. "Hotlinks" connect information between the database and the spreadsheet, with database changes automatically transferred to the spreadsheet.

Silverado operates with 1-2-3- and SuperCalc-style commands and reads 1-2-3 and SuperCalc4 file formats. You can sort and resort data with no limit on the number of sort fields. Totals and subtotals are available at any level, and you can analyze data from most views.

The program utilizes background processing, shortening the time required for report generation.

Database outlining is another one of Silverado's features. It enables you to view information at any level of subtotaling or detail.

You also have a choice of several ways to view information, including the Spreadsheet View, Form View, Crosstab View, and Report View.

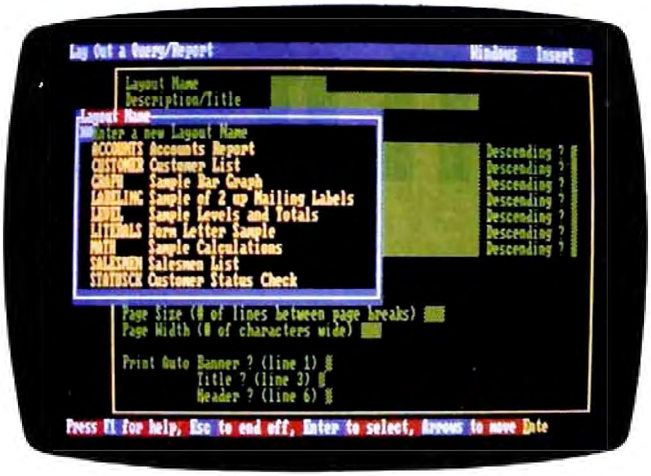
Silverado also features virtual data memory that automatically accesses available memory devices. Small files use the available standard memory and will use expanded memory if it is present. Files that exceed the memory capacity are swapped to disk.

The program runs on the IBM PC, XT, AT, and compatibles with two floppy disk drives or one floppy drive and one hard disk drive. At least 512K bytes of RAM is required, as well as MS-DOS or PC-DOS 2.0 or higher, and Lotus 1-2-3 version 2.0 or higher or SuperCalc4.

Price: $149.

Contact: Computer Associates International Inc., 2195 Fortune Dr., San Jose, CA 95131-1820, (408) 432-1727.

Inquiry 803.



```
Lay Out a Query/Report                                    Windows  Insert
        Layout Name
        Description/Title
   Layout Name
   Enter a new Layout Name
    ACCOUNTS Accounts Report                              Descending ?
    CUSTOMER Customer List                                Descending ?
    GRAPH    Sample Bar Graph                             Descending ?
    LABELING Sample of 2 up Mailing Labels                Descending ?
    LEVEL    Sample Levels and Totals                     Descending ?
    LITERALS Form Letter Sample                           Descending ?
    MATH     Sample Calculations                          Descending ?
    SALESMEN Salesmen List
    STATUSCK Customer Status Check
        Page Size (# of lines between page breaks)
        Page Width (# of characters wide)

        Print Auto Banner ? (line 1)
                   Title ? (line 3)
                  Header ? (line 6)
Press F1 for help, Esc to end off, Enter to select, Arrows to move Date
```

Silverado operates as a window inside a spreadsheet.

Finance Manager II

Finance Manager II consists of general ledger, account-reconciliation, financial-utilities, accounts receivable, and accounts payable modules. You can purchase the modules separately or run them as an integrated system.

The general ledger module lets you set budgets, compare expenses, keep track of tax deductions, record all transactions, and calculate your net worth. You can produce general-journal, income-statement, accounts-listing, balance-sheet, and budget-listing reports by month, quarter, year, or year-to-date. You can store up to 1999 accounts and up to 30,000 transactions per year.

The account-reconciliation module runs with the general ledger module and enables you to balance bank statements, keep track of outstanding checks, verify charge-card transactions, and produce automatic balance statements.

The financial-utilities module helps you make calculations, create a depreciation schedule for your assets, and calculate loan payments. You can produce loan amortization schedules and calculate present and future values of annuities.

With the accounts receivable module you can calculate finance charges, print customer lists and mailing labels, and produce cash flow forecasts. Reports provided include an accounts receivable journal, balance-forward statements, customer invoices, and a schedule of receivables.

The accounts payable module lets you maintain a permanent record of purchases and print checks, vendor lists, and mailing labels.

Finance Manager II modules run on the IBM PC, XT, AT, and compatibles with MS-DOS or PC-DOS 2.0 or higher, 256K bytes of RAM, and two floppy disk drives or one floppy disk drive and a hard disk drive. All modules can run independently except the account-reconciliation module, which requires the general ledger.

Price: General ledger, $40; account reconciliation, $15; financial utilities, $20; accounts receivable, $30; accounts payable, $30.

Contact: Hooper International, P.O. Box 08430, Fort Myers, FL, 33908-8430, (813) 466-0050.

Inquiry 804.

Expert Tax Advice

Ask Dan About Your Taxes is a rule-based tax preparation program that gives you a personalized analysis of your taxes, taking the most recent tax-law changes into account, and carries results to on-line tax forms.

Using an expert system, Ask Dan runs you through individually tailored question-and-answer sessions, automatically completing relevant tax forms or lines in the process. Legal Knowledge Systems reports that you can override the expert at any time, change your answers, and let Dan recompute your tax forms. The program asks yes/no, multiple choice, and fill-in-the-blank questions. It also offers a customized checklist that describes deductions, income items, credits, and additional tax debts you may have.

The program can assist you on IRAs, filing status, exemptions, alimony, medical deductions, taxes paid, charitable deductions, interest and dividend income, capital gains, sale of a home, child care credit, and moving expenses.

With each answer, your tax form is recomputed spreadsheet-style on-screen. The program contains Form 1040, schedules A through F, R, SE, and about 20 others. You can print the forms on any printer, the company reports, and they are suitable for submission to the IRS.

The program runs on the IBM PC and compatibles with at least 512K bytes of RAM and a hard disk drive or two floppy disk drives. The company reports that Ask Dan will ship in mid-January.

Price: $69.95.

Contact: Legal Knowledge Systems Inc., 195 Maplewood St., Watertown, MA 02172, (617) 923-2322.

Inquiry 805.

continued

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```
                 Employee List
Employee Name        Dept        Job Title

D'Amato,      Employee Data Will Be Changed
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Forreste  Address   :4868 Oak Dr
Hess, Ch  City      :Sandy Springs State:GA         Zi
Huffstut  Phone #   :(404)555-9823 Birth: 4/28/55   Se
Keller,
Masters,  Employee #: 498
McNeil,   Dept #    :1800   Research and Development
Porter,   Job Title
Smith, W
Smyth, M  Salary/Mo   1600 Personnel
Sullivan  Last Incr   1700 Production
          Next Incr   1800 Research and Development
↑↓ to Scr             1900 Sales
F3 to Add             2000 Security
F1 for He  F5 to Pri
```

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Circle 30 on Reader Service Card

SOFTWARE • BUSINESS AND OTHER

Networking Reports

The Snow Report Writer network version merges data from multiple sources such as Lotus 1-2-3, dBASE, and over 55 others, including languages.

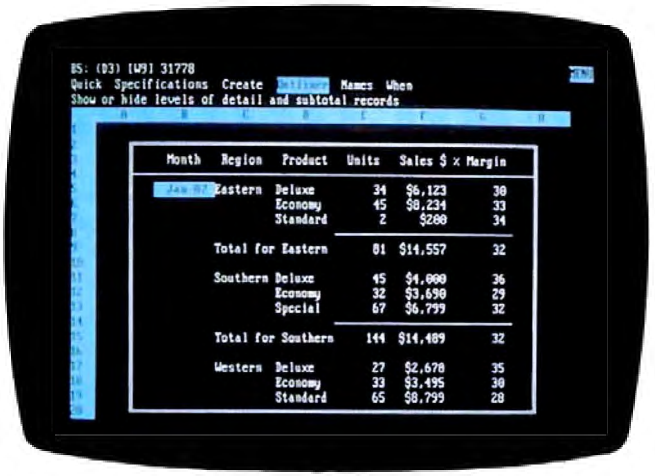
You can create columnar reports, forms, mailing lists, labels, form letters, and business graphics. Windowing and help is provided throughout the program. It also has record locking and file protection.

The Snow Report Writer runs on the IBM PC and compatibles with at least 384K bytes of RAM. A hard disk drive is recommended. The program supports Novell, PC NET, Token Ring, and 3-Com networks.

Price: $995 for eight workstations.

Contact: Snow Software, 2360 Congress Ave., Clearwater, FL 34621, (813) 784-8899.

Inquiry 806.



```
B5: (D3) [W9] 31778
Quick  Specifications  Create  Outline  Names  When
Show or hide levels of detail and subtotal records

       Month   Region   Product   Units   Sales $ x Margin

       Jan 87  Eastern  Deluxe       34    $6,123      30
                        Economy      45    $8,234      33
                        Standard      2      $200      34

               Total for Eastern     81   $14,557      32

               Southern Deluxe       45    $4,000      36
                        Economy      32    $3,690      29
                        Special      67    $6,799      32

