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AT Memory Expansion Boards

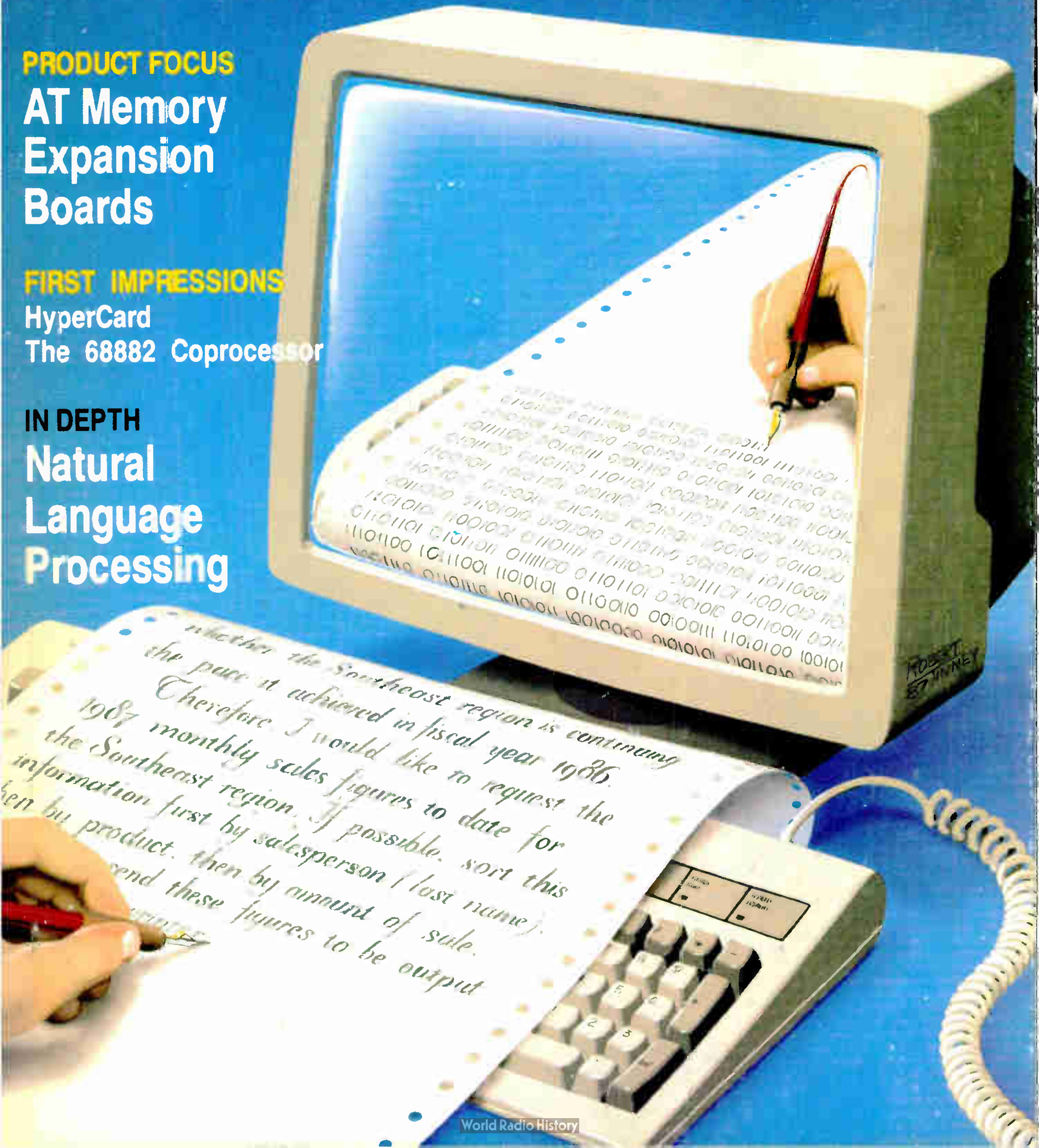
FIRST IMPRESSIONS

HyperCard

The 68882 Coprocessor

IN DEPTH

Natural Language Processing



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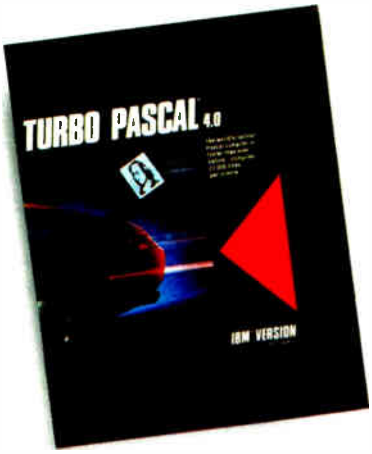

4.0 uses logical units for separate compilation

Pascal 4.0 lets you break up the code gang into "units," or "chunks." These logical modules can be worked with swiftly and separately—so that an error in one module is seeable and fixable, and you're not sent through all your code to find one error. Compiling and linking these separate units happens in a flash because your compiling horsepower is better than 27,000 lines a minute.* And 4.0 also includes an automatic project Make.