               Total for Southern   144   $14,489      32

               Western  Deluxe       27    $2,670      35
                        Economy      33    $3,495      30
                        Standard     65    $8,799      28
```

The Snow Report Writer network version.

Waveform Editing

With Sound Designer Universal you can edit the waveforms and digital signals of musical samples on the Macintosh. The Universal edition of the program supports a variety of MIDI samplers. You can display up to three waveforms on the Mac screen and edit each sound with up to 1/50,000-second accuracy, according to Digidesign.

Looping is done with a special loop window and a flexible cross-fade looping function. You can digitally mix, merge, equalize, and compress sounds, as well as perform complex frequency analysis using the program's three-dimensional fast-Fourier-transform display.

You can also use Sound Designer Universal to transfer sounds between samplers. The Universal edition of Sound Designer does not contain the front-panel editing and Karplus-Strong digital synthesis capabilities.

To run Sound Designer, you need a 512K-byte Macintosh or a Mac II.

Price: $395.

Contact: Digidesign Inc., 1360 Willow Rd, Suite 101, Menlo Park, CA 94025, (415) 327-8811.

Inquiry 807.

Graphic Design and Technical Report Writing

Word-CAD combines the functions of a word processor with those of a CAD program.

With Word-CAD, you can place lines, rectangles, ellipses, and polygons in engineering units of your choice on scalable grids. The program also has zoom and scaling, move and delete, rotation, perspective, and dimensioning. The program includes a line generator that lets you draw irregular shapes directly into memory. You can save drawings as symbols and call them into a drawing for placement at any point.

The word-processing portion of the program is called Word-Edit. It lets you enter copy, move, change, and cut-and-paste operations. You also have bold, compressed, expanded, italic, underline, and subscript and superscript text at your disposal. Up to three fonts are resident in RAM at any time, along with bit-mapped text. You also have the ability to format headlines and subheads and to flow columns of text around graphics.

Word-CAD supports ASCII text. It requires an IBM PC with at least 512K bytes of RAM; one floppy disk drive; and a CGA, EGA, or Hercules monochrome adapter. It is designed for use with a dot-matrix printer, enabling it to produce drawings up to 13½ inches wide and up to 30 feet long.

Price: $99.

Contact: Iam, P.O. Box 2545, Fair Oaks, CA 95628, (916) 961-8082.

Inquiry 808.

Fix That Database

Hilco Software has combined two of its database utilities, added some features, and named it Quick-Fix-2. The MS-DOS program repairs dBASE II and III files, as well as files from Clipper, FoxBASE, and WordTech databases, by performing combinations of the following functions: resetting the record counter in the header, replacing corrupted headers, realigning data within the database, replacing high bits and control characters, and removing invalid end-of-file markers.

QuickFix-2 has no limit to file size. The vendor says the program will recover any data in the DOS directory. The software also has context-sensitive help, the ability to view database records, and a feature that lists records containing bad bytes.

The program requires MS-DOS 2.0 or higher and 192K bytes of RAM.

Price: $29.

Contact: Hilco Software, 11266 Barnett Valley Rd., Sebastopol, CA 95472-9555, (707) 829-5011.

Inquiry 809.

AP Stylebook on Disk

The KeyNotes AP Stylebook works with your word-processing program. When you need access to AP style or reference information, you press a hot key, which opens a menu of entries in the stylebook. Or, you can use the automatic search mode.

The Stylebook offers you information on capitalization, abbreviation, punctuation, spelling, and numbers and their usage. It also gives you guidelines on sports and business writing, and there are individual guides to punctuation and computer terms.

The program is available for the IBM PC with PC-DOS or MS-DOS 2.0 or higher; another version is available for Macs with at least 128K bytes of RAM.

Price: $49.95.

Contact: Digital Learning Systems, 4 Century Dr., Parsippany, NJ 07054, (201) 538-6640.

Inquiry 810.

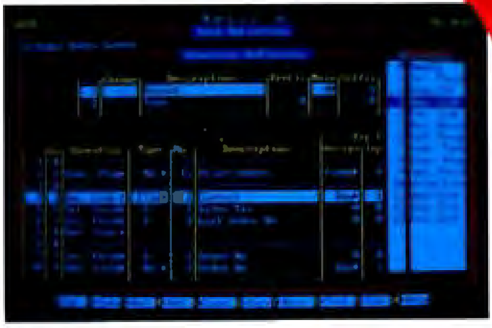
MAGIC PC: A REVOLUTION IN POWER, PRICE & PROGRAMMING SPEED.

You know how database applications are created — by hacking out line after line of time-consuming code. Most DBMS' and 4GL's give you some programming power. But when it comes to serious applications, they keep you bolted to your seat writing mountains of tedious code. And rewriting it all over again with every design change.

Imagine how much faster you'd be if you could replace the painful coding phase with an innovative visual technology which takes only a fraction of the time: Introducing Magic PC—the revolutionary Visual Database Language from Aker Corporation:

High-Speed Programming:

With Magic PC's visual design language you quickly describe your programs in non-procedural Execution Tables. They contain compact programming operations which are executed by Magic PC's runtime engine. You fill-in the tables using a visual interface driven by windows and point-and-shoot menus. One table with 50 operations eliminates writing more than 500 traditional lines of code. Yet with Magic PC you don't sacrifice any power or flexibility.



With a powerful set of high-level non-procedural operations you program at only a fraction of the time

Maximum Power AND Simplicity:

With Magic PC, you can generate robust DBMS applications including screens, windows, menus, reports, forms, import/export, and much more! Plus, Magic PC has one of the friendliest user interfaces you've ever seen. Using Magic PC you can look-up and transfer data through a powerful Zoom Window system. Magic PC even lets you perform command-free queries.

Btrieve Performance:

Magic PC incorporates Btrieve, the high-performance file manager from SoftCraft. This gives you exceptional access speed, extended data dictionary capabilities, and automatic file recovery!

Virtually Maintenance-Free:

With Magic PC you can modify your application design "on the fly" without any manual maintenance. Magic PC automatically updates your programs and data files on-line! This also makes Magic PC an ideal tool for prototyping complete applications in hours instead of days.

FREE Networking:

Magic PC comes complete with LAN features. Develop multi-user applications for your LAN with Magic's file and record-locking security levels.

Stand-Alone Runtime:

Distribute your applications and protect your design with Magic PC's low cost runtime engine.

All For Only $199:

Best of all, Magic PC is an unbeatable bargain. For a limited time, Magic PC's price has been reduced to only $199! Yes, this is the same Magic PC that normally lists for $695! And Magic PC eliminates the need for a separate DBMS, compiler, or application generator. It comes complete with all the tools you need to develop your own database applications instantly.

$199 – With A Money-Back Guarantee!

For a limited time, you can get Magic PC for only $199. And even at this low price, Magic PC is risk-free. If you're not completely satisfied, simply return it within 30 days and we'll buy it back (less $19.95 restocking fee). And if you'd like a preview, Magic PC's Tutorial Demo is available for just $19.95.

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> *"Magic PC's data base engine delivers powerful applications in a fraction of the time. . . there is truly no competitive product."*
> Victor Wright – PC Tech Journal

Also recommended by: *PC Magazine, PC World, PC Week, Computer Language, Data Base Advisor,* and many other publications worldwide.

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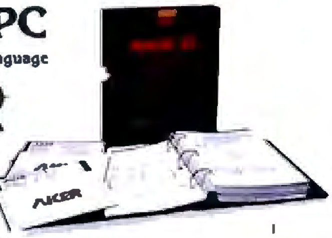

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Company ______

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City ______ State ______ Zip ______

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Account No ______

Acct. Name ______ Exp. Date ___/___

Signature ______

Return to: **Aker Corp.**, 18007 Skypark Cir B2, Irvine, CA 92714

System requirements: IBM PC, XT, AT, PS/2 or 100% compatible with 512K RAM, hard disk and DOS 2.0 or later. 5¼" format, not copy protected. Dealer pricing available. *Return policy valid in US only.

Circle 476 on Reader Service Card

REGIONAL SECTION

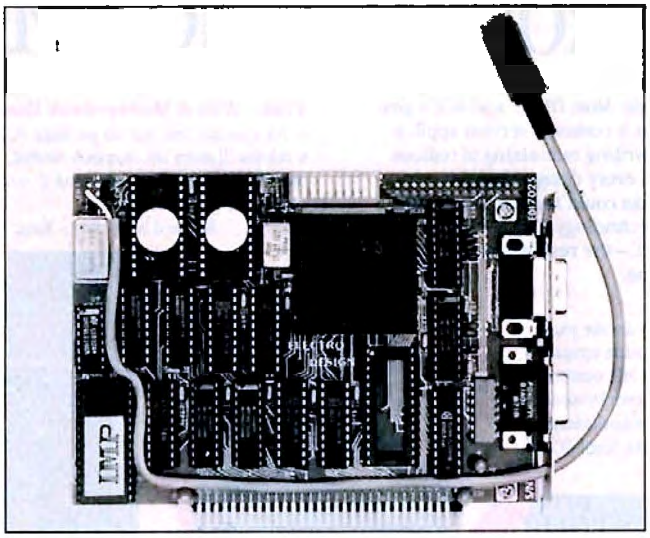
PACIFIC COAST

Touch, See, and Hear with AVM Board

The Audio/Video/Mouse Board fits into a half-slot in your IBM PC, XT, AT, or compatible and provides either monochrome or color graphics with a 640- by 200-pixel resolution from a single video port.

The AVM Board features a Microsoft-compatible mouse port and dual-channel music/voice synthesizers. You can program the synthesizers to provide voice commands and sound effects and to play digitized music. Each synthesizer provides three channels of audio signal with a frequency response of up to 30 KHz.

You can use up to four AVM Boards in one computer, with different program information presented by each card.



The AVM Board combines graphics, sound, and a mouse port.

Price: $395.
Contact: Electro Design Inc., 690 Rancheros Dr., San Marcos, CA 92069, (619) 471-0680.
Inquiry 867.

Send Data at Speed of (Infrared) Light

Hewlett-Packard's HP82242A infrared printer-interface module plugs into any of the HP-41 calculator's I/O ports. It transmits data via an infrared light beam at a rate of 78 characters per second to Hewlett-Packard's HP82240A infrared printer. Your calculator can be up to 18 inches away from the printer.
Price: $65.
Contact: Inquiries Manager, Hewlett-Packard Co., 1000 Northeast Circle Blvd., Corvallis, OR 97330; for telephone inquiries, call (800) 752-0900, Dept. 772A, for the location of your nearest Hewlett-Packard dealer.
Inquiry 868.

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COMPUTOWN

Circle 478 on Reader Service Card

Merge Text and Graphics with The Complete Fax

The Complete Fax is a $499 facsimile board that plugs into a full slot in your IBM PC, XT, AT, or compatible. You can receive and send facsimiles in the background at up to 4800 bits per second.

The board lets you send facsimiles at a predetermined time. You can also send facsimiles to multiple recipients in a single session, poll with password protection, and log incoming facsimiles with time stamps.

With The Complete Fax you can send ASCII word-processing documents. You can also merge text and graphics. It supports CGA, EGA, and Hercules cards, as well as Dr. HALO II, PC Paintbrush, and Microsoft Windows programs.

The Complete Fax runs on the IBM PC, XT, AT, and compatibles running MS-DOS or PC-DOS 2.1 or higher. It requires 384K bytes of RAM, a hard disk drive, a standard telephone line with an RJ-11 or RJ-14 connector, and a Touch-Tone telephone.

Price: $499.

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

Inquiry 869.

3-D Helicopter Simulator

This simulation puts you in the pilot's seat of either the "Sierra Helicopter" or an Apache attack helicopter. You can fly alone or with an opponent or partner via modem.

The 3-D Helicopter Simulator features views of three-dimensional objects in 16 colors and 360-degree views of the landscape. It provides flight, target practice, single-player combat, and dual-player combat modes. You can fly backward or sideways, take off vertically, and watch yourself fly from a ground, satellite, or tracking-camera perspective.

3-D Helicopter Simulator comes with eight scenery files. It runs on the IBM PC and compatibles with MS-DOS or PC-DOS 2.0 or higher and 256K bytes of RAM. It supports Hercules monochrome, InColor, CGA, EGA, Tandy 1000, and PCjr color cards, Hayes-compatible modems, and joysticks.

The program comes on both 3½- and 5¼-inch floppy disks.

Price: $49.95.

Contact: Sierra On-Line Inc., P.O. Box 485, Coarsegold, CA 93614, (209) 683-6858.

Inquiry 870.

Hyundai 80286

The heart of the Super-286C computer is an 80286 microprocessor running at either 8 or 10 MHz. It includes 640K bytes of RAM (expandable to 1 megabyte) four 16-bit and two 8-bit expansion slots, an EGA video card, a clock/calendar, two serial ports, one parallel port, and one floppy disk drive.

The Super-286C also includes a 101-key keyboard and a monochrome monitor. Electric Desk software that comes bundled with the computer includes database management, word processing, a spreadsheet, and a communications program.

Price: $1499.

Contact: Hyundai Electronics America, 4401 Great America Parkway, 3rd Floor, Santa Clara, CA 95054, (408) 986-9800.

Inquiry 871.

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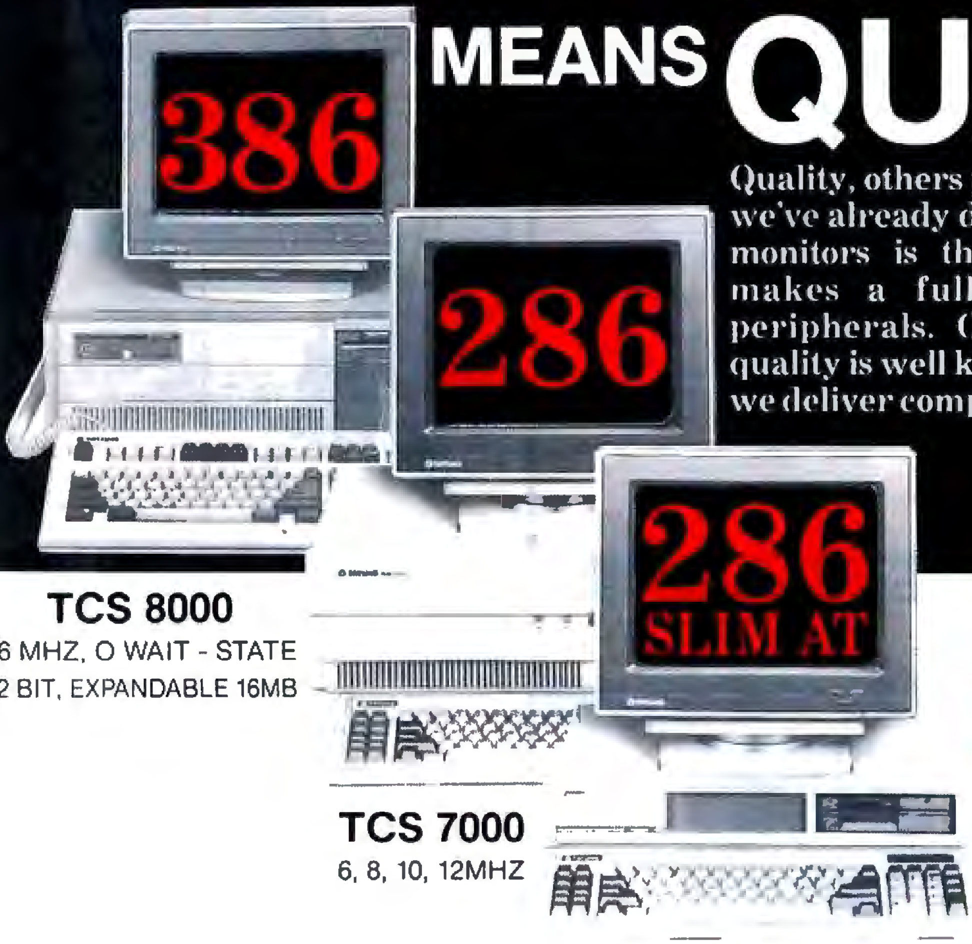

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MICROMINT INTRODUCES A STAND-ALONE SERIAL DIGITAL IMAGING SYSTEM. The MICROMINT **ImageWise™ Serial Digital Imaging System** is the most cost effective and versatile high performance grayscale video digitizing system on the market today. The ImageWise system has been designed to function as a standalone digitizer or as an integral component of a complete tele-imaging system. **ImageWise™**'s serially bit mapped digitized pictures give it almost universal compatibility with any computer capable of attaching to a modem or terminal. It is ideally suited for CAD/CAM, Desktop Publishing, automatic inspection, and security applications.
Critical System functions such as image resolution and picture update can be controlled and commanded remotely. Images are transmitted and received serially, either compressed or uncompressed, and can be displayed, transmitted, stored, edited, or processed for use in a variety of industry standard application software.

IMAGEWISE SYSTEM SPECIFICATIONS

- NOT bus dependent — can function standalone
- True frame grabber — uses a high speed flash A/D converter and 64K bytes of static RAM to capture an image in 1/60th second
- Accepts any B/W or color NTSC video signal
- Stores pictures as 244 lines of 256 pixels, 64 levels grayscale
- Resolution of transmitted image is software selectable, all images are represented in 64 levels of gray scale
  - Selectable Resolutions
    - High 256x244x6
    - Med 128x122x6
    - Low 64x61x6
- Video Input 1 volt peak-to-peak B&W or color 75 ohm termination
- Video Output 75 Ohm, 1.5 V peak-to-peak NTSC composite video
- Serial Input/Output RS-232 — 8 bit, one stop bit, no parity 300 bps — 57.6Kbps selectable data rate — Xon / Xoff Handshaking Switch selectable data compression (on/off)
- Modem compatible. Easily functions as a video telephone to send video images anywhere
- Video processing, disk upload/download, and display utilities provided for PC DOS and MS DOS machines

Optional PC Utilities Disk converts ImageWise™ files for use with popular Desktop and Paint Programs.

DT01	ImageWise Digitizer, Transmitter	$349.00
DR01	ImageWise Receiver, Display	$349.00

Announcing

OEM-286 — $775.00
complete PC/AT-CPU

Low Power!

Expansion Card Form Factor!

100% AT Compatible!

MICROMINT's **OEM-286** is a complete PC/AT-CPU and more. The **OEM-286** is the first low power 100% AT compatible which has been specifically designed for OEM use within the industrial and business sectors. The **OEM-286** features the Zymos CMOS POACH set and 100% compatible Award BIOS. The development of the POACH chip set has allowed the 199 IC's on a standard AT to be reduced to 90 IC's and two SIMMS. What this means for you is:

1) The overall size of a standard AT/CPU has been condensed into the expansion card form factor (13¼" x 3⅞")
2) Power requirements are less then 1 A @ 5 volts
3) **OEM-286** plugs into a passive backplane for easy connection to other expansion peripherals

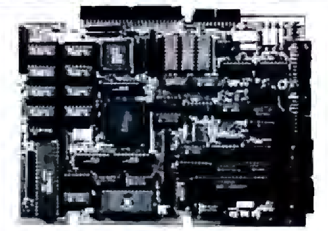
The **OEM-286** is available in both 8 and 10 MHz versions and comes with the Award BIOS.

OEM-286 FEATURES

- 100% AT compatible
- 80286 Microprocessor 8 or 10 MHz
- 80287 Co-Processor optional
- 64 Kbytes of SRAM can accommodate 96 Kbytes
- 512 Kbytes of RAM
- Keyboard Controller
- Expansion card size factor
- Standard interface to the System Expansion Bus
- Battery backed real time clock
- Award BIOS included

OEM-286/8	8 MHz AT/CPU	$775.00
OEM-286/10	10 MHz AT/CPU	$825.00
OEM-286/BP	8 SLOT PASSIVE BACKPLANE	$115.00

SB180FX — $409.00
Single Board Computer



SB180FX TECHNICAL SPECIFICATIONS

PROCESSOR
- Hitachi HD64180, an 8-bit CPU in a 68 pin PLCC package
- Superset of Z-80 instruction set including hardware multiply
- Integrated Memory Management Unit with 512K bytes address space
- Dynamic RAM refresh
- Wait state generator
- Clocked serial I/O port
- 2 channel Direct Memory Access Controller
- 2 channel Asynchronous Serial Communication Interface
- 2 channel 16-bit Programmable Reload Timer
- 12 interrupts
- Dual bus interface to 68xx and 80xx support chips
- 6.144MHz, 9.216MHz, and 12.288 MHz system operation

MEMORY
- 512K bytes dynamic RAM on board
- Memory externally expandable to 4 Mbyte RAM
- Either an 8K 2764, 16K 27128, or 32K 27256 EPROM usable
- Full function 8K ROM resident monitor

INPUT/OUTPUT
- Console RS-232 serial port with auto baud rate select to 38,400 baud
- Peripheral RS-232 serial port, full hand shaking 150-38,400 baud
- Line printer parallel I/O port
- 16 bits bi-directional parallel I/O
- 16-bit address decoding, I/O port decoding, and dual bus interface brought out to expansion bus connector
- Can be directly attached to GT180 640 x 480 color graphics adapter
- Fully implemented SCSI hard disk and communications bus interface

FLOPPY/HARD DISK INTERFACE
- Uses Standard Micromint's 9266 disk controller
- Compatible with NEC 765A controller
- On-chip digital data separator
- Can control 3½", 5¼" and 8" floppy disk drives — up to 4 in any combination
- Handles both FM encoded (single density) and MFM encoded (double density) data
- NCR 53C80 SCSI bus controller for hard disk or network communication

SOFTWARE COMPATIBILITY
- CP/M, ZRDOS, ZCPR3 Compatible

SB180FX-1	SB180FX - 6.144 MHz computer board populated w/ 256K bytes RAM, 8K byte ROM monitor, without SCSI chip. Add $50.00 for 9 MHz.	$409.00
SB180FX-1-30	SB180FX-1 computer board w/document, three-disk Z-System software including ZRDOS, ZCPR3 utilities, Z80 assembler, and ZDM debugger, BIOS and ROM monitor sources, and BIOS for SCSI hard disk. Supplied on five 5¼" SB180 format (DSDD) disks.	$499.00

SB180 — $299.00
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SB180-1	SB180 6.144 MHz single board computer w/256K bytes RAM and ROM monitor. Add $50.00 for 9 MHz	$299.00
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COMM180-S	SCSI Hard Disk Interface	$150.00

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GT180 — $395.00
Graphics Display System

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The **GT180** offers these features:
- Advanced graphics controller provides intelligent link between computer and user
- Only 3.75" x 8" piggy backs on either an SB180 or SB180FX computer
- High resolution at a low cost: 640 x 480 with 16 of 4096 colors
- Hardware drawing commands: LINE, RECTANGLE, POLYLINE, POLYGON, CIRCLE, ELLIPSE, ARC, FILLED RECTANGLE, PAINT PATTERN, WINDOW and COPY to name but a few
- Automatic translation of logical X-Y coordinates to physical frame buffer addresses
- Fast drawing speed of 2 million pixels per second
- Provides fully programmable horizontal split screens and window screen
- Fully supported by **GT180** Graphix Toolbox written in Modula 2

GT180-1	Graphic Display Expansion Board (TTL RGB only)	$395.00
GT180-2	Graphic Display Expansion Board (TTL RGB and Analog RGB)	$449.00

SB180
Software and Accessories

SB180-U	Uniform Disk Format Conversion Software	$ 69.95
SB180-ZMSO/TKBBS	Z-MSG Bulletin Board Software	$100.00
SB180-MOD2	Turbo Modula 2	$ 69.00
SB180-MOD2G	Turbo Modula 2 w/Graphix Toolbox	$ 89.00
SB180-CASE	Four half height 5¼" drive enclosure w/power supply, mounting brackets and hardware for the SB180 or SB180FX	$197.00
SB180-CABLE	Set of 4 cables including power, term, disk and print	$ 79.00

BCC22 — $249.00
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- 24 lines x 80 characters
- Separate transmit & receiver baud rates (110-19,200bps)
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- 31 Graphic characters
- 25th line reverse video status display
- 21 escape functions
- 14 control functions
- Directly drives composite video or separated sync monitor
- All functions are firmware controlled. Source code available

EDITING FEATURES typeover, clear to screen to space or null, erase to end of page, erase to end of line, absolute cursor addressing

VIDEO ATTRIBUTES reverse video, half intensity, double height, double width, underlined, blinking and blank characters

BUS CONFIGURATION MICROMINT BCC compatible or no bus connection necessary for stand-alone operation with parallel keyboard

BCC22	TERM-MITE Smart Terminal Board	$249.00
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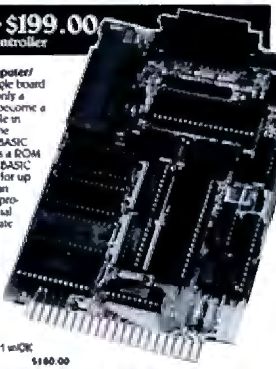
BCC52 — $199.00
BASIC 52 Computer/Controller



The MICROMINT **BCC52 Computer/Controller** is a stand-alone single board microcomputer which needs only a power supply and terminal to become a complete system programmable in BASIC or machine language. The **BCC52** uses the Intel 8052AH-BASIC microprocessor which contains a ROM resident 8K byte floating point BASIC interpreter. It contains sockets for up to 48K bytes of RAM/EPROM, an "intelligent" 2764/128 EPROM programmer, 3 parallel ports, a serial terminal port with auto baud rate selection, a serial printer port.

BCC52*
Basic-52 Computer/Controller
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BCC55
Multi Function Expansion Board w/OK
adds 6 ports and 62K bytes **$180.00**

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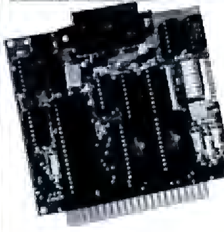

Features:
- Uses Z8 single chip microcomputer
- On board tiny basic interpreter
- 2 on board parallel ports & serial port
- 6 interrupts (4 external)
- Just connect a CRT and write control programs in Basic
- 6K Bytes of RAM or EPROM memory on board
- Baud rates 110-9600 bps
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- Consumes only 1.5 watts at +5, +12 & −12V

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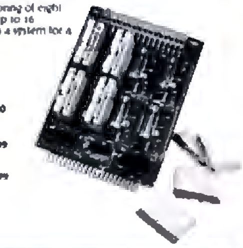

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BCC52 & BCC11
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BCC52-ROM A/B	ROM A and B Utilities BASIC extensions and Assembler	$100.00
BCC52/41	ROM C Utilities Real Time Clock and Power I/O firmware	$ 34.00
BCC52-0K-CLK	SMARTIME BCC52 Clock and ROM C	$ 60.00
BCC52-8K-CLK	SMARTIME BCC52 Clock with RAM and ROM C	$ 79.00
BCC55	Multi Function Exp. Board w/OK — adds 6 ports and 62K byte	$180.00
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BCC22K	Parallel Enclosed ASCII keyboard	$ 79.00

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Tribute 224	'565
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Zenith 183-92 (10MB)	'2460

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Circle 482 on Reader Service Card (DEALERS: 483)

SHORT TAKES

BYTE editors offer hands-on views of new products.

NEC MultiSpeed HD: A Best-Seller Gets a Big New Feature

The NEC MultiSpeed certainly ranks as one of the most popular IBM PC-compatible laptop computers. The dual-processor speeds, twin 720K-byte floppy disk drives, supertwist LCD screen, and full-size keyboard of the original have been upgraded twice, first with an electroluminescent screen (the MultiSpeed EL) and now with a 20-megabyte internal hard disk drive.

I had a chance to look at a preproduction sample of the MultiSpeed HD, and I found that the sum of the parts is a fast, highly usable, very portable computer. The hard disk drive is, of course, the most notable component in this version. According to the CORETEST, the 20-megabyte hard disk drive has an average seek time of 75.6 milliseconds and a data transfer rate of 260.3K bits per second. I'm a dedicated fan of hard disk drives, and I found this one to be fast enough to be well worth the cost in battery life.

According to NEC, the nickel-cadmium battery in the MultiSpeed HD should power the machine for 4 to 6 hours if the screen backlighting and hard disk drive are not used; 2 to 4 hours if the backlighting and hard disk drive are used occasionally (or if the backlighting is adjusted to a low intensity); and 1 to 2 hours if the backlighting is at full bright and the hard disk drive is accessed frequently. A full recharge of the battery (from a fully discharged state) takes 8 hours. According to NEC, you can operate the computer from AC power without the battery in place.

There will be slight cosmetic changes between the computer that I saw (and we photographed) and the final version shipped to purchasers.

The MultiSpeed HD is bundled with MS-DOS version 3.2 and the NEC set of memory-resident programs. The pop-up software includes a telecommunications program; notepad, filer, outliner, dialer, and setup software; and on-line help screens. You can disable the memory-resident software by using the Killpop program supplied with the computer.

This promises to be a solid laptop computer, offering most of the functionality of a desktop turbo XT computer in a package that can be carried easily and used without an AC umbilical cord. If I were planning to carry this computer a lot, I would definitely buy the optional carrying case ($99). The MultiSpeed HD does have a built-in handle, but the rather bulky AC adapter and numerous holes and slots in the plastic case of the computer cry out for a case to corral and protect the machine.

—Curt Franklin

The Facts:
NEC MultiSpeed HD
$3695

Software included:
MS-DOS version 3.2; NEC pop-up software.

NEC Home Electronics (U.S.A.) Inc.
1255 Michael Dr.
Wood Dale, IL 60191-1094
(312) 910-1776
Inquiry 852.

GOfer: RAM-Resident Text Searcher

Frequently, I've got to find a block of text fast. Deadlines are approaching, and I have nothing for clues but a couple of key words. This is when GOfer, a pop-up text finder from Microlytics for MS-DOS machines, comes in very handy.

After loading the program (it normally occupies 79K bytes of RAM, but you can load it to use more or less, or you can use it as a stand-alone package), I loaded XyWrite III Plus and called up GOfer. The search process starts at a window wherein you specify the text you want found by filling in one to eight blanks, each of which can take 20 characters.

You don't have to remember the exact word (or words) you're hunting for; you just have to be close (case and spelling don't have to match precisely). With the capability to fine-tune these searches, you can be very specific or you can play the old "sounds like" charades game. I sent GOfer after words I was sure were buried in some text file and after words that were similar. Each time, it came back with a hit. Search strategies can also be based on logical relationships.

Before the program goes looking for text, you tell it where to look by specifying drives, paths, or subdirectories. If you're

continued

not sure where you want it to look, you can tell it to look at all the files on the disk. I sent GOfer into the jungle of my hard disk to see if, as Microlytics claims, there's no limit to the number of files the program can search.

The only times I ran into problems were when I missed a step in the procedure. It does take a few minutes to tell GOfer what you want it to look for and where you want it to look, but the program then whips through files in its search for text.

When the program finds the word, it flashes the chunk of surrounding text on the screen, with the first letter of the searched word highlighted. (At the top of the screen are the name and the location of the file.) GOfer will then send the found text to a printer, to a disk file, or to another program. I was able to easily export snippets of text from my hard disk to XyWrite documents.

I've also used GOfer to jump out of XyWrite and browse through disk files, which saved me from having to shut down the file I was in, calling up a suspect, and then storing it and calling back the document I was in.

If you're cursed with tons of text files but not blessed with great powers of recall, GOfer can save you from spending lots of time wandering in the wilds of your hard disk in search of that certain word.

—D. Barker

The Facts:
GOfer
$79.95

Requirements:
IBM PC or compatible with 256K bytes of RAM, MS-DOS 2.0 or higher, and one disk drive.

Microlytics
300 Main St.
East Rochester, NY 14445
(716) 377-0130
Inquiry 853.

The TransImage 1000: Versatile OCR in a Low-Cost Package

The Facts:
The TransImage 1000
$2495

Requirements:
IBM PC, XT, AT, or compatible; MS-DOS 2.0 or higher.

TransImage Corp.
910 Benicia Ave.
Sunnyvale, CA 94086-2887
(408) 733-4111
Inquiry 851.

The TransImage 1000 is a product that relieves you of the burden of deciding between high functionality and low cost. The package contains three components: the TransImage scanner, the TransImage controller board, and software to make it all work. The controller board gives the scanner its power. It is centered on a Motorola 68000 processor and a series of custom logic chips.

The custom chips contain the heart of the TransImage's topological-recognition scheme. By using a topological-recognition algorithm, instead of the template-matching algorithm used by most low-cost optical-character-recognition scanners, the TransImage scanner is able to recognize a much broader range of typefaces, including typeset, italic, and kerned fonts, than most scanners available for less than $10,000.

The scanner itself must have been designed with ergonomics in mind, as the scanning unit fit into my hand quite well. Six programmable keys on the top of the scanner, if programmed judiciously, can substantially reduce the number of times you must move between the scanner and the computer keyboard during input.

An important design feature of the scanner is the set of broad rollers on the bottom of the unit. These rollers help keep the scanner moving in a straight line while scanning, increasing the accuracy of the scanning process.

The software of the TransImage includes stand-alone and memory-resident programs. The stand-alone program lets you set exposure levels, practice with the scanner, and train the scanner to recognize new or confusing characters. The program is menu-driven, with rudimentary on-line help available. The memory-resident portion lets you choose among driver files that interface with applications programs. Interface files for a number of popular programs (including Lotus 1-2-3, WordStar, WordPerfect, and dBASE II) come with the scanner, and you can program interface programs for many other applications.

I found the TransImage easy to use, although there was a marked increase in scanning accuracy as I became more practiced in centering the scanner on a line and moving it smoothly and evenly across the page. In my tests, I was able to scan pages from BYTE and *Fortune*, several press releases and advertising brochures, and a tabloid newspaper.

The TransImage was quite accurate, although it had trouble with multiple white spaces and very small, closely spaced type (TransImage recommends scanning text that is set between 8 and 14 points). I was impressed with its versatility and accuracy, especially compared to low-cost scanners that work only with typewritten, monospaced typefaces.

—Curt Franklin

continued

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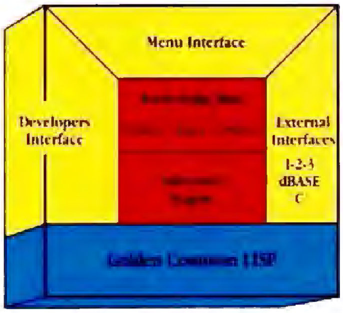

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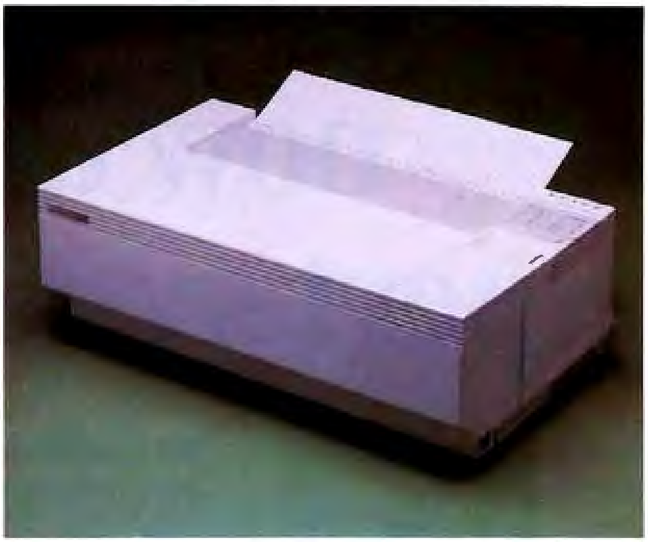
Circle 103 on Reader Service Card

RuggedWriter 480: Hewlett-Packard's Fast 24-pin Printer



The Facts:

RuggedWriter 480
$1695

Hewlett-Packard
3000 Hanover St.
Palo Alto, CA 94304
(415) 857-1501
Inquiry 854.

Options:
Serial/HP-IB interface, $200; optional automatic sheet feeder, $250; optional font cartridge, $150.

Hewlett-Packard's new RuggedWriter 480 dot-matrix printer has the highest throughput of the 16 24-pin printers BYTE has tested during the past year. On the five-page test document (described in the April 1987 BYTE on page 203), the $1695 unit achieved a draft throughput rate of 189 characters per second and a near-letter-quality (NLQ) throughput of 143 cps.

The closest competitors among units BYTE has tested are the C. Itoh C-815 Supra at 187 cps draft throughput and the Nissho NP-2410 at 104 cps NLQ throughput. Graphics throughput of the RuggedWriter was 726 cps; only two 24-pin units had a higher rating, the Fujitsu America DL 2600 (933 cps) and the Nissho NP-2410 (833 cps).

The subjective NLQ print quality of the unit was superior—comparable to the best of the 24-pin units BYTE has tested—but the draft-quality rating was only average. Graphics quality was second only to JDL's 850 EWS printer. The noise level of the printer was in the lower half of the group. For example, the NLQ noise level was 72 decibels. The other 24-pin units tested ranged from 68 dB to 78 dB (four were quieter, six were louder, and five had the same rating).

The RuggedWriter is a wide-carriage printer and handles up to four-part forms. The unit has two paper-handling systems built in: hand feed and fanfold tractor feed. An automatic cut-sheet feed tray is available for $250. A control panel makes it easy to switch between the three paper paths.

If you select automatic sheet feed or hand feed while forms are loaded, the printer automatically retracts the fanfold paper from the platen without completely releasing it; when you reselect the fanfold path, the unit returns the fanfold paper to the platen area. Another important feature for office use is the

continued

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ability to tear off a form and resume printing at the top of the next form.

Other front-panel controls include selection of NLQ, draft, and compressed typefaces. When an optional font cartridge ($150) is installed, the front-panel button also allows selection of four additional fonts or a downloaded font. The RuggedWriter comes with a 2K-byte input buffer; the font cartridge adds 16K bytes of additional buffer space.

For software control, the RuggedWriter emulates an Epson LQ-1000; it also recognizes Hewlett-Packard's printer control language. The standard printer comes with a parallel and serial interface. An optional serial/Hewlett-Packard Interface Bus (HP-IB) interface costs $200.

—George A. Stewart

Velan-2V: Video-Port Expander

The Velan-2V video-port expander lets you connect two analog monitors to one analog video port. It works with the IBM PS/2 computers and VGA-compatible video cards.

Setup and operation are easy. Simply disconnect the monitor from the video port. Connect the video port to the input port of the Velan-2V. (This cable is included with the unit.) Then plug the two analog monitors into the output1 and output2 analog ports of the Velan-2V. Flip on the power switch on the front panel, and both monitors can display the same picture.

The unit contains active amplifiers for the red, blue, and green analog signals, with a 100-MHz bandwidth for no loss in resolution. This boost in video signal permits positioning the monitors up to 25 feet from the computer, using a standard cable, or up to 50 feet from the computer, using the optional low-loss video cables.

I tested the unit on an IBM PS/2 Model 80 and on an IBM PC using a Sigma Designs Sigma VGA card. I used the IBM 8513 and NEC MultiSync XL color monitors for the tests.

On the Model 80, the unit performed flawlessly. Both monitors displayed the same screen with good color and resolution. It is possible to simultaneously use both a monochrome and a color monitor on a PS/2 computer with the Velan-2V. The Model 80 reads the ID bits of the monitor (lines 4, 11, and 12 on the video cable) and configures the output of the VGA port for that particular monitor. Network Technologies recommends that you attach the monitor with the lowest functionality to the output1 port. Both monitors will then operate at the lowest common mode.

When I ran the test on the Sigma VGA card, again both monitors operated correctly. The NEC MultiSync monitor had the advantage of adjusting itself to whatever mode the Sigma VGA card was in. The IBM 8513 monitor could operate only in its standard mode of 640 by 480 pixels.

The Velan-2V is ideal for situations where a group of people need to see the output from one computer.

—Stan Wszola

The Facts:

Velan-2V
$279

Network Technologies Inc.
19145 Elizabeth St.
Aurora, OH 44202
(800) 742-8324
Inquiry 855.

Options:
Low-loss video-extension cables: 25 feet, $70; 35 feet, $80; 50 feet, $90.

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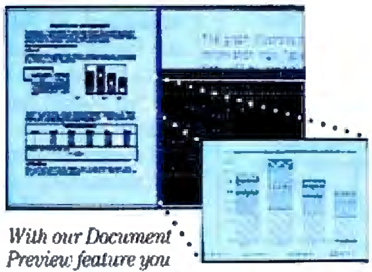

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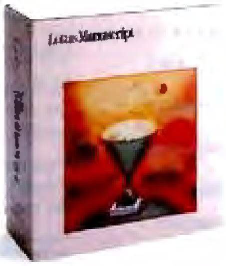

Lotus Manuscript

Book One: Interactive Authoring

Book One helps you create interactive presentations by combining color pictures, sound, text, and animation using the model of a book to organize your work. You place elements on a page, combine these pages into chapters, and the chapters into a book. Book One currently works only on the EGA and CGA. It also can use either the keyboard or a Microsoft-compatible mouse.

More than 40 fonts are supplied, as well as a font editor for creating your own. There are four graphics modes: A, B, E, and P. If you have a CGA, you can use modes A, B, and P. Modes A and B are the low-resolution 4-color and high-resolution monochrome modes of the CGA. Mode P displays the top or bottom of a page, using a 400- by 200-pixel resolution. If you have an EGA, you can use mode E, which is the 16-color, 640- by 350-pixel resolution of the EGA.

The graphics elements consist of circles, boxes, sketches, fill patterns, and graphics fonts. You can also pull in digitized pictures.

The program's animation features let you manually move objects by specifying the steps for drawing, removing, and drawing the object again in another position, or you can have Book One animate the object by specifying a starting and an ending position. With sketch animation, given two sketches, each with the same number of dots, Book One will animate the transformation of one into the other. Font animation takes a series of small predefined pictures that can be displayed at high speed to create the illusion of motion. Sound elements are entered as a four-element string consisting of the note, the octave, note lengths, and rests. Book One provides commands for controlling the flow of the program and waiting for user input.

You need not be a programmer to use Book One, but it was difficult to navigate through its features. The user interface consists of 55 icons divided over three menus, and submenus are associated with many of these icons. In theory, you must memorize 11 symbols from which the icons are constructed. However, I found the sheer number of icons overwhelming, and often it was not obvious how they worked together.

The documentation, which consists of an introductory guide, an advanced guide, and a reference manual, is not well organized. In the introductory guide, the directions for using the fill command neglect to say that you must choose a border color to stop the fill in graphics modes A and E. Otherwise, the fill covers the whole screen. The reference guide contained this information.

I found the demonstrations included with Book One slow and unexciting, and the sound effects accompanying them were annoying. In all fairness, I think the performance is limited by the hardware it's running on. (I used a Compaq 386 with an EGA.) But if you want build animated presentations on an IBM PC, XT, or AT, Book One is certainly easier to use than a general programming language.

—*Eva White*

The Facts:

Book One
$295

Paralax Software Publishers
2550 Ninth St.
Berkeley, CA 94710
(415) 848-9898
Inquiry 856.

Requirements:
IBM PC, XT, or AT with 512K bytes of RAM, an EGA or CGA, and a high-density floppy disk drive and a hard disk drive or two high-density floppy disk drives.

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Surpass: 1-2-3 Superset

Surpass is a powerful new program that's a worthy competitor to Quattro, Excel, PlanPerfect, and similar spreadsheets that challenge the dominance of Lotus 1-2-3.

Instead of being a clone, Surpass is a functional superset of 1-2-3. Thus, all your current Lotus worksheets, macros, and learned keystroke sequences should work with Surpass. (We tested a late beta version and found no incompatibilities.)

The added commands and functions are what really make Surpass stand out. For example, you can have up to 32 different spreadsheets open and at least partially in view at any time (via overlapping windows). Of course, only the three or four windows "on top" will be large enough and visible enough to work on. But you can access other open spreadsheet windows with as few as four keystrokes. (The total number of spreadsheets you actually can open depends on the size of the spreadsheets and available memory. Surpass requires at least 512K bytes of RAM and can use up to 8 megabytes of Lotus/Intel/Microsoft Expanded Memory Specification [LIM/EMS] memory.)

Having multiple spreadsheets on-screen makes it easy to use Surpass's slick "hot link" feature: You can link any cell or range of cells to any others simply by opening the appropriate spreadsheet window and using familiar, Lotus-like commands. (You can also link to nonopened spreadsheets.) Once linked, changes in one spreadsheet automatically force recalculations of all other spreadsheets in the linked chain.

Fortunately, Surpass is intelligent about recalculations: You can choose to have them proceed in the background, or you can select "dependency recalc," in which only the cells affected by the new data are recalculated.

If you've ever struggled with 1-2-3's column-width settings, you'll like Surpass's automatic column-width sizing: With this option, the columns automatically adjust themselves to fit your largest numbers.

Surpass has a built-in macro recorder, and you can store macros in "libraries" accessible from any worksheet. Its Undo command works just as you'd expect it to. Surpass supports Lotus-style graphics, but with the extra eye appeal of a third dimension (the third dimension does not convey information, but just gives a more polished look).

Surpass also has a "find" feature that makes it easy to locate any numeric or alphabetic string in any worksheet. Also, it comes with a point-and-shoot "visual file manager" that lets you select files from anywhere on your disk without having to type long path names.

Surpass has something else going for it: Seymour Rubenstein. His name may not be a household word, but you have heard of the last major product he was associated with: WordStar. It's too soon to say whether or not Surpass will become the "WordStar of spreadsheets," but if you need a spreadsheet program that offers enhancements over 1-2-3 without sacrificing compatibility, Surpass is worth a look.

—Fred Langa

The Facts:

Surpass
$495

Surpass Software Systems
14 Commercial Blvd.
Suite 131
Novato, CA 94949
(415) 382-8840
Inquiry 857.

Requirements:
IBM PC, XT, AT, or PS/2 with a 1.5-megabyte hard disk drive, 512K bytes of RAM, and DOS 2.1 or higher. Supports all current graphics standards and a math coprocessor.

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How to tell the difference between DESQview™ 2.0 and any other environment.

One picture is worth a thousand promises.

Selecting DESQview, the environment of choice, can give you the productivity and power you crave, without the loss of your old programs and hardware. If you like your existing programs, want to use them together, transfer data between them, print, sort, communicate with or process-in-background, yet still have the need to keep in place your favorite PC(8088, 8086, 80286 or 80386), DESQview is the "proven true" multitasking, multiwindowing environment for you. Best of all, DESQview 2.0 is here now, with all the money saving, time saving, and productivity features that others can only promise for the all-too-distant future.

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"Windows, promises, but DESQview delivers"—MICROTIMES, Birell Walsh.

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INFO WORLD
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9.1

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SYSTEM REQUIREMENTS
IBM Personal Computer and 100% compatibles (with 8086, 8088, 80286 or 80386 processors) with monochrome or color display; IBM Personal System/2 • Memory: 640K recommended; for DESQview itself 0-145K • Expanded Memory (Optional): expanded memory boards compatible with the Intel AboveBoard; enhanced expanded memory boards compatible with the AST RAMpage • Disk: Two diskette drives or one diskette drive and a hard disk • Graphics Card (Optional): Hercules, IBM Color/Graphics (CGA), IBM Enhanced Graphics (EGA), IBM Personal System/2 Advanced Graphics (VGA) • Mouse (Optional): Mouse Systems, Microsoft and compatibles • Modem for Auto-Dialer (Optional): Hayes or Compatible • Operating System: PC-DOS 2.0-3.3; MS-DOS2.0-3.2 • Software: Most PC-DOS and MS-DOS application programs; programs specific to TopView 1.1, GEM 1.1 and Microsoft Windows 1.03 • Media: DESQview 2.0 is available on either 5¼" or 3½" floppy diskettes

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PC MAGAZINE EDITOR'S CHOICE
NOV. 24, 1987

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This ad is for people who don't know where to find Smalltalk. Or why.

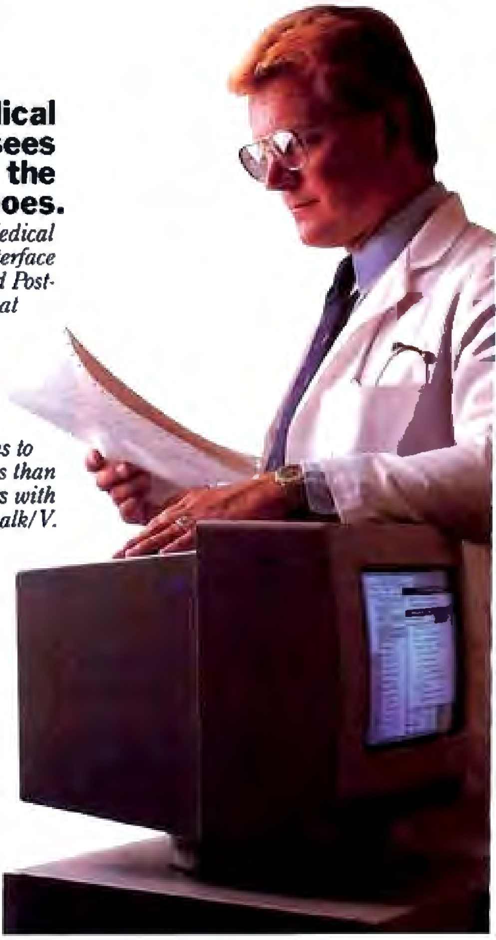
Today, the single most important emerging software technology is OOPS, object-oriented programming. It's destined to dramatically change the way you use your personal computer.
You'll find it doing things you never expected.
And by people you never suspected.

In an emergency room in Vancouver, it's saving lives through animation.

What if a medical textbook could come to life? What if it could show the effects emergency treatment might have on patients? And do it all through moving pictures? These thoughts led Folkstone Design, Edge Training & Consulting, and Inform Software in Vancouver, B.C., to create the first animated, interactive textbook for emergency room technicians and in-training paramedics. They found Smalltalk/V could easily facilitate a combination of text, color graphics and animation to illustrate various physical processes and the results of medical intervention.

At the UCLA Medical Center, it sees patients before the doctor does.

Mike McCoy, M.D., at the UCLA Medical Center, found that he could easily interface Smalltalk/V with dBASEIII and PostScript. His application, now in use at the Clinic, turns a functional status questionnaire on each new patient into a laser printed, advisory analysis for the doctor to review prior to seeing the patient. A program like this would normally take a specialist months to produce. It took Dr. McCoy less than 100 hours with Smalltalk/V.



In this rendering, only the relations between arterioles, venules, capillaries, nd lymphatics are epicted. In addition, he direction of fluid low is shown. The luid shown in the blood vasculature is blood, whereas the fluid in the lymphatics does not usually contain blood cells and is often considered an ultrafil-

It's working on Florida's freeways.

Running on IBM's new PS/2, a Smalltalk/V application developed by Greiner Engineering's Mike Rice, lets highway engineers create highly sophisticated graphic analyses of any proposed reconstruction. So now, instead of having to deal with a gridlock of Federal and State regulations, engineering specifications and endless calculations, an engineer can quickly explore alternative design strategies using a mouse, windows and VGA color graphics.

Smalltalk/V requires DOS and 512K RAM on IBM PC/AT/PS or compatibles and a CGA, EGA, Toshiba T3100, Hercules, or AT&T 6300 graphic controller. A Microsoft or compatible mouse is recommended. Not copy protected. dBASEIII, PostScript and PS/2 are trademarks of Ashton-Tate, Adobe Systems and International Business Machines Corporation respectively.

You can find it in space.

On a project commissioned by NASA, Dr. Christine Mitchell at the Georgia Institute of Technology, chose to use Smalltalk/V as an integral part of a new man-machine interface. The application, written in Smalltalk, continually monitors the commands of the Satellite Network Operator, the state-of-the-network and the overall mission plans.

To NASA, Smalltalk/V means real-time. Real OOPS. Real results.

It's tracking white-tail deer on the Barrier Islands of Georgia.

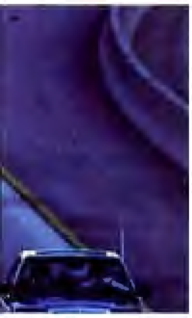
Dr. Lee Graham, a National Park Service ecologist chose Smalltalk/V to write an application to help manage the white-tail deer population on the Barrier Islands of Georgia. Dr. Graham found that Smalltalk/V, with its visual interface and class structure, is a perfect tool to graphically simulate the complex, ecological interactions of natural systems.

It's making headlines in Arizona.

When Digital Composition Systems sat down to build an electronic typesetting system, they had three major requirements. It had to have the most advanced user interface. It had to be fast. And, it had to be able to turn untrained personnel into high quality typographers. Of all the languages in the world, they chose Smalltalk/V. The result is the Signature Series, recognized and reviewed by The Seybold Report. It's now marketed by Digital Composition Systems and one of the largest digital typesetting firms in the world, Varityper AM International.

What thousands of people have found is OOPS.

Object-Oriented Programming (OOPS) is programming by defining objects, their inter-relationships and their behavior. Objects can represent both real-world entities like people, places, or things. They can also represent useful abstractions such as stacks, sets and rectangles.



OOPS models the way you think and the way things really are. It lets you solve problems by breaking them down into easily handled sub-problems and their inter-relationships. The solutions you come up with can be re-used to solve new problems. Ultimately, OOPS makes programming a simple, logical process of building on the work of others.

Why thousands more are finding their way to Smalltalk/V.

First of all, Smalltalk/V makes OOPS easy.

It's also fast. In fact, it's the fastest OOPS programming available on a PC.

And it's easy to learn. It comes complete with a tutorial that's the best introduction to OOPS available.

Smalltalk/V also has a few other features worth noting. Like a user-extendable, open ended environment. Source code with browser windows for easy access and modification. A huge toolkit of classes and objects for building a variety of applications. A sophisticated source-level debugger. Object-oriented Prolog integrated with the Smalltalk environment. And bit-mapped graphics with bit and form editors, just to name a few.

Then, there's its unbelievable price of only $99.95. (Optional application packs at $49.95 include Communications, EGA/VGA Color and Goodies.)

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With all this to offer, it probably won't come as a surprise to you that more people are solving more problems with Smalltalk/V than any other OOPS.

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SQL Database Management Systems

Richard Finkelstein and Fabian Pascal

A look at the six packages for the IBM PC or PC AT that now use SQL

Everybody seems to be talking about SQL (Structured Query Language) for relational database management systems (RDBMSes). But even though most major database suppliers have announced future support of SQL in their products, only a half-dozen database software packages for the IBM PC or PC AT currently claim to use SQL: Informix-SQL, Ingres for PCs, Oracle, SQLBase, XDB II, and XQL.

The major strength of SQL is that it deals with *sets* of data. In fact, SQL is defined by relational mathematics—the very base of relational databases. It therefore needs no new constructs to solve any database management problem. Moreover, the nature of SQL lets you simply tell the RDBMS "what" you want done without having to tell it "how." Also, SQL offers a standard (as defined by ANSI and IBM) method to query very large databases and exchange data with mainframes.

The problem is that SQL has created a lot of confusion. At the heart of this confusion is the standards issue. Based on IBM's Database 2 (DB2) mainframe product, ANSI defined two levels of SQL: Level 1, which is a rudimentary definition, and Level 2, which is more comprehensive.

All implementations but XQL come close to matching Level 2 and then go beyond that by offering several enhancements. Also, the way in which the query optimizer is implemented can greatly affect the performance of the database. [Editor's note: *See "Fast Data Access" by Jonathan Robie on page 243.*]

Informix-SQL

Informix-SQL 2.0 ($795) from Informix Software has three major components: an interactive SQL capability, an application development tool (Perform), and a report writer (Ace). It requires an IBM PC, PC AT, or compatible with a hard disk drive, 640K bytes of RAM, and DOS 2.1 or higher.

The interactive portion of the package lets you enter an SQL query, store it, retrieve a previously stored query, and execute a query. Results are displayed on the screen, and you can then scroll forward through them. Options to change databases, create tables, execute queries, and so forth are displayed at the top of the screen.

Perform lets you develop screens to maintain the tables in the database. It is composed of nonprocedural commands that describe the screen, specify editing criteria for the fields, and permit some basic assignment and arithmetic commands to manipulate screen data.

Ace has a similar architecture, composed of nonprocedural commands that describe the report layout and the data items that appear on the report.

Unfortunately, Perform and Ace do not use SQL. To compensate for this, Informix Software developed Informix-4GL 1.0 ($995). Its purpose is to provide an application developer with a fully functional development tool that can access databases using SQL. Developers can retrieve, update, and insert sets of rows with SQL.

Informix-SQL
Ingres for PCs
Oracle
SQLBase
XDB II
XQL

You can also use SQL to provide sophisticated, yet concise, editing logic. Informix-4GL contains a full complement of statistical functions, string-manipulation commands, and array-handling capabilities. It also contains basic assignment and looping constructs.

Informix-4GL doesn't have a screen painter, which could be a time-saver during the screen-design process. Informix-4GL is portable to a wide variety of platforms, including many Unix machines and DEC's VMS operating system.

Informix-SQL 2.1 and Informix-4GL 1.1, which feature improved performance characteristics, are now available.

Informix offers two types of network architectures. It can support local-area networks (LANs) (e.g., Novell, PC Network, and IBM's Token-Ring) by having Informix software at each workstation access a database residing on a file server.

If a system can use a Unix system as a database server, Informix offers an alternative requester/server network called StarLAN, which places one copy of the Informix database manager on a central Unix node. Applications built using Informix-SQL or Informix-4GL access all database information through this central

continued

Richard Finkelstein is a senior consultant with Codd and Date Consulting Group (25 East Washington St., Suite 1500, Chicago, IL 60602) and author of the upcoming book Using SQL on the PC, *to be published by Howard W. Sams.*

Fabian Pascal (2950 Van Ness St. NW, #524, Washington, DC 20008) is an independent consultant specializing in SQL DBMSes. He has published a report concerning optimizers and performance for SQL PC database products.

Because Oracle 5.1 mimics mainframe versions, it requires 1 megabyte of extended memory.

node, while executing their program logic on the local IBM PC workstations. This type of system provides better recovery, locking, and security than a file-server approach, while reducing network traffic for increased performance.

Recently, Informix introduced a high-performance database server called Turbo. Besides increasing performance even further, Turbo has better concurrency control and recovery than did its predecessors.

Informix offers several other tools for the IBM PC. One of them is the Informix Datasheet Add-In ($199.95), which merges a Lotus 1-2-3 worksheet with an Informix database. Informix also gives programmers the capability of writing programs in procedural languages with embedded SQL using an embedded-language interface. While Informix provides C, Ada, and COBOL embedded-language capabilities in its Unix versions, the IBM PC version currently has only a C interface available (ESQL/C for $595).

Ingres for PCs

Ingres for PCs 5.0 ($950) from Relational Technology has its roots in the minicomputer world, as do Informix-SQL and Oracle. It requires an IBM PC, PC AT, or compatible with two floppy disk drives, 640K bytes of RAM, and DOS 2.1 or higher. Ingres was originally developed at the University of California at Berkeley and was one of the first RDBMSes.

The commercial implementation of Ingres for mainframes (a public domain version also exists) has the largest installed base among DEC VAX users. The IBM PC version maintains the same front end as the mainframe version of Ingres, but it was rewritten to take full advantage of the PC architecture.

Ingres has always been known for its strong internal architecture. It has sophisticated optimizer algorithms that greatly enhance performance. The basic product supports both SQL and Ingres's proprietary relational language called QUEL. Even though QUEL is very powerful, Relational Technology has chosen to also support SQL to maintain the industry standard.

You can access Ingres's databases with command-language statements or with a query-by-example facility. (This facility, which is forms-oriented, lets you manipulate data in designated fields in a fill-in-the-blank way.) The command-language interface allows queries to be stored and retrieved. You can scroll the results up, down, left, and right.

The Query-By-Forms (QBF) tool creates default screens for tables, views, or `JoinDefs`. Views store logical table definitions and let you access those defined tables just as any other table. `JoinDefs` are defined joins of two tables. You can update tables through `JoinDefs` but not through SQL views. End users can enter queries using QBF in a query-by-example mode by simply entering values and Boolean operations in the screen fields. Results are retrieved, and users can browse through them a screen at a time.

For more sophisticated applications, Relational Technology offers Ingres 4GL ($500). Ingres 4GL is powerful in that it handles complex entry and update applications, like those that require multiple tables per screen, and it is well integrated with QBF, SQL, and the Ingres report writer. It can also access programs written in Ingres's C interface. The screen painter that comes with Ingres 4GL is easy to use, and it lets a developer build and change screens quickly and easily.

Ingres's report writer is also nice, but it is missing the Report-By-Forms (RBF) interface supplied on the mainframe versions of Ingres. RBF allows reports to be designed on a screen. The company says RBF will be available early in 1988.

Relational Technology recently announced several gateway products that let users access non-Ingres databases. On the PC, Ingres now offers a gateway to dBASE III files.

Oracle

Oracle 5.1 ($1295), recently released by Oracle Corp., is a direct port of Oracle's minicomputer and mainframe counterparts. Because version 5.1 includes many new capabilities and mimics Oracle's mainframe versions, it requires a minimum of 1 megabyte of extended memory on an otherwise standard IBM PC AT with a hard disk drive and DOS 3.1 or higher.

While this is a nonstandard hardware environment, it does provide more room than the other programs for application code by leaving most of the 640K bytes of main memory free. Also, it increases performance with sophisticated data-buffer management. Oracle will run on 100 percent IBM compatibles like the Compaq, but it may have problems running on other clones because of ROM BIOS sensitivity. The company maintains a list of manufacturers it supports.

You can enter, edit, and save SQL queries using SQL*Plus. Multiple rows of retrieved data are displayed a screen at a time. When the screen becomes full, the user is asked if more rows should be displayed. Unfortunately, no scrolling is supported.

An earlier version of Oracle, 4.1, supported an end-user query tool called Easy*SQL. This package prompted users with questions and built SQL commands automatically. Casual users, therefore, did not have to know SQL to use Oracle. Easy*SQL is currently not available for version 5.1, but it is due out in 1988. Oracle has also announced Oracle QMX for 1988. This is a query-by-example interactive interface similar to IBM's QMF mainframe product.

SQL*Forms is Oracle's nonprocedural application development tool. It has a nice window interface and also contains a screen painter for screen design and "triggers," which execute SQL procedures at specific points on the forms (e.g., on entry or on exit from fields and on exit from a form). Procedures consist of SQL commands and other types of instructions (e.g., assignment and string-manipulation operations).

Packages like Ingres, Informix-SQL, and XDB II combine explicit statements like `IF ... THEN ... ELSE` statements with SQL to control the program logic. In Oracle, this is done implicitly with triggers, which execute SQL statements and can activate other triggers depending on whether a return condition is true or false. Both of these environments are very powerful and much easier to work with than procedural languages. For those who need procedural languages, C and FORTRAN interfaces for Oracle are included, and a COBOL interface is available for $395.

SQL*Reports is a capable tool, but it is limited in that it cannot handle heavily formatted reports. However, Oracle is promising a highly functional report writer in early 1988. In the meantime, you can purchase SQR ($295) from SQ Software (2000 Lee Rd., Cleveland, OH 44118, (216) 397-0551). This package, which is also available for SQLBase, greatly enhances Oracle's report-writing capabilities by letting you generate complex reports.

Oracle bundles an add-in module with the package that you may find helpful. SQL*Calc is an integrated spreadsheet that can access Oracle databases. Oracle has also announced a Lotus 1-2-3 interface for users who need to interface directly with 1-2-3 worksheets.

If you want to run Oracle in a network,

Networkstation Oracle provides a link between an Oracle application running on a PC with an Oracle database residing on a minicomputer.

Oracle also offers a distributed database product, SQL*Star. While this has limited optimization—it cannot decide whether a distributed database join, for example, should be done on the mainframe or the IBM PC—and does not include distributed update capabilities, it does let you transparently access Oracle databases at remote sites.

Oracle has also announced a database server that will be able to run on the IBM PC AT under the Xenix operating system. According to the company, this product should now be available.

SQLBase

SQLBase from Gupta Technologies was the first DBMS to implement a requester/server architecture on a LAN using a PC AT at the server node. SQLBase 3.2.2 ($995, single-user; $1995, multiuser) was specifically designed to work in a requester/server environment and can manage its own multitasking under DOS. It requires a PC AT or compatible with a hard disk drive, 640K bytes of RAM, and DOS 3.1 or higher. (Gupta should be shipping version 3.3 by the time you read this.)

At the time of this review, several other SQL vendors, including Oracle, Relational Technology, and Software Systems Technology, had announced database servers for the PC AT, but Gupta Technologies is the only company to implement an SQL server under DOS.

Database servers can centrally control database locking, recovery, and security. All this is done automatically by the database server, relieving the programmer from the problems of transaction and recovery management.

Under typical networked database configurations, each workstation includes its own copy of the RDBMS. Each time an application requests rows of information from tables, the RDBMS goes to the file server to retrieve all the rows from all the tables that are part of the request. The RDBMS then selects particular rows from the tables at the workstation.

In a requester/server environment, all database processing is performed by the server. Only those rows that are specifically needed are sent back to the requester (workstation), reducing network traffic and increasing performance. All database transaction and recovery management (locking, commit, rollback, security, and so forth) are centrally controlled by the server, providing a stable network environment. The workstation

continued

Table 1: *The basic list of SQL commands. A "Yes" indicates the package includes a particular command; a "No" indicates it does not. All packages except for XQL meet at least the ANSI Level 1 SQL implementation.*

SQL Command	Informix 2.0 ($795)	Ingres 5.0 ($950)	Oracle 5.1 ($1295)	SQLBase 3.2.2 ($995)	XDB II ($395)	XQL 1.0 ($795)
DML						
SELECT	Yes	Yes	Yes	Yes	Yes	Yes
COLUMNS	Yes	Yes	Yes	Yes	Yes	Yes
EXPRESSIONS	Yes	Yes	Yes	Yes	Yes	No
DISTINCT	Yes	Yes	Yes	Yes	Yes	No
FROM	Yes	Yes	Yes	Yes	Yes	Yes
WHERE	Yes	Yes	Yes	Yes	Yes	Yes
GROUP BY	Yes	Yes	Yes	Yes	Yes	Yes
HAVING	Yes	Yes	Yes	Yes	Yes	Yes
ORDER BY	Yes	Yes	Yes	Yes	Yes	Yes
SUBQUERIES	Yes	Yes[6]	Yes	Yes	Yes	Yes
UPDATE SET	Yes	Yes	Yes	Yes	Yes	Yes
WHERE	Yes	Yes	Yes	Yes	Yes	Yes
SUBQUERIES	Yes	Yes	Yes	Yes	Yes	No
INSERT INTO	Yes	Yes	Yes	Yes	Yes	Yes
SUBQUERY	Yes	Yes	Yes	Yes	Yes	No
DELETE FROM	Yes	Yes	Yes	Yes	Yes	Yes
SUBQUERY	Yes	Yes	Yes	Yes	Yes	Yes
UNION	Yes	Yes	Yes	Yes	Yes	No
CORRELATED QUERIES	Yes	Yes	Yes	Yes	Yes	No
DML Predicates						
BETWEEN	Yes	Yes	Yes	Yes	Yes	Yes
LIKE	Yes	Yes	Yes	Yes	Yes	No[1]
IS NULL	Yes	No	Yes	Yes	Yes	Yes
EXISTS	Yes	Yes	Yes	Yes	Yes	No
ALL	Yes	Yes	Yes	Yes	Yes	No
ANY	Yes	Yes	Yes	Yes	Yes	No
SOME	No	No	No	No	No	No
[NOT]	Yes	Yes	Yes	Yes	Yes	Yes
DML Functions						
AVG	Yes	Yes	Yes	Yes	Yes	Yes
COUNT (*)	Yes	Yes	Yes	Yes	Yes	No
COUNT	Yes	Yes	Yes	Yes	Yes	Yes
MAX	Yes	Yes	Yes	Yes	Yes	Yes
MIN	Yes	Yes	Yes	Yes	Yes	Yes
SUM	Yes	Yes	Yes	Yes	Yes	Yes
DDL						
ALTER TABLE	Yes	No	Yes	Yes	Yes	Yes
CREATE TABLE	Yes	Yes	Yes	Yes	Yes	Yes
NOT NULL	Yes	No	Yes	Yes	Yes	No
CREATE INDEX	Yes	Yes	Yes	Yes	Yes	Yes
CREATE UNIQUE INDEX	Yes	No	Yes	Yes	Yes	No[2]
CREATE VIEW	Yes	Yes	Yes	Yes	Yes	Yes
DROP TABLE	Yes	Yes	Yes	Yes	Yes	Yes
DROP INDEX	Yes	Yes	Yes	Yes	Yes	Yes
DCL						
GRANT	No[3]	No[4]	Yes	Yes	Yes	Yes
REVOKE	No[3]	No[4]	Yes	Yes	Yes	Yes
Other						
COMMIT WORK	Yes	No[5]	Yes	Yes	Yes	No
ROLLBACK WORK	Yes	No[5]	Yes	Yes	Yes	No

[1] XQL supports `CONTAINS`, which is a subset of `LIKE`.
[2] XQL supports `UNIQUE` indexes with field attributes in the `CREATE INDEX` statement.
[3] Informix supports `GRANT` and `REVOKE` on its multiuser versions.
[4] Ingres supports `GRANT` and `REVOKE` on its multiuser versions.
[5] Ingres supports `COMMIT WORK` and `ROLLBACK WORK` on its multiuser versions.
[6] Ingres subqueries cannot include built-in functions.

still executes the program logic but is relieved of all DBMS activity.

SQLBase can manage several servers on a network, and the program on a given PC can connect to any database on any server. The SQLBase catalog keeps track of which server contains which database. This capability implements a form of distributed database processing. Programmers must still manage their own commit logic (in SQL terms, all modifications are tentative until they are made firm [committed] or erased [rolled back]) when updating across multiple servers.

Table 2: *Extensions that vendors have implemented. While each company may not explicitly implement the extension in the same way, similar functions are grouped under the same command. You should refer to a vendor's documentation for the exact definition and SQL command for the indicated function.*

SQL Extension	Informix	Ingres	Oracle	SQLBase	XDB II	XQL
DML						
Outer join	Yes	No	Yes	No	No	No
Update statistics	Yes	No	No	No	No	No
Select into temp	Yes	No	No	No	No	No
Recursive select	No	No	Yes	No	Yes	No
Edit masks	No	No	Yes	No	No	Yes
Update set Subquery	No	No	Yes	No	No	No
Functions						
Statistical	No	No	Yes	No	Yes	No
Arithmetic	No	Yes	Yes	No	Yes	No
String functions	No	Yes	Yes	Yes	Yes	No
Date and time	Yes	Yes	Yes	Yes	Yes	No
DDL						
Create table with check option	No	No	No	Yes	No	Yes
Create table as select	No	Yes	Yes	No	Yes	No
Create synonym	No	No	Yes	Yes	Yes	No
Rename table	Yes	No	Yes	Yes	Yes	No
Modify columns	Yes	Yes	Yes	Yes	Yes	Yes

Table 3: *We conducted the following nine tests on each package. Descriptions accompany the SQL queries.*

1. Load 1000 records.
2. Create a unique index on sequence number (`SEQNO`).
3. Create an index on ZIP.
4. `SELECT * FROM PERSONS WHERE ZIP = '60606' AND SEQNO < '999'`
(Tests the ability of the optimizer to choose the correct index. In this case, performance is increased by using the index ZIP.)
5. `SELECT * FROM PERSONS WHERE ZIP = '60606' OR SEQNO = '999'`
(Tests the ability of the optimizer to use indexes in OR logic. In this case, using both indexes reduces the query to select just those rows that meet the ZIP-code or sequence-number criteria, but simply scanning the full table takes a great deal of time. Note that if the query was `SEQNO < '999'`, the index should not be used.)
6. `SELECT * FROM PERSONS WHERE SEQNO > '980' ORDER BY ZIP`
(Tests the ability of the optimizer to use the ZIP index so that the query does not require an external sort.)
7. `SELECT SUM(SALARY) FROM PERSONS`
(Tests the aggregate [mathematical] functions.)
8. `SELECT ZIP FROM PERSONS GROUP BY ZIP HAVING COUNT(*) > 5`
(Grouping requires a sort with the additional grouping functions. Packages with efficient sorts will fare best on this test.)
9. `SELECT A.SEQNO,B.SALARY FROM PERSONS A, PERSONS B`
`WHERE A.SEQNO = B.SEQNO AND A.ZIP LIKE '606%'`
(Tests self-join with `LIKE` selection algorithms. There are several ways of executing this query. For example, the rows that contain `'606%'` can be chosen first and then joined, or the optimizer can join all rows first and select only those with a `ZIP` of `'606%'`.)

Gupta Technologies now offers a companion product called SQLNet, which costs $20,000 per mainframe and $1995 per PC gateway. This provides an APPC (advanced program-to-program communication) link to mainframe relational databases like DB2. Essentially, this lets the program on the PC interact with a mainframe database in the same way that it interacts with any other database on the network. The APPC link will send SQL requests to DB2 and receive back any rows returned by DB2.

SQLBase's end-user and development tools consist of an interactive SQL capability and a C interface that contains embedded SQL statements. According to the company, SQLWindows, a top layer to SQL that provides 4GL capabilities, should be available in the first quarter of 1988. Developers who need to create reports can use SQ Software's SQR report writer, which is available from Gupta Technologies for $295.

XDB II

What distinguishes Software Systems Technology's XDB II ($395) from its competitors are its friendly end-user interface and application development tool set. It requires an IBM PC, PC AT, or compatible with two double-sided floppy disk drives (a hard disk drive is recommended), 512K bytes of RAM, and DOS 2.0 or higher. The company clearly understands the types of tools required on the PC and has built them so that they can be quickly learned by novice users.

Upon entering XDB, you are presented with a menu listing all the options. The first option lets you create or alter tables using a table-definition screen. You can also use the SQL command language, but you will probably find the ease of the table-creation facility more to your liking.

Another option gives you update or query capabilities on single tables using XDB's Edit program. Edit creates a default screen for a table and lets you enter new rows, update existing rows, and delete rows in a table. If you want to browse through the table, you can enter search criteria in the fields, and XDB will retrieve all rows that meet the criteria. If more than one row is retrieved, you can use the PageUp and PageDown keys to browse through the rows.

XDB's interactive SQL lets you store queries and retrieve them for later use. The queries can be stored with a comment to assist you in recalling the correct query. Results of queries are displayed on the screen multiple rows at a time. You

continued

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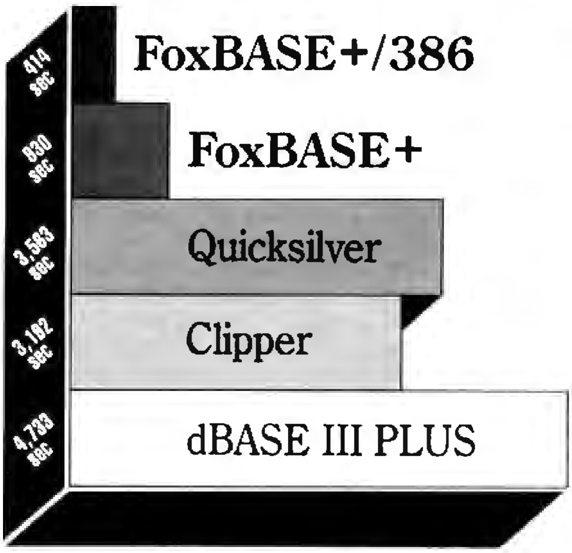

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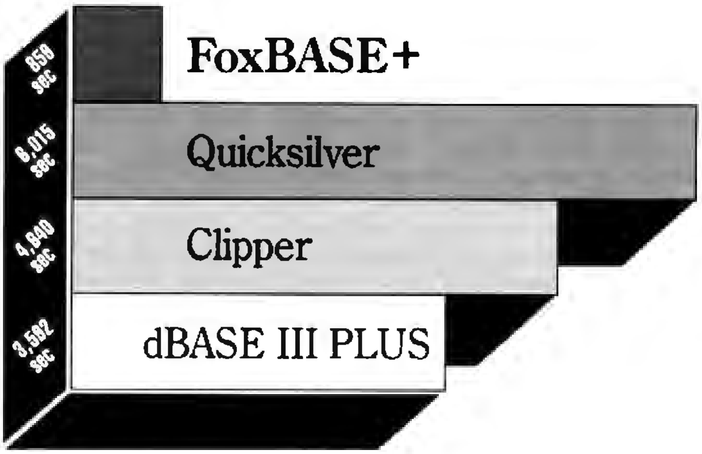

BYTE Magazine

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**Using the suite of benchmarks published in Data Based Advisor, March 1987.

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can scroll right, left, up, and down to review the results of a query. Query results can be printed immediately or formatted with the interactive report writer.

The report writer is accessed directly from the interactive SQL facility. Once loaded, the report writer can format a report by moving columns to different positions on a line or to different lines. You can add titles, perform calculations, change column names, assign report breaks, and define the physical-report format page and margin sizes.

Throughout this process, you can see the effects of each command immediately on the screen. When the report is completed, you can print it out or save the commands in a special report file. The commands can then be executed again with another interactive SQL query, or they can be run in a batch mode.

The application development tools of XDB include the optional Forms generation package ($295), which lets you paint a screen, define edit logic, and use SQL for inserts, updates, and deletes. The system is window-oriented and easy to use. Forms can also be run in a batch mode and can be used to create complex reports beyond the scope of XDB's report writer.

XDB also includes a simple-to-use menu generator that is used to integrate a set of reports, forms, .BAT files, DOS commands, or other menus into an application. You can purchase an optional graphics package for $69. Other options include C and COBOL interfaces for $295 and $395, respectively. These interfaces let you embed SQL commands into your programs.

XQL

XQL 1.0 ($795) comes from Novell Development Products Division, formerly SoftCraft, the developers of the well-known and highly regarded Btrieve. XQL requires an IBM PC, PC AT, or compatible with a hard disk drive, 512K bytes of RAM, and DOS 2.1 or higher. Btrieve 4.10, necessary but sold separately ($245, single-user; $595, multiuser), provides a sophisticated file management system that application developers can include in BASIC, Pascal, and C programs.

XQL is an attempt to place a relational database layer on top of the Btrieve system. However, XQL does not conform to any SQL standard. Unfortunately, Novell touts it as being an SQL product, which only clouds the otherwise good improvements to Btrieve that XQL delivers.

XQL has its own syntax that does not match any SQL database mentioned in this review. SQL users will be frustrated with this unique implementation. XQL is missing many important SQL operations, including subquery capabilities, from which SQL derives its name (the "structured" in "structured query language" comes from its subquery functions). Refer to table 1 for more details on XQL's syntax limitations.

XQL also has an awkward optimizer. All tables require at least one index, and the secondary-table column in a join must be indexed. The optimizer is very crude and frequently disrupts the query. For instance, if you restrict a `SELECT` command (by using a `WHERE` clause), the XQL optimizer will attempt to use an index to increase performance.

On the other hand, if the command includes an `ORDER BY`, it will override the optimization. A developer is therefore forced to make a decision between optimization and sorting. Other peculiarities of the XQL optimizer are conscientiously discussed in the documentation.

Despite these serious limitations, XQL does provide an interactive retrieval capability. Only forward scrolling is supported, but results can be output to any device. XQL queries can be stored or retrieved for future use.

The XQL query language can be embedded into BASIC, Pascal, and C programs. XQL lets programmers manipulate both application-defined tables and system-catalog tables. Table and field definitions can be interrogated and modified, and security can be maintained from within a program.

Novell offers a network database server called Btrieve/N, which implements the database server/requester architecture. It has fairly good locking and recovery facilities, though not on a par with SQLBase, in that it does not provide precise record and page locking.

There is much merit in what Novell has attempted, but we strongly disagree with labeling this language SQL. The company recognizes the limitations of XQL and says it is in the process of developing a full SQL implementation. In the meantime, Btrieve users will probably appreciate the XQL interface, but they should not confuse it with SQL.

Standard SQL Features

Table 1 lists standard SQL DML (data-manipulation language), DDL (data-definition language), and DCL (data-control language) commands. These are found in the ANSI and IBM standards. The DML contains the basic `SELECT`, `UPDATE`, `INSERT`, and `DELETE` commands.

All commands should have subquery capabilities. The `EXISTS` predicate is particularly important, since it is required for the relational division operation. `IS NULL` supports null values, and the `UNION` command supports the relational union operation.

The DDL is used to define tables, indexes, and views. All packages support these commands, but each differs on the data types supported. ANSI Level 2 also requires a `PRIMARY KEY` specification, which all the packages are missing.

`COMMIT WORK` and `ROLLBACK WORK` are transaction-management commands that let you physically commit or roll back database modifications. All the packages that implement this command can be

continued

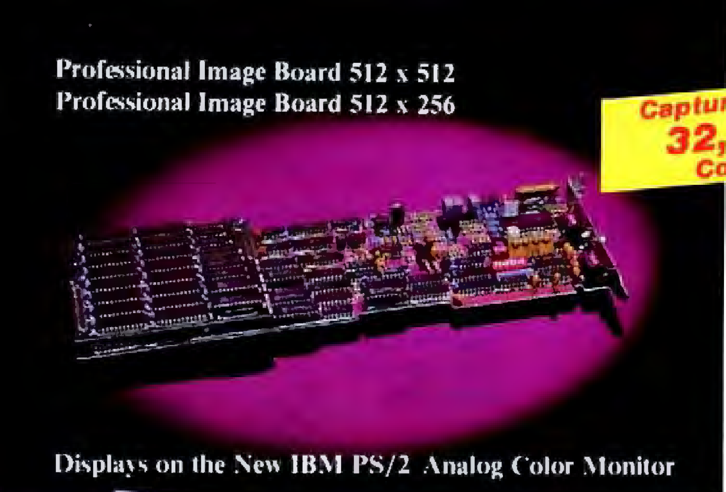
Table 4: *A description of the* PERSONS *table created by the performance tests.*

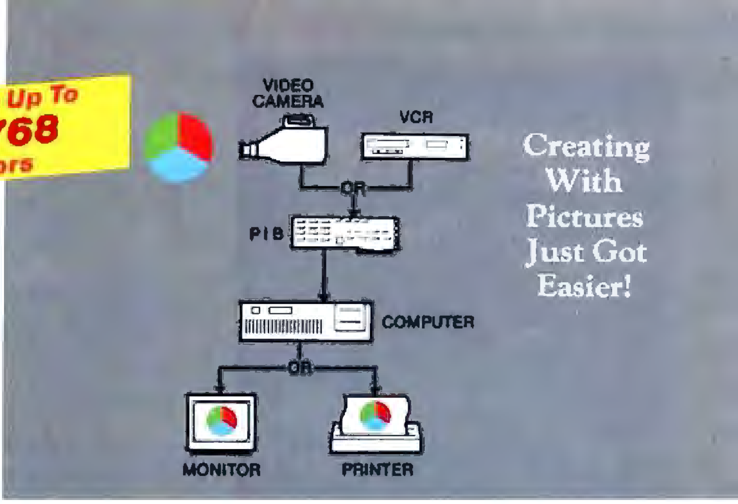
```
SEQNO CHAR(4)
NAME CHAR(30)
TITLE CHAR(30)
COMPANY CHAR(30)
DEPARTMENT CHAR(30)
ADDRESS CHAR(30)
ADDRESS2 CHAR(30)
CITY CHAR(20)
STATE CHAR(2)
ZIP CHAR(10)
SALARY MONEY
```

Table 5: *Performance test results. All times are in seconds.*

Query No.	Informix	Ingres	Oracle	SQLBase	XDB II	XQL
1	23	29	76	35	64	316[1]
2	43	30	21	46	16	[1]
3	78	22	24	48	18	23
4	39	6	5	2	1	4
5	20	13	5	23	9	29
6	10	21	24	22	7	6
7	26	9	8	17	9	44
8	124	41	15	9	30	37
9	19	33	24	46	40	12

[1] XQL requires that a unique index exist when the table is initially defined. The results of test 1 include the time required for test 2. The XQLUTIL utility was used, which loads a table with a series of SQL inserts. Loading may be faster using the Btrieve load utility.





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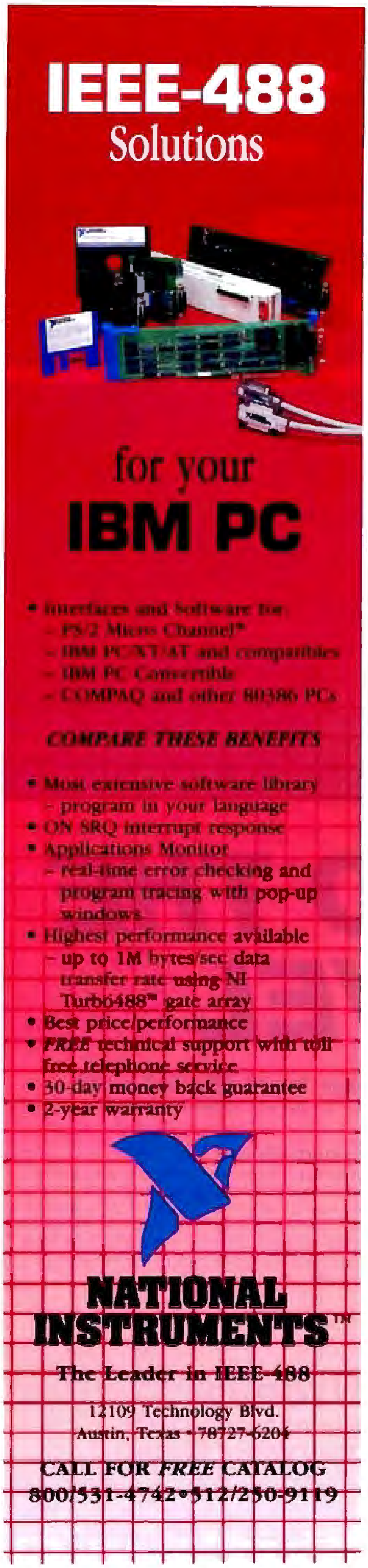

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Inquiry 947.

used interactively.

The commands in table 2 are nonstandard and are meant to increase the functionality and usability of SQL. The `OUTER JOIN` query is important when a row in one table does not have a matching value in the secondary joined table. The outer join ensures that all rows are returned in a query. Packages that do not have an outer join can simulate the command by using `UNION`.

The `UPDATE STATISTICS` command is used to update the system catalog with statistical information that the optimizer can use. The recursive `SELECT` is useful for bill-of-material explosion-type problems.

Three packages (see table 2) let you create tables using a `SELECT` statement. When used with a `CREATE` statement, the tables will be permanent. Informix-SQL is the only product that allows the creation of temporary tables. Of course, all packages let you drop tables or indexes (this is not part of either ANSI level) when they are no longer needed. All the systems also let you modify column definitions after a table is created. (IBM's SQL only lets you add new columns.)

Performance Tests

The performance tests we ran were designed to exercise the SQL optimizer and test conformance of the SQL syntax. Keep in mind that the performance you experience is relative to the given environment and application you work with. An application that relies heavily on updates may not require tables to be joined. Some applications may require several tables to be joined, while others may consist primarily of two table joins. In looking over the test results, be advised to examine your own application needs.

We conducted our SQL queries on an 8-MHz IBM PC AT with 640K bytes of main memory and 1 megabyte of extended memory. The table that we used contained 1000 rows, and each row contained about 150 bytes of information, with a maximum length of 325 bytes. Information was derived from a real mailing list. Table 3 is a list of the nine tests that were executed. Table 4 is a description of the table created. Table 5 contains the test results.

All the products were able to execute the SQL queries without modification, with two exceptions. Ingres uses an asterisk instead of a percent sign with its `LIKE` predicate. XQL requires double parentheses around the join expression in test 9. Also, XQL uses a `BEGINS WITH` or `CONTAINS` predicate instead of `LIKE`. `LIKE` is slightly more powerful, since wild cards can be intermixed within the character string.

XQL is also very unforgiving. It requires a blank space preceding and directly after an equal sign. It also requires all field names to be unique in a database. While creating the test table (`PERSONS`) in XQL, we received several duplicate field error messages that did not indicate where the problems were. After listing the directory, we managed to define unique field names.

Each product has strengths and weaknesses depending on the type of query. In some cases, it may be possible to address these problems by fine-tuning the query to make better use of the optimizer. Generally, products that make better use of indexes perform best. Overall, the optimizers did well—even though most of the SQL products are fairly new to the PC. ■

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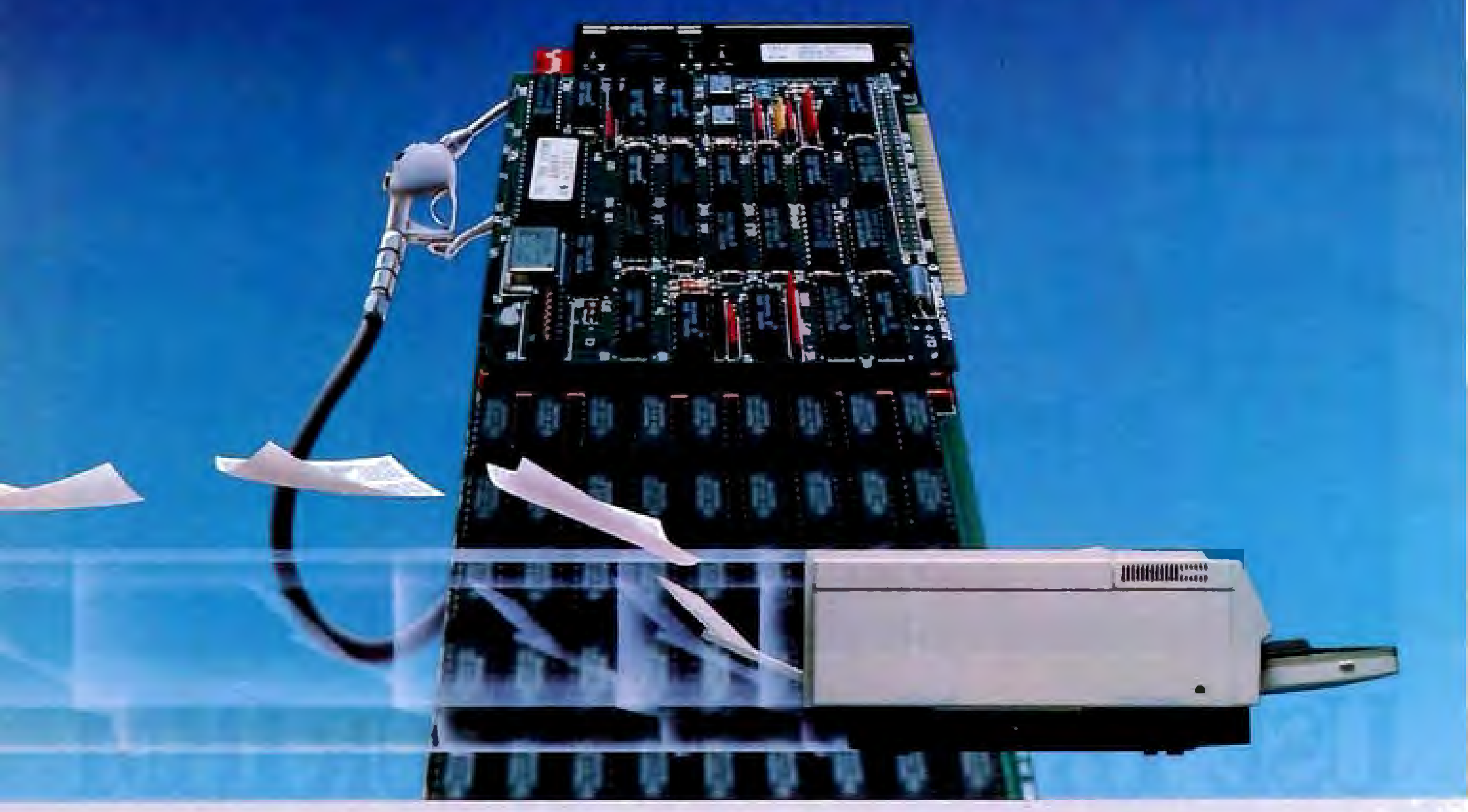

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Circle 265 on Reader Service Card

Curtis Franklin Jr.

SQL-based Database Managers

Microcomputer databases with mainframe tools

Dealing with complex data sets requires small-system programmers and users to depend on powerful tools. For many database applications, this means using a database manager based on IBM's SQL. The consultants, programmers, and end users on BIX discussed three of the most popular SQL-based packages for microcomputers: Informix-SQL, Oracle, and Ingres. They also mentioned Btrieve, which has an SQL-based version, Btrieve-XQL.

Most love the power and flexibility that these complex packages offer, but there are also some concerns about tradeoffs in speed and ease of use.

The BIX Product Focus presents a variety of informal, diverse opinions from users of a selected class of products. (For more information on the terms and technologies discussed, see the preceding Group Review.) Messages selected for publication may be edited for length or clarity. The views expressed here are those of each message's author, and they do not necessarily reflect those of BYTE or BYTE's reviewers.

INFORMIX-SQL

dbms/app__builder #194, from wsmith (William Smith).

I purchased Informix-SQL because versions are available for Xenix machines, MS-DOS machines, and most minicomputers. When purchased with File-it, an Informix-compatible file manager, simple applications remain simple to implement. It took only about 10 minutes to set up and enter data into an address database. The system can manipulate strings of up to 32,000 characters, but the data-entry program Perform is awkward to use for strings of greater than 80 characters. There is no full-screen report writer, but the system comes with its own report programming language, Ace, which makes it very easy to output records consecutively. If you take the time to learn a few tricks, Ace will even let you output different records on the same line, a feat that is surprisingly difficult for most databases.

dbms/app__builder #196, from rbrenner (Rick Brenner).

We spent a month converting menus and many programs from C to Informix. We were astonished; simple menu selections that happened instantaneously under BTree took up to 40 seconds. I'm not talking about searching files; I'm talking about just opening up files and getting set to be able to do something. We paid approximately $2000 for the package and the phone support and another $3000 in programming time, only to finally trash the whole effort after about 30 days and go back once again to our superfast BTree.

dbms/app__builder #271, from schin (Sam Chin).

I agree that Informix is very powerful, but its SQL and Ace run times give me terrible error messages like "Syntax Error" without telling me where the error occurred. I still use it, though, because there doesn't seem to be anything better and it is totally flexible.

dbms/other #136, from schin.

I use Informix-SQL and Informix-ESQL/C on a Unix machine and on a Novell network. ESQL/C is an implementation of an embedded SQL for C. You can actually embed SQL statements in C by prefacing them with a $. You define variables that are shared between ESQL and C so that you can extract data through ESQL and massage it with C. A preprocessor converts the ESQL and C code mix to pure C code after checking the SQL for syntax, and you then compile it with your favorite C compiler (ESQL/C libraries on the PC use the Microsoft C Compiler version 3.0). Informix also provides versions that do automatic file and record locking on Unix, Xenix, and any network that conforms to the MS-NET standard for file and record locking (such as 3Com's 3+, IBM's Token-Ring, and NetWare 2.0). Other Informix products are ESQL/COBOL; C-ISAM, a file manager (built into Informix); and Informix-4GL, an integrated fourth-generation language based on SQL.

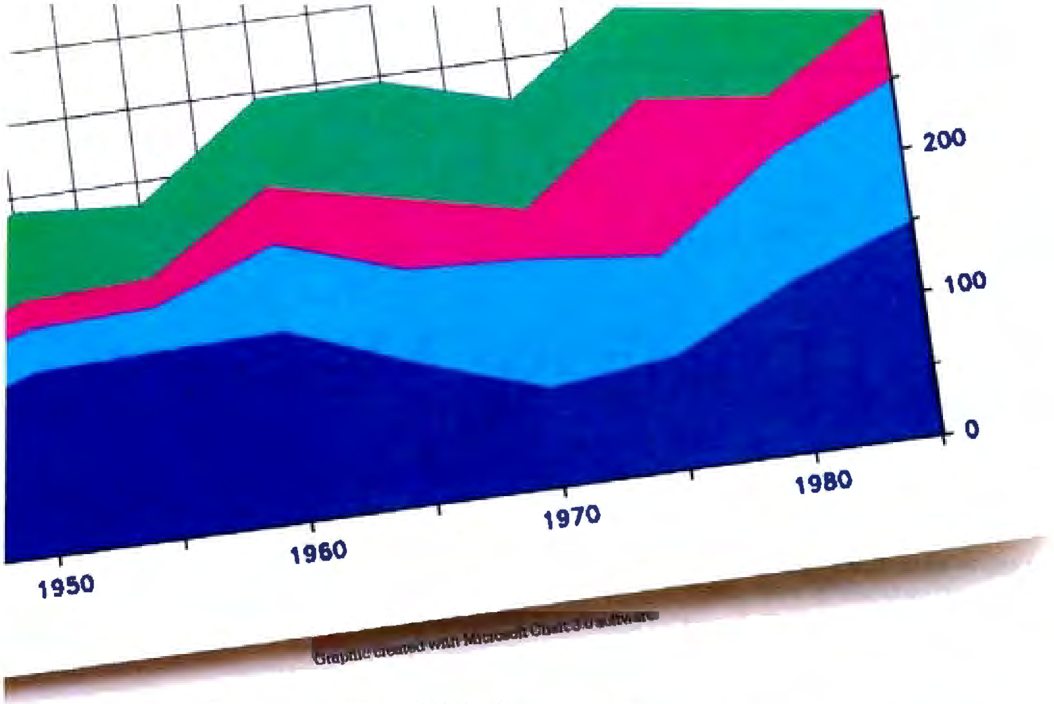
ORACLE

dbms/other #115, from wseeley (Bill Seeley).

The main problem with SQL is that it provides only a data-definition and data-manipulation language (DDL/DML) and has not been fleshed out by IBM with a full set of integrated fourth-generation tools, such as screen painters, report generators, and a data dictionary. It is also not available on anything but IBM mainframes (it is called SQL in the VM/CMS environment and DB2 in the MVS environment). Oracle has a complete set of fourth-generation tools and runs on PCs, a wide variety of minicomputers (both under Unix and proprietary operating systems), and IBM mainframes under both VM/CMS and MVS. It also has a built-in microcomputer-to-mainframe link and an optional spreadsheet called SQL*Calc. The microcomputer version has an optional end-user interface called Easy*SQL.

I've just spent the last couple of weeks doing a hands-on evaluation of these products, and in general they seem pretty good. The one problem Oracle seems to have is keeping all the versions for all the various machines in sync. Some of the subsystems are not yet available under all versions. Another problem with Oracle is that it is a *superset* of SQL and thus

continued



doesn't guarantee portability of code or data to other SQL systems (i.e., it is only downward-compatible with SQL, and it can't read/write IBM SQL databases).

Focus is a proprietary product developed by Information Builders and is a mature product that has been around a number of years. The DDL/DML is not quite as elegant as SQL, but it has a rich feature set. It has a nice system for table generation and query (Filetalk and Tabletalk) that enables end users to easily create relational tables and extract data from them. It also has a nice screen painter and a quasiprocedural language for controlling data entry and validation. Focus is also available for PCs, selected minicomputers (not as many as Oracle), and IBM mainframes, and it has a built-in microcomputer-to-mainframe link. Focus evolved out of the Information Center environment, and one of its major strengths is its ability to interface with a wide variety of other mainframe DBMSes (e.g., Cullinet's IDMS/R, IBM's SQL and VSAM, and Computer Corporation of America's Model 204). I've also had an opportunity to do a hands-on evaluation of Focus, and it seems a bit easier to use than Oracle and more consistent across the microcomputer-to-mainframe versions.

INGRES

dbms/other #270, from jrobie (Jonathan Robie).

I just received two copies of Ingres last week. The basic design is almost identical to that of the minicomputer implementation. Documentation is also quite similar—the Ingres Quickdemo section is incorrect for the PC version, but it is correct for the VMS version!

I played with it a little, and I really like the user interface. It has real SQL and QUEL, is callable from C, and has a good forms editor and report writer. This is a real relational database, and the minicomputer version was voted database product of the year in *Digital Review*. My initial impressions are favorable. It does have problems with memory management, though. I hope it gets a little more solid with time.

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dbms/dbwars #141, from jrobie.

Ingres, Oracle, and Informix will all run on a *wide* variety of machines, all support some form of distributed database, and all allow external programs to make calls to their utilities. If you can afford them (they are *expensive*), these might be logical choices. They make great demands on your computer systems, though.

---

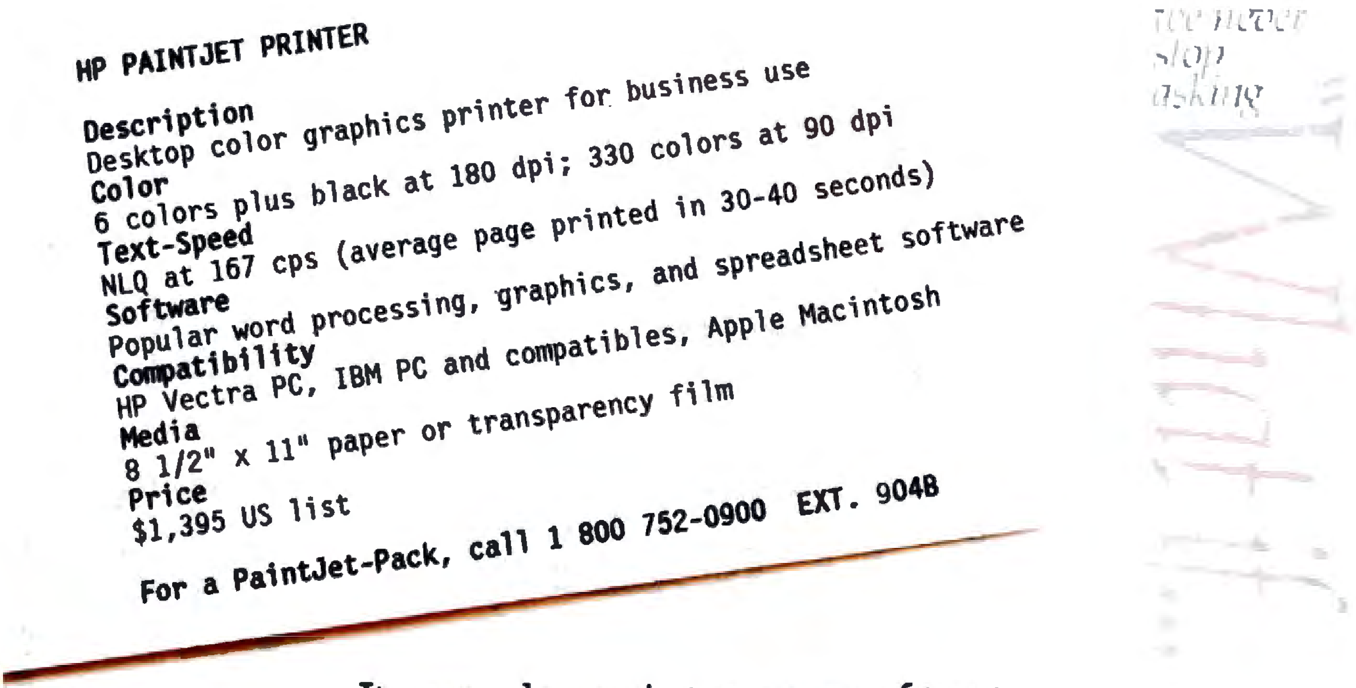
dbms/dbwars #182, from jrobie.

Ingres is a *very* nice relational database that is much more powerful than dBASE, R:base, Condor, and the like. It has both SQL and QUEL—a superior query language that did not become the standard. It has good query optimization (very important for *large* data sets) and runs on any machine you might be considering. It *is* expensive, eats RAM, and takes a lot of disk space. This is not the best solution for someone who needs a simple filing system.

BTRIEVE

dbms/callable #13, from pmahoney (Peter Mahoney).

Btrieve is very good and very fast. The multilanguage interface is nice also. C-tree is also a good product. Faircom, its



BIX PRODUCT FOCUS

developer, is good with support and upgrades. It is also as portable as they claim. I developed an application under DOS and then ported it to RSX-11 using C-tree under RSX-11. No small task, but possible. C-tree is for C only, though.

---

dbms/callable #22, from jcoombs (James J. Coombs).

"Memory-resident DBMS" sounds a lot like Btrieve. I don't use it, but a lot of people speak highly of Btrieve. I do know that it runs resident and can optionally be evicted upon termination of the application. I tried a shareware file cataloger that used the program and left the DBMS in RAM. I don't recall how much RAM was being consumed, but I would guess that it was around 100K. I would call them up for more definite information. Also, people on the BOSS BBS use Btrieve. In fact, I think the BBS itself uses Btrieve. The author, Dan Doman, would probably be happy to discuss its merits with you (BOSS at (201) 568-7293–C language conference [registration required]; PCSI [Doman's home board] at (212) 529-0498).

My impression is that if you don't need source code and can live within Btrieve's limitations (e.g., maximum record length), then Btrieve is the best choice. If its limitations are a problem, you would be well-advised to negotiate a solution before purchasing Btrieve; I have heard complaints from at least one person who was having trouble working out an arrangement for customization or purchasing source code. If you need source code for porting or customizing, then C-tree is the best choice (assuming you are coding in C). Oh, yes, report generation is handled through a separate program–Rtrieve–and there is another called Xtrieve. The company is SoftCraft, and they advertise regularly. There might be some other possibilities, such as purchasing a run-time library for a DBMS and writing your own TSR routine. The run-time library would still provide you with the management functions.

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dbms/callable #29, from abender (Andrew L. Bender).

Btrieve is very good in terms of security. The preimaging files protect the user against data corruption quite well. As to security in terms of intrusion, a user code will scramble the file beyond recognition so that one would have to be quite a hacker to figure out what it says.

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dbms/other #186, from abender.

If you really want to get an application up to maximum speed once you get it going in an interpretive language like Revelation, KMan, or even dBASE III Plus, I suggest that you give serious thought to getting away from that kind of database administration and going with a different approach. I transferred an entire KMan system (six floppies) to Lattice C using Btrieve/N as my file handler and Vitamin C as a screen handler. There is no comparison in speed, and Btrieve's excellent recovery and preimaging make for an almost breakproof system. You can do any kind of field validation in Vitamin C. I stayed away from Clipper and such things because that kind of compiler is tied so tightly to the dBASE III procedural language that I found it very inflexible without considerable "own code" stuff. ■

Curtis Franklin Jr. is a technical editor for BYTE. He can be contacted at BYTE, One Phoenix Mill Lane, Peterborough, NH 03458, or on BIX as "curtf."

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- Microsoft C and Turbo C: Describes language, including statements, operators, data types and structures.
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- Tables: ASCII chart, line-drawing characters, keyboard codes, error codes, operators, etc.

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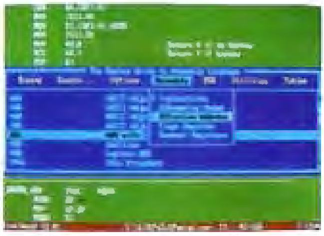

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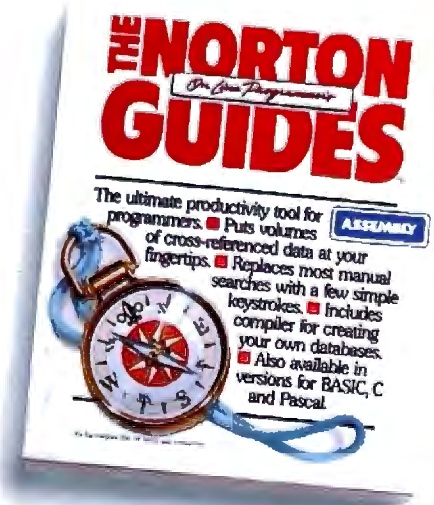

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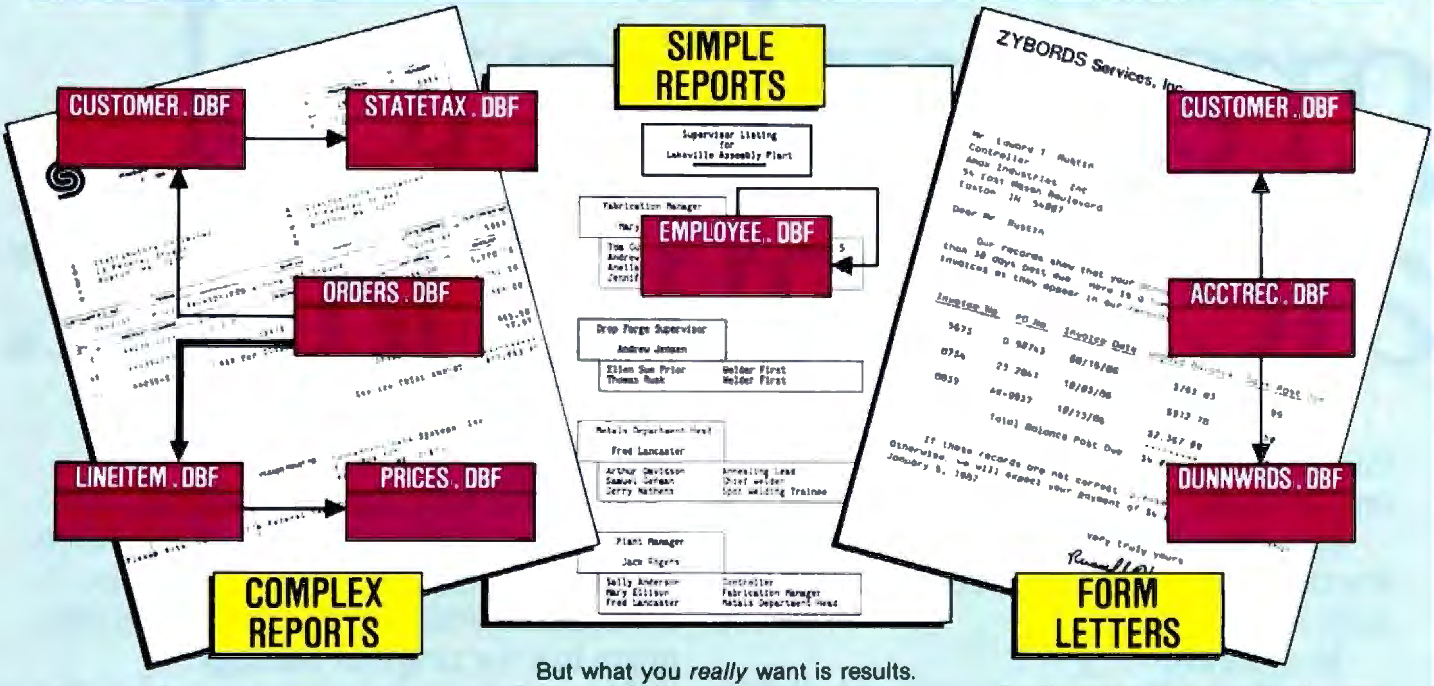

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Cache in the Chips

Ed McNierney

The PC Designs GV-386 offers more speed and less wait

The PC Designs GV-386 is another hybrid entry into a growing field of 16-megahertz 80386 computers that use the speed and performance of the 80386 CPU while still retaining full IBM PC AT compatibility. Although it runs at the same clock speed as most other 80386 systems, it uses clever design components to squeeze as much performance as possible out of the system. The result is a high-powered PC AT–compatible computer.

As reviewed, the GV-386 came with 4 megabytes of RAM, a Priam 40-megabyte hard disk drive, and a Toshiba 1.2-megabyte 5¼-inch floppy disk drive. The computer has eight expansion slots, two 8-bit and six 16-bit. The two 8-bit slots were filled with a half-length Everex EGA-compatible display card and a half-length Everex serial/parallel card. One 16-bit slot contained the full-length combination floppy disk/hard disk controller card.

An 80287 math coprocessor running at 6, 8, or 10 MHz is supported, and the review system was equipped with a 10-MHz version. The system unit also features a keylock on the front panel and a convenient Reset switch next to the power, disk-access, and Turbo (16-MHz) indicator LEDs. The power supply is rated at 200 watts and is switchable from 115 volts AC to 220 volts. An NEC MultiSync monitor was included with the review system.

The system comes with a one-year warranty for parts and labor and a 30-day money-back guarantee of IBM compatibility. The list price for the entire package is $5221.

Software Features

The GV-386 uses the American Megatrends 386-BIOS. This BIOS, composed of four 27256 ROMs, lets you interrupt and cancel the power-on RAM test by pressing the Escape key. Since the unit can be configured with a lot of RAM, this shortcut is a real convenience, especially if you do software development that may require frequent use of the Reset switch. After the self-test, you can press the Delete key to enter the ROM-based Setup utility; no separate disk is required. Configuration CMOS RAM is powered by four AA batteries.

The Quarterdeck Expanded Memory Manager 386 (QEMM) and DESQview 2.0 are bundled with the system, as are MS-DOS 3.2 and GWBASIC 3.2. The QEMM software lets you use the extended memory in the system as Expanded Memory Specification (EMS) expanded memory; when used in conjunction with DESQview 2.0, it provides a powerful multitasking environment. You can run multiple DOS applications in separate windows at the same time.

Fast RAM

The PC Designs motherboard is unusual in that it can hold up to 4 megabytes of RAM. Other 386-based systems, such as the Compaq Deskpro 386, use a separate 32-bit memory board and slot. All RAM on the GV-386 motherboard is accessed by the processor through a 32-bit-wide data path, so the RAM sockets must be fully populated for the system to operate properly. The board is designed to accept 64K-bit, 256K-bit, or 1-megabit RAM chips; the 36 sockets provide 256K bytes, 1 megabyte, or 4 megabytes of parity-checked RAM.

The memory consists of 120-nanosecond dynamic RAM (DRAM); this type of RAM requires the insertion of two wait states for processor access. Although this is normally a severe performance penalty, 120-ns DRAM is relatively inexpensive and readily available, so upgrading a base 1-megabyte system to 4 megabytes is affordable. PC Designs has enhanced the performance of this DRAM system with a 64K-byte cache of 45-ns static RAM (SRAM) that can run with zero wait states, allowing full processor access to memory without delay. The SRAM cache has access to all 16 megabytes of the machine's addressable memory, so memory added on an expansion board is cached just as effectively as system board memory.

The use of cache memory is not free,

continued

Ed McNierney is a principal engineer at Lotus Development Corp. He can be reached at 54 Pleasant St., Groton, MA 01450, or on BIX as "mced."

PC Designs GV-386

Company
PC Designs Inc.
2500 North Hemlock Circle
Broken Arrow, OK 74012
(800) 322-4872
(918) 251-5550 in Oklahoma

Size
21⅓ by 17⅓ by 6⅘ inches; 45 pounds

Components
Processor: Intel 80386 running at 16 MHz with zero wait states or at 8 MHz; 6-, 8-, or 10-MHz Intel 80287
Memory: 1 megabyte of zero-wait-state DRAM on motherboard (system maximum of 16 megabytes); 64K bytes of 45-ns static cache RAM
Mass storage: One half-height 1.2-megabyte 5¼-inch floppy disk drive; one 40-megabyte hard disk drive
Display: Everex EGA-compatible display adapter with an NEC MultiSync monitor
Keyboard: 101-key modified AT-style enhanced keyboard
I/O interfaces: One parallel port (DB-25); two serial ports (one DB-9, one DB-25); six 16-bit PC AT-compatible expansion slots; two 8-bit PC-compatible expansion slots

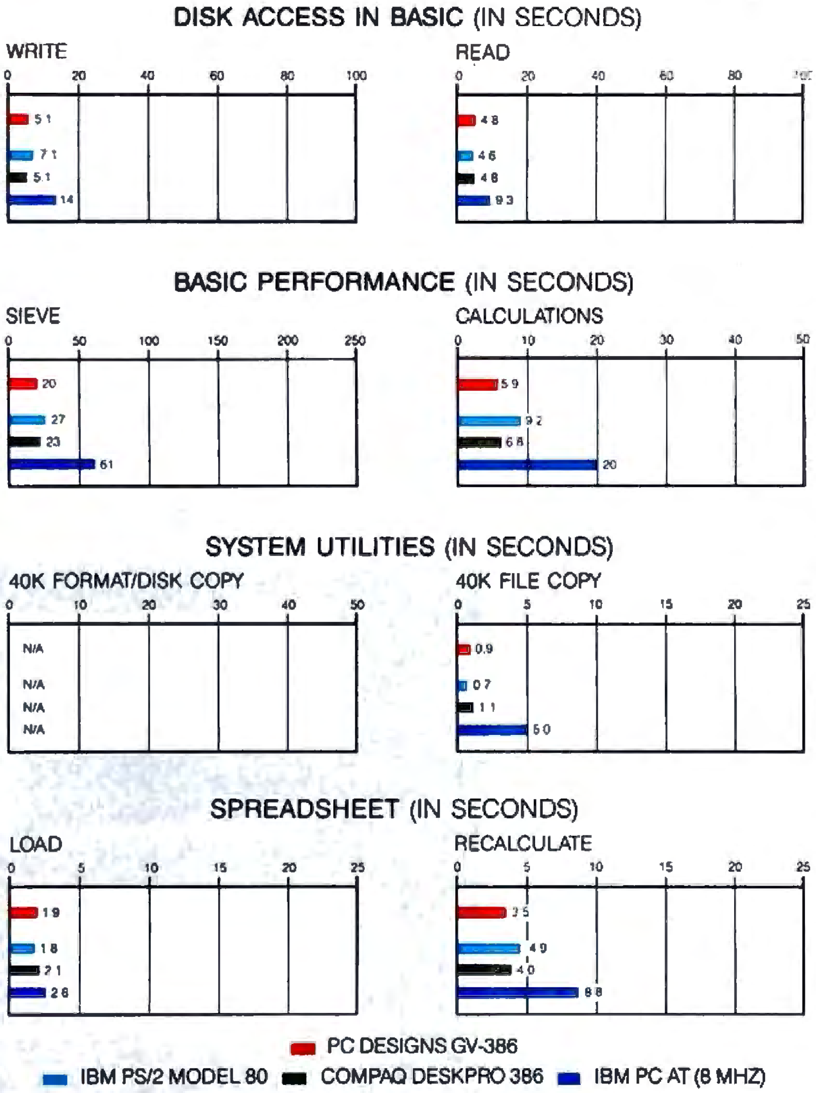
Software
Quarterdeck Expanded Memory Manager 386; ROM-based Setup utility

Options
Hard disk drives (from 20 to 230 megabytes): $475 to $2495
Tape backup units: $589 to $759
Graphics cards: $75 to $285
Display monitors: $95 to $599
Internal modems: $109 to $199
EGA graphics cards: $159 to $350
10-MHz 80287-10 math coprocessor: $355
MS-DOS 3.2 with GWBASIC 3.2: $99
3-megabyte expansion RAM on motherboard (total of 4 megabytes of RAM): $885
NEC MultiSync monitor: $599
MS-DOS version 3.2: $99

Documentation
User's Guide and Operations Manual; DESQview and QEMM user documentation

Price
Base system (1 megabyte of RAM, 40-megabyte hard disk drive, 1.2-megabyte floppy disk drive): $3124
System as reviewed: $5221

Inquiry 885.



Test	GV-386 10-MHz 80287	Model 80 16-MHz 80387	Compaq 386 8-MHz 80287	Compaq 386 16-MHz 80387	IBM PC AT 8-MHz 80287
Dhrystone*	4356	3626	3748	3748	1590
Fibonacci	48.55	57.26	53.12	53.11	126.22
Float	5.80	1.62	6.80	1.43	10.98
Savage	18.05	9.49	21.53	8.95	37.30
Sieve	5.07	6.45	5.99	5.98	24.60
Sort	6.29	7.74	5.58	5.58	43.17

*Higher numbers denote faster performance.

The Disk Access benchmarks write and then read a 64K-byte sequential text file to a hard disk. Sieve runs one iteration of the Sieve of Eratosthenes. Calculations performs 10,000 multiplication and division operations. The 40K Format/Disk Copy benchmark is not performed on computers with only one floppy disk drive. The 40K File Copy benchmark copies a 40K-byte file on the hard disk. The Spreadsheet tests load and recalculate a 100-row by 25-column Multiplan (1.06) spreadsheet. All BASIC benchmark programs were run with MS-DOS 3.20 and GWBASIC 3.20 on the PC Designs GV-386; PC-DOS 3.3 and BASICA 3.3 on the Model 80 and PC AT; and Compaq DOS 3.1 and Compaq BASIC 3.11 on the Deskpro. The table contains the results of C language benchmarks (see "A Closer Look" by Richard Grehan in the September 1987 BYTE). All times are in seconds, except for the Dhrystone, which is in Dhrystones per second.

however. When data is written to memory, it must be written to both the cache RAM and the standard DRAM. As a result, data writes do not benefit from the cache; they run at the two-wait-state speed expected from the 120-ns DRAM. Also, if the processor needs to access data that is not currently stored in the cache, the system must perform a read from the DRAM as well as update the cache memory with the new data. This delay slows down reads from noncached memory to three wait states.

Of course, the entire principle of cache memory relies on the fact that software retains a certain frequency of reference; that is, memory that has been read recently is likely to be read again. Although such redundant data reads may not be common in well-designed software, caching applies to instruction fetches as well and can greatly improve the performance of tight programming loops.

The cache memory system in the GV-386 is tested as part of the system's power-on self-test. If the cache is found to be faulty, the system disables it and displays an error message; the system can still be operated normally. The cache can also be selectively enabled or disabled from the keyboard. This feature is designed to provide maximum compatibility with copy-protected or timing-sensitive software. All the tested software operated properly with the cache enabled.

The result of PC Designs' performance efforts is significant. Designing a cache memory system that really boosts execution speed of real-world applications is not easy, but PC Designs has succeeded. By using a rather large cache size, the GV-386 ensures a high ratio of cache hits and therefore a measurable benefit to the user. The BYTE Dhrystone benchmark rates the GV-386 at 4356 Dhrystones per second when the cache is enabled, a performance level that is 15 percent higher than the Compaq Deskpro 386 and 20 percent higher than the IBM PS/2 Model 80.

The value of the cache system is further demonstrated by the fact that the GV-386's Dhrystone performance drops to 3259 Dhrystones per second, well below the Compaq and PS/2 machines, when the cache memory system is disabled. The BASIC benchmarks also show an increase in performance with the cache enabled on the GV-386 as compared to the Compaq 386. All benchmark results shown on page 128 were produced with the 64K-byte cache enabled.

Hardware Features

The disk system on the reviewed machine consisted of a 1.2-megabyte floppy disk drive and a 40-megabyte hard disk drive. The hard disk was set up as two 20-megabyte DOS partitions through the use of the Priam disk driver software. The hard disk drive has an access time of 27.4 milliseconds and a data-transfer rate of 238.8K bytes per second (as measured by the CORETEST utility). The disk also showed a remarkably low track-to-track seek time of 4.1 ms. The Priam hard disk drive is a full-height drive and fills the entire left disk bay. The right disk bay has space for three half-height devices, all accessible from the front of the computer.

PC Designs GV-386 offers a keyboard- or DIP switch–selectable clock speed of 16 MHz or 8 MHz. When the clock speed is set at 8 MHz, the cache can still be enabled or disabled, but it makes no measurable difference in performance. The standard system RAM is fast enough to keep up with the 8-MHz speed.

Because disk-based copy-protection schemes are sensitive to clock speed, most other 80386 systems automatically slow the processor down to 8 MHz whenever the floppy disk drive is being accessed. The slowdown in system speed is unnoticeable since the floppy disk drive is the real limiting factor, and the compatibility gained is worth the trade-off. Unfortunately, the GV-386 slows down the processor for only the operations required by the DOS FORMAT and DISKCOPY programs, not for all floppy disk accesses. As a result, Lotus 1-2-3 Release 2 would start up only if the processor was slowed down to 8 MHz. Once the program started, however, the speed could be brought back up to 16 MHz.

The keyboard is a Maxi-Switch 101-key unit that uses a modified enhanced AT keyboard layout. Except for the L-shaped Enter key and backslash key to the left of the Backspace key, the keyboard is identical to the enhanced layout. The MaxiSwitch keyboard has a switch on the underside that lets you swap the positions of the Caps Lock and left Control keys. The GV-386 documentation claims that the Escape key can be moved, but it gives no instructions for accomplishing this. The keyboard feel is soft and quiet.

The system unit contains eight full-length expansion slots. To maintain compatibility with the majority of PC add-on cards, the I/O connectors are run at a clock speed of 8 MHz, independent of the processor speed. Since most add-on boards are not designed to run any faster than 8 MHz, this feature lets you purchase new hardware without worrying about compatibility.

Documentation

The *User's Guide and Operations Manual* supplied with the GV-386 is very in-

continued

teresting; it's unlike any comparable manual. Nearly 200 pages of information are presented in a somewhat disorganized manner. The preface covers the compatibility guarantee and warranty information. The first chapter of the manual is devoted to a well-written overview of the technical features of the 80386 processor. Although a note indicates that the chapter is of interest only to programmers, it is still a bit daunting to have the first page of chapter 1 contain such terms as "barrel shifter" and "prefetch queue."

The manual is clearly and concisely written. It appears to be written for the technically competent owner who is likely to buy a stripped-down machine and who feels comfortable adding disk drives, memory, and I/O boards. The manual includes a potpourri of technical information, supplying I/O address maps, tables of hard disk drive parameters, system-board switch settings, system error messages, and programming information. A comprehensive set of troubleshooting suggestions is provided to assist the user with most of the common setup and installation problems. Separate booklets are included for the Priam hard disk drive and the serial/parallel card.

Interspersed with this technical information are chapters that go into great detail describing keyboard commands in BASIC (a topic covered much better in the supplied GWBASIC manual) and a useful but slightly condescending tutorial for new users that is laid out in a question-and-answer format. Perhaps the best indication of the tone of the entire documentation set comes from the first page of the chapter entitled "For New Users." Although it states that "This chapter is written specifically for the person who has never used a personal computer," the first step in the orientation process is to remove the cover of the system unit so that you can look inside.

Compatibility

The GV-386 demonstrated excellent compatibility with the PC AT and with 80386-specific software. Lotus 1-2-3 version 2.01, Microsoft Word 3.0, the Microsoft Bus Mouse, Microsoft Windows version 1.03, and SideKick version 1.56A all ran correctly, except that Lotus 1-2-3 had to be started at 8 MHz or installed onto the hard disk. I also used Borland's Turbo C to test compatibility and system performance. The sample MicroCalc spreadsheet program supplied with Turbo C (7700 lines of C code) compiled in only 25 seconds, as opposed to 71 seconds required by the Compaq Deskpro 386.

The 80386 control software and operating systems I tested included Digital Research Concurrent DOS 386, PC-MOS/386, DESQview 2.0, Microsoft Windows/386, and a prerelease version of Microsoft OS/2 version 1.0. All worked without any problems.

Final Judgment

The system requires little technical skill to set up and use. In addition to the excellent warranty, PC Designs offers a toll-free help line to registered owners, so buyers can get ready assistance and information.

The PC Designs GV-386 is a compatible, high-speed personal computer. It is well-suited for any application that requires an 80386 processor or high processing speeds, ranking at or near the top of the 80386 range in all the benchmarks and tests. Its cache memory system is well-designed and produces a measurable increase in system throughput when compared to other 80386 systems. The GV-386 is a solid, robust machine; its designers paid attention to features and detail. Given the trend toward software with large memory requirements, the GV-386's ability to hold 4 megabytes of RAM on the motherboard is a valuable asset. ■

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The Toshiba T3100/20

Curtis Franklin Jr.

This laptop strikes a balance between portability and power

If an AT-class machine is part of your normal working environment, the Toshiba T3100/20 ($4699) can let you work with your usual tools when you are traveling. The T3100/20 is built around an Intel 80286 microprocessor running with one wait state at 8 MHz, switchable to 4 MHz. It comes standard with 640K bytes of 120-nanosecond RAM, which allows it to run software that runs on desktop ATs. Mass storage for the T3100/20 consists of a 720K-byte 3½-inch floppy disk drive and a 20-megabyte hard disk drive with a run-length-limited (RLL) controller. The size of the hard disk drive and the fact that it uses RLL encoding are the only differences between the T3100/20 and the older T3100 with a 10-megabyte hard disk drive.

A highly readable gas-plasma display tops the system. The display swings up to reveal a full-size 81-key keyboard with 10 function keys running across the top. A template (a blank is provided with the computer) can sit in a shallow well above the function keys. Above the template, the T3100/20 sports seven LED indicators for Power/Speed, disk use, external monitor, and keylocks. With RGB, parallel, and 9-pin serial ports lined up across the rear of the computer, the I/O of the T3100/20 is complete, especially for a laptop computer. The power supply is switchable between 115 and 230 volts.

Toshiba does not provide a battery pack for the T3100/20; the company has designed the system to operate from an AC power outlet. While this limits the use of the computer to times when an electrical outlet is handy, the convenience of a hard disk drive and an easily readable screen may be more important in some situations. [Editor's note: *For those who want a laptop that does not need an electrical umbilical cord, see the text box "The Toshiba 1000" on page 135.*]

All these AT-class features are packed into a compact 15-pound box, measuring approximately 12 by 3 by 14 inches, which comes standard with a padded nylon carrying case. The unit also comes with MS-DOS 3.2 and Lotus Metro, a desk accessory that provides a notepad, an appointment book, and a clipboard (among other features).

The unit I reviewed had an optional RAM upgrade ($1699), providing 2 megabytes of Expanded Memory Specification (EMS)-compatible RAM for programs that can make use of it, and an optional 1200-bit-per-second internal Hayes-compatible modem ($399). As reviewed, with added memory and modem, the system retails for $6797. Other options include an IBM PC-compatible five-slot expansion chassis ($999) and a 5¼-inch external floppy disk drive ($499). See page 134 for a complete list of options with prices.

The Power

When compared with other popular laptop computers, the Toshiba is at least twice as fast as most that operate at 4.77 MHz and is about 20 percent faster than the NEC MultiSpeed operating at 9.54 MHz. [Editor's note: *See "The NEC MultiSpeed" by David Satz in the September 1987 BYTE.*] You can easily switch the speed of the T3100/20's processor from the keyboard by using a three-key combination.

In addition to the advantage in calculation speed, the 3100/20's internal hard disk drive gives it an obvious advantage in disk access over floppy disk drive-based portables. For example, the spreadsheet used in the BYTE benchmarks took approximately 7 seconds to load from the MultiSpeed's floppy disk drive. The spreadsheet loaded from the 3100/20's hard disk drive in just over 1 second. In comparison to the PC AT's hard disk drive, the Toshiba's hard disk drive turns in a slightly better performance. The CORETEST gives the data transfer rate of the T3100/20's hard disk drive as 107.4K bytes per second, and the average seek time as 77.7 milliseconds.

The Toshiba stands out most not in calculation speed, which is impressive, but in clarity of display, which is amazing. Its resolution is 640 by 400 pixels, giving a

continued

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Toshiba T3100/20

Company
Toshiba America Inc.
Information Systems Division
9740 Irvine Blvd.
Irvine, CA 92718
(714) 538-3000

Size
12⅛ by 3 by 14⅛ inches; 15 pounds

Components
Processor: 16-bit 80286 running at 4 or 8 MHz
Memory: 640K bytes of RAM, expandable to 2.6 megabytes internally
Mass storage: One 720K-byte 3½-inch floppy disk drive and one 20-megabyte hard disk drive
Display: Red-orange 5¾- by 7½-inch flat gas-plasma with 25-line by 80-column text and 640- by 400-pixel monochrome graphics; also emulates IBM CGA graphics
Keyboard: 81 keys; 10 function keys; separate cursor keys; LED indicators for Caps Lock, Num Lock, and Scroll Lock keys
I/O interfaces: RS-232C 9-pin male connector; 25-pin female parallel connector; RGB video 9-pin female connector

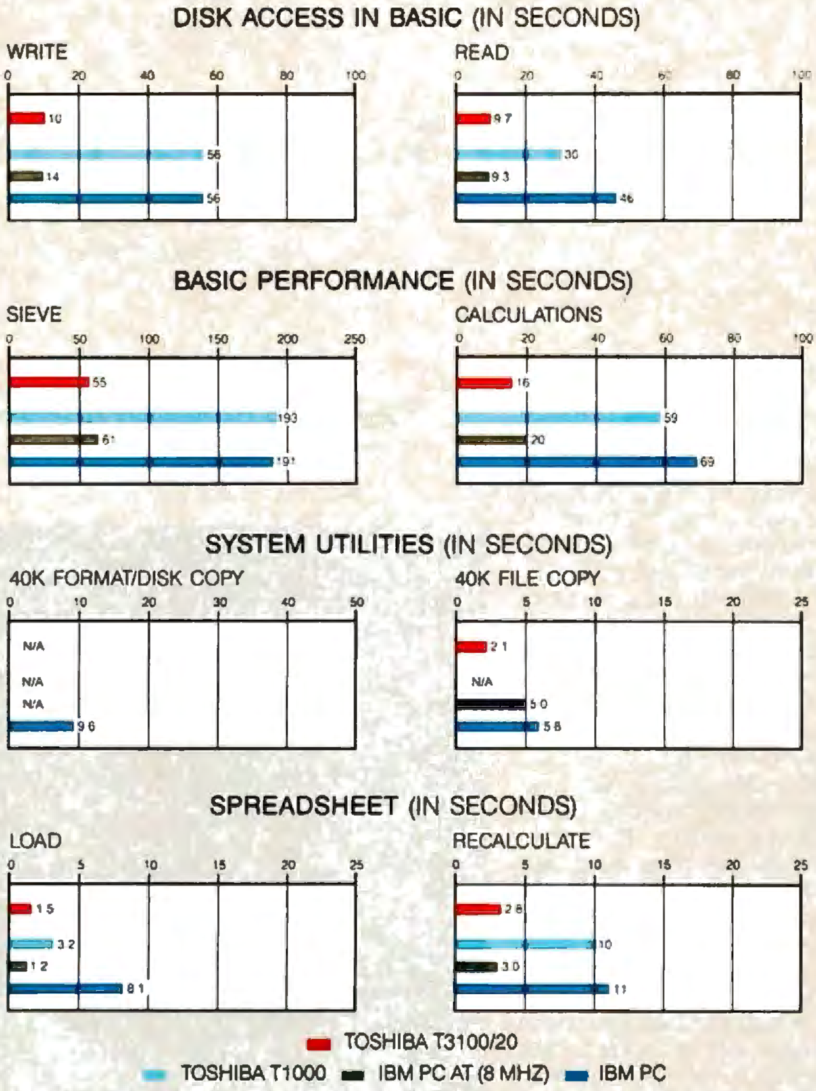
Software
MS-DOS version 3.2; Lotus Metro

Options
Internal 1200-bps modem: $399
5¼-inch external floppy disk drive: $499
Floppy link file-transfer board/cable: $199
15-key numeric keypad: $99
IBM PC-compatible five-slot expansion chassis: $999
Interface card for expansion chassis: $199
2-megabyte RAM upgrade: $1699

Documentation
168-page *Toshiba T3100 Portable Personal Computer User's Manual*

Price
$4699

Inquiry 887.


DISK ACCESS IN BASIC (IN SECONDS)

BASIC PERFORMANCE (IN SECONDS)

SYSTEM UTILITIES (IN SECONDS)

SPREADSHEET (IN SECONDS)

The Disk Access benchmarks write and then read a 64K-byte sequential text file to a hard disk. Sieve runs one iteration of the Sieve of Eratosthenes. Calculations performs 10,000 multiplication and division operations. The 40K Format/Disk Copy benchmark is not performed on computers with only one floppy disk drive. The 40K File Copy benchmark copies a 40K-byte file on the hard disk. The Spreadsheet tests load and recalculate a 25- by 25-cell Multiplan (1.06) spreadsheet. GWBASIC 2.1 was used for the disk access and basic performance tests. On the T3100/20 and the IBM PC AT, the disk access, file copy, and spreadsheet tests were performed from the hard disk drive; on the T1000 and the IBM PC, the disk access, file copy, and spreadsheet tests were performed from the floppy disk drives.

full 25 lines by 80 columns. The red-orange gas-plasma display is a large part of the T3100/20's appeal and usefulness, and there is no question that it is far more readable than even the best LCD screens. The character set of most LCDs is blocky at best. The characters on the Toshiba are sharp and easy to read, due in part to the screen's 1-to-1 aspect ratio. In addition, LCD displays tend to "ghost" as information scrolls down the screen, making it difficult to read information from the MS-DOS TYPE command, or from a bulletin board or on-line information service at 1200 bps. The T3100/20's screen showed no lag or ghosting and no flicker under fluorescent lights.

For all its virtues, however, the Toshiba's display has a serious drawback: The surface of the screen is smooth and highly reflective. In my office, the fluorescent lights overhead caused considerable glare. The screen reflected light from the overhead fixtures, the image of my clothing, and anyone who happened to walk into my office. All this activity in front of the characters on the screen was

Toshiba T1000

Company
Toshiba America Inc.
Information Systems Division
9740 Irvine Blvd.
Irvine, CA 92718
(714) 538-3000

Size
12⅛ by 2 by 11 inches; 6½ pounds

Components
Processor: 8-bit 80C88 running at 4.77 MHz
Memory: 512K bytes of RAM, expandable to 1.2 megabytes internally
Mass storage: One 720K-byte 3½-inch floppy disk drive
Display: Supertwist LCD with 25-line by 80-column text and 640- by 200-pixel monochrome graphics
Keyboard: 82 keys; 10 function keys; separate cursor keys
I/O interfaces: RS-232C 9-pin male connector; 25-pin female parallel connector; RGB video 9-pin female connector; RCA-type composite monochrome connector

Software
MS-DOS version 2.11 (in ROM);
Borland SideKick

Options

Internal 1200-bps modem	$399
Internal 768K-byte memory card	$549
External 5¼-inch floppy disk drive	$499
Automobile power adapter	$59
17-key numeric keypad	$99
Floppy Link	$199
Universal AC adapter (100 V to 264 V AC)	$59
Carrying case	$59
MS-DOS 3.2 (on floppy disks)	$75

Documentation
116-page *Toshiba T1000 Portable Personal Computer User's Manual*

Price
$1199

Inquiry 888.

The Toshiba T1000

The Toshiba T1000 ($1199) presents a nearly complete contrast to its bigger brother, the T3100/20. Where the T3100/20 trades elements of portability for power, the T1000's scales are tipped in favor of portable convenience. In fact, the T1000 is the first laptop I've seen that's better than the venerable Tandy model 100 for the type of work (writing on the road) for which I need a portable.

The T1000 (see photo A) is a full IBM PC-compatible computer in a compact 6½-pound package. In its standard configuration, the T1000 comes with an 80C88 running at 4.77 MHz, 512K bytes of 100-ns RAM, MS-DOS version 2.11 in ROM, a single 720K-byte 3½-inch floppy disk drive, a 25-line by 80-column supertwist LCD screen with a resolution of 640 by 200 pixels, a full-size 82-key keyboard, and video (RGB and composite), parallel, and serial ports.

Photo A: *The Toshiba T1000 is a 6½-pound 80C88-based laptop that operates from rechargeable batteries.*

The machine that I reviewed had the optional 1200-bps internal modem ($399). It also had a memory-expansion board with 768K bytes of 100-ns RAM ($549) that could be configured as a nonvolatile RAM disk. Like the T3100/20, the T1000 is covered by a one-year warranty, with an extended two-year warranty available at extra cost. For a complete list of the available options and their prices, see the box at left.

Without the RAM disk, the T1000 harks back to the olden days of personal computing, when disk space was precious and users often had to spend a considerable amount of time swapping disks with files back and forth in laborious "housecleaning." With the RAM disk in place, the T1000 becomes the most portable IBM PC-compatible computer I've ever used, free not only from the power cord but also from the extra baggage of numerous floppy disks.

After setting up the RAM disk (a one-time, 1-minute procedure), I installed the XyWrite III Plus word processor, the communications program PC-Talk, and Lotus 1-2-3 on the RAM disk. There was still plenty of room left over for files that I needed to work on, and working completely from the RAM disk was both much faster and less of a battery drain than working from the floppy disk drive.

As with any battery-powered device, battery life is an important issue for the T1000. The nickel-cadmium battery on the computer lasted from 3 to 5 hours before the low-battery indicator was activated; the exact time depended on how much disk activity had taken place. According to Toshiba, the nonvolatile RAM is safe as long as any charge remains in the battery. One user's RAM disk was still intact 2 days after the low-power light came on; however, I would recommend that you recharge the battery as soon as possible after the light appears.

Of course, the T1000 is no match for the T3100/20 in computing speed, but then, a PC is no match for an AT. Life is filled with decisions and compromises. In this case, the T1000 trades bulk, expandability, and speed for functionality and tremendous portability at a reasonable price.

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more than a little distracting. The screen angle is adjustable across a wide range, but no angle (at least, no angle that left the screen visible from my chair) could eliminate the glare. In fairness, my office lighting is tough on displays, and the sparse incandescent lighting found in most hotel rooms is perfect for the gas-plasma display. The problem with glare also turns up with the screen on the Compaq Portable III, which has a gas-plasma screen that is very similar to the Toshiba T3100/20's.

Using the Power

I ran a number of programs on the T3100/20, including Lotus 1-2-3 Release 2, XyWrite III Plus, WordStar 4.0, Pibterm 3.2.5, PC-Talk III, GWBASIC 2.1, and Reflex version 1. All ran quite well. The only problems arose when CGA graphics were displayed on the gas-plasma screen in such a way that the "colors" were indistinguishable from one another.

As mentioned earlier, the computer comes packaged with MS-DOS version

continued

3.2 and Lotus Metro. As a longtime user of SideKick, I was impressed by Metro's ease of use and the flexibility and power of the various desk accessories.

The T3100/20's keyboard is a solid, middle-of-the road affair. It does not offer the tactile feedback of the IBM keyboards or an audible key click, but it is far superior to some of the mushy keyboards sold with clones. The lack of a separate numeric keypad may be important to some users, but I found the layout easy to use and work with. An optional numeric keypad is available for $99 for those who need one.

The Toshiba T3100 Portable Personal Computer User's Manual, included with the system, is thorough, clearly written, and well organized. A one-year warranty is standard on all components; a two-year warranty on all components is available at additional cost.

The Beauty and the Blemishes

The T3100/20's predecessor, the T3100, achieved the rank of status symbol among many of America's regular business travelers. A major factor in the status of the T3100, and of the T3100/20 as well, is the laptops' appearance. These machines, with their angular, sleek, matte-gray plastic cases, conjure Eurotech visions of an elegant office. The only part of the T3100/20 that seems out of place is its handle.

It's not that the handle is useless; it makes a dandy stand to bring the machine and its keyboard to the proper angle for typing. The problem is that the handle might suggest that the computer can be carried around without its case. From desk to desk in an office, this is OK, but venturing outside with a bare T3100/20 would be a major mistake. For one thing, there's no place to put the power cable. For another, the case has holes in it. There are cooling slots in the back of the display panel and an opening for the cooling fan in the rear of the computer, thus affording lots of opportunities for water and assorted detritus to get in and wreak havoc on this beautiful and rather expensive machine.

Another drawback of the T3100/20 is its cooling fan. Obviously, in a computer based on the components used by this machine, forced-air cooling is a must. Unfortunately, the fan in the Toshiba makes a sound at a pitch and volume optimal for making my teeth itch. The noise is made worse by an apparent interaction with the hard disk drive: Disk activity causes a definite change in the noise pitch of the fan, in addition to the normal sounds of disk access.

The third problem has to do with the power consumption of the T3100/20, which is high enough to require connection to an AC power outlet. I didn't think the power requirements would be a severe handicap; I simply planned my work for places where I could expect to find an electrical outlet. I didn't reckon on the security forces at LaGuardia Airport. Their hand-check of a computer is simple: Turn it on, and if the screen does computer-like stuff, it's a computer. We searched the X-ray machine for an outlet while the passengers for the 6:00 shuttle stacked up behind me. This episode aside, I found that a portable computer is most useful when it can be used in a car, on a plane, or in an airport waiting area. All this is sacrificed with the Toshiba T3100/20.

A Stiff Competitor

The Toshiba T3100/20 is certainly at or near the top of the portable computer field in both price and performance. I expect it to compete directly with two other computers on the market: the NEC MultiSpeed, which runs faster than the crowd of 8088-based portables, and the Compaq Portable III, which uses an 80286 CPU clocked at 12 MHz. The T3100/20's hard disk drive speeds operations and reduces the number of floppy disks in your carrying case. In sheer screen readability, the Toshiba comes out well on top. On the other hand, the MultiSpeed frees you from dependence on an AC power supply—and does it for $2195, a considerably lower price than that of the T3100/20.

The Compaq Portable III shares many features with the Toshiba T3100/20. They both have 80286 CPUs, internal hard disk drives, and gas-plasma displays. The price of a Portable III with a 20-megabyte hard disk drive is $4999, which is about the same as that of the T3100/20, and it too has to be plugged into an electrical outlet.

The Compaq's advantages include its capability (through a piggyback unit) to use full-size AT add-in boards, and its speed, from a 12-MHz system clock. The Toshiba gets the nod for pure portability: The Compaq is 5 pounds heavier, and its lunch-box configuration is more cumbersome than the Toshiba's flat shape. Lastly, the Toshiba is a simply a better-looking computer than the Portable III. This didn't make my spreadsheets recalculate faster or replace the AC power cord, but it did please my sense of aesthetics. [Editor's note: *For more information on the Compaq Portable III, see the review "Compaq's new Carry-on" by John Unger in the May 1987 BYTE.*]

The Toshiba T3100/20 is expensive, but for the money you get 80286 power and greater portability than any other AT compatible. You can buy computers that are more portable, and you can buy faster computers, each for less money than the Toshiba. But if you need speed and portability in one package, the Toshiba T3100/20 should be at the top of your list. ■

VIEWS FROM BIX: T3100/20 and T1000

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laptops/reviews #4, from Tom Moran.

I do software development and must occasionally visit distant customers. I've taken the T3100/20 to Europe and Asia. With the hard disk, I can take along essentially a duplicate software development environment and make any changes, or show any demonstrations, on the spot. The disk can also be a "data briefcase" for taking large files to and fro. My customers and my hotels always have electricity, and the plane or airport between customers is the last place I need to use the computer. The T3100/20 often draws admiring and curious crowds. I think that has had a positive effect on my meetings.

---

laptops/reviews #5, from Richard Berry.

I am using a T3100/20. The fan pitch is actually a high-voltage leak from the power supply, as near as I can tell. I had a previous T3100 that sounded like nails on a chalkboard. It appears that the stronger the power draw, the quieter the noise is. To demonstrate this, close your screen with the machine on. It should be quite strong at that point. I simply took my machine back and had it replaced. My present machine has no noise at all. Since Toshiba offers an excellent service policy, you may wish to send it back to be repaired. My only experience with service has been with the 20-meg upgrade through the DYN service network, but I was extremely impressed, sending in my machine Monday night and receiving the upgraded machine Wednesday morning. As I said, the screeching is not unknown among the T3100s, but it isn't a necessity to operating the machine.

---

laptops/reviews #6, from Jean U. Thoma.

If the Toshiba T1000 had a seat for an 8087 coprocessor (which could take the physical space of the modem), it would reach a vast market in universities. Without it, engineering software runs 3 times slower or not at all, so I am unable to recommend it to students. I like the T1000 for portability and memory, but I sorely miss the coprocessor. I use only laptops, at home and on or off campus, and do not need batteries since I always find an electric outlet.

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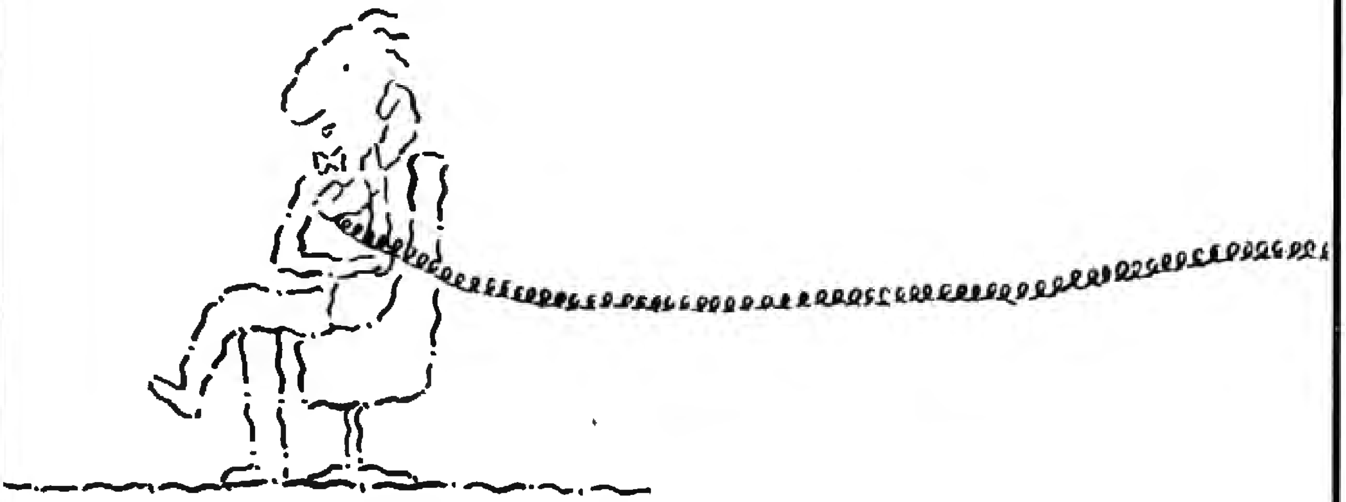

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The Symmetric 375

Patrick Wood

> *Symmetric's new system brings Berkeley Unix to a portable box*

The Symmetric 375 computer is a small, portable Berkeley Standard Distribution (BSD) 4.2 Unix system loaded with many useful features. Its small size (about that of a Compaq Portable II) and weight (22 pounds) make it the only portable BSD Unix system I know of. The list price of the system reviewed here (which includes a bundled terminal and printer) is $8995, but Symmetric discounts the price to $8,095 if it is prepaid.

System Hardware

The Symmetric uses a National Semiconductor NS32016 processor running at 11 megahertz with no wait states and a 64-bit NS32081 floating-point processor. The reviewed system came with 2 megabytes of 150-nanosecond dynamic RAM (expandable to 8 megabytes) and an 85-megabyte (unformatted size) hard disk drive. Due to a shortage of the 60-megabyte standard SCSI cassette tape drives, the review system came equipped with a 1-megabyte floppy disk drive.

The Symmetric has several ports on the back, including four serial ports that can be set from 50 bits per second to 38.4K bps, a Centronics parallel port, a 10-megabit "thick" Ethernet port, a SCSI port with an asynchronous transfer rate of 1 megabyte per second, an ST506 hard disk drive port, and a floppy disk drive port. The system also has a Reset button and an LED digital display located in the back. The digital display shows the current interrupt level, and you know the system has hung if the number doesn't change.

The hard disk drive is fairly fast, with a 28-millisecond average access time. The floppy disk drive can read both 40- and 80-track floppy disks in a number of configurations; it read a Xenix tar disk (made on a 360K-byte floppy disk) with no trouble. The system comes with two commands for handling MS-DOS disks: `msdir` and `msget`. I was able to copy the BYTE benchmark files from MS-DOS formatted floppy disks with no problems.

The inside of the Symmetric is rather unexciting: There are no slots for expansion cards, and most of the circuitry is on the main board, with a few cables leading off to peripherals and a power supply.

System Software

The Symmetric runs a "plain vanilla" Berkeley 4.2 BSD Unix. It supports demand paging to disk with a 16-megabyte virtual memory address space for each process. The standard Berkeley features, such as job control and the new terminal driver, performed flawlessly, as did vi and the C shell. The Bourne shell was the standard Seventh Edition version. The line-printer spooler worked fine (with a serial printer), and none of the system utilities I used showed any departure from a standard BSD system.

I ported several thousand lines of C code from a variety of sources designed to run on Berkeley Unix, and all of it compiled and ran without change, except for a problem with floating-point numbers (discussed below). Some code designed to run on System V and Xenix V ported over, but some of these programs simply wouldn't run at all. This is hardly surprising, given the differences between these versions of Unix. Symmetric says that, by the time you read this, a new version of the operating system will be available that supports both BSD 4.3 and the System V Interface Definition (SVID), the standard by which Unix systems are compared to AT&T's System V.

The Symmetric 375 is shipped with eight standard languages: C, FORTRAN-77, Pascal, BASIC, APL, assembly language, LISP, and ICON. Of these, I evaluated only the C compiler. The review system also came loaded with optional software, including TEX, Ingres, EMACS, SPICE, TOP, GDB, Q-CALC, the Symmetrix Kernel Configuration Package, and a window manager for

continued

Patrick Wood (Pipeline Associates Inc., 49 Manito Ave., Lake Hiawatha, NJ 07034) is the coauthor of four books on Unix and C and is consulting editor for the Sams Unix System Library. He is also vice president of Pipeline Associates Inc., a company specializing in Unix and C training and consulting. He can be contacted on BIX as "patwood."

Symmetric 375

Type
Portable 4.2/4.3 BSD Unix system

Company
Symmetric Computer Systems
40487 Encyclopedia Circle
Fremont, CA 94538
(415) 651-6090

Size
14 by 6 by 12 inches; 22 pounds

Components
Processor: 11-MHz National Semiconductor 32-/16-bit NS32016, with NS32081 floating-point unit and NS32082 memory management unit
Memory: 2 megabytes of zero-wait-state RAM, expandable to 8 megabytes; 8K-byte ROM start-up program
Mass storage: 85-megabyte (unformatted size) internal hard disk drive; internal 60-megabyte SCSI cassette tape drive
Ports: Four serial RS-232C ports, configured as DCE and speed-selectable from 50 bps through 38.4K bps; Centronics-compatible parallel port; 10-megabit Ethernet with TCP/IP support; external Shugart-style floppy disk interface; external SCSI interface; external ST506 hard disk interface
Other: DEC VT-52-/VT-100-/VT-220-compatible Esprit Opus 220 terminal with amber screen, detached keyboard, Epson-compatible printer, and clock/calendar with battery backup

Software
Berkeley Unix 4.2, FORTRAN-77, assembly language, Pascal, LISP, ICON, BASIC, APL, and C

Options

8 megabytes of RAM:	$2200
170-megabyte hard disk drive:	$1900
380-megabyte hard disk drive:	$3200
760-megabyte hard disk drive:	$4500
Q-CALC:	$750
University Ingres:	$20
EMACS:	$20
SPICE:	$15
TOP:	$15
GDB:	$20
Kernel Configuration Package:	$100
TEX:	Contact company for availability

Documentation
The 375 Owner's Manual, 232 pages

Price
Symmetric 375 with terminal and printer: $8995 ($8095 prepaid)
Symmetric 375 low-end system with 50-megabyte hard disk drive, 1-megabyte 5¼-inch floppy disk drive and without SCSI port and Ethernet port: $5550 ($4995 prepaid)

Inquiry 886.

Apple Macintosh computers. Of these, I tested TEX, EMACS, Q-CALC, and GDB. All performed well. In all, 30 megabytes of software was supplied with the system, some of it in source code form. With the exception of Q-CALC and the Kernel Configuration Package, the optional software is available on floppy disks for a copying fee of either $15 or $20 per program. Software distribution on 50-megabyte TEAC cassette tapes is available at $15.50 per tape.

The C compiler on the Symmetric seems slow because it spends a lot of its time in the optimization phase and produces tight code. Symmetric claims that its C compiler is "highly compatible with Berkeley VAX C" and that "all data types except `float` and `double` are bitwise identical to VAX convention." The `float` and `double` data types follow the IEEE 754 standard floating-point format, to support the NS32081 math chip. However, the compiler's floating-point compatibility leaves much to be desired. For example, the code

```
struct obj {
        float x;
        float y;
} obj;

test (p1, p2)
struct obj *p1, *p2;
{
        float y;

        y = p2->y;
        y = y * (p2->y - p1->y);
         /* dies on this line */
}
```

produces this error message:

```
"test.c", line 12: compiler error:
expression causes compiler loop:
try simplifying
```

This code compiles properly on a VAX running BSD 4.3, Xenix V, and Borland's Turbo C compiler. It also compiles properly on the Symmetric if the structure elements are anything but `float` or `double`, or if the pointers `p1` and p2 are static.

GDB, a symbolic source-code debugger, was supplied with this system. I used it to debug a couple of programs that I had difficulty porting. I was able to find simple bugs with GDB's extensive on-line help facilities.

The Symmetrix Kernel Configuration Package allows the system administrator to customize the configuration of the operating system. It lets you add or remove device drivers, thus changing the amount of memory required by the kernel.

The Symmetric comes with a stripped version of Donald Knuth's TEX text-formatting system (the full font package is around 300 megabytes). It doesn't include all the TEX font files, but it does include all the files for 300-dot-per-inch printers in sizes from 5 to 12 points, as well as 10-point fonts for printers of other resolutions. This represents an intelligent compromise: 300-dpi laser printers abound, and they are good devices for getting reasonable-looking output from TEX.

Communications Software

The Symmetric is shipped with a couple of networking packages: UUCP, the standard Unix networking software, and TCP/IP, the standard BSD Ethernet software, which includes commands for copying files to and from remote systems, remote command execution, and remote log-in. It also comes with SL/IP, a serial networking package.

The Berkeley version of UUCP that comes with the system had some problems communicating with my Xenix system at 9600 bps. I could send data from the Symmetric to my Xenix system (an AT&T PC 6300 running Xenix V) without any problems; however, data sent the other way caused UUCP's communications program `uucico` to fail. At 9600 bps, some files did make it through, but the effective transmission rate was around 400 bytes per second (probably due to the number of packet retries).

Communicating with other systems over the modem worked properly. The program `tip`, used to connect to the modem for logging into remote systems, worked well, and the `uucico` program transferred and received files with no problems. The only drawback of this system is that it has trouble dropping the DTR line, causing the modem to remain connected to some systems. Although there may be a way to fix this, I couldn't determine how from the documentation provided.

I didn't test the TCP/IP or SL/IP software because I didn't have access to an Ethernet network or another system that could run SL/IP; however, the `localhost` command (used to test the local part of TCP/IP via cooperating processes) worked fine.

Terminal, Printer, and Documentation

The Symmetric 375 is bundled with a VT-220–compatible Esprit Opus 220 terminal with a detached keyboard and an amber screen. The keyboard contains the full ASCII character set, an 18-key numeric keypad on the right, 18 programmable function keys across the top, and

continued

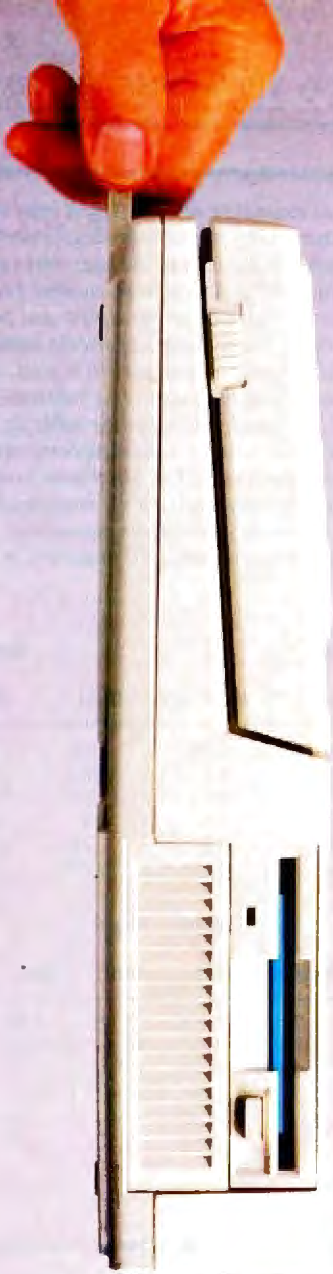

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Table 1: *Unix benchmarks. User time is time spent executing nonprivileged instructions. System time is time spent executing privileged (kernel) commands (i.e., system calls) plus system-level overhead (e.g., context switching between processes). Real 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 megabytes 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.*

Unix benchmarks

		Pipe			System Call			Function Call
Machine	**Unix version**	**Real**	**User**	**System**	**Real**	**User**	**System**	**Delta user**
Symmetric 375	4.2 BSD	13.53	0.01	6.75	6.98	1.13	5.70	0.90
IBM PC XT	PC/IX	16.6	0.1	7.6	39.8	2.9	35.6	4.7
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

	Sieve			Write	Read	Shell			Loop		
	Real	**User**	**System**	**Real**	**Real**	**Real**	**User**	**System**	**Real**	**User**	**System**
Symmetric 375	2.73	2.58	0.06	2.25	5.38	4.66	0.26	1.96	8.18	8.01	0.08
IBM PC XT	8.2	7.8	0.3	11.6	20.7	8.5	1.1	3.2	32.2	31.5	0.3
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):

		Number of concurrent processes					
Machine	**Unix version**	**1**	**2**	**3**	**4**	**5**	**6**
Symmetric 375	4.2 BSD	4.65	6.42	8.15	9.80	11.61	13.29
IBM PC XT	PC/IX	10.6	23.4	42.8	74.1	84.2	130.7
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

Table 2: *The BYTE C language benchmarks. (For more information, see "A Closer Look" by Richard Grehan in the September 1987 BYTE.) All times are in seconds, except for the Dhrystone, which is in Dhrystones per second. The Dhrystone version is 1.1, using no registers, for 50,000 iterations.*

Test	**Symmetric 11-MHz 32081 FPU**	**IBM PC AT 8-MHz 80287**	**Model 80 16-MHz 80387**	**AT&T PC 6300 No FPU**	**AT&T Unix PC No FPU**	**Sun-3/160 16-MHz 68881**	**VAX 8600**
Dhrystone*	793	1590	3626	561.5	980	3333	8888.67
Fibonacci	206.16	126.22	57.26	356.45	185.4	44.13	33.40
Float	4.57	10.98	1.62	764.50	39.1	14.67	0.40
Savage	103.39	37.30	9.49	6607.00	1009.0	205.30	5.35
Sieve	46.19	24.60	6.45	59.03	41.0	11.23	4.55
Sort	47.08	43.17	7.74	105.42	51.9	12.07	4.27

* Higher figures denote faster performance.

11 cursor keys. It consumes under 50 watts of power.

I'm used to an IBM PC keyboard layout, and I found the layout of this keyboard almost unusable. For example, the Shift Lock key is on the left-hand side between the *A* and the Control key; the > and < symbols are on a special key on the left-hand side, to the left of the Shift key; and the | symbol is on a special key to the right of the Return key. These keys are used extensively on Unix systems, so I had trouble getting used to the layout. Since the Opus 220 lists for $675, I would suggest getting a terminal you're comfortable with and asking Symmetric for a credit.

The printer was unavailable for review. However, considering the low cost of today's printers and the fact that many people already have one or two, it seems odd to bundle one in with this system. Again, I see no reason to get the printer with the system and suggest that you ask Symmetric for a credit for it or that you settle for the low-end version of the system, which doesn't include the printer or the terminal.

No printed documentation was available when the system was first sent to me. Symmetric explained that the documentation was being revised and reprinted. However, the standard Berkeley Unix manual pages were on the computer, so I was able to navigate my way through the system. A few weeks later, I received *The 375 Owner's Manual*, which includes schematics of the CPU board but lacks an index and is very light on introductory material.

Performance and Problems

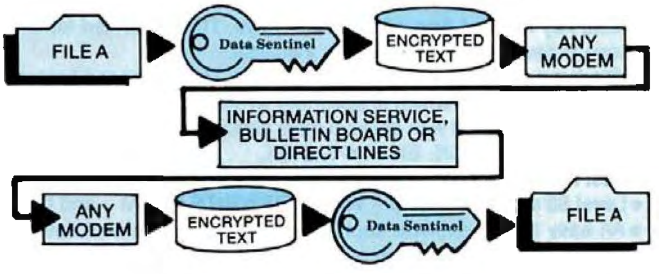
I ran the BYTE Unix benchmarks (see "Benchmarking Unix Systems" by David F. Hinnant in the August 1984 BYTE) and the BYTE 32-bit C benchmarks (see "A Closer Look" by Richard Grehan in the September 1987 BYTE) on the Symmetric 375, an IBM PC XT running PC/IX, an AT&T PC 6300 running Xenix V, an AT&T Unix PC running System V, a Sun-3/160 running Sun BSD Unix 4.2 release 3.2, and a VAX 8600 running BSD 4.3 (see tables 1 and 2).

As the Unix benchmarks show, the Symmetric's performance is roughly three times that of the PC 6300 and is about the same as the Unix PC's, except for the disk I/O and the multitasking benchmark (the Unix PC was tested with 1 megabyte of memory and a slower disk drive). The C benchmarks show that the Symmetric tested slightly slower than the AT&T Unix PC, except in the floating-point benchmarks, where the Symmetric's floating-point unit (FPU) gave it an advantage. The Symmetric has less raw processing power than an 8-MHz IBM PC AT and isn't nearly as fast as the Sun. Ken McDonell's Monash benchmarks, which are more extensive workload-based Unix benchmarks, show the Symmetric running about 40 percent slower than a DEC MicroVAX II and a Sun-3/50 and about 60 percent slower than a Sun-3/160.

The Centronics port failed to work with my Okimate 20 printer with a parallel-port PC personality module. Although I tried a number of tests, technical support was unable to help me get the printer to work with the system. [Editor's note: *We attempted to use a Citizen Model 120D printer and experienced the same problem. We contacted Symmetric's technical support, and after we conducted several tests, technical support concluded that something had gone wrong with the handshake electronics to the printer port for the review system.*]

Under normal use, the system didn't crash. However, it did crash when I dis-

continued



Circle 260 on Reader Service Card

connected the cables while troubleshooting the Centronics printer connections. The system also crashed when I tipped the unit 45 degrees forward and caused the disk to mistrack. The fourth time I did this, the system crashed and refused to boot properly. A call to technical support informed me that tipping the unit had affected the alignment of the disk's read/write head and subsequently had damaged a boot file. Technical support was able to talk me through booting from the floppy disk drive, checking the hard disk drive, restoring the damaged files, and getting the system operational again.

The person I dealt with from Symmetric's technical support was quite knowledgeable. Also, to my surprise, I wasn't bounced around to several people to find one who could fix my problem; instead, the first person I spoke with in technical support helped me with both the disk and printer problems.

Portable BSD Unix, But at a Price

The Symmetric 375 is a nice system for people who need a portable Unix system. Its portability is hampered, however, by the fact that you need a separate terminal to use it (unlike, say, a Compaq Portable). The many languages provided with the system make it ideal for program development for Berkeley Unix. It performed well, but the disk can't be subjected to much stress while running. The system is fast, but not as fast as the current generation of 80286/80386 PC clones. Its lack of high-resolution bit-mapped graphics puts it at a disadvantage with respect to Suns and VAXstations.

The real question for the prospective buyer of this system is whether its features justify its price compared to other small Unix systems. For about the same price, you can get a similarly configured Sun-3/50 or VAXstation 2000 running Berkeley Unix with an Ethernet port. For around $5000, you can get a similarly configured 80386-based PC clone, without an Ethernet port, that runs Xenix V or Unix System V Release 3 and can easily outperform the Symmetric. The PC clone can also run multiple MS-DOS programs as processes under Unix. Note that all these other systems have bit-mapped displays, while the Symmetric uses an ASCII terminal.

If you're looking for a portable Berkeley Unix system, this is it. If you're looking for a portable software development system with a wide choice of programming languages, the Symmetric looks good. However, if you're looking for just a portable Unix system, you may want to look at the Compaq Portable III or one of the small 80386-based portables starting to come out now. ■

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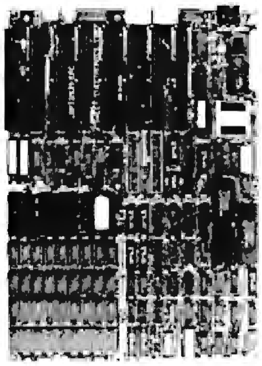

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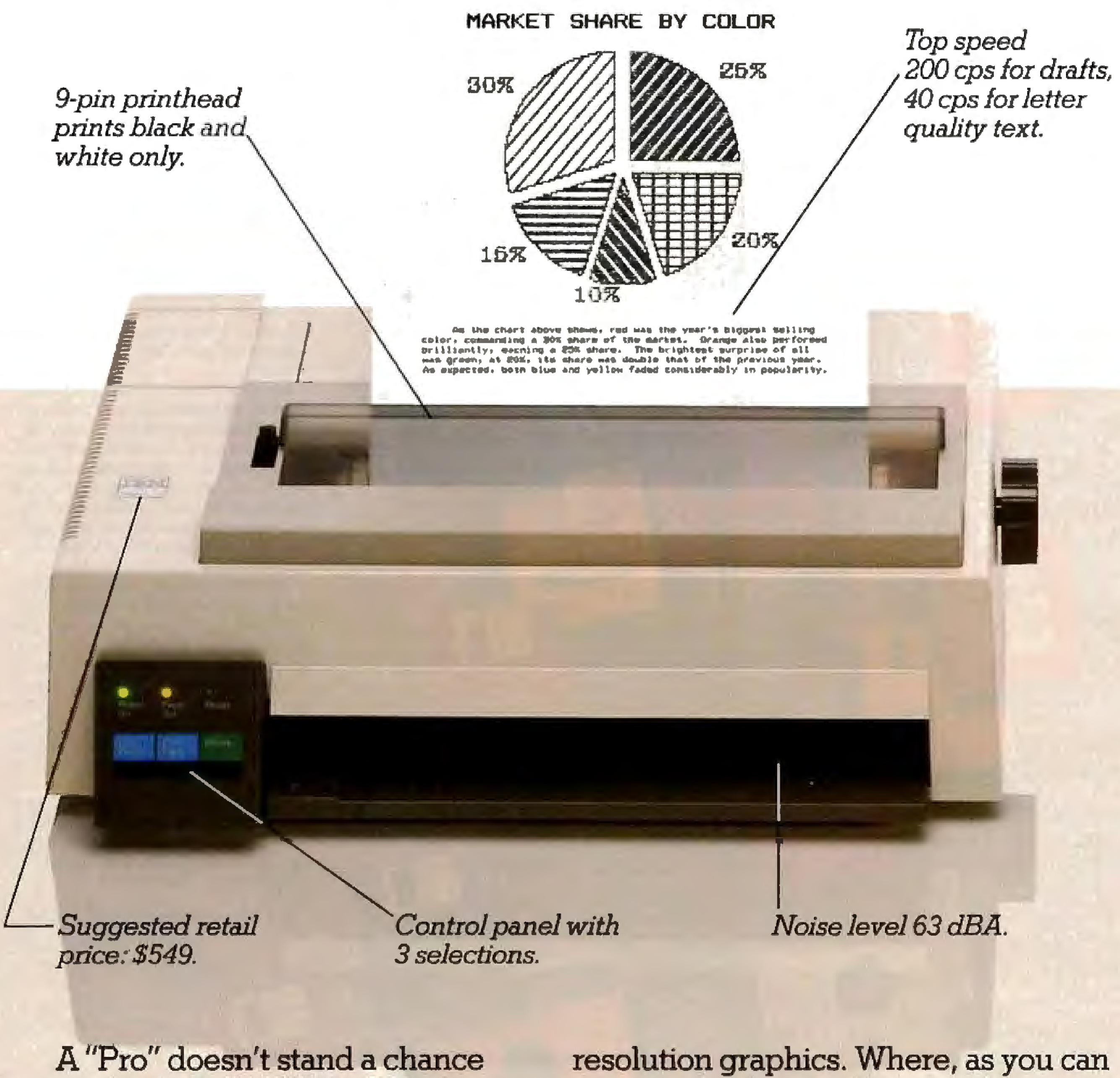
HOW TO B



As the chart above shows, red was the year's biggest selling color, commanding a 30% share of the market. Orange also performed brilliantly, earning a 25% share. The brightest surprise of all was green, at 20%. its share was double that of the previous year. As expected, both blue and yellow faded considerably in popularity.

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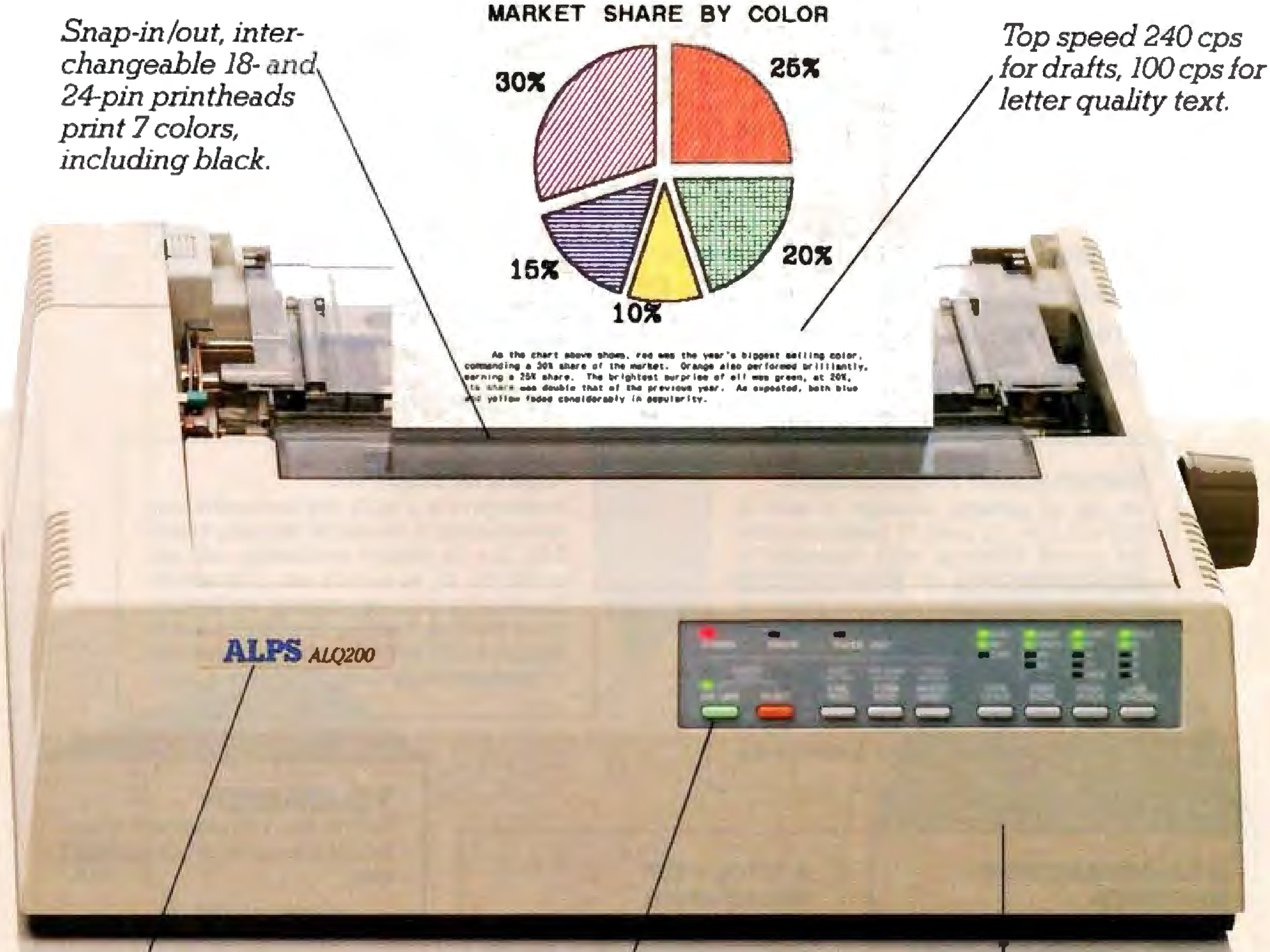

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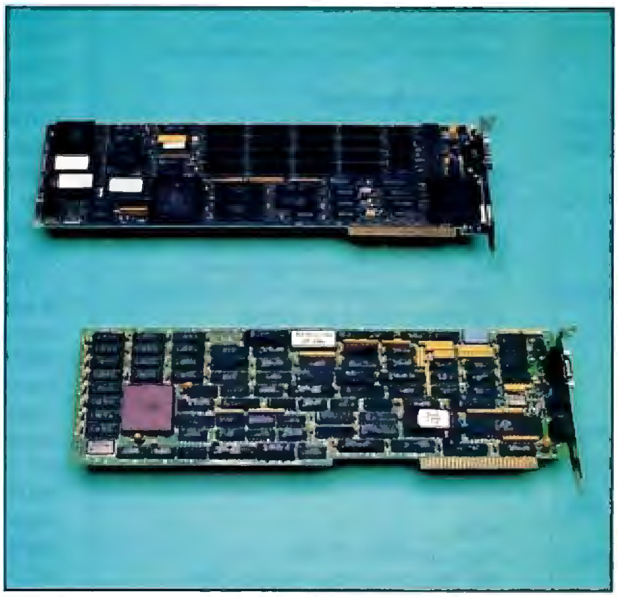
High-Performance Graphics Boards

Bill Nicholls

We can no longer expect the main system processor to adequately handle ever-more-complex applications and, at the same time, maintain high-performance graphics on displays with more and more pixels. To relieve the graphics bottleneck, two new high-performance graphics boards for IBM PC, AT, and compatible systems are now available: Vermont Microsystems' Image Manager 640 (VMI 640) and the Verticom 2Page Display (VTP) system. The VMI 640 uses the TI 34010 graphics processor chip, while the VTP incorporates the Intel 82786 graphics processor chip (see the text box "Graphics Coprocessors" on page 154).

Both boards emulate the CGA and provide their own high-resolution modes and custom drivers for a number of software products (see the box on page 152 for details). They also differ radically from each other in several ways. The VMI 640 is a medium-high-resolution (640 by 480 by 256 pixels) color board for MultiSync-type displays (an EGA monitor does not have the required bandwidth), particularly useful for CAD applications. The VTP is a high-resolution (1280 by 960 pixels) monochrome board, with a 19-inch monitor included.

Separate graphics processors provide high-speed, high-resolution displays



The Image Manager 640 (top) and Verticom 2Page (bottom) graphics boards.

To give you an idea of how these boards differ from current display controllers, let's compare a CGA display controller with the new designs. The first thing that jumps out at you (besides the prices—$1695 for the VMI 640 and $1295 for the VTP) is the amount of memory included on the new boards. The display on a CGA board has only 32K bytes of RAM. The VMI 640 board has 128K bytes of ROM (twice that of an AT), 140K bytes of RAM for the processor, and 300K bytes of RAM for the display. The VTP board has 512K bytes of RAM for the display and 8K bytes of ROM.

VMI 640

My VMI 640 full-length board arrived well protected with a 2-inch three-ring binder. The documentation is well organized and clear, has plenty of diagrams, makes no assumptions about what you know, and has a competent table of contents and index. It describes the installation process and gives detailed instructions. The board requires very few jumper adjustments, and I had no problem installing the VMI 640, which requires a long expansion slot in an IBM PC, XT, AT, or compatible computer. I was particularly happy to discover that the VMI could operate in dual-monitor fashion with an existing display (i.e., you can use a standard graphics adapter—CGA, EGA, or Hercules—with the VMI in the same system simultaneously).

The VMI's CGA emulation is top-notch. It uses a custom VLSI chip to perform the emulation, and the CGA character set takes advantage of the display's 400 scan lines to replace the 8- by 8-pixel CGA font with an 8- by 16-pixel one. This is a CGA that you could work with all day without getting eyestrain. The VMI's CGA-emulation speed is faster than the IBM CGA board and is compatible with all the software I tested. (The VMI even ran in my Sanyo 885; that and the IBM CGA board were the only ones that would.)

The VMI 640 also has a well-designed PGL (Professional Graphics Language) software package and can emulate the IBM Professional Graphics Controller (PGC). This package includes a language manual and reference card, a special MS-DOS program that you can use to interactively write commands that are immediately executed on the screen, and C language bindings for professional software development.

The high-resolution performance of the VMI under Microsoft Windows varied from slow to glacial. Scroll times were two to three and a half times that in the CGA mode, and the delay increased

continued

Bill Nicholls received his B.S. in physics from Notre Dame University and is the owner of BGW Systems Inc. He can be contacted at BGW Systems Inc., 16714 Meridian S, Suite 200, Puyallup, WA 98373, or on BIX as "billn."

Image Manager 640

Company
Vermont Microsystems Inc.
11 Tigan St.
P.O. Box 236
Winooski, VT 05404
(802) 655-2860

Size
Standard XT full-length expansion card: 13⅓ by 4 inches

Features
640- by 480- by 256-color resolution; screen refresh is 60 hertz noninterlaced, 30.48 kilohertz horizontal; 16-million-color palette; 300K-byte on-board graphics RAM arranged in 8 bit planes; uses the TI 34010 graphics processor running at 6 MHz with 128K bytes of processor ROM and 140K bytes of processor RAM; supports the complete set of PGL commands; emulates CGA, IBM PGC, VMI VM-8820, and Image Manager 1024. Support for applications software includes: Ansys, Anvil-1000MD, AutoCAD, CADKEY, CADvance, DataCAD 2 and 3, Design Board Professional, GM 1000, Personal Designer, Pro-Series, Redliner, TGRAF-05 and -07, Uniras Series, and VersaCAD. Board consumes 5 volts DC at 2 amps typical.

Hardware Required
IBM PC, XT, AT, RT, or true compatible

Software Required
MS-DOS 2.1 or higher

Documentation
Three-ring binder with two 5½- by 8½-inch typset manuals: *Installation and Usage Guide*, 65 pages plus introduction, appendix, and index; and *Professional Graphics Language Version 2.0*, 170 pages plus appendix and index

Price
$1695

Inquiry 889.

Verticom 2Page Display System

Company
Verticom
545 Weddell Dr.
Sunnyvale, CA 94089
(800) 433-5760
(408) 747-1222 in California

Size
Standard XT expansion card: 4⅕ by 13⅓ inches

Features
Monochrome display with 1280- by 960-pixel resolution; screen refresh is 64 Hz noninterlaced, with 63.65 KHz horizontal; 512K bytes of on-board graphics RAM; incorporates a 20-MHz Intel 82786 graphics coprocessor with 8K bytes of processor ROM; provides CGA emulation and a Microsoft InPort Device Interface. Support for applications software includes Microsoft Windows, GEM, AutoCAD ADI, Aldus PageMaker, and Ventura Publisher. Controller consumes 5 volts at 3 amps maximum.

Hardware Required
IBM PC, XT, AT, or compatible

Software Required
MS-DOS 2.1 or higher

Options
Programmer's Guide and System Toolkit, free if requested with purchase of VTP system; $20 if purchased separately

Documentation
Two 5½- by 8½-inch spiral-bound manuals: *Operations Guide*, 61 pages plus appendix; *Programmers' Guide*, 107 pages plus appendix

Price
2Page controller: $1295
With Verticom 2Page monochrome monitor: $2395
Verticom 2Page monochrome monitor alone: $1395

Inquiry 890.

with the speed of the system. The low performance was clearly linked to the beginning of each page, where a pause of almost a second occurred. A call to the company revealed that Windows places a " >> " character at the beginning of each page and that the symbol is not in the character set (Helvetica) that the board uses as a default. The company said that because of Windows' driver limitations, each time this symbol appears, the current character set is cleared, the set with this symbol is downloaded, the symbol is displayed, and the whole process is done again to reload the correct character set to continue the display process. I let them know I thought they had a serious performance bug, and they promised to look for a solution.

I made several calls to the support people. While I couldn't permanently disguise the fact that I was a reviewer, the response was prompt and competent for simple as well as technical questions.

VTP

The VTP board and display arrived in two boxes. The board appears well made; it is fully packed with circuits and has no jumper wires visible. The 19-inch monochrome display was packaged face-down in a large, heavy cardboard box with molded plastic cushions on all sides. According to the documentation, the VTP is compatible with the IBM PC, XT, and AT, the Compaq Deskpro 286 and 386, and the Hewlett-Packard Vectra.

The documentation for this massive package consists of a slim spiral-bound book entitled *Operations Guide*, with scattered installation instructions and some README files on the driver disk. The 5½- by 8½-inch manual has a table of contents buried 9 pages deep, has no index, and was run off on a letter-quality printer with right-margin justification, which makes it difficult to read. The pages have large margins, few diagrams, and less than 80 worthwhile pages. Because of the manual's shortcomings, you'll need some technical knowledge to install this board.

The VTP has a number of annoying installation restrictions: You cannot use it with an EGA in the same system or with a Compaq monochrome/CGA board. The board creates an address restriction for software access (in the A0000-A03FF hexadecimal range), so if you try to access this area, the system will hang. You also have to set a few jumpers; fortunately, there is a clear jumper diagram in appendix A.

The manual's discussion of interrupts is confusing, mixing XT and AT interrupt structures and the mouse and CGA interrupts almost at random. The manual presents no clear solution for resolving conflicts between the interrupts and address ranges that the board requires and the interrupts and address ranges required by other system components. You cannot reconfigure the VTP to use other memory addresses. This is especially annoying because the Intel 82786 chip has the ability to locate those addresses anywhere in the bottom 4 megabytes of address space.

Another unnecessary restriction is the VTP's lack of support for monitors other than the VTP display (actually a Phillips model M19P114B monitor). You can program the Intel 82786 chip for a wide variety of monitors; this is an opportunity that Verticom missed.

A second slim volume, entitled *Programmer's Guide*, is an optional document for those who'd like to try programming the display directly. Only the hardiest programmers should apply. In addition to the guide and the system tools disk, you need the full Intel documentation on the 82786, an assembler and linker, some experience with assembly language and with graphics, and a lot of patience to put a working program together. A Toolkit disk provided with the manual includes one example in assembly language that consists of almost nothing but Verticom-supplied macros and one-line comments. You get neither bindings nor information on how to drive the display from a higher-level language such as Pascal or C.

If you execute software that drives the screen in reverse video (black on white), the old scrolling method of blanking the screen will strobe annoying horizontal black bars about ½ inch in height on the display. This is not primarily a fault of the VTP, but the nature of the display makes the problem very obvious.

I tested Aldus PageMaker under Windows and found that the tutorial displayed very nicely. On closer inspection, I found that the fit-in-window display option made the type unreadable, but the actual-size choice exceeded the screen size for the two facing pages (even though the type was legible at close range). DESQview 2.0, however, would not boot up with the VTP display installed as the only display. The system froze, and I had to turn the power off and back on to get it to reboot.

In high resolution, the VTP display shows mixed CAD performance against the base CGA speed. Using the version 1.2 Windows driver supplied by Verticom, I achieved some interesting results. The speed was not impressive, running about one-half to one-third that of raw CGA. However, 9.6 times as many pixels were being updated on the screen, and the font legibility was very good.

A couple of service calls to Verticom gave me the impression that the general support level is good, but below that of VMI. A couple of times the support line was busy; when I finally got through, the person answering took my number and said that a support person would call back. The callbacks were delayed by various amounts of time, one taking more than a day. Based on the available documentation, it is likely that this support service will be busier than it should be.

Performance

I encountered a dilemma when I considered benchmarking the VTP and VMI graphics boards. Before this review, there was no set of benchmarks, standard or otherwise, for graphics displays. While I do not expect complete agreement on the benchmarks I developed, they are at least a starting point.

There are a number of reasons for the lack of graphics benchmarks. Until recently there have been only two classes of graphics controllers: too dumb (such as CGA), and too expensive (such as PGC). Since the great majority of us use only the former, benchmark results are dependent on the host processor and whatever method of writing to the controller's memory the benchmark uses. In addition, the earlier (pre-single-chip) technology for graphics processors generated large and expensive display subsystems, restricting their use to a few critical applications.

After considerable head scratching, I decided on a matrix of tests that would cover multiple dimensions of the use of graphics. Since no end user buys a graphics processor except as part of a functioning system, the relevant point is how these boards work in a system. I decided that I should cover host processor dependence, resolution dependence, simple drawing tests, complex drawing tests, and real-world application tests.

To examine host processor dependence, I tested a variety of display controllers (CGA, EGA emulation of CGA, the VMI, and the VTP) in systems of different speeds. I ran the tests on a 16-megahertz ALR Access 386 with 512K bytes of 32-bit memory, 512K bytes of 16-bit extended memory, a 30-megabyte hard disk drive, and a 1.2-megabyte floppy disk drive (see table 1a). Then I ran them on an 8-MHz ALR Dart 286 with 1 megabyte of memory, a 40-megabyte hard disk drive, and a 1.2-megabyte floppy disk drive (see table 1b).

Simple drawing tests are those requiring a minimum of calculation to draw graphics shapes on the screen. These tests show the maximum sensitivity to graphics performance, as opposed to host computational speed. (These tests follow a set suggested by Jim Omura on BIX.)

Complex drawing tests are designed to reproduce real use of graphics devices, including windowing and complex shapes. The complex function tests use a modified version of Borland's Turbo Graphix Toolbox demo program.

Real-world application tests use software that places large demands on the graphics capability of the system. For this series of benchmarks, I tested Microsoft Windows version 1.03 and AutoCAD version 2.6 in typical use that demands graphics performance.

I executed the Windows test in Windows Write by scrolling an 80K-byte file from top to bottom. After Write displayed the first page, I began timing when I pressed the PageDown key, and I stopped when Write beeped at the end of the file. I used AutoCAD to display two fairly complex drawings: Softwest, a complete printed-circuit-board drawing (207K-

continued

Table 1: *The benchmarks were run on (a) a 16-MHz 80386 system and (b) an 8-MHz 80286 system. The real-world benchmarks (c) were also run on the VMI and VTP boards in high-resolution modes. All times are in seconds.*

(a) 80386 at 16 MHz

Test	IBM CGA	EGA CGA	VMI CGA	VTP CGA
Simple	16.48	16.2	15.82	16.14
Complex	35.83	38.62	33.3	35.42
Windows	29	39	28	28.5
AutoCAD				
Softwest	76	76	71	78
Test	37	37	34	37

(b) 80286 at 8 MHz

Test	IBM CGA	EGA CGA	VMI CGA	VTP CGA
Simple	26.34	26.58	26.8	26.44
Complex	51.91	54.87	48.89	52.18
Windows	52.5	54	51	52
AutoCAD				
Softwest	124	126	123	125
Test	59	60	58	59

(c) High-resolution mode

	80386 16 MHz		80286 8 MHz	
Test	VMI 640	VTP	VMI 640	VTP
Windows	107	100	127	136
AutoCAD				
Softwest	78	91	138	143
Test	36	50	61	78

Graphics Coprocessors

The TI 34010 chip is a general-purpose 32-bit microprocessor with special graphics support instructions (see "The TMS34010 Graphics System Processor" by Carrell R. Killebrew Jr. in the December 1986 BYTE). Its strengths are its great flexibility, customization via software, large memory-address range, and its ability to act as host as well as graphics processor. Its weaknesses are the requirement for minimum programming to drive the display, a fairly complex instruction set (with a long learning curve), and, as a result, the probability that each manufacturer's board will have a different software interface.

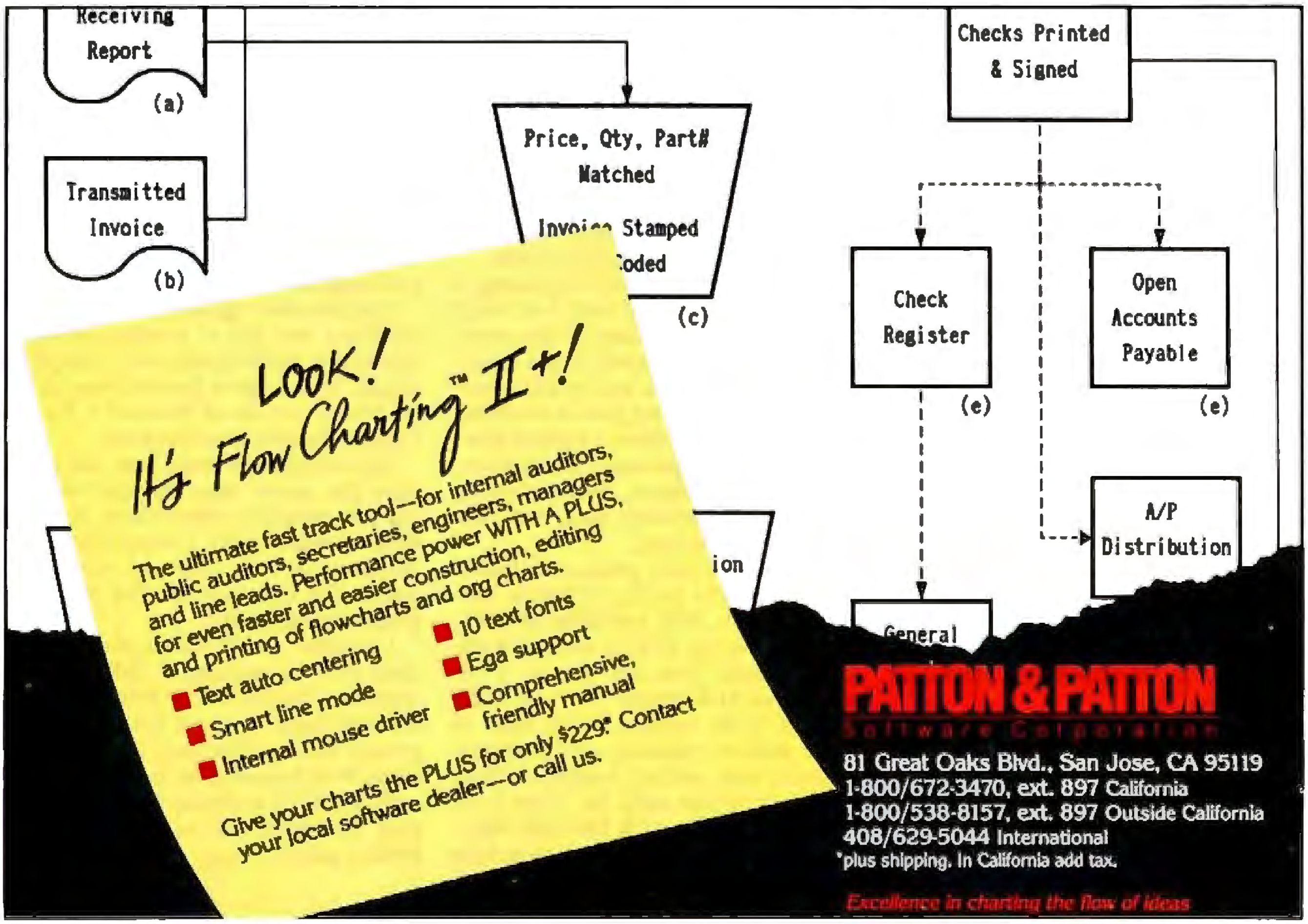
The Intel chip is a hardware coprocessor design with built-in graphics drawing capability that can be driven by calls with sets of parameters (see my "Inside the 82786 Graphics Chip" in the August 1987 BYTE). Its strengths include a simpler standard interface, built-in support for most basic graphics operations, and a flexible display-support capability. Its weaknesses are the requirements for host processor support and programming where the built-in functions cannot meet specific needs.

byte file), and Test, a simpler image (167K-byte file) with a lot of curves (a rainbow of colors drawn as a series of arcs). I began timing when I pressed the Return key after the filename and stopped after the drawing finished when AutoCAD prompted with `Command` on the bottom left of the display. I also ran these real-world tests on both boards in high-resolution mode. See table 1c for the results.

Operations in high resolution (compare tables 1a and 1b with table 1c) were anywhere from slightly to dramatically slower than the equivalent CGA operations. This was a significant disappointment to me, as I had expected that the graphics processors would more than make up for the work of updating extra pixels.

On reflection, I concluded that the responsibility for the lack of performance cannot be laid entirely at the board manufacturer's door. The essential cause of the performance problem is the lack of a well-defined and generally used graphics interface—other than, possibly, Microsoft Windows. Unfortunately, Microsoft designed Windows before graphics processors were available, and the results indicate that the interface defined by Windows drivers does not lend itself to efficient operation with graphics processors.

Thus, these graphics boards deliver on the higher resolution and flexibility that their processors can give, but they can't deliver on their performance promise with most current software. (Those programs whose designers have specifically incorporated code to make use of the processor's advanced features are the exceptions.) Future software based on a device-independent interface between the host processor and the graphics processor could dramatically improve both the graphics display and the system's performance. This could be especially true of a multitasking operating system that takes advantage of the support and memory



that the graphics processor provides.

[Editor's note: *In evaluating the boards for this article, the author ran many more tests than we can show here. For the complete set of benchmark results, see the BIX conference graphic.disp/review.*]

Assets and Liabilities

The VMI 640 board comes from a manufacturer with a history of providing high-resolution graphics boards and software support for the CAD user. The experience shows. This board is well suited for CAD, CAE, or perhaps business and scientific graphics. It also performs well in a mixed-task environment because of the superior CGA emulation.

With the exception of the problem in the current Windows driver, the board's performance and the manufacturer's support are about all you could ask for. I'm particularly impressed with the board's ability to run in so many dual-monitor configurations. The only thing left to wish for is a lower price: $1695 will restrict the sales of this board.

When the full Windows screen opens up in front of you the first time you use the VTP, the impact is considerable. I have to commend Verticom for supplying a very readable Windows font.

The VTP display is well suited to page layout; if you spend a significant amount of time at this, the VTP should provide sufficient productivity enhancement to justify the cost ($2395). If you already have a large screen that can be driven by the controller, the cost of the controller alone ($1295) is much easier to bear.

However, for the price Verticom is asking, the very least you should expect is comprehensive, carefully indexed, and accurate documentation. Verticom should also add the ability to configure the board for addresses other than A0000. Finally, Verticom should broaden the base of compatible software (to include DESQview, for example), improve the CGA emulation, and expand the number of supported monitors. ■

[Editor's note: *Source code (nonexecutable) listings of SIMPLCGA and CMPLXCGA, the simple and complex drawing benchmarks, respectively, are available on BIX, on BYTEnet, on disk, and in the Quarterly Listings Supplement. See "Program Listings" in the table of contents. Portions of CMPLXCGA based on Borland's Turbo Graphix Toolbox are used by permission from Borland International. To "find" source code in the Listings areas on BIX and BYTEnet, search by article title, author name, or issue date. Some archived files may contain numerous listings for a single article. A description of the file also accompanies each entry.*]

GCC's Personal Laserprinter

Donald Evan Crabb

The Personal Laserprinter from General Computer Corp. (GCC) is designed to compete with the Apple LaserWriter Plus in single-user desktop publishing. While some companies (e.g., QMS and Dataproducts) are trying to beat Apple with laser printers that offer greater performance yet are priced somewhat lower than the LaserWriter Plus ($4000 and up), GCC hopes to beat Apple mostly with its price: Where the LaserWriter Plus lists for a hefty $5799, the GCC Personal Laserprinter comes in at a trim $2599.

Features and Description

The differences between the LaserWriter Plus and the Personal Laserprinter (PLP) are significant. The LaserWriter Plus is designed as a shared device to be accessed over an AppleTalk network. The PLP is a single-user device dedicated to a single Macintosh.

The LaserWriter Plus contains its own MC68000 CPU, RAM, and ROM, and a complete implementation of PostScript. The PLP has no CPU or memory and doesn't speak PostScript. It prints by accepting a compressed QuickDraw image sent to it by the Macintosh, while the LaserWriter Plus composes its own print image.

Communications between a Macintosh and a PLP take place through a SCSI connection. The actual imaging is by a semiconductor laser, similar to the one used in the LaserWriter Plus. The PLP's engine, produced by Ricoh, gives a resolution of 300 by 300 dots per inch and is rated at 6 pages per minute.

Like the Canon engine in the LaserWriter Plus, the Ricoh engine is a "write-black" design: Toner sticks to the imaging drum in places charged by the laser. Unlike the Canon engine, however, the PLP's Ricoh engine does not use a single printing cartridge that combines the toner and the imaging drum. Instead, it uses two separate snap-in cartridges for the drum and the toner.

The toner cartridge lasts about 1500 pages, while the imaging drum (OPC in PLP/Ricoh parlance) must be replaced about every 20,000 pages. The OPC drum's cleaning assembly must be replaced separately every 10,000 pages. These figures compare to a rated life of about 3000 pages for a Canon LaserWriter Plus cartridge.

The toner cartridges list for $29, and the OPC cartridges cost $199. The OPC cleaning assemblies cost $99. A Canon LaserWriter Plus cartridge lists for about $120, but it can be recharged with toner several times; the Ricoh toner cartridges cannot be recharged. In the long run, then, the PLP/Ricoh system costs more to use than a LaserWriter Plus/Canon system, given current costs for the different supplies.

The Ricoh engine has a theoretical durability advantage over the Canon engine: 180,000 lifetime pages versus 100,000. In practice, the LaserWriter Plus has proved to be a rock-solid printer that will last far beyond 100,000 images before requiring a major overhaul or replacement of the imaging system. The monthly rated duty cycle of both printers is 3000 pages; these figures can be safely exceeded, however.

Because of the printing method of the PLP, a hard disk drive is required to store the compressed QuickDraw files it will print. The PLP is also a memory-intensive device; it needs at least 1 megabyte of RAM for its printer-support software to spool the compressed QuickDraw files properly.

Bitstream Fonts

The PLP comes with two sets of Bitstream fonts that mimic the PostScript fonts used by the LaserWriter Plus. These fonts are mathematically defined in out-

continued

Personal Laserprinter

Type
Laser printer

Company
General Computer Corp.
580 Winter St.
Waltham, MA 02154
(617) 890-0880

Size
9 by 16 by 16½ inches (without paper tray); 38 pounds

Features
Ricoh print engine, rated at 6 ppm; 300-by 300-dpi resolution; set of six Bitstream font families; Personal Laserprinter Print Manager and system resource; high-quality and draft printing modes; SCSI address preset to 3, externally switchable; power requirements: 120 V or 240 V AC

Hardware Required
Macintosh Plus, SE, or II with at least 1 megabyte of RAM and a hard disk drive; SCSI cable and terminator

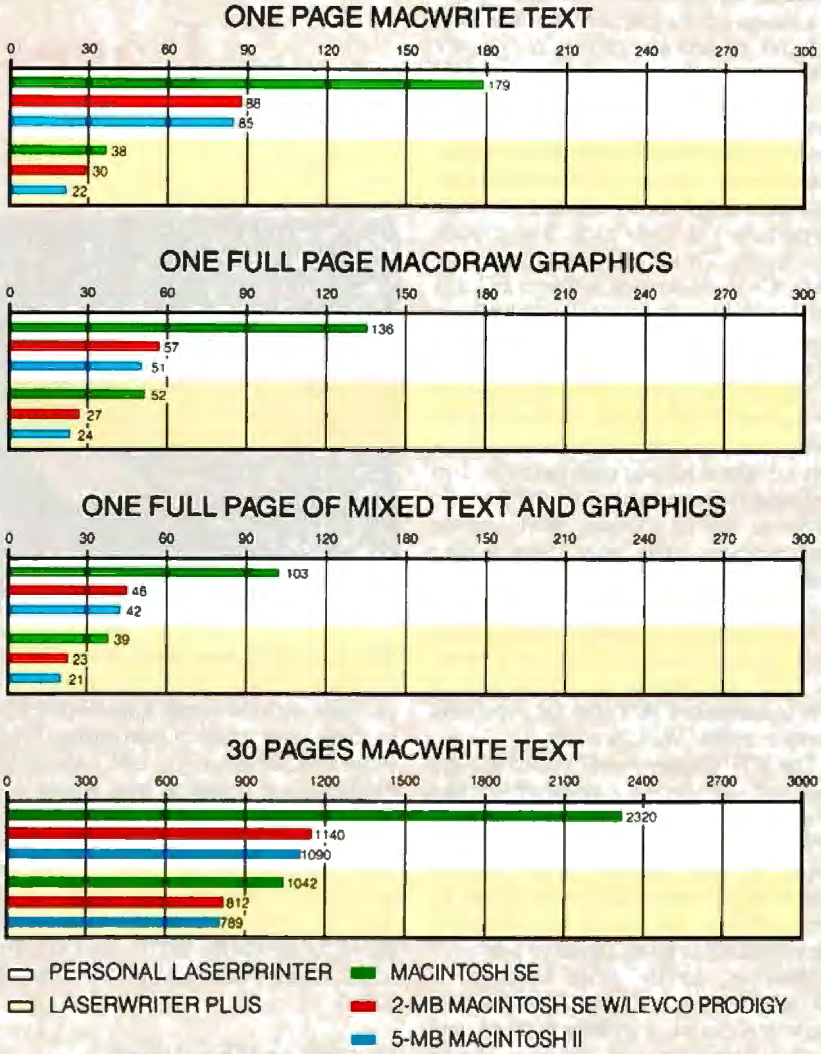
Software Required
Personal Laserprinter printing resource file and font disks

Options
SCSI cable: $49
SCSI terminator: $30
Set of seven additional Bitstream font families: $299

Documentation
96-page spiral-bound manual; two addenda; on-line documentation (minimal) in Personal Laserprinter Print Manager

Price
$2599 (includes one OPC and toner cartridge; does not include SCSI cable or terminator)

Inquiry 891.



All benchmarks were run with no RAM cache, System 4.1, Finder 5.5, MacWrite version 4.6, MacDraw version 1.9.5, and Courier font.

line form, like the PostScript fonts, so that they offer the same high-quality 300-dpi resolution, regardless of their point size.

Unlike the PostScript fonts that are stored in the LaserWriter Plus, the Bitstream fonts must be stored on your Mac's hard disk (because the PLP has no ROM or RAM), where they occupy about 1 megabyte of storage. The Bitstream fonts supplied with the PLP look like the LaserWriter Plus's Courier, Helvetica, Times, Symbol, Palatino, and Helvetica Narrow fonts. GCC offers a $299 set of seven additional Bitstream font families.

The PLP connects to the Macintosh Plus, the Macintosh SE, or the Macintosh II through the SCSI port. The SCSI address is preset to 3 at the factory, but an easy-to-set external push button allows a quick change. Setup took about 30 minutes, from opening the box to printing my first test page.

The complete PLP package includes the printer, one toner cartridge, one OPC assembly, three disks, the spiral-bound manual, two manual addenda, a warranty card, and a power cord. The printer lacks the needed SCSI cable and terminator, which are available from GCC for $49 and $30, respectively. GCC provides the usual 90-day warranty, but it does not offer any extended warranty coverage—a disadvantage, since Apple offers the AppleCare extended warranty for the LaserWriter Plus.

Printing Software

The PLP includes its own printer software: the Personal Laserprinter Print Manager, the Personal Laserprinter 1.0 system resource, and the Bitstream fonts. You can install the Print Manager anywhere you like; I put mine in a special hard disk directory to keep track of all my PLP files. The Personal Laserprinter 1.0 system resource must be copied into the System Folder, so that the System and Chooser can access it. I also put all the

continued

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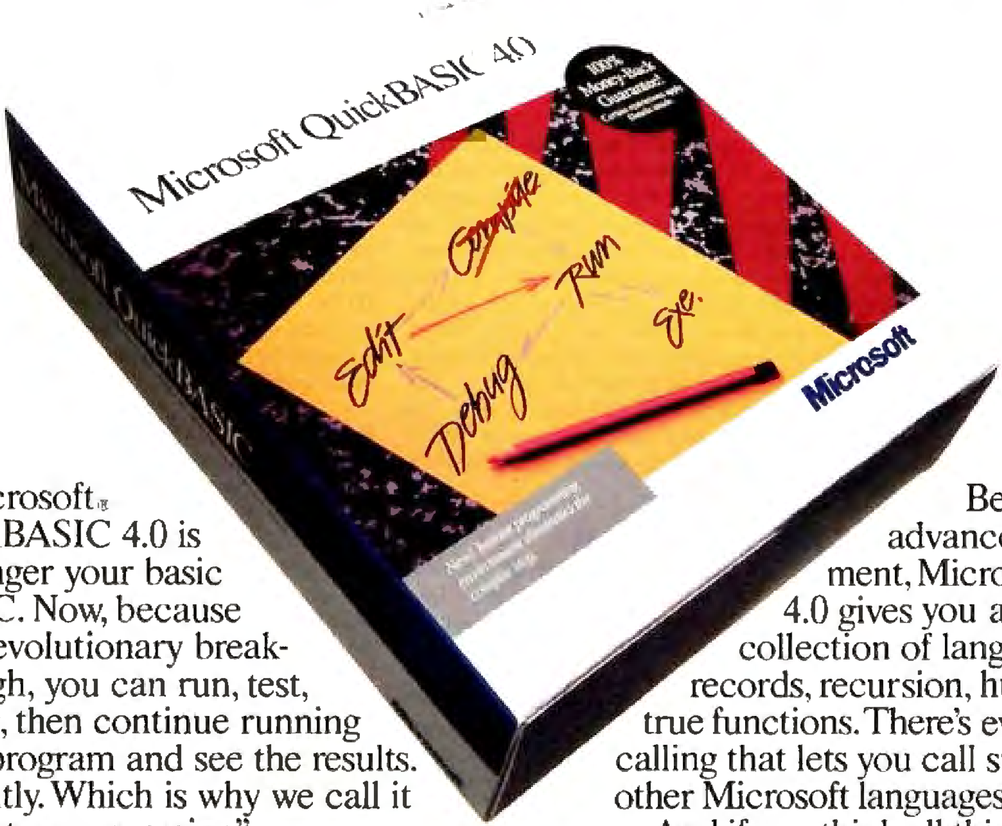

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The Mac II's processing speed helped close the gap on the LaserWriter Plus's advantage, but it wasn't enough to make up for the lack of a CPU and RAM in the PLP.

Bitstream fonts into my PLP directory.

If you already have LaserWriter Plus fonts installed, the DA/Font Mover will replace some of those fonts with PLP fonts that have the same name. This is inconvenient if you want to alternate between a PLP and a LaserWriter Plus, since you'll always get the Bitstream screen version of those fonts when you are editing a file. Of course, during printing, the LaserWriter Plus will print with its own built-in PostScript fonts, so the inconvenience is not a serious one.

Because GCC had to provide a print-management utility for the PLP, the company decided to add some options that you don't find in the Apple LaserWriter Plus print dialog boxes. These additional options include the ability to spool files to disk for later printing (not a true print spooler that returns control to your Macintosh earlier than straight-through printing); a limited letter-kerning capability; draft printing (similar to the ugly Imagewriter draft mode); the ability to process bit-map images with smoothing; and a preview option.

Print previewing is by far the most useful option. By building a print-spool file, the print manager's previewer lets you see the final Macintosh page in as close an approximation to WYSIWYG (what you see is what you get) as your Mac screen allows. I only wish I could add this preview feature to Apple's standard LaserWriter Plus print dialog box.

Like many other GCC products, the PLP comes with very good documentation. Its 96 pages are broken up into four chapters on setting up the printer, installing software and printing, using the printer, and maintenance and troubleshooting. Each section is well written, but the opening chapter on installation and setup suffers from poor illustrations. Two addenda update the changes made in the PLP software since its beta release.

Performance

There is no getting around it—the PLP is a slow printer. To test performance, I compared the times the two printers took to print four different documents: a one-page MacWrite 4.6 file, consisting of the string "The Quick Brown Fox Jumped Over The Lazy Dog" repeated; a one-page MacDraw 1.9.5 file (four images of a custom-designed business card); a 30-page MacWrite 4.6 file (30 pages of the one-page MacWrite example); and a page combining text and graphics.

For each printer, I ran the four tests on three systems: a 1-megabyte Macintosh SE, a 2-megabyte Mac SE with a Levco Prodigy SE accelerator board installed, and a 5-megabyte Mac II (see the graph on page 156).

Even with the 5-megabyte Macintosh II, the PLP's times were slower than the slowest LaserWriter Plus/Macintosh combination, except for the time required to print a full page of MacDraw graphics. The processing speed of the Mac II helped close the gap dramatically on the LaserWriter Plus's advantage, but it wasn't enough to make up for the lack of a CPU and RAM in the PLP. In short, the ways in which GCC has chosen to cut costs in the PLP made an obvious difference in printing speed in the tests I conducted.

Software Compatibility

GCC provides an extensive list of software that will not work with the PLP: Great Plains Accounting 4.10, Layered's Insight 1.02, Software Ventures' Microphone 1.0, OverVUE 2.1a from ProVue, Aldus PageMaker 2.0 (although Aldus offers a free upgrade, 2.0a, that will print on the PLP), Apple's AppleLink 2.0, Red Ryder 10.0, Maitreya Design's miniWRITER, and VersaTerm-PRO.

GCC also provides a list of software that works with the PLP, although with some problems: Telos' Business Filevision; Cricket Draw; Odesta's Double Helix; Microsoft's Chart, Excel, File, Filemaker Plus, Word 3.01, Works, and PowerPoint; Ann Arbor Softwork's FullPaint; Apple's HyperCard, MacPaint, MPW, and MacWrite; Lotus's Jazz; Think Technologies' Lightspeed C and Pascal; MindWork Software's MindWrite; Living Videotext's More; Blyth Software's Omnis 3 Plus; Broderbund's Print Shop; and Silicon Beach Software's SuperPaint.

The release notes with the printer detail the problems with printing and the processes required to make each of these packages print with the PLP. I tried all the workarounds and found that they act just as GCC says they do.

In addition to these programs, there are programs that will work with the PLP but, because they rely heavily on the abilities of PostScript, will produce Imagewriter-quality results at best. These packages include Cricket Draw, Adobe Illustrator, and Quark XPress.

By comparison, GCC's list of software that works without problems is smaller: Acius's 4th Dimension, Symmetry's Acta, Cricket Graph, Ashton-Tate's dBASE Mac, Apple's MacDraw, MacTerminal, and MacProject, Paragon Courseware's QUED/M, Orange Micro's Ragtime, Letraset's Ready-Set-Go, Data Tailor's Trapeze, and T/Maker's WriteNow.

When a software package and the PLP work together, either seamlessly or through a special workaround, the output quality is generally high. It is at least as good as any LaserWriter Plus output of the same document, and in many cases, the PLP graphics looks slightly crisper and the text a bit blacker. Because of differences in the positioning of QuickDraw- versus PostScript-generated graphics, most PLP output is not aligned quite the same as equivalent LaserWriter Plus output.

Recommendations

The PLP is not the universal answer to Macintosh owners who need a high-quality laser page printer but who don't want to part with more than $4000.

Freelance writers or text-oriented consultants, for example, may find that the PLP is a big win. The output of the PLP is about equivalent to the LaserWriter Plus or to the other 300-dpi Macintosh laser printers on the market. If you can get by without PostScript (many users can't), and if you already own a faster Macintosh (accelerated Mac Plus, Mac SE, or Mac II), then you're likely to find that the PLP is a wonderful printer at an affordable price.

On the other hand, if you are heavily dependent on accurate PostScript output, like many desktop publishing users, graphics designers, engineers, and others, then the Bitstream fonts and QuickDraw graphics of the PLP do not provide the flexibility and quality of PostScript (although, for some applications, they are close).

The PLP is also not a good laser-printing solution for offices that want to share printers, since it is a SCSI device that must be assigned to a single Mac. Its lack of AppleTalk support is a major limitation for those users who need to share computer resources within work groups.

Finally, this is one very slow printer. Because (unlike the LaserWriter Plus) it has no CPU or RAM to speed page processing, its printing speed is largely dependent on the computing bottlenecks of the Mac that drives it. The speed problem is compounded by the printer's memory needs. Although the machine can work with a 1-megabyte Mac Plus, I often got `Out of Memory` messages when I tried to print long documents containing text and graphics.

In fact, when I tried to print a single copy of this review in its unedited form (a 12-page Microsoft Word 3.01 file) on a 5-megabyte Mac II, the PLP print manager ran out of memory because I had set a 3-megabyte RAM cache. I ran into this out-of-memory problem most often with Microsoft Word 3.01 and Excel 1.03.

For the small business owner, consultant, or manager in a larger corporation who needs an inexpensive laser printer for his or her Macintosh, the PLP can be very attractive. For my own needs, I can't afford to give up 100 percent PostScript compatibility or waste time dealing with software workarounds when printing, so I'll pass on the PLP. ■

Donald Evan Crabb (Department of Computer Science, University of Chicago, Ryerson Hall 260, 1100 East 58th St., Chicago IL 60637) is the director of instructional laboratories for the computer science department of the University of Chicago and is a lecturer in the department and the college.

VIEWS FROM BIX:
PostScript vs. Non-PostScript Printers

macintosh/reviews #25, from Tom Hedges.

A general comment on non-PostScript laser printers: I think this is a bad mistake, on the part of both GCC and others (even Apple, according to persistent rumors). Granted, Adobe may be charging too much for its implementations, but the coming clones should inject some needed competition to that market. The advent of PostScript has given the personal computer industry a very powerful, resolution-independent way to output text, line graphics and even high-quality scanned gray-scale images (on the phototypesetters). The LaserWriter provides a very accurate proofing device for professional desktop publishing and a final output device for many others.

The problem that comes from the release of significant numbers of non-PostScript printers is that software developers will be forced back to the Apple QuickDraw standard in order to be compatible and will not be able to take full advantage of the superior abilities of the PostScript output devices. This is particularly true in the gray-scale scanned-image-output area, where Letraset and my firm, Fractal Software, along with others, are just now starting to provide good support for gray-scale image output. With the price of the RIP hardware coming quickly down and the royalties for PostScript under competitive pressure, it seems a very shortsighted move to "expand" the laser printer market for the Mac in the direction of the IBM-compatible world, namely toward "dumb" laser printers.

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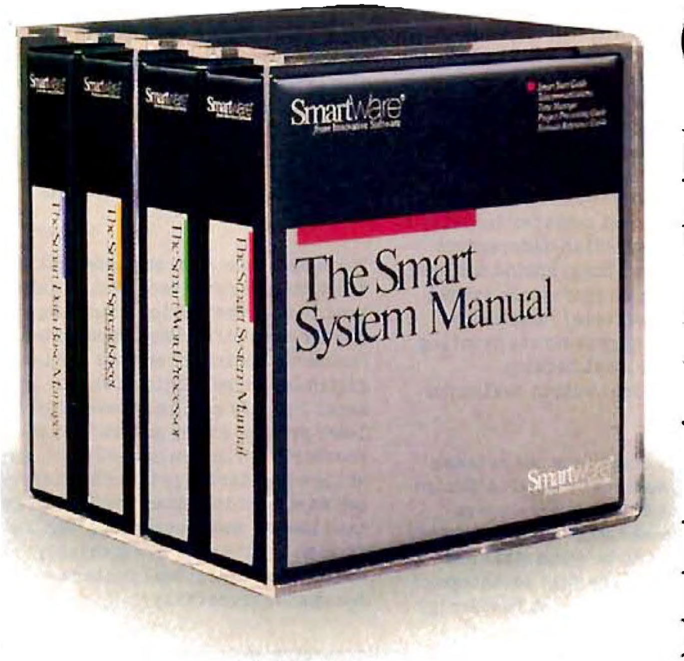
macintosh/reviews #28, from Chris Crawford.

Tom Hedges made a strong case against the dumb laser printers, and in general I tend to be sympathetic to such arguments. But the cost difference between the PostScript printers and the PLP is gigantic; we're talking a factor of two here! I simply could not have afforded a laser printer at the prices that the PostScript printers now sell for. And while a PostScript printer is faster and can do more things than the PLP, I find that the PLP does everything that I want it to do, quite well. I especially like the notion that additional fonts move into the system gracefully.

To some people, the



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Allegro CommonLISP

Ernest R. Tello

Allegro CommonLISP version 1.0 ($600) is an interactive programming environment for the Apple Macintosh based on the Common LISP standard as defined in Guy L. Steele's book *Common LISP: The Language*. Allegro CL was produced jointly by Coral Software Corp. of Cambridge, Massachusetts, and Franz Inc. of Berkeley, California. It is a complete Common LISP running on a microcomputer, and for this reason it should be a good delivery environment for Common LISP programs from larger machines.

A complete microcomputer implementation of Common LISP

The implementation consists of an incremental compiler, an EMACS-style editor, a debugger, an object-oriented programming system called Object LISP, and Macintosh interface tools for creating windows, menus, and dialog boxes. Allegro CL has a pseudomultitasking system that lets you edit code while programs are compiling or executing in the background. The garbage collector is a mark/compact/forward collector that implements virtual memory by loading functions into memory only as they are needed. The garbage collector is invoked automatically when either the Macintosh operating system or LISP needs more memory.

Allegro CL comes on two double-sided 800K-byte floppy disks. The minimal hardware required to run the system is a Macintosh Plus, SE, or II with 1 megabyte of RAM and 1.6 megabytes of disk storage; it can support up to 8 megabytes of RAM. The manual recommends 2 megabytes of memory and a hard disk drive. This is good advice; I found that the system does not run very well with only 1 megabyte of memory.

Good Environment

Allegro CL provides an interactive menu system that lets you edit and debug without leaving the LISP environment. The main menu bar in Allegro CL has the following command options: File, Edit, Eval, Tools, and Windows. These menu items give you access to the editor, the compiler, the debugger, and other tools. The Windows menu option lets you easily cycle through the windows open on the screen.

The Listener is a special window on the screen through which you type commands and get responses. The Listener behaves exactly like an interpreter, although in this case it is based on incremental compilation. Allegro CL automatically compiles any new function definitions. (You can turn off this feature by setting the `*compile-definitions*` variable to nil.)

The Eval menu has options for evaluating either a selected expression or the entire editing buffer. The Eval menu also includes an option that lets you save compiled code in a file by specifying the names of the source file and the destination file for the compiled code.

Two modes are available for the evaluation of LISP expressions: one that conforms exactly to the Common LISP standard, and one that is faster but does not support the debugging functions `evalhook` and `applyhook`. You select the latter by setting the `*fast-eval*` variable to true.

The full-screen window-oriented editor in Allegro CL is called FRED, an acronym for "FRED Resembles EMACS Deliberately." FRED is an EMACS-style editor that allows multiple windows and the use of a mouse. The advantage of using an EMACS-style editor is that you can customize it to suit your needs. For example, you can add macros for commonly executed key sequences as commands to the Edit menu. Each individual editor window can have a separate package or Common LISP name space associated with it. One chapter of the *User's Manual* is devoted to documenting how to customize the editor.

Because of the scarcity of auxiliary keys on the standard Mac keyboard, it is not easy to implement an EMACS-style editor on this machine. Allegro CL handles the problem by using the Option key as a Meta key and the Clover key and Shift-Clover key for Control and Command, respectively. The editor also supports more recent Mac keyboards that include a separate Control key. In addition, the Macintosh Clipboard has been integrated with the EMACS kill-ring. Any time text is moved to the Clipboard, it is also automatically moved to the top of the kill-ring, and vice versa.

The Tools menu has options for debugging, such as a window-based inspector, backtrace, stepper, and trace facility. The inspector lets you browse about in data structures, examining and modifying them. Allegro CL implements the inspector as a window-oriented utility that can be invoked in three ways. First, you can select the `Inspect` option on the Tools menu. Second, when within the FRED editor, you can use the key command Control-X Control-I; this causes the current LISP expression to be inspected. The third way of invoking the inspector is directly from the LISP listener by calling the `inspect` function and supplying it with an argument. So, for example, `(inspect *inference-engine*)` would open an inspector window on the inference-engine class.

Allegro CL also supports a typical LISP backtrace facility as a dialogue window. The backtrace window pops open whenever the listener enters a break-loop. This can happen either when an error occurs or when a programmer calls

continued

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Allegro CommonLISP 1.0

Type
Common LISP programming language

Companies
Coral Software Corp.
P.O. Box 307
Cambridge, MA 02142
(617) 547-2662

Franz Inc.
1995 University Ave.
Berkeley, CA 94704
(415) 548-3600

Format
Two 800K-byte 3½-inch floppy disks

Language
LISP

Computer
Macintosh Plus, SE, or II with 1 megabyte of RAM and 1.6 megabytes of disk storage; 2 megabytes of RAM and a hard disk drive are recommended

Software Required
Macintosh system version 2.1 and Finder 5.5 or higher

Documentation
Common LISP: The Language; *Common LISP: The Index*; 200-page *User's Manual* describing implementation details

Price
$600

Inquiry 883.

a break deliberately (for example, by selecting the `Backtrace` option on the Tools menu). Two tables appear in the backtrace dialogue window. The table at the top displays the functions on the stack awaiting return values. Preceding the name of each function is the address of the function's stack frame in hexadecimal. The lower table displays the values of the functions listed above. Currently, the backtrace does not show the names of lexical values.

The compiler uses tail recursion to minimize stack space. Tail recursion is an optimization used when an iterative process is described recursively. This means that only the most recent iteration of a loop appears in the stack history of a backtrace window. When debugging, you will want to turn off this optimization by setting the `*nx-tailcalls*` variable to nil; then there will be no tail-recursion optimization, and all the function calls will be found in the backtrace call history.

A trace function is implemented in accordance with the Common LISP standard and also extends to the Object LISP system. You attach the trace function to a particular function so that tracing occurs for each call to that function. In the case of method functions that are defined for different classes, you can trace each of the versions of the function separately by sending the trace message to a specific object and telling it which method to trace.

Allegro CL implements a form of pseudomultitasking that allows editing and various other operations to be done while LISP programs are compiling or executing. For this reason, the Macintosh watch cursor is not used in this environment. However, some tasks in Allegro CL (e.g., garbage collection and event processing such as menu selection) are noninterruptible. This means that during these tasks other operations, such as LISP evaluation, are halted.

Object LISP

Object LISP is an interesting and full implementation of object-oriented programming for Common LISP, but it suffers from two handicaps: There is little experience in its use, and the Common LISP community is standardizing on the CLOS (Common LISP Object System) standard. (The manufacturers say they will replace Object LISP with CLOS when the specification of CLOS is complete.) While CLOS incorporates some features of Object LISP, it is closer to the approaches taken by Xerox CommonLoops and Symbolics New Flavors.

However, Object LISP is an interesting way to implement objects in Common LISP. I particularly like the way it places classes and instances on the same level. It has always seemed artificial to be able to create objects only as instances of already existing classes. In Object LISP, you create instances the same way you create classes, so it is perfectly legal to create an object that is neither a class nor an instance of a class. This is ideal for applications where the problem is to determine what something is, such as a disease or a malfunction. Once it is determined, the object can be assigned to the class, and further processing can be driven by the methods and variables it has now inherited.

Another good feature of Object LISP is that objects can be modified "on the fly," while programs are running. I would like Object LISP to be included with Allegro CL even when CLOS becomes available.

Unfortunately, while making the switch from Object LISP to CLOS won't be difficult, it won't be transparent, either. Also, the manual cautions the programmer that portions of code that need to run efficiently should not be written in Object LISP. It is unfortunate that the developers never got around to optimizing their implementation of Object LISP.

Interface Tools

Allegro CL provides interface tools for building Macintosh menus, windows, and dialog boxes. Menus and windows in the current implementation of Allegro CL are implemented on top of Object LISP by means of the menu and window classes. A window is a subclass of the stream class. Every menu item in a menu object has five characteristics: the title, the keyboard equivalent (if any), the font style, check mark or no check mark, and enabled or disabled. An entire menu bar for an application in Allegro CL is simply a list of menu objects. The `menubar` function returns a list of the menus currently active in the menu bar. You can easily change the menu bar at any time by using the `set-menubar` function, which can be assigned to any LISP expression that returns a list or sublist.

Different types of windows are implemented not as different subclasses of the window class, but as different alternatives to the `:window-type` option of the window class itself. There are seven different window types: document, document-with-grow, document-with-zoom, double-edge-box, single-edge-box, shadow-edge-box, and tool.

A dialog box is a special kind of window that contains various messages and options that are sensitive to mouse clicks. Both the dialogs themselves and the items they contain, such as buttons, check boxes, radio buttons, static text, editable text, and tables, are created as instances of their own object classes. Since the dialog class inherits from the window class, dialogs can do anything ordinary windows can do.

Event Handling and Graphics

Allegro CL typically handles events initiated by a user automatically as a background task. For applications that need to handle user events explicitly, a variety of event-handling methods are available to programmers. For example, you can specify the response of window objects to certain types of events or to all events directed at them; you can specify a hook procedure that gets the first chance to process any event; or you can disable all background processing of events and handle them with a special event loop. Typically, programming languages on the Macintosh support only the last and most difficult type of event handling. With a system like Allegro CL, however, the first type often suffices.

Allegro CL Benchmarks

Jean-Denis Muys-Vasovic

I ran the Gabriel benchmarks on a Macintosh II with 5 megabytes of RAM, a 68881 floating-point coprocessor, and an Apple 20SC hard disk drive. Table A shows the results, along with the values for the VAX 750-CL and the Symbolics 3600 from Richard P. Gabriel's book *Performance and Evaluation of LISP Systems* (Cambridge, MA: MIT Press, 1985). Every benchmark ran without any modification, with the exception of the Puzzle benchmark. Puzzle has a variable named `*d*`. Since Allegro has a system variable with the same name, I renamed `*d*` to `*dd*` in Puzzle.

Common LISP has a `declare` statement that gives compile-time information to the compiler. A `declare` statement can be associated with every block of code: the scope of a function, of a loop, of a lambda expression, and so on. Allegro CL has two flavors of the `declare` statement: type declarations and optimizing declarations.

Type declarations tell the compiler that one or more variables will hold a known type of data—for example, a numeric index. This allows the compiler to generate specialized and more efficient code. Recall that variables in LISP can hold any value: numerical, symbolic, string, and so on.

With optimizing declarations, you can then tell the compiler to optimize the compiled code for safety, space, or speed. You write something like: `(declare (optimize (safety` *`n1`*`) (space` *`n2`*`) (speed` *`n3`*`)))`, where *n1*, *n2*, and *n3* are integers between 0 and 3. The integer 0 indicates not to optimize in a particular way, and the integer 3 means to optimize as much as possible in that direction. `Safety` controls the ability to handle errors and interrupt the code, `space` controls the memory used, and `speed` controls how fast the code runs.

The first column in table A shows the times for the benchmarks without optimization. The second column shows the times with the optimization statement `(declare (optimize (safety 0) (space 0) (speed 3)))` added to each definition. I did not include any type declaration because this would have involved some semi-intelligent process of code and would not have been a fair comparison. In columns where two values are separated by a slash, adding the two numbers gives the total time; the second number indicates how much of that total time was spent in garbage collection.

Table A: *The first column gives the times for the Gabriel benchmarks run under normal conditions. The second column gives times for these same tests optimized for speed. Values for the VAX 750-CL and Symbolics 3600 are those published in Richard P. Gabriel's book* Performance and Evaluation of LISP Systems. *A detailed description of the benchmarks can also be found in this book.*

Test	Allegro CL (normal)	Allegro CL (optimized)	VAX 750-CL	Symbolics 3600
Tak	1.40	0.70	0.61	2.69
Stak	16.05	14.97	6.21	2.58
Ctak	4.40	3.433	13.86	7.65
Takl	15.03	6.65	12.35	6.44
Takr	1.47	0.92	4.39	0.06
Boyer	35.15	22.083	69.38/79.30	11.99
Browse	62.06/3.17	51.58/3.25	195.11/164.05	30.80
Destructive	8.93	7.600	11.30	3.03
Traverse-init	35.35	18.57	35.44	8.62
Traverse	131.08	49.08	217.21	49.95
Deriv	27.22/3.25	26.16/3.12	24.50/49.63	5.12
Dderiv	27.00/2.98	26.10/3.00	32.90/45.80	5.24
Div2-iter	5.22	3.267	14.32/24.85	1.85
Div2-rec	5.27	2.617	9.07	2.89
Fft	61.22/2.95	60.00/2.97	131.59/101.84	4.75
Puzzle	72.62	64.85	231.79	13.89
Triangle	899.85	826.37	1021.35	151.70
Fprint	9.17	8.983	6.08	2.60
Fread	2.93	3.167	11.21	4.60
Tprint	30.02	29.25	4.11	4.89
Frpoly2rxyz1	0.02	0.02	0.06	0.00
Frpoly2r2	0.02	0.02	0.06	0.00
Frpoly2r3	0.02	0.02	0.06	0.00
Frpoly5rxyz1	0.17	0.13	0.37	0.05
Frpoly5r2	0.25	0.25	0.16	0.19
Frpoly5r3	0.2	0.17	0.48	0.05
Frpoly10rxyz1	1.57	1.17	3.38	0.49
Frpoly10r2	2.67	2.27	7.25	2.89
Frpoly10r3	1.92	1.50	4.69	0.54
Frpoly15rxyz1	10.22	7.57	21.51	3.45
Frpoly15r2	20.55	17.97	57.00/51.82	22.35
Frpoly15r3	12.22	9.63	31.05/26.80	3.84

On the whole, Allegro is very fast. Its only weak point is the speed of the text display Tprint. This is a drawback of the graphics-only aspect of the Macintosh. Allegro CL is nearly always faster, and sometimes much faster, than the VAX 750-CL. It is slower than the Symbolics 3600, but seldom by a factor of more than 2.

[Editor's note: *Source code (nonexecutable) listings for the Gabriel benchmarks are available on BIX, on BYTEnet, on disk, and in the Quarterly Listings Supplement. See "Program Listings" in the table of contents. To "find" source code in the Listings areas on BIX and BYTEnet, search by article title, author, or issue date. Some archived files may contain numerous listings for a single article. A description of the file also accompanies each entry.*]

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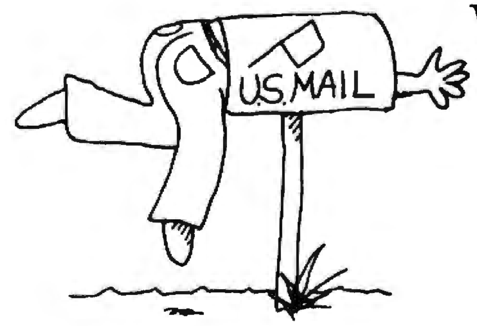
Allegro CL implements graphics support through a set of functions that provide an interface to the Macintosh QuickDraw package. So far, the routines completely support only Macs with the 64K-byte ROMs. To use more recent QuickDraw features, you must write low-level trap routines. Allegro CL currently provides two basic kinds of graphics functions: those that must be performed within some window object, and those that can be used globally without reference to the window system.

One important advantage of the Allegro CL graphics routines over the comparable Pascal QuickDraw functions described in *Inside Macintosh* is that Allegro CL's routines are written to take full advantage of the optional argument capability of Common LISP. This means that, in cases where operations have to be performed for all the objects on the screen at a given time, functions can simply be applied to the list that keeps track of all current screen objects.

You can have text drawn in a window by designating the window as an output stream. The text is displayed starting at the current pen position, and its appearance is determined by the window's current font, size, and mode.



Low-Level ROM Access

Most programmers will be able to do everything they need with Allegro's high-level Macintosh routines. However, Allegro CL provides a means for making direct calls to the Macintosh ROM. The main purpose of this low-level access is for using traps not provided in the higher-level interface and, if necessary, for optimizing those that are provided. Low-level traps that can be called from Allegro CL include both those that handle arguments on the stack and those that handle them using registers. This low-level interface must be used with care, since it is very easy to crash the system while using it.

Making low-level calls requires an understanding of how memory is partitioned in Allegro CL. The basic division is between the two types of data, Macintosh resource data and LISP structure data. These two types of data are stored in the Application heap and the LISP heap, respectively. The Mac Application heap is needed in this context primarily for storing data used for communicating with the Mac ROM. Before any data can be passed to the ROM, it first has to be put in the format used either by the Application heap or the stack.

Allegro CL also provides a set of functions and macros that let LISP programs manipulate data stored in Pascal record formats—the main format used by the Macintosh Operating System. You can use these functions to access and manipulate Macintosh resources and data structures created at run time, such as window setups and text-edit records. The functions supported include `defrecord`, which defines new record types, `make-record`, which creates new records, and `dispose-record`, which deallocates records. Various other functions access, copy, and manipulate record data.

For documentation of generic Common LISP functions and variables, the standard texts *Common LISP: The Language* by Guy L. Steele and *Common LISP: The Index* by Rosemary Simpson are also shipped with the product. Implementation specifics are covered in a *User's Manual* that consists of about 200 pages of text divided into 13 chapters and four appendixes. Programmers are expected to refer to the standard texts for documentation of portable Common LISP behavior and functions.

Benchmarks

Although the manufacturers claim that Allegro CL will run on a Macintosh with just 1 megabyte and no hard disk drive, I don't think anyone should consider using that configuration. The reason stems partly from the sheer size of Common LISP and partly from the fact that Allegro CL uses a virtual-memory architecture, which results in a lot of disk activity.

I tried running the Gabriel benchmarks on a Macintosh SE with 1 megabyte of RAM. Although it ran, garbage collections and disk accesses were so frequent that it was clear why the manufacturers recommend using a 2-megabyte machine. Most users doing serious artificial intelligence work with this system will want to run it on a Macintosh II with 2 megabytes or more of RAM.

Because I was running so close to the memory limits, I did not think it fair to benchmark Allegro CL on my machine. However, Jean-Denis Muys-Vasovic ran the suite of Gabriel benchmarks on a Macintosh II with 5 megabytes of memory (see the text box "Allegro CL Benchmarks" by Jean-Denis Muys-Vasovic).

What's Missing?

Unlike many state-of-the-art LISP systems today, Allegro CL does not provide complete on-line documentation. There is no on-line tutorial here, either. The written documentation, though excellent in many respects, lacks an index of topics and a concise summary of functions present in the system that are not part of Common LISP. To look up a given function, you have to go to the chapter it should be in and hunt for it.

Also missing is a way of packaging applications for stand-alone delivery. According to the company, a stand-alone application generator, as well as a foreign-language interface to C, Pascal, and assembly language, are in the works.

Allegro CL is a very well crafted programming system, but I regret that the CLOS system standard, the object-oriented extension to Common LISP, has not yet been finalized. The object-oriented aspect of this implementation is extremely important, since the user environment is built on it.

The definitive implementation of the Allegro CL environment will be present when CLOS replaces Object LISP as the object-oriented extension and when the application generator and the foreign-language interface are included. However, since Allegro CL adheres to the Common LISP standard, the base of Common LISP programs can be migrated from minicomputers to the microcomputer world. Also, the benchmarks show that, when used with a machine like the Macintosh II, Allegro CL is clearly a system on which substantial development efforts can be conducted. ■

Personal REXX

Namir Clement Shammas

Personal REXX 1.6 ($125) from Mansfield Software Group implements a subset of VM/CMS REXX on the IBM PC, with some extensions to tap into DOS. REXX is an interpretive, mainframe programming language similar to PL/I but easier to learn. Personal REXX also contains additional functions specifically for the IBM PC. (The original REXX was created by Michael Cowlishaw of IBM's United Kingdom Scientific Center.)

As a programming language, Personal REXX supports structured coding, an external stack, and global variables, and it provides various clauses, constructs, and looping features. It lacks the math functions and working memory necessary to be a useful general-purpose language, but its parsing and environmental-interfacing capabilities make it a powerful language for batch programming. For a summary of its capabilities, see table 1.

Personal REXX requires an IBM PC, XT, AT, PS/2, or compatible with at least 256K bytes of RAM and one disk drive, running MS-DOS or PC-DOS 2.0 or higher. It occupies from 115K to 140K bytes of memory, depending on the size of the internal-storage area (ISA), which may range from 10K to 40K bytes. The default ISA size is 30K bytes; you can change it with the command `SET RXISA=nn`. Personal REXX also supports the Expanded Memory Specification (EMS). I tested Personal REXX on a 6-megahertz IBM PC AT running under PC-DOS 3.1 with 512K bytes of RAM, 1.5 megabytes on an AST Advantage! card, and a 6-MHz 80287 coprocessor chip.

The language comes on one 5¼-inch floppy disk that contains sample programs, several utilities, the interrupt manager, and the interpreter. The interrupt manager is memory-resident and must be loaded before you invoke the interpreter. REXX.EXE contains the Personal REXX interpreter, which is loaded into memory from DOS at the `REXX` command; appending the `/R` command directive makes most of the interpreter memory-resident. RX.EXE invokes the memory-resident version of the language. Adding the `/U` option to the `RX` command will unload REXX.EXE from memory while it invokes RX.EXE.

Data Types and Variables

REXX supports various structured-coding facilities while keeping data typing simple. It uses characters to support two basic data types—strings and numbers—and makes no explicit distinction between integers and reals. Variable names are not case-sensitive and don't have fixed data types associated with them. Thus, a variable that stores a numeric value one time may be reused to store a string of characters another time, and vice versa.

There are three classes of variables: simple symbols, compound symbols, and stems. Simple symbols are synonymous with simple variables. Compound symbols are similar to arrays and use a period in the identifier's name. Stems are identifiers that end with a period and are considered the "parents" of compound variables.

For example, *Total.* is a stem, while *Total.Sum* and *Total.SumSquares* are compound symbols that stem from *Total.* This is not merely an aesthetic relationship; REXX lets you write the clause *Total.* = 0 to assign zeros to all those compound symbols that start with *Total.* Thus, you can collectively initialize compound symbols without using an explicit loop. Compound symbols may contain more than one stem. For example, *Cell.I.J* is a two-dimensional compound symbol; *Cell* is one stem, *I* the other.

REXX supports a string-based, indirect-access scheme with compound symbols not commonly available in other languages. For example,

```
X = "Sum"
Total.Sum = 10;
Total.Sum2 = Total.X
```

The first statement assigns the string constant "Sum" to the scalar *X*; the second assigns 10 to the compound symbol *Total.Sum*. In the third statement, REXX first interprets *Total.X* as *Total.Sum*, since *X* has been assigned the value "Sum." Consequently, REXX assigns the value 10 to the compound symbol *Total.Sum2*.

Stacks and Global Variables

REXX uses an external stack, or queue, onto which its programs can put data items. The words *stack* and *queue* refer to the same structure; the difference between the two lies in how the structure is used. The `PUSH` instruction sends data

continued

onto a last-in first-out (LIFO) stack, while the `QUEUE` instruction sends data onto a FIFO queue. The `PULL` instruction serves to read data from the stack or queue.

In other words, you have one "pile" of data items. If you `PUSH` data, it goes on the top of the pile; in this case, the pile is called a stack. If you `QUEUE` data, it goes on the bottom of the pile; in this case, the pile is called a queue. In either case, when you access the data with `PULL`, it comes off the top. There is no way to access data from the bottom of the pile.

In Personal REXX, you must install the stack and specify its size (between 1K and 62K bytes) using the stack-manager utility that comes with it. The external stack also lets you increase the size of the type-ahead buffer from the standard 15 keystrokes to a maximum of 159.

A REXX utility also maintains external global variables that are static and accessible to different programs. These global variables divide into three classes, based on their lifetimes: *Simple* global variables remain in memory until you power down or reboot the system; *session* global variables are retained for the life of a session, which can span several reboots; and *permanent* global variables are available permanently. Session and permanent global variables are stored in the DOS files SESSION.GLV and LASTING.GLV (always located at the root directory of the current drive), respectively. To start a new session, you must erase the SESSION.GLV file. REXX provides commands to transfer data among the various global variables and both local variables and the external stack.

The `GLOBALV SET` *`var_name value`* command defines a simple global variable and assigns it a value. Similarly, the `GLOBALV SETS` and `GLOBALV SETP` commands set session and permanent global variables, respectively. The `GLOBALV PUT` and `GLOBALV GET` commands provide duplication of the global variables and their contents between REXX programs and the memory area for global variables. You can also group global variables.

Clauses, Constructs, and Loops

REXX programs consist of various kinds of clauses: null clauses, labels (used to define procedures, functions, and error-trapping code), assignments, instructions, and commands. You may place multiple clauses on one line, but they must be delimited by semicolons.

REXX provides a collection of math, string, comparative, and logical operators. It supports the four basic numerical operations plus raising to a power, integer division, and remainder. Double bars are used to concatenate strings. The logical AND, OR, XOR, and NOT operators are also available. There are two sets of comparative operators: one for normal comparisons (in which strings may be padded with trailing blanks), and the other for strict comparisons (in which strings must be exactly the same). For example, a normal comparison of `(' '=")` yields a 1, for true, but a strict comparison, `(' '==")`, returns a 0, for false.

A number of instructions exist to control numeric accuracy and display format. For example, the `NUMERIC FORM [SCIENTIFIC | ENGINEERING]` specifies scientific or engineering format for displayed numbers. Also, `NUMERIC DIGITS` *expr* specifies the arithmetic precision to *expr* significant digits. You can assign the number of digits you want to ignore during a numeric comparison with the instruction `NUMERIC FUZZ` *`expr`*.

There are two decision-making constructs: the `IF...THEN...ELSE` and `SELECT` statements. If you put the `THEN` and `ELSE` clauses on the same line, you must precede the `ELSE` keyword with a semicolon. If the `THEN` and `ELSE` clauses contain multiple statements, you must enclose them in a `DO...END` block. While this resembles Pascal's `BEGIN...END`, it is actually a single-iteration `DO` loop in REXX. You can't have `ELSE-IF` components in an `IF` statement, although nested `IF` statements are supported. However, you can obtain the effect of one or more `ELSEIF`s with the `SELECT` statement.

The `SELECT` construct doesn't contain a switch expression with its accompanying case lists. Rather, the `SELECT`

Table 1: *A list of the capabilities and functionalities of Personal REXX.*

Interpreter	Yes
Support visual environment	No
Built-in editor	No
Data types	Numeric and string
Need to declare scalar variables	No
Need to declare nonscalar variables	No
Support external stack	Yes
Support external static global variables	Yes
Decision-making constructs	
`IF` statements	
`IF...THEN`	Yes
`IF...THEN...ELSE`	Yes
Multiline `IF...THEN...ELSE`	Yes
`ELSEIF`	No
`SELECT`	Yes
Use switch variable	No
`OTHERWISE` clause	Yes
`DO` loops	
One-iteration loop	Yes
Fixed iteration loop with no control variable	Yes
Open loop	Yes
Fixed iteration loop with a control variable	Yes
Step option	Yes
`FOR` fixed number of times	Yes
`WHILE` test	Yes
`UNTIL` test	Yes
Cycle in a loop	Yes
Exit a loop	Yes
Multiline user-defined routines	
Functions	Yes
Procedures	Yes
Recursive	Yes
Predefined functions	
Basic string manipulation	Yes
Extended character-based word manipulation	Yes
Math functions	No
Data-representation conversion	Yes
Date/time functions	Yes
PC hardware-information query functions	Yes
DOS access functions	Yes
PC hardware-access functions	Yes
Windows	Yes (library)
Text-file I/O	
Sequential, variable-length line I/O	Yes
Sequential character I/O	Yes
Random-access, variable-length line I/O	No
Random-access character I/O	Yes
Error trapping	Yes
Resume execution of offending lines after error	No
Tracing capabilities	Yes
Interactive tracing	Yes

keyword is followed directly with one or more WHEN clauses, each containing a complete logical expression. The THEN keyword separates the logical expression from the outcome statement (with multiple statements enclosed in the single-iteration DO...END loop here also). SELECT also has an optional OTHERWISE clause that acts as a catch-all. For example,