4.0's cursor automatically lands on any trouble spot

4.0's interactive error detection and location means that the cursor automatically lands where the error is. While you're compiling or running a program, you get an error message at the top of your screen *and* the cursor flags the error's location for you.

4.0 gives you an integrated programming environment

4.0's integrated environment includes pull-down menus and a built-in editor. Your program output is automatically saved and shown in the output window. You can Scroll, Pan, or Page through all your output and know where everything is all the time. Given 4.0's integration, you can edit, compile, find and correct errors—all from inside the integrated development environment.

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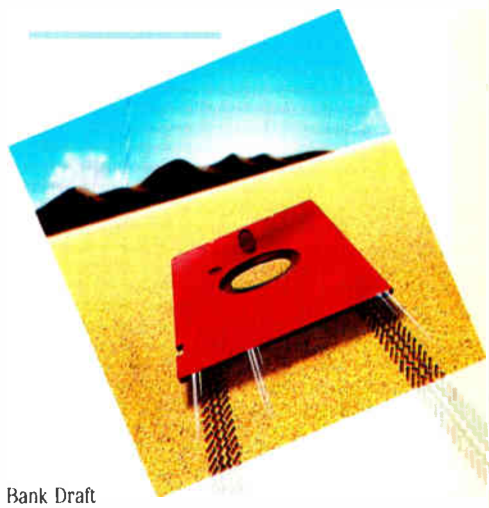

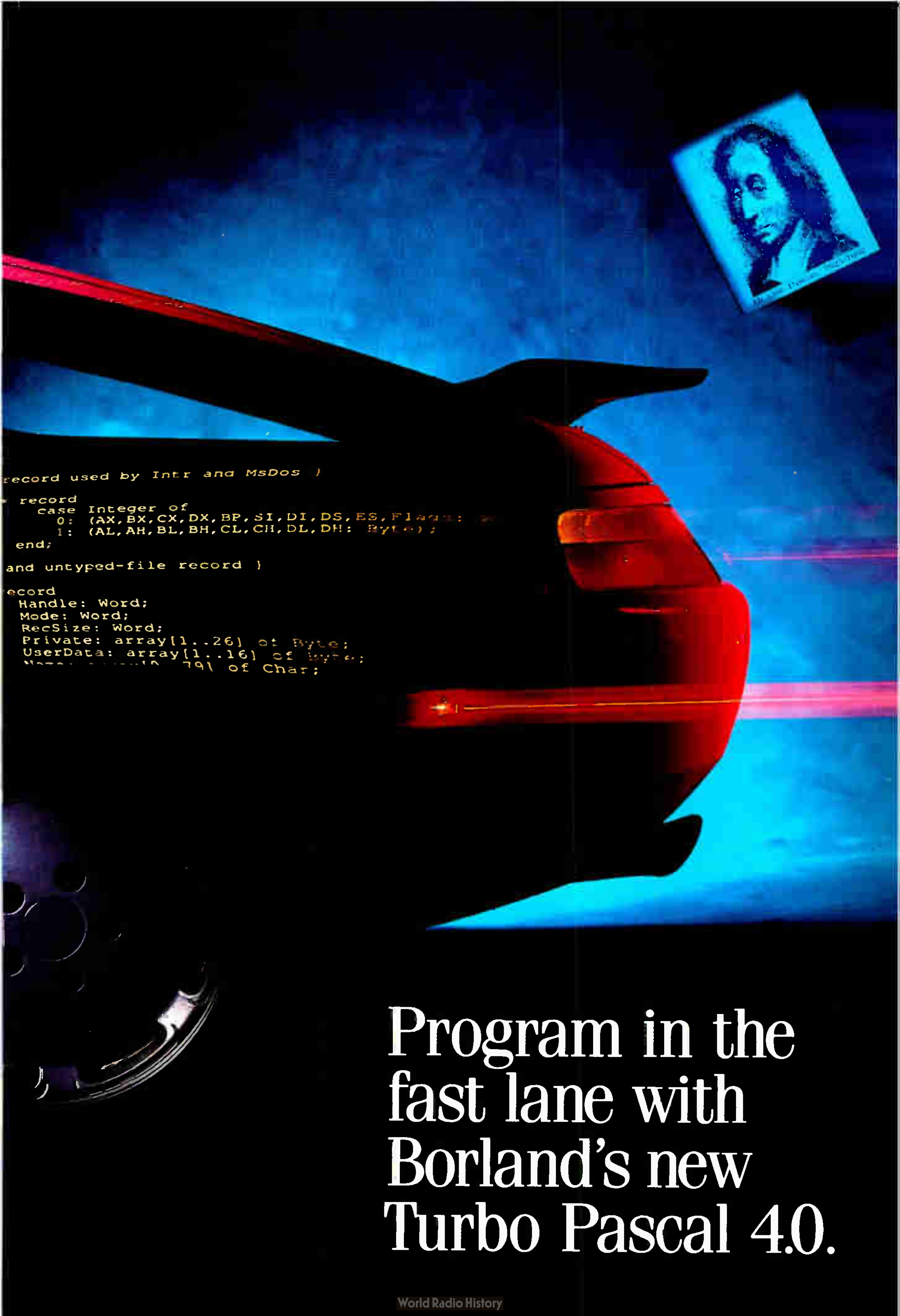
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Sieve (25 iterations)

	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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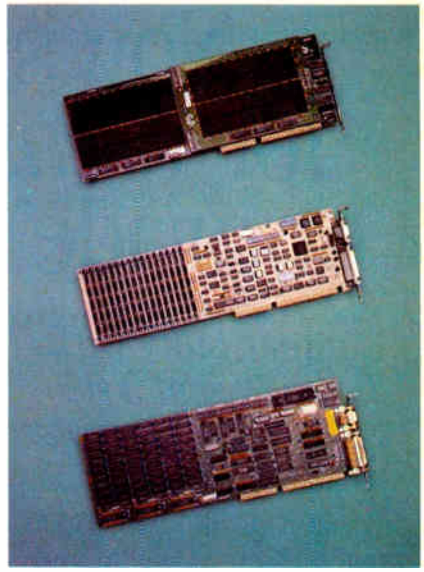

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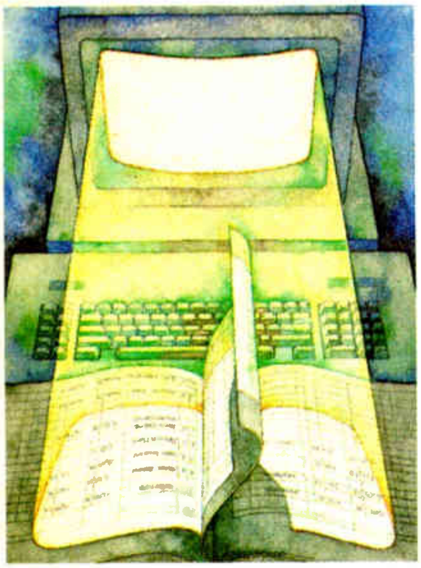

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The "B" Word

If you want to make a BYTE editor cringe these days, mention the "B" word: benchmarks. We're in the midst of a major overhaul of our current standard benchmarks, and it's proving to be an enormous task.