```
SELECT
 WHEN x = 1 THEN
  DO
  statements
  END
 WHEN x > 1 THEN
  DO
  statements
  END
 OTHERWISE
  DO
  statements
  END
END /* SELECT */
```

REXX supports three forms of the DO loop: single-iteration (DO *statements* END), repetitive, and conditional. The repetitive loop may indicate the specific number of iterations, the keyword FOREVER (to loop continuously), or a loop-control variable, *var* = *first* TO *last* [BY *step*] [FOR *count*]. The conditional loop contains either WHILE *logical expression* or UNTIL *logical expression*. Repetitive and conditional clauses can coexist in a single DO loop.

DO loops end with the END keyword and an optional end-of-loop name. The ITERATE instruction is used to cycle the innermost DO loop. ITERATE has an unusual ability: You can skip the remaining portion of one or more inner DO loops and cycle back to an outer DO loop, so that any intervening inner loops are bypassed. You specify an end-of-loop name on the ITERATE instruction to cycle to the END statement of the outer loop (which also contains the end-of-loop name); then the outer loop continues if it has more iterations to perform. To my knowledge, the only other programming language with this ability is Ada. You can also exit a DO loop altogether with the LEAVE instruction.

Environmental Issues

Console I/O in REXX is simple but flexible. The SAY instruction displays items on the screen; you can list multiple items delimited by spaces after the SAY keyword, which always issues a carriage return. For keyboard input, you can follow the PULL instruction with a list of input variables, and you can use PULL with the PARSE instruction.

The combined PARSE PULL command lets you control input assignment. For example, PARSE UPPER PULL translates the input characters to uppercase. In addition, PARSE can store input in several variables with or without an input template. For example, PARSE PULL hours ":" minutes ":" seconds takes a string from the keyboard input, such as 12:22:50, and assigns 12 to *hours*, 22 to *minutes*, and 50 to *seconds*.

PARSE is not limited to keyboard input, however. It can work with other program components, such as variables, the program's arguments, source code lines, and input-file lines. This instruction can parse the contents of a variable (using a data template), extract information, and store it in other variables. For example, if the variable *name* contains the string "Ada Augusta Byron," then the statement PARSE VAR name first 4 middle 12 last assigns "Ada" to *first*, "Augusta" to *middle*, and "Byron" to *last*.

One highlight of this language is its ability to interact with its environment. Typically, the environment for Personal REXX is DOS. However, in place of DOS, you can invoke the language from Mansfield Software's editor, KEDIT, and make it REXX's environment.

The interface between REXX and its environment is not at all casual. The environment is such an integral part of the language that any program instruction the interpreter doesn't recognize is considered to be a command and is passed to the environment. To avoid being limited to its "parent" environment, REXX supports the ADDRESS instruction, which lets you direct commands to other environments.

REXX also has an INTERPRET instruction that enables the interpreter to read a character string as instruction code during run time. This is a very powerful mechanism for user-modified or self-modifying programs.

Functions and Procedures

Function and procedure declarations begin with a label name (which ends with a colon), followed by the PROCEDURE keyword. If the function or procedure needs to access global variables, an EXPOSE *variable_list* clause follows the keyword. The called routine can alter the values of exposed variables; any parameters are declared on the line following the PROCEDURE line.

Procedures are CALLed with their optional parameters delimited by spaces; they issue a RETURN to the calling routine without any returned value. Functions, on the other hand, are CALLed with their optional parameters enclosed in parentheses; they issue a RETURN *expression* to the calling routine, with a value in the predefined variable, RESULT.

In a REXX program, functions and procedures follow the main program body, which must end with an EXIT statement. Like procedures and functions, the main program can define a list of parameters (REXX calls them arguments) delimited by spaces. However, these arguments receive their values from the input typed at the DOS command level. If more arguments are supplied than are declared in the main program or routine, the last-declared argument inherits any extras. REXX's predefined string-manipulation functions let you detect and extract each of the extra arguments.

Personal REXX 1.60

Type
Interpretive programming language

Company
Mansfield Software Group Inc.
P.O. Box 532
Storrs, CT 06268
(203) 429-8402

Format
One 5¼-inch floppy disk

Language
C language

Hardware Required
IBM PC, XT, AT, PS/2, or compatible with at least 256K bytes of memory (640K bytes recommended) and one disk drive

Software Required
MS-DOS or PC-DOS 2.0 or higher

Documentation
210-page *Personal REXX User's Guide*; *The REXX Language: A Practical Approach to Programming* by Michael Cowlishaw (Prentice-Hall, 1985)

Price
$125

Inquiry 884.

The language also provides a collection of built-in functions, most of which fall into the following categories: string manipulations, conversions among different numeric representations, file I/O, time and date queries, and queries about arguments. Notably absent, however, are math functions, such as logarithms, trigonometric functions, and square-root calculations.

The most impressive functions are the ones for string manipulation. They resemble those of BASIC or Pascal, but they pay special attention to character-based words. Spaces in a character string are considered to be word delimiters. The word-related functions deal with word

continued

position and word count, as opposed to character position and character count. You can extract words from a string, count the words in a string, and obtain the position of a word in a string.

For example, to extract the third word in the string *Name*, you would use the function `WORD(Name,3)`. Similarly, to delete four words from the string *Days* starting with the second word, you would use the function `DELWORD(Days,2,4)`. In other words, you don't have to know the exact character position of the word or the length of the extracted or deleted strings. The REXX functions do the work.

Personal REXX also provides functions for tapping into the hardware and the operating system. The hardware-information routines return data such as the genre of the IBM PC (including the new PS/2 models), the number of serial and parallel ports, the date of the installed ROM, the amount of RAM, and the number of floppy disk drives.

The DOS function group performs operations such as changing directory or drive, returning the current directory path, getting a directory of files, returning the volume label, creating or deleting a directory, and returning the value of a DOS environment parameter.

The hardware-access group contains routines that manipulate the screen cursor, the screen, and the display attributes. Other routines in this group perform `PEEK`s and `POKE`s and port I/O.

A fourth group includes miscellaneous routines that perform data conversion, return the amount of EMS memory available, convert a string to uppercase or lowercase, and return the stack status. The RXWINDOW library contains a set of window functions that let you open and close a window, display the borders, perform I/O, define or remove an input field, and set the attributes of an entire window or portions of it.

REXX supports file I/O using text lines or characters. The `CHARS(`*`filename`*`)` and `LINES(`*`filename`*`)` functions return a 1 (i.e., true) if there are more characters or lines, respectively, to be read from the file. Thus, REXX provides two forms of the logical `EOF()` function common in BASIC and Pascal.

The functions `CHAROUT` and `LINEOUT` write characters and lines, respectively, out to file. Likewise, you can use `CHARIN` and `LINEIN` to read characters and lines, respectively. REXX automatically opens files the first time you attempt to read from or write to them.

Personal REXX deviates from the mainframe version by not supporting random access of variable-length lines, since PC-DOS does not support such a file-access scheme. However, while performing character I/O, you can specify the starting location of the I/O task. This is REXX's mechanism for supporting random character access.

Tracing and Trapping

REXX also offers flexible tracing capabilities. Using tracing directives, you can trace all clauses (`A`), commands (`C`), errors (`E`), failures (`F`), results (`R`), intermediate results (`I`), and labels (`L`). Personal REXX can also redirect the trace output to the printer.

Personal REXX also supports interactive tracing, during which the interpreter executes a clause and then pauses to wait for your command. You can respond by pressing Enter, to resume execution, or by typing = to re-execute the last clause; any other response goes to the interpreter for immediate execution. While tracing, REXX displays various symbols at the beginning of each line to indicate the nature of the item shown on that line (e.g., result, intermediate result, or label).

The language provides two general error-trapping mechanisms via the `SIGNAL` instruction. In the first, `SIGNAL` directs the program flow to a label that is either a string constant or an expression (whose value specifies the target label). The predefined variable `SIGL` returns the offending line of source code.

The second mechanism tackles predefined types of fatal errors by using `SIGNAL [ON | OFF]` *`condition`*. Some error examples are `SYNTAX`, which occurs when REXX detects a syntax error; `NOVALUE`, which occurs when an uninitialized variable is used to evaluate an expression; and `FAILURE`, which occurs when a command passed by REXX to its environment fails.

Error trapping doesn't contain any program-resumption mechanism, so you can't simply resume executing a troubled program. This is acceptable since most REXX programs are batch programs, and a malfunctioning batch file can cause unexpected damage.

Testing Personal REXX

I generated Personal REXX programs to run the BYTE Floating Point, Disk Write, and Disk Read benchmarks on my system. I loaded the REXX programs and interpreter from a RAM disk. For comparison, I also ran the same tests in BASICA 3.10 on the same machine.

The Disk Write benchmark timings were almost identical (47 seconds for Personal REXX and 46 seconds for BASICA to write a 64K-byte sequential text file to a blank, formatted floppy disk). However, the Disk Read timings differed significantly: BASICA required only 23 seconds to read a 64K-byte sequential text file, while Personal REXX needed 90 seconds. I can't find any reason for this difference in performance.

Performance on the Floating Point benchmark (performing 10,000 iterations of a double-precision multiplication and division test) also varied considerably: 176 seconds for Personal REXX and only 79 seconds for BASICA. This difference is more easily explained: Personal REXX doesn't use the 80287 to enhance its slower interpreter.

I was unable to run the Sieve benchmark because I ran out of ISA memory. The Sieve contains a very large array, and Personal REXX's 40K-byte maximum for both program and variables was not enough.

[Editor's note: *FLOATPT.REX, WRITE.REX, and READ.REX contain the code used for the benchmarks. ROOT.REX is a REXX program that solves for the root of a nonlinear equation. It provides an example of the* `INTERPRET` *instruction and lets you key in the function's expression (as well as a guess at the root) at run time. These four programs are available in Personal REXX 1.6 source code for the IBM PC and compatibles on BIX, on BYTEnet, on disk, and in the Quarterly Listings Supplement. See "Program Listings" in the table of contents. To "find" source code in the Listings areas on BIX and BYTEnet, search by article title, author, or issue date. Some archived files may contain numerous listings for a single article. A description of the file also accompanies each entry.*]

Capability-Oriented

As a general-purpose language, Personal REXX is limited by the size of its 40K-byte working memory and the absence of math functions. It is also a fairly slow interpreter overall. However, its strength lies in its capabilities, not its speed. Its DOS interface, hardware-access functions, and ability to address various environments, along with its parsing, word-manipulation, and string-manipulation functions, make Personal REXX a very powerful batch language. ■

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VIEWS FROM BIX: PERSONAL REXX

other.langs/reviews #4, from Paul Hoffman.

There are over 100,000 PCs connected to IBM mainframes, and probably at least 75,000 are running CMS (Conversational Monitor System). The fact that Personal REXX is so close to REXX under CMS means that these users can now control their PCs in a fashion almost identical to how they control their mainframes. With more and more people using CMS, learning about how to use a very basic CMS tool like REXX is very valuable. Personal REXX is an excellent way to do so. It also lets you write scripts/macros/batch files on one machine and easily convert them to run on the other.

other.langs/reviews #7, from Salvatore Ricciardi.

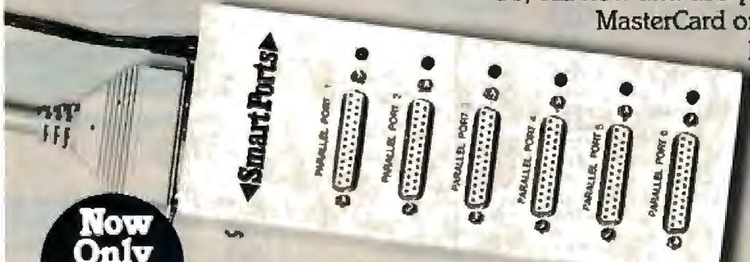
The review fails to mention that REXX is IBM's SAA (Systems Application Architecture) committed command interpreter. Certainly this merits a note. The main advantage of Personal REXX is its use as a replacement for Batch and as a programmatic interface to KEDIT. I don't believe it is meant to be a replacement for BASIC. While the language features are there, perhaps it should be reviewed in the context of a command interpreter that has a good set of language features.

other.langs/reviews #12, from Mark Guzdial.

The product doesn't impress me from this review. I have more capability from the Unix Shell or the public domain shells for the PC, so the language description makes the product sound rather weak. But I can understand the argument that this is a great environment for developing scripts to use on CMS. That would impress me more and give me an idea of the real value of the product.

other.langs/reviews #13, from Cheyenne Wills.

From a language viewpoint, REXX is a very nice command language (if you are from the Unix world, read "shell language"). It just so happens that you can use the same language for your editor macros, or anything else that has been set up to interface with it. Having REXX on the PC means that I can replace all my .BAT files with a "real" language. (IBM also markets a subset of REXX for the PC. It is included with the VM BOND product.) By the way, what I use REXX for mostly is not command scripts, but editor macros.



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@Liberty and the Baler

Paul Schauble and Rick Cook

A spreadsheet compiler lets a programmer turn a spreadsheet into a tamperproof, stand-alone program. It automatically produces a compiled version of the spreadsheet that runs faster and takes less memory than the interpreted version, while producing exactly the same results.

The first generation of spreadsheet compilers makes a bold claim—that you can take a Lotus 1-2-3 spreadsheet and speed up its execution while hiding formula information from users. You can let other people benefit from your work without giving away your secrets.

The two Lotus 1-2-3 compilers we tested, @Liberty—pronounced "At Liberty"—($99.95) from SoftLogic Solutions and the Baler version 3.27 ($495) from Brubaker Software, only partially meet these goals. While spreadsheets compiled with these products give the same computational results as a Lotus 1-2-3 spreadsheet, neither of them is really Lotus command set–compatible. Many spreadsheets will have to be rewritten before compiling with either of these products. Neither compiler is suitable for the casual Lotus user; both assume that the programmer is thoroughly familiar with MS-DOS and Lotus 1-2-3.

The Tests

We tested each of the compilers on six different spreadsheets. Three of these—Savage, Recalc, and Scroll—are used frequently in BYTE. The other three were selected from our previous projects.

We ran the tests on a Multitech 900, an 80286-based AT clone running MS-DOS 3.2 with a 6-MHz clock speed and no floating-point unit (FPU). In addition, the compiled programs were run on a standard IBM PC with and without an 8087 FPU. We used Lotus 1-2-3 version 1A for all comparisons.

@Liberty

@Liberty comes with one manual for the spreadsheet programmer and 10 copies of the run-time manual for executing compiled spreadsheets. Under the program's license, you cannot copy any part of the package, so distributing the compiled spreadsheets requires buying one copy of @Liberty for each 10 users.

These spreadsheet compilers are among the first of their kind

The typeset manual adequately covers the features of @Liberty, and it is easy to understand. The preparer's manual is written at a fairly high level and assumes the reader is quite familiar with both Lotus and general computer-operating techniques.

The run-time manual (packaged separately) lacks installation instructions, and so cannot stand alone. This is unfortunate, since it could have been written for a less-experienced operator.

Because of these documentation limits, the compiled spreadsheets need to be operated by a knowledgeable person. You can't simply put one on a disk, mail it out to all your field offices, and expect untrained users to get it up and running.

We tested a version of @Liberty identified only as the "initial version." @Liberty consists of a separate compiler and run-time modules. It requires an IBM PC–compatible machine using PC-DOS or MS-DOS 2.0 or higher with a monochrome, CGA, EGA, VGA, or Hercules video card and display. The graphing features will not operate on a standard monochrome monitor.

@Liberty automatically senses and uses an 80x87 FPU when present. Memory requirements depend on the spreadsheet being processed. The compiler operates on any machine with 384K bytes of RAM, enough to support Lotus itself. The run-time module executes most moderate-size (1000- to 2000-cell) spreadsheets on a 384K-byte machine.

@Liberty processes spreadsheets in the Lotus 1-2-3 version 1A format. It claims to process spreadsheets from Lotus 1-2-3 version 2, as long as they do not use commands unique to version 2.

The biggest weakness of @Liberty is its minimalist approach to spreadsheet programming. The run-time package does not support a number of Lotus 1-2-3 commands, including `RANGE`, `COPY`, `MOVE`, `DATA`, and most of the Worksheet submenu. The documentation claims these commands are used only for designing a spreadsheet. Unfortunately, this isn't quite true; these commands are often used in macros.

To alleviate this problem, @Liberty provides many additional macro commands (e.g., `BORDERS ON/OFF`, `BEEP`, and `HOME ON/OFF`). This helps, but these commands are not supported by Lotus. This makes it impossible to move a spreadsheet directly from Lotus to the compiler. Rather than creating and testing a spreadsheet in Lotus and then compiling it, you end up using Lotus as a specialized text editor.

@Liberty doesn't always tell you when a spreadsheet will not run because of missing commands. Some spreadsheets compile nicely, but they bomb on execution.

These limitations showed up in our tests. Two of our sample spreadsheets compiled without error, but failed to run. It is possible to rewrite the macros using @Liberty's extra commands, but this requires major changes. It generally is not possible to make a version of one of these

continued

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Table 1: *The timings (in seconds) for the spreadsheet tests using @Liberty and the Baler. File sizes are in bytes.*

	Savage	Recalc	Scroll	Savage error
Lotus				
AT clone	39	2	39	-2.0e-08
PC w/o 8087	127	5.6	121	
PC w/ 8087*	127	5.6	121	
@Liberty				
Compile time	16	33	33	
Compile size	33,391	75,787	75,787	
AT clone	47	2	81	-1.00e-06
PC w/o 8087	166	2.3	282	
PC w/ 8087	12	2	N/A	
Baler version 3.27				
Compile time	656	520	520	
Compile size	42,661	63,573	63,573	
AT clone	17	1	16	-3.56e-09
PC w/o 8087	163	10.8	173	
PC w/ 8087	9.3	4	N/A	

N/A = Not applicable; an 8087 does not affect scroll operations.
* =Lotus 1-2-3 version 1A does not support an FPU.

spreadsheets that works in both Lotus and @Liberty. We did not convert these spreadsheets for this review.

The Savage, Recalc, and Scroll spreadsheets converted and executed without error, but none contained any macros. On Savage and Recalc, the precision of the calculations was very good. In all three cases, the final results from @Liberty matched those from Lotus.

Although a compiled program usually executes faster than an interpreted one, @Liberty's spreadsheets were considerably slower than the Lotus originals (see table 1). Execution times without an FPU were about 20 percent to 30 percent longer than the spreadsheets run with Lotus. However, the compiled spreadsheets were about 15 percent smaller than their Lotus counterparts. [Editor's note: *Soft-Logic Solutions claims that it is possible to create @Liberty spreadsheets that run faster, slower, or the same as their Lotus counterparts. The individual operations in @Liberty are slightly slower than Lotus; but where Lotus recalculates all cells in a spreadsheet, @Liberty recalculates only those cells whose values are affected by a previous calculation.*]

One feature of @Liberty, notably absent in Lotus, is control over screen colors. The @Liberty run-time package has commands to separately change foreground and background colors for the data and command areas on the screen; however, the commands are present only in the run-time package, so the programmer cannot select colors. Once set, colors will not be saved with the spreadsheet and must be reset manually each time you load the spreadsheet.

The Baler

The Baler comes on three floppy disks in an IBM-size three-ring vinyl binder and cardboard slipcase. There is only one copy of the program and manual in the package, but the license agreement lets you make unlimited copies of the run-time software, and the compiled spreadsheets may be distributed without royalty or limitations. Unfortunately, this privilege does not extend to the manual, so the programmer has no documentation to include with the compiled spreadsheets. Brubaker Software would do well to produce a separate, copyable manual for the run-time package.

The manual assumes the reader is experienced with both Lotus and MS-DOS. Even so, it leaves too much unsaid. While the Baler's commands are much closer to Lotus's than @Liberty's, there are still important differences; for example, the Baler does not support deleting rows and columns from a spreadsheet. These differences are not adequately explained, particularly for the file-handling commands, and the sparse index makes it difficult to find information.

We reviewed the Baler version 3.27. It requires a 512K-byte IBM PC or full compatible running MS-DOS version 2.0 or higher. The Baler does not support any form of graphics and operates only in text mode on any monitor. The memory requirement for the compiled program depends on the size of the spreadsheet. A small spreadsheet (less than 500 cells) executes on a 384K-byte machine. A hard disk drive is a practical requirement: You need to have on-line the spreadsheet, the Baler itself, QuickBASIC, the Baler run-time library, the QuickBASIC run-time library, the linker, and Lotus. You could run from floppy disks, but an edit/compile/test cycle would have you changing disks four times.

The company says the compiler processes spreadsheets from Lotus 1-2-3 versions 1A, 2, and 2.01. It also claims the compiler can process spreadsheet files from Symphony and VP-Planner, provided that they do not use features unique to those programs.

The Baler supports an 80x87 FPU if selected on compilation. If a spreadsheet is compiled without an FPU switch, it will not use an FPU, even if one is present. If a spreadsheet is compiled for an FPU, it will use the FPU if present and emulate it if absent. However, to use an FPU, the spreadsheet must be compiled on a machine with an FPU.

Unlike @Liberty, the Baler is not complete as delivered. It generates BASIC code for Microsoft QuickBASIC version 3.0 and requires that QuickBASIC be installed with it. The Baler's installation instructions do not cover QuickBASIC.

We discovered it is possible to have QuickBASIC installed and working but not usable with the Baler. The problem is that when the Baler does its translation, it creates a batch file that has QuickBASIC calls in it and then executes this file. For this to work, QuickBASIC has to be in the same directory as the Baler or it has to be findable via the "path" variable. When we first tested the Baler, we had QuickBASIC in a directory by itself so the Baler couldn't find it. This requirement is not stated in the Baler documentation, but an experienced programmer should be able to resolve these problems quickly.

The BASIC code is specific to the Baler and probably could not be adapted to other uses. Spreadsheet execution uses the QuickBASIC run-time library and follows those conventions.

One convention the Baler does *not* follow is the MS-DOS convention for handling path names. Under MS-DOS, a filename by itself is assumed to refer to a file in the current directory. Thus, `bale` *`filename`* would compile the spreadsheet in the current directory.

But the Baler doesn't work that way. Instead, it remembers the path name from its last invocation and uses that path. This may help the novice user, but it is guaranteed to confuse anyone familiar with MS-DOS conventions.

Like @Liberty, the Baler also has a set color feature. A configuration file that is used by both the compiler and compiled spreadsheets determines screen colors. The configuration file is distributed with the compiled spreadsheet, so the programmer has control over colors on the screen.

	@Liberty	**Baler version 3.27**
Type	Spreadsheet compiler	Spreadsheet compiler
Company	SoftLogic Solutions 1 Perimeter Rd. Manchester, NH 03101 (603) 627-9900	Brubaker Software 8625 North County Line Rd. E Lafayette, IN 47905 (317) 564-2584
Format	One 5¼-inch floppy disk	Three 5¼-inch floppy disks
Computer	IBM PC or compatible with 384K bytes of RAM and MS-DOS 2.0 or higher with monochrome, CGA, EGA, VGA, or Hercules video card and display	IBM PC or compatible with 512K bytes of RAM; MS-DOS 2.0 or higher and QuickBASIC 3.0
Documentation	100-page programmer's reference and ten 36-page user's manuals	A single 130-page manual for both programmer and user
Price	$99.95	$495 including QuickBASIC
	Inquiry 892.	**Inquiry 893.**

Running @Liberty simply compiles a spreadsheet, whereas running the Baler brings up a configuration menu that allows removal of Lotus error checking, overriding formulas, adding format commands, specifying `Range Protect`, invoking the `Data` commands, and using the data-interchange format (DIF) facility. Removing these features makes the compiled spreadsheet smaller and perhaps more secure. Brubaker Software claims that removing Lotus error checking also reduces run times, but we found no significant differences.

The Baler has a menu-activated audit feature that produces reports that cross-reference and document the spreadsheet. While not a substitute for testing, it helps locate problems in a large spreadsheet and serves as a permanent reference.

The Baler's execution speed was excellent. Run times averaged about half that of Lotus and down to 40 percent of the run times from @Liberty. The price for this speed is very slow compile times. Compiling a spreadsheet with the Baler (our tests left Lotus error checking on) takes from 15 to 40 times longer than @Liberty: Most of the time was spent in the Baler itself; the QuickBASIC compile and link times were relatively insignificant—1 minute out of a 10-minute compile cycle.

The Baler implements much more of the Lotus command set than @Liberty; for example, it implements the `COPY`, `MOVE`, and `RANGE` functions, but @Liberty does not. The only major omission is the graphics facility. In keeping with the style of the manual, the only mention of this omission is buried in an appendix. Unique commands are also provided, mostly for additional display formats that do not affect spreadsheet operation. The compiled spreadsheet has the format commands, `Range Protect` and `Unprotect`, the `Data` menu, and the ability to read DIF files. Despite this, there were still problems with our test spreadsheets.

Of the test spreadsheets, Savage and Recalc compiled and executed without error. Precision of calculation was excellent; the results matched Lotus to more than seven significant digits.

But error checking was a problem. We used the Savage spreadsheet to test error handling on all three products. With Lotus and @Liberty, specifying an invalid starting value resulted in a spreadsheet full of error values, as first the invalid value and then the error propagated through the chain of formulas.

We ran this test through the Baler both with and without Lotus error checking enabled. With error checking, the first formula using the incorrect value was not recalculated and kept its value. The rest of the formulas in the chain used this value in their calculations. Without error checking, the first formula returned a completely erroneous value that was then used by all the other formulas. The result was a spreadsheet filled with incorrect values with no indication of an error. Although no similar problems were seen in the other tests, this did not inspire our confidence in the product.

One of our test spreadsheets failed to compile. One of the cells contained the formula @NPV(B122,D69. . .D69). The compiler converted the range D69. . .D69 to a single-cell reference D69; then it complained that the @NPV function required a range specification. This is obviously a bug rather than a deliberate design decision.

Our second test spreadsheet compiled and executed with only minor changes to its macros. The Baler normally saves spreadsheet data in a different file than the spreadsheet itself. The macros that automatically saved the spreadsheet needed to have the embedded filenames changed. Although we did not do so, we could have changed the macros to execute either in Lotus or in the Baler.

Another test spreadsheet required the same change of filenames but then crashed. This spreadsheet used the Lotus `/FILE COMBINE COPY NAMED` command to extract data from a disk file. The Baler was unable to locate the named range; again, this is a bug rather than a deliberate design feature.

The Savage, Recalc, and Scroll spreadsheets from both compilers were executed on an IBM PC with and without an 80x87 FPU.

The First of Their Kind

These spreadsheet compilers are among the first of their kind. As might be expected of first-generation products, they have serious problems. Neither @Liberty nor the Baler can be expected to reasonably compile a spreadsheet of any complexity. In most cases, the spreadsheet will have to be redone for the limitations of the chosen compiler, and the result will not run in Lotus or in the other compiler. This makes it difficult to construct and debug a spreadsheet with Lotus and then compile and distribute it. The changes required demand a new test cycle.

Unless you really need to distribute a spreadsheet in a form that keeps users from fiddling with the formulas, you are probably better off distributing uncompiled Lotus 1-2-3 spreadsheets or waiting for a more developed spreadsheet compiler.

A good second-generation spreadsheet compiler should completely duplicate the command set and execution characteristics of the spreadsheet program, except for the minimum necessary changes a compiler requires. Ideally, the spread-

continued

sheet program would have a development mode that would exactly duplicate the effects of the compiler.

With this combination, a spreadsheet that has been developed and tested with the interactive spreadsheet program could be compiled and distributed without modifications or the need for retesting. Not only would the compiler have most of the characteristics of the interactive program, but the interactive program would have some of the characteristics of the compiler. Experience with other languages indicates this happens only when the compiler and interpreter come from the same company.

In the meantime, it is important to use @Liberty and the Baler cautiously when you need to hide the information contained in a spreadsheet. A user can run the compiled spreadsheet but can neither modify it nor see the hidden formulas or tables. A compiled spreadsheet can produce a publicly available result with a secret mechanism.

Another advantage is cost. You can distribute compiled spreadsheets without having to purchase a copy of Lotus for each user. Even when you are limited to 10 spreadsheets per copy of the program, as with @Liberty, this adds up to a considerable savings.

However, unless a present need is overwhelming, we recommend waiting for the next generation of spreadsheet compilers to appear. ■

Microsoft's Bookshelf

Rusel DeMaria

We may be on the threshold of an era when such things become commonplace, but for now, a reference source like Microsoft's Bookshelf represents a remarkable advance in computer information technology. Bookshelf is arguably the first general-purpose application for CD-ROM. Bookshelf's CD-ROM contains the complete text of 10 major reference works, as well as a sophisticated memory-resident user interface designed to locate and retrieve information.

The references on the Bookshelf CD-ROM (I tested version 1.00) are: *The American Heritage Dictionary*, *The World Almanac and Book of Facts 1987*, *Bartlett's Familiar Quotations*, *The Chicago Manual of Style*, Roget's II: Electronic Thesaurus, *U.S. ZIP Code Directory;* Houghton-Mifflin Spelling Verifier and Corrector, Forms and Letters, Houghton-Mifflin Usage Alert, and *Business Information Sources* (compiled by the Regents of the University of California).

Since most of its resources are available in book form, you might well wonder what makes Bookshelf such a superior reference source. For starters, Bookshelf's fast search features and its ability to cut and paste directly from CD-ROM to various personal-computer word processors reduce research time dramatically. For example, *The World Almanac and Book of Facts 1987* is nearly 1000 pages of tightly compressed text. Imagine searching such a book for every reference to the city of San Francisco; the task could easily take days. With Bookshelf, you can locate, read, and even transfer passages in a matter of minutes; it took me about 20 minutes to locate and read every reference to San Francisco in *The World Almanac and Book of Facts 1987*.

You can execute Bookshelf either as a stand-alone application or as a terminate-and-stay-resident (TSR) program. When operating Bookshelf as a TSR, you can call it up from within other applications.

Bookshelf fully supports several major word processors, including Microsoft Word (I tested version 3.1), PC-Write version 2.71, WordPerfect 4.2, MultiMate Advantage (version 1), IBM DisplayWrite III, Volkswriter 3, XyWrite III and III Plus, and WordStar 4. It also recognizes Lotus 1-2-3 and Multiplan, but it does not perform automatic lookup and replacement or paste into these applications. Other word processors and text editors may allow a limited interface. For instance, in tests with programs not specifically supported (a beta copy of Borland's Sprint and Broderbund's MemoryMate), I found that lookup and cut-and-paste functions worked very well, but automatic text replacement was disabled in the spelling corrector and thesaurus.

Installing and Learning

To use Bookshelf, you need an IBM PC-compatible computer, MS-DOS or PC-DOS 3.1 or higher, a CD-ROM drive, and the MS-DOS CD-ROM extensions (device drivers generally supplied with the CD-ROM drive that allow your PC to operate the CD-ROM drive as though it were a single, large disk drive). I tested Bookshelf on an 8-MHz AT with 640K bytes of memory, a 30-megabyte hard disk drive, a 1.2-megabyte floppy disk drive, a 360K-byte floppy disk drive, and an Amdek LaserDrive 1.

Before installing Bookshelf, you must install the CD-ROM drive and its driver software. You then execute the Setup program, which presents questions about your equipment and uses your responses to complete installation of the software and modification of the AUTOEXEC.BAT file on your floppy disk or hard disk (whichever you boot from). The full set of programs uses about 600K bytes of disk space. To load Bookshelf as a TSR, simply enter `books` from the PC-DOS prompt; to run the program in stand-alone mode, enter `books /s`.

Once installed, the CD-ROM drivers add about 13K bytes to your system's environment space used by the CONFIG.SYS file. Microsoft's CD-ROM extension driver adds another 28K bytes, and the Books program uses another 135K bytes when residing in memory; thus, Bookshelf requires at least 176K bytes of free RAM. If you want to run any worthwhile applications with Bookshelf installed as a TSR, you'll probably need a 512K-byte machine. Although Bookshelf is tolerant of some other TSR programs (e.g., you can use it with SuperKey if you follow instructions given in a READ.ME file on the Bookshelf CD), Microsoft recommends using Bookshelf without other TSRs. If you discover a conflict while running Bookshelf in TSR mode, you can remove the program from memory using the `Unload` command.

The documentation consists of a short reference and installation guide and a quick-reference pamphlet to commands. The Learn program on the CD takes you through an excellent guided tour of the program and its capabilities. Finally, there is on-line help available through either context-sensitive help screens or a help index.

Using Bookshelf

Bookshelf uses the type of interface popularized by Apple's Macintosh: pull-down menus and dialog boxes with buttons and text entry fields. Bookshelf works with the Microsoft Mouse as well as the PC Mouse from Mouse Systems, but you can also use the program from the keyboard.

When running Bookshelf as a TSR, you call it up by pressing Alt-Left Shift, which causes the Bookshelf menu bar to appear at the top of the screen. At this point, you can hit the first letter of any menu item (e.g., *T* for thesaurus), or you can use the Alt key in combination with a letter key to implement a search or open a particular dialog box.

For example, if you press Alt-Left Shift, then immediately press Alt-*T*, the thesaurus opens and searches for synonyms of any word at the current cursor location (the cursor can be either inside the word or just past it). This allows you to type a word and then immediately check its spelling or look for synonyms or a definition.

Moving around within dialog boxes, which are common to most references, is awkward if you're using the keyboard. The Tab key moves from one text entry field or button to the next. The space bar executes the current button, but the Return key executes the default selection (the default selection's button is surrounded by a double bar). I often found myself pressing the Return key out of habit when I should have pressed the space bar. (You don't have these problems if you use a mouse.)

Bookshelf also uses Macintosh-like scroll bars to handle tables that are longer or wider than a single screen. Although the keyboard works well for scrolling up and down a long table (using the PageUp and PageDown keys), it is sluggish when you scroll across a table wider than one screen. However, you can quickly hide individual columns of any table to bring off-screen columns into view. Additionally, you can lock titles on long tables so that column header information is always displayed as you scroll through the data. (This feature works automatically unless you turn it off from the Options menu.)

The zoom features make Bookshelf operate a little like a hypertext document. [Editor's Note: *For a description of hypertext, see William Hershey's review of Guide in the October 1987 BYTE.*] If you find a reference to a subject in an index or a table of contents, zooming lets you go to the chapter, subheading, or paragraph levels, or directly to the text of that entry. Some searches reveal only the chapter, the subhead, or the first lines of particular results, and you can go to the full text by pressing Return, or you can use `Zoom In` to move down one level. Some entries contain cross-references; others contain footnotes. Special commands under the Options menu let you view these supplementary texts and, in the case of cross-referenced material, to return to the original text immediately.

You can copy up to 50 lines of text at a time into Bookshelf's clipboard; for long passages, you can copy the first 50 lines, then append to the clipboard for as much data as you need. Finally, you can paste the entire contents of the clipboard into your word processor.

Whenever you discover an important passage, table, or other text that you'll want to refer to again, Bookshelf lets you create bookmarks. You add a descriptive title to each bookmark, and later, when you want to return to that point, you simply choose `View Bookmark` (Alt-O) from the Options menu and select the particular bookmark's name. Since Bookshelf stores bookmarks on your hard disk or floppy disk, the number of bookmarks you can create is limited by the amount of free disk space you have.

The References

Using Bookshelf's thesaurus, you can locate synonyms for a word in text or a word that you enter into the thesaurus's dialog box. You can also perform multiple searches and cross-reference the results of a search (i.e., search for a synonym to a synonym). If you're using a Bookshelf-compatible word processor, you can automatically replace the original word on your screen with the selected synonym.

Bookshelf's *American Heritage Dictionary* contains the definitions and origins of over 200,000 words. Its limited phonetic spelling checker is useful on occasion, but I would not rely on it in place of Bookshelf's separate spelling verifier. On the other hand, the wealth of words and their definitions makes this an extremely useful dictionary. For example, "rise" has 35 distinct definitions, many with sample sentences, as well as a set of synonyms and their definitions.

The dictionary's search capabilities are impressive. I searched for all definitions that contained both the words "scientific" and "mathematical," and within about 10 seconds, the program presented four entries: "engineering," "index," "operations research," and "parameter." In contrast, a search for definitions containing either "scientific" *or* "mathematical" took about 27 seconds but located 210 entries.

The dictionary also features a biography and geography section. Each entry is brief; for example, the biographical entry for Nikola Tesla reads: "Tesla, Nikola. 1856–1943. Croatian-born Amer. electrical engineer, physicist, and inventor."

The Houghton-Mifflin Spelling Verifier and Corrector can check the spelling of an individual word or an entire screen of text. If it finds a word it doesn't recognize, it offers you the opportunity to search for alternative spellings, look up another word or spelling, add the word to a user dictionary (so that it can be identified in the future), ignore the word, replace it, or cancel the search. (It does not bypass additional occurrences of ignored words encountered during the same search, however.)

Bookshelf version 1.00

Type
Multifaceted reference and lookup tool on CD-ROM

Company
Microsoft Corp.
16011 Northeast 36th Way
P.O. Box 97017
Redmond, WA 98073-9717
(206) 882-8080

Format
One CD-ROM (High Sierra format)

Hardware Required
IBM PC or compatible; if Bookshelf is used as a TSR, it requires a minimum of 512K bytes of memory for a hard disk drive system (640K bytes for floppy disk drive systems and 256K bytes if used stand-alone); Microsoft Mouse or PC Mouse recommended

Software Required
MS-DOS or PC-DOS 3.1 or higher; CD-ROM drive with MS-DOS CD-ROM extensions; compatible word processor (recommended). CD-ROM drive supported by Microsoft CD-ROM extension software; drives supported include Hitachi 1502S/1503S, Sony CDU-100, and Amdek LaserDrive-1.

Documentation
Short reference and installation guide; quick-reference pamphlet; on-disk tutorial program Learn; help screens

Price
Disk alone: $295
Bundled with Amdek LaserDrive, MS-DOS CD-ROM extensions, and controller card: $1285

Inquiry 894.

The spelling verifier is phonetically based (e.g., it will find "psychotic" from "sikotic"), but it isn't perfect. I asked it to look up the misspelled word "cronic"; it found "ironic." When I instructed it to seek more alternatives, it found "conic" and finally, on the third try, "chronic." By contrast, Microsoft Word 3.1 on the

continued

Macintosh found "chronic" the first time but failed the "sikotic-psychotic" test.

Bookshelf's `Usage Alert` tool checks the proper usage of words and phrases. For instance, you may be unsure whether you should use "effect" or "affect" in a particular sentence. `Usage Alert` determines whether an individual word (or an entire screen of text) has usage rules associated with it. The usage rules displayed are brief definitions. (For example, *principle* is defined as "rule, law" and *principal* as "chief, money.") You also can suppress certain words or phrases so that they will not be flagged during a `Usage Alert` scan.

The Chicago Manual of Style is a well-known reference for English language usage. As a Bookshelf reference, it offers almost instantaneous access to the rules governing good writing. For example, if you have a question regarding punctuation within parentheses, you can search for entries containing "punctuation" and "parentheses." You might want to narrow the search to only paragraphs that contain references to "punctuation" and "parentheses," or further narrow it to refer to "question marks" and "parentheses." Searches of this type usually yield results in less than 10 seconds.

The World Almanac and Book of Facts 1987 is a massive compendium of information ranging from who won the 1985 Academy Awards to a complete list of U.S. senators, imports and exports from each state, and many other interesting facts and statistics. With the *Almanac*, the capabilities of Bookshelf make the search possibilities virtually endless.

Not all words can be the target of search operations. You cannot search for numbers other than four-digit years (e.g., 1987); nor can you use wild cards, so you have to design searches exactly. The good news is that you can put several search criteria on one line (for OR operations; the string to request a search for California or Michigan might read California, CA, Michigan, MI), and you can have up to three levels of AND operators. If you want to search for information containing references to California *and* cotton, you would place "California" on one text-entry line of the dialog box and "cotton" on another.

With over 22,500 quotations in *Bartlett's Familiar Quotations*, you should never be at a loss for someone else's words. You can search by author or by subject matter and construct complex searches on multiple criteria. A search for entries containing references to "crime" or "money" and "politics" came up with one entry from Aristotle and another from Will Rogers.

The *Business Information Sources* reference contains a compendium of business resources, including periodicals and books, government agencies, specific market-oriented groups, and other information for business users. A search for references to "advertising" and "television" revealed seven entries, which included books about television advertising as well as statistical articles.

You use the ZIP code locater to look up five-digit ZIP codes for standard postal addresses. You can either enter addresses into the ZIP code locater's dialog box or place the cursor after the state in a standard two-line address so that when you call up Bookshelf, it reads the address directly from your word-processing document. (It also will paste the complete address back into your document when it has located the ZIP code.)

Although the ZIP code locater even supports post office boxes, it isn't foolproof. In one test, it failed to recognize an address as valid, and in another it returned the wrong ZIP code for a post office box in New York City. The problem in both these cases was that the official *U.S. ZIP Code Directory* contains more than one listing for these addresses, but the program did not return a message to that effect. In all other tests, however, it returned the proper ZIP codes in under 5 seconds.

If you've ever wondered how to phrase a difficult letter or set up a financial form, then you should appreciate Bookshelf's Forms and Letters reference. Divided into four categories (Business Forms, Business Letters, Business Outlines and Checklists, and Personal Forms), the Forms and Letters reference is full of useful information and practical templates. There are financial forms (e.g., financial statements, cash disbursements, and expense tracking); business letters of all kinds (with helpful hints); special outlines for marketing plans, pricing, and other business applications; and several personal finance forms as well. The Forms and Letters' `Transfer Forms` option will transfer an entire form directly to a fully supported word processor. Even if you're using an application that Bookshelf does not support, copy and paste procedures often work. As a last resort, you can copy the form to the clipboard, then save the clipboard to an ASCII file.

Let Your Fingers Do the Walking

Bookshelf's few flaws do not detract from its overall value as a reference. About the only thing missing is an encyclopedia.

There is no question that Bookshelf puts at your fingertips a library of information that won't simply sit on the shelf. It's so easy to find and extract what you want that Bookshelf invites usage in ways that ordinary books do not.

One of the greatest pleasures Bookshelf offers is the opportunity to browse through reference works any time the mood strikes. Finding useful information is aided by powerful search features, but it is also aided by the convenience of a computer interface that can often lead to serendipitous discoveries. For professional writers, students, business people, and anyone who likes to have lots of information, Bookshelf is more than a reference; it is an opportunity. ■

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MGMStation CAD

Rusel DeMaria

MGMStation CAD version 2.09II, from Micro CAD/CAM Inc., is a powerful two-dimensional drafting program that runs on most Macintoshes (512K Mac, Mac XL, Mac Plus, Mac SE and Mac II) and costs $799. MGMStation CAD is not a simple, freehand sketch application, nor is it MacDraw. This program produces high-precision drawings to be used in machining and industrial design. Its floating-point accuracy and finely tuned user interface also allow it to be used by professional draftsmen, architects, or electrical engineers.

Billed as "Professional CAD for the Mac," Micro Graphics Manufacturing Station CAD (or MGMS, for short) offers a wide variety of drafting tools in the form of menus and icons. In addition to the basic tools of the trade (e.g., points, lines, arcs, and fillets), MGMS can create and manipulate symbol libraries, create groups from individual drawing entities, calculate and draw dimension statements, use built-in plotter support,

continued

When Your Computer Sends An *S.O.S.* It Can Cost You *Plenty.*

- •SECTOR NOT FOUND
- •FILE ALLOCATION TABLE BAD
- •DISK ERROR READING FAT
- •DISK NOT READY
- •INVALID DRIVE SPECIFICATION
- •DATA ERROR
- •GENERAL FAILURE
- •ERROR READING
- •WRITE FAULT
- •BAD SECTOR
- •NON-SYSTEM DISK OR DISK ERROR
- •READ FAULT
- •BAD DATA
- •ABORT, RETRY, IGNORE
- •PLUS HUNDREDS MORE !!!

A ***revolutionary, new*** way You can ***successfully*** attack The ***costliest*** problem In business computing today.

No matter what they say, every one of these messages usually means: data loss due to hard disk failure. Part of your business is suddenly missing-in-action. So you call technical support. Pay for *unnecessary* repair or replacement. Pay overtime *attempting* to recover or reconstruct as much of your scrambled information as possible. Spend your valuable time soothing customers' ruffled feathers because one of your computers is "down." *Again.*

Think about it a moment: how much have these disguised hard disk error messages *already* cost you in *unrecoverable* data, time and torture?

Now for the shocker: *your average business user sees these disguised hard disk failures many times each year!* ***But it doesn't have to be that way anymore ...***

The ***good*** news is:

Disk Technician™ and ***Disk Technician+™*** Automated AI Software Systems ***virtually eliminate these DOS error messages by eliminating the hard disk problems that cause them.*** Both are designed to work with IBM PC, XT, AT and true clones.

Disk Technician™ Is
preventive maintenance software
that *repairs* and *maintains* hard disks
by *predicting* and *correcting* failures
before *and* after they happen
— *without removing programs and data!*

Can you *imagine* the time, torture and money you will save yourself? Your department? Your company? *Plenty.*

There is simply no other program that can deliver what Disk Technician™ does. Over 7 years' painstaking R&D were needed to bring this revolutionary system to you.

It's easy to use: requires absolutely *no* technicial skills and *less than 60 seconds* of operator time daily. It runs *automatically and unattended.* Anyone who can press **ENTER** can use it. *Easily.* Read our reviews.

The Power of Disk Technician™

Disk Technician™ predicts, detects, repairs and recovers hard disk data problems on the most fundamental level possible: *that of the single occurance, single bit soft error.*

This unique ability is used as an *early warning* mechanism that allows Disk Technician™ to accurately predict which areas of the hard disk will eventually cause problems — *problems unknown to you until it is too late.*

Only Disk Technician™ is able to find and correct *marginal* areas *before* they affect your valuable data. And your bottom line.

Disk Technician™ keeps a history in its database of failure patterns it detects. The astounding accuracy of Disk Technician™ and the long-term reliability of your hard disks depend on decisions reached by its artificial intelligence (AI) considering data gathered from previous tests it has performed on your system.

Million-dollar mainframe reliability For PCs?

Disk Technician™ uses special proprietary write and read testing to identify marginal bits and/or continual dynamic changes. Then, comparing current test results with its database of previous failure patterns, Disk Technician™ AI makes an *early warning* decision as to whether or not these errors will cause data loss.

The power of Disk Technician™ daily testing, AI, precision accuracy and history database virtually assures million dollar mainframe reliability for PCs.

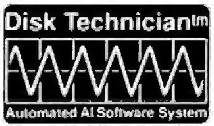
All this and "glitch" protection, too?

SafePark™ memory resident software program (*included!*) works with *all* of your programs *all* of the time to prevent destruction of your data from static electricity, turning power on-and-off, brownouts, surges and spikes. When these "glitches" occur they can write garbage into anything the disk heads happen to be located over — sometimes wiping out an entire disk!

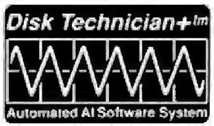
After 7 seconds (user adjustable between 1 - 15 seconds) of hard disk inactivity, SafePark™ automatically moves the heads over a "safe zone" created by Disk Technician™. Once the heads have been moved — which will almost *always* be the case — and a power glitch occurs, any damage will be confined to the safe zone: *protecting your valuable data and programs.*

If reliability, cost and downtime are important to you **— daily use of Disk Technician™ is a must. Because the time to prevent disaster is *before* it happens!**

Choose your hard disk Reliability assurance:



Choose Disk Technician™ for hard disks up to 32 megs with MFM controllers. $99.95



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Circle 209 on Reader Service Card (DEALERS: 210)

MGMStation CAD version 2.09II

Type
CAD program

Company
Micro CAD/CAM Inc.
5900 Sepulveda Blvd. #340
Van Nuys, CA 91411
(818) 376-0008

Format
Three 400K-byte 3½-inch floppy disks: one system disk with installation program and device drivers and two master disks with MGMS CAD application; key disk is required

Implementation Language
Macintosh Programmers' Workshop Pascal

Computer
512K Mac (with two disk drives), Mac XL, Mac Plus, Mac SE, or Mac II

Software Required
System 3.2; Finder 5.3 or higher

Output Devices
Supports Imagewriter and LaserWriter printers and Houston DMP series, Hewlett-Packard and compatibles, Graftek, Gould, and Apple Color pen plotters and Roland plotters

Documentation
Micro Graphic Manufacturing Station, 145 pages

Price
$799 for CAD package with plotter drivers and Geometry Analysis module (calculates area, perimeter, moment of inertia, etc.)

Options
IGES module: $500
MGMS CAD/CAM: $7000

Inquiry 895.

and more. I evaluated MGMS on a Mac II with 2 megabytes of RAM and an NEC MultiSync color monitor.

User Interface

MGMS's user interface is one of its more controversial features. Although it departs from some traditional Mac procedures, given the context of precision drawing, it is both logical and easy to use. Many commands are used for the exact placement of points, lines, arcs, and other entities and often require some keyboard input or several mouse clicks to identify exact locations. This method of manipulation does not resemble the typical MacDraw point-and-drag operations.

One variation on the Mac interface is MGMS's use of icons. The usual pull-down menus are present, but along the left side of the screen are 11 icons; each icon represents a submenu of graphic functions. Though this system differs from the traditional Mac interface, it allows many commands to be accessed from one screen without excessive submenu levels.

Another variation is MGMS's implementation of user prompts. A typical Mac application prompts you for an action using a dialog box that has a message and option buttons. MGMS blanks the menu bar and places a message there with your options. Rather than using a mouse, you type the first character of the option performing the selected action, or type the requested information (text or digits) and hit the Return or Enter key. For example, when selecting `Quit` from the File menu, MGMS prompts `Save the document before exit? •Yes• •No•`; typing n causes MGMS to discard the file and return you to the desktop.

Many menu choices set the program into a specific mode of operation. For instance, choosing `Delete` allows you to delete specific entities from a drawing. You delete by clicking on a particular line, curve, or shape. You stay in delete mode until you leave it by using one of MGMS's convenience features—the "mouse escape." To escape any ongoing mode, you just move the mouse to the left-hand row of icons, aborting the current action. When working with MGMS, this mouse-escape technique becomes second nature.

Pull-down menus control general features of the program: The File menu controls file operations, printing, and plotting; the Zoom menu controls various zoom options; and the Group menu controls group operations. The General menu allows you to undo certain commands and modify the grid and drawing sizes, as well as repaint all the elements of a drawing, or only the actual drawing group itself (leaving out dimensions, labels, and hatching). The Hatch menu selects various hatch-and-fill patterns (a future version will allow you to select color on the Mac II). The Text menu selects the labeling mode. The Library menu handles specific library functions, and the Calc menu summons an on-screen calculator.

MGMS handles measurements in both the English and metric systems. When entering feet and inches, you can enter a value—for example, 10 feet, 6 inches—as 10f 6; as total inches (126); as decimal feet (10.5f); or as a fraction (10 1/2f). You can enter a measurement in meters or feet at any time by entering the appropriate letter (i.e., 5m would represent 5 meters). Usable coordinate systems include polar coordinates (by angles), Cartesian coordinates (x and y), or user-defined grid coordinates.

Construction Icons

The 11 icon menus used in the actual construction of drawings are Point, Line, Arc, Fillet, Sect(ion), Spline, Rotate, Mirror, Dimen(sion), Types (lines), and Delete. Within each menu are several choices used in creating precision drawings.

MGMS excels at precision drawing. Many options allow exact placement of objects, lines, arcs, and other details. Under the Point menu, there are options for setting an absolute point; incrementing the position of an existing point; choosing a new or an existing point; and finding the midpoint/vector point, a point on an existing arc, a polar increment point, a point on the grid, or any free point. The Line menu includes automatic creation and exact placement of parallel lines; and lines perpendicular to other lines, arcs, free lines, and so on.

You can create all kinds of arcs and circles from existing points in a drawing: from exact center, radius or angle dimensions entered at the keyboard, or in several other ways. In addition, the Fillet menu offers easy ways to create a fillet (an arc that forms part of an imaginary circle and is tangent to two objects) between lines, lines and arcs, two arcs, from arc to point, and tangent between two arcs or tangent between an arc and a point. Another option, `Fillet All Corners`, lets you create fillets on all corners of a figure in one continuous operation.

The Sect(ion) menu enables you to resection lines and arcs and trim intersecting lines and arcs. This menu also includes chamfering (connecting two nonparallel lines by another straight line—similar to filleting, but with straight lines instead of arcs).

The Spline menu contains options that create shapes, curves, and contour offsets. You can, for instance, use a prepared file of Cartesian coordinates (perhaps originally generated from a spreadsheet or database) to define a complex curve, or you can enter up to 80 coordinate pairs from the keyboard. The program then creates a smooth curve between the starting and ending coordinates, using the intermediary points as guides. These coordinates approximate the use of a spline in manually drawn

continued

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Performance Chart
(execution times in seconds)

	Power C	MS C	Turbo C
1) fib*	23.8	47.0	26.4
2) sieve*	27.6	40.2	25.5
3) tdbl*	3.5	9.0	9.6
4) diskio*	13.5	14.2	14.3
5) report**	11.0	86.3	60.7
6) drystone**	36.6	38.2	31.8
Compile/Link	73.9	187.6	81.4
EXE File Size	25120	29008	27184

Benchmarks from Dr. Dobb's Journal* & Computer Language**. First four programs test 1) function calling, 2) loops/integer math 3) floating point math, & 4) disk I/O. Programs 5 & 6 simulate typical applications. Tests compiled from command line using Make supplied with each compiler. Tests run on 8 MHz AT with medium model of Power C 1.0, MS (Microsoft) C 4.0, & Turbo C 1.0.

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MGM works on a standard Macintosh screen. However, it works better on a large screen display because more data in a large design is visible.

curves. The Spline menu also has commands for creating contour offsets for both open and closed figures. You can create inside or outside offsets after you've selected the distance. In effect, the contour offsets create an outline of any shape in the drawing.

The Shapes option, found under the Spline menu, allows you to select predefined shapes, such as rectangle, round rectangle, hexagon/polygon, slot, and D-hole. For each shape, you enter the appropriate dimensions from the keyboard, and the program creates the shape at the current point in the drawing.

The Rotate menu is similarly versatile, letting you rotate and duplicate defined groups in various ways, such as to specific points on the drawing or to a point indicated with the mouse. You also can click and drag groups to a new location or assign them to a new coordinate location entered from the keyboard.

Mirroring allows you to create mirror images around the *x* or the *y* axis or around a sloping *x* or *y* axis. You can choose to include or exclude hatching in the mirrored image.

Dimensions let you mark the two points of a dimension line, then mark where the line should be drawn. You can select different hash marks for the dimension lines from a special Install program that's run separately. You also can nest dimension lines or run them together in one long, subdivided line. The only drawback to dimensioning applies to architects: The vertical dimension statement cannot be placed along the edge of the object or rotated at angles; it always displays horizontally inside the dimension line. Other than that, MGMS offers instant and effortless dimensioning.

Organizing the Data

You can zoom a drawing by setting a new scale or by outlining a portion of the drawing using `Cursor Zoom`. You can use `Cursor Zoom` many times to blow up specific details of the drawing, returning instantly to the full picture using the `Original View` command or typing Command-B (one of the useful keyboard-equivalent commands for selections in the menu bar).

MGMS works on a standard Mac screen. However, it works better on a large screen display such as Megagraphic Images' MegaScreen because more data in a large drawing is readily accessible; on a smaller screen, you spend a lot of time scrolling about the drawing. At first, I found the lack of keyboard equivalents in the left-hand icon menus to be annoying. Constant scrolling of the mouse to the left side of a large screen was cumbersome, but setting the mouse-tracking speed to a higher rate in the Control Panel solved the problem.

Grouping is accomplished in one of two ways: by clicking on individual entities or by defining a region with the mouse. Although MGMS does not have true layering, you can treat groups as layers since you can hide or display any defined group at any time. As an example, you might have a plumbing layout defined as one group in a house plan. By hiding or displaying that group, you could effectively work within different "layers." The disadvantage to this, however, is that in order to make alterations, you have to ungroup the plumbing group, alter it, and then regroup it.

You can define any group as a symbol in a symbol library. Libraries can contain up to 56 symbols, but you can have unlimited numbers of libraries. You can pick any symbol from the libraries, rotate or scale it, then paste it into a drawing at whatever point you choose. Then, if necessary, you can ungroup the symbol, modify it, delete it, or manipulate it using normal group commands.

For more complex effects, you can even load an existing drawing over the current one. You also can import MacDraw (or compatible) documents or export in PICT format via the Clipboard.

You label drawings in the text mode. Labeling is versatile, allowing various types of text displays and labels. You can enter comments, labels, balloons, or tables of entries. Text size can be modified as a percentage of the total drawing, but only two fonts are available: Monaco and a special Symbol font. Also, text cannot be rotated. You can, however, choose different types of pointers, select the exact position at which the text should point, and modify the position and size of text labels as needed.

Documentation and Add-On Modules

MGMS comes with a fairly basic manual and tutorial that—considering its size and complexity—is remarkably easy to learn. However, the learning time required varies depending on how much prior CAD experience a user has.

This is not a package for casual graphics applications. Its real strength is its fine precision. Some experimentation is necessary to achieve fluidity with the program. Experienced users of both AutoCAD and MGMS will like the latter's accuracy of object placement and speed of drawing construction. MGMS's user interface makes designing easier with MGMS than with AutoCAD.

MGMS has a few add-on modules available from Micro CAD/CAM or from third-party vendors. For those people needing full CAD/CAM capabilities, MGMS is ideal because it is often marketed with the Manufacturing Design Systems CAM program (called MGMS CAD/CAM) for accurate manufacturing applications. It costs $7000, but this includes installation and training, and MGMS CAD/CAM uses the Mac and a serial connection to drive manufacturing equipment, quite unlike the situation where buying a software product and reading a manual will suffice. Another company, Compu-Arch, offers three symbol libraries: architectural symbols (for $195), electronic and electrical drafting symbols ($195), and interior design symbols ($195). Micro CAD/CAM also offers an Initial Graphics Exchange Specification (IGES) module for $500.

A Geometry Analysis program also is included with MGMS but, according to the manufacturer, it will eventually be an optional add-on module. The program can determine the area, perimeter, moment of inertia, and center of gravity of a contour or figure. Results can be saved to a file if required.

CAD for the Professional

MGMS is a powerful and versatile CAD program for the Macintosh whose user interface is designed to achieve precision drawings; it may not appeal to people who like to point, click, and drag everything. At times, the precision features may inhibit free-form creativity, but for those who need precise results, that may be a small price to pay. In some cases, it makes sense to do the more free-form work in MacDraw, then import the results to MGMS for further refinement.

Although some Mac users have criticized the user interface's departure from the Mac standard, I think it serves its purpose well. It takes getting used to, but once you pass the learning curve, it provides a great deal of utility, and it lets users accomplish goals in record time. ■

Rusel DeMaria is a freelance writer. He can be contacted at 109 Akea Place, Kula, HI 96790.

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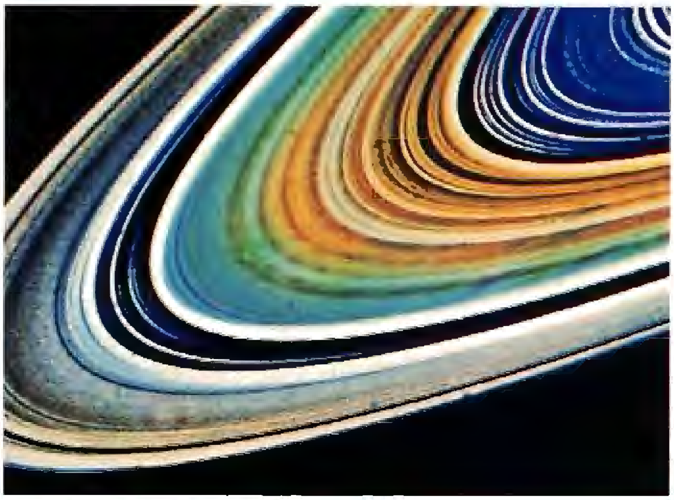

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Circle 93 on Reader Service Card (DEALERS: 94)

A Writer's Tools

Jerry Pournelle

Editors, spelling checkers, and CD-ROMs: searching for the perfect system

I'm back at Chaos Manor after many adventures. *Prince of Mercenaries* is finished—well, there's still the exciting final chapter to do, but that's plotted, and action scenes are easy to write—and ought to be out from Baen Books sometime in 1988. I spent a couple of weeks in Silicon Valley, mostly working on the book, but I also got to Hackers 3.0—the third edition of the Hackers' Conference—and some press conferences. When I got back to Chaos Manor, the place was, of course, filled with stuff, so it's hard to see where I should begin.

Text-Editor Blues

I wrote *Prince of Mercenaries* with Symantec's Q&A Write. This is one of those programs I have to call infuriatingly excellent. I've written about it before, and normally I wouldn't use so much space on one program, but the problems are illustrative. Let me explain.

First, Q&A Write is, in the main, extraordinarily easy to use. The documentation is spotty, varying from pretty good to positively harmful. I'm beginning to think that no text editor can have really good documentation. Still, the help screens really are nice, and most of the instructions are quite intuitive.

Symantec has thoughtfully built in the old WordStar commands—Control-G deletes a character, Control-T deletes a word, Control-F jumps forward a word, and so on—as well as the more "modern" commands, like Control-right arrow to jump forward a word.

Q&A Write also has a very good macro capability. Thus, if you grew up on Electric Pencil, you can redefine Control-Y to be "delete to end of line" and Control-U to be "delete entire line." Indeed, you can key nearly any multistroke sequence to be accomplished by a single command. Good macro capability is essential in a text editor.

Second, it has a quite sophisticated search-and-replace facility. For example, you can search for all italic characters and replace them with underlines in one operation. You can even convert all italic *cats* into boldface **dogs** if you've a mind to.

As it happens, some of the early chapters of *Prince of Mercenaries* had been written on old Zeke the Z80 using CP/M WRITE, which defines underlining by enclosing the text to be underlined in underbar characters, _thus_. I developed a macro that would search for the first underbar character, delete it, mark the text as italic until it came to the next underbar, delete that, and go find the next set.

This worked fine until it found the very last phrase marked by underbars, after which it did strange things. Eventually, I discovered that Q&A Write didn't stop searching and replacing when it reached the end of the text. Instead, it wrapped back to the beginning and started over.

"Intolerable," I muttered. Spelunking through the manual, I found that if I pressed PageDown after I entered the search and replace command mode, I could tell the editor to stop searching at the end of the text. I could even make that the default. If you press the Help key (F1) when in search and replace mode, you'll learn things not discussed in the manual. There are pages of options. Score more points for Symantec.

I ran into at least a dozen things like that, poorly documented or even undocumented features, until I began to believe there wasn't anything that program couldn't do. Then came time to print.

Paging, Paging

My old text editor, CP/M WRITE, doesn't bother with pages. You just type in what you want. If you want to force a page break at a particular point, you insert a formfeed character. WordStar does much the same thing with its `.pa` command. This method is clean, neat, and intuitive.

Q&A Write tries to be "what you see is what you get," or "WYSIWYG," which means that it not only shows you the page breaks, but all the blank lines at the top and the bottom of the page. This is annoying if you're trying to write a column. I don't need to see an electronic analogue of paper.

The page breaks can be eliminated, though, if you tell Q&A Write that your page length is zero. This seems a bit odd, but it does work, and it's what I used when I wrote *Prince of Mercenaries*; and after all, when you're writing letters it really is nice to see the page breaks, so that additional capability is a bonus.

I stored my manuscript as one-chapter files. Q&A Write is a "text in memory" editor, meaning that there's a finite length to the size of a document you can work on. Some people object to that, but it's all right by me. I'd as soon break my work into chapter-size chunks.

However, when I print the stuff, I like to have a different header on each chapter, so that if I'm thumbing through the printed text and find an error, it's easy to see from the header which chapter I'm in. I tend to use a single running header related to the title, then the chapter number, so that *Prince of Mercenaries* would have headings like "Prince-1" and "Prince-2."

Alas, Q&A Write won't let you put headers on a pageless document. WRITE accepts dot commands: you say `.lh Prince-2` (beginning the line with the `.lh`, of course), and from that point on, every page has a left header of "Prince-2" until you put a different `.lh` command

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.

in the text stream. Similarly, you can have variable footers if you like. Not with Q&A Write. Unless your document has been saved with a finite page length, the program won't accept headers or footers at all.

Well, I thought, all right, I'll tell each chapter it now has 66-line pages, and then I'll add my headers. This was a bit of work I hadn't expected to have to do, but it's easier than rewriting the book with some other word processor, which is what I'd probably have had to do, since I don't have a program that converts Q&A Write files to WordPerfect or WordStar.

Before I went to all that work, though, I thought I'd experiment a bit; and that's just as well, since I'd have been wasting my time.

In Memoriam

Nearly every text editor I've used has been a "text in memory" editor: it works only on files it can hold in memory, and it can't create a file larger than the memory space it has to work with. As I said above, some people hate this, but it has never bothered me.

The advantage of "memory only" processing is speed. The disadvantage is that if you want to do a global search and replace, you have to do it for every one of your files. (This is enough of a disadvantage that I've sometimes concatenated WRITE files into one big WordMaster file, done the global replacements, then broken the text back into chapter-size files.)

It's not a problem for printing, at least not with CP/M WRITE, which has provisions for linking files: at the end of the file, you simply put `/ FILENAME.EXT` as the last line (where the filename you give is the filename for the next chapter), and when you go to print, the linked files are automatically read in and printed.

There was once a version of WRITE that actually used the linkages to control search and replace as well, but that got lost in a later version. It would be a great advantage if you could optionally do search and replace through linked files, but it's not vital. Clearly, though, "text in memory" editors simply *must* allow print linkages. This seems so obvious, I never thought about how Q&A Write would handle long documents until I was ready to print *Prince of Mercenaries*.

I found out soon enough. The program solves the problem by ignoring it.

That is: Q&A Write has a provision for linking files. You merely insert a command of the form `JOIN filename`, which has about the same effect as WRITE's `link` in that, when you're printing, as the program comes to the `JOIN` command, it reads in the referenced file and prints it. Alas, it doesn't do that very well, because it ignores the new file's header. The header you put on the very first page of your document will be the header you get for the rest of it.

In fact, `JOIN` ignores the formatting saved with the file and reformats the incoming file to conform with the formatting (e.g., margins, page length, single- or double-spaced) of the file that contains the `JOIN`. That's all right, but it wouldn't give me a different header for each chapter. Whatever header I started printing with would be what I'd keep.

There is another way. Instead of `JOIN`, you can use the Q&A Write `QUEUE filename` command. This one treats the new file as a separate document and thus preserves the header and footer (and formatting) you put on it when you saved it. Since all the chapters were saved as pageless documents, I'd have had to call up each one and change those formats, then save the document again. That might have been worth doing—but `JOIN` begins the *page numbers* all over again each time that it calls in a document. That wasn't precisely what I wanted either.

No WYSIWYG

It took me about 3 frustrating hours to discover all this. I decided to go with the `JOIN` system. That is, I created a document that contained a title page, followed by `*JOIN PRINCE1.QW*`, the page-break command, `*JOIN PRINCE2.QW*`, page break, and so on, all through the 20-odd chapters. This was pretty tedious, but at least I'd get consecutive page numbers from beginning to end. Publishers like that...

Halfway through that process I had an idea. Since I want to create my documents in the "pageless" mode—that is, give the program a page length of zero—but I also want them to have headers, suppose I tell the program that the page has, not zero length, but a very long length, say, 99,999 lines? That way I'd get a header, but no page breaks. It was a good idea, too; but Q&A Write won't accept page lengths longer than about 200 or so. Back to zero page lengths. Tediously, I created the `JOIN` document.

Now, of course, I wanted to print my book double-spaced. Fine. Tell the Q&A Write program that. It accepts the command—and does nothing with it. It will print a document double-spaced, all right, but it doesn't show the double-spaced page breaks.

It doesn't even tell how many pages the document will be: it continues to act as if you were going to print single-spaced. Since one of the options in Q&A Write is to print from page X to page Y, it is a little odd to tell it to print from page 1 to page 7 in order to produce 13 pages of double-spaced text.

When I called Symantec about that, I was told that Q&A Write wasn't intended as an editor to create books. It's mostly meant for business correspondence. I told them I bet there are quite a few people out there who have to create a long document once in a while.

Font Support

If that weren't bad enough, Q&A Write likes to boast of its ability to handle type fonts, and, indeed, it does that in a fairly simple way. I have the Z font for my Hewlett-Packard LaserJet Plus, and it's wonderful, with three sizes each of Times Roman and Helvetica, plus some others. Normally, telling the LaserJet Plus about its fonts is a black art, but Q&A Write does this automatically and can change fonts within a line.

This sounded great, and I wanted to use the feature to write fancy letters with several fonts. Alas, if you tell Q&A Write to print your document in Times Roman of the same point size as Courier 10-pitch (the LaserJet Plus default), it does that nicely, but the page breaks and line-end breaks have zero relationship to what you see on the screen. Formatting the text neatly is nearly impossible.

It's no good trying to use one typeface for your letterhead and another for the body of the letter, either. Sure, Q&A Write will print both fonts on one page, but you'll waste a lot of paper trying to figure out *where* on the page the text will be. There's just no relationship between what you see on the screen and what comes out on paper.

Also, if you have numbers in the text, the columns don't line up. Neither do the tabs. I was using Q&A Write to create my expense reports (it has a primitive calculation routine built in), but I found I had to do them in Courier rather than in Helvetica or Times Roman.

In fairness, Q&A Write is a character editor, intended to run with monochrome screens as well as with machines that support graphics. It's not supposed to show you different fonts on the screen. On the other hand, if you've got graphics capability, you probably ought to have an editor that makes use of it.

Certainly, I want an editor that understands the font metrics well enough to show me, if not the fonts themselves, at least the line and page lengths I'll get when I print. I suppose some business tasks don't require that capability, although offhand I can't think of too many. Any reports that involve forms or tabular columns of numbers will need better WYSIWYG than Q&A Write has.

continued

Paradox: the top-rated relational database manager in the world

Source: Software Digest*

Software Digest Rating	Overall Evaluation	Program Name	Version Tested	Ease of Learning	Ease of Use	Error Handling	Performance	Versatility	Memory Requirement	Price
☆☆☆☆	8.7	Paradox	1.1	🟦	🟦	🟦	🟦	🟦	512K	$495
☆☆☆☆	8.2	XDB	1.10	🟦	🟦	🟦	🟦	🟦	320K	$750
☆☆☆	7.6	PowerBase	2.3	🟦	🟦	🟦	🟨	🟥	384K	$349
☆☆☆	7.0	Open Access II	2.0	🟨	🟨	🟦	🟦	🟦	256K	$395
☆☆☆	7.0	DataEase	2.5/2	🟦	🟦	🟥	🟦	🟦	384K	$600
☆☆	6.6	dBASE III PLUS	1.1	🟨	🟨	🟦	🟦	🟨	384K	$695
☆☆	6.4	R:BASE System V	1.1	🟨	🟨	🟦	🟥	🟦	512K	$700

RATINGS KEY
(On a scale of 0 to 10)
Overall Evaluation

☆☆☆☆☆	9.0 or higher
☆☆☆☆	8.0 - 8.9
☆☆☆	7.0 - 7.9
☆☆	6.0 - 6.9
☆	5.0 - 5.9

All Other Ratings

🟦	7.0 - 9.9
🟨	5.0 - 6.9
🟥	UNDER 5.0

Paradox® is once again the top-rated program, with the latest version scoring even higher than last year's top score." (Software Digest's 1987 Ratings Report is an independent comparative ratings report for selecting IBM PC business software. Ratings Report tests were done by the prestigious National Software Testing Laboratory, Philadelphia, Pennsylvania.)

The Ratings Report message is crystal clear: there is no better relational database manager than Paradox. NSTL tested 12 different programs and amongst other results, discovered that Paradox is 3 times faster than dBASE® and 6 times faster than R:BASE® on a two-file join with subtotals test.†

Paradox combines ease of use with power and sophistication

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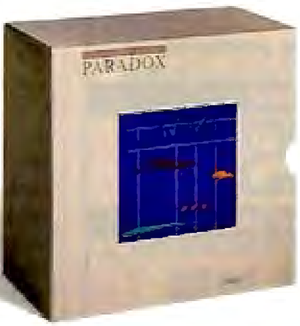
>
> *David Schulman, Bendix Aerospace* "



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*Reprinted with permission by Software Digest from its July 1987 Report covering 12 relational database programs.

†Test was designed and executed by NSTL. A 1,000-record and a 10,000-record file were joined. A short text field from the 1,000-record file and a numeric field from the 10,000-record file were selected (using the 1,000-record file indexes). The short text field was grouped and sorted in ascending order, the numeric field was subtotaled for each group, and the results output to a null printer. Test times from the last keystroke on the command sequence until return of program control were recorded and averaged.

**Rebate request must be received by Borland no later than February 15, 1988. Mail to: Paradox Rebate Department, Borland International, 4585 Scotts Valley Drive, Scotts Valley, CA 95066

††If within 60 days of purchase this product does not perform in accordance with our claims, call our customer service department, and we will arrange a refund.

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Finally, it's inexcusable that the program won't tell me how many pages I'll get if I double-space.

So: here I am with a text editor that's awfully good for text creation. It's about the most transparent editor I've found so far. It doesn't get in the way, the macro capability is good, and there are plenty of built-in commands. It's fast and has the ability to export my text into ASCII files that can be sent into BYTE's Atex system or otherwise put on the wire.

The only trouble is that it can't print a simple double-spaced manuscript of 300 or more pages. Clearly, I was better off with WordStar.

Now What?

I drifted away from WordPerfect largely because of its complexity compared to Q&A Write. Now I discover Q&A Write isn't going to do the job. I'll always want a paper copy of my books. More than that, Jim Baen, my editor at Baen Books, is spoiled: he likes the way the book looks in Times Roman with *real italics*.

I suppose I can live with Q&A Write's limits. It is certainly the easiest to use, really the best in its price range, and maybe they'll make some fixes.

However, I'll be trying several more editors in the next few months. WordPerfect is certainly a contender. It's perhaps more complicated than I need, but what the heck, it does seem to do the job—and unlike Q&A Write, the WordPerfect format is known to a number of desktop-publishing programs that can format my books *exactly* the way I want them.

Another possibility is Microsoft Word 4.0, which people I respect tell me is wonderful. I got to looking at it today, and I still cannot find any references on how to delete a word, delete to the end of the line, or delete an entire line, without taking your hands off the keyboard. As far as I can see, you have to mark the word (either with the arrow keys or the mouse), then hit the Delete key. That gets in the way of creative writing, and I won't do it.

I want to have delete word, delete line, and delete to the end of the line as single Control-key keystrokes. Spelunking through the Microsoft Word 4.0 manual reveals the flat statement that you can build macros to do all this. It doesn't tell me how, but I think I see the light. Given that I can do that, I find a great deal to like about Microsoft Word 4.0; and it will certainly support my LaserJet Plus Z cartridge, since that one was developed for use with Microsoft Word.

The "stylesheet" features are also appealing; Microsoft Word lets you keep files of various formats and insert them

continued

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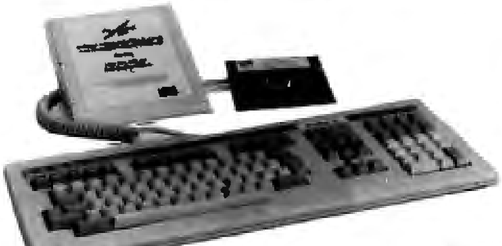

into documents at need. One stylesheet is for letters, another for the opening page of a chapter, another for regular pages, and so on. The Word manual explicitly tells me I can change my "running heads" any time I want to, provided that the new running head is the first paragraph on the page and marked as a header, so I'll be able to print chapters the way I like. All in all, Microsoft Word 4.0 looks very tempting.

I have also promised John Hild, president of XyQuest, that I'll try XyWrite III Plus, which can't possibly be as good as some of my professional colleagues tell me it is. Or maybe it can be.

XyWrite has become something of a standard within the publishing industry. While it's not yet standard practice to submit books on disk, that day is getting closer; and all the publishers I know will accept XyWrite files that have embedded ASCII commands. The way this works, to mark a passage as italic, you use some scheme like <ITALIC>this will appear in italics<ROMAN>; which is fairly easy to do using XyWrite macros.

According to Frank Romano, who is publisher of *TypeWorld* and a spokesperson for the publishing industry, so long as you use a consistent scheme and your text is in ASCII, publishers will be able to translate it.

XyWrite is faster than the dickens, and the only reason I didn't use it in the first place was that version 2.0 would not work with SideKick. XyWrite III Plus has been tamed down so that you can use it with your favorite memory-resident programs.

Finally, there's good old WordStar 4.0 and a new edition of WordStar 2000.

Those are the main candidates. They all swear they are trustworthy, loyal, friendly, thrifty, and very, very fast. Certainly, they'll all do 300-page double-spaced manuscripts with consecutive page numbers and different headers at the top of each chapter.

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I, for one, don't need to see status

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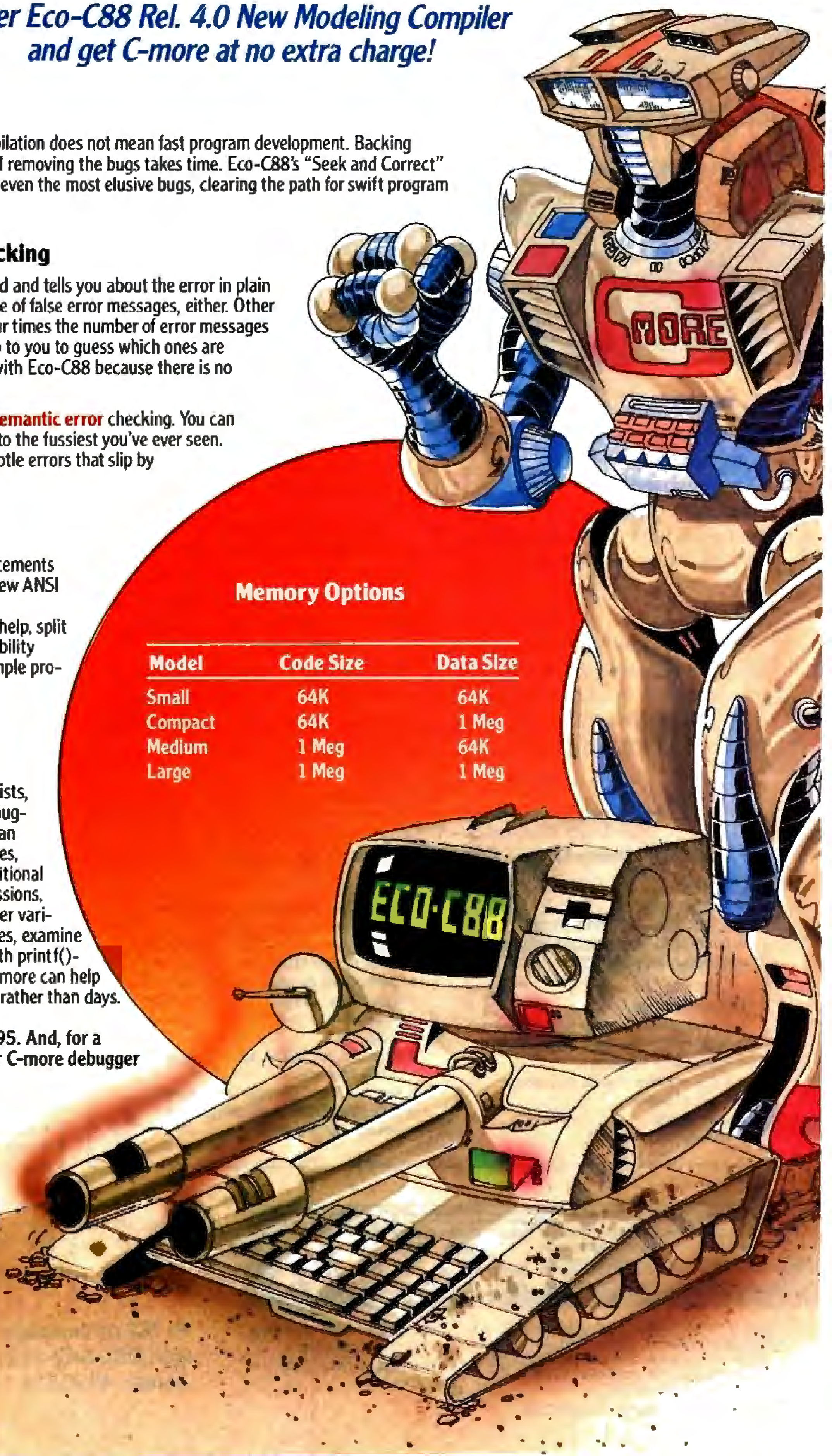

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lines, rulers, help lines, or anything else on my screen; what I want to see there is my text, and the more of it, the better. For reasons I have never understood, editor designers almost never provide a toggle that lets you simply blank out all the helpful information and fill the screen with what you've written and nothing else. I don't know why.

When you're creating text, you don't need a lot of fancy commands. If you write the way I do, with trial sentences and words and suchlike, you will want the ability to do selective deletions cleanly and easily. Of course, you want your paragraphs to reformat as you insert and delete. Also, you want to be able to vary the margins to suit the job at hand, and you want an easy way to get word and line counts. Mostly, though, you want something you can feel comfortable with.

As a businessman, I write a lot of letters, and while most are only a single page, some are longer. It would be nice if my program would, somehow, generate letterhead from normal paper so that I don't have to put letterhead into the laser printer every time I want to send correspondence. It would also be nice if it were easy to call up a "letter format" form to take care of margins and such. Finally, some kind of attached card-file system to keep track of the correspondence would be helpful.

All that, though, can't compensate if the editor can't do the primary task of producing manuscripts in the format that editors like.

As I've been writing this (in Q&A Write; this goes in electronically, so the print problems don't apply, and I won't meet deadlines if I change text editors tonight), I've been checking the Microsoft Word 4.0 manual; so far, I haven't thought of anything it doesn't claim to be able to do. That's certainly the next program to try.

Spelling Checkers

I recall stories of some famous advertising people who insisted that their staff use the products they advertised. If you have the Arrow shirt account, you wear Arrow shirts. Drink Schweppes. Etc. I don't care much about the advertisers, but I sure wish the people who design user software were forced to use it. In particular, I think anyone who publishes a text editor and doesn't use it to create that editor's documents ought to be shot.

It's the same with spelling checkers. Sometimes I can't believe the people who design them actually use them at all.

Take my situation. I write for a living. It's important that my manuscripts be as near perfect as possible. Since Robert

continued

Heinlein once solemnly informed me that I was a terribul spellur, you may imagine my relief when the first really good spelling checkers came out.

Alas, the first few were better than many of those that followed.

A decent spelling-checker program needs *at least* three dictionaries. First is the Main dictionary. This one is saved in a special algorithmic format to make searches faster. It's often impossible to insert or delete words from the Main dictionary.

Second is the Update dictionary. This is the one that gets things missed by the Main dictionary. Words like your own name, lots of plurals, favorite slang expressions, and so on; words you're likely to use in any kind of document.

Third are specialized dictionaries. As a science fiction novelist, for example, I have alien characters with odd names, like Chowpeentulk and Harpanet. I certainly don't want those in the Update dictionary or anywhere else that will be searched when I'm not working on the particular book that employs those names. I thus need, in a word, a Special dictionary.

I can make a good case for there being yet a fourth dictionary, but I won't bother. My point is that I don't want to look at the same dictionaries every time; and of the three dictionaries I use, at least two will have been created by me.

So far, so good. My quarrel with most spelling checkers is that even if they allow me to invoke several optional dictionaries, they make it very difficult to create them.

The exception to this is The Word Plus from Wayne Holder, which offers you one-keystroke commands to put a word into the Update (press *U*) or the Special (press *S*) dictionary. The words are then automatically put in the proper place in the appropriate dictionary file. Since that program first came out in the 1970s, you'd think later program designers would have made theirs at least as good as Holder's used to be, but most didn't bother.

Worse, Oasis now sells a version of The Word Plus that doesn't work that way. Naturally, that's the version Symantec bought. Sigh. On the other hand, Microsoft Word 4.0 clearly uses the old version of The Word Plus and *does* support Update and Special dictionaries.

Microsoft Bookshelf

I knew CD-ROMs were the wave of the future the first time I ever heard of them. I got an Amdek CD-ROM reader as soon as it came out. The Amdek engine is made by Hitachi, and Amdek ships it as a class act, with cables and instructions carefully packaged so that it takes no time to set it up. Of course, once I had a CD-ROM reader, there wasn't much to do with it—*Grolier's Encyclopedia* is interesting to experiment with, but it's not something I use much.

On the other hand, given that Microsoft sponsored the CD-ROM conferences, it was pretty clear that Microsoft would be one of the first companies to bring out a spectacular application of CD-ROM technology; and they did. Microsoft Bookshelf is a preview of the future.

What Microsoft did was put *The American Heritage Dictionary*, *Roget's Thesaurus*, *The World Almanac and Book of Facts*, *Bartlett's Familiar Quotations*, *The Chicago Manual of Style*, the *Houghton Mifflin Spelling Verifier* (a book of forms and letters that will be very useful to small businesspeople), the *U.S. ZIP Code Directory*, the *Houghton Mifflin Usage Alert*, and *Business Information Sources*, along with their indexes, on a single CD-ROM disk.

They then made an interface that's pretty easy to work with. Naturally, it's geared to work best with Microsoft Word 4.0, but so what? I tried it with WordStar, XyWrite, and WordPerfect, and it works fine with all of them. However, it will *not* work with Q&A Write or the current DESQview.

The interfacing isn't perfect. Some of the early beta-test versions were bloody awful. The release version is pretty good. The control software is generally RAM-resident, though you can use Bookshelf as a stand-alone program. When you invoke it, there's a command line at the top faintly reminiscent of Digital Research's GEM.

If you've called up the thesaurus, for example, the program will offer to look up the word that happens to be under the cursor (if you're merely in DOS, that will be the prompt, which the thesaurus is unlikely to find). If you want it to look up a different word, you type that in. Bookshelf shows you the synonyms and offers to substitute one of them. All this works quite smoothly.

The interface with the other books is similar. There are also browse features. When you use it in document mode, you've got the option of cutting stuff out of the books and pasting it into your work. Generally, it's pretty easy to do that.

What's important isn't that there are a few glitches and frustrations in the user interface: it's that, glitches and all, it's a heck of a lot easier to use all those references as part of Microsoft Bookshelf than it is to get up, go find the printed copy of the book, and use it manually. Most professional writers—at least the ones I know—own copies of almost every one of these books, but they seldom use the things because it's just too much trouble. No longer.

When word processors first came out, I was far too lazy to do without one, and as far as I know, I wrote the first book—certainly the first science fiction book—ever done on a microcomputer. Back then, I said that pretty soon all books would be written with the little beasts; and while there are exceptions (I know some writers who still use foolscap and pens they dip in ink), that's a prediction that has effectively come true.

I'll make another: in 10 years (probably fewer), all professional writers will have CD-ROM readers, and if they don't have Microsoft Bookshelf, it will be only because someone has brought out an even more complete set of writers' tools on CD-ROM; and unlike the shelves of reference books we all keep but don't use enough, the CD-ROM references will be used every day.

More Writing Tools

When I went off into hiding to write, I needed something to put Zelda the Zenith Z-248 on, so I hared off to hardware stores. By sheer good luck, I ran into a desk made by Foremost Furniture (502 Middle St., Archbold, OH 43502). Their Model 4530, of simulated wood on fiberboard, is one of the best computer desks I've seen yet, and it costs only about $50 retail.

It's large and has a pull-out keyboard drawer. That drawer is big enough for the keyboard and has a raised level for a mouse; under the raised level is a separate drawer big enough for labels, disks, small tools, and other stuff. There's also a matching hutch. This desk and a stand to hold stuff you're copying from can make a real difference in productivity.

While I was at Spring COMDEX, I bought The Winner, a dual-level computer table manufactured by Hubbard Furniture (P.O. Box 104, Northbrook, IL 60065). This is a stand of good design, better looking than Foremost's desk and a bit smaller. It's good, too, and their catalog is definitely worth writing for.

The right furniture can make a real difference in work habits.

QuickBASIC 4.0

Microsoft has done it again. QuickBASIC 3.0 wasn't bad, but some of it was kludged up and rushed out in order to match features in Borland's Turbo BASIC. It was probably a mistake for Microsoft to do that. In any event, QuickBASIC 4.0 is new from the ground up, with features that are truly stunning.

To begin with, it's got records; that is, data structures that contain several data types. String data must, naturally, be declared as fixed-length (as all strings are in Pascal); once you've done that, QuickBASIC 4.0 records work just about the way Pascal records do. As a result, the dreaded `FIELD` statement is no longer needed. It still exists, but that's largely to retain compatibility with programs written for earlier versions.

Unlike version 3.0, which had a separate compiler for programs to be run on machines with a math chip, 4.0 is unified; there's a conversion program to read your old Microsoft binary-number files, but all mathematical operations are now done in IEEE standard format. You don't have to have a math chip in your machine to compile, but if you do have one, 4.0 will use it automatically.

I think the most impressive feature is the debugger. When you interrupt a program, you are automatically in the appropriate section of the source code. You can cause the assembly language instructions associated with that code to come onscreen. You can also revise the source code and restart the program from where it left off without recompiling the whole thing. The debugger is little short of amazing.

I haven't had QuickBASIC 4.0 very long, but I think I'm in love. This is what BASIC ought to be.

Hackers 3.0

The annual Hackers' Conference has become a bit more sedate, but it remains the most interesting computer conference of the year, at least for me. It's hard to come up with specifics. I spend most of my time talking with small groups, rather than listening to the presentations, and the main result is mutual stimulation of ideas. Mostly, I guess, it's the excitement; this is one of the last places where people aren't ashamed to say they love these little machines.

This year, there were lots of buttons:

MS-DOS & OS/2
Just Say No

There was also a slogan:

PS/2: Yesterday's Hardware, Today
OS/2: Yesterday's Software, Tomorrow

to which I added

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And, of course, there was a strong mixture of Unix enthusiasts. I must say

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that as I watch the OS/2 story unfold, I do begin to wonder: if Unix is ever made stable enough to be put in ROM, so that you don't need a guru to maintain the system, there's less and less reason why it won't catch on. I think of little that OS/2 promises that you can't do with Unix; and now that American Management Systems has actually developed the long-mythical user-friendly Unix shell, who knows?

However, Unix isn't going anywhere without a major backer. The obvious major backer is AT&T, a company with deep pockets, brilliant engineers and designers, and a monopolist's attitude toward marketing. Think how different the world would have been if, a few years ago, AT&T had bought Apple Computer for its marketing savvy.

At one meeting, someone wryly observed that if AT&T would copy-protect System V Unix, within 6 months it would be so widespread that nothing would be able to stop it.

Actually, I suppose the most probable outcome is that a year after OS/2 comes out, there will be as many OS/2 users as Unix users, after which both will continue in parallel and without actually competing, Unix growing slowly, and OS/2 charging ahead; but while that's the most probable event, it's by no means inevitable. After all, the main objection to Unix was that it's too big and too slow—and that applies just as strongly to OS/2.

The main excitement at Hackers 3.0 was hypertext. Hypertext is an idea that Ted Nelson expressed many years ago in, among other places, his book *Computer Lib: You Can and Must Understand Computers Now!*: the idea that document storage needn't be linear, that you can and should be able to jump from one relevant idea to another by ideas and relevance; and that small computers can store ideas in ways that make that easy.

The implementation of hypertext is under the control of Project Xanadu, with most of the work being done by Roger Gregory in his spare time. This project is very probably the library system of the future; the only thing stopping its completion is money. If you've got a spare 10 bucks, there are an awful lot worse things you can do than send the money to Project Xanadu (Xanadu Corp., 2438 Newhall St., San Jose, CA 95128).

Meanwhile, the closest thing to hypertext is HyperCard for the Macintosh. Since everyone else has already written about HyperCard, I don't have to. Interestingly, Apple, the company that seems so quick to complain about "look and feel," had a presentation about HyperCard in which, oddly enough, Ted Nel-

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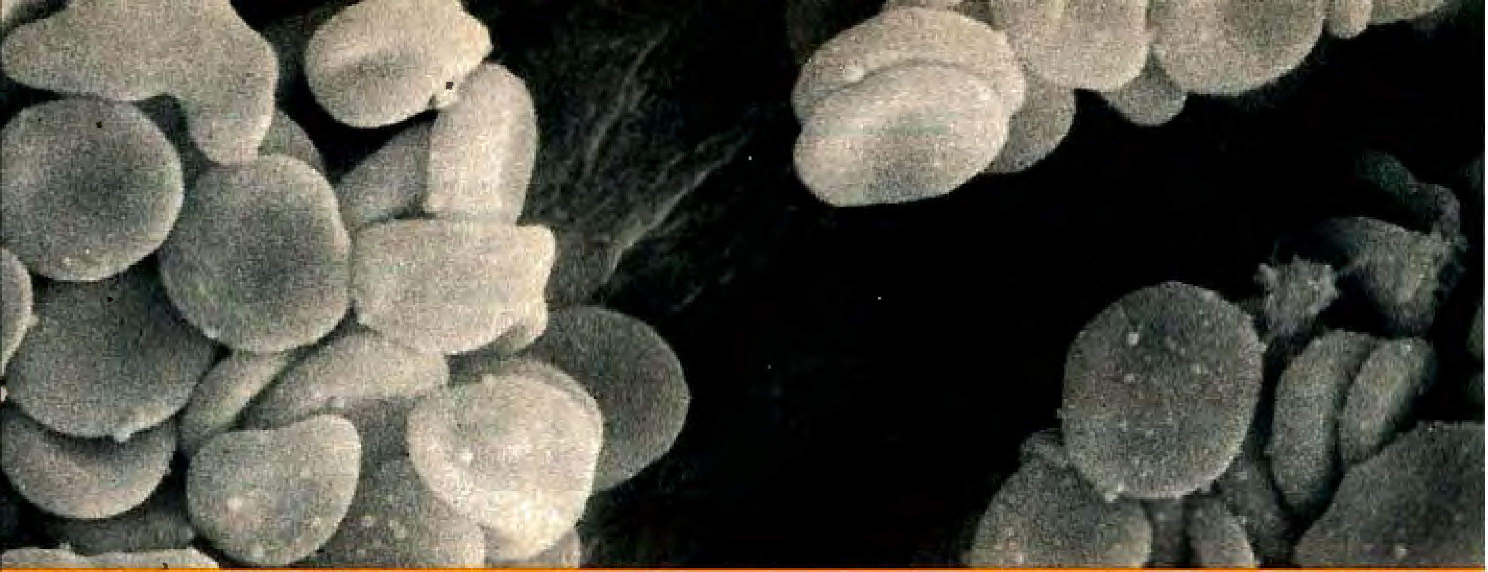

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son's name never appeared (although the Apple spokeswoman who gave the presentation said that would be fixed Real Soon Now).

HyperCard really is a neat hack, a software breakthrough that deserves its popularity.

Fire Power

By far the most popular game at Hackers 3.0 was Fire Power, a new Amiga game from MicroIllusion. This is a joystick-controlled arcade-type game involving tanks. It can be played solitaire against the computer, on a split screen with a live opponent, or through a modem against a live opponent.

The graphics are stunning. There are still a few bugs on interface control. When you blow up buildings—which you do often—they collapse to rubble. No matter how careful you are at driving your tank, you can get it stuck; sometimes stuck so that it's impossible to retrieve. There's no game command to release you. You have to restart the game.

The map is complex, the action is fast, and everyone liked the game. It was fascinating to watch two pacifists yelling like savages as they blew each other's buildings away.

At Hackers 3.0 I played Fire Power awhile, after which someone asked me if I had reconsidered my opinion of the Amiga's multitasking operating system. It seemed a fair remark. However, when I got home and loaded my own copy of Fire Power, I managed to get a system crash and guru meditation (Commodore's miserable excuse for humor in error messages) within 5 minutes.

Since that time, I've seen the guru several times. The game will be going along fine, when two of the automated helicopters will somehow stick together, or one of the tanks gets blocked in a strange way; then the screen goes blank, and out comes the guru.

I don't know if I have a broken copy of the game; at Hackers 3.0 the game was played all weekend, and if there was ever a crash, I didn't see it.

Even with the crashes, this is one of the best arcade games I've ever played. I sure like blowing up my friends.

Ancient Art of War at Sea

I mentioned this one before, but it's just too good to pass off with one line.

Broderbund named this to be reminiscent of their Ancient Art of War, but, in fact, it's not about ancient times: it's the age of fighting sail, and about the best game of that period I have ever seen. There are some limits I wish it didn't have—for example, fleets can have at most three ships in them, so you can't really play out Trafalgar—but for sheer realism, this beats the competition all hollow.

There's a strategic level, in which you give long-range orders to little artificial symbols; and a combat level, in which really neat graphic representations of sailing ships "tack" and "wear ship" and generally react the way you'd expect.

There are six different opponents, from a crazy Viking who makes no plans at all, to Lord Nelson who will probably beat you every time. In addition to the 10 or so preset scenarios, there's a game-building kit that lets you set up your own maps, allocate fleets to yourself and your enemies, and choose your opponent.

I do wish they'd work on the user interface, and there's one serious bug involving captured ships—if you capture an enemy and there's another enemy fleet close behind, the next fight will be between your crippled prize and the new enemy. They'll win, after which *your* next fight will be against their newly recaptured ship, and so on, until you wish you could scuttle the darned thing and get

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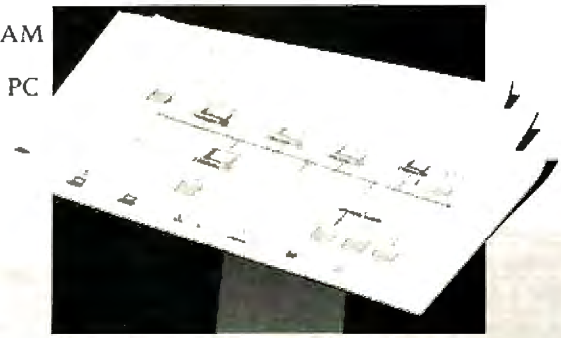

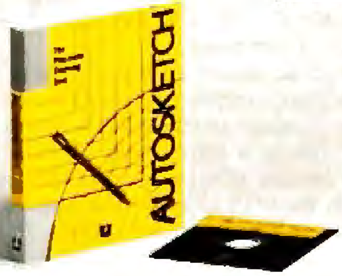

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the whole thing over with.

Forget the bugs, though. You'll love this game. Recommended.

Winding Down

I'm out of space, and I haven't talked about half the stuff here. There's Electrohome's new 19-inch multiple-sync monitor that will handle everything from PGA to CGA and comes with an optional box that will let you connect it to cable to be your television set. This thing is *great.* Next month, I'll try to do it justice.

I also have received Office Publisher, a new desktop-publishing package that's really simple to use. I'm no expert on desktop publishing, but I like this package. The documents actually explain how to do things.

There are new video boards from Orchid and Zenith. Both support a wide variety of video outputs, from CGA to VGA, and thus are designed to work with multiple-sync monitors like the Electrohome. I find EGA color good enough—text on the EGA is crisp and readable—but PGA is even better.

EGA is the business standard now (although there are probably more monochrome monitors in the business world), but it will be a short-lived standard, largely because of some technical design flaws in the EGA chip set (and besides, EGA doesn't have square pixels). If I were buying a monitor, I wouldn't even consider one that didn't support multiple-sync frequencies.

The Atari Mega ST is a 4-megabyte machine with more bang for the buck than anything I've seen. More and more, I am beginning to believe that the Atari ST really is the machine for the rest of us: it's fast, reliable, inexpensive, and getting a lot of software. In Europe, the Atari is considered a serious business machine. I don't see why it can't be here.

The book of the month is John Dos Passos' *Midcentury.* I picked up a copy in a library sale, so the edition I have is long out of print, but I'm sure there are still some around.

There are three computer books of the month. Two of them are by Dan Shafer: *Turbo Prolog Primer* and *Advanced Turbo Prolog Programming*, both published in 1987 by Howard W. Sams. The other book is by Khin Maung Yin, *Using Turbo Prolog* (Que Books, 1987). You'll want them all. If I had to pick one single recommendation for people who want to try to keep up with the computer revolution, I'd say, "Get and learn Turbo Prolog." Declarative languages like Prolog will be the wave of the future.

All in all, a good month. Now, if you'll excuse me, I'll get back to Fire Power. Who cares about the silly guru? ■

Jerry Pournelle 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."

UNLEASH YOUR 80386!

Your 80386-based PC runs at least twice as fast as your old AT. This is good, but not great. The products described below will unleash the true potential of your 80386, giving you 4 to 16 times the power of your old AT. These new MicroWay products include a family of 80386 native code compilers and the mW1167 numeric coprocessor.

Examples of the increases in capacity and performance include:

- Programs compiled with MicroWay NDP Fortran-386 execute 2 to 8 times faster than those compiled with existing 16-bit Fortrans. NDP Fortran-386 can also address up to 4 gigabytes of memory instead of the standard 640 kbytes. MicroWay's NDP compilers and the programs they generate run on MS-DOS or Unix V.
- NDP Fortran-386 generates code for the 80287, 80387 or MicroWay's mW1167. The mW1167 has a floating point throughput exceeding 2.5 megaflops, which is 4 to 5 times the throughput of an 80387 and is comparable to the speed achieved by the VAX 8600.

Equally important, whichever MicroWay product you choose, you can be assured of the same excellent pre- and post-sales support that has made MicroWay the world leader in PC numerics and high performance PC upgrades. For more information, please call the Technical Support Department at

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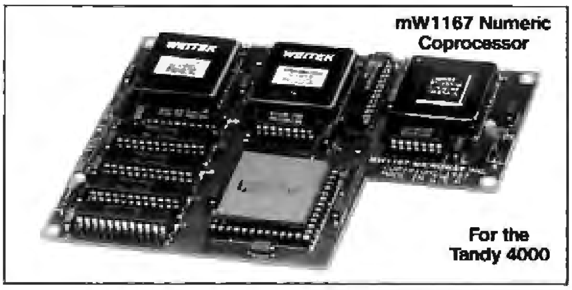
mW1167 Numeric Coprocessor

For the Tandy 4000

MicroWay® 80386 Support

MicroWay 80386 Compilers

NDP Fortran-386 and **NDP C-386** are globally optimizing 80386 native code compilers that support a number of Numeric Data Processors, including the 80287, 80387 and mW1167. They generate mainframe quality optimized code and are syntactically and operationally compatible to the Berkeley 4.2 Unix f77 and PCC compilers. MS-DOS specific extensions have been added where necessary to make it easy to port programs written with Microsoft C or Fortran and R/M Fortran.

The compilers are presently available in two formats: Microport Unix 5.3 or MS-DOS as extended by the Phar Lap Tools. MicroWay will port them to other 80386 operating systems such as OS/2 as the need arises and as 80386 versions become available.

The key to addressing more than 640 kbytes is the use of 32-bit integers to address arrays. NDP Fortran-386 generates 32-bit code which executes 3 to 8 times faster than the current generation of 16-bit compilers. There are three elements each of which contributes a factor of 2 to this speed increase: very efficient use of 80386 registers to store 32-bit entities, the use of inline 32-bit arithmetic instead of library calls, and a doubling in the effective utilization of the system data bus.

An example of the benefit of excellent code is a 32-bit matrix multiply. In this benchmark an NDP Fortran-386 program is run against the same program compiled with a 16-bit Fortran. Both programs were run on the same 80386 system. However, the 32-bit code ran 7.5 times faster than the 16-bit code, and 58.5 times faster than the 16-bit code executing on an IBM PC.

NDP FORTRAN-386™	**$595**
NDP C-386™	**$595**

MicroWay Numerics

The **mW1167™** is a MicroWay designed high speed numeric coprocessor that works with the 80386. It plugs into a 121 pin "Weitek" socket that is actually a super set of the 80387. This socket is available on a number of motherboards and accelerators including the AT&T 6386, Tandy 4000 and MicroWay Number Smasher 386 (Jan. '88). It combines the 64-bit Weitek 1163/64 floating point multiplier/adder with a Weitek/Intel designed "glue chip". The mW1167™ runs at 3.6 MegaWhetstones (compiled with NDP Fortran-386) which is a factor of 16 faster than an AT and 3 to 5 times faster than an 80387 .... **$1495**

Monoputer™ – The INMOS T800-20 Transputer is a 32-bit computer on a chip that features a built-in floating point coprocessor. The T800 can be used to build arbitrarily large parallel processing machines. The Monoputer comes with either the 20 MHz T800 or the T414 (a T800 without the NDP) and includes 2 megabytes of processor memory. Four or more Transputers can be easily linked together to form a Quadputer. A single T800 is comparable in speed with an mW1167-equipped 80386. The compilers to drive one or more Monoputers include Occam, C, Fortran, Pascal and Prolog.

Monoputer T414-20[1]	**$1495**
Monoputer T800-20[1]	**$1995**
Biputer™ T800/T414[2]	**$4995**
Quadputer™ T414-20[2]	**$6995**

[1] Includes Occam [2] Includes TDS

80287 ACCELERATORS

287Turbo-10	**$450**
287Turbo-12	**$550**
287TurboPlus-12	**$629**

80386 Multi-User Solutions

AT8™ - This intelligent serial controller is designed to handle 8 users (16 with two boards) in a Xenix or Unix environment with as little as 3% degradation in speed. It has been tested and approved by Compaq, Intel, NCR, Zenith, and the Department of Defense for use in high performance 80286 and 80386 Xenix or Unix based multi-user systems **$1299**

MicroPort Unix 5.3 is a port of the new Unix 5.3 to the 80386. MicroWay NDP-386 compilers currently run on this version of UNIX.

MicroPort Unix 5.3 ....from $399

PC-MOS-386™ is an 80386 operating environment that turns an AT with an AT8 into an MS-DOS multi-user system. The system makes it possible to run applications such as Lotus 1-2-3 on terminals. The operating system also has a Phar Lap compatibility mode that runs programs developed with the Phar Lap versions of MicroWay's compilers .... **from $199**

Phar Lap™ created the first tools that make it possible to develop 80386 applications which run under MS-DOS yet take advantage of the full power of the 80386. These include an 80386 monitor/loader that runs the 80386 in protected linear address mode, an assembler, linker and debugger. These tools are required for the MS-DOS version of the MicroWay NDP Compilers.

Phar Lap Tools $399

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80287-10 10 MHz	**$349**
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80287-6 6 MHz	**$179**
8087-2 8 MHz	**$154**
8087 5 MHz	**$99**

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MICROPORT SYSTEM V/386(COMPLETE)	*SPECIAL*	799	679
MICROSOFT WINDOWS/386		195	125
PC-MOS 386		CALL	CALL
PHARLAP 386/ASM/LINK		495	419
PHARLAP 386 DEBUG		195	155
SCO XENIX SYS V 386 (COMPLETE)		1495	1195
VM/386	*SPECIAL, NEW*	195	119
X-AM		595	535

APL

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APL*PLUS/PC		595	429
POCKET APL		95	79
SCREEN ACE		195	165

ARTIFICIAL INTELLIGENCE

		LIST	OURS
ACTIVE PROLOG TUTOR		65	55
ARITY STANDARD PROLOG		95	79
LPA PROLOG PRO COMPILER		895	759
LPA PROLOG PRO INTERPRETER		395	339
MICROSOFT LISP		250	155
PC SCHEME		95	85
SMALLTALK/V	*NEW* V. 2.0	99	79
STAR SAPPHIRE LISP		495	445
TURBO PROLOG		100	65
TURBO PROLOG TOOLBOX		100	65
VP EXPERT		100	89

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ADVANTAGE DISASM	*SPECIAL*	295	249
ADVANTAGE LINK	*NEW*	395	359
ASMLIB		149	125
DR ASSEMBLER + TOOLS		200	179
EZ_ASM		70	65
MS MASM	*REBATE*	150	95
PASM86		195	109
PLINK86PLUS		495	275
RELMS CROSS ASSEMBLERS		CALL	CALL
UNIWARE CROSS ASSEMBLERS		CALL	CALL
VISIBLE COMPUTER 80286		100	89

BASIC

		LIST	OURS
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FINALLY!		99	89
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INSIDE TRACK		65	55
MACH 2		75	59
MS QUICKBASIC	*REBATE*	99	65
QBASE		89	79
QUICK-TOOLS		130	109
QUICKPAK		69	59
SCREEN SCULPTOR		125	95
STAY-RES		69	55
TRUE BASIC		100	69
TURBO BASIC		100	65
DATABASE TOOLBOX		100	65
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TELECOM TOOLBOX		100	65

C++

		LIST	OURS
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PFORCE++		395	209

C COMPILERS

		LIST	OURS
AZTEC C-COMMERCIAL		499	CALL
AZTEC C-DEVELOPERS		299	CALL
C86PLUS		497	375
HIGH C		595	CALL
LATTICE C		500	265
W/SOURCE		900	495
MICROSOFT C		450	269
QUICK C	*REBATE*	99	65
TURBO C		100	65

C INTERPRETERS

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INSTANT C		495	369
INSTANT C/16M	*NEW*	895	CALL
RUN/C		120	79
RUN/C PROFESSIONAL		250	155

C LIBRARIES

		LIST	OURS
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BLACKSTAR FUNCTIONS		99	79
C ASYNCH MANAGER		175	135
C-FOOD SMORGASBORD		150	95
W/SOURCE CODE		300	179
C/PAC (PFORCE, PRE-C)	*SPECIAL*	495	CALL
C TOOLS PLUS/5.0		129	99
C UTILITY LIBRARY		185	119
C-XPERT		295	249
ESSENTIAL COMMUNICATIONS		185	119
COMMUNICATIONS PLUS		250	189
GREENLEAF C SAMPLER	*SPECIAL*	95	69
GREENLEAF COMM LIBRARY		185	125
GREENLEAF FUNCTIONS		185	125
MULTI-C		149	135
PFORCE		295	209
RESIDENT C W/SOURCE		198	149
THE HAMMER		195	119
TIMESLICER		295	265
W/SOURCE CODE		1000	895
TURBO C TOOLS		129	99
WKS LIBRARY	*NEW*	89	79

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MICROSOFT COBOL		700	439
MICROSOFT SORT		195	129
OPT-TECH SORT		149	99
REALCICS		995	785
REALIA COBOL		995	785
W/REALMENU		1145	899
RM/COBOL		950	759
RM/COBOL-85		1250	999
RM/SCREENS		395	315
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SCREENPLAY		175	129

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		LIST	OURS
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MS BASIC COMPILER		195	139
MS BASIC INTERPRETER		99	69
CONSULAIR MAC C (MAC II)		600	509
DBASE MAC		495	CALL
MS FORTRAN COMPILER		295	209
LIGHTSPEED C		175	125
LIGHTSPEED PASCAL		125	89
MAC C JR.		80	59
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MACNOSY V2		90	69
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TURBO PASCAL		100	65
NUMERICAL METHODS TOOLBOX		100	65
DATABASE TOOLBOX		100	65
Z BASIC		90	69

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DBASE III PLUS		695	429
DBASE TOOLS FOR C		80	65
DBASE GRAPHICS FOR C		80	65
DBRIEF		95	85
DBC III		250	169
DBUG III		195	179
DBXL		139	99
DBPOWERPAK III		100	89
DB/RA		200	179
DB FIND		99	89
DFLOW		149	125
DOCUMENTOR		295	219
FOXBASE PLUS		395	339
GENIFER		395	299
HI-SCREEN XL		149	119
QUICKCODE III PLUS		295	239
QUICKSILVER		599	499
SILVERCOMM LIBRARY		150	139
TOM RETTIG'S LIBRARY		100	85
R&R		109	19
UI PROGRAMMER		295	219

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BREAKOUT		125	89
C-SPRITE		175	119
PERISCOPE I		345	279
PERISCOPE II		175	139
PERISCOPE II-X		145	105
PERISCOPE III 8 MHZ		995	799
PERISCOPE III 10 MHZ		1095	899
PFIX 86 PLUS		395	209
SOFTPROBE II/TX		750	715
T-DEBUG PLUS		60	49
XVIEW86		60	49

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		LIST	OURS
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BOOKMARK		100	79
COMMAND PLUS		80	69
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FASTBACK		175	129
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NORTON COMMANDER		75	55
NORTON UTILITIES		100	59
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EMACS		295	265
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MKSVi		75	69
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PMATE		195	109
SPF/PC		195	145
VEDIT PLUS		185	129
XTC		99	79

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		LIST	OURS
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XTRIEVE		245	185
REPORT OPTION		145	99
BTRIEVE/N		595	455
XTRIEVE/N		595	455
REPORT OPTION/N		345	269
C-TREE		395	315
R-TREE		295	239
C-TREE/R-TREE BUNDLE		650	519
DBC III		250	169
DBC III/II W/SOURCE CODE		500	359
DBC III PLUS		750	595
DBVISTA		195	139
INFORMIX ESQL/C		595	CALL
INFORMIX 4GL		995	CALL
INFORMIX SQL		795	CALL
PHACT MANAGER		249	219
XQL	*SPECIAL, NEW*	795	599

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		LIST	OURS
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LAHEY FORTRAN		477	CALL
LAHEY PERSONAL FORTRAN 77		95	89
MICROSOFT FORTRAN		450	269
RM/FORTRAN		595	479
WATFOR FORTRAN		375	335

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DIAGRAM'ER/DOCUMENT'ER		129	115
DIFF-E-Q		495	445
FORTLIB		125	109
FORTRAN ADDENDA		165	139
FORTRAN ADDENDUM		95	85

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GRAFLIB		175	169
GRAFMATIC/PLOTMATIC		135	119
MATHPAC		495	445
NO LIMIT		129	115
SSP/PC		350	269
TEKMAR GRAPHICS LIB.	*NEW*	195	165

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ESSENTIAL GRAPHICS		250	185
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GSS GRAPHIC DEV. TOOLKIT		495	375
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HALO (5 MICROSOFT LANG.)		595	389
METAWINDOW		195	159
METAWINDOW PLUS		275	229
TURBOWINDOW/C		95	79
TURBO HALO (FOR TURBO C)		100	79

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LOGITECH MODULA-2			
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SYSTEM V/AT (COMPLETE)		549	475
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SOFTWARE DEV. PACKAGE		249	209
TEXT PREPARATION PACKAGE		199	169
UNLIMITED LICENSE KIT		249	209
SCO:			
XENIX SYSTEM V (COMPLETE)		1295	995
DEVELOPMENT SYSTEM		595	499
OPERATING SYSTEM		595	499
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XENIX FOR PS/2 50,60,80	*NEW*	CALL	CALL
WENDIN:			
OPERATING SYSTEM TOOLBOX		99	79
PCVMS		99	79
PCNX		99	79
WENDIN-DOS		99	79
WENDIN-DOS APPLICATION KIT		99	79

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MICROSOFT PASCAL		300	185
PASCAL-2		350	329
PROFESSIONAL PASCAL		595	CALL
TURBO PASCAL	*NEW* V. 4.0	100	65
TURBO PASCAL DEV. LIB.	*NEW*	395	259

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DOS/BIOS & MOUSE TOOLS		75	69
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FLASH-UP TOOLBOX		49	45
INSIDE TRACK		65	55
MACH 2		75	59
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SMALLTALK/V NEW V. 2.0—New version is a high-performance, production quality object-oriented programming environment. Includes:
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*A set of tools for organizing and browsing the Smalltalk source code.
*An incremental program development capability.
*Bitmap graphics with optional color support.
List: $99 **Special Price: $79**

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TURBO ADVANTAGE		50	45
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TURBO ASM		99	69
TURBO ASYNCH PLUS		129	99
TURBO EXTENDER		85	65
TURBO HALO		129	99
TURBO MAGIC		99	89
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TURBO POWER TOOLS PLUS		129	99
TURBO POWER UTILITIES		95	79
TURBO PROFESSIONAL 4.0	*NEW*	99	79
TURBO WINDOW/PASCAL		95	79
UNIVERSAL GRAPHICS LIBRARY		150	119

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C POWER WINDOWS		130	115
C-SCAPE		279	265
CURSES W/SOURCE CODE		250	169

	LIST	OURS
GREENLEAF DATA WINDOWS	225	155
W/SOURCE CODE	395	269
JYACC FORMAKER	495	449
JYACC JAM	750	679
MICROSOFT WINDOWS	99	65
MS WINDOWS DEVELOPMENT KIT	500	309
PANEL	295	215
PANEL PLUS	495	395
PANEL/QC (QUICK C)	129	95
PANEL/TC (TURBO C)	129	95
QUICKSCREEN	195	175
SCREEN ACE	195	159
SCREENSTAR W/SOURCE	198	155
VIEW MANAGER	275	199
VITAMIN C	225	159
VC SCREEN	99	79
WINDOWS FOR C	195	149
WINDOWS FOR DATA	295	235
ZVIEW	245	169

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BAS_C (COMMERCIAL)	375	319
BAS_PAS (ECONOMY)	149	125
BAS_PAS (COMMERCIAL)	280	239
BASTOC	495	399
BASTOC (BASICA VERSION)	795	639
DB2C	299	CALL
DBX TRANSLATOR	350	299
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CARBON COPY PLUS *NEW*	195	139
DAN BRICKLIN'S DEMO PROGRAM	75	59
DAN BRICKLIN'S DEMO TUTORIAL	50	45
HS/FORTH	395	359
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LATTICE RPG II COMPILER	750	629
MASTER FORTH	125	115
MKS AWK	75	69
MKS TOOLKIT	139	115
NORTON GUIDES	100	65
PC FORTH	150	109
PERSONAL REXX	125	99
PL1_86	750	675
PRO-C	399	379
SAPIENS V8	300	269
SET: SCIL	349	319
SOFTSCREEN HELP	195	149
THE WEINER SHELL	199	179

BLAISE

ASYNCH MANAGER (C/PASCAL)	175	135
C TOOLS PLUS/5.0	129	99

	LIST	OURS
EXEC	95	79
LIGHT TOOLS FOR DATALIGHT C	100	79
PASCAL TOOLS/TOOLS 2	175	135
TURBO ASYNCH PLUS	129	99
TURBO C TOOLS	129	99
TURBO POWER TOOLS PLUS	129	99
VIEW MANAGER (C/PASCAL)	275	199

HARDWARE PRODUCTS

AMDEK 722 MONITOR	750	499
AMDEK 730 MONITOR	899	569
AST ADVANTAGE PREMIUM W/512K	495	319
AST RAMPAGE! 286 W/512K	545	349
HERCULES GRAPHICS CARD PLUS	299	195
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Large Companies (1000+ employees)	446,000
Engineering Job Function	582,000
Influence Purchase of PCs/EDP/Communications	597,000
Use a PC at place of business	1,032,000
Use a Mac at place of business	95,000
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Fortune 500	318,000
Middle Management	138,000
Engineering Job Function	546,000
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Use a PC at place of business	937,000
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Source: Mediamark Research, Inc.
Fall 1987

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Fortune 500	34.05
Middle Management	79.22
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Medium Companies (50–999 employees)	63.11
Large Companies (1000+ employees)	25.04
Engineering Job Function	19.19
Influence Purchase of PCs at business	23.17
Influence Purchase of:	
PCs/EDP	21.56
PCs/EDP/Communications	18.71
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Real-World Answers

Ezra Shapiro

Reflex Plus, PhoneNet, and a TOPS network solve some practical dilemmas

I started out the month trying to solve a simple problem that shouldn't have been a problem. I needed to build a name-and-address database, then merge it into both form letters and mailing labels. I had little time to complete the project, so I had to get up and running quickly.

Because I wanted to use some downloadable Adobe fonts on my QMS laser printer, I decided to work on the Macintosh. I also think it's easier to construct data-entry forms on the Mac than it is on the IBM PC. Two solid votes for the Mac. I went to work.

My first attempt was with Microsoft Works. It's incredibly easy to use, and you can merge fields from the database module into documents created with the word processor. What could possibly be easier? Well, because Works is supposedly geared to the entry-level user, it's missing a few features. In this case, I was chagrined to learn that it lacks any sort of blank-line control; if I had a null field for a person's corporate title, there was no way I could avoid a blank line in the middle of my address block. Scratch Works.

"OK," I thought. "I'll use the database in Works, then dump out a tab-delimited text file that I'll merge into big, powerful Microsoft Word 3.01. That's a serious word processor. This should turn out to be a cinch."

Hah. Though Word has some impressive mail-merge features, like a minimal macro language with `if...endif` constructions for printing optional fields and punctuation marks, its blank-line control is only half-implemented. Word can squelch blank lines, but only if they're the result of nonprinting instructions or comments. Once again, I faced a gaping hole if somebody didn't have a corporate title. Scratch Word.

The next try was with FileMaker Plus, which has great facilities for designing both data-entry and report forms. It even has an option to "slide" fields up and to the left if it encounters any that are empty. "This should work," I said, "and it's more elegant than merging into a word processor."

So I set about building a form-letter matrix with FileMaker Plus, figuring that the "slide up" command would take care of my blank lines. That it did, but I fiddled for 3 hours and never got the line spacing to look decent. Scratch FileMaker Plus.

At this point, with deadlines looming, the power supply in my Mac Plus went up in a puff of acrid smoke. I hauled it off to the shop and put in a call for a rental Macintosh SE. All told, I lost a day and a half. During those 36 hours without a Mac, I piled up the manuals for all the other Mac databases I have in my collection and started reading.

I find Double Helix extremely convoluted; it's about as easy for me to get data out of Double Helix as it is to get baggage out of United Airlines (the only airline that has lost my luggage on a flight between San Francisco and Los Angeles). Though the documentation indicated that I could *probably* create a report form that would accomplish my mail merge, I didn't have the time to fuss with anything but 100 percent certainty. Scratch Double Helix.

Two hours with the documentation of Omnis 3 Plus convinced me that I was looking at one of the most unreadable manuals ever written. I couldn't begin to determine if it could do the job. (I later learned from an Omnis guru that it could, in fact, handle my merge, but I'd already given up.) Scratch Omnis 3 Plus.

I never got around to looking at either 4th Dimension or dBASE Mac; I ended my search with Borland's Reflex for the Mac. I had liked the product (called Interlace before it was acquired by Borland) when I'd tried it more than a year ago. I felt fairly sure that I could get it running in the limited time I had remaining.

The documentation was worse than I remembered, with massive tutorials and little command reference, but I uncovered a feature called "variable height text," which takes an area in a report and pulls up any data lower on the page to fill gaps left by null fields. It sounded like a winner.

When the SE rental unit arrived, I began designing my project with Reflex. I created both a flat database file structure and a data-entry form in less than 10 minutes. Using the Clipboard, I cut the text of my letter out of Word and pasted it into a "label" area on my Reflex report form. I wrote a formula for a variable-height address block and positioned it over the letter. Done.

I had a database and a form-letter matrix within Reflex that spat out printed mailers as fast as I could feed paper into my laser printer. There was only one minor annoyance: Reflex won't let you have more than one text attribute in any defined region of a report, so I had to edit the letter to eliminate any italic and boldface phrases.

In the middle of all this, Borland announced an update package called Reflex Plus. Since the company promised a new, shrink-wrapped copy of Reflex Plus to any journalist who attended the announcement shindig, I headed south to Santa Clara with software lust in my heart. When I returned to San Francisco, bearing an uncomfortably large box in a bright red tote bag, I rushed to the SE, plugged in the new disks, and replaced Reflex for the Mac with Reflex Plus.

continued

Ezra Shapiro is a consulting editor for BYTE. Contact him at P.O. Box 146069, San Francisco, CA 94114, or on BIX as "ezra." Because of the volume of mail he receives, Ezra, regretfully, cannot respond to each inquiry.

Reactions to Reflex Plus

Reflex Plus is the first product packaged as part of Borland's Professional Series. Documentation is no longer a cheaply printed paperback book; you get a fat loose-leaf binder in a striking black-and-red slipcase. The manual has been completely rewritten. Introductory, tutorial, and reference materials are neatly broken out into discernible sections. The topics are ordered logically and treated exhaustively; this is light-years ahead of the old Interlace documentation. The index is lengthy and thorough, and I liked using it.

The basic Interlace/Reflex engine is still familiar, but some features have been added and some commands have been moved around. You first enter a list of field names in a "database overview" window. Next, you go back through the list and declare field types and select "key fields." (Because Reflex indexes its data files, you must have a unique key—made up of one or more fields—in every record.)

Reflex follows a very relational model; you can set up links between data files on a one-to-one, one-to-many, or many-to-many basis. Linking is accomplished by simply drawing a line on-screen in the overview window from one field name to another. There's no need to establish an overall data library or collection; Reflex databases exist as separate files on disk, even if they're connected.

It's best to set up relationships at the outset, as Reflex demands that the linked fields be empty, but it's no big deal to add fields and links to existing databases later on, though you may have to export some data from one structure to another.

Reflex for the Mac allows multiple report forms but only one data-entry system. Reflex Plus stores both input and output forms as separate files, so you can have as many of each as you need. Forms are designed on a standard Macintosh page grid; you move objects around with the mouse.

Calculated fields in entry and report forms make use of a wide selection of formula functions, and Reflex Plus employs a device, called a "repeating collection," that lets you display intricate relationships on any form.

The best news is that once you get the hang of Reflex Plus (which should take no longer than an hour or two), you can do amazing things with it. Unless you need full programmability, network support, absolute control of the user interface, and/or "choice" fields that let you enter data by selecting from a list of predefined alternatives, Reflex Plus is an ideal program.

The relational features will enable me to take my mailing list and convert it into a full-blown order-entry system when the time comes. Because every file is indexed, search speed on either the Mac Plus or the SE is quite acceptable. I like this program, even if the $279 price tag for Reflex Plus is quite a jump from the $99 for Reflex for the Mac.

Items Discussed

PhoneNet ....$59.95 per connection
Farallon Computing
2150 Kittredge St.
Berkeley, CA 94074
(415) 849-2331
Inquiry 939.

Reflex Plus $279
Borland International
4585 Scotts Valley Dr.
Scotts Valley, CA 95066
(408) 438-8400
Inquiry 940.

TOPS/DOS (MS-DOS).........$189
TOPS for the Macintosh $189
TOPS FlashCard
(PC AppleTalk card)..........$239
TOPS
2560 9th St., Suite 220
Berkeley, CA 94710
(415) 549-5900
Inquiry 941.

As one of the few writers I know never to have been quoted in one of Borland's direct-response advertisements, I'm finally willing to say something favorable about a Borland product: Reflex Plus offers tremendous versatility in the management and display of data. Building complex, interrelated database structures is no longer a mysterious process available only to elite programmers; anyone with half a brain can make Reflex Plus perform magic tricks.

That said, I have one final comment. I could control blank lines with WordStar on a CP/M machine 5 years ago. I'm appalled that Microsoft missed this feature in its two Mac word processors. On the other hand, I was relieved to find databases that could handle what I consider to be text-management functions. Must the Mac be forever doomed to be called a lousy machine for word processing? Come on, let's get with it, you guys.

In Praise of TOPS

Networks used to make me nervous. I broke into a cold sweat when anyone mentioned token ring, file and record locking, twisted-pair cabling, or any of the other buzzwords associated with the arcane science of networking.

There were two reasons for this phobia. First, I was worried that the increasing emphasis on local-area networks was a scheme cooked up by the Forces of Darkness to squelch the independent spirit of "personal" computing. Second, I saw the purely technical and mechanical aspects of hooking up a network as a way to spend uncounted hours on my hands and knees under my worktable, muttering curses as I struggled vainly to connect patently unconnectable devices.

Furthermore, I didn't believe I needed a network. There are no coworkers in my basement with whom I have to share my resources; it's just me, a bunch of computers, and a bunch of printers. And I have enough serial cables, null modems, and gender changers to hook the various machines together and shoot files around the room to my heart's content. Or so I thought.

Then I began to have these annoying little problems. I started a project that involved moving megabyte files between the Macintosh and the Tandon AT clone; even at high data transfer rates, this took a lot of time and tied up both machines. Next, software for the Tandon began arriving with PostScript printer drivers; how could I test this stuff without linking the Tandon to the QMS laser printer?

True, the QMS has connectors for both AppleTalk and a standard serial cable, but there's also a switch on the side of the printer that has to be set to tell it which port to use. I've neatly blockaded that side of the printer with the corpse of my old Compaq Portable, and I didn't want to have to rearrange the whole place just to get at the switch. Finally, I hit the limit on the Mac's 20-megabyte DataFrame and began eyeing the empty regions of the Tandon's 40-megabyte hard disk as a solution to my space woes, if only I could get to it.

So, with a sinking feeling in my stomach, I decided to try out the TOPS AppleTalk network. I was not happy about this, but there seemed to be no way out. I was so uncomfortable with the decision, in fact, that I put off installing the thing for nearly 2 weeks.

You've probably gotten the point by now. When I finally went to work, it took me all of 20 minutes to get TOPS running, and most of that time was spent taking apart the Tandon to install the AppleTalk card. I haven't read more than, oh, 25 pages of the manuals that come with the network, and everything has behaved wonderfully.

Files zip back and forth between the

continued

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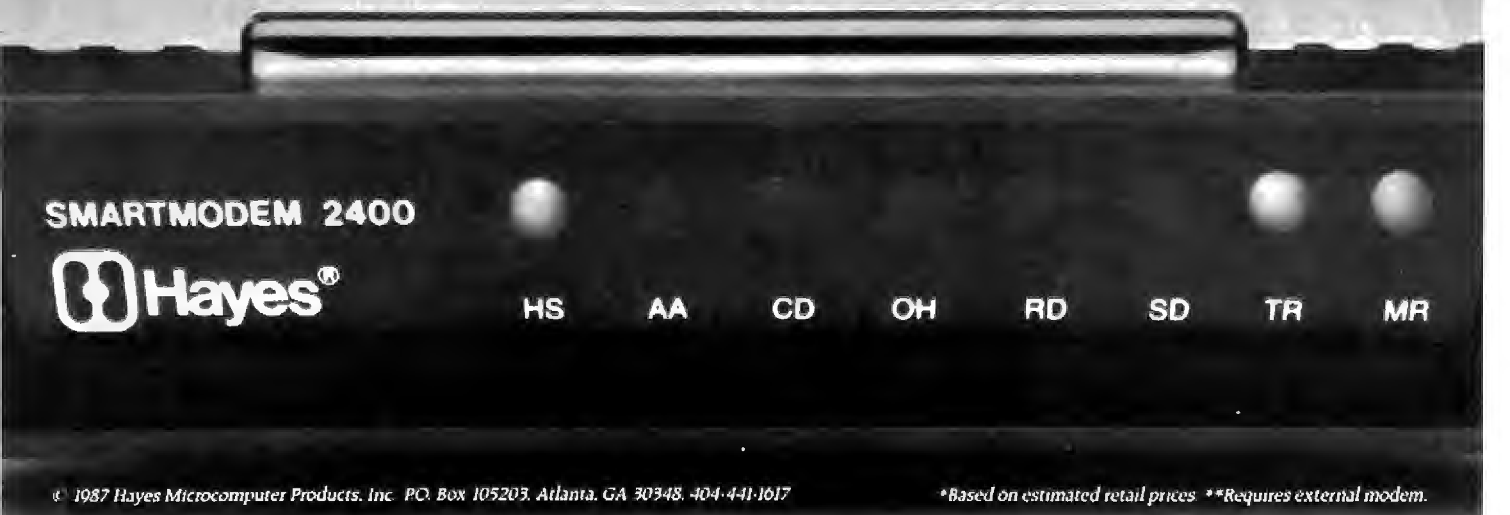

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Circle 108 on Reader Service Card

two computers like lightning (I can even run a program on one computer and edit a file on the other without any transfer at all), the Tandon now speaks to the laser printer on a polite basis, and I'm using the Tandon's disk to hold the overflow from the DataFrame. I'm beginning to consider myself a stupid jerk because I didn't do this any sooner.

TOPS stands for "transcendental operating system," but the *T* could just as easily indicate "transparent." It's sold as software for both the MS-DOS world and the Mac world, at $189 per machine, and it will run with PC AppleTalk cards from TOPS, Apple, Hercules, Tandy, and anyone else who follows Apple's specs. (The Mac has AppleTalk built in, so you don't need an add-in board.)

For cabling, I had the choice of either Apple's kits ($75 per machine) or PhoneNet from Farallon Computing ($59.95 per machine). I went with PhoneNet; not only is it a little less expensive, but you can use standard RJ-11 modular cables to connect machines, or nab any two unused wires in your installed telephone cabling to go from room to room.

Software installation is automated on both the PC and the Mac (batch file on the PC side, self-contained program on the Mac side). The PC software seems a bit more cumbersome to run than the Mac software, but it's not much more complex than any other similar DOS task—setting up a mouse, for example.

The central act in using TOPS is logging on to the network and "publishing volumes"; that is, declaring which drives or directories you're willing to make available to other computers on the network and assigning read/write or read-only status to your volumes. Once that's out of the way, you can access published files on any other station as if you were accessing files on an external drive connected to your machine.

TOPS keeps track of what's where. Mac files look like PC files when viewed from MS-DOS; PC files look like Mac files when viewed from the Mac. TOPS assigns valid filenames appropriate to the operating system. You can copy a file from one environment to the other and back again, and TOPS won't miss a beat. Even a netophobe like myself can handle it without much brainpower.

The salient point in all this, for me, is that TOPS is an ideal operating-system extension in any environment with more than one computer, even if there's only one user. It's vital if you've got a Macintosh and a PC-type machine, but it also makes sense if you're using computers of the same species.

I've read scads of analyses of TOPS (and other low-cost networks) that grade it in comparison to larger, faster, multiuser networks. Not one of these analyses has looked at TOPS for teeny environments like mine. But it works, and it works spectacularly well, even if I don't have to tap its capabilities for password protection and AppleTalk zones.

I do not have the facilities to simulate a multiuser network load; I can't say how many machines TOPS will support without performance degradation. For the simple kinds of operations a single user will perform, though, I concur with a comment in the TOPS manual: Loading a program or file from another computer's hard disk is about as fast as loading from an internal floppy disk on your machine. In other words, the decrease in speed is barely noticeable.

In about a month, TOPS has proven to be valuable for backup operations, storage, file transfer, and editing between operating systems. I'm becoming as addicted to it as I am to hard disks. I simply would not have two or more computers without a copy of TOPS for each. ■

J&R MUSIC WORLD

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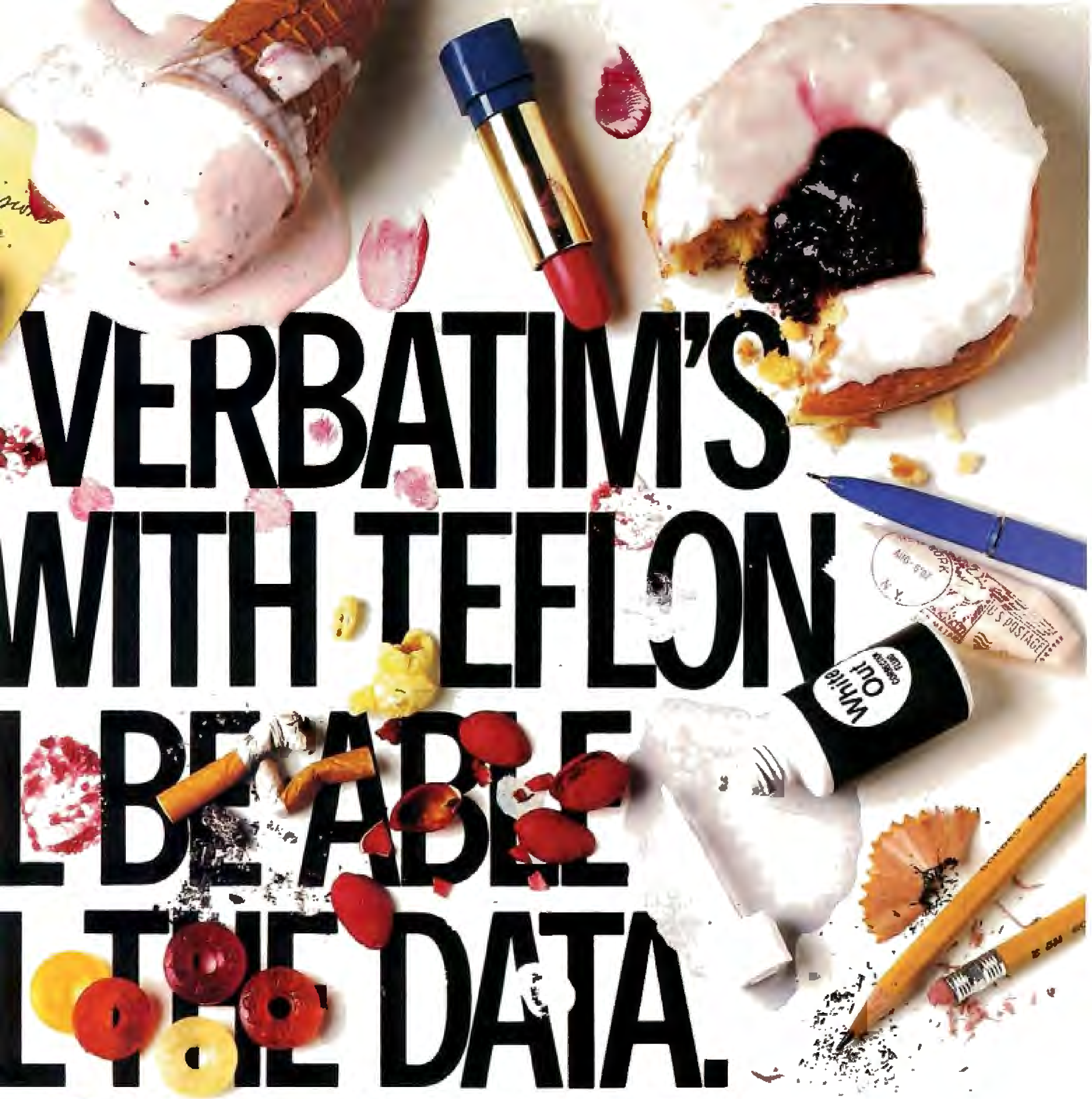
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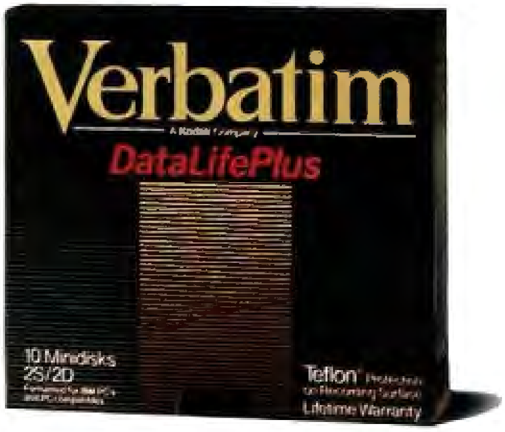
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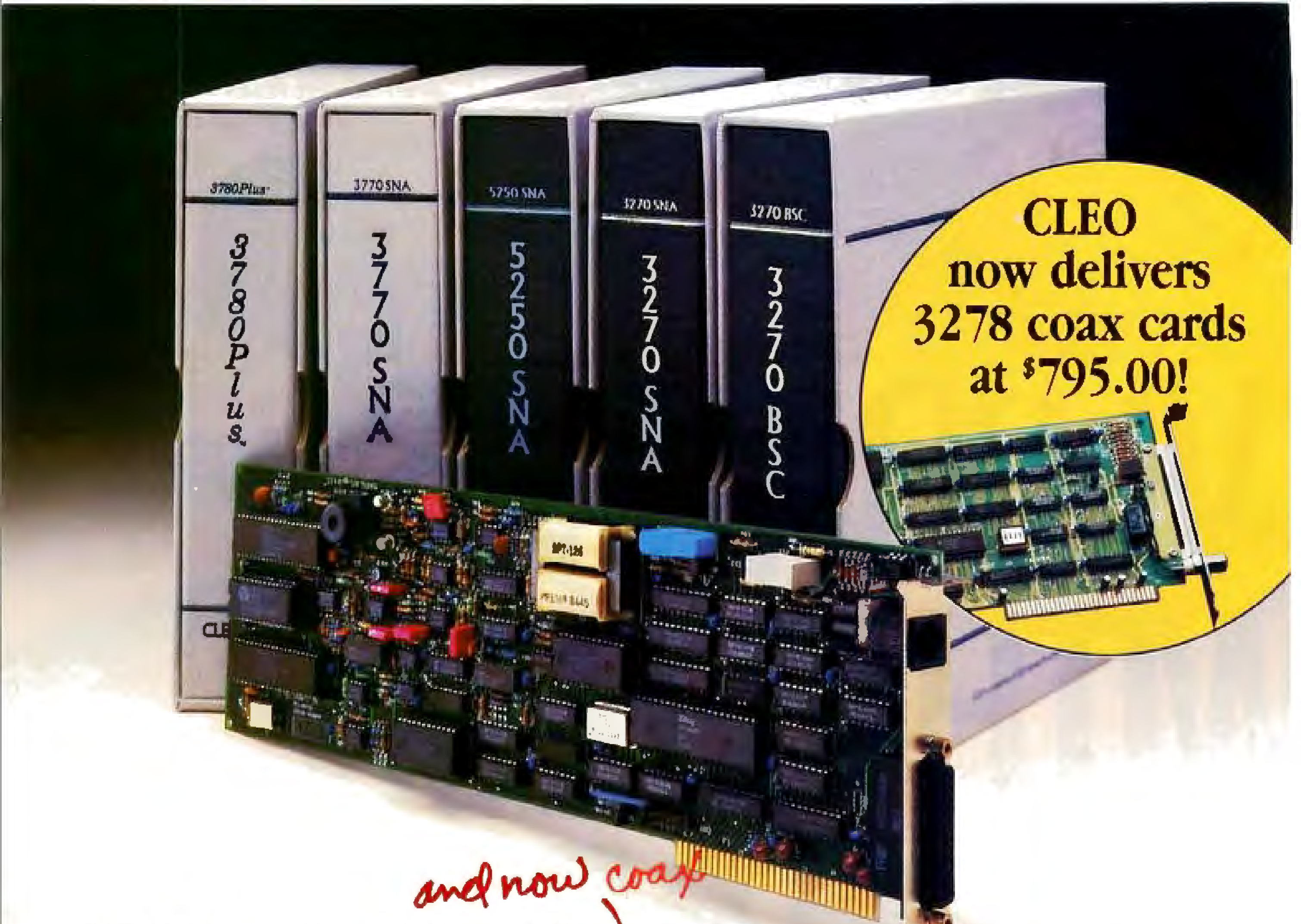

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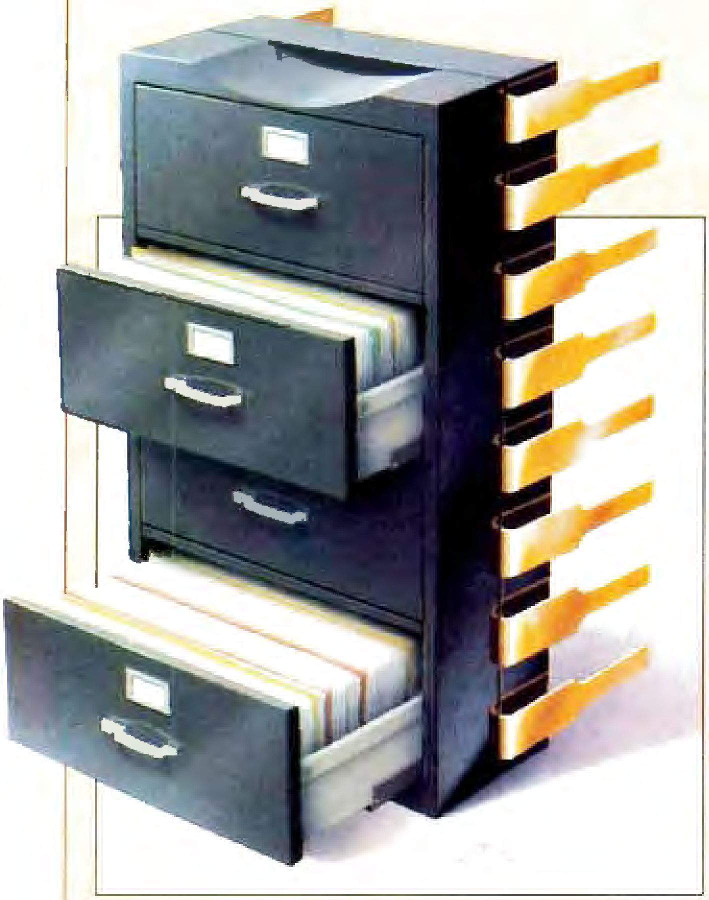
Managing Megabytes

Introduction

Managing Megabytes



The memory capacity of personal computers is undergoing another round of inflation, with the onset of 32-bit architectures and operating systems. New hard disks, video disks, and CD-ROM devices are bringing similar increases in the area of nonvolatile, high-speed storage. The megabyte has joined the kilobyte as a common coin for measuring memory and storage.

Unfortunately, you won't benefit fully from this increase in capacity until software is available that takes full advantage of it. To be sure, OS/2 in the 80x86 world and MultiFinder and A/UX in the Macintosh world offer system-level support for large memories. But the end user needs applications specifically designed to take advantage of the vast data sets, high-density graphics images, and voluminous text files that can live in megabyte storage systems.

The four articles in this section present some of the new techniques and design ideas for managing megabytes.

In "A Better Way to Compress Images," Michael F. Barnsley and Alan D. Sloan present a new technique for image processing, storage, and retrieval that yields compression ratios of 10,000 to 1. This is the first detailed exposition of the method outside of academic literature. The authors include a BASIC program so that interested readers can see the image-reconstruction part of the method at work.

Theodor H. Nelson, originator of the hypertext concept, presents a detailed explanation of the storage scheme for Project Xanadu. Xanadu is the first node of a proposed worldwide hypertext network. It uses a radical new system for storing the vast quantities of text, image, and other data that may be generated by entirely new categories of application programs and their users.

Database consultant Jonathan Robie explains why traditional personal-computer style database management systems are not adequate tools in the megabyte era. "Fast Data Access" is a good introduction to the next generation of DBMS tools.

"Achieving Mainframe Performance" by Wink Saville gives a programmer's view of the challenges and opportunities of working with large memories and storage devices. He cites some general principles and gives specific algorithms demonstrating how three common operations—displaying bit-image graphics, computing trigonometric functions, and sorting data—can be speeded up significantly by using the extra memory available. The author writes from experience: He spearheaded the development of a 2.4-gigabyte CD-ROM development system at Meridian Data Inc.

For further information on some of the topics presented in this section, refer to the Resource Guide on page 265.

—Ken Sheldon and George A. Stewart,
Technical Editors

A Better Way to Compress Images

Mathematics is providing a novel technique for achieving compression ratios of 10,000 to 1—and higher

Michael F. Barnsley and Alan D. Sloan

THE NATURAL WORLD is filled with intricate detail. Consider the geometry on the back of your hand: the pores, the fine lines, and the color variations. A camera can capture that detail and, at your leisure, you can study the photo to see things you never noticed before. Can personal computers be made to carry out similar functions of image storage and analysis? If so, then image compression will certainly play a central role.

The reason is that digitized images—images converted into bits for processing by a computer—demand large amounts of computer memory. For example, a high-detail gray-scale aerial photograph might be blown up to a 3½-foot square and then resolved to 300 by 300 pixels per square inch with 8 significant bits per pixel. Digitization at this level requires 130 megabytes of computer memory—too much for personal computers to handle.

For real-world images such as the aerial photo, current compression techniques can achieve ratios of between 2 to 1 and 10 to 1. By these methods, our photo would still require between 65 and 13 megabytes.

In this article, we describe some of the main ideas behind a new method for image compression using fractals. The method has yielded compression ratios in excess of 10,000 to 1 (bringing our aerial photo down to a manageable 13,000 bytes). The color pictures in figures 1 through 5 were encoded using the new technique; actual storage requirements for these images range from 100 to 2000 bytes.

A mathematics research team at the Georgia Institute of Technology is developing the system, with funding provided by the Defense Advanced Research Projects Agency (DARPA) and the Georgia Tech Research Corporation (GTRC). Our description is necessarily simplified, but it will show you how a fractal image-compression scheme operates and how to use it to create exciting images.

Describing Natural Objects

Traditional computer graphics encodes images in terms of simple geometrical shapes: points, line segments, boxes, circles, and so on. More advanced systems use three-dimensional elements, such as spheres and cubes, and add color and shading to the description.

Graphics systems founded on traditional geometry are great for creating pictures of man-made objects, such as bricks, wheels, roads, buildings, and cogs. However, they don't work well at all when the problem is to encode a sunset, a tree, a lump of mud, or the intricate structure of a black spleenwort fern. Think about using a standard graphics system to encode a digitized picture of a cloud: You'd have to tell the computer the address and color attribute of each point in the cloud. But that's exactly what an uncompressed digitized image is—a long list of addresses and attributes.

To escape this difficulty, we need a richer library of geometrical shapes. These shapes need to be flexible and controllable so that they can be made to conform to clouds, mosses, feathers, leaves, and faces, not to mention waving sunflowers and glaring arctic wolves. Fractal geometry provides just such a collection of shapes. For a hint of this, glance at the pictures in *The Fractal Geometry of Nature* by Benoit Mandelbrot, who coined the term *fractal* to describe objects that are very "fractured" (see references for additional books and articles). Some elementary fractal images accompany this article.

Using fractals to simulate landscapes and other natural effects is not new; it has been a primary practical application. For instance, through experimentation, you find that a certain fractal generates a pattern similar to tree bark. Later, when you want to render a tree, you put the tree-bark fractal to work.

What *is* new is the ability to start with an actual image and find the fractals that will imitate it to any desired degree of accuracy. Since our method includes a compact way of representing these fractals, we end up with a highly compressed data set for reconstructing the original image.

Overview of Fractal Compression

We start with a digitized image. Using image-processing techniques such as color separation, edge detection, spectrum analysis, and texture-variation analysis, we break up the image into segments. (Some of the same techniques

continued

Michael F. Barnsley and Alan D. Sloan are professors of mathematics at the Georgia Institute of Technology (Atlanta, GA 30332) and officers of Iterated Systems Inc. (1266 Holly Lane NE, Atlanta, GA 30329).

Figure 1: *IFS-encoded color image of three-dimensional ferns (4 transformations, 100 bytes).*

Figure 2: *IFS-encoded color photo of Black Forest, color set adjusted to give winter tones (120 transformations, 2000 bytes).*

Figure 3: *IFS-encoded color photo of a Bolivian girl (120 transformations, 2000 bytes).*

form the basis for the automatic coloring of black-and-white motion pictures.) A segment might be a fern, a leaf, a cloud, or a fence post. A segment can also be a more complex collection of pixels: A seascape, for example, may include spray, rock, and mist.

We then look up these segments in a library of fractals. The library doesn't contain literal fractals; that would require astronomical amounts of storage. Instead, our library contains relatively compact sets of numbers, called *iterated function system* (IFS) codes, that will reproduce the corresponding fractals. Furthermore, the library's cataloging system is such that images that look alike are close together: Nearby codes correspond to nearby fractals. This makes it feasible to set up automated procedures for searching the library to find fractals that approximate a given target image. A mathematical result known as the Collage Theorem (more on that later) guarantees that we can always find a suitable IFS code—and gives a method for doing so.

Once we have looked up all the segments in our library and found their IFS codes, we can throw away the original digitized image and keep the codes, achieving our compression ratio of 10,000 to 1—or even higher.

Iterated Function Systems

We start by explaining how a set of IFS codes can approximate a natural image.

IFS theory is an extension of classical geometry. It uses affine transformations, explained below, to express relations between parts of an image. Using only these relations, it defines and conveys intricate pictures. With IFS theory, we can describe a cloud as clearly as an architect can describe a house.

By studying the following sections, you should be able to encode and decode fascinating black-and-white image segments, such as leaf skeletons, tree shadows, spirals, and thunderheads. You should also obtain an overview of how a fully automated fractal compression system operates.

Affine transformations can be described as combinations of rotations, scalings, and translations of the coordinate axes in n-dimensional space. An example in two dimensions is

$$W(x,y) = (\tfrac{1}{2}x+\tfrac{1}{4}y+1,\ \tfrac{1}{4}x+\tfrac{1}{2}y+2),$$

which can also be written in matrix form as

$$W\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} .5 & .25 \\ .25 & .5 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} 1 \\ 2 \end{bmatrix}.$$

This transformation moves the point (0,0) to (1,2) and moves (−1,0.5) to (0.625, 2). To confirm your understanding of the idea, you should work out where it moves the point (1,1). We denote this transformation by W; the notation $W(S)$ denotes the subimage of W on a set of points S.

Now let's see what W does to a picture of a smiling face, F, lying on the x,y plane (see figure 6). The result is a new, squeezed face $W(F)$. The affine transformation has deformed and moved the face. Notice that the eyes in the transformed face $W(F)$ are closer together than they are in F. We say that the transformation W is contractive: It always moves points closer together.

Another example of a contractive affine transformation is shown in figure 7. This time it acts on a leaf to produce a new, smaller leaf.

The general form for an affine transformation is

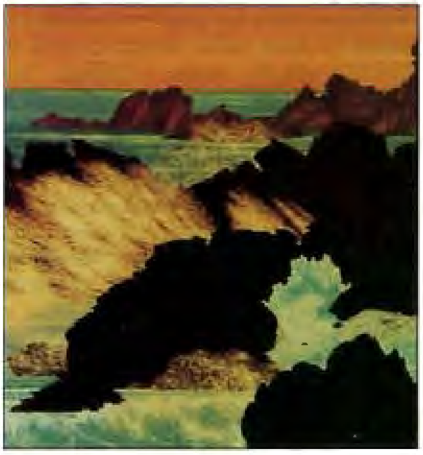


Figure 4: *IFS-encoded color photo of the Monterey coast (60 transformations, 100 bytes).*

Figure 5: *IFS-encoded color image from* A Cloud Study *(30 transformations, 500 bytes).*

Photographs © 1987 Georgia Tech Research Corp. Figure 1: Barnsley; Figures 2 and 3: Barnsley, Jacquin, Malassenet, Reuter, Sloan: Figures 4 and 5: Barnsley, Jacquin, Reuter, Sloan.

$$W\begin{bmatrix}x\\y\end{bmatrix}=\begin{bmatrix}a & b\\c & d\end{bmatrix}\begin{bmatrix}x\\y\end{bmatrix}+\begin{bmatrix}e\\f\end{bmatrix}=\begin{bmatrix}ax+by+e\\cx+dy+f\end{bmatrix},$$

where the coefficients a, b, c, d, e, and f are real numbers.

If we know in advance the translations, rotations, and scalings that combine to produce W, we can generate coefficient values as follows:

$$a = r\cos\theta,\ b = -s\sin\phi,$$
$$c = r\sin\theta,\ d = s\cos\phi,$$

where r is the scaling factor on x, s is the scaling factor on y, θ is the angle of rotation on x, ϕ is the angle of rotation on y, e is the translation on x, and f is the translation on y.

How can you find an affine transformation that produces a desired effect? Let's show how to find the affine transformation that takes the big leaf to the little leaf in figure 7. We wish to find the numbers a, b, c, d, e, and f for which the transformation W has the property

$$W(\text{big leaf}) \approx \text{little leaf}.$$

Begin by introducing x and y coordinate axes, as already shown in the figure. Mark three points on the big leaf (we've chosen the leaf tip, a side spike, and the point where the stem joins the leaf) and determine their coordinates (α_1,α_2), (β_1,β_2), and (γ_1,γ_2). Mark the corresponding points on the little leaf and determine their coordinates $(\tilde{\alpha}_1,\tilde{\alpha}_2)$, $(\tilde{\beta}_1,\tilde{\beta}_2)$, and $(\tilde{\gamma}_1,\tilde{\gamma}_2)$, respectively.

Determine values for the coefficients a, b, and e by solving the three linear equations

$$\alpha_1 a + \alpha_2 b + e = \tilde{\alpha}_1, \quad (1)$$
$$\beta_1 a + \beta_2 b + e = \tilde{\beta}_1, \quad (2)$$
$$\gamma_1 a + \gamma_2 b + e = \tilde{\gamma}_1, \quad (3)$$

and find c, d, and f in similar fashion from these equations:

$$\alpha_1 c + \alpha_2 d + f = \tilde{\alpha}_2, \quad (4)$$
$$\beta_1 c + \beta_2 d + f = \tilde{\beta}_2, \quad (5)$$
$$\gamma_1 c + \gamma_2 d + f = \tilde{\gamma}_2. \quad (6)$$

We recommend the use of an equation solver such as TK Solver Plus (Universal Technical Systems, Rockford, Illinois) or Eureka (Borland International, Scotts Valley, California) for finding the coefficient values. Doing it manually can be tedious.

Now that we know what a contractive

continued

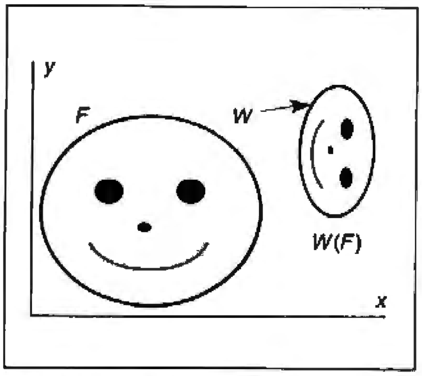


Figure 6: *An affine transformation* W *moves the smiling face* F *to a new face* W(F). *The transformation is called contractive because it moves points closer together.*

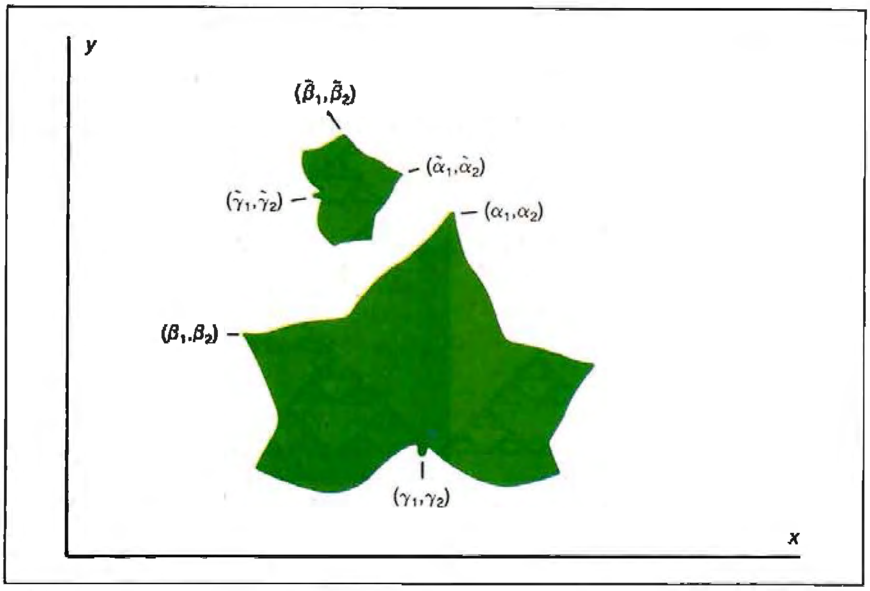


Figure 7: *Two ivy leaves fix an affine transformation* W.

Table 1: *IFS codes for a Sierpiński triangle.*

W	a	b	c	d	e	f	p
1	0.5	0	0	0.5	0	0	0.33
2	0.5	0	0	0.5	1	0	0.33
3	0.5	0	0	0.5	0.5	0.5	0.34

Table 2: *IFS codes for a square.*

W	a	b	c	d	e	f	p
1	0.5	0	0	0.5	0	0	0.25
2	0.5	0	0	0.5	0.5	0	0.25
3	0.5	0	0	0.5	0	0.5	0.25
4	0.5	0	0	0.5	0.5	0.5	0.25

Table 3: *IFS codes for a fern.*

W	a	b	c	d	e	f	p
1	0	0	0	0.16	0	0	0.01
2	0.2	−0.26	0.23	0.22	0	1.6	0.07
3	−0.15	0.28	0.26	0.24	0	0.44	0.07
4	0.85	0.04	−0.04	0.85	0	1.6	0.85

Table 4: *IFS codes for fractal tree.*

W	a	b	c	d	e	f	p
1	0	0	0	0.5	0	0	0.05
2	0.1	0	0	0.1	0	0.2	0.15
3	0.42	−0.42	0.42	0.42	0	0.2	0.4
4	0.42	0.42	−0.42	0.42	0	0.2	0.4

affine transformation is and how to find one that maps a source image onto a desired target image, we can describe an iterated function system. An IFS is a collection of contractive affine transformations. Here's an example of an IFS of three transformations:

$$W_1\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 0.5 & 0.0 \\ 0.0 & 0.5 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix},$$

$$W_2\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 0.5 & 0.0 \\ 0.0 & 0.5 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix},$$

$$W_3\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 0.5 & 0.0 \\ 0.0 & 0.5 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} .25 \\ .5 \end{bmatrix}.$$

Each transformation must also have an associated probability, p_i, determining its "importance" relative to the other transformations. In the present case we might have p_1, p_2, and p_3. Notice that the probabilities must add up to 1. That is, $p_1 + p_2 + p_3 = 1$.

Of course, the above notation for an IFS is cumbersome. Table 1 expresses the same information in tabular form. Other examples of IFS codes are given in tables 2 through 4. Notice that an IFS can contain any number of affine transformations.

The Random Iteration Algorithm

Now let's see how to decode an arbitrary IFS code using the random iteration method. Remember that in general an IFS can contain any number, say m, of affine transformations, W_1, W_2, W_3, . . . , W_m, each with an associated probability. The following code summarizes the method:

```
(i) Initialize: $x=0$, $y=0$.
(ii) For $n=1$ to 2500, do steps (iii)-(vii).
(iii) Choose $k$ to be one of the numbers 1, 2 , . . . , $m$, with probability $p_k$.
(iv) Apply the transformation $W_k$ to the point $(x,y)$ to obtain $(\bar{x},\bar{y})$.
(v) Set $(x,y)$ equal to the new point: $x=\bar{x}$, $y=\bar{y}$.
(vi) If $n > 10$, plot $(x,y)$.
(vii) Loop.
```

Applying this procedure to the transformation in table 1 produces the figure shown in figure 8—a fractal known as the Sierpiński triangle. Increasing the number of iterations n adds points to the image. Figure 9 shows the result of the random iteration algorithm applied to the data in table 3, at several stages during the process. By increasing the scale factor used in plotting, you can zoom in on the image (see figure 10). The text box on page 221 contains a BASIC implementation of the method with additional comments on programming.

You may wonder why the first 10 points are not plotted (step (vi)). This is to give the randomly dancing point time to settle down on the image. It is like a soccer ball thrown onto a field of expert players: Until someone gains control of the ball, its motion is unpredictable, or at least is independent of the players' actions. But eventually a player gets the ball, and its motion then becomes a direct result of the skill of the players. The fact that our transformation is contractive guarantees that the "ball" will eventually get to one of the "players," and that it will stay under control after that.

How do we know that the random iter-

continued

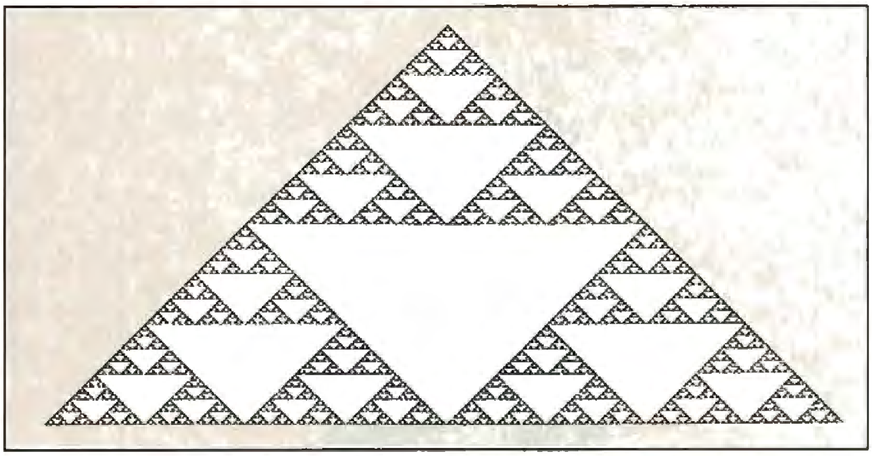


Figure 8: *The result of applying the random iteration algorithm to the IFS code in table 1. It is called the Sierpiński triangle.*

Figure 9: *A fern appears when the random iteration algorithm is applied to the IFS code in table 3.*

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ation algorithm will produce the same image over and over again, independent of the particular sequence of random choices that are made? This remarkable result was first suggested by computer-graphical mathematics experiments and later given a rigorous theoretical foundation by Georgia Tech mathematician John Elton.

The Collage Theorem

Our next goal is to show a systematic method for finding the affine transformations that will produce an IFS encoding of a desired image. This is achieved with the help of the Collage Theorem.

To illustrate the method, we start from a picture of a filled-in square S in the x,y plane, with its vertices at (0,0), (1,0), (1,1), and (0,1) (see figure 11). The objective is to choose a set of contractive affine transformations, in this case W_1, W_2, W_3, W_4, so that S is approximated as well as possible by the union of the four subimages $W_1(S) \cup W_2(S) \cup W_3(S) \cup W_4(S)$. Figure 11 shows, on the left, S together with four noncovering affine transformations of it; on the right, the affine transformations have been adjusted to make the union of the transformed images cover up the square.

To find the coefficients of these transformations, we use the method described earlier in the section on iterated function systems, leading to simultaneous equations 1 through 3 and 4 through 6. The values one finds in the present case are given in table 2. When the random iteration algorithm is applied to this IFS code, the square is regenerated.

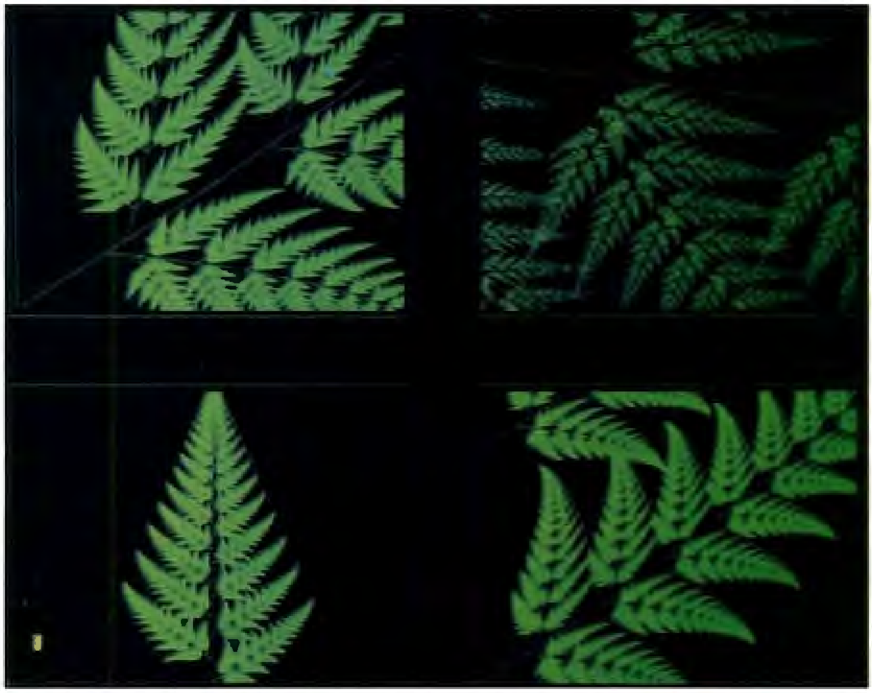

Figure 10: *Successive zooms on pieces of an IFS-encoded fern.*

The preceding example typifies the general situation: You need to find a set of affine transformations that shrink distances and that cause the target image to be approximated by the union of the affine transformations of the image. The Collage Theorem says that the more accurately the image is described in this way, the more accurately the transformations provide an IFS encoding of it.

Figure 12 provides another illustration of the Collage Theorem. At the bottom left is shown a polygonalized leaf boundary, together with four affine transformations of that boundary. The transformed leaves taken together do not form a very good approximation of the leaf; in consequence, the corresponding IFS image (bottom right), computed using the random iteration algorithm, does not look much like the original leaf image. However, as the collage is made more accurate (upper left), the decoded image (upper right) becomes more accurate.

So, there's a fundamental stability here. You don't have to get the IFS code exactly right in order to capture a good likeness of your original image. Moreover, the IFS code is robust: Small perturbations in the code will not result in unacceptable damage to the image. In each of the above examples, we have used four transformations to encode the image. However, any number can be used.

For example, the spiral image in figure 13 can be encoded with just two contractive affine transformations. See if you can find them. Then determine the IFS transformation coefficients and input them to the random iteration algorithm to get the spiral back again.

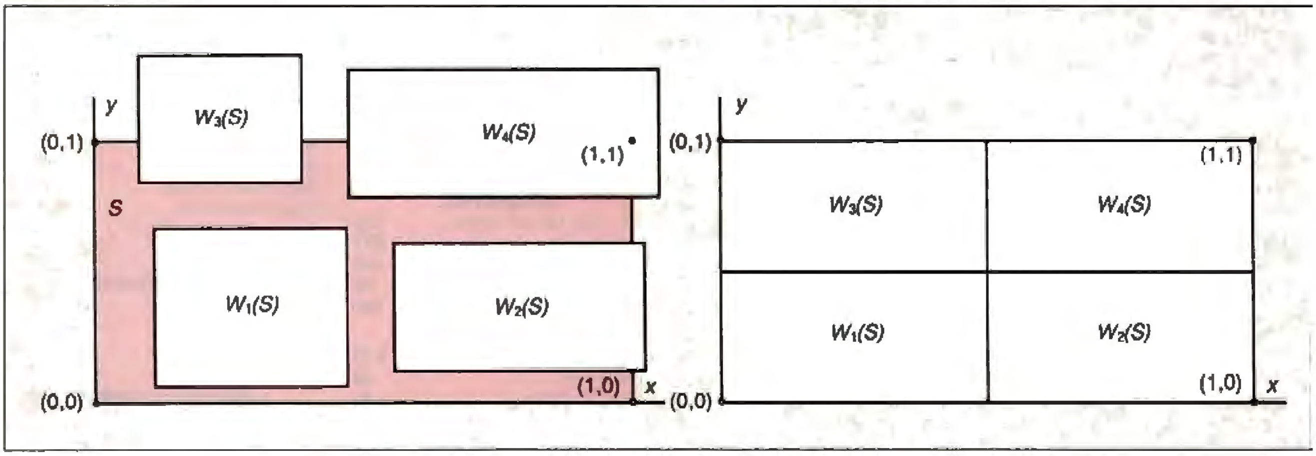

Figure 11: *The collage theorem is used to encode a classical square S. The correct IFS code is obtained when the four affine transformations of S cover S, as shown on the right.*

Assigning Probabilities

Once you have defined your transformations, you need to assign probabilities to them. Different choices of probabilities do not in general lead to different images, but they do affect the rate at which various regions or attributes of the image are filled in. Let the affine transformations W_i corresponding to an image I be

$$W_i \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} a_i & b_i \\ c_i & d_i \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} e_i \\ f_i \end{bmatrix},$$

where $i = 1, 2, 3, \ldots, n$. Then the amount of time that the randomly dancing point should spend in the subimage W_i is approximately equal to

$$\frac{\text{area of } W_i}{\text{area of } I}.$$

continued

IFS Decoding in BASIC

Listing A is a BASIC implementation of the random iteration algorithm. It includes the data for the Sierpiński triangle, but you can use it to process any IFS tables. In particular, you will want to try the data in tables 2, 3, and 4. Be sure to set the variable `m` correctly; it tells the program how many transformations are in the IFS.

It is also essential that the probabilities in `p()` add up to 1. For speed, the transformations should be listed in descending order of probability: the highest probability transformation first, and the lowest probability last.

The program includes variables for rescaling and translating the origin to accommodate the range of the points being plotted to the limits of your screen. If the image is too wide, decrease `xscale`; if the points are too close horizontally, increase `xscale`. Adjust `yscale` similarly to get a good vertical point spread. To move the image, adjust `xoffset` and `yoffset`.

You can do these adjustments by trial and error: Run the program; interrupt it and change the offsets and scale factors; and run it again. Or, you can replace the plot command `pset` with a command to print the values of `x` and `y` and run the program to get an exact idea of the range of points being plotted, so you can adjust the scale and offsets more precisely.

Another way to arrange the program is to have it read all the data—`m`, `a()`, `b()`, `c()`, `d()`, `e()`, `f()`, `p()`, `xscale`, `yscale`, `xoffset`, and `yoffset`—from a disk file specified by the user. Instead of reading in the coefficients a, b, c, and d, you may want to read in angles θ and ϕ and scale factors r and s, and then calculate the coefficients.

The random iteration method is computation-intensive, so we recommend use of a compiler such as Microsoft's QuickBASIC or Borland's Turbo BASIC. If your computer has a floating-point coprocessor and your compiler supports one, so much the better.

Listing A: *A BASIC program demonstrating the use of the random iteration algorithm to reconstruct an IFS-compressed image.*

```
10 'Allow for a maximum of 4 transformations in the IFS
20 DIM a(4), b(4), c(4), d(4), e(4), f(4), p(4)
30 '
40 'Transformation data, Sierpinski triangle
50 'First comes the number of transformations
60 'then the coefficients a through f and probability pk
70 'The values for pk should be in descending order.
80 DATA 3
90 DATA .5,0,0,.5,0,0,.34
100 DATA .5,0,0,.5,1,0,.33
110 DATA .5,0,0,.5,.5,.5,.33
120 '
130 'Read in the data
140 READ m
150 pt = 0  'Cumulative probability
160 FOR j = 1 TO m
170     READ a(j), b(j), c(j), d(j), e(j), f(j), pk
180     pt = pt + pk
190     p(j) = pt
200 NEXT j
210 '
220 'Set up for Graphics
230 SCREEN 3          'Select graphics screen
240 xscale = 350      'Map [0,1] onto [0,350]
250 yscale = 325      'Map [0,1] onto [0,325]
260 xoffset = 0
270 yoffset = 0       'Leave the y-origin
280 '
290 'Initialize x and y
300 x = 0
310 y = 0
320 '
330 'Do 2500 iterations
340 FOR n = 1 TO 2500
350     pk = RND
360     'The next line works for m<=4. It must be modified
370     'for values of m > 4.
380     IF pk <= p(1) THEN k = 1 ELSE IF pk <= p(2) THEN k = 2
                  ELSE IF pk <= p(3) THEN k = 3 ELSE k = 4
390     newx = a(k) * x + b(k) * y + e(k)
400     newy = c(k) * x + d(k) * y + f(k)
410     x = newx
420     y = newy
430     'Use PRINT x,y instead of the PSET line
440     'to see the range of coordinates. Then fix
450     'xscale, yscale, xoffset, and yoffset
460     IF n > 10 THEN PSET (x * xscale + xoffset, y * yscale
                  + yoffset)
470 NEXT n
480 '
490 LOCATE 24, 35
500 PRINT "Press any key to end.";
510 WHILE INKEY$ = ""
520 WEND
530 '
540 'Return to text screen
550 SCREEN 0
560 END
```

Figure 12: *The Collage Theorem is applied to a leaf. The collage at lower left isn't much good, so the corresponding IFS image, shown at lower right, is a poor approximation. But as the collage improves, upper left, so does the IFS image.*

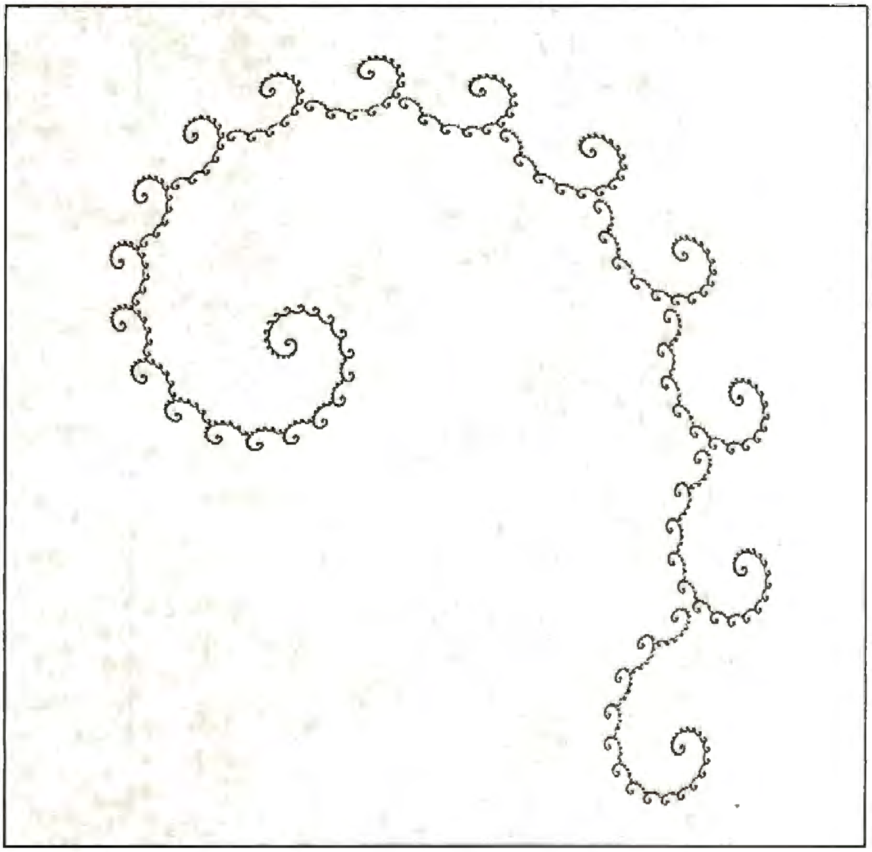

Figure 13: *Can you find the IFS codes for this spiral image? Only two transformations are needed.*

So long as $ad - cd$ is not 0, it is a standard calculus result that our ratio equals the determinant of the transformation matrix for W_i. So a good choice for the probability p_i is

$$\frac{a_i d_i - b_i c_i}{\sum_{k=1}^{n} |a_k d_k - b_k c_k|},$$

provided none of these numbers p_i comes out to be 0. A 0 value should be replaced by a very small positive value, such as 0.001, and the other probabilities correspondingly adjusted to keep the sum of all the probabilities equal to 1.

We now summarize the compression and decompression process: An input image is broken up into segments through image-processing techniques. These image components are looked up in the IFS library using the Collage Theorem, and their IFS codes are recorded. When the image is to be reconstructed, the IFS codes are input to the random iteration algorithm. The accuracy of the reconstructed image depends only on the tolerance setting used during the collage mapping stage.

Applications

For graphics applications, we use a more sophisticated procedure that allows full-color images to be encoded. Combinatorial searching algorithms can be used to automate the collage mapping stage. Figures 2, 3, and 4 were obtained using IFS theory at compression ratios in excess of 10,000 to 1. These images were based on photographs in recent issues of *National Geographic*. A full-sequence video animation, *A Cloud Study*, was shown at SIGGRAPH '87. This was encoded at a ratio exceeding 1,000,000 to 1 and can be transmitted in encoded form at video rates over ISDN lines (ISDN stands for integrated services digital network, a concept for integrated voice and data communications). A frame from the animation is shown in figure 5.

The IFS compression technique is computation-intensive in both the encoding and decoding phases. Computations for the color images were all carried out on Masscomp 5600 workstations (dual 68020-based systems) with Aurora graphics. Complex color images require about 100 hours each to encode and 30 minutes to decode on the Masscomp.

For practical applications, you need custom hardware that can speed the encoding and decoding process. An experimental prototype, the IFSIS (iterated function system-image synthesizer), decodes at the rate of several frames per second. The IFSIS device was produced from a cooperative effort between GTRC, DARPA, Atlantic Aerospace Electronics Corporation, and Iterated Systems, and it was demonstrated on October 5, 1987, at the third annual meeting of the Applied and Computational Mathematics Program of DARPA. It can be connected to a personal computer through a serial port; the personal computer sends the IFS codes to the device, which responds by producing complex color images on a monitor.

The IFSIS is a proof of concept for faster devices with higher resolution. Once the higher-performance IFSIS devices are combined with ISDN telecommunication, full-color animation at video rates over phone lines will be a reality.

Another area for future application of IFS encoding is automatic image analysis. What's in a picture? Does it show a spotted sandpiper or a robin? The more complex the image or the more subtle the question, the harder it becomes for an algorithmic answer to be formulated. But here's the point: Whatever the answer, it will proceed faster if stable, compressed images are used. The reason for this is that image-recognition problems involve combinatorial searching, and searching times increase factorially with the size of the image file.

During the spring of 1987, Iterated Systems was incorporated to develop commercial applications of IFS image compression. It is exciting to see how an abstract field of mathematics research is leading to new technology with implications ranging from commercial and industrial work to personal computing. ■

ACKNOWLEDGMENTS

Figures 2 through 5 were encoded by graduate students François Malassenet, Laurie Reuter, and Arnaud Jacquin. All color images were produced in the Computergraphical Mathematics Laboratory at Georgia Institute of Technology and are copyright 1987, GTRC.

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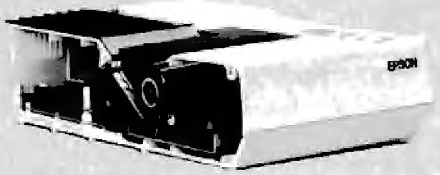

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Project Xanadu provides a model for the possible future of mass storage

Theodor H. Nelson

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The present system, Xanadu 87.1, is an operational file server program, intended to run in many computers of a network, that performs a full set of functions and that can be incrementally improved without major revision up to the full performance of the network. This article is an introduction to its principal concepts and indexing schemes.

I began what is now Project Xanadu in the fall of 1960 as a term project for a graduate course at Harvard on computers in the social sciences. During the 1960s, it evolved into a new set of data structures (see reference 1), then a single-user workstation (reference 2), and finally the idea grew to its present scope, detailed in my book *Literary Machines* (reference 3).

Through all this time, however, two main specifications remained the same: A user would be able to see and follow arbitrary links between pieces of nonsequential text and be able to intercompare different versions of documents, noting which parts were the same—a feature I believe to be necessary for office systems and other forms of interconnected writing (such as hypertext).

Project Xanadu has suffered from too much publicity. The project is well known, but not well understood. Its greatest aspiration, a universal instantaneous hypertext publishing network, has not been generally understood at the technical level and has created various false impressions. One publication, for example, referred to it as "a database-to-be the size of the world"—a very muddled description.

We at Project Xanadu have another great aspiration for the same software and underlying ideas: the organization and clarification of files on a small scale, cleaning up the clutter of computer files that now chokes both individuals and offices. People everywhere are drowning in little files with mysterious names whose origins and relationships are forgotten. We want to clear that up as well.

We believe we have a unifying technical solution to both problems.

A New Form of Storage

We have a model of storage that is rational yet radical: rational because it proposes to keep things orderly to a degree they could never be before; and radical because it requires a fundamental change in the way computers are programmed. Like other new paradigms, this presents an entirely new worldview, and it provokes various forms of confusion and anger.

Our generic name for this is "xanalogical storage." Xanalogical storage lets units be built from parts of other units and linked together in various ways. I will explain this concept further and then present various technical details—such as the addressing system and its arithmetic, and the structure of links—by which we create the particular xanalogical structure of the Xanadu system.

Often, apparently simple designs for data storage merely foist complexity on users, requiring many adaptations *outside* the design. Traditional computer storage is such a system; it pushes onto the user the problem of naming and keeping track of hundreds or thousands of files and their backup copies, and the relations between them. Existing systems encourage clutter; files with unknown contents are saved as a precaution, and the connections between things get lost and deteriorate.

What individual users and offices don't know they need is a system of storage that keeps track of the origins and variations of everything. Such a system would let a user see the origin of any part of a document, provide insight into its meaning in different contexts, and allow it to be used in new ways easily.

For example, consider a lawyer who uses variations of the same contract repeatedly. He will tell his secretary, "I want to give this client the modifications we did for Jones, but also the changes we

continued

Theodor H. Nelson (Project Xanadu, 8480 Fredericksburg, Suite 138, San Antonio, TX 78229) is the director of Project Xanadu and the inventor of the hypertext concept.

did for Smith." On the screen, he ought to be able to see each borrowed part highlighted in both old and new contexts. Without this, in today's offices, a good secretary must do what the system ought to do—keep track of the origins and interconnections of the material.

Traditional computer file structures have also generated many computer applications—and their problems—as we now know them. Conventional files are streams of bits divided into blocks and given a name. Text systems began when someone decided to treat the sequence of bits as text characters, then set up controls for their revision. Database programs began when someone decided to treat individual blocks as units and divide them into named and addressable fields.

In this way, I would argue, our applications programs have become artificially divided into functions on the basis of how they are implemented. This keeps us misled into believing that such programs as "database' and "text" are divinely ordained, and leads us away from designing functions best suited to particular uses.

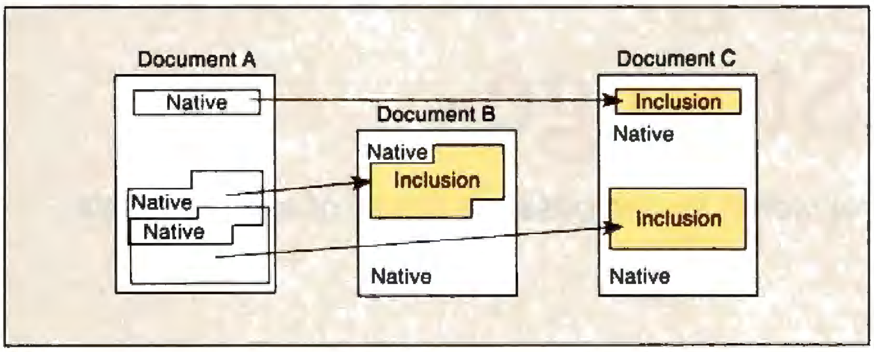


Figure 1: *A Xanadu document can consist of native bytes, which originated with the document, and inclusions of native bytes from other documents.*

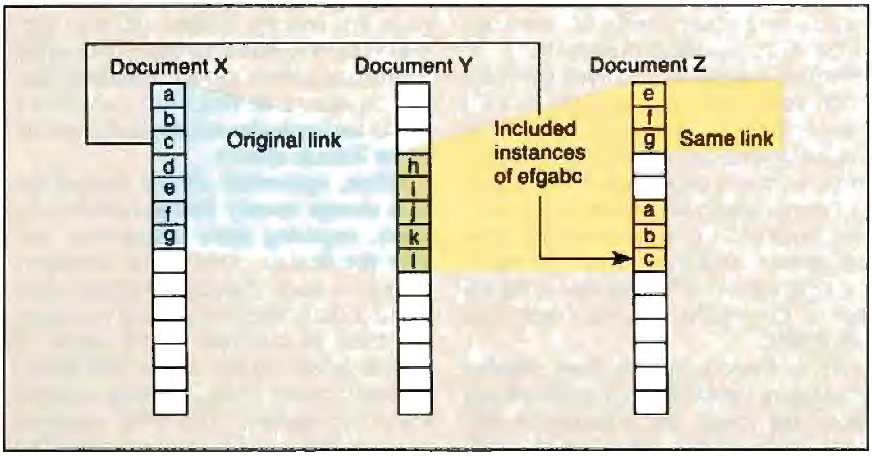


Figure 2: *An example of linking: Some of the bytes of document X have been included into document Z. Since those bytes contain links to document Y, Z and Y are now linked.*

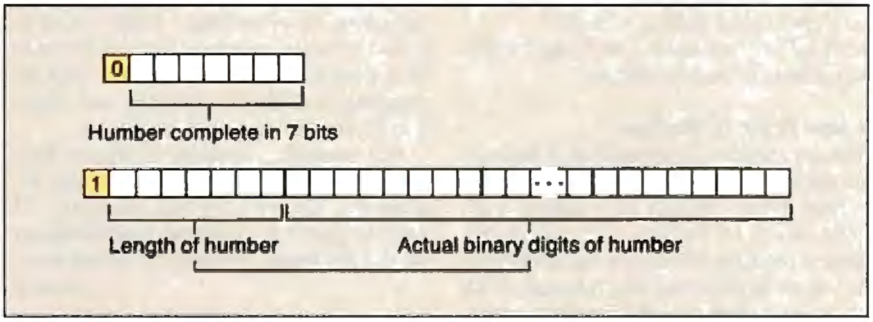


Figure 3: *Humbers can be represented by 1 or more bytes. A 0 in the first bit signals that the number is complete in 1 byte. A 1 in the first bit means that the remaining bits of the first byte specify the length, in bytes, of the number, which can be a binary number up to 1016 bits long—an extremely long number.*

The alternative is a new module for maintaining storage in its real complexity, permitting you to understand the interrelation of all stored materials. Under this storage paradigm, you can ascertain the origin of every part of every document (in a way that will even save space in some environments), as well as make note (as if using a highlighting pen and sticky notes) of every interconnection and feature of interest. To distinguish materials stored in this way, I will avoid confusion by not using the word "file," since that is what conventionally stored units are called. I will use the term "document" for materials stored according to this new paradigm.

Building Documents by Inclusion

In the Xanadu paradigm, a document consists of *native bytes*, which originated with the document, and *inclusions*, which are bytes native to other documents but also present by inclusion, or virtual copy, in this one (see figure 1). Conceptually, there is only one copy of every byte (though for both safety and implementation there are generally other copies). A byte is just as fully a part of a document in which it is included as it is part of the document to which it is native.

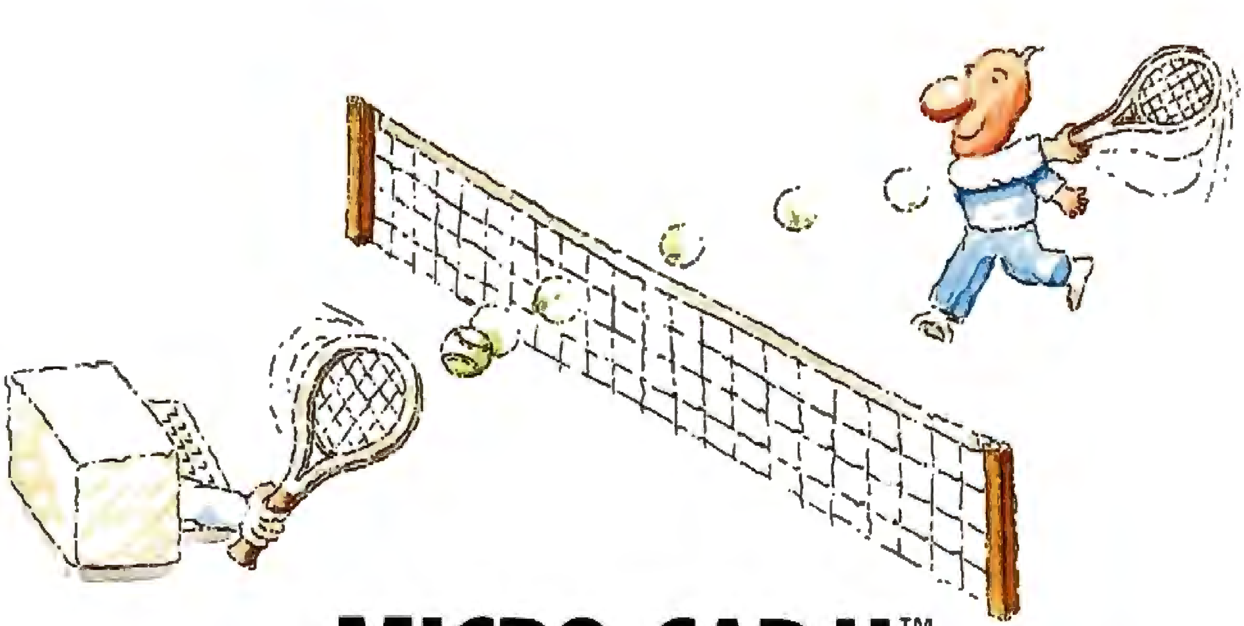
Thus, a document consists (first approximation) of native bytes and a structure of pointers (hidden and maintained by the storage system) for bringing instances of included bytes from other documents. By various system commands, you can ask where bytes came from, ask to see them in their original context, and so on.

At about this point some people—especially assembly language programmers who like to optimize systems for speed—invariably ask, "What about efficiency?" Well, at every stage in the development of system facilities, some people object to a lack of raw access. But keeping in mind that storage and computers are cheap, and people are expensive, then the real efficiency is *human* efficiency, and it is that efficiency we are trying to maximize.

Keeping Track

A truly efficient storage system needs a data structure that keeps track of arbitrary links between arbitrary portions of arbitrary documents. This is important for hypertext, for the marking and annotation of all kinds of data, and for search-

continued



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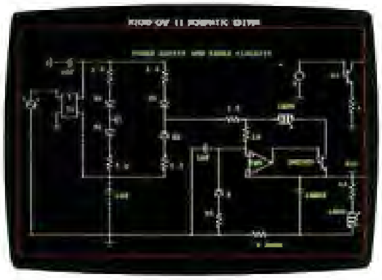

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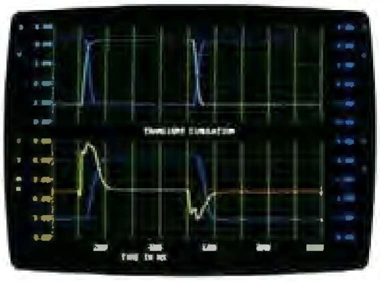

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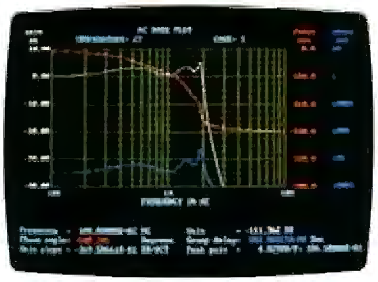

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ing on such links and markings.

In the Xanadu system, we do this by attaching links not to points in the data, but to the bytes themselves. Thus, a given link is present on every document in which any of the bytes (native or included) are linked to another document.

For example, in figure 2, some of the bytes of document X have been included in document Z. Since those particular bytes are linked to document Y, the same link now exists between Z and Y. This link will always exist between Z and Y until the last of those linked bytes from X is deleted from Z.

We have taken pains to generalize this linking system so that it can work seamlessly across all disk, computer, and network boundaries as the world of computer storage becomes united. Our storage program is designed to be run in parallel on networks of an unlimited number of servers that respond essentially as a whole.

Link types are extensible, and any user can create new ones. Although primitive links are two-sided, one-sided links can be used; links can also be combined (like CAR and CDR in LISP) into structures of arbitrary richness.

Links can be searched for by type and by endpoints throughout the universe of data. Thus, we see the flat file with searchable links as potentially a universal data structure.

Since the "byte" parts of a file can be instanced anywhere, and for different purposes, this method encourages using the link mechanism to represent those parts that are variable, arbitrary, and viewpoint-dependent. For example, paragraphs and text attributes such as underlining are represented by links; thus, each included instance of specific text material can easily be underlined and paragraphed differently.

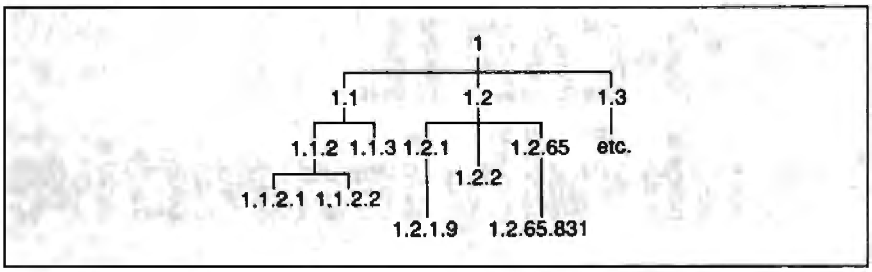

Figure 4: *A small branching structure of simple tumblers.*

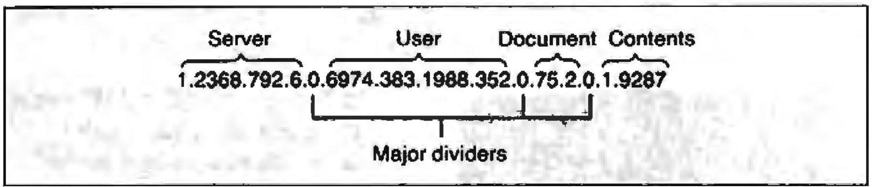

Figure 5: *Xanadu address tumblers are divided into four fields: Server, User, Document, and Contents. Each field can be short or long depending on the complexity of the item being addressed, and the major divider ".0." is used to separate fields. The digit 1 in the first position of the Contents field indicates that this tumbler designates a byte; a 2 in the first position would indicate a link.*

Table 1: *Sample commands from Xanadu's FEBE protocol, in simplified form.*

`DELETEVSPAN (doc, span)`	Deletes the span.
`MAKELINK (doc, from-spanset, to-spanset, type)`	Makes a link from one document to another.
`FINDNUMOFLINKSTOTHREE (home-set, from-set, to-set, type)`	Returns the number of links of the specified type residing in the home-set between the specified sets.
`FINDLINKSFROMTOTHREE (home-set, from-set, to-set, type set)`	Finds all the links of the specified types connecting any bytes of specified sets, provided that those links reside in the home-set.
`FINDDOCSCONTAINING (spans)`	Returns a list of all documents containing any of the material specified by the span addresses.

The Numbering Problem

Our system must keep track of a very large number of items: an ever-growing network of serving units (computers, also called nodes or file servers) with no center; an ever-expanding system of documents, growing unpredictably; an ever-expanding number of authors and publishers, business users, scholars, and miscellaneous accounts; and an ever-proliferating system of versions of documents, some controlled by their originators and others not.

Keeping track of all this essentially means keeping track of a lot of numbers, some of them small and some very large. These internal numbers are used for counts and pointers, and for the overall scheme of where things are and how to get to them. We could, of course, treat the growing universe of documents (or "docuverse") as a large integer domain, sparsely occupied by assigned document addresses. However, this would mean unoccupied areas using up many, many precious bits.

In designing the structure, we faced the problem of how to specify a sprawling, rapidly and unpredictably growing docuverse in a tractable form, with an indexing scheme that could possibly grow very large and still be cogent and parsimonious on the small-scale integer manipulations within individual documents.

As an inspiration, we looked to the Dewey decimal system, which, while not perfect, doesn't waste a lot of space on empty characters. It led us to the concept of forking numbers—numbers that can be continually separated to make more numbers—which we have developed in an unusual way.

The solution to our numbering problem involves two concepts. The first is the use of compound numbers called *humbers*.

Humber stands for "humongous number," which can be represented by 1 or more bytes. The very first (or *completeness*) bit signals whether the number is complete in 1 byte. If this bit is unset (equal to 0), the remaining 7 bits hold the number itself (ranging from 0 to 127), and the entire number is stored in the 1 byte (see figure 3).

continued

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```
INVOICE
Invoice No.:                 Date:                  Time:    14:01:11
                                                 Customer
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WDLA    Windows for Data  Lattice                   Shipping:
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Cursor keys scroll, ENTER selects and ESC exits choice menu
```

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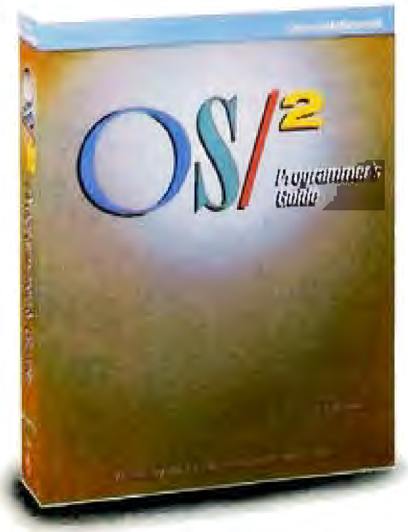

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A completeness bit that is set (equal to 1) means that the remaining 7 bits of the first byte specify the length, in bytes, of the number. The largest 7-bit number (1111111) equals 127 (decimal), so the bytes that follow the first byte can carry a binary number up to 1016 bits (127 × 8) long, a number greater than 10^{300}, and larger than we will need very soon.

In this scheme, numbers occupy no more space than they need; they are short most of the time (when needed for small incrementation) and stretch out whenever needed, without any change in the generalized manipulation routines. There is little space overhead: the completeness bit, the first byte (if over 128), and no more than 7 bits in the length of the mantissa, if over 128.

Humbers are digits represented in the main addressing scheme of our system, which we call *tumblers*—a name chosen because the action of our system resembles that of the rotary mechanisms of a lock, which slide and increment independently with respect to each other.

Anatomy of a Tumbler

A tumbler consists of a series of integers, called "digits," that have no upper limit. The digits of the tumbler are separated by minor dividers, or points. Thus,

.373.
.675923.
.40.

are examples of tumbler digits.

One digit can become several by a forking or branching process. For instance, the digit

.2.

can branch into several more items, each of which is a successive daughter item placed "under" the digit:

.2.1.
.2.2.
.2.3.
.2.4.

Similarly, the sixth item under ".2.4." is

.2.4.6.,

and the 312th item under that is

.2.4.6.312.

The use of such numbers imposes a tree structure upon the address space of the system (although not upon material contained in the system). Figure 4 shows a small branching structure of simple tumblers.

The tumbler space is an accordion-like master address space, potentially very large, that provides for the notation of the complex relations between documents, their ancestors and progeny, their owners, their home locations on the network, and the expansion of the network itself.

We have developed these basic mathematical ideas into the Xanadu system as follows: The digits in a tumbler are divided into fields, which are separated by the major divider ".0.", a kind of punctuation between the fields that also has certain useful mathematical properties.

As set up for the Xanadu system, the four major fields of tumblers are expandable indefinitely, with three major dividers between them. These fields are called Server, User, Document, and Contents. Tumblers may be shorter or longer depending on the complexity of the item being addressed, as shown in figure 5.

The Server is the node on which a document is stored, either a single physical device or a logical division that may be mapped to subdevices or collections of

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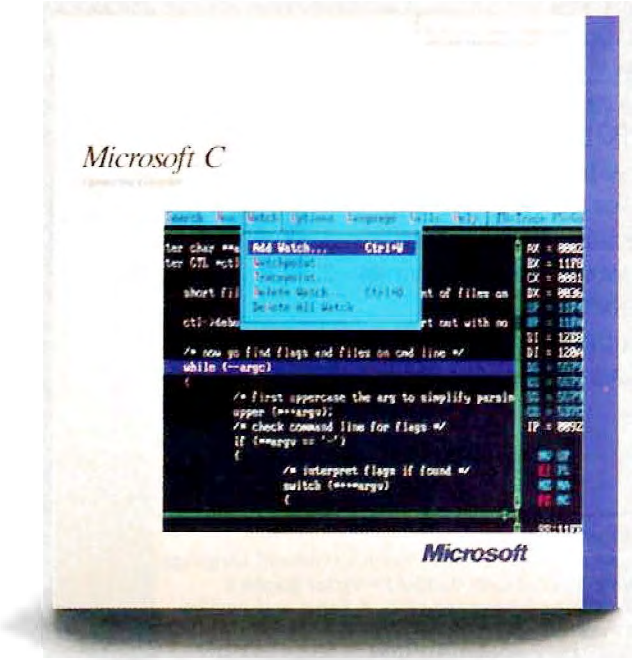

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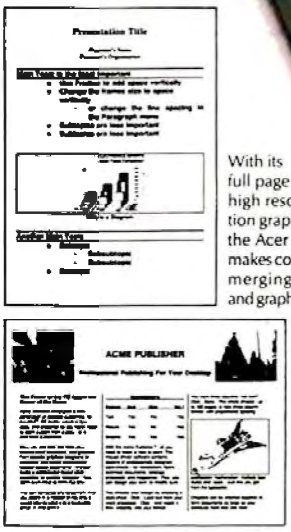

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devices in the future, all of which would branch within this first field.

The User field of the tumbler designates the owner of a document, which can also branch off within this field to indicate daughter accounts, departments, interests and projects, or areas of recordkeeping.

A Document is the logical entity in which materials are stored. Within this field, subdivisions can branch off to represent different versions of the document, as shown in figure 4.

The final tumbler field specifies the individual contents and can represent either bytes or links. When this section of a tumbler address begins with a 1, the address is that of a byte. Thus

X.0.X.0.X.0.1.1

indicates the first byte of the document, and

X.0.X.0.X.0.1.9287

indicates the 9287th byte of the document.

Numbers with 1 as the first digit in the last field can, by interpretation, map sequential data other than simple bytes (e.g., a DNA sequence).

When the fourth section of a tumbler address begins with a 2, the address is that of a link. The number after the 2 indicates the number of the link. Thus,

X.0.X.0.X.0.2.352

indicates the 352nd link contained in this document.

In the future, numbers above 2 could be used in the first position of this field to indicate that the following digits are parts of nonsequential structures, such as a graphic image, a video frame, or a musical notation.

Two Types of Tumblers

Tumblers are used in two ways: They can refer to an *address* (a place tumbler, as discussed already), or to a *span* of the address space—a series of bytes and/or links, a series of documents, a tree structure in the address space, or even the entire docuverse.

A span is represented by two tumblers: an address tumbler and a *difference tumbler*. These tumblers are governed by different rules. To begin with, address tumblers are stable, referring to the same entity no matter how much additional material is added to the docuverse; they remain valid wherever you are.

A difference tumbler, on the other hand, is valid only in relationship to its tumbler address. Difference tumblers are derived from two address tumblers in a process called *tumbler subtraction*. This involves the first object in a specified subtree (the subtrahend) and the first element *after* the specified subtree (the minuend), which is always "larger" (in the sequence of tumblers) than the subtrahend; the result is a difference tumbler representing the intended span.

The rules for tumbler subtraction are as follows: Place the subtrahend under the minuend; start at the left, and for every field that is the same in both tumblers, place a zero (maintaining the field divider zeros as checkpoints, always in correspondence); when you encounter a difference in corresponding digits, subtract the integers in that position. (The result cannot be negative; this would mean the subtrahend was larger than the minuend, which is illegal.) All digits that follow are copied down from the top row.

For example, the span of addresses between the tumbler address

1.0.1.0.1.0.1.9287

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Circle 70 on Reader Service Card (DEALERS: 71)

and the earlier tumbler address

1.0.1.0.1.0.1.7156

is represented by the earlier address and the difference tumbler

0.0.0.0.0.0.0.2131.

This is the simplest kind of tumbler subtraction, in which the tumbler addresses have the same Server, User, and Document fields.

A more complex example of tumbler subtraction, in which a span covers two different users, would be:

1.0.234.0.45.0.1.334
1.0.112.0.17.0.1.977

0.0.122.0.45.0.1.334

It may help to think of tumbler subtraction as something like "step backward one chapter, three paragraphs, and two lines."

Tumbler addition involves the first element in a specified subtree (the augend) and a difference tumbler (the addend) representing the span; the result will represent the first element after the specified subtree.

The mechanics of tumbler addition are as follows: For every leading zero in the second row, the corresponding integer is copied down from the first row. When a nonzero digit is encountered in the second row, an addition between the two rows is performed for that field. All additional fields are copied down from the second row, as shown in the following examples:

1.0.1.0.1.0.1.7156 (first tumbler in tree)
0.0.0.0.0.0.0.2131 (difference tumbler)

1.0.1.0.1.0.1.9287 (first tumbler after end of tree)

1.0.112.0.17.0.1.977 (first tumbler in tree)
0.0.122.0.45.0.1.334 (difference tumbler)

1.0.234.0.45.0.1.334 (first tumbler after end of tree)

Let me stress that tumbler arithmetic as presented here has been contrived, like many other mathematical activities we need, rather than discovered.

Span addresses are necessary to specify what links point to and from, and to specify the domains to be searched for documents and links in the various user requests to the system. Subtraction is the process needed to specify the spans, and addition is its inverse. This system has some interesting and helpful features. For example, it lets you refer to the entire docuverse simply by using a span whose difference tumbler has a 1 in the very first position.

A Matter of Protocols

Now that we have a scheme for referring to documents and the links between them, I'll explain how the system will handle these pieces. Xanadu has two main sets of protocols, which dictate how the system behaves: FEBE (front end to back end) and BEBE (back end to back end).

All requests to the Xanadu system are made by applications programs through the FEBE protocol, which manipulates the addresses (and spans of addresses) necessary to find text and links and to follow them. The FEBE protocol also includes instructions for insertion in a document, deletion from a document, and rearrangements of unlimited size.

continued

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Table 1 contains samples of FEBE commands. Note that these commands are not seen by the user but handled invisibly by programs in the user's front-end machine. Some of the commands as presently defined will return avalanches of material. Further refinement of the protocol will specify handshaking methods for controlling this.

The BEBE protocol, which is still undergoing definition, will connect nodes of the Xanadu network so as to meld the contents of separate Xanadu servers into a single unified space, where different nodes contain maps of the whole docuverse with varying degrees of detail.

Application Design

The interior design of applications for use with the Xanadu storage engine is very different from conventional application design, since so much is handled by the storage mechanism. All references to links and stored materials go through the FEBE protocol (even if the entire Xanadu module is bound into the program), and the programmer's design work becomes, to a large extent, the user interface.

Note that the application designer is no longer constrained by old categories of programs, since the Xanadu data structure provides a broad-spectrum representation method for word processing, databases, CAD/CAM, molecular modeling, seismographic data, bit-mapped graphics, image synthesis, and other functions, which can be combined in new ways. Software designers have not merely a license, but a mandate, to start from scratch, since (regrettably) no existing programs will work with our model of storage. But we believe that applications as presently implemented—balkanized, irreparably divided in function, and carved into zones of partial compatibility—have reached the limit of common sense and tolerability.

As when any higher-level function migrates to system software and language facilities, some programmers may feel that part of their creativity has been taken away. On the contrary, we believe that our system frees programmers for the truly creative work of designing interaction, visualization, and conceptual structure. Applications programmers are usually so busy with the impediments of storage and data-structure maintenance that they tend to sleight the more important subtleties of interaction and what I call "virtuality"—the conceptual structure and feel of a system. Now they can concentrate fully on these issues.

Implementation

The Xanadu storage engine described above presently exists in full prototype, available via phone line for experimentation by serious developers. Its software mechanisms are proprietary and are presently covered by trade secret; we hope to publish them at a future date.

The present architecture is chiefly the work of Mark S. Miller and Roger Gregory, with myself, Stuart Greene, Eric Hill, and Roland King. The program is written in C under Unix. In the current version (August 1987), it compiles to about 135K bytes on the 68000 microprocessor. A local search space of 10 megabytes is desirable, though we expect that to be reducible for personal and office applications. The resident protocol manager (required by applications programs) compiles to about 35K bytes.

[Editor's note: *The C source code for the Xanadu protocol handler for applications programs is available on BIX, on BYTEnet, on disk, and in the Quarterly Listings Supplement as the file XANADU.PRO. See "Program Listings" in the table of contents. To use the module, you will need a C compiler for the IBM PC, the Macintosh, or the Amiga. Serious ap-*

continued

plications developers who have a program incorporating this module and wish to experiment with the Xanadu system can contact Roger Gregory at (408) 244-2643.]

We have dealt with a large-scale problem where clean design is vital—both inner simplicity and a clean interface to the outside world. We believe we have achieved this.

Our analysis indicates that as the number of documents and links grows, degradation of the performance of the system will, at best, be log-like and at worst, square root-like: a rate of deterioration that is greater at first, then leveling off. For instance, each time the number of links doubles, there should be only a slight degradation of performance.

Unfortunately, this analysis doesn't give us base rates to judge what performance we'll get on presently available machines, and we await these empirical figures with great interest.

The present design calls for the use of sequential computers. However, given our long-term goals and today's new hardware, we expect to introduce various types of parallelism to improve performance and make the system practical on the scale we intend.

Universal Hypertext Publishing

The grand ambition of the Xanadu system is not "a database the size of the world," but rather a repository publishing network for anybody's documents and contents, which users may combine and link to freely.

This will permit a new form of electronic publishing, entirely within the tradition of paper publishing but greatly streamlined: One need not ask permission to republish something, but simply place it in a document as an inclusion. The bytes will not be physically copied, but only included by reference.

Nothing will ever be misquoted or out of context, since the user can inquire as to the origins and native form of any quotation or other inclusion. Royalties will be automatically paid by a user whenever he or she draws out a byte from a published document. The permission procedures of conventional publishing are bypassed, with complete fairness to all parties. Blanket permission for inclusion and linkage must be granted contractually by a user when depositing a document for publication. Legal accountability for both links and text will be the responsibility of their owners. Private documents can be stored under the same system, but with slightly different rules: A private document can include or link to published documents, but not vice versa.

Today's conventional databases will not satisfy the information needs of the noncomputing public, nor can they provide methods for publishing the ever-more-interconnected writings now being placed on electronic networks. It is our hope to bring the power of electronic access to the new and sweeping literary medium of hypertext, in all the forms that the mind can devise. ■

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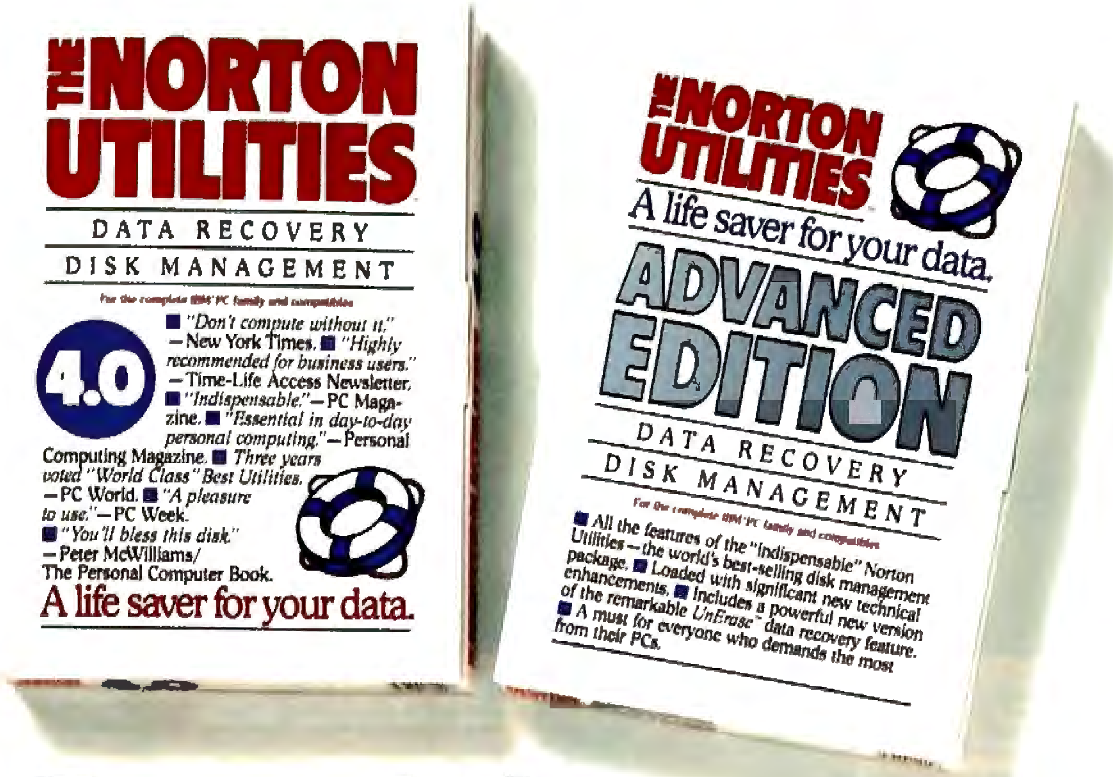

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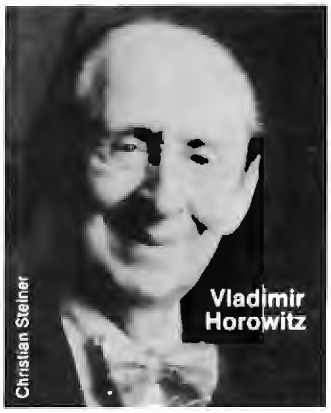

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Fast Data Access

As personal computers accommodate larger and larger databases, we'll need new methods of "query optimization" to get at the data quickly

Jonathan Robie

THE HARDWARE FOR handling very large data sets on personal computers is here: 20-megabyte and 40-megabyte hard disk drives are commodity items. IBM has decided to port DB2, its mainframe relational DBMS, to the OS/2 operating system, and has announced that a 314-megabyte hard disk drive will be available for the PS/2 Model 80.

However, these large data sets require careful handling. Accessing the data in the wrong way can bog down the computer for hours or even days. You can't get quick responses if your query requires a 30-megabyte table to be sorted or if it compares every item in three 5-megabyte tables.

Mainframe and minicomputer users, who have dealt with large databases for years, have come up with two basic solutions. The first is to use hierarchical or network database managers that use pointers to set up paths for accessing data. These systems are called navigational databases because the user must "navigate" a series of pointers, telling the database manager precisely how to find the desired information. They are very efficient in the hands of an expert, but they are much harder to use than relational database managers.

The second solution is to use a query optimizer to find an efficient way of answering the user's question, making use of indexes, hashing, and other aspects of the database's organization. The user does not tell the database manager how to access the information and never sees the access plan that is used.

Query optimizers for relational databases are the focus of this article. I will explain why they are necessary, cite general principles for query optimization, and show how a query optimizer generates an access plan for a simple query.

The Need for Query Optimization

Query optimizers are found on nonprocedural relational database managers (see the text box "Database Terminology" on page 244). The user's queries specify what information is wanted but not how the database manager should go about finding that information.

The query optimizer chooses an efficient access plan for the query using information about the structure of the database. If the optimizer makes the right choices, a relational database can be extremely efficient, but wrong choices can make it unbearably slow.

Almost all relational systems with query optimization use SQL (pronounced "sequel") or Quel as a query language. Of the two, SQL has wider support, and ANSI has adopted a SQL standard. Microcomputer programs that use SQL include PC Ingres, Sybase, Informix, Oracle, Emerald Bay, and SQLBase.

I would like to illustrate the nonprocedural nature of SQL with an example that will be used throughout this article. Figure 1 shows a simple database that might be used by a hardware store to manage its supply. Suppliers are each assigned a supplier ID (`sid`), and parts are assigned a parts ID (`pid`). The supply table tells how many parts are in stock for each supply ID and parts ID. Suppose the manager of the store wanted to know which items in stock came from Wanda's Warehouse. He might use the following SQL statement:

```
select parts.pname, supply.quantity
 from parts, supplier, supply
 where supplier.sname
 = "Wanda's Warehouse"
 and supply.sid = supplier.sid
 and supply.pid = parts.pid;
```

This query involves three tables and three conditions. Somehow we have to relate information across all three tables. The query does not specify how to do this.

The worst possible way to answer this query is also the most obvious—create a temporary table that has the information from all tables and pick out the rows that meet all the conditions. Suppose we have 650 parts that are commonly stocked, 500 items currently in stock, and 150 suppliers. Each row in the first table must be combined with each row in the second, and the result combined with each row of the third. Our temporary table would have 650 × 500 × 150 rows.

But the `where` clause tells us that we don't need to use all these rows. We need only the rows from the supplier table in which `supplier.sname = "Wanda's Warehouse"`. Once we know the supplier ID from this row, we need only the rows from the supply table that match it, and

continued

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we need only parts that are indicated by these rows. If only 15 items in stock are supplied by Wanda's Warehouse, we can find the answer using only 1 row in the supplier table, 15 in the supply table, and 15 in the parts table.

Some General Principles

Most relational databases create temporary tables to combine information from pairs of tables. The text box below explains how the join operation is used to do this. You will need to know about joins to understand the rest of this article. SQL does not have an explicit join statement, but when several tables are referenced in a query, they must be joined to process the query.

There are two basic ways the database manager can join tables. The first is called a nested-loops join and involves comparing every row in one table to every row in the other and combining the qualifying rows.

The sort-merge join is generally much more efficient. The sort-merge algorithm sorts each table on the columns that will be compared to join them. After this is done, each table can be scanned in order, and each row of each table will need to be examined only once. If one or both tables are in order, there is no need to sort before merging. Sometimes an index will let you retrieve data in the desired order; this can cut processing significantly.

The order in which tables are combined is extremely important. Temporary tables are merged with other tables, and

continued

Database Terminology

The terms *relational* and *nonprocedural* are often misused. Ted Codd, who invented the relational model, once griped that it is hard to find a vendor that does not claim its DBMS is relational. It is important to realize that most database managers claiming to be relational are not.

A relational database stores all information in tables and can manage data by direct manipulation of these tables without reference to other constructs. The basic relational operators—select, project, and join—each produce a new table by combining one or more tables. Any piece of information in a relational database can be accessed directly by referring to the table name, key value, and column name. According to Codd, a database that meets these criteria can claim to be minimally relational. (To be fully relational requires much more, but exploring that is beyond the scope of this discussion.)

By these definitions, dBASE and R:base are not relational database managers. The dBASE program does not allow direct manipulation of tables but requires the use of work areas in order to relate tables. To gain acceptable performance, the user or programmer must explicitly reference the indexes on these tables. R:base provides relational operators, but it does not allow the user or programmer to reclaim the space from a table without repacking the database. Since every relational operator creates a table, this makes it impractical to use R:base as a relational database manager. Most R:base programmers relate tables through the use of pointers, which is not necessary in a minimally relational database system.

Query optimizers are not used in products like dBASE or R:base. In dBASE, indexes must be explicitly used by the programmer. In R:base, indexes are used only for the last field mentioned in a query. In both languages, the programmer must know the structure of the tables in order to ensure efficient access.

One database manager, Condor 3, is relational but not nonprocedural. The user or programmer explicitly specifies the operators to be performed. Because of this, Condor III does not need a query optimizer but relies on the programmer to supply an efficient method of processing the query.

Joins are a way of combining two tables. The query shown in table A joins the supply and supplier tables from our sample database, combining each row from the first table with each row from the second. In the result set, the first three columns come from the supply table and the rest from the supplier table. This is sometimes called a Cartesian cross product. If there are n_1 rows in the first table and n_2 rows in the second, then the result set will have $n_1 \times n_2$ rows.

We usually want only a subset of the Cartesian cross product. For instance, we might be interested in only those cases in which `supply.sid` matches `supplier.sid`. This cuts down the number of rows considerably. Table B illustrates how this more restrictive join reduces the size of the result set.

Table A: *Results of the join command* `select * from supply, supplier`.

sid	pid	quantity	sid	sname	city
1	1	4	1	Big Bucks Supply	Lansing
1	2	12	1	Big Bucks Supply	Lansing
2	1	23	1	Big Bucks Supply	Lansing
2	2	5	1	Big Bucks Supply	Lansing
1	1	4	2	Wanda's Warehouse	Boston
1	2	12	2	Wanda's Warehouse	Boston
2	1	23	2	Wanda's Warehouse	Boston
2	2	5	2	Wanda's Warehouse	Boston
1	1	4	3	People's Stuff	Ann Arbor
1	2	12	3	People's Stuff	Ann Arbor
2	1	23	3	People's Stuff	Ann Arbor
2	2	5	3	People's Stuff	Ann Arbor

Table B: *Result set after the command* `select * from supply, supplier where supply.sid = supplier.sid`.

sid	pid	quantity	sid	sname	city
1	1	4	1	Big Bucks Supply	Lansing
1	2	12	1	Big Bucks Supply	Lansing
2	1	23	2	Wanda's Warehouse	Boston
2	2	5	2	Wanda's Warehouse	Boston

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(DEALERS: 32)

(a) Parts

pid	pname	size
1	galvanized bolts	6
2	paintbrush	0
3	bucket	10
...	...	...

(b) Supplier

sid	sname	city
1	Big Bucks Supply	Lansing
2	Wanda's Warehouse	Boston
3	People's Stuff	Ann Arbor
...	...	...

(c) Supply

sid	pid	quant
1	1	4
1	2	12
2	1	23
2	2	5
...	...	...

(d) Result Set

pname	quant
galvanized bolts	23
paintbrush	5
...	...

Figure 1: *The supplier/parts database consists of three tables: (a) parts, (b) supplier, and (c) supply. Table (d) shows a result set after the following command:* `select parts.pname, supply.quantity from parts, supplier, supply where supplier.sname = "Wanda's Warehouse" and supply.sid = supplier.sid and supply.pid = parts.pid;`.

every row in a temporary table means extra processing later on. We want to keep them as small as possible. Whenever we merge two tables, we can use the `where` clause of the query to determine which rows are worth keeping.

Consider our sample query. If we start by combining the supply table with the parts table, the only restriction we can use is `parts.pid = supply.pid`. This means that our temporary table must include every combination in which the two columns match, so it will contain a row for each of the 500 items currently in supply.

If instead we start by combining the supplier table with the supply table, we can use the restrictions `supplier.name = "Wanda's Warehouse"` and `supply.sid = supplier.sid`, so our temporary table contains only the 15 items supplied by Wanda's Warehouse. In general, we'll use as many restrictions as possible whenever we merge tables, and we'll try to begin with the merges that produce the smallest tables.

But our query optimizer can't guess the size of the temporary tables without first guessing how many rows will satisfy a condition. If every supplier had the name "Wanda's Warehouse," starting with the supply table would not produce small temporary tables.

In ANSI standard SQL, you can specify that every value for an indexed field must be unique. This is often used on the key field for a table. If the table was created with this option, then we can guarantee that no more than one row can have a given value in the indexed field. If there is no unique index, then the database manager must either make guesses based on the form of the query or keep distribution information on the data in tables.

Query optimizers that use only the form of the query make statistical assumptions about the distribution of information in the table. This method is not terribly precise, and optimizers that have access to the distribution of data tend to outperform optimizers that do not. One common way of doing this is to divide the table into ranges that each contain an equal number of values and to store the highest value in each range. This method is called distribution steps. According to Bob Epstein, principal architect of Sybase, 100 steps is good for general use, but in some systems the number of steps used will vary with the size and characteristics of the table. The Ingres database manager varies the number of items in each step depending on the distribution.

If the query optimizer needs to know the distribution of data, optimization must be performed when this information is available. If a query is embedded in an applications program, there are three times that a query might be optimized—at compile time, when the query is first executed, or every time that a query is executed.

If the query is optimized at compile time (as in IBM's DB2), distribution information is not available and cannot be used by the optimizer. If the query is optimized the first time it is executed, the initial distribution is known. In some applications, though, this distribution might change while the program is running. If the query is optimized every time a query is executed, distribution information is guaranteed to be current, but the overhead of optimizing each time is considerable.

For most applications, it is sufficient to optimize the first time a query is executed, since the distribution of information in most databases is relatively stable. Since this is not adequate for all applications, it is helpful to provide a way of forcing the query to be optimized each time it is run (Ingres and Sybase do this).

A good query optimizer knows the quickest ways to get at information. It takes full advantage of indexes and hashing. If we want only rows that match a certain value, and the field that holds that value is indexed or hashed, there is no need to examine most rows in the table. The index can also be used to access data in a desirable order. Earlier I discussed the advantages of sorting tables before merging. If there is an index on the fields that will be the basis for the join, the index can be used to avoid a sort.

A query optimizer explores potential solutions, determines their cost, and stores the cheapest solution at each step. Whenever new possibilities are explored, they are compared to the cheapest solution. The cost of the solution includes both the CPU cost and the I/O cost. The relative weights of each will vary from one system to another. Since some queries tend to be CPU-bound and others tend to be I/O-bound, it is important to weigh these costs appropriately. Queries that involve a lot of data are usually I/O-bound, and those that involve little data are usually CPU-bound.

One additional cost to be considered is that of optimization itself. There is no point in spending a long time to optimize a query on a table with five rows. A good optimizer knows when to quit.

These are the basic principles behind query optimizers. Some ways of combining data are much more efficient than others. Factors that significantly affect the amount of processing include the order in which we retrieve data from a table, the order in which tables are merged, maintenance of statistical information on the contents of tables, and the use of indexes and hashing. A good optimizer must know the relative costs in its own environment, and it must also know when to quit.

A Programmer's View

To get a programmer's technical view of query optimizers, I asked Bob Epstein to give some specific examples of how query optimization is implemented in Sybase.

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Toshiba America, Inc., Information Systems Division prices and you have two similar queries: How many stocks are between $1 and $5, and how many are between $100 and $105? Sybex's internal statistics tell it that one query is likely to get you 20 percent of the stock market, the other less than 1 percent. Epstein notes that Sybex does the same thing for character fields as well as numbers, since nearly all keys are character-type. That gives you, with an arbitrary resolution that you can tune, the total breakdown of the distribution of the data.

Let's say we are dealing with 1 percent resolution: We know what value separates each 1 percent of data. If there are a million records, we store every 10,000th value. We can estimate the size of the result by noting how many intervals it spans. Contrast that to an optimizer that has no information about the information in a table. To this optimizer, the two stock market queries are equivalent. It can't tell if it has one record in a result set or a million.

A Simple Example

Now let's consider how an optimizer might handle our sample query. The actual heuristics will vary somewhat from one optimizer to another, but we'll use methods that are fairly typical. We'll make a fairly exhaustive list of the possibilities, examine the costs, and decide on an execution plan. Our plan will focus on the order in which the three tables will be combined and on the most efficient ways of combining them. Some optimizers combine the tables one step at a time and use information about the results to make more informed decisions in later processing. Others do all optimization before the query begins.

The information available to our optimizer is the structure of the query, the size of the tables, the available indexes, and the approximate distribution of data in indexed fields. We must choose a pair of tables to combine first. We want to avoid creating large tables in early processing, since this data will be involved in all later processing. If `supplier.sname` is uniquely indexed, we know that only one row will contain "Wanda's Warehouse." Therefore, merging `supplier.sname` with another table is likely to produce a small result. Our optimizer can guess that the supplier name should be one of the two tables in the first join.

Now we need to choose the second table for the first join. In order to avoid unnecessarily large temporary tables, we need a table that has some direct relationship to the supplier table. The `where` clause in our query says that `supplier.sid = supply.sid`. Once we have sup-

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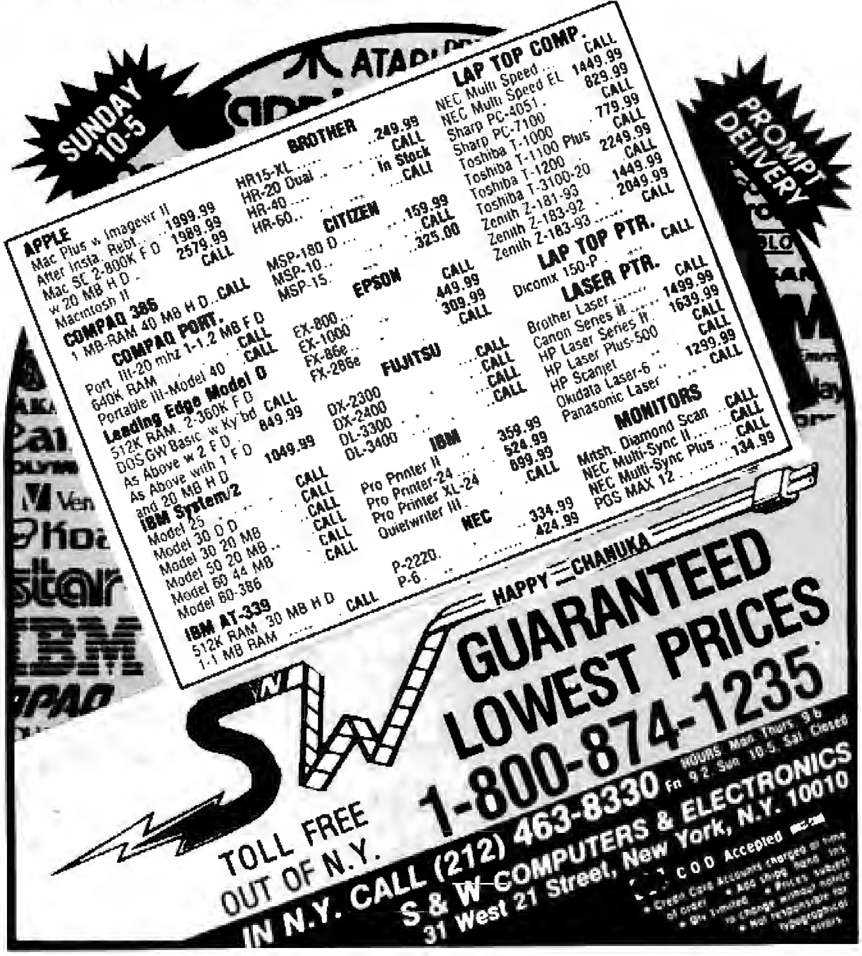

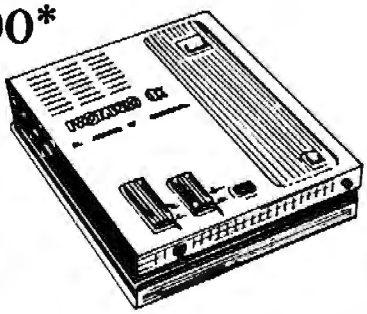

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`plier.sid`, we can narrow down the number of rows needed from the supply table. Nothing in the `where` clause relates the supply table directly to the parts table. If we joined the supply table and the parts table first, then the size of the temporary table would be the product of the sizes of the two tables, which is 150 × 600. If we join the supply and supplier tables, then our result would have no more than 500 rows, even if everything in stock came from Wanda's Warehouse, since only one row in the supply table is relevant.

If our optimizer uses intermediate results in setting up the plan, even more information is available. It can look up the supplier ID for Wanda's Warehouse and consult the distribution information in the supplier table, finding that there will be approximately 15 rows in the temporary table. Clearly, the first step is to join the supply and supplier tables. The most efficient way to do this is to use the index on `supply.sid` to find all matching rows. We need two columns in this intermediate table: `supply.quant`, to report the result, and `supply.pid`, to find the parts name from the parts table.

Now we can find our answer by joining our temporary table to the parts table and keeping only the columns asked for in the query. The cheapest way to access the parts table is through the index on the parts ID. Our temporary table is sorted by `supplier.sid`, so we'll sort it on `pid` before merging. This is cheap, since the temporary table has only 15 rows. The final result set includes `parts.pname` and `supplier.quant` from this join.

Let's examine the access plan generated by the query optimizer. I'll show the results for each step (only a few rows are given for each result). As I list the steps, I'll review the reasons these steps were selected.

1. Select the supplier named "Wanda's Warehouse." Since `supplier.sname` is uniquely indexed, we know there will be only one row:

sid
2

2. Use the index on `supply.sid` to select `supply.quant` and `supply.pid` for those rows matching the `sid` in our temporary table. This table is linked to our temporary table by the condition `supply.sid = supplier.sid`. No other table is linked to the temporary table by a condition, so if we chose another table we would not know which rows are needed and would have to include all rows.

Steps 1 and 2 would generally be done as a single step, but are separated here for the sake of clarity.

quant	pid
5	2
23	1
...	...

3. Sort the temporary table on `pid`. In the next step, we'll be joining our temporary table to parts using the index on `parts.pid`, and this index provides rows in `pid` order. If our temporary table is sorted on `pid`, we can merge the two tables directly without making unnecessary comparisons.

quant	pid
23	1
5	2
...	...

4. Use the index on `parts.pid` to create the result set with `supply.quant` and `parts.pname` where `parts.pid` matches the `pid` in our temporary table.

pname	quant
galvanized bolts	23
paintbrush	5
...	...

This access plan is a set of specific procedures for finding the desired result. In a procedural database manager, the user would have to specify this access plan; our query optimizer has derived it for us.

No Room for Inefficiency

Large databases must be handled efficiently. Larger, more powerful microcomputers and the rush to SQL will result in many more large relational databases on microcomputers. Relational database managers depend on query optimizers to find efficient ways to access data. The best access plan is not always obvious from the structure of the query, and it actually depends on the distribution of data in the tables. Combining tables in the wrong way can be disastrous, but combining them properly is quite efficient. I have listed some of the general principles that are used by query optimizers and given an example of how a query optimizer generates an access plan.

For additional information on products and references, see the Managing Megabytes Resource Guide on page 265. ■

ACKNOWLEDGMENT

The author would like to thank Bob Epstein of Sybase and Bob Kooi of Relational Technologies for their time and help.

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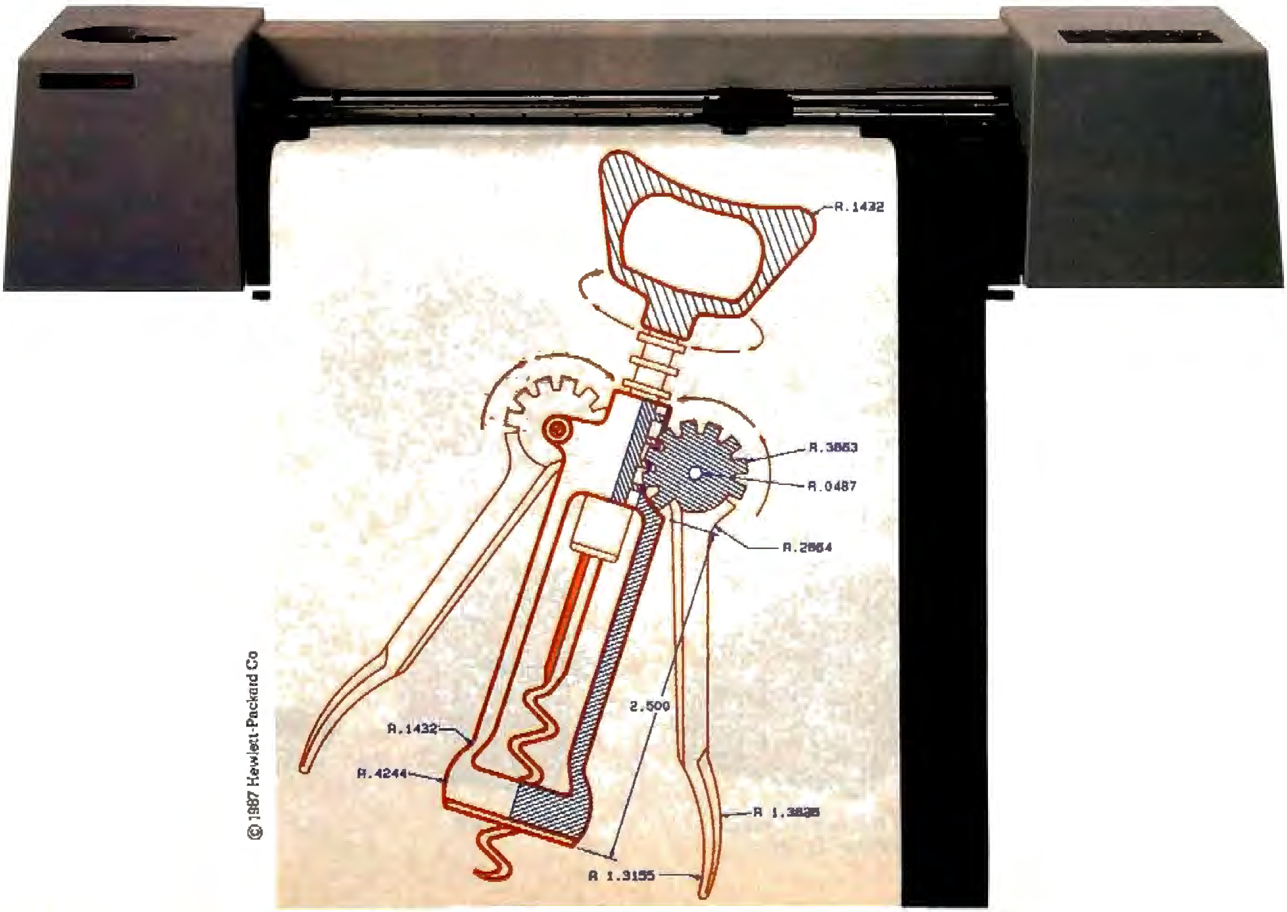

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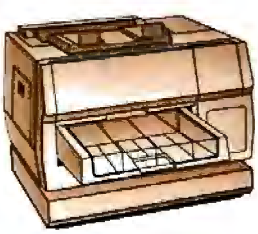

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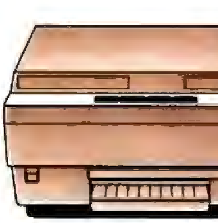

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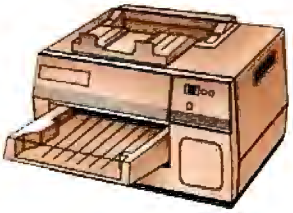

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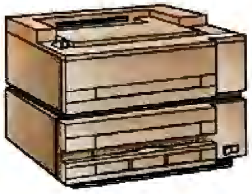

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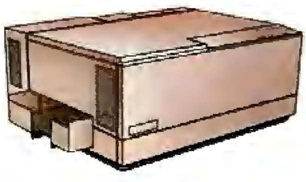

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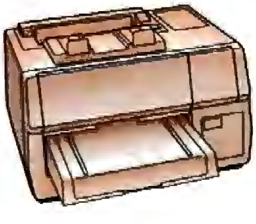

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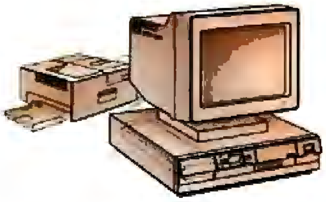

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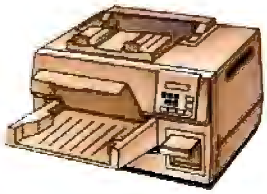

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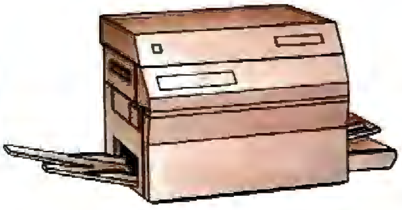

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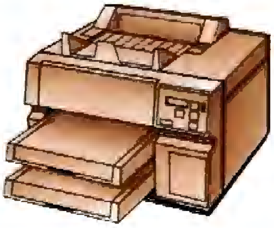

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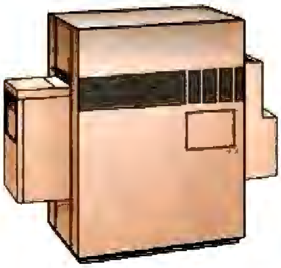

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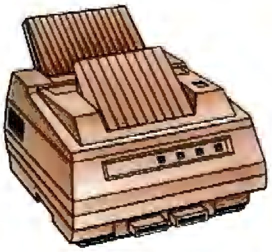

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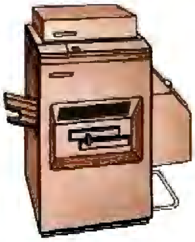

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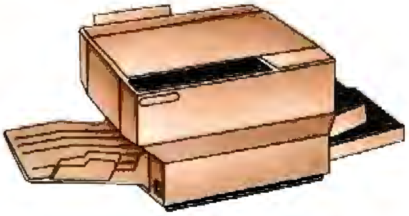

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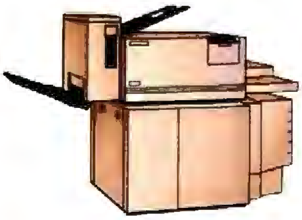

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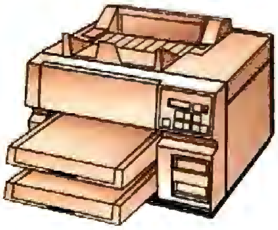

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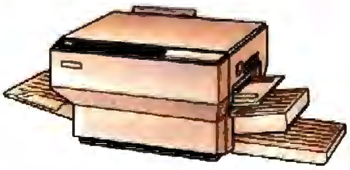

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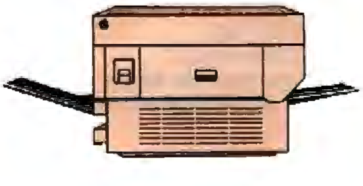

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Achieving Mainframe Performance

Having large amounts of on-line storage in a personal computer opens the door to techniques that speed performance significantly

Wink Saville

RAW PROCESSING POWER is often the primary consideration in evaluating the capabilities of personal computers. Unfortunately, this viewpoint rarely presents the complete picture. True, today's personal computers offer the same processing power found in mainframes 5 or 10 years ago, but it is the availability of large amounts of storage, both internal (RAM) and external (hard disk drives, CD ROM, and so forth), that has enabled personal computers to take a giant leap forward. Configured with this expanded memory, personal computers can execute applications that were once the domain of mainframes and minicomputers.

Early personal computers contained little more than 1000 bytes of memory. The Apple computers, with 64K bytes of memory and a quarter-megabyte of storage on a floppy disk, improved on this, and the IBM PC signaled a new era with 640K bytes of memory and a 10-megabyte hard disk drive. Now, a personal computer can be configured with more than 8 megabytes of RAM and 2 gigabytes of on-line storage in the form of hard disks. Storage of this magnitude in a personal computer can translate into mainframe-like performance.

This is not to say that personal computers can replace mainframes. Obviously, most large-scale applications call for the horsepower, sophisticated operating systems, and speed found in mainframe computers. My point is that, in certain applications, expanded memory in a personal computer can produce results in which the trade-off between performance and cost is nothing short of spectacular. In other words, a personal computer might take 10 times longer than a larger machine to complete the task, but it will do the job at one-hundredth the cost.

The key for the programmer lies in knowing how to make the best use of expanded memory in personal computers. The three examples cited in this article—a graphics compression/display program, a mathematics routine, and a sort—serve to illustrate the kinds of tasks that can now be handled efficiently on personal computers.

Graphics: Zooming in

The expanded memory of microcomputers greatly enhances their ability to handle graphics. Expensive hardware is no longer required to produce striking bit-mapped images or to manipulate artwork in new and startling ways.

In this example, the task is to display bit-mapped images with different degrees of resolution. First, the image is scanned at 300 dots per inch (dpi). Each image consumes about 1.25 megabytes of space on the hard disk. To enlarge or crop the image, it is necessary for the microcomputer to provide the ability to zoom in and out on the image.

The image could be stored on a hard disk, but this would limit viewing to a small section at a time. Even rapid transfer rates would prove painfully slow in displaying several images in succession. This is unacceptable in a commercial setting.

The speed problem is solved when a personal computer has 4 megabytes of RAM—for instance, an IBM PC with Lotus/Intel/Microsoft (LIM) extended memory. The initial data feed is a little slow, but once the information has been stored in RAM, you can pan the image or manipulate it quickly in any fashion.

Having the image in RAM gives you the ability to zoom in and out on the image rapidly, which is important in many graphic arts applications. You accomplish this effect by converting the original 300-dpi image to 150 dpi, 75 dpi, and 37.5 dpi and storing each version in RAM.

In the case of newsletter production, the lowest resolution provides a "Greeked" image of a page: You can determine the placement of headlines, columns of text, and photos, but none of the words can be read and none of the photos recognized. This level of detail would be useful in the early stages of page layout or as a final check of the end product before it is printed.

Since the image is stored in RAM at various resolution levels, you can move the cursor to any point in the display and immediately zoom to a higher level of resolution to review that portion of the page in greater detail. In desktop-publishing applications, for instance, you can zoom to a photo caption, headline, or subhead to check style or content. The method used to reduce the resolution by one half is to remove every other pixel in

continued

Wink Saville is vice president of software development at Meridian Data Inc. and author of several books on assembly language. He can be reached at 1239 Linda Vista Dr., San Marcos, CA 92069.

Listing 1: *A C program to create lower-resolution versions of a bit-mapped image, for use in computers with LIM extended memory.*

```
#define LINT_ARGS

#include <stdio.h>
#include <stdlib.h>
#include <types.h>
#include <io.h>
#include <fcntl.h>
#include <stat.h>

#define CREATE_RW ((int)(O_CREAT | O_RDWR | O_TRUNC |
                                      O_BINARY))
#define OPEN_RW ((int)(O_RDWR | O_BINARY))
#define OPEN_RD ((int)(O_RDONLY | O_BINARY))
#define RW_PERMISIONS ((int)(S_IREAD | S_IWRITE))
#define WORDS (640/16)    /* 640 pixels horizontal */
#define LINES (480)      /* 480 line vertical */

unsigned int srceArray[ LINES ] [ WORDS ];
unsigned char destArray [ LINES/2 ] [ WORDS ];

void abortCompress( msg )
char *msg;
/**********************
purp: call perror with the message then exit
**********************/
{
perror( msg );
exit( 1 );
}
unsigned char cvrt2Byte( w )
unsigned int w;
/**********************
purp: convert the word to a byte
by removing every other bit
**********************/
{
static unsigned char nibCompress[16] =
{
0x0, 0x1, 0x0, 0x1, 0x2, 0x3, 0x2, 0x3, 0x0, 0x1, 0x0, 0x1,
                                      0x2, 0x3, 0x2, 0x3
};
   unsigned char lowNib,highNib;

   lowNib = nibCompress[ w & 0xf ] | (nibCompress[ w>>4) &
                                      0xf ] <<2);
   highNib = nibCompress[ (w>>8) & 0xf ] | (nibCompress[
                                      (w>>12) & 0xf ]<<2)
   return( lowNib | (highNib<<4));
}

void main(argc, argv)
int argc;
char *argv[];
/**************************
purp: convert
**************************/
{
int inHdl outHdl;
unsigned int numLines,numWords;
unsigned int curLine, curWord;
unsigned int *srce;
unsigned char *dest;
if( argc != 3 )
   {
   printf("Compress a 640 x 480 image to 320 x 240\n");
   printf("\n");
   printf("Usage: inputFile outputFile\n");
   printf("  inputFile == The input file name\n");
```

continued

both dimensions. Repeating this process generates successively lower resolution images.

Listing 1 gives the method's implementation in C. The large amount of RAM in this application frees the programmer from worrying about memory constraints.

Sine

The next example uses a lookup table to implement the sine function. The program produces a significant performance increase over the use of other software or hardware implementations of the mathematical functions. Such an approach is practical only when plenty of memory is available.

Most programming languages provide a mathematical library for computing the sine (and other trigonometric functions) of an angle. Typically, the languages use a polynomial approximation to convert or to solve for the sine. This process may involve many different floating-point operations, requiring significant amounts of processing time.

The table-lookup approach gives vastly improved speeds. The degree of accuracy available depends on how much memory can be allocated to the table: Double precision will require twice as much storage as single precision, for instance, but access times will not be significantly affected by the degree of precision needed.

The basic algorithm is simple and requires just a few lines of code to express (see listing 2). The angle is passed to the subroutine, converted to an integer, and used as an index into the array of sine values to be returned. Prior to the subroutine's first use, an initialization program has computed the table of values. This table can be as accurate as you want to make it. For example, 360 data points will result in 1 degree of resolution on the sine. (If you allow for a few precalculations before using the lookup table, just 45 data points will give the same degree of resolution, since the trigonometric identities will map any angle into an equivalent angle on the interval [0,45).)

Using this approach, the result is accurate to within 1 degree and is typically expressed in two decimal places. There is no arbitrary limit to the refinement possible. Expanding the table's size to include fractional angles will produce greater accuracy—but will, of course, consume greater amounts of memory.

The algorithm runs 2 to 30 times faster than the standard sine algorithm used in the floating-point package of Microsoft C 4.0 (see table 1).

A number of existing applications use

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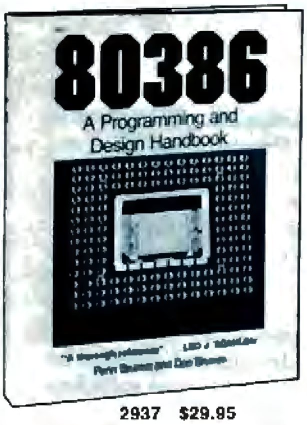

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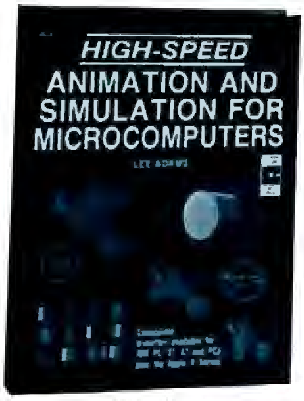

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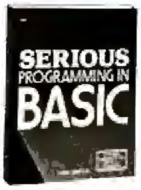

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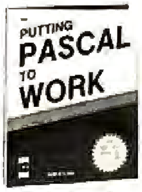

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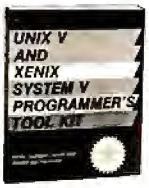

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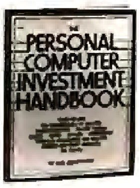

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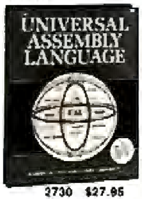

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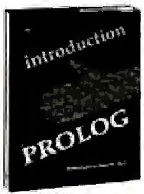

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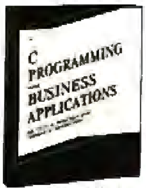

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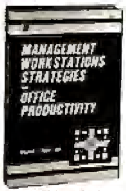

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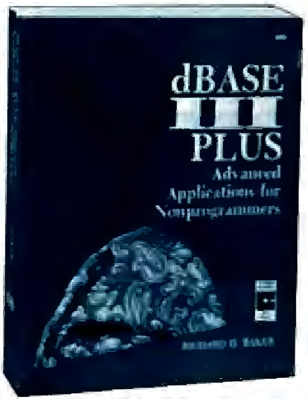

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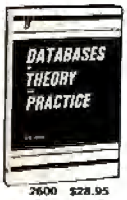

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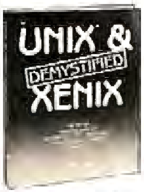

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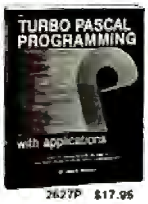

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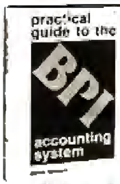

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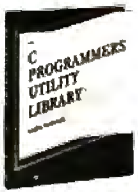

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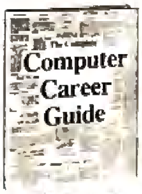

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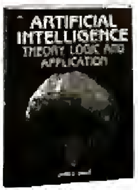

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```
   printf("  outputFile == The output file name\n")'
   exit( 1 );
   }

/* initialize */
sizeSrceArray = sizeof( srceArray );
sizeDestArray = size of ( destArray );
numLines = sizeof( srceArray ) / sizeof( srceArray[0] );
numWords = sizeof( srceArray[0] ) / 2;
/* read in the file */
if((inHdl = open( argv[1], OPEN_RD )) == -1)
   abortCompress("Unable to open inFile");
if(read( inHdl, (char *)srceArray, sizeSrceArray) !=
                                       sizeSrceArray)
   abortCompress("Unable to fill input buffer");
/* loop on every other line and remove every other pixel */
for( curLine = 0; curLine < numLines; curLine += 2 )
   {
   dest = &destArray[ curLine / 2 ][0];
   srce = &srceArray[ curLine ][0];
   for( curWord = 0; curWord   numWords; curWord++ )
      {
      *dest++ = cvrt2Byte( *srce++ );
      }
   }
/* write output file */
if((outHdl = open( argv[2], CREATE_RW, RW_PERMISIONS )) ==
                                       -1)
   abortCompress("Unable to create the output file");
if(write( outHD1, (char *)destArray, sizeDestArray) | =
                                       sizeDestArray)
   abortCompress("Unable to write the output file"); }
```

Listing 2: *A C program to implement a fast sine function using table lookups.*

```
#define LINT_ARGS

#include <stdio.h>
#include <stdlib.h>
#include <math.h>
#include <types.h>
#include <time.h>

#define PI (3.14159265358979323846)
#define TWO_PI ( 2.0 * PI )
#define radians( x ) ( ( x * TWO_PI ) / 360.0 )
int fastMathInitialized = 0;  /* not 0 if initialized */
double fastMathTableSize;  /* size of the tables */
double fastMathTableSinInc;
float *fastMathSinTable;   /* pointer to the sin table */
long curTime;

int fastMathInit (tableSize)
   unsigned int tablesize;
   /**********************************
   purp: initialize the fast math tables
   returns: 0 if no errors
   **********************************/
   {
   unsigned int i;

   if( fastMathInitialized == 0 )
      {
      if((fastMathSinTable = (float *)calloc(tableSize,
                                       sizeof(float))) == NULL)
         return( 1 );
```

continued

this approach in situations where speed is essential. Flight Simulator is a good example. The rotation of images on a personal computer screen at realistic speeds precludes the use of slower numeric approximation routines; lookup tables are used instead. The techniques used in Flight Simulator can be applied to a wider class of applications involving the manipulation of designs and graphics on a personal computer, assuming sufficient RAM is available.

Sorting Large Amounts of Data

To sort large amounts of data (i.e., hundreds of megabytes), you must obviously turn to mass storage devices to hold temporary files. However, the availability of extra RAM opens the door to techniques that will greatly improve sort times.

The sort algorithm I'm recommending takes the input file; sorts it into small sections; writes the small, newly sorted sections to an output file; and merges the small sections into a larger, sorted output file. The critical factor in this operation is the amount of memory available to the user. The more memory that is available, the larger the initial sort can be. This means that fewer merges are required to get the final sort. As a result, the final sort will be completed more quickly; the speed improvement is proportional to the amount of RAM available for the initial data sorting.

In a test run on a Compaq 386, a 150-megabyte file was sorted in 1.7 hours and merged in 3 hours, for a total completion time of 4.7 hours. The same file was sorted on a Burroughs 7900—a very large mainframe computer—in 30 minutes. The task took 8 times longer on the microcomputer, but it was completed at a fraction of the cost.

The algorithm used to sort large amounts of data on a personal computer is based on fixed-length fields. That is, data fields of a predetermined length are first sorted and then merged into the final output file. The program is not complex and could be generalized without degrading performance.

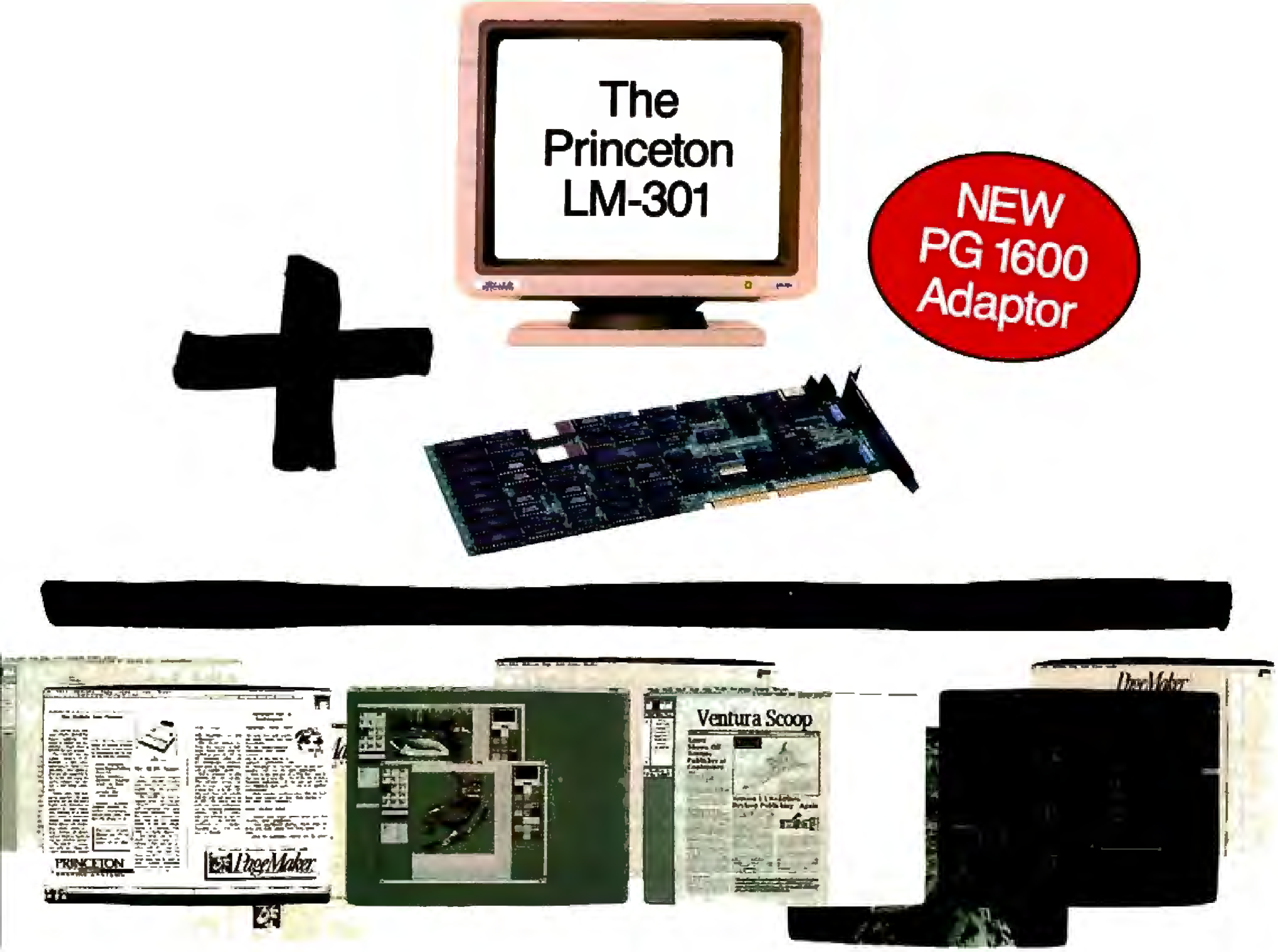
The sort/merge algorithm is straightforward. I'll illustrate the method using a stack of 30 cards numbered 1 through 30, in random order (see figure 1).

First, divide the 30 cards into three stacks of 10 and sort each of the three stacks. Each stack-sort operation corresponds to an in-memory sort.

Next, merge the three piles by taking the lowest-numbered card showing on top of the three stacks and saving it in an output stack.

Repeat the process until all three piles are empty, having been merged in order

continued



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```
    fastMathTableSize = (double)tableSize;
    fastMathTableSinInc = ( TWO_PI ) / fastMathTableSize;
    for(i = 0; i    tableSize; i++)
      {
      fastMathSinTable[ i ] = (float)sin( (double)i *
                         fastMathtableSinInc );
      }
    fastMathInitialized = 1;
    }
  return( 0 );
  }
  double angle 2 Idx (angle)
  /*********************************
  purp: convert the angle to an index
  *********************************/
  {
  unsigned int idx;

  if((angle   < 0.0 ) || ( angle >= TWO_PI))
    {
    angle = angle - (unsigned int)(angle / TWO_PI) *
                         TWO_PI;
    if( angle   < 0.0 )
      angle += TWO_PI;
    }

  return((unsigned int))( angle / fastMathTableSinInc ) +
                         0.5));
  }
double fastSin( angle )
  double angle;
  /*********************************
  purp: compute the sin of the angle in radians
  *********************************/
  {
  return((double)fastMathSinTable[ angle2Idx(angle) ] );
  }

double fastestSin( angle )
  unsigned int angle;
  /********************************
  purp: compute the sin of the angle in radians,
        expressed as an integer, I.E. use angle2Idx
        to convert the angle to an Index
  *********************************/
  {
  return((double)fastMathSinTable[ angle ] );
  }


void startTiming()
  /*****************************
  purp: start the timer
  *****************************/
  {
  time(&curTime);
  }

double endTimingSecs()
  /*****************************
  purp: return number of seconds since startTiming
  *****************************/
  {
  long endTime;

  time(&endTime);
  return((double)(endTime - curTime));
  }

void main(argc,argv)
  int argc;
```

continued

```
char *argv[];
/******************************
test speed of sin
******************************/
{
unsigned int tableSize,angleIndex;
unsigned long loops, i;
double value, endTime, result, fastSinfps;
double fastSinfps, sinfps, speedFactor;
if( argc < 3 )
   {
   printf("Usage: fastsin loops value (tableSize)\n");
   printf(" loops == number of times the sin of value to
                                       be taken\n");
   printf(" value == value to take sin of\n");
   printf(" tableSize == size of the look up table
                                       (default=360)\n");
   exit( 1 );
   }
if( sscanf(argv[1],"%li",&loops) != 1 )
   {
   printf("Bad loops value\n");
   exit( 1 );
   }
if( sscanf(argv[2],"%lf",&value) != 1 )
   {
   printf("Bad loops value\n");
   exit( 1 );
   }
tableSize = 360;
if(argc == 4)
   {
   if( sscanf(argv[3],"%i",&tableSize) != 1 )
      {
      printf("Bad tableSize value\n");
      exit( 1 );
      }
   }

if(fastMathInit( tableSize ) != 0)
   {
   printf("Error initializing fast math routine, NOT
                                       enough memory\n");
   exit( 1 );
   }

/* convert from degrees to radians */
value = radians(value);


/* standard C library sin function */
startTiming();
for( i = loops; i != 0; i-- )
   {
   result = sin( value );
   }
endTime = endTimingSecs();
if(endTime   > 0.0)
   sinfps = (double)loops / endTime;
else
   sinfps = 0.0;
printf("time=%5.31f, sin=%lf, functions per second =
                                       %-0.31f\n",endTime,
/* time fastSin */
startTiming();
for( i = loops; i != 0; i-- )
   {
   result = fastSin( value );
   }
endtime = endTimingSecs();
if(endTime   > 0.0)
```

continued

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```
      fastSinfps = (double)loops / endTime;
   else
   /* time fastestSin */
   angleIndex = angle2Idx( value );
   startTiming();
   for( i = loops; i != 0; i-- )
      {
      result = fastestSin( angleIndex );
      }
   endTime = endTimingSecs();
   if(endtime  > 0.0)
      fastestSinfps = (double)loops / endTime;
   else
      fastestSinfps = 0.0;
   printf("time=%5.31f, fastestSin=%1f, functions per second
                                            = %-0.31f\n",endTime,


   /* performance report */
   if( sinfps  > 0.0 )
      speedFactor = fastSinfps / sinfps;
   else
      speedFactor = 0.0;
   printf("fastSinfps / sinfps = %-0.31f\n", speedFactor );

   if( sinfps  > 0.0 )
      speedFactor = fastestSinfps / sinfps;
   else
      speedFactor = 0.0;
   printf("fastestSinfps / sinfps = %-0.31f\n", speedFactor
                                            );
   }
```

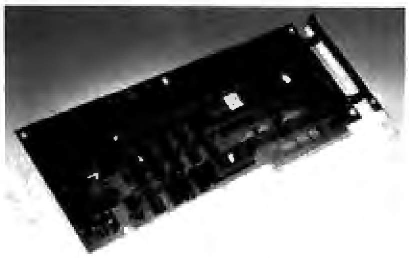
into the output stack. The merge operation does not make use of large amounts of RAM.

The cards represent fixed-length fields of data, and the numbers represent the data to be sorted. Variations on the process can be used to handle large and more complex sorts. The sort lends itself to large-RAM machines because you can choose the size of the initial stacks so as to take advantage of all available RAM.

A similar technique can be used to sort words rather than numbers. A user with a number of large documents to be stored on CD-ROM can, for example, sort the key words of the document. The final output, called an inverted index, will show where key words are used throughout the document.

A series of test runs on a Compaq 386 running at 16 MHz produced the results shown in table 2. The figures show the results of three different sorts of 20,000 records, 50 bytes each, with a 10-character field as the sort field. The first run sorted 10 records at a time into 2000 sorted sections. The second sorted 100 records into 200 sections, and the third sorted 1000 records into 20 sections. The sections were put into six output files and

continued



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BYTE 1/1/88

Table 1: *Performance of the table-lookup routine compared with standard sine functions in C, with and without a floating-point processor. Times are for 100,000 computations of the sine of 45 degrees.*

Times for Compaq 286 Portable III with software FP

	Computations per second	Speed-up factor
sin	215.6	1
fastSin	574.4	2.7
fastestSin	6839.9	31.7

Times for 16-MHz Compaq 386 with an 80287

	Computations per second	Speed-up factor
sin	1411.2	1
fastSin	2880.1	2.0
fastestSin	21413.3	15.2

Table 2: *Comparison of sort times on a 16-MHz Compaq 386 using various amounts of RAM to hold the active data.*

Elements	Sections	Sort time	Merge passes	Merge time
10	2000	34.46	5	118.14
100	200	39.10	3	68.66
1000	20	35.14	2	41.36

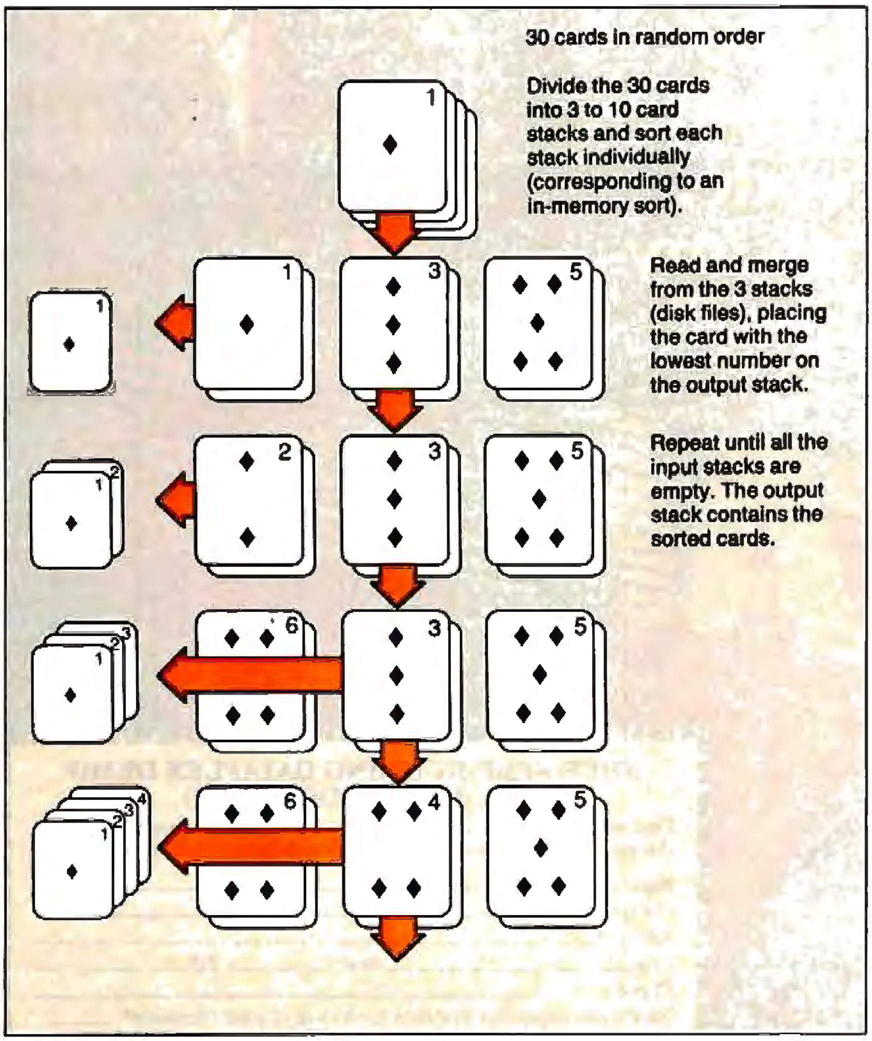

Figure 1: *Illustration of the technique for in-memory sorts on very large data sets.*

were then merged.

The time to sort the files is about the same, regardless of the number of sections created. Each merge pass is about 22 seconds. It is clear, therefore, that the fewest number of merge passes will produce the shortest sort time.

You can decrease the merge time in two ways: Increase the size of the initial sort, or increase the number of files to merge. However, increasing the number of files does not pay off in the long run, due to the increased number of seeks required. Nevertheless, increasing the amount of memory will increase performance until the size of the file equals the size of the memory.

The Importance of RAM

Increased storage enables microcomputers to perform operations that were beyond their capabilities a few years ago. Larger RAM quickly translates into increased performance. Large, external storage capacity with relatively small RAM will get the job done, but at a painfully slow pace. To be effective, large external storage capacity must be coupled with ample RAM. The result is high performance on a small machine.

Note that some fancy footwork may be required because the IBM PC does not have a linear address space: The programmer cannot define a 1-megabyte array. With a large linear address space, as on the 68000-based and 80286/80386-based computers in protected mode, the task would be much simpler. Even with the complications of a nonlinear address space, the expanded memory, if used correctly, can give a microcomputer some mainframe-class performance ratings on given tasks.

As a programmer who used to work on a microcomputer that had 1024 bytes of RAM and a cassette recorder for external memory, I'm painfully aware of the numerous constraints that are synonymous with lack of memory. Fortunately, the RAM shortage problem is going away fast. The trick now is to find programming techniques that make optimal use of all that extra RAM. ■

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SELECTED READING LIST, QUERY OPTIMIZERS

The following articles introduce the major techniques used in commercial query optimizers today. The database query-optimizer article combines approaches used by Selinger with distribution information proposed by Piatetsky-Shapiro and Connell. Youssefi and Wong use a different technique called decomposition.

Selinger, Pat, et al. "Access Path Selection in a Relational Database Management System." *Proceedings of the 1979 ACM-SIGMOD Conference on the Management of Data.*

Piatetsky-Shapiro, Gregory and Charles Connell. "Accurate Estimation of the Number of Tuples Satisfying a Condition." *Proceedings of the 1984 ACM-SIGMOD Conference on the Management of Data.*

Youssefi, Karel and Eugene Wong. "Query Processing in a Relational Database Management System."

Wong, Eugene and Karel Youssefi. "Decomposition—A Strategy for Query Processing." *ACM Transactions on Database Systems*, vol. 1, no. 1, September 1976, pp. 223–241.

For a general overview of query-optimization techniques, see:
Jarke, Matthias and Juergen Koch. "Query Optimization in Database Systems." *Computing Surveys*, vol. 16, no. 2, pp. 111–152.

This is my favorite general introduction to relational databases:
C. J. Date. *Relational Database—Selected Writings 1986.* Reading, MA: Addison-Wesley.

These two articles by Codd define the relational model in detail:
E. F. Codd. "Is Your DBMS Really Relational?" *Computerworld*, October 14, 1985, pp. ID/1–ID/9.

E. F. Codd. "Does Your DBMS Run by the Rules?" *Computerworld*, October 14, 1985, pp. 49–60.

—Jonathan Robie

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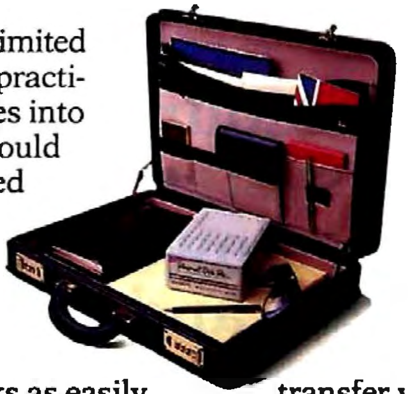

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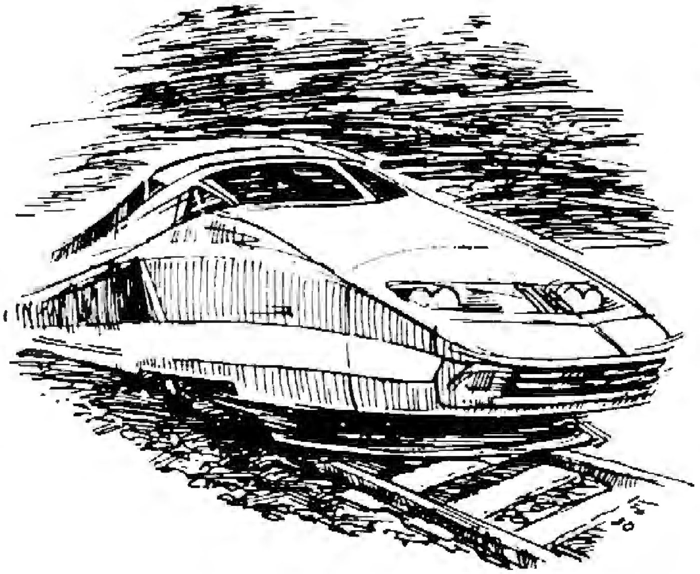
PC MAGAZINE EDITOR'S CHOICE

GV-286 "It coaxes extraordinary performance through the use of imaginative design and careful engineering." October 13, 1987



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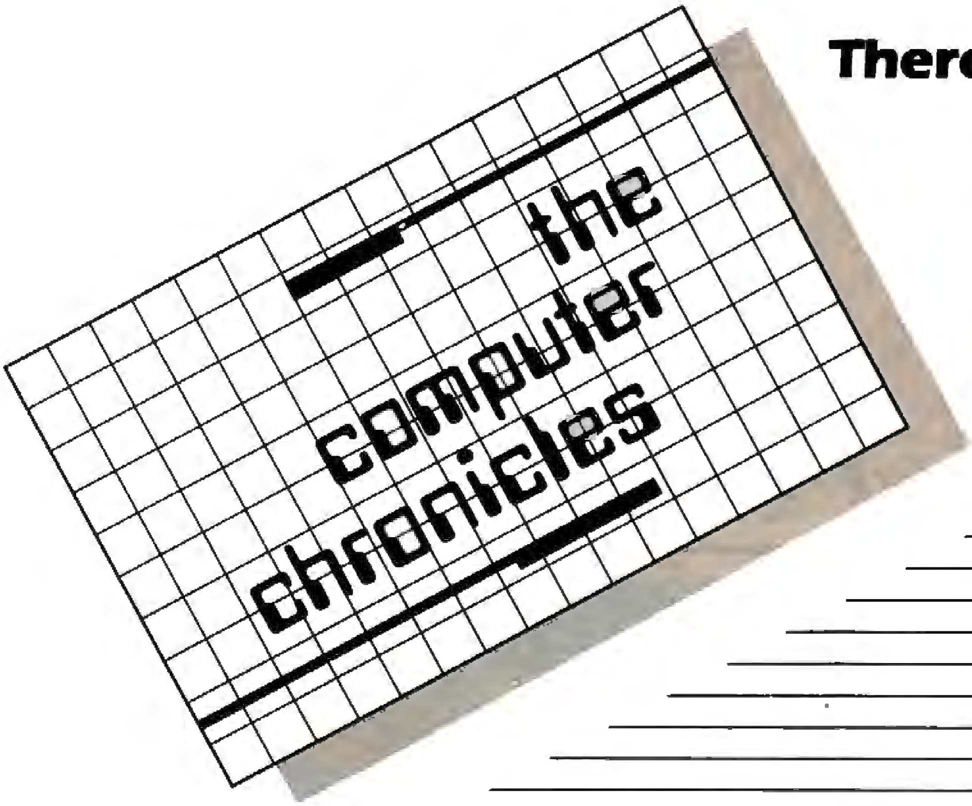

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Part 1: The Hardware

Steve Ciarcia

The BCC180 Multitasking Controller

Using a Hitachi CPU, Steve comes up with this multitasking single-board computer

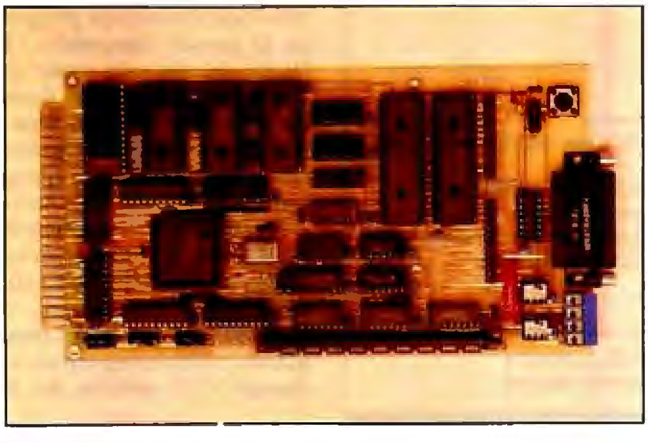
Necessity is indeed the mother of invention. I have been known to stretch that adage on occasion, but my track record is pretty consistent. Many people think that I study trends in computer technology, intensively investigate reader interest, and carefully formulate a writing strategy that results in the projects you see. While I do consider all those factors, the actual selection process is considerably less complex. If I need it, I build it.

Again, I am at the point where I need to configure a new piece of controller hardware or resort to less popular alternatives. I am presently installing and testing a video motion and tracking system that I may document as a future project. (McGraw-Hill's lawyers will probably hyperventilate when I start discussing the "laser targeting" section, but that's a story for another time.)

Using eight video cameras, the system senses motion and triggers specific control actions depending upon what it "sees." While real video recognition is still a bit in the future, coordinating all the control decisions presently generated—even from the uncompleted video unit and a multitude of hard-wired sensors—is becoming a monumental task.

Generally, I would code these kinds of control applications in interpreted BASIC on a board like my BCC52 (see the August 1985 Circuit Cellar). I could then use all its bus-compatible peripherals for the control and sensor I/O.

However, given the magnitude of the task, I thought a BASIC interpreter would be too slow unless it was liberally salted with assembly language calls. Either I had to write more assembly language code (I'm not enamored with programming as it is), dedicate a large computer to the task (an expensive alternative), or design a small controller that was both fast and powerful enough to accomplish the task (sure, why not).



The BCC180 Computer/Controller

This new controller is called the BCC180 (table 1 lists its specifications). Designed from the ground up for efficiency and performance, the BCC180 uses the same 64180 CMOS Z80 instruction-compatible processor as my SB180 and SB180FX computers (see the September 1985 Circuit Cellar). Configured primarily for process control, the BCC180 uses the same 44-pin I/O expansion bus as the BCC52. All the BCC bus peripherals that I've described over the years will work nicely.

The BCC180 also contains a substantial amount of on-board I/O. It has six parallel ports and three serial I/O ports, and it communicates command and control decisions serially via RS-232C, RS-422, or RS-485. It can accommodate up to 384K bytes of on-board memory, which can be pure application code, monitor and application code, or a resident high-level language and application code.

BASIC-180

The most significant aspect of the BCC180 is its new approach to high-speed, high-level-language programming. Like the BCC52, I dictated that the BCC180 would have a ROM-resident BASIC. Unlike the BASIC-52 interpreter (albeit fast by most standards), the BCC180 has a *compiled multitasking* BASIC—BASIC-180—written by Softaid Inc. (8930 Route 108, Columbia, MO 21045). BASIC-180 was configured and adapted specifically for the 64180, and for the BCC180 in particular.

Unlike many generic BASICs that have 64K-byte ceilings, BASIC-180 uses the BCC180's hardware in the most efficient manner to optimize performance, and it can address and utilize a full megabyte of program space. (I've installed BASIC-180 as an EPROM rather than mask-programming it onto the processor. You can remove or switch the BASIC-180 EPROM at any time to allow the BCC180 to function completely in Z80 or 64180 assembly language code or another high-level language like C or Pascal.)

By using a multitasking BASIC compiler, I will have enough performance to continue my video-control project, plus the added benefit of a user-friendly software development environment. BASIC-180 can run up to 32 independent program tasks of up to 32K bytes each *concurrently* and, while task complexity does affect execu-

continued

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tion speed, is a real screamer.

I'll go into benchmarks later, but if you are familiar with BASIC-52 and anxious for some comparisons, I'll give you a quick one: At 6.144 MHz, BASIC-180 executes an integer variable `FOR...NEXT` loop benchmark approximately 100 times faster than BASIC-52 does!

BASIC-180 comes in two flavors: disk-based, for development on an SB180/SB180FX, and ROM-based, for development on the BCC180 board. Using the disk-based version, you can create and—to a certain degree—test programs on the SB180/SB180FX. This lets you use a full-screen editor for writing source code and a disk drive for saving the code. You obviously can't test a program that requires any BCC180-specific I/O operations on the SB180, but you can test fundamental operations without change.

Table 1: *Specifications for the BCC180.*

Processor

Hitachi HD64180, an 8-bit CPU in a 68-pin PLCC package
Superset of Z80 instruction set, including hardware multiply
Integrated memory-management unit
Dynamic RAM refresh
Wait-state generator
Clocked serial I/O port
Two-channel direct-memory-access controller
Two-channel asynchronous serial-communication interface
Two-channel 16-bit programmable reload timer
12 interrupts
6.144-MHz and 9.216-MHz system operation

Memory

Up to 384K bytes of total memory on-board
128K bytes of either static RAM (62256) or EPROM (27256)
Optional 256K-byte dynamic RAM SIMM
Full-function 8K-byte ROM monitor included

I/O

Console RS-232C serial port with automatic data transfer rate selectable to 38,400 bps
Peripheral serial port, 150 through 38,400 bps, selectable RS-232C, RS-422, or RS-485
48 bits of bidirectional parallel I/O
64K-byte I/O space available through the BCC bus edge connector

Power Supply Requirements

+5 V +/− 5 percent @ 700 mA (fully populated with LSTTL)
+12 V +/− 20 percent @ 30 mA
−12 V +/− 20 percent @ 30 mA
12-V supplies are required only for RS-232C operation

Dimensions and Connections

4.5- by 8.5-inch board
Dual 22-pin (0.156-inch) edge connector
Compatible with all Micromint BCC-series I/O expansion boards
25-pin DB-25S connector for RS-232C serial console I/O
20-pin header for RS-232C serial peripheral port
Four screw terminals for RS-422/RS-485 serial peripheral port
Two 26-pin headers for six bidirectional parallel ports

Operating Conditions

Temperature: 0-50 degrees C (32-122 degrees F)
Relative humidity: 10-90 percent, noncondensing

Once you've written the code on the SB180 and you've verified that it's syntactically correct, you can compile it into one or more binary files and burn them into an EPROM (with the Circuit Cellar serial EPROM programmer, perhaps) or send the files directly to the BCC180 (with the monitor ROM installed) for testing in RAM or programming into an EPROM there.

If you don't have an SB180 for development or prefer to do all the development on the BCC180, you can use the ROM-based version of BASIC-180. It supports all the features of the disk-based version with a few modifications: Instead of saving program source code to disk, the ROM-based compiler saves it to EPROM. Only as much of the EPROM is programmed as is necessary to store the source code, so multiple programs (or versions of the same program) can be saved to the same EPROM. This is often referred to as write once, read many (WORM) storage. When you fill the EPROM up, you can simply erase it and use it again.

Additionally, the compiler can program the object code directly into an EPROM. You can then use this EPROM to replace the BASIC-180 ROM for auto-start applications. You might also want to compile the object code into RAM, where you can execute the program immediately.

The BCC180's Hardware

The BCC180 uses the same Hitachi HD64180 (or Zilog Z180) microprocessor used on my SB180 and SB180FX computers (see figure 1 for the BCC180's schematic). Briefly, this chip executes the complete Z80 instruction set, plus a few new instructions (including an 8-bit multiply).

The chip contains an on-board memory management unit (MMU), a built-in direct-memory-access (DMA) controller with two DMA channels, two asynchronous serial ports, one synchronous serial port, two 16-bit programmable reload timers, and eight internal and four external interrupt sources with a built-in interrupt controller.

The HD64180 can address up to 1 megabyte of memory and 64K I/O ports. Since the BCC bus has only 16 address bits, I decided that all memory would be resident on the main board and that all transactions the BCC180 carried out through the bus would be I/O-based. As a result, I tried to squeeze as much memory as possible onto the board.

The BCC180 contains four 28-pin sockets (IC10 through IC13) addressed in 32K-byte increments, starting at physical address 00000 and going through 1FFFF hexadecimal. Each socket will accommodate either a 27256 EPROM or a 62256 static RAM chip. This lets you burn the control program into one or more EPROMs and place it at low memory for execution upon reset.

You can use zero-power RAM (static RAM that contains its own battery) or SmartSockets (sockets that contain a battery) with static RAM chips plugged into them in the remaining sockets to provide inexpensive, nonvolatile storage. A 74LS138 (IC14) decodes each socket's address.

The four sockets just described allow up to 128K bytes of static RAM storage, but what about applications that need a lot of temporary storage? Dynamic RAM is ideally suited in cases where large amounts of storage are needed in a small area but that doesn't have to be battery-backed.

Dynamic memory arranged on a single in-line memory module (SIMM) is becoming more popular these days, so I added a SIMM socket to the BCC180, decoded to start at physical address 40000 hexadecimal. A 256K-byte SIMM brings the BCC180's total on-board system memory up to 384K bytes. An address multiplexing circuit made up of three 74LS158s (IC15 through IC17) switches the SIMM address lines between row

continued

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addresses and column addresses. ME\ generates RAS\, and the flip-flop circuit made up of IC18 through IC20 generates CAS\.

Unfortunately, 384K bytes must be the upper limit for the time being. While the current HD64180s can address 1 megabyte of memory, they provide only 8-bit refresh (1 megabyte needs 9-bit refresh). Keeping possible future developments in mind, however, I've wired the SIMM socket to accommodate a 1-megabyte SIMM. If a new version of the HD64180 becomes available that provides 9-bit refresh, you'll be able to plug a 1-megabyte SIMM into the socket and bring the total system memory up to 896K bytes (since the SIMM's addressing starts at 40000 hexadecimal, we must throw away 256K bytes of the 1-megabyte SIMM).

Next, if a process-control computer is going to be useful, it must be able to deal with real-world inputs and outputs. For that

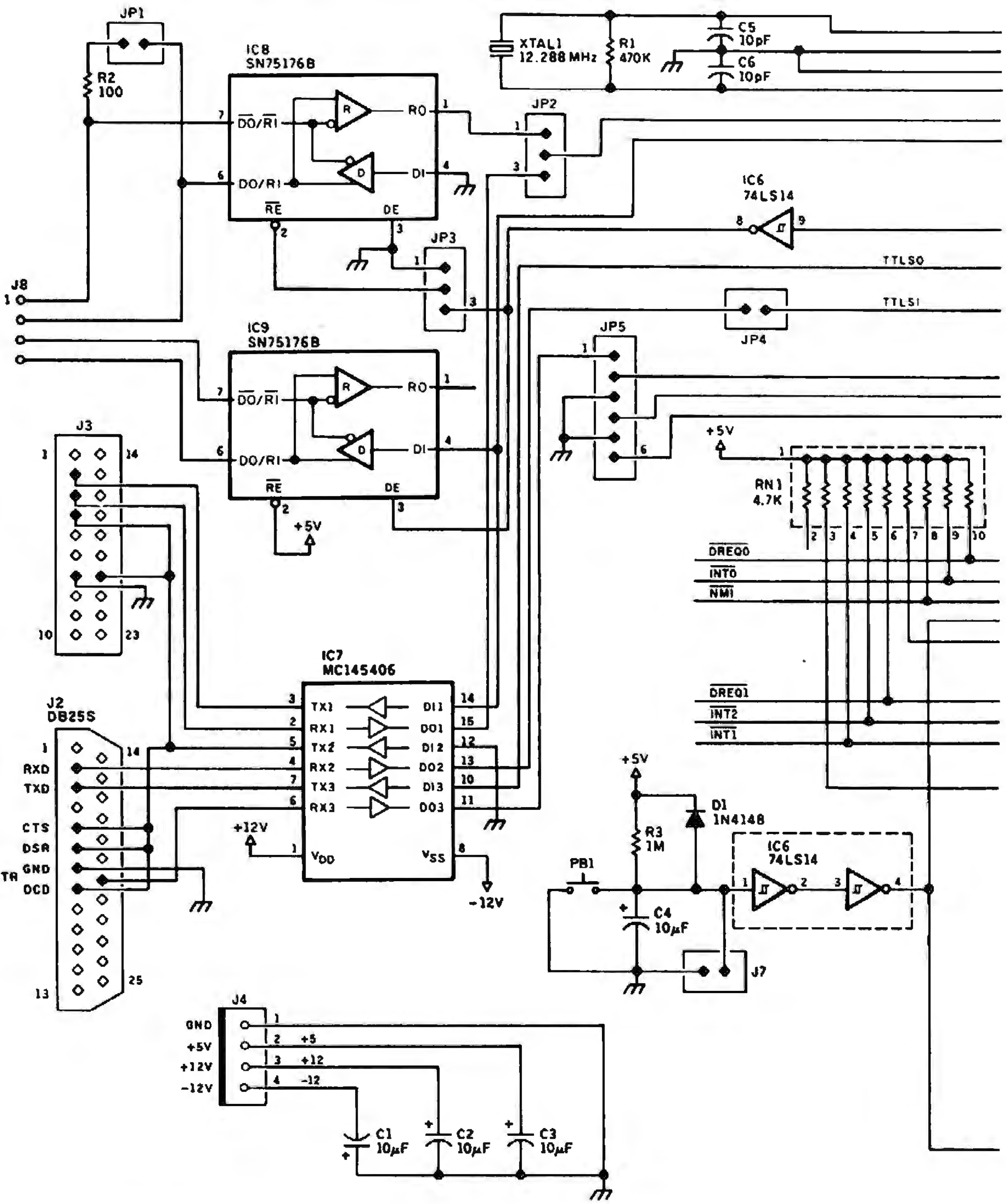


Figure 1: *Schematic for the BCC180 computer/controller.*

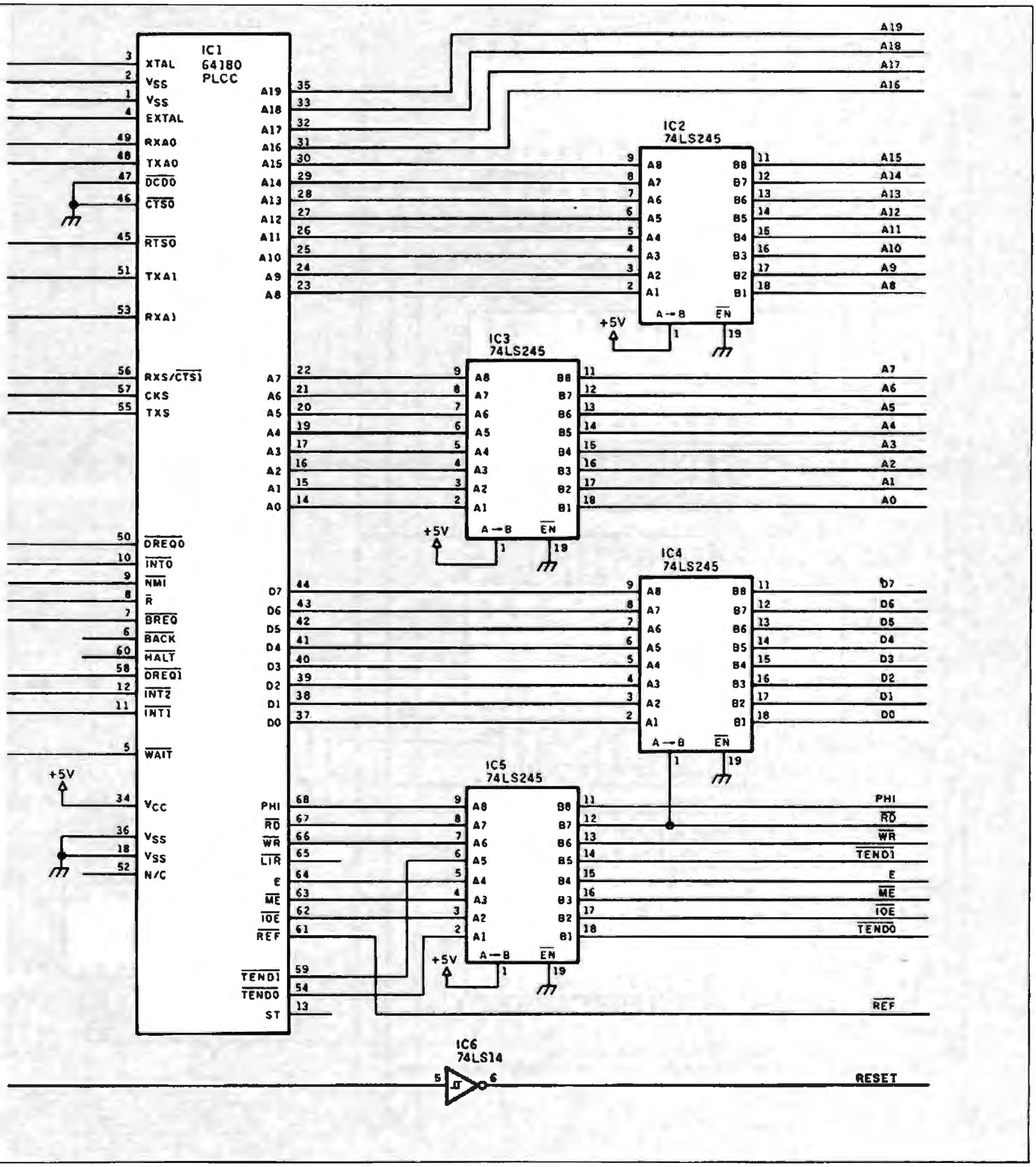
reason, two 8255 peripheral interface adapters (PIAs) are on the BCC180. Each 8255 has three 8-bit parallel I/O ports that can be individually configured for input or output, for a total of 48 bits of parallel I/O on the board (available on two 26-pin Berg-type connectors, J5 and J6).

In figure 1, IC23 and IC24 are the 8255s, and IC19, IC21, and IC22 decode an I/O address for each chip. You can select the addresses for the 8255s using jumpers JP10 and JP11.

Besides having parallel I/O, the BCC180 also has serial I/O. The serial ports let you communicate, via terminal, with the BCC180 and let it access external data-collection devices. Two asynchronous serial ports are built into the HD64180.

Serial port 1 uses an MC145406 (IC7) to convert TTL-level signals to RS-232C levels and is connected to a standard DB-25 connector (J2). Normally, you would connect an external termi-

continued



nal to J2. I've also connected serial port 1 to the BCC bus to allow TTL-level communication directly.

You can use the second asynchronous serial port (port 0) with one of three interfaces: RS-232C, RS-422, or RS-485. If you connect a jumper between pins 2 and 3 of JP2, port 0 passes its signals through the MC145406 for use as an RS-232C port.

J3 connects port 0 to the outside world in this configuration. When JP2 has a jumper between pins 1 and 2, port 0 communicates through the two SN75176B chips (IC8 and IC9) for use in either an RS-422 or an RS-485 application.

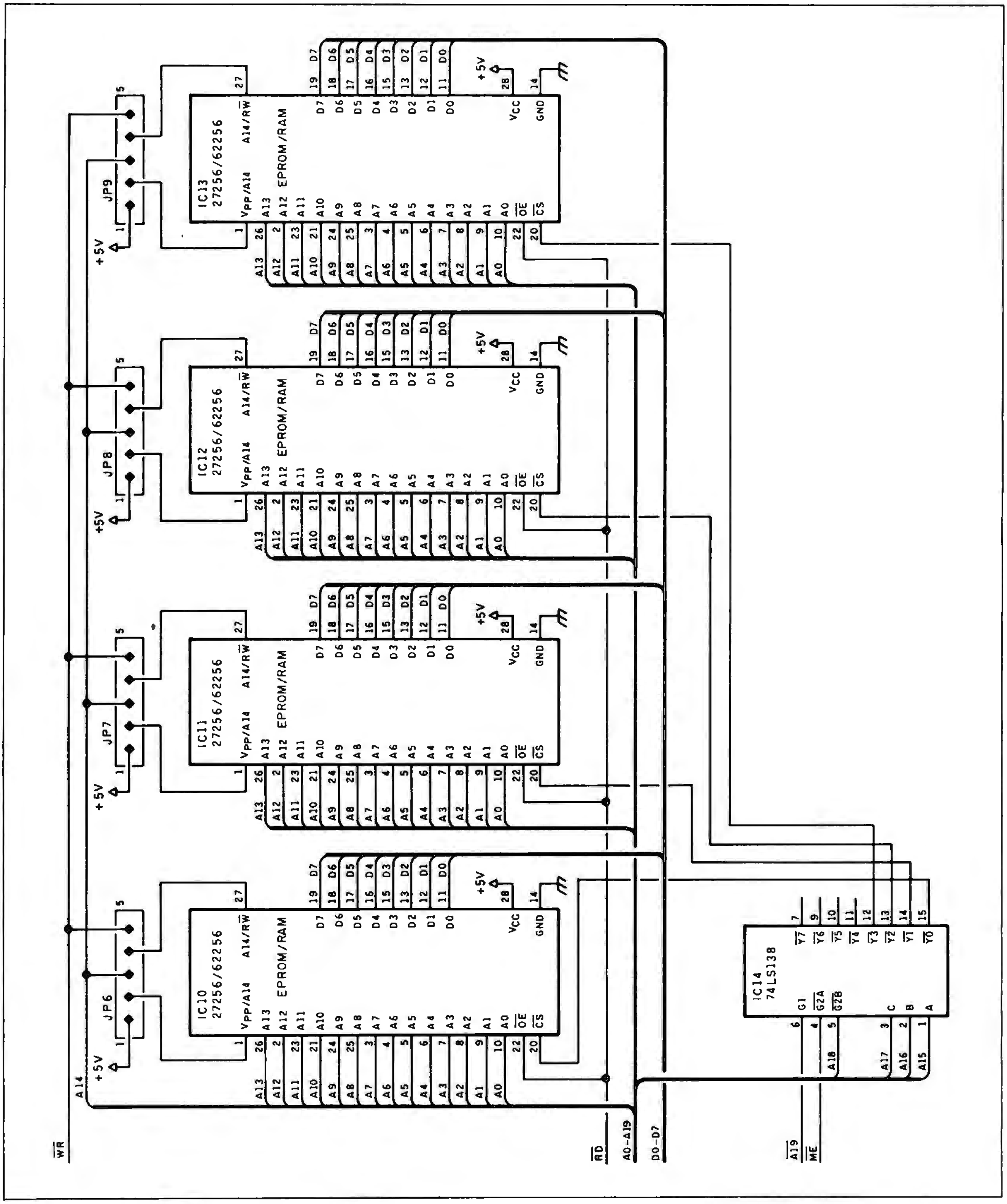


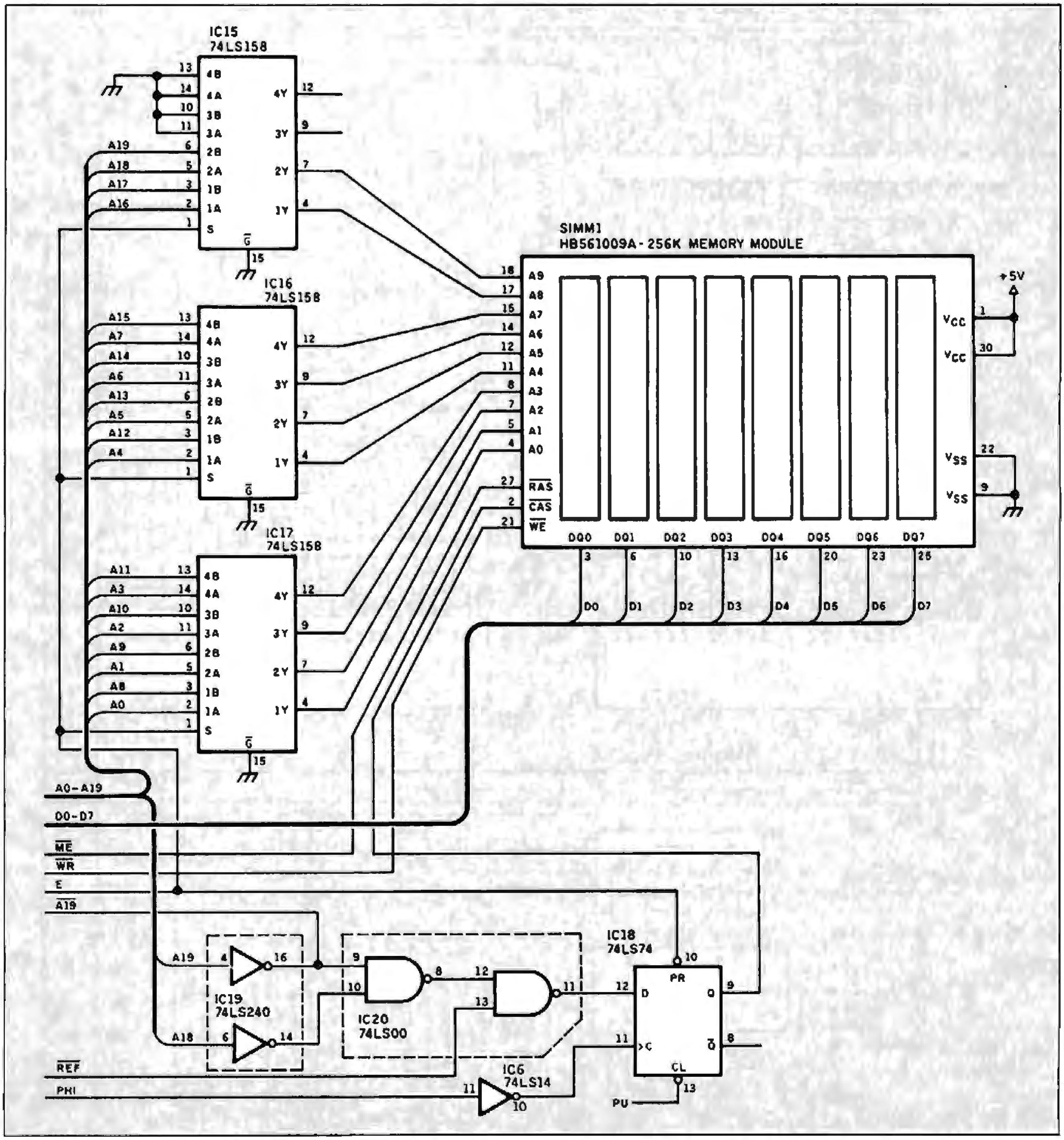
Figure 1: *Continued.*

Due to their relatively high noise immunity over long distances, RS-422 and RS-485 are becoming popular for use in communicating between remote data-collection sites and a central controller. Unlike RS-232C, which is single-ended (one wire is tied to ground, and a voltage varies on the other), RS-422 and RS-485 use balanced lines for data transmission.

In a balanced line, the voltage differential between the two wires is what's important, rather than the absolute voltage referenced to ground. The absolute voltage of the pair of wires referenced to ground can be anywhere from −7 volts to +12 V, and it won't affect the operation of the connection. The twisted-pair telephone line running into your home is an example of a balanced line. In RS-422 uses, separate transmit and receive pairs allow full-duplex operation, and each line has just one driver and one receiver. Its setup is similar to RS-232C, in that it's used mostly for point-to-point connections.

RS-485, on the other hand, is usually used in a party-line configuration. A single twisted pair connects numerous devices, and each device has a driver and a receiver connected to the same pair of wires. Only one driver can be active at a time, and all the receivers can be active at once. It's up to the software

continued



designer to implement a protocol. Although it can operate only in half-duplex, it is a simple and inexpensive way to implement a local-area network (LAN).

Although the BCC180's SN75176B is intended primarily for use in RS-485 applications, since RS-485 is really just a specialized use of RS-422, this driver IC will work well in most RS-422 applications. If you place a jumper between pins 1 and 2 on JP3, port 0 is set up for double-pair, full-duplex RS-422 operation. Placing a jumper on JP3 between pins 2 and 3, and tying together pins 1 and 3 and pins 2 and 4 on J8, configures the board for single-pair, half-duplex RS-485 operation.

The BCC Bus

In the early days of microcomputers, Intel wanted to increase the capability of its microprocessors without increasing the number of pins needed on the chip. The company started using a method

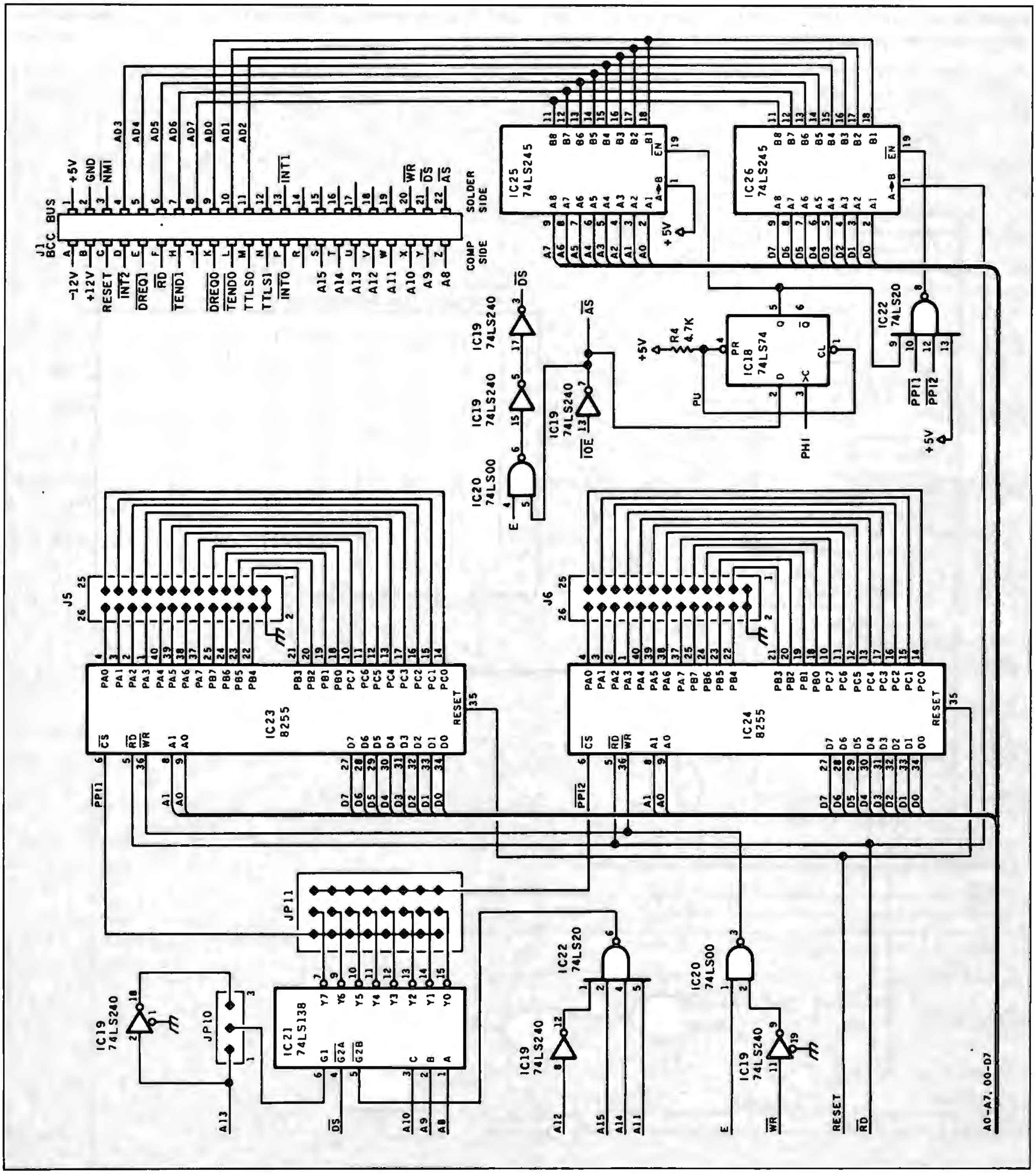


Figure 1: *Continued.*

known as multiplexing to place the eight low-order address lines on the same pins as the eight data lines. During the first clock cycle of a machine cycle, the high-order address is placed on the high-order address lines, and the low-order address is placed on the combined address/data lines.

When the address is stable, the microprocessor provides a strobe signal so that the low-order address bits can be latched into an external buffer. During the rest of the machine cycle, the system can use the same address/data lines for data since the low-order address bits have been latched.

When Zilog was started by several former Intel employees, some of Intel's design philosophies must have followed. While address/data multiplexing wasn't used on the Z80, it was used on the Z8. When I designed the BCC11 computer/controller (see the July 1981 Circuit Cellar) using the Z8 as the processor, I included the same multiplexed address/data lines in my definition of the BCC bus. Any peripheral card that you plug into the BCC bus must include the external latch mentioned above to latch the low-order address bits so the same lines can be used for data.

The BCC52 used the Intel 8052. Since the chip was from Intel, it had a multiplexed address/data bus like the Zilog Z8, and it was an easy task to attach it to the BCC bus. Consequently, all the peripheral boards that had been designed since the introduction of the BCC11 could function with the BCC52.

When I decided to make a BCC bus–compatible board using the 64180, it presented a bit of a problem. Since the HD64180 does not have a multiplexed address/data bus, I had to create a multiplexed bus interface.

The 8052 generates an address-strobe signal (AS\) and a data-strobe signal (DS\). When the address is stable and ready to be latched, the processor generates a low-to-high transition on AS\. During a write cycle, when data is stable on the bus, the processor generates a low-to-high transition on DS\ to tell the peripheral that it can read the data.

Likewise, during a read cycle, when the processor reads the data bus, it generates a low-to-high transition on DS\ to indicate that it's done with the data being presented to it.

A look at the HD64180's timing diagrams shows that the I/O enable line (IOE\) goes from high to low at the end of T1 (the first clock cycle) to indicate the start of an I/O cycle. (Remember, we want all bus transactions to be I/O-based.) Since the address is stable at the beginning of T1, IOE\ was a perfect candidate for use in generating AS\. Indeed, all it takes is an inverter to create the needed AS\ signal.

Generating DS\ is a little trickier, but not much. For that, I employed the ever-popular and ever-mystifying E signal. Most data sheets won't give you precise information on E's function. The HD64180 data book says nothing more than, "E is a synchronous clock for connection to HD63xx series and other 6800/6500 series compatible peripheral LSI."

Turning to the timing diagrams again, I discovered that, for an I/O read, E goes from high to low at the end of T3 (the last clock cycle) to signify that the processor has read the data bus. For an I/O write, E goes from high to low in the middle of T3 to signify that data is stable. It turns out that this is exactly what we need to generate DS\. Combining E and IOE\ through an AND gate and inverting the result yields the desired active-low DS\ signal.

I used two 74LS245s (IC25 and IC26) with their "B" sides tied together to perform the multiplexing of the address and data lines. RD\ controls the direction line of the data buffer (IC26) so that it can operate bidirectionally, while the address buffer (IC25) is hard-wired for output-only operation.

To control the buffer-enable lines, we delay AS\, using a 74LS74 flip-flop (IC18). When a machine cycle starts, AS\ is low and passes through the flip-flop, enabling the address buffer and disabling the data buffer. After AS\ goes high, whatever other devices are on the BCC bus have latched the address bits, so the BCC180 disables the address buffer and enables the data buffer. To avoid race conditions and to allow for a small hold time, we don't disable the address buffer until the next rising edge of PHI after AS\ goes high.

This corresponds to the start of T2 (the second clock cycle) and provides plenty of time for the data to propagate through the data buffer before it is needed. At the completion of the machine cycle, when AS\ goes low again, the address buffer is reenabled by the rising edge of the first clock cycle of the next machine cycle. Since the address bus isn't stable until after the next machine cycle has started, we've preserved the address setup time.

The rest of the signals on the bus are straightforward. Most of them are connected to the HD64180, with the outputs going through buffers. Along with the two used for multiplexing the address and data bus (IC25 and IC26), a total of six 74LS245s are used. Needless to say, this is a well-buffered board. All the inputs are pulled high using 4.7-kilohm resistors.

The BCC180 Monitor ROM

Now that we have some hardware, we need something to make it go. I've already alluded to the special multitasking BCC180 BASIC that I'll begin describing next month, but the system needs something at a lower level so that we can exercise all parts of the machine without writing driver programs or purchasing the BASIC. For that purpose, part of the software for the BCC180 includes a monitor ROM.

The monitor provides functions that let you inspect memory, change memory, access I/O devices, and read and program EPROMs (see table 2). Veteran SB180 users will note the similarity between this monitor and the one on the SB180.

When you've installed the monitor ROM in the BCC180 and applied power to the controller, the system sends `BCC180` to the terminal at 9600 bits per second. This message will display clearly on a terminal properly set for 9600 bps.

However, if you've set the terminal for some rate other than 9600 bps, pressing Return tells the BCC180 the terminal's actual data transfer rate. The system will then display an opening banner (at the proper data transfer rate) showing the amount of RAM and ROM in the system and give you a command prompt. Once in the monitor, you can obtain a full help screen by typing ?.

From the monitor, you can fill memory with a byte value, copy blocks of memory from one location to another and verify that the copy was performed properly, display sections of mem-

continued

Table 2: *The ROM monitor provided with the BCC180 is a complete set of utilities and debugging aids. You invoke commands using a single character.*

BCC180 ROM Monitor

A —ASCII table
B —Bank select
C —Copy EPROM
D —Download hexadecimal file
E —Emulate terminal
F —Fill memory
G —Goto program
H —Hexmath
I —Input port
J —Jump to ROM language
L —List memory
M —Move memory
N —New command
O —Output port
P —Printer select
Q —Query memory
R —Read EPROM
S —Set memory
T —Test system
U —Upload hexadecimal file
V —Verify memory
W —Write EPROM
X —Examine CPU registers
Y —Yank I/O registers

ory on the terminal, and modify individual memory locations. You can also search memory for a particular series of bytes.

The Bank command lets you set the 64K-byte bank of memory on which the above commands operate. (The system requires this command since the software is aware of only 64K bytes of memory, but the external address bus can access up to 1 megabyte of memory.)

The monitor lets you directly access I/O devices, both on the BCC180 board and on the BCC bus. Using a series of Input and Output commands, you can check a board that's just been plugged into the bus without having to write and debug a program.

Another useful function of the monitor is its EPROM programming support. You can transfer into memory the contents of an EPROM that has been plugged into the programming board, examine and possibly modify the contents, then program the block onto a blank EPROM. You can also send a file in Intel hexadecimal format to the BCC180 and have the computer program an EPROM.

This is the basis of the SB180-based development system I described earlier. On the SB180, you create a hexadecimal file containing the object code, then transfer that file to the BCC180 monitor. You use the monitor to program the final EPROM.

On the miscellaneous side, the monitor has commands that let you examine and modify the HD64180's general-purpose registers and display, with labels, the processor's 64 internal I/O registers. As a help to programmers, the A command displays an ASCII table, and H can perform simple hexadecimal mathematics.

Experimenters

While the BCC180 is available commercially, I encourage you to build your own. If you don't mind doing a little work, I will support your efforts as usual. A hexadecimal file of the executable code for the BCC180's ROM monitor is available for downloading from my bulletin board at (203) 871-1988. Alternatively, you can send me a preformatted IBM PC or SB180 disk with return postage, and I'll put the file on it for you. Add $5 for a printed copy of the BCC180 manual.

I also have a number of copies of the BASIC-180 development software that, for the price of the manuals and distribution media, I will gladly give to experimenters who build the BCC180. Of course, this free software is limited to noncommercial personal use.

Next Month

I'll finish the hardware with a description of the BCC180's auxiliary EPROM programmer board and introduce BASIC-180. As I begin talking about BASIC-180, I'll include a tutorial on multitasking. ■

I'd like to acknowledge and personally thank Ken Davidson and Jack Ganssle for their efforts on the BCC180 project. Ken Davidson's extensive knowledge of the HD64180 helped us avoid the omnipresent hardware design pitfalls, and Jack Ganssle's superb software talents helped explain multitasking in a way that can really be understood.

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.

It's virtually impossible to provide all the pertinent details of a project or cover all the designs I'd like to in the pages of BYTE. For that reason, I have started a 24-page bimonthly supplemental publication (with no advertising) called Circuit Cellar Ink, which presents additional information on projects published in BYTE, new projects, and supplemental applications-oriented materials. For a one-year subscription, send $14.95 to Circuit Cellar Ink, P.O. Box 3378, Wallingford, CT 06492, or call (203) 875-2199.

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.

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3. BASIC-180 multitasking BASIC compiler for ROM- or disk-based development. Contains both BASIC-180 EPROM for direct use on BCC180 board and BASIC-180 disk for direct use or software development on SB180. Includes 100-page user's manual. Compiled code may be freely used without further license. BASIC-180 DEV $250
4. An auxiliary 27256 EPROM programmer board for the BCC180. BCC180PROG5 .... $89

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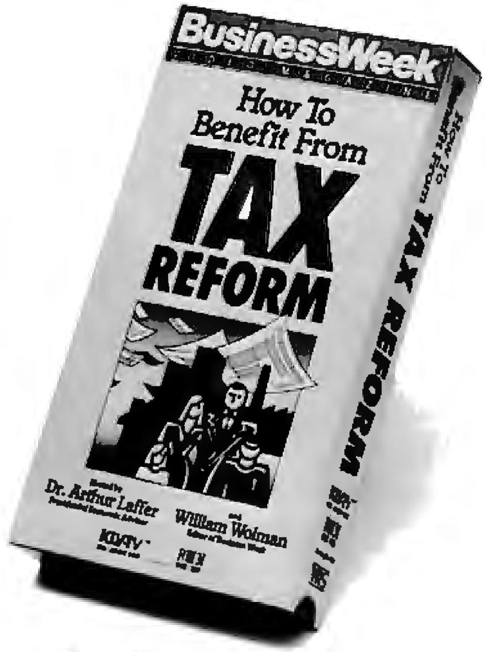

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Dick Pountain

Changing Reverse Polish to Infix

We can perform math in "infix" notation, but computers need to use reverse Polish notation

Parsing is one of those activities that really separates computers from humans. Parsing streams of symbols into meaningful messages seems to come easily to us humans. It's as if the template for a language parser is hard-wired into our brains, and that learning to speak is just filling out this template with the vocabulary of an actual human language.

The lessons in sentence parsing that many of us took in school just taught us to name the parts of speech; the parsing ability was already there subconsciously, or we couldn't have understood the lessons (or anything else for that matter).

Computers conspicuously lack this innate ability to parse. At the lowest level, a computer regards all input as a sequential stream of stuff (e.g., machine op codes) to be acted upon one at a time in strict sequence. If we want the computer to perceive a more complex structure in its input stream, we must program it to parse the stream according to the rules of some grammar or syntax.

The parsing of human (or natural) languages presents formidable difficulties to the parser writer because the syntax rules of our languages are complex, fluid, and inconsistent. The way a word is to be interpreted often depends upon the whole context in which it occurs, including not just the surrounding sentence, but maybe the whole utterance.

Our brains, which appear to be optimized for this sort of large-scale pattern matching, cope admirably, but computers find it hard going indeed. Natural-language parsers are included in some software packages, from adventure games to database managers, but their limited capabilities give some indication of the difficulty of the task.

Computer languages are deliberately designed with restricted grammars that a computer can parse more easily than, say, English. In particular, these grammars are usually of the kind called "context-free," which, crudely put, means that a symbol has the same meaning regardless of its surrounding symbols.

Most high-level computer languages are built around a parser or syntax analyzer, which processes the input source code, looking for well-formed constructs according to the syntax rules of the language. To see how such a parser is designed, see Jonathan Amsterdam's delightful series on building the SIMPL compiler (December 1985 through February 1986 BYTE).

Infix

The parsing of mathematical expressions is a special case (which is easier than parsing a whole programming language) that can be applied separately, for example, in the construction of calculators.

Most popular programming languages (e.g., BASIC, Pascal, and C) include a mathematical-expression parser that accepts expressions written in the infix notation (also referred to as "algebraic notation" by calculator manufacturers) we learn at school. Infix means that a binary operator, say +, sits between its operands, as in 3 + 4.

The infix notation is so widely learned and so natural that someone raised on BASIC might wonder that an expression like

x = 34 + 57/(120 * 3)

needs parsing at all. Unfortunately, the typical computer can't perform arithmetic in this order.

If we attempt to persuade a computer to execute the expression 3 + 4 in that sequence, we are saying: "Take 3, now add, now take 4." But the computer can't add until it has both values to be added, just as you can't make an omelet until you have broken the eggs. The point becomes clearer if we express the addition in a hypothetical assembly language:

```
mov regA,3
mov regB,4
add regA,regB
```

We need to move the two values into the registers before the addition can take place. Hence, infix notation is not at all natural for computers.

Instead, computers prefer a postfix ordering in which the operator always follows its operands. Reverse Polish notation (RPN) is a way of writing mathematical expressions in postfix form; 3 + 4 in RPN becomes 3 4 +. Its great attraction to a computer is that an RPN expression requires no brackets, so the computation can proceed in a strictly sequential manner. For example, the infix expression

5 * (7 + 9/(5 + 6))

becomes

5 7 9 5 6 + / + *

in RPN. It's convenient to use a stack to hold the operands when evaluating RPN expressions. The operators are then applied successively to the top two stack items.

continued

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Expression Parsing

An expression parser is a program that takes expressions in the infix form that humans prefer and reorders the operations into the postfix form that computers prefer. Given that BASIC, Pascal, and many other languages have an expression parser built in, why would anyone but a compiler writer want to write one?

Listing 1: *Pseudocode for Forth's interpreter.*

```
Program ForthInterpreter
  Get next word
  IF word is found in dictionary
  THEN execute it
  ELSE try to convert it to a number
       IF it's a valid number
       THEN push it onto stack
       ELSE ERROR
       ENDIF
  ENDIF
```

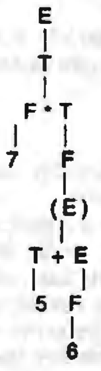

Figure 1: *The parse tree for the expression 7 * (5 + 6). E, F, and T stand for expression, term, and factor.*

Listing 2: *Pseudocode of the algorithm for converting expressions from infix to reverse Polish notation.*

```
Program Expression
   REPEAT Term UNTIL Finished

 Subprogram Term
    Read the next symbol -> NextSymbol
    IF NextSymbol IS
         ')' THEN  Finished
         '(' THEN  Expression
         '+' THEN  Term
                   Compile +
         '-' THEN  Term
                   Compile -
         '*' THEN  Term
                   Compile *
         '/' THEN  Term
                   Compile /
  identifier THEN  Compile its
                   execution address
      number THEN  Compile as a literal
                 ELSE
      ERROR      "Illegal element
                   in Expression"
      ENDIF
```

Well, for one thing, not all languages have such a parser. Some languages such as LISP and Prolog employ a prefix notation (i.e., operator before operands), since, in these languages, programs work via function applications.

(Some modern LISP dialects do in fact have an outer "shell" that parses infix expressions, as does Turbo Prolog.) Other languages such as Forth and PostScript already employ postfix notation.

Also, even in languages like BASIC and Pascal, the expression parser is normally available only to the language system itself, not to the user. If you write a program that takes mathematical expressions as strings input by the user at run time (e.g., a graphing program or an equation-solving program), you'll likely find that you have to parse these strings yourself, the hard way.

Acorn's BBC BASIC (and, I believe, the old Sinclair/Timex BASIC) has a function called `EVAL("<string>")` that takes a string and evaluates it as an infix expression, but this is not present in all BASICs.

The case of Forth is particularly interesting. The extremely small and simple Forth interpreter parses the input stream hardly at all, so math is naturally performed in strictly sequential (reverse Polish) order. Forth treats its input as a stream of words separated by spaces. The action of the interpreter is simple indeed (see listing 1). It would almost be true to say that Forth has no syntax at all, but the control structures do impose a few rules.

The RPN math doesn't phase seasoned Forth users who, like Hewlett-Packard calculator users, have become used to it. Some people even prefer it because the need for brackets is removed (see, for example, "Complex Math in Pascal" by David Gedeon in the July 1987 BYTE). There's no denying that it becomes a royal nuisance if large and complicated algebraic expressions have to be processed often, and that it is off-putting to casual users.

In a fairly large Forth program I wrote some time ago, I decided to incorporate a simple expression parser to permit the user to enter infix expressions instead of expressions in RPN. The Forth language supports recursion, and a recursive-descent algorithm seemed the most likely to produce a compact solution.

However, my parser needed to be very small indeed; much smaller, for example, than the typical Pascal implementation of a recursive-descent parser that can run to more than 200 lines of code (see Jonathan Amsterdam's August 1985 BYTE article, "Context-Free Parsing of Arithmetic Expressions," for a Modula-2 version).

Accordingly, I made several sacrifices to keep the size down. The first was to support the +, −, *, and / operations only for single (i.e., 16-bit) numbers. The second, and most hurtful, was to abandon operator priority, so that evaluation proceeds strictly from left to right unless parentheses are used. The third was that the parser works only in compiling mode. Thus, it cannot be used as a calculator to evaluate expressions interactively at the keyboard.

On the bright side, the parser costs absolutely nothing in runtime overhead, as it does all its work at compile time; the compiled code is *exactly* what Forth would have produced had you entered the expression in RPN.

I saved the most space of all by shortcutting the parse-tree generation stage of the recursive-descent algorithm. In many implementations of the recursive-descent method, the parser constructs a tree that depicts the expression viewed through the rules (or "productions") of the associated grammar. To illustrate, let's take this simple grammar for arithmetic, using +, −, *, and / as used in Jonathan Amsterdam's August 1985 article:

```
expression → term
             term + expression
             term − expression

  term → factor
         factor * term
         factor / term

    factor → number
             −factor
             (expression)
```

In this notation, loosely based on Backus-Naur form, the symbol → means "may consist of," and a new line indicates alternatives (e.g., "term" or "term + expression") and so on. The rules say that an expression may be the sum or difference of terms, which are in turn the product or quotient of factors, and that a factor might be a number, a factor preceded by unary minus, or a whole expression surrounded by parentheses.

The rules are all recursive (i.e., the same name appears on right- and left-hand sides), and applying them successively leads you down through the levels, ending with a number (hence, the name recursive descent). The precedence of the operators is inverse to their order of appearance in the rules: + and − are lower than * and /, which are lower than unary minus and parentheses.

Applying these rules in succession to the expression 7 * (5 + 6) would yield the parse tree shown in figure 1. This tree might be physically represented as a linked list and then passed to another procedure for code generation (or, in the case of an interpreter, for direct evaluation).

Instead, I chose a scheme in which the "tree" is inherent in the course of the computation but is never explicitly created. My grammar is also more elementary, since with no operator precedence, terms and factors need not be distinguished:

```
expression → term
             term + expression
             term − expression
             term * expression
             term / expression

  term → number
         identifier
         (expression)
```

I permit a term to be the identifier or name of any Forth word in the dictionary; constants and variables are the kinds of words most likely to be used here, but see below. The algorithm for compiling expressions is shown in pseudocode in listing 2, and it clearly illustrates how infix is turned to RPN by grabbing the next term *before* compiling the operator.

Notice also that term is both self-recursive and mutually recursive with expression. To turn this algorithm into Forth code requires little effort.

A problem that must be overcome is that the scoping rules of Forth, like those of Pascal, forbid forward references to words that are not yet defined. Such a forward reference is required to set up the mutual recursion of expression and term.

One solution is to create a variable called `FORWARD`, and then a dummy definition of the yet-to-be-defined word that just fetches the content of this variable and executes it. When the real definition of the word is completed, you take its execution address, store it into `FORWARD`, and voilà (see listing 3).

You use the parser like this:

```
: TEST INFIX( 7 * ( 3 + 4 ) ) ;
```

which compiles to exactly the same code as the RPN:

```
: TEST 7 3 4 + * ;
```

Expanding the Parser

Note that spaces are mandatory between all the symbols. Constants can be used in expressions, and so can variables, as long as they are followed by the @ operator to fetch their contents:

```
13 CONSTANT A VARIABLE B 12 B !

: TEST INFIX( A + 6 * ( B @ - 10 ) ) ;
```

If you find this @ offensive, you can modify the parser so that it automatically fetches the contents of a variable. However, to do this, you need to identify a variable just by looking at its code address (in the default section of the `CASE` in `NEXT-TERM`), and this involves a comparison with a system-dependent absolute address that you can determine only by inspecting your compiler.

In fact, this parser will accept and execute any defined Forth word inside an expression, but only those words that take nothing from the stack and return exactly one value will produce meaningful results.

An example of a word so usable could be `RANDOM`, which produces a random number. You could also include the Forth loop index words `I` and `J` in expressions contained in `DO` loops. It is easy to add extra binary operators to the `CASE`, and with rather more effort to accommodate double or floating-point numbers.

There is no explicit error checking in this code; the `NUMBER`

continued

Listing 3: *Forth code for implementing the algorithm given in listing 2. This code is standard Forth-83, with the addition of two almost universally adopted extensions:* `ASCII`, *which returns the code of a character, and the Eaker* `CASE` *construct. If you don't have* `ASCII`, *just use the actual code values for the "(" and ")" characters, namely, 40 and 41. A recursive call in Forth requires you to use either the word* `RECURSE` *or* `MYSELF` *rather than the name of the word itself. In the unlikely case your Forth system doesn't have either, you can define* `MYSELF` *as*

```
: MYSELF  CONTEXT @ @  NAME> , ;  IMMEDIATE
```

```
( holds address for forward reference)
  VARIABLE FORWARD
 ( dummy definition; merely executes the
      forward reference)
: INFIX(  FORWARD @ EXECUTE ;
 ( get blank delimited word from the
  input stream and extract its first
  char)
: NEXT-SYMBOL  BL WORD DUP 1+ C@  ;
  (  --- addr char )
 : NEXT-TERM  NEXT-SYMBOL DUP
  (   --- flag )
   ASCII ) = IF 2DROP
   0  EXIT ENDIF
   ASCII ( = IF DROP  INFIX(
   1  EXIT ENDIF
       FIND
       ( is it in dictionary?)
       IF DUP CASE
            ['] + OF  MYSELF
                DROP ,  ENDOF
            ['] - OF  MYSELF
                DROP ,  ENDOF
            ['] / OF  MYSELF
                DROP ,  ENDOF
            ['] * OF  MYSELF
                DROP ,  ENDOF
            , ( default:just compile it)
              ENDCASE
        ELSE NUMBER DROP [COMPILE]
             LITERAL
        ENDIF 1 ;
 : INFIX(   BEGIN NEXT-TERM WHILE REPEAT ;
  IMMEDIATE
 ( store address for the forward
   reference)
' INFIX(  FORWARD !
```

routine will return its own error message if an unidentified symbol is encountered. Similarly, Forth itself will report an unmatched right parenthesis. An unmatched left parenthesis, on the other hand, will put the compiler into an endless loop waiting for ")", though the Break key will break out of this.

There is a neat way to trap this latter error, but one that will appall most computer scientists: Add an extra test to see if the next symbol is a ";", which would mark the end of the enclosing colon definition and mean the parser has run away. Just insert the following as the second line of `NEXT-TERM`:

```
ASCII ; IF CR ." Unmatched left parenthesis!"
  ABORT ENDIF DUP
```

Next month, I'll present an algorithm for generating multi-column page text. ■

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James L. Conger

Using Financial Tools for Nonfinancial Simulations

With Monte Carlo (random number) simulations, spreadsheets can model real-world events

Spreadsheets were originally designed for accounting problems such as balance sheets and forecasts. However, users have found that a spreadsheet is a versatile model for solving many numeric problems.

This article describes how you can use Lotus 1-2-3 to simulate inventory problems. Users of SuperCalc and VisiCalc will find the examples easy to follow, since the three programs use similar notations.

It is almost always cheaper and more efficient to try out a new idea through simulation before actually building the project. "Monte Carlo simulation" is an eye-catching name for using random numbers to simulate real-world events. This technique is now widely used in both industry and the military (see references 1 and 2).

The Problem: A Small Oil Terminal

An oil terminal receives its supply from a manufacturing plant and delivers it to customers. Production is steady at 2000 barrels per day and can be stopped or started with 1 day's notice. The terminal has 5000 barrels of storage room in a tank. The terminal's many small customers have a combined average of 9 orders per day. Each order is for 200 barrels. How many times a month will the terminal be unable to satisfy all of its customer orders?

A little arithmetic shows that the average sales demand is only 1800 barrels a day. Since the production capacity is 2000 barrels per day, it might seem that the customers could always be satisfied. Unfortunately, things are not that simple.

The 9-orders-per-day average is made up of orders placed by many customers. Although the order rate may average 9 per day, on any given day you might get 10 orders, or 7, or 15. Clearly, if you get 15 orders several days in a row, the inventory tank will be depleted, causing missed sales. You need a way to simulate the incoming orders.

The Poisson Distribution

The Poisson distribution is an integral part if the simulation. In cases where many customers order independently, and where each customer has a low probability of placing an order on a

continued

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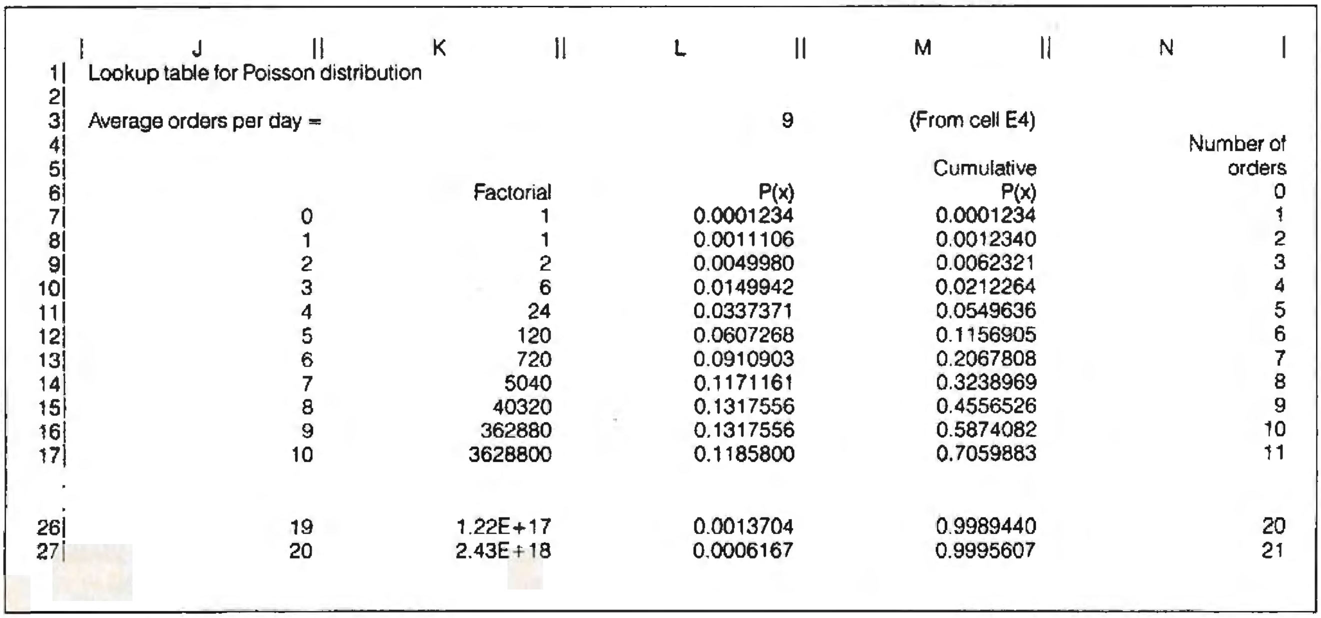

```
    |      J      ||       K       ||      L      ||      M      ||      N      |
  1| Lookup table for Poisson distribution
  2|
  3| Average orders per day =                      9    (From cell E4)
  4|                                                                  Number of
  5|                                                   Cumulative        orders
  6|                          Factorial         P(x)         P(x)             0
  7|              0                  1    0.0001234    0.0001234             1
  8|              1                  1    0.0011106    0.0012340             2
  9|              2                  2    0.0049980    0.0062321             3
 10|              3                  6    0.0149942    0.0212264             4
 11|              4                 24    0.0337371    0.0549636             5
 12|              5                120    0.0607268    0.1156905             6
 13|              6                720    0.0910903    0.2067808             7
 14|              7               5040    0.1171161    0.3238969             8
 15|              8              40320    0.1317556    0.4556526             9
 16|              9             362880    0.1317556    0.5874082            10
 17|             10            3628800    0.1185800    0.7059883            11
  .
  .
 26|             19           1.22E+17    0.0013704    0.9989440            20
 27|             20           2.43E+18    0.0006167    0.9995607            21
```

Figure 1: *The Poisson distribution lookup table. Figure 2 shows the formulas behind this portion of the spreadsheet.*

given day, the Poisson distribution will describe the probability of receiving a given number of orders on any one day (see reference 3).

The Poisson distribution has a convenient feature: You can calculate every value if you know the average. The formula is $P(x) = A^x e^{-A}/x!$, where $P(x)$ represents the probability that you will receive x orders on a given day, A represents the average number of orders, and e is the base of the natural logarithms (approximately 2.7183).

continued

```
   |     J        ||      K       ||             L              ||      M       ||      N      |
 1|  Lookup table for Poisson distribution
 2|
 3|  Average orders per day =                             +$E$4      (From cell E4)
 4|                                                                                   Number of
 5|                                                                 Cumulative           orders
 6|                           Factorial                       P(x)        P(x)                0
 7|                0                  1  ($L$3^J7)/(K7*(@EXP($L$3)))    +L7+M6           +$J7+1
 8|          +$J7+1              (J8*K7)  ($L$3^J8)/(K8*(@EXP($L$3)))    +L8+M7           +$J8+1
 9|          +$J8+1              (J9*K8)  ($L$3^J9)/(K9*(@EXP($L$3)))    +L9+M8           +$J9+1
```

Figure 2: *Column J is a series of ascending integers starting with 0. Column K calculates the factorial of J. Column L uses the factorial to calculate the probability of a given number of orders, using the Poisson formula and the average number of orders (9 in this case). For example, the probability of getting exactly 7 orders on a given day is 11.7 percent (see figure 1, cell L14).*

```
   |    A     ||     B      ||     C      ||     D       ||      E      ||      F       ||     G      ||     H      |
 1|  Simulation of an inventory tank
 2|
 3|               Enter max    Enter rate                 Avg. number     Enter avg.
 4|                    5000          2000                           9            200                           Gal.
 5|                                                                                             Gal.          missed
 6|       Day     Inventory    Production    Random no.  No. of orders  Gal. ordered         shipped           sales
 7|  ----------------------------------------------------------------------------------------------------------------
 8|         1          2500          2000   0.061857207              5          1000            1000               0
 9|         2          3500             0   0.162162030              6          1200            1200               0
10|         3          2300          2000   0.430322811              8          1600            1600               0
11|         4          2700          2000   0.031907307              4           800             800               0
12|         5          3900             0   0.766562630             11          2200            2200               0
13|         6          1700          2000   0.162895409              6          1200            1200               0
14|         7          2500          2000   0.392827360              8          1600            1600               0
15|         8          2900          2000   0.451411125              8          1600            1600               0
16|         9          3300             0   0.369841825              8          1600            1600               0
17|        10          1700          2000   0.443499729              8          1600            1600               0
18|        11          2100          2000   0.589248446             10          2000            2000               0
19|        12          2100          2000   0.968387924             15          3000            2100             900
20|        13          2000          2000   0.552589404              9          1800            1800               0
21|        14          2200          2000   0.184578735              6          1200            1200               0
22|        15          3000          2000   0.379185897              8          1600            1600               0
23|        16          3400             0   0.426193598              8          1600            1600               0
24|        17          1800          2000   0.734686950             11          2200            1800             400
25|        18          2000          2000   0.952955192             14          2800            2000             800
26|        19          2000          2000   0.794911813             11          2200            2000             200
27|        20          2000          2000   0.040212391              4           800             800               0
28|        21          3200             0   0.118399010              6          1200            1200               0
29|        22          2000          2000   0.108103999              5          1000            1000               0
30|        23          3000          2000   0.958301718             14          2800            2800               0
31|        24          2200          2000   0.593840786             10          2000            2000               0
32|        25          2200          2000   0.162433155              6          1200            1200               0
33|        26          3000          2000   0.330655601              8          1600            1600               0
34|        27          3400             0   0.951867276             14          2800            2800               0
35|        28           600          2000   0.123729203              6          1200             600             600
36|        29          2000          2000   0.596039101             10          2000            2000               0
37|        30          2000          2000   0.319844722              7          1400            1400               0
38|        31          2600          2000   0.878265568             13          2600            2600               0
39|  ----------------------------------------------------------------------------------------------------------------
40|   Average          2445          1612   0.452829610              8          1722            1629              93
```

Figure 3: *The main portion of the spreadsheet, minus the Poisson lookup table. The formulas behind the left side of the spreadsheet (columns A through C) are shown in figure 4. The formulas behind the right side of the spreadsheet (columns D through H) are shown in figure 5.*

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```
   |         A           ||          B          ||                    C             |
 1|  Simulation of an inventory tank
 2|
 3|                                     Enter max                          Enter rate
 4|                                          5000                                2000
 5|
 6|                    Day              Inventory                          Production
 7|--------------------------------------------------------------------------------------
 8|                      1                  +B4/2          @IF($B8+$C$4>$B$4,0,$C$4)
 9|                  +A8+1          +$B8+$C8-$G8          @IF($B9+$C$4>$B$4,0,$C$4)
10|                  +A9+1          +$B9+$C9-$G9         @IF($B10+$C$4>$B$4,0,$C$4)
```

Figure 4: *We start inventory at half full to get the model going. Each successive day's tank inventory is the inventory from the previous day plus production and minus sales for the day. We conservatively assume that the day's sales occur before the production arrives. Thus, sales are missed if the tank does not have sufficient barrels at the start of the day, regardless of possible filling of the tank later in the day.*

```
   |     D       ||             E              ||     F      ||          G           ||     H     |
 1|
 2|
 3|                                  Avg. number   Enter avg.
 4|                                            9         200                                  Gal.
 5|                                                                               Gal.      missed
 6|    Random no.                  No. of orders  Gal. ordered                  shipped       sales
 7|----------------------------------------------------------------------------------------------------
 8|      @RAND     @VLOOKUP($D8,$M$7..$N$27,1)     +$E8*$F$4    @IF($B8-$F8>0,$F8,$B8)      +$F8-$G8
 9|      @RAND     @VLOOKUP($D9,$M$7..$N$27,1)     +$E9*$F$4    @IF($B9-$F9>0,$F9,$B9)      +$F9-$G9
10|      @RAND    @VLOOKUP($D10,$M$7..$N$27,1)    +$E10*$F$4 @IF($B10-$F10>0,$F10,$B10)    +$F10-$G10
```

Figure 5: *Column E employs the* `@VLOOKUP` *command to scan the Poisson table (figure 1). The random number in column D here is compared with the contents of column M in figure 1. The largest value in M not exceeding the random number is the match. Column N provides the corresponding number of orders. The volume ordered is the number of orders times the barrels per order (column F here). The amount shipped cannot be greater than the amount in the tank. The difference between the amount ordered and the amount shipped shows up as lost sales in column H.*

Note that the Poisson distribution gives P(x) only for whole-number values of x. It does not define the probability of receiving 3½ orders or −2 orders.

Using this formula, you can calculate how often, on the average, you will receive a given number of orders. For example, using the problem's average of 9 orders per day, the probability of getting only 2 orders is

$$P(x) = 9^2e^{-9}/2! = .004998 = 0.50\%.$$

In order to make use of the Poisson distribution, use a random-number generator and the lookup-table function in the spreadsheet.

Putting the Poisson Distribution in a Spreadsheet

A random number between 0 and 1 will determine the number of orders for a given day. For our problem, the average number of orders is 9.

Once you have calculated the probabilities, use a lookup table of the Poisson distribution as shown in figure 1.

To use the probabilities calculated in figure 2 in a lookup

continued

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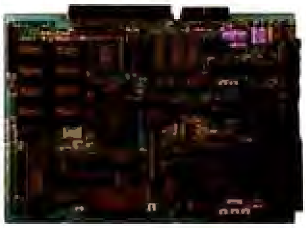

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table, add them in ascending order to provide the cumulative probability (column M). Compare the random number with column M's values to find the largest value in column M not exceeding the random number.

To get the number of orders, go across to column N. A random number of 0.29 would correspond to 7 orders, while 0.59 would yield 10 orders.

Note that column N is offset by one position from the starting values in column J. This compensates for the way the lookup function "backs up" to the previous row when a match is found. For example, any random number below .0001234 would yield a result of 0 orders on that day (cell N6 is the output).

The combination of random numbers between 0 and 1 and the Poisson lookup table allows you to produce a series of orders with the right average and with the right variability.

Figure 3 shows the simulated first month of the terminal's operation. The Poisson lookup table (columns J to N) is located to the right of the main simulation section and is not repeated in figure 3. Figures 4 and 5 show the formulas behind the numbers in figure 3.

You can enter the input values for the production, maximum inventory, average number of orders, and the size of the orders under the appropriate heading in row 4. After that, you can hit the Calc key and watch the simulated month take place.

Interpreting the Results

At the bottom of figure 3 are the averages of the column values. Note that although the input average number of orders per day was 9, the actual average was 8.

Figure 3 therefore represents a slightly worse than average month as far as sales go. If you simulate the next month (regenerate the random numbers used in column D, and set the inventory at the last day's level) you will get a different average. This new average will of course result in a different number of orders and missed sales.

You need to repeat the simulation perhaps 20 times to get a representative feel for the number of missed sales. You can answer "what if" questions by changing the input conditions. You might try a larger tank or higher production levels on the production side, or a greater average number of sales or higher number of barrels per sale on the sales side.

Final Comments

You can extend this general approach to any arbitrary level of complexity. For example, you might use a second set of random numbers to simulate unplanned failures in the production unit, or mechanical breakdowns of the tank's pump.

Keep in mind, though, that when adding new *random* variables, you need to use an independent source of random numbers. Your simulation would lose a degree of realism if it always showed high sales demands coinciding with broken pumps, for instance. For large simulations, a full-scale simulation language (see references 1 and 2) is more efficient than using a spreadsheet. However, for small problems where you need a fast answer, the spreadsheet approach works extremely well. ■

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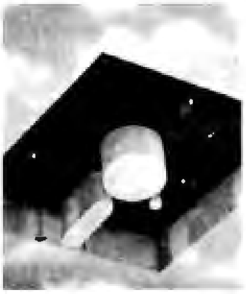

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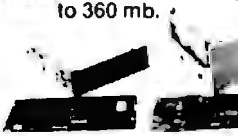

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7407	.39	.29	74121	.45	.35
7408	.35	.25	74123	.55	.45
7410	.29	.19	74125	.55	.45
7414	.49	.39	74126	.69	.59
7416	.39	.29	74143	3.95	3.85
7417	.39	.29	74150	1.35	1.25
7420	.35	.25	74154	1.35	1.25
7430	.35	.25	74158	1.59	1.49
7432	.39	.29	74173	.85	.75
7438	.39	.29	74174	.59	.49
7442	.55	.45	74175	.59	.49
7445	.79	.69	74176	.99	.89
7446	.89	.79	74181	1.95	1.85
7447	.89	.79	74189	1.95	1.85
7448	2.05	1.95	74193	.79	.69
7472	.89	.79	74198	1.85	1.75
7473	.39	.29	74221	.99	.89
7474	.39	.29	74273	1.95	1.85
7475	.49	.39	74365	.65	.55
7476	.45	.35	74367	.65	.55

74LS

74LS00	.29	.19	74LS165	.75	.65
74LS02	.29	.19	74LS166	.99	.89
74LS04	.35	.25	74LS173	.59	.49
74LS05	.35	.25	74LS174	.49	.39
74LS06	1.09	.99	74LS175	.49	.39
74LS07	1.09	.99	74LS189	4.59	4.49
74LS08	.29	.19	74LS191	.59	.49
74LS10	.29	.19	74LS193	.79	.69
74LS14	.49	.39	74LS221	.69	.59
74LS27	.35	.25	74LS240	.69	.59
74LS30	.29	.19	74LS243	.69	.59
74LS32	.35	.25	74LS244	.69	.59
74LS42	.49	.39	74LS245	.89	.79
74LS47	.99	.89	74LS259	.99	.89
74LS73	.39	.29	74LS273	.89	.79
74LS74	.35	.25	74LS279	.49	.39
74LS75	.39	.29	74LS322	4.05	3.95
74LS78	.55	.45	74LS365	.49	.39
74LS85	.59	.49	74LS366	.49	.39
74LS86	.35	.25	74LS367	.49	.39
74LS90	.49	.39	74LS368	.49	.39
74LS93	.49	.39	74LS373	.79	.69
74LS123	.59	.49	74LS374	.79	.69
74LS125	.49	.39	74LS393	.89	.79
74LS138	.49	.39	74LS590	6.05	5.95
74LS139	.49	.39	74LS624	2.05	1.95
74LS154	1.09	.99	74LS629	2.95	2.85
74LS157	.45	.35	74LS640	1.09	.99
74LS158	.45	.35	74LS645	1.09	.99
74LS163	.59	.49	74LS670	1.09	.99
74LS184	.59	.49	74LS688	2.39	2.29

74S/PROMS*

74S00	.29	74S188*	1.49
74S04	.29	74S189	1.09
74S08	.35	74S196	2.49
74S10	.29	74S240	1.49
74S32	.35	74S244	1.49
74S74	.45	74S253	.79
74S85	1.79	74S287*	1.49
74S86	.49	74S288*	1.49
74S124	2.75	74S373	1.49
74S174	.79	74S374	1.40
74S175	.79	74S472*	2.95

74F

74F00	.29	74F139	.69
74F04	.29	74F157	.69
74F08	.29	74F193	2.95
74F10	.29	74F240	.99
74F32	.29	74F244	.99
74F74	.39	74F253	.69
74F86	.39	74F373	.99
74F138	.69	74F374	.99

CD—CMOS

CD4001	.19	CD4076	.59
CD4008	.69	CD4081	.25
CD4011	.19	CD4082	.25
CD4013	.29	CD4093	.35
CD4016	.29	CD4094	.89
CD4017	.49	CD40103	2.49
CD4018	.59	CD40107	.49
CD4020	.59	CD40109	.79
CD4024	.49	CD4510	.69
CD4027	.35	CD4511	.69
CD4030	.29	CD4520	.75
CD4040	.65	CD4522	.79
CD4049	.29	CD4538	.79
CD4050	.29	CD4541	.89
CD4051	.59	CD4543	.79
CD4052	.59	CD4553	4.95
CD4053	.59	CD4555	.79
CD4063	1.49	CD4559	7.95
CD4066	.29	CD4566	2.49
CD4067	1.29	CD4583	.89
CD4069	.25	CD4584	.39
CD4070	.25	CD4585	.89
CD4071	.25	MC14411P	8.95
CD4072	.25	MC14490P	4.49

MICROPROCESSOR COMPONENTS

MISCELLANEOUS CHIPS

Part No.	Price
D765AC	4.95
WD9216	6.95
85H90	9.95

Z80, Z80A, Z80B SERIES

Z80	1.25
Z80-CTC	1.79
Z80-DART	4.95
Z80-PIO	1.79
Z80A	1.69
Z80A-CTC	1.79
Z80A-DART	4.95
Z80A-PIO	1.69
Z80A-SIO/0	5.75
Z80B	3.49
Z80B-CTC	3.95
Z80B-PIO	4.29

6500/6800/68000 SER.

6502	2.65
65C02 (CMOS)	8.95
6520	1.95
6522	3.95
6532	6.49
6551	4.49
65C802 (CMOS)	19.95
6800	1.95
6802	3.95
6810	1.25
6821	1.75
6840	3.95

6500/6800/68000 Cont.

Part No.	Price
6845	3.95
6850	1.95
6852	1.49
MC68000L8	11.95
MC68000L10	13.95
MC68010L10	49.95
MC68020RC12B	169.95
MC68881RC12A	149.95

8000 SERIES

8031	3.95
80C31	9.95
8035	1.95
8073	9.95
8080A	2.95
8085A	2.49
8086	5.95
8086-2	6.95
8087(5MHz)	129.95
8087-1(10MHz)	229.95
8087-2(8MHz)	169.95
8088	6.49
8088-2	8.95
8116	4.95
8155	2.49
8155-2	3.49
8156	3.95
8202	5.95
8203	9.95
8212	1.49
8224	2.25

8000 SERIES Cont.

Part No.	Price
8228	2.95
8237-5	4.95
8243	2.25
8250A	6.49
8250B (For IBM)	6.95
8251A	1.89
8253-5	1.95
8254	4.95
8255A-5	1.89
8257-5	1.95
8259-5	2.25
8272	4.95
8279-5	2.95
8741	9.95
8742	29.95
8748 (25V)	7.95
8748H (HMOS 21V)	9.95
8749	9.95
8751	39.95
8755	14.95

DATA ACQUISITION

ADC0804LCN	3.19
ADC0808CCN	5.95
ADC0809CCN	3.95
ADC0816CCN	11.95
ADC1205CCJ-1	19.95
DAC0808LCN	1.95
DAC1008LCN	4.95
AY-3-1015D	4.95
AY-5-1013A	2.95

MICROPROCESSOR SALE!

Part No.		Price
8052AHBASIC	CPU w/BASIC Interpreter.	$ 29.95
MC68008L8	32-Bit MPU (8-Bit Data Bus).	$ 19.95
MC68701	8-Bit EPROM Microcomputer	$ 14.95
MC68705P3S	8-Bit EPROM Microcomputer	$ 14.95
MC68705U3L	8-Bit EPROM Microcomputer	$ 10.95
80286-10	16-Bit Hi Performance MPU.	$ 99.95
80287-8	Math Co-processor (8MHz).	$299.95
80287-10	Math Co-processor (10MHz).	$329.95
80387-16	Math Co-processor (16MHz) GRID ARRAY	$494.95

DYNAMIC RAMS

Part No.			Price
4116-15	16,384 x 1	(150ns)	.89
4128-20	131,072 x 1	(200ns) (Piggyback)	3.25
4164-120	65,536 x 1	(120ns)	1.75
4164-150	65,536 x 1	(150ns)	1.25
4164-200	65,536 x 1	(200ns)	.99
TMS4416-12	16,384 x 4	(120ns)	3.49
8118	16,384 x 1	(120ns)	.49
41256-100	262,144 x 1	(100ns)	4.95
41256-120	262,144 x 1	(120ns)	3.95
41256-150	262,144 x 1	(150ns)	3.25
50464-15	65,536 x 4	(150ns) (4464)	4.95
511000P-10	1,048,576 x 1	(100ns) 1 Meg.	34.95
514256P-10	262,144 x 4	(100ns) 1 Meg.	29.95

STATIC RAMS

2016-12	2048 x 8	(120ns)	1.69
2018-45	2048 x 8	(45ns)	8.95
2102-2L	1024 x 1	(250ns) Low Power	1.95
2114N	1024 x 4	(450ns)	.99
2114N-2L	1024 x 4	(200ns) Low Power	1.49
21C14	1024 x 4	(200ns) (CMOS)	.49
2149	1024 x 4	(45ns)	2.49
5101	256 x 4	(450ns) CMOS	1.95
6116P-3	2048 x 8	(150ns) CMOS	1.89
6116LP-3	2048 x 8	(150ns) LP CMOS	1.95
6264LP-12	8192 x 8	(120ns) LP CMOS	4.25
6264P-15	8192 x 8	(150ns) CMOS	3.49
6264LP-15	8192 x 8	(150ns) LP CMOS	3.75
6514	1024 x 4	(350ns) CMOS	3.49
43256-15L	32,768 x 8	(150ns) Low Power	11.95

EPROMS

TMS2516	2048 x 8	(450ns) 25V	6.95
TMS2532	4096 x 8	(450ns) 25V	6.95
TMS2532A	4096 x 8	(450ns) 21V	5.95
TMS2564	8192 x 8	(450ns) 25V	9.95
TMS2716	2048 x 8	(450ns) 3 Voltage	9.95
1702A	256 x 8	(1μs)	6.95
2708	1024 x 8	(450ns)	4.95
2716	2048 x 8	(450ns) 25V	3.75
2716-1	2048 x 8	(350ns) 25V	4.25
27C16	2048 x 8	(450ns) 25V (CMOS)	5.49
2732	4096 x 8	(450ns) 25V	3.95
2732A-20	4096 x 8	(200ns) 21V	4.25
2732A-25	4096 x 8	(250ns) 21V	3.95
27C32	4096 x 8	(450ns) 25V (CMOS)	5.95
2764-20	8192 x 8	(200ns) 21V	4.25
2764-25	8192 x 8	(250ns) 21V	3.75
2764A-25	8192 x 8	(250ns) 12.5V	3.95
2764-45	8192 x 8	(450ns) 21V	2.95
27C64-15	8192 x 8	(150ns) 21V (CMOS)	6.49
27128-20	16,384 x 8	(200ns) 21V	6.95
27128-25	16,384 x 8	(250ns) 21V	5.95
27128A-25	16,384 x 8	(250ns) 12.5V	5.25
27C128-25	16,384 x 8	(250ns) 21V (CMOS)	6.95
27256-20	32,768 x 8	(200ns) 12.5V	6.95
27256-25	32,768 x 8	(250ns) 12.5V	5.95
27C256-25	32,768 x 8	(250ns) 12.5V (CMOS)	7.95
27512-20	65,536 x 8	(200ns) 12.5V	13.49
27512-25	65,536 x 8	(250ns) 12.5V	11.95
68764	8192 x 8	(450ns) 25V	13.95

EEPROMS

2816A	2048 x 8	(350ns) 5V Read/Write	5.95
2817A	2048 x 8	(350ns) 5V Read/Write	7.95
2865A	8192 x 8	(250ns) 5V Read/Write	9.95
52B13 (21V)	2048 x 8	(350ns) 5V Read Only	1.49

COMMODORE CHIPS

Part No.	Price
LAG570	10.95
WD1770	11.95
SI3052P	2.49
6502	2.65
6504A	1.95
6507	4.39
6510	9.95
6520	1.95
6522	3.95
6525	4.95
6526	14.95
6529	2.95
6532	6.49
6545-1	4.95
6551	4.49
6560	10.95
6567	14.95
6569	24.95
6572	8.95
6581 (12V)	14.95
6582 (9V)	14.95
8360	14.95
8501	10.95
8502	7.95
8563	15.95
8564	9.95
8566	24.95
8701	9.95
8721	14.95
8722	9.95
*251104-04	10.95
310654-05	9.95
318018-03	10.95
318019-03	10.95
318020-04	10.95
325302-01	10.95
325572-01	14.95
*82S100PLA**	15.95
901225-01	11.95
901226-01	11.95
901227-03	11.95
901229-05	11.95

*No specs. available

**Note: 82S100PLA U17 (C-64)

SATELLITE TV DESCRAMBLER CHIP

The MM5321 is a TV camera sync generator designed to supply the basic sync functions for either color or monochrome 525 line/60Hz interlaced and camera video recorder applications. **COLOR BURST GATE & SYNC ALLOW STABLE COLOR OPERATION**

MM5321N. $11.95

INTERSIL Also Available!

74HC HI-SPEED CMOS

Part No.	Price	Part No.	Price
74HC00	.25	74HC175	.69
74HC02	.25	74HC221	1.19
74HC04	.29	74HC240	.99
74HC08	.29	74HC244	.99
74HC10	.29	74HC245	.99
74HC14	.49	74HC253	.59
74HC30	.29	74HC259	.89
74HC32	.29	74HC273	.99
74HC74	.39	74HC373	.99
74HC75	.39	74HC374	.99
74HC76	.45	74HC595	1.29
74HC85	.79	74HC688	.99
74HC86	.39	74HC943	8.95
74HC123	.69	74HC4040	.99
74HC125	.49	74HC4049	.59
74HC132	.60	74HC4050	.59
74HC138	.49	74HC4060	.99
74HC139	.49	74HC4511	1.29
74HC154	1.49	74HC4514	1.79
74HC160	.65	74HC4538	.89
74HC174	.69	74HC4543	1.19

74HCT — CMOS TTL

74HCT00	.29	74HCT139	.59
74HCT02	.29	74HCT157	.69
74HCT04	.29	74HCT174	.69
74HCT08	.29	74HCT175	.69
74HCT10	.29	74HCT240	.99
74HCT32	.29	74HCT244	.99
74HCT74	.49	74HCT245	1.19
74HCT86	.49	74HCT373	1.19
74HCT138	.59	74HCT374	1.19

74C—CMOS

74C00	.29	74C174	.79
74C02	.29	74C175	.79
74C04	.29	74C221	1.79
74C08	.35	74C240	1.79
74C10	.35	74C244	1.79
74C14	.59	74C373	1.95
74C32	.35	74C374	1.95
74C74	.59	74C912	8.95
74C85	1.49	74C915	1.39
74C86	.35	74C920	6.95
74C89	5.40	74C921	6.95
74C90	.99	74C922	3.95
74C154	2.95	74C923	3.95
74C173	1.05	74C925	5.95

LINEAR

DS0026CN	1.95	LM1458N	.39
TL074CN	1.10	LM1488N	.49
TL084CN	.99	DS14C88N (CMOS)	1.19
AF100-1CN	6.95	LM1489N	.49
LM307N	.45	DS14C89N (CMOS)	1.19
LM309K	1.25	LM1496N	.89
LM311N	.45	MC1648P	3.49
LM317T	.79	LM1871N	1.95
LM318N	.99	LM1872N	1.95
LM319N	1.29	LM1896N-1	1.49
LM323K	3.95	ULN2003A	.79
LM324N	.39	XR2206	3.95
LM338K	4.95	XR2211	2.95
LM339N	.39	XR2243	1.95
LF347N	1.79	26LS29	3.95
LM348N	.69	26LS31	1.19
LM350T	2.95	26LS32	1.19
LF351N	.39	26LS33	1.49
LF353N	.49	LM2901N	.39
LF355N	.79	LM2907N	1.29
LF356N	.89	LM2917N (8 pin)	1.95
LF357N	1.09	MC3419CL	6.95
LM358N	.49	MC3446N	1.69
LM360N	2.19	MC3450P	1.95
LM361N	1.79	MC3470P	1.95
LM380N-8	.99	MC3471P	1.95
LM386N-3	.89	MC3479P	4.79
LM387N	.99	MC3486P	1.69
LM393N	.39	MC3487P	1.69
LM399H	2.95	LM3900N	.49
LF411CN	.79	LM3905N	1.19
TL497ACN	1.49	LM3909N	.99
NE540H (C540H)	2.95	LM3914N	1.95
NE555V	.29	LM3916N	1.95
XRL555	.59	NE5532	.69
LM556N	.49	NE5534	.69
NE558N	.89	7805K (LM340K-5)	1.29
LM565N	.99	7812K (LM340K-12)	1.29
LM567V	.79	7815K (LM340K-15)	1.29
NE592N	.89	7805T (LM340T-5)	.49
LM741CN	.29	7812T (LM340T-12)	.49
LM747CN	.59	7815T (LM340T-15)	.49
MC1350P	1.09	7905K (LM320K-5)	1.35
MC1372P	1.95	7905T (LM320T-5)	.59
MC1377P	2.29	75472	.59
MC1398P	8.95	75477	.89
LM1414N	1.29	MC145106P	3.25
		MC145406P	2.95

IC SOCKETS

Low Profile		Wire Wrap (Gold) Level #3	
8LP	.11	8WW	.59
14LP	.12	14WW	.65
16LP	.13	16WW	.69
24LP	.25	24WW	1.19
28LP	.27	28WW	1.39
40LP	.29	40WW	1.89

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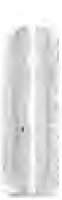
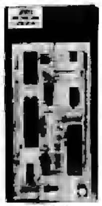
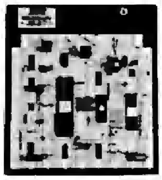
Jameco Solderless Breadboard Sockets

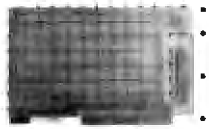

JE23


JE24


JE27

Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price
JE20	6½ x ¾	200	0	$ 2.29
JE21	3¼ x 2⅛	400	0	$ 4.49
JE22	6½ x 1⅜	630	0	$ 5.95
JE23	6½ x 2⅛	830	0	$ 7.49
JE24	6½ x 3⅛	1,360	2	$14.95
JE25	6½ x 4¼	1,660	3	$22.95
JE26	6⅞ x 5¾	2,390	4	$27.95
JE27	7¼ x 7½	3,220	4	$37.95

Jameco General Purpose Prototype PC Boards


JE417 (Pictured)

- Wire Wrap
- Component Testing
- Point-to-Point Wiring
- 31/62 Connection

JE415 (6½", No Pads, PC/XT)	$14.95
JE417 (6½", Plated w/Pads, PC/XT)	$19.95

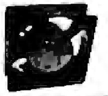
Extender Board

JE421 (4¾ Extender, 31/62 Connector)	$19.95

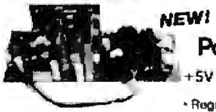
DATA BOOKS

30003	National Linear Data Book (82)	$19.95
30005	Logic Data Book - Vol II (84)	$19.95
30009	Intersil Data Book (87)	$14.95
21398	CMOS Cookbook (86)	$14.95
210830	Intel Memory Handbook (87)	$17.95
230843	Intel Microsystem Hndbk. Set (87)	$24.95

MUFFIN/SPRITE-STYLE FANS



TA450S Torin Industries (4 68 sq., 50 cfm)	$11.95
SU2A1 EG&G Rotron (3 125" square, 34 cfm)	$11.95



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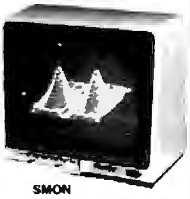
Jameco Computer Power Protection


JE1190

JE1190	Power Base	$29.95
JE1191	6-Outlet Power Strip	$11.95
JE1192	300 Watt Back-Up	$299.95
JE1193	500 Watt Back-Up	$399.95

IBM AND APPLE COMPATIBLE DISPLAY MONITORS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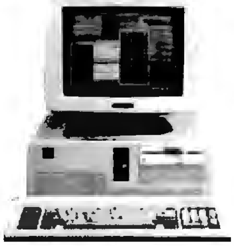

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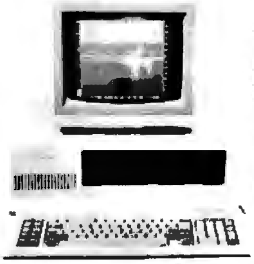

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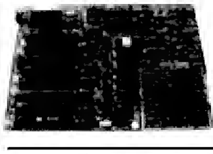

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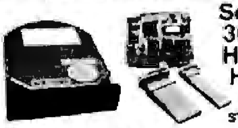

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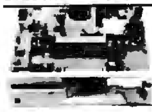

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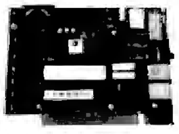

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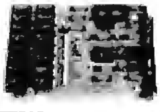

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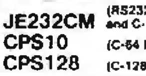

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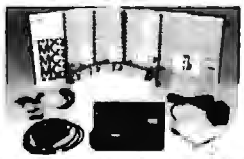

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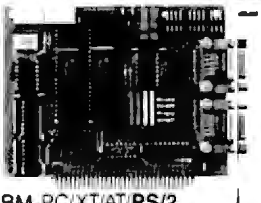

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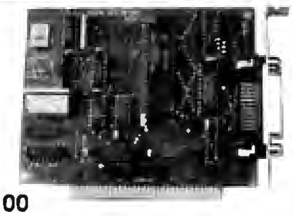

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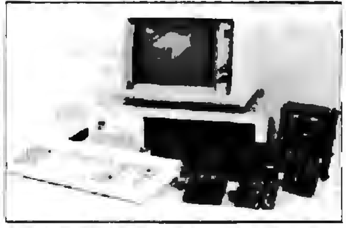

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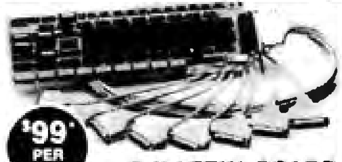

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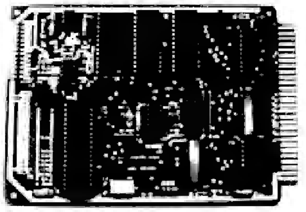
ForthCard

ON THE STD-BUS



as Low as $179

The ForthCard provides the ability to develop Forth code using a single board including **on-card EEPROM programming.** Operating as a **stand alone computer** or as an STD bus CPU this card is perfect for projects that require a simple dedicated SBC while allowing for memory and I/O expansion. Forth programs can be entered directly [illegible] or downloaded from your PC's serial port, blown into [illegible] the RAM or [illegible] ROM and auto executed on power up.

The evaluation unit is available [illegible] as little as **$299. OEM** versions of the card may be purchased for **$179** each [illegible] 10).

The **ForthBox** is a complete [illegible] the [illegible] card cage Cabinet and Power Supply.

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VISA

Circle 114 on Reader Service Card

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The PROBLEM	The SOLUTION
Your free backup utility is slow, difficult to use, and can only restore files to ready-made directories	CLIP keeps a log of its backups, so you can afford to be selective. It maintains a menu of your customized commands, so you do not have to stop and think. It is fast, and it compresses data
It does not record its progress—so you backup everything to be safe	
Or nothing because it's such a bore.	Result—fewer disks, less time, less effort, no worry, greater security

• Unique high-speed data compression • Several ways to select backup files • Save to any media or to a network • Menu or command-line driven • Instant menu editing + help • PS/2, PC, XT, AT or Compatibles •

Keele Codes have five years specialist experience in backup. Purchasers of 1000+ CLIP units include major internationals Philips and British Telecom.

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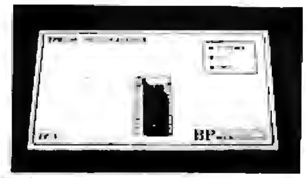
University of Keele, Newcastle, Staffordshire ST5 5BG, U.K.

Tel: 011-44782-629221 (FAX -613847) Telex: 36113 UNKLIB G

Circle 137 on Reader Service Card

EPROM PROGRAMMER
$349



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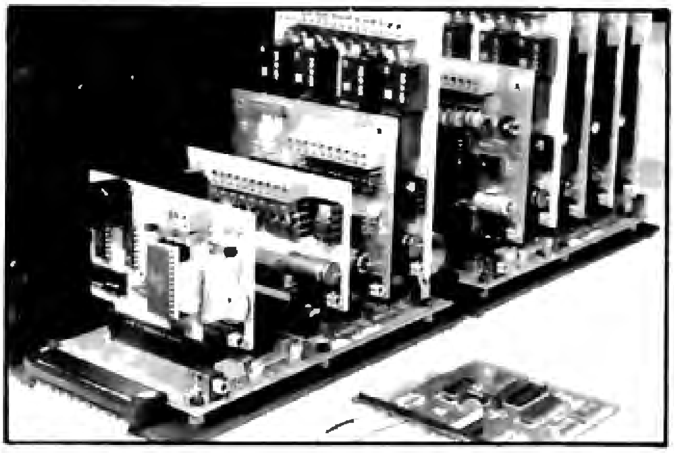
Circle 155 on Reader Service Card

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**

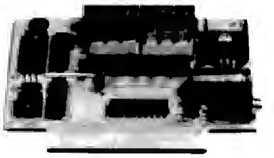
Powerful clock/calendar with: battery backup for Time, Date and Alarm setting (time and date); built in alarm relay, led and buzzer; timing to 1/100 second. Easy to use decimal format. Lithium battery included.

Touch Tone® Decoder **PH-145: $79**

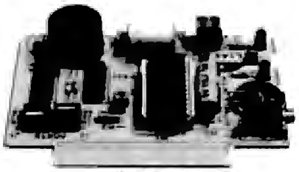
Each tone is converted into a number which is stored on the board. Simply read the number with INP or POKE Use for remote control projects, etc.

A-BUS Prototyping Card **PR-152: $15**

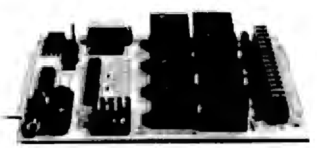
3½ by 4½ in. with power and ground bus. Fits up to 10 I.C.s



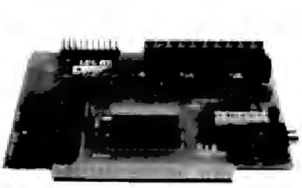
ST-143



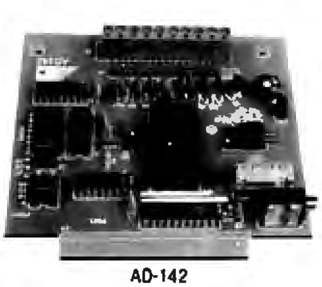
CL-144



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.

Current Developments

Intelligent Voice Synthesizer, 14 Bit Analog to Digital converter, 4 Channel Digital to Analog converter, Counter Timer, Voice Recognition.

A-BUS Adapters for:

IBM PC, XT, AT and compatibles Uses one short slot	AR-133 .$69
Tandy 1000, 1000 EX & SX, 1200, 3000. Uses one short slot	AR-133...$69
Apple II, II+, IIe Uses any slot	AR-134...$49
TRS-80 Model 102, 200 Plugs into 40 pin "system bus"	AR-136 $69
Model 100. Uses 40 pin socket (Socket is duplicated on adapter)	AR-135. .$69
TRS-80 Mod 3,4,4 D. Fits 50 pin bus. (With hard disk use Y-cable)	AR-132...$49
TRS-80 Model 4 P. Includes extra cable. (50 pin bus is recessed)	AR-137...$62
TRS-80 Model I. Plugs into 40 pin I/O bus on KB or E/I	AR-131. $39
Color Computers (Tandy). Fits ROM slot Multipak or Y-cable	AR-138. .$49

A-BUS Cable (3 ft, 50 cond.) **CA-163: $24**

Connects the A-BUS adapter to one A-BUS card or to first Motherboard

Special cable for two A-BUS cards: **CA-162: $34**

A-BUS Motherboard **MB-120: $99**

Each Motherboard holds five A-BUS cards. A sixth connector allows a second Motherboard to be added to the first (with connecting cable CA-161: $12). Up to five Motherboards can be joined this way to a single A-BUS adapter. Sturdy aluminum frame and card guides included

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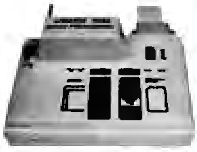
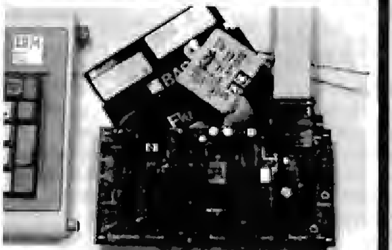
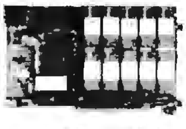
All lines open weekdays 9 to 5 Eastern time

Circle 10 on Reader Service Card




EMULATOR



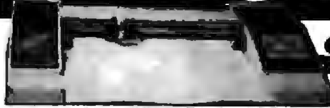



Presto!
A Link to Mainframe Graphics


PC E-Z-READER

California Digital

17700 Figueroa Street ● Carson, California 90248



$129

PLOTTERS

The Sweet "P" 100 was private labeled for the Epson corporation under the Comrex Brand. This plotter makes short work of translating financial and numeric data into a graphic presentation. Many ready to run programs such as Auto/CAD and Lotus 1-2-3 already support this plotter.

The Sweet "P" 100 features programmable paper sizes up to 8½ by 120 inches, 6 inch per second plot speed and 0.004" step size. Easy to implement Centronics interface allows the Sweet "P" 100 immediate use with the printer port of most personal computers.

This is your opportunity to purchase a plotter which was originally priced at $795 for only $129

Also available is a support package which includes demonstration software, interface cable, a multicolor pen assortment and a variety of paper

HPGL ● 11" by 17"

$795

Western Graphtec Model 2000 operates under the Hewlett Packard graphic language and has both parallel and serial interface. Size "B" plotter, 11" by 17" flat bed with eight self capping color pens. Maximum plotting speed 10" per second, resolution .05mm with repeatability of .004"

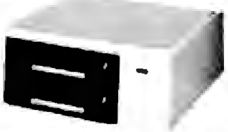
To blow out the remaining inventory, California Digital has slashed the price of MP/2000 to $795. Hurry! only 180 plotters left

PLOTTERS	
Sweet "P" 100 (Comrex) 8½ by 120"	$129
Houston Instruments DMP29 11 by 17	
Houston Instruments DMP42, 11 by 17 8 color	[illegible]
Houston Instruments DMP41, 42 C/D 24 by 36	
Houston Inst. DMP51/52MP C/D, 14 pen	
Houston Instruments DMP56, 8 color 34 by 44	4795
Houston Instr. PC695, 11 by 17 multi-pen	379
Roland DXY 880 11 by 17 multi-pen 8 color	[illegible]
CalComp 1043GT plotter	[illegible]
DIGITIZERS & MOUSE	
Hitachi Tiger Tablet 11 by 11"	[illegible]
Summagraphics Summasketch 12" 4 button	[illegible]
Summagraphics SummaMouse 100 line	[illegible]
Microsoft serial mouse with paint brush	[illegible]
Microsoft bus mouse card w/paint brush	[illegible]

20/20 Bernoulli Box

~~$3495~~

$1595



California Digital has purchased these 20/20 Bernoulli systems from Iomega. The units needed some minor alignment and had to be sent back to Iomega. These have to sold as as reconditioned, but for all practical purpose they are new and come with a **one year Iomega factory warranty.**

The 20/20 Bernoulli Box features removable cartridges and delivers reliability, expandability, transportability, security and speed in one versatile subsystem. It lets you transfer megabytes of information safely and swiftly for primary or backup storage. Or combine several software programs onto a single cartridge for easy switching from one to another

Reliable... the Box has incredible resistance to shock and vibration completely eliminating the possibility of head crash

security essential? Don't lock up your system... just lock up the cartridges.

20 + 20 Subsystem.. $1595; Non bootable controller .. $159;
Bootable controller... $189; 20 Megabyte Cartridges...

$35

We have them again.. The Remex 480 was a sell out two years ago but we located an additional 10,000 units and are offering these 2/3 height IBM/PC compatible 360K/Byte drives at only $35 each at quanity two

	One	Two	Ten
REMEX 480 ⅔ height for PC	39	35	29
TANDON 65L/2 360K, ½ ht.	79	75	72
TANDON 101/4 full ht. 96 TPI.	119	109	99
FUJITSU 5¼" half height	95	89	82
MITSUBISHI new 501 half ht.	119	109	105
MITSUBISHI 504A AT comp.	149	139	135
TEAC FD55BV half height	109	99	89
TEAC FD55FV 96 TPI, half ht.	119	109	105
TEAC FD55GF for IBM AT	149	139	135
PANASONIC 455 Half Height	109	99	89
PANASONIC 475 1.2 Meg./96	119	115	109
Switching power supply			49
Dual enclosure for 5¼" drives			59
3½" DISK DRIVES			
SONY MP-53W 720K/Byte	139	129	123
SONY MP-73W, 2 Meg.	179	169	call
TEAC 35F 720 K/Byte	129	119	115
TEAC 35X, 2 Meg.	call	—	—
5¼" form factor kit	—	—	20

$2495

$759

80 Character Daisy Wheel Printer

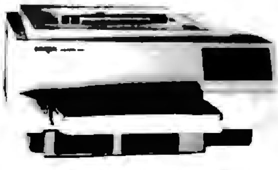
These Fujitsu Daisy Max 830 were manufactured for Motorola's Computer Division. The purchase order was canceled and Fujitsu was forced to liquidate these 80 character per second daisy wheel printers at "fire sale" prices

Features bullet proof construction, your choice of either Centronics parallel or RS-232 serial interface. Diablo 630 wheels and commands, programmable line spacing in increments of 1/96" and column spacing of 1/120". The printer is also capable of underscoring, bold overprint, shadow print, centers and justifies along with vector plotting.

Factory suggested price of the Daisy Max 830 was $2495. California Digital is offering this liquidated special at only $759. Tractor and sheet feeders available

PRINTERS

IBM Thermal printer, 80 col., serial	539
Fujitsu D830 80 cps., daisy wheel	759
Silver Reed EXP-800 136 col., 40 cps.	729
Juki 6300 daisy wheel 40 cps.	819
NEC 8850 Spinwriter daisy wheel 55 cps	1150
NEC P6/660P 10" 216 cps. NLQ	469
NEC P7/760P 15" 216 cps. NLQ	650
Olympia NP80, 200 cps draft, 40 nlq	329
Olympia NP136, 15" same as above	459
Epson FX86E NLQ 10" 240 char/sec	399
Epson FX286E NLQ 15" 240 char/sec	539
Epson EX1000 300 cps. NLQ/54 cps	589
Citizen MSP 10 160 cps. 10	299
Citizen MSP 15 160 cps. 15	449
Okidata 182 80 column, par'l	239
Okidata 192+ 136 column, par'l	345
Okidata292 136 column, parallel	489
Panasonic P1080/I 10" 120 cps	229
Panasonic P1091/I, 10" 160 cps	299
Panasonic P1592 15" 180 cps	429
Star Gemini NX10, 120 cps 10" NLQ	239
Star Gemini NX15 120 cps 15" NLQ	359
Toshiba 321, 24 wire head 216 cps, NLQ	519
Toshiba 341, 24 wire head 216 cps 15"	629
Printronics P300 dot matrix, 300 LPM	3995
Printronics P600 dot matrix, 600 LPM	5795
LASER PRINTERS	
Apple Laser Writer Plus Postscript	4295
QMS PS/800 2 meg Postscript 8 pgs	4295
Hewlett Packard Series II, laser printer	1795
Texas Instr. OmniLaser 2108 P/S 8 pgs	4295
Texas Inst. OmniLaser 2115 P/S 15 pgs	5695
Quadram Quad/Laser 5 Megabytes	2995



HEWLETT PACKARD

LASER JET II

$1795

Standard features of the new Hewlett Packard Series II Laser printer. 512 K byte memory expandable to 4 Megabytes, both serial and parallel ports. List price $2495 California Digital price $1795. Memory upgrade, type fonts and toner cartridges available

Other Laser Printers available

Texas Instruments ● Okidata ● Apple ● Ricoh
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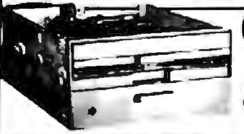

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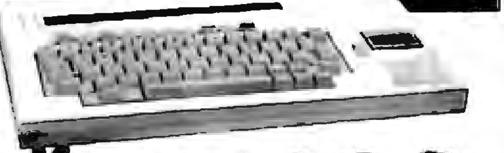


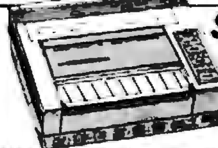
Xerox Laptop

$189

The Xerox Sunrise 1810/1815 is by far the best value we have ever seen in a laptop computer. This is the ideal computer for students, journalists or anyone who has to capture data away from their desk. The Sunrise is a self contained battery and AC portable. The Xerox Sunrise was originally prices at $2995. Xerox has since elected to drop the computer from their product line. California Digital has purchased all the remaining inventory and is making the unit available at a fraction of its original cost

This laptop features a built in three line 80 column liquid crystal display, 64K of memory along with both RF monitor and television outputs. The internal 300 baud Bell 103 full duplex and 1200 baud Bell 202A half duplex modem is capable of auto dialing. The units has both centronics parallel and a serial port programmable to 19,200 baud. Self contained micro cassette is capable of capturing data from the keyboard as well as doubling as a audio recorder for dictating messages.

An optional dual floppy disk drive module, pictured above, is available for only $159. Also available, for $59 is an 80 column printer that mounts in the drive module. The Sunrise features a CP/M operating system which allows the operator to use any CP/M program in Xerox 5¼" disk format and over 5000 CP/M programs available in public domain. While files from the Sunrise may be transfered to IBM/PC type computers, the 1810/1815 is **NOT** compatible with the IBM/PC computer



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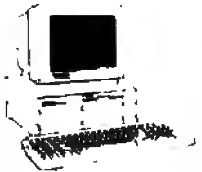

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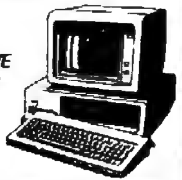

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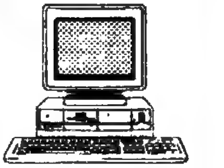

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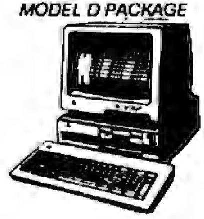

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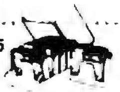

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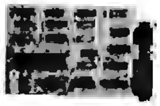

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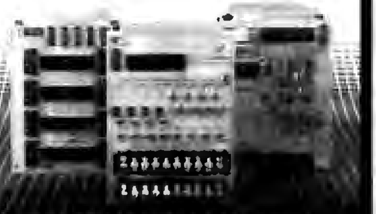
Circle 302 on Reader Service Card

6800/6809
Micro Modules



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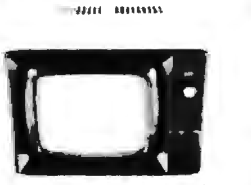

12 VDC Power regulated Mounted in plastic cabinet, w/brightness control knob
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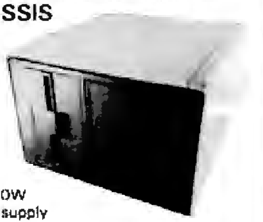

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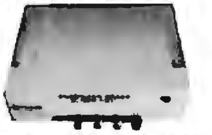

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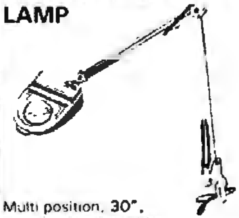

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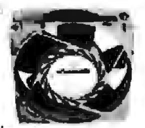

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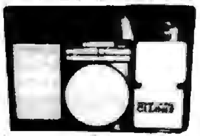

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IBM® AT Compatible)
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Double side, high density; 160 tracks. Mfr Panasonic #JU-475
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96TPI, (DOS 3.2 Compat.
Double side, quad density.
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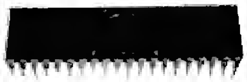
MICROCOMPUTERS with EPROM

MC68701



The **MC68701** is an 8-bit single chip microcomputer unit that enhances the capabilities of the M6800 family TTL compatible, requires one +5V power supply for nonprog operation Includes 2048 bytes of eprom, 128 bytes of RAM, serial comm interface (SCI), parallel I/O, and a 3 function programmable timer Item #9496
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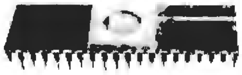
MC68705



MC68705 HMOS, 8-bit, medium performance microcomputer On-chip resources 3776 bytes Eprom, 112 bytes RAM 8 inputs & 24 programmable bidirectional outputs Self programming boot strap
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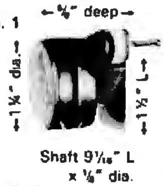
Fig. 1



Shaft 9⁷⁄₁₆" L x ⅛" dia.

Fig. 2

Shaft 1⅛" L x ⅜" dia.

Item No.	Step Angle	Volts DC	Stall Torque oz/in	Type	Mfr. & Part No.	Fig	Price
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				2 0	MO61-FF-6201B		2/$37.50
7630	1.8	3.0	200	PM	Superior Electric	2	$34.50 ea
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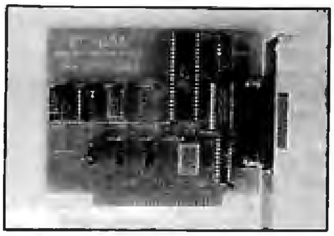

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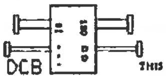

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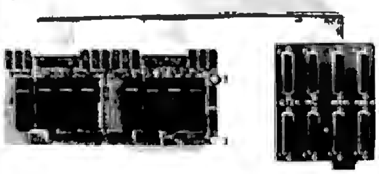

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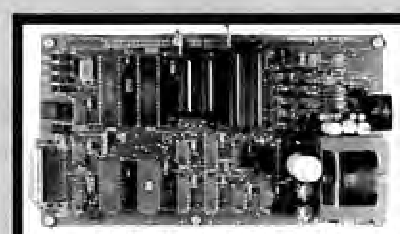

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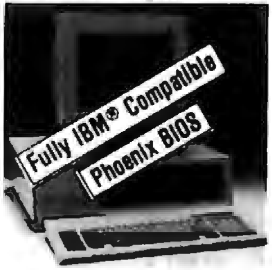

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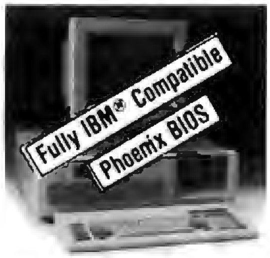

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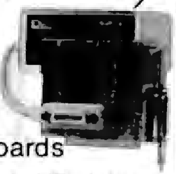

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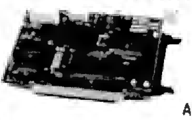

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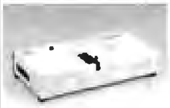

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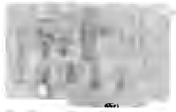

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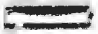

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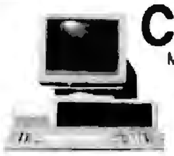

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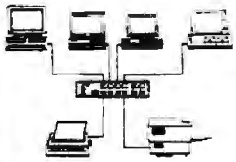

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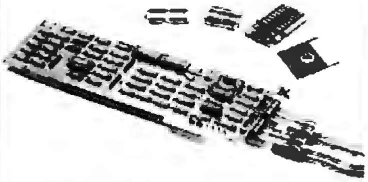

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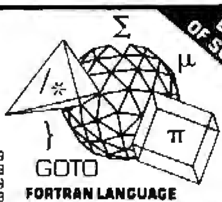

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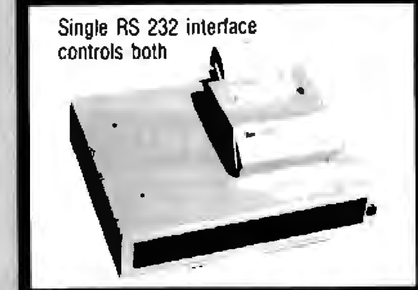

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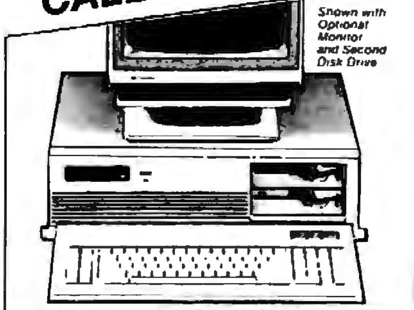

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74LS01	.18	74LS122	45	74LS242	.69
74LS02	.17	74LS123	.49	74LS243	.69
74LS03	.18	74LS124	2.75	74LS244	.69
74LS04	.16	74LS125	39	74LS245	.79
74LS05	.18	74LS126	.39	74LS251	.49
74LS08	.18	74LS132	39	74LS253	.49
74LS09	.18	74LS133	49	74LS257	.39
74LS10	.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
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74LS33	.28	74LS160	.29	74LS365	39
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74LS42	.39	74LS163	.39	74LS373	.79
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7404	.19
7406	.29
7407	.29
7408	.24
7410	.19
7411	.25
7414	.49
7416	.25
7417	.25
7420	.19
7430	.19
7432	29
7438	.29
7442	.49
7445	.69
7447	.89
7473	.34
7474	.33
7475	.45
7476	.35
7483	.50
7485	59
7486	.35
7489	2.15
7490	.39
7493	.35
74121	.29
74123	.49
74125	.45
74150	1.35
74151	.55
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74157	.55
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74F138	.79
74F139	.79
74F253	.89
74F157	.89
74F240	1.29
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74S02	.29
74S04	.29
74S08	.35
74S10	.29
74S32	.35
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4011	.19	4069	.19	74HC157	.55
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4013	.35	4081	.22	74HC245	.85
4015	.29	4093	.49	74HC273	.69
4016	.29	14411	9.95	74HC373	.69
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4018	.69	14497	6.95	74HCT00	.25
4020	.59	4503	.49	74HCT02	.25
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22	50V	.05	.005	50V	.05
33	50V	.05	.01	50V	.07
47	50V	.05	.05	50V	.07
100	50V	.05	.1	12V	.10
220	50V	.05	.1	50V	.12

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.01µf	50V	.14	1µf	50V	.18
.047µf	50V	.15	47µf	50V	25

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RADIAL			AXIAL		
1µf	25V	.14	1µf	50V	.14
4.7	50V	.11	10	50V	.16
10	50V	.11	22	16V	.14
47	35V	.13	47	50V	.19
100	16V	.15	100	35V	.19
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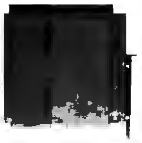

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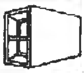

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PE-140	NO	9	8,000	$89
PE-140T	YES	9	8,000	$139
PE-240T	YES	12	9,600	$189

SWITCHES

SPDT	MINI-TOGGLE ON-ON	1.25
DPDT	MINI-TOGGLE ON-ON	1.50
DPDT	MINI-TOGGLE ON OFF-ON	1.75
SPST	MINI-PUSHBUTTON N.O	.39

DIP SWITCHES

4 position	.85	7 position	.95
5 position	.90	8 position	.95
6 position	.90	10 position	1.29

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	—	—
	GREY	HOODxx	.39	.39	---	.39	.69	.75

ORDERING INSTRUCTIONS:
INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED EXAMPLE A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR

MOUNTING HARDWARE 59¢

LIGHT EMITTING DIODES

LED DISPLAYS

FND-357(359)	COM CATHODE	.362"	1.25
FND-500(503)	COM CATHODE	.5"	1.49
FND-507(510)	COM ANODE	.5"	1.49
MAN-72	COM ANODE	.3"	.99
MAN-74	COM CATHODE	.3"	.99
TIL-313	COM CATHODE	.3"	.45
TIL-311	4x7 HEX W/LOGIC	.270"	10.95

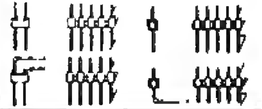
DIFFUSED LEDs

		1-99	100-UP
JUMBO RED	T1¾	.10	.09
JUMBO GREEN	T1¾	.14	.12
JUMBO YELLOW	T1¾	.14	.12
MOUNTING HDW	T1¾	.10	.09
MINI RED	T1	.10	.09

"SNAPABLE" HEADERS

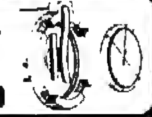
CAN BE SNAPPED APART TO MAKE ANY SIZE HEADER. ALL WITH .1" CENTERS

1x40	STRAIGHT LEAD	.99
1x40	RIGHT ANGLE LEAD	1.49
2x40	2 STRAIGHT LEADS	2.49
2x40	2 RIGHT ANGLE LEADS	2.99



3 VOLT LITHIUM BATTERY $1.95

HOLDER $1.49



25 PIN D-SUB GENDER CHANGERS $7.95

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	.16	.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	2.60	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

> I would like you to know that I think you have a special employee in Helen M ... giving the usual courteous and competent service that I have come to expect from JDR. Keep up the good work.
>
> John Medcalf

EMI FILTER $4.95

LINE CORDS

2 conductor 39¢ 3 conductor 99¢
3 conductor w/female socket $1.49

CALL FOR VOLUME QUOTES

Circle 131 on Reader Service Card

64K DRAM 4164 150ns \$1^{29} 256K DRAM 41256 150ns \$2^{95}

MONITOR STANDS

MODEL MS-100 $12.95

- TILTS & SWIVELS
- STURDY PLASTIC CONSTRUCTION

MODEL MS-200 $39.95

- TILTS AND SWIVELS
- BUILT-IN SURGE SUPRESSOR
- BUILT-IN POWER STATION INDEPENDENTLY CONTROLS UP TO 5 120 VOLT AC OUTLETS
- UL APPROVED

NASHUA DISKETTES

BOXES OF 10

5¼"	DS/DD 360K	\$8^{95}
5¼"	DS HD 1.2M	\$24^{95}
3½"	DS/QD 720K	\$18^{95}

5¼" DS/DD SOFT SECTOR

49¢ea BULK QTY 50 **39¢ea** BULK QTY 250

5¼" DISKETTE STORAGE FILE $8.95

- HOLDS 70 5¼" FLOPPIES
- STURDY, ATTRACTIVE SMOKED ACRYLIC CASE
- COMPLETE WITH HINGED DIVIDERS

VERSION FOR 3½" FLOPPIES AVAILABLE
$9.95

2 WAY SWITCH BOXES $39.95

- CONNECT 2 PRINTERS TO 1 COMPUTER OR VICE VERSA
- SERIAL & PARALLEL MODELS AVAILABLE
- ALL LINES SWITCHED
- GOLD PLATED CONNECTORS & QUALITY SWITCHES

6' INTERFACE CABLES

MEETS FCC REQUIREMENTS 100% SHIELDED

IBM COMPATIBLE PARALLEL PRINTER	$9.95
CENTRONICS (MALE TO FEMALE)	$15.95
CENTRONICS (MALE TO MALE)	$14.95
IBM COMPATIBLE MODEM CABLE	$7.95
RS232 SERIAL (MALE TO FEMALE)	$9.95
RS232 SERIAL (MALE TO MALE)	$9.95
COILED KEYBOARD EXTENDER	$7.95

JOYSTICK \$19^{95}

- SET X-Y AXIS FOR AUTO CENTER OR FREE MOVEMENT
- FIRE BUTTON FOR USE WITH GAME SOFTWARE
- INCLUDES ADAPTOR CABLE FOR IBM

SWITCHING POWER SUPPLIES

PS-135 $59.95

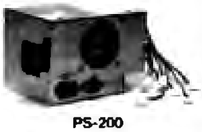
- FOR IBM XT COMPATIBLE
- UL APP., 135 WATTS
- +5V 15A, +12V 4.2A
  -5V .5A, -12V .5A
- ONE YEAR WARRANTY

PS-150 *150W MODEL* \$69^{95}

PS-135/150

PS-200 $89.95

- FOR IBM AT COMPATIBLE
- 200 WATTS
- +5V 22A, +12V 8A
  -5V .5A, -12V .5A
- ONE YEAR WARRANTY



PS-200

PS-A $49.95

- FOR APPLE TYPE SYSTEM
- +5V 6A, +12V 3A
  -5V 1A, -12V 1A
- APPLE CONNECTOR

PS-1558 $34.95

- 75 WATTS, UL APPROVED
- BY POWER SYSTEMS
- +5V, 7A, +12V 3A
  -12V/250mA, -5/300mA

PS-1558

MONITORS

SAMSUNG MONOCHROME

- IBM COMPATIBLE TTL INPUT
- 12" NON-GLARE, LOW DISTORTION, AMBER SCREEN
- RES: 720 x 350
- SWIVEL BASE
- 1 YEAR WARRANTY

$129.95

MULTISYNC *BY NEC* **$549.95**

- ORIGINAL CGA/EGA PGA COMPATIBLE MONITOR
- AUTO FREQUENCY ADJUSTMENT
- RESOLUTION AS HIGH AS 800 x 560

EGA *BY CASPER* **$399.95**

- 15.75/21.85 KHz SCANNING FREQUENCIES
- RES: 640 x 200/350
- .31mm DOT PITCH
- 14" BLACK MATRIX SCREEN
- 16 COLORS FROM 64

RGB *BY CASPER* **$279.95**

- COLOR/GREEN/AMBER SWITCH
- RES: 640 x 240
- RGB/IBM COMPATIBLE
- 14" NON-GLARE SCREEN
- .39mm DOT PITCH
- CABLE FOR IBM PC INCLUDED

MONOCHROME *BY HYUNDAI* **$69.95**

- IBM COMPATIBLE TTL INPUT
- 12" NON-GLARE AMBER SCREEN
- ATTRACTIVE CASING WITH A TILT/SWIVEL BASE

TOLL FREE
800-538-5000
U.S. AND CANADA

20MB HARD DISK ON A CARD

- SAVES SPACE AND REDUCES POWER CONSUMPTION
- IDEAL FOR PCs WITH FULL HEIGHT FLOPPIES
- LEAVES ROOM FOR A HALF LENGTH CARD IN ADJACENT SLOT

$349

RITEMAN II PRINTER

- 160 CPS DRAFT, 32 CPS NLQ MODE
- SUPPORTS EPSON/IBM GRAPHICS
- 9 x 9 DOT MATRIX
- FRICTION AND PIN FEEDS
- VARIABLE LINE SPACING & PITCH

\$219^{95}

IBM COMPATIBLE PRINTER CABLE	$9.95
REPLACEMENT RIBBON CARTRIDGE	$7.95

DISK DRIVES

5¼" SEAGATE HARD DISK DRIVES

ST-225	HALF HEIGHT 20MB 65ms	$259
ST-238	HALF HEIGHT 30MB 65ms (RLL)	$299
ST-251	HALF HEIGHT 40MB 40ms	$469
ST-277	HALF HEIGHT 60MB 40ms (RLL)	$649
ST-4038	FULL HEIGHT 30MB 40ms	$559
ST-4096	FULL HEIGHT 80MB 28ms	$895

½ HEIGHT FLOPPY DISK DRIVES

5¼" TEAC FD-55B DS DD 360K	$99.95
5¼" TEAC FD-55F DS QUAD 720K	$119.95
5¼" TEAC FD-55G DS HD 1.2M	$129.95
5¼" FUJITSU M2551A DS DD 360K	$89.95
5¼" FUJITSU M2553K DS HD 1.2M	$119.95
5¼" DS DD 360K	$69.95
5¼" DS HD 1.2M	$109.95
3½" MITSUBISHI DS DD (AT OR XT)	$129.95

DISK DRIVE ACCESSORIES

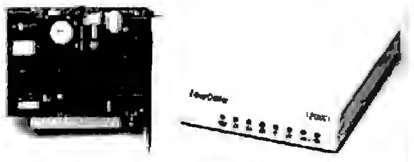
½ HT MOUNTING HARDWARE FOR IBM	$2.95
MOUNTING RAILS FOR IBM AT	$4.95
"Y" POWER CABLE FOR 5¼" FDDs	$2.95
5¼" FDD POWER CONNECTORS	$1.19

DRIVE ENCLOSURES WITH POWER SUPPLIES

CAB-2SV5	DUAL SLIMLINE FOR 5¼"	$49.95
CAB-1FH5	FULL HEIGHT FOR 5¼"	$69.95
CAB-2SV8	DUAL SLIMLINE FOR 8"	$209.95
CAB-2FH8	DUAL FULL HEIGHT FOR 8"	$219.95

EASYDATA MODEMS

All models feature auto-dial/answer/redial on busy, power up self test, touchtone or pulse dialing, built-in speaker, Hayes and Bell Systems 103 & 212A compatible, full or half duplex, PC Talk III Communications software with internal models and more.



INTERNAL

12H	1200 BAUD ½ CARD	$69.95
24B	2400 BAUD FULL CARD	$179.95

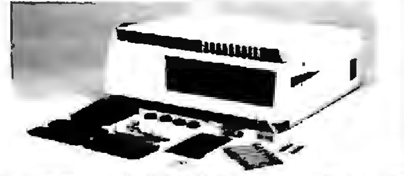
EXTERNAL

(NO SOFTWARE INCLUDED)

12D	1200 BAUD	$119.95
24D	2400 BAUD	$219.95

COMPUTER CASES

Attractive, sturdy steel cases fit the popular sized motherboards and include speakers, faceplates, expansion slots and all necessary hardware



XT STYLE FLIP-TOP $34.95
XT STYLE SLIDE-TOP $39.95
AT STYLE SLIDE-TOP $69.95

- FRONT PANEL KEYLOCK AND LED INDICATORS

JR. AT STYLE FLIP-TOP $149.95

- INCLUDES 180 WATT POWER SUPPLY
- FRONT PANEL KEYLOCK AND LED INDICATORS

Visit our retail store located at 1256 S. Bascom Ave. in San Jose, (408) 947-8881

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FAX (408) 378-8927 • Telex 171-110

PLEASE USE YOUR CUSTOMER NUMBER WHEN ORDERING

TERMS: Minimum order $10.00. For shipping and handling include $2.50 for UPS Ground and $3.50 for UPS Air. Orders over 1 lb. and foreign orders may require additional shipping charges—please contact our sales department for the amount. CA residents must include applicable sales tax. All merchandise is warranted for 90 days unless otherwise stated. Prices are subject to change without notice. We are not responsible for typographical errors. We reserve the right to limit quantities and to substitute manufacturer. All merchandise subject to prior sale. A full copy of our terms is available upon request. Items pictured may only be representative

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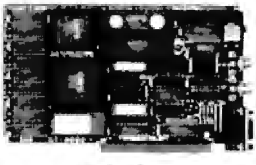
ALL MCT PRODUCTS CARRY A 1 YEAR WARRANTY

INTERFACE CARDS

FROM MODULAR CIRCUIT TECHNOLOGY



LOW COST

MCT-EGA

DISPLAY CARDS

MCT-MGP MONOCHROME GRAPHICS $\$59^{95}$

TRUE HERCULES COMPATIBILITY SUPPORTS LOTUS 123
- SOFTWARE DRIVER ALLOWS COLOR GRAPHICS PROGRAMS TO RUN ON A MONOCHROME MONITOR
- PARALLEL PRINTER PORT

MCT-EGA ENHANCED GRAPHICS ADAPTOR $\$149^{95}$

100% IBM COMPATIBLE PASSES IBM EGA DIAGNOSTICS
- 256K OF VIDEO RAM ALLOWS 640 x 350 IN 16 OF 64 COLORS
- COMPATIBLE WITH COLOR AND MONOCHROME ADAPTORS

MCT-CG COLOR GRAPHICS ADAPTOR $\$49^{95}$

COMPATIBLE WITH IBM COLOR GRAPHICS STANDARDS
- SHORT SLOT SUPPORTS RGB, COLOR & COMPOSITE MONOCHROME
- 640/320 x 200 RESOLUTION, LIGHT PEN INTERFACE

MULTIFUNCTION CARDS

MCT-MF MULTIFUNCTION $\$79^{95}$

ALL THE FEATURES OF 6 PACK AT HALF THE PRICE
- 0-384K DYNAMIC RAM USING 4164s
- SERIAL, PARALLEL, GAME PORTS, CLOCK/CALENDAR

MCT-MGMIO MONOGRAPHICS I/O $\$119^{95}$

TOTAL SYSTEM CONTROL FROM A SINGLE SLOT
- 2 FLOPPY CONT. SERIAL, PARALLEL, GAME PORT, CLOCK CAL
- RUN COLOR GRAPHICS SOFTWARE ON A MONOCHROME MONITOR

MCT-MIO MULTI I/O FLOPPY $\$79^{95}$

A PERFECT COMPANION FOR OUR MOTHERBOARDS
- SERIAL, PARALLEL, GAME PORT, CLOCK CALENDAR
- SUPPORTS UP TO 2 360K FLOPPIES, 720K WITH DOS 3 2

MIO-SERIAL 2nd SERIAL PORT $\$15^{95}$

MCT-IO MULTI I/O CARD $\$59^{95}$

USE WITH MCT-FH FOR A MINIMUM OF SLOTS USED
- SERIAL PORT, CLOCK CALENDAR WITH A BATTERY BACK-UP
- PARALLEL PRINTER PORT ADDRESSABLE AS LPT1 OR LPT2

IO-SERIAL 2nd SERIAL PORT $\$15^{95}$

MCT-ATMF AT MULTIFUNCTION $\$139^{95}$

ADDS UP TO 3 MEGABYTES OF RAM TO THE AT
- USER EXPANDABLE TO 1.5 MB OF MEMORY (ZERO K INSTALLED)
- INCLUDES SERIAL PORT AND PARALLEL PORT

ATMF-SERIAL 2nd SERIAL PORT $\$24^{95}$
MCT-ATMF-MC PIGGYBACK BOARD (NO MEMORY) $\$29^{95}$

MCT-ATIO AT MULTI I/O $\$59^{95}$

USE WITH MCT-ATFH FOR A MINIMUM OF SLOTS USED
- SERIAL, PARALLEL AND GAME PORTS
- USES 16450 SERIAL SUPPORT CHIPS FOR HIGH SPEED OPERATION

ATIO-SERIAL 2nd SERIAL PORT $\$24^{95}$

MEMORY CARDS

MCT-RAM 576K RAM CARD $\$59^{95}$

A CONTIGUOUS MEMORY SOLUTION IN A SHORT SLOT
- USER SELECTABLE CONFIGURATION AMOUNTS UP TO 576K USING 64K & 256K RAM CHIPS (ZERO K INSTALLED)

MCT-EMS EXPANDED MEMORY CARD $\$129^{95}$

2 MB OF LOTUS INTEL MICROSOFT COMPATIBLE MEMORY FOR XT
- CONFORMS TO LOTUS INTEL EMS
- USER EXPANDABLE TO 2 MB
- EXPANDED CONVENTIONAL MEMORY, RAMDISK AND SPOOLER

MCT-ATEMS AT VERSION $\$139^{95}$

DRIVE CONTROLLERS

MCT-FDC FLOPPY DISK CONTROLLER $\$29^{95}$

QUALITY DESIGN OFFERS 4 FLOPPY CONTROL IN A SINGLE SLOT
- INTERFACES UP TO 4 FDDs TO AN IBM PC OR COMPATIBLE
- SUPPORTS BOTH DS DD AND DS/QD WITH DOS 3.2

MCT-HDC HARD DISK CONTROLLER $\$79^{95}$

HD CONTROL FOR WHAT OTHERS CHARGE FOR FLOPPY CONTROL
- SUPPORTS 16 DRIVE SIZES INCLUDING 5, 10, 20, 30 & 40 MB
- DIVIDE 1 LARGE DRIVE INTO 2 SMALLER, LOGICAL DRIVES

MCT-FDC-1.2 1.2MB FLOPPY CONTROLLER $\$69^{95}$

ADD VERSATILITY & CAPACITY TO YOUR XT
- SUPPORTS 2 DRIVES, BOTH MAY BE 360K OR 1 2 MEG
- ALLOWS DATA TO FLOW FREELY FROM XTs TO ATs

MCT-FH FLOPPY/HARD CONTROLLER $\$139^{95}$

SYSTEM STARVED FOR SLOTS? SATISFY IT WITH THIS TIMELY DESIGN
- INTERFACES UP TO 2 FDDs & 2 HDDs, CABLING FOR 2 FDDs & 1 HDD
- SUPPORTS BOTH DS DD & DS QD WITH DOS 3.2

MCT-ATFH AT FLOPPY/HARD CONTROLLER $\$149^{95}$

FLOPPY HARD DISK CONTROL IN A TRUE AT DESIGN
- SUPPORTS UP TO 2 360K 720K 1 2MB FDDs AS WELL AS 2 HDDs USING STANDARD CONTROL TABLES

Seagate

½ HEIGHT HARD DISK DRIVES

40 MB $\$469$
60 MB $\$649$

Drives are Seagate models ST-251 (40 MB) & ST-277 (60 MB RLL) 5¼" half heights FAST 40ms access time!

½ HT HARD DISK SYSTEMS

20 MB $\$289$
30 MB $\$329$

Systems include Seagate ½ height hard drive, drive controller, cables & instructions. All drives are pre-tested & warranted for 1 year.

IBM COMPATIBLE MOTHERBOARDS

FROM MODULAR CIRCUIT TECHNOLOGY

MCT-TURBO TURBO 4.77/8 MHz $\$99^{95}$
- 4.77 OR 8 MHz OPERATION WITH 8088-2 & OPTIONAL 8087-2 CO-PROCESSOR
- FRONT PANEL LED SPEED INDICATOR AND RESET SWITCH SET SUPPORTED
- CHOICE OF NORMAL/TURBO MODE OR SOFTWARE SELECT PROCESSOR SPEED

MCT-XTMB STANDARD MOTHERBOARD $\$87^{95}$

MCT-ATMB 80286 6/8 MHz $\$379^{95}$
- 8 SLOT (2 EIGHT BIT, 6 SIXTEEN BIT) AT MOTHERBOARD
- HARDWARE SELECTION OF 6 OR 8 MHz
- 1 WAIT STATE
- KEYLOCK SUPPORTED, RESET SWITCH, FRONT PANEL LED INDICATOR
- SOCKETS FOR 1 MB OF RAM AND 80287
- BATTERY BACKED CLOCK

MCT-BATMB MINI 80286 $\$389^{95}$
- REPLACEMENT BOARD FOR XT STYLE CHASSIS
- OPERATE AT 6-10 MHz WITH UP TO 1MB ON-BOARD MEMORY (ZERO K INSTALLED)
- SOCKET FOR 80287 MATH CO PORCESSOR
- BATTERY BACKED CLOCK
- 8 SLOTS: 2 EIGHT BIT, 6 SIXTEEN BIT
- USES CHIPS & TECHNOLOGY CHIP SET FOR RELIABILITY AND SMALL SIZE

IBM COMPATIBLE KEYBOARDS

FULL ONE YEAR WARRANTY

MCT-5339 $\$79^{95}$
- IBM ENHANCED STYLE LAYOUT
- SOFTWARE AUTOSENSE FOR XT OR AT COMPATIBLES
- LED INDICATORS
- AUTO REPEAT FEATURE
- SEPARATE CURSOR PAD

MCT-5060 $\$59^{95}$
- IBM AT STYLE LAYOUT
- SOFTWARE AUTOSENSE FOR XT OR AT COMPATIBLES
- LED INDICATORS
- AUTO REPEAT FEATURE

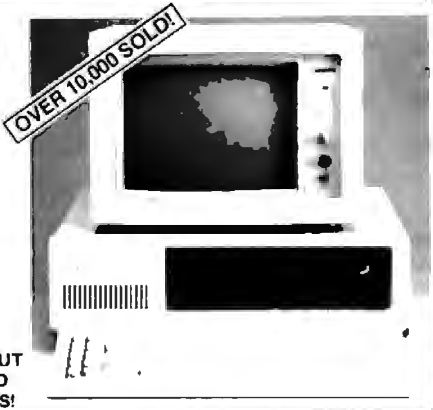
MCT-5150 XT STYLE LAYOUT $\$49^{95}$

MCT-5151 KB5151™ EQUIV. $\$69^{95}$

WHY BUY A SYSTEM FROM JDR?

- BUILD IT YOURSELF AND SAVE!
- MONEY BACK GUARANTEE (ASK FOR DETAILS)
- LEARN ABOUT THE INNER WORKINGS OF A COMPUTER
- MOST ORDERS SHIPPED IN 24 HOURS
- QUALITY COMPONENTS AND COMPETITIVE PRICES
- TOLL FREE TECH SUPPORT IN THE U.S. AND CANADA
- YOU CAN ASSEMBLE A SYSTEM IN ABOUT 2 HOURS WITH A SCREWDRIVER & OUR EASY-TO-FOLLOW INSTRUCTIONS

BUILD YOUR OWN 256K XT COMPATIBLE



- MOTHERBOARD
- 256K OF MEMORY
- 135 WATT POWER SUPPLY
- FLIP-TOP CASE
- XT STYLE KEYBOARD
- 360K FLOPPY DRIVE
- DRIVE CONTROLLER
- MONOCHROME MONITOR
- GRAPHICS ADAPTOR

FOR ONLY $\$489^{15}$

ANYONE CAN BUILD A SYSTEM IN ABOUT 2 HOURS USING A SCREWDRIVER AND OUR EASY-TO-FOLLOW INSTRUCTIONS!

DEVELOPMENT TOOLS

FROM MODULAR CIRCUIT TECHNOLOGY

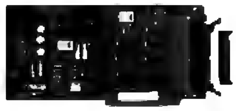
MCT-EPROM PROGRAMMER $\$129^{95}$

PROGRAMS 27xx & 27xxx EPROMS UP TO 27512
- SUPPORTS VARIOUS PROGRAMMING FORMATS AND VOLTAGES
- SPLIT OR COMBINE CONTENTS OF SEVERAL EPROMS OF DIFFERENT SIZES
- READ, WRITE, COPY, ERASE CHECK AND VERIFY
- SOFTWARE FOR HEX AND INTEL HEX FORMATS

MCT-EPROM-4 4 GANG PROGRAMMER $\$169^{95}$
MCT-EPROM-10 10 GANG PROGRAMMER $\$299^{95}$

MCT-PAL PAL PROGRAMMER $\$269^{95}$

MCT-MP PROCESSOR PROG. $\$199^{95}$



PARTIAL LISTING ONLY-CALL FOR A FREE CATALOG!

Circle 132 on Reader Service Card

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.

EDITORIAL INDEX BY COMPANY

COMING UP IN BYTE

Products in Perspective:

Next month, we'll have a Group Review you'll want to keep on hand for permanent reference: Using state-of-the-art lab equipment, we objectively rate 15 multiscan monitors. Of course, we'll also include an associated BIX Product Focus discussion.

System reviews: the Compaq Deskpro 386 running at 20 MHz; Tandy's new model 4000; and two laptop portables, the Spark and the Snap 1 + 1, both from Datavue. Hardware reviews include evaluations of five optical disk drives and another one on six new memory boards for the IBM PS/2 machines.

Software reviews detail the latest Pascal from Borland—Turbo Pascal 4.0 and MPW's C for the Macintosh. Application reviews include a comparison of McMax with dBASE for the Macintosh, MathCAD, and RS/1, a modeling and statistical-analysis program from BBN Software.

Columnists Jerry Pournelle and Ezra Shapiro present their unique perspectives in Computing at Chaos Manor and Applications Only, respectively.

In Depth:

The In Depth section focuses on the Lisp programming language. Individual articles will be "Lisp: A Language for Stratified Design," "The Semantics of Scheme," "How Lisp Has Changed," "Lisp Implementation and Performance," "Parallelism in Lisp" and a Resource Guide pointing out Lisp sources of supply and information.

Features:

Articles in the lineup for February include a discussion of "EMS 4.0," "The Definicon Transputer Multiprocessor," and a method for achieving "Fast Hartley Transforms."

Steve Ciarcia presents Part 2 of his multitasking computer/controller construction project. Dick Pountain's contribution will be a piece on methods for producing "Multicolumn Paged Text."

A MESSAGE TO OUR SUBSCRIBERS

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A. What is your primary job function? (Check one only)
1 ☐ Business Owner, General Management, Administrative
2 ☐ MIS/DP, Programming
3 ☐ Engineering/Scientific, R&D
4 ☐ Professional (law, medicine, accounting)
5 ☐ Other

B. How many people does your company employ?
1 ☐ 25 or fewer
2 ☐ 26–99
3 ☐ 100–499
4 ☐ 500–999
5 ☐ 1000 or more

C. Reason for request: (Check all that apply).
1 ☐ Business use for yourself
2 ☐ Business use for your company
3 ☐ Personal use

D. Your next step after information is received:
1 ☐ Purchase order
2 ☐ Evaluation
3 ☐ Specification/Recommendation

E. Please indicate the product categories for which you influence the selection or purchase at your (or your client's) company or organization. (Check all that apply).
1 ☐ Microcomputers
2 ☐ Peripherals
3 ☐ Software
4 ☐ Accessories and supplies

F. For how many microcomputers do you influence the purchase of products at your (or your client's) company or organization?
1 ☐ 1
2 ☐ 2–4
3 ☐ 5–9
4 ☐ 10 or more

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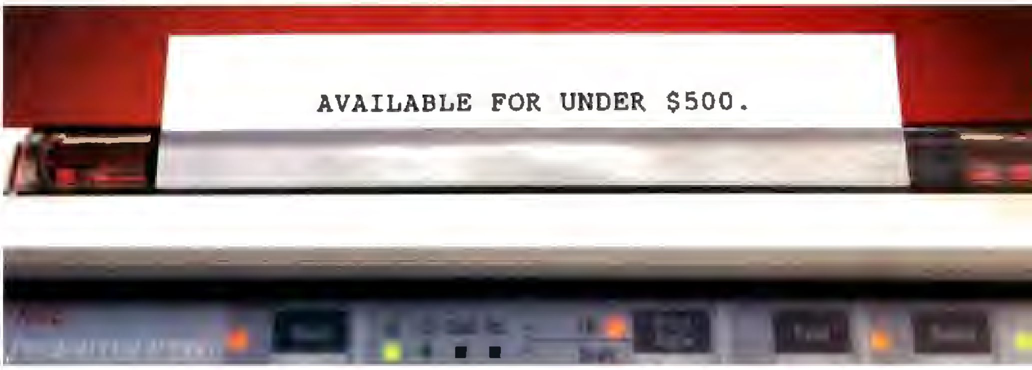

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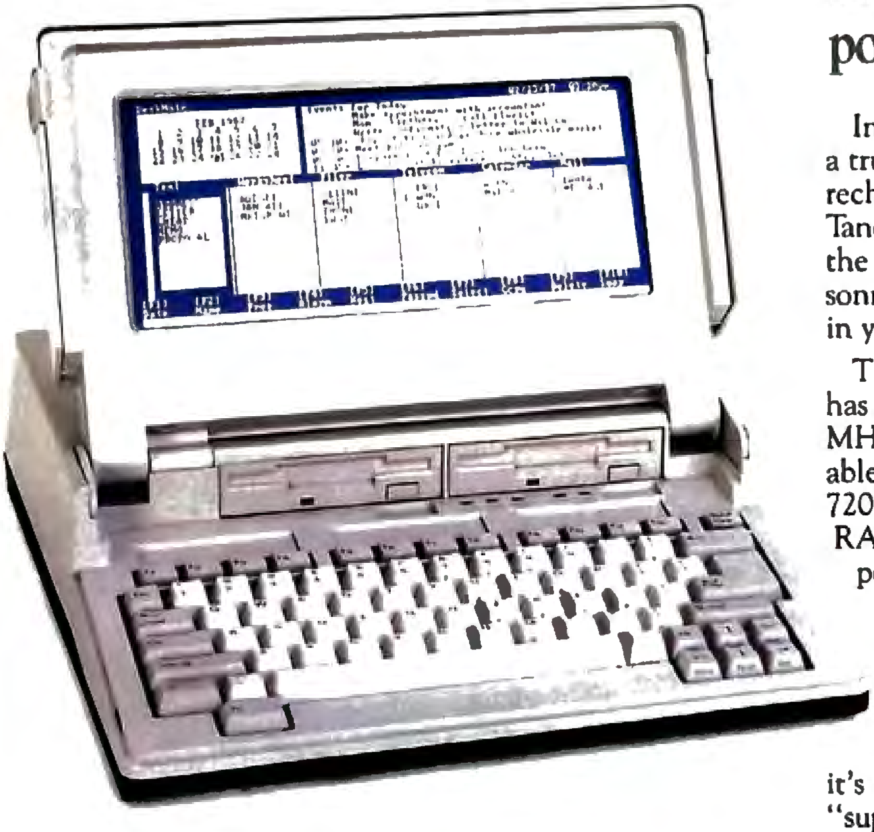

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