BYTE has more experience in benchmarking personal computers than just about anyone: More than 10 years ago, in our third issue, we proposed some preliminary benchmarks for testing the relative merits of machines like the 8008-based Scelbi-8B and the 6800-based Altair 680. (Yes, the Intel and Motorola partisans had already broken into armed camps.)

Of course, by today's standards, those early metrics were neither sophisticated nor comprehensive. But, even then, BYTE's broad coverage was such that you could make comparisons both within and across brands and within and across chip families. From day one, we've compared machines that are similar *and* machines that use wholly different CPUs and widely differing architectures, and we've also compared the software that runs on those machines.

When you think about it, the only way comparisons really make sense—and the only way they live up to their promise—is if they avoid tunnel vision. It's *never* enough simply to know how hardware and software products stack up for a single chip family, or worse, for a single brand. With incomplete or one-sided information, how can you possibly make informed decisions about which products are best for the task at hand? (By way of analogy, imagine trying to decide what's the "best" vehicle for your family by checking the specs on just one product line from, say, Ford.)

In time, our first informal metrics evolved into a formal suite of benchmarks. They served well for a number of years. Some, in fact (like the prime-number Sieve of Eratosthenes), have gone on to become virtual industry standards. But with the proliferation of 32-bit hardware and software, the old standards come up short.

How do you fairly and accurately run benchmarks in a multitasking environment? How can you ensure that a clever compiler doesn't optimize your high-level-language benchmark into meaninglessness? For that matter, how do you work around the fact that very new hardware may not have any software designed to take advantage of the new features? Or, if you're working at the chip level, how can you ensure that a timing test of, say, register moves has any bearing on real-world applications?

"Tweaking" is another can of worms. If you choose, you can optimize your benchmark tests to use every available trick to wring speed out of a given piece of hardware or software. But then, to be fair, you have to similarly optimize the benchmark for every other product you test. This is neither practical, nor true to the concept of benchmarking, which is supposed to apply the same unvarying standard in each test.

Tweak recklessly, and you've thrown away the ability to make direct, head-to-head comparisons. But if you *don't* optimize, you're omitting factors that could be crucial to performance.

And then there's obsolescence: There's no point in writing new benchmarks that will be instantly useless when the 486 and 030 machines debut.

The list of potential pitfalls goes on and on. On the whole, designing benchmarks is about as neat, clean, and simple as nailing jelly to a tree.

Of course, there are answers to these and the myriad other issues that arise in benchmarking 32-bit systems, and we began exploring new benchmarks as soon as the first 32-bit systems appeared. By midyear, we presented early working versions of some of our new benchmark programs.

As of now, we've gained an enormous amount of experience with the Macintosh II and numerous other 68020-based products; this is also true with the PS/2 Model 80, Compaq 386, and many other 80386-based machines. We've also gotten to know several different multitasking operating systems and climbed the learning curve of a number of compilers for 32-bit systems.

No less important, we've learned what you want in benchmarks: Through an informal telephone poll of hundreds of BYTE readers and a major, statistically rigorous editorial survey, we've found that you want both low-level *and* high-level tests—nitty-gritty, technically detailed benchmarks, coupled with tests that are more general and applications-oriented. You don't want "blind" benchmarks: You want to know exactly what our benchmarks are, what they measure, and where they came from.

With this information in hand, we're developing the specifications, methodologies, and code for a new suite of benchmarks that will let us accurately gauge the relative performance of machines from both the Intel and Motorola camps and the software they run. We're focusing first on system-level tests—CPU, FPU, memory, video/graphics subsystems, disk and peripheral I/O, and others.

In some cases, we'll adopt existing, widely accepted benchmark tests; in others, we'll work from scratch to develop original benchmarks that fill in the gaps between the readily available Fibonacci numbers, Dhrystones, and such. But in all cases, our new benchmarks will retain the traditional and unique strengths of BYTE's benchmarks: You'll be able to use them to make comparisons across brands and across chip families.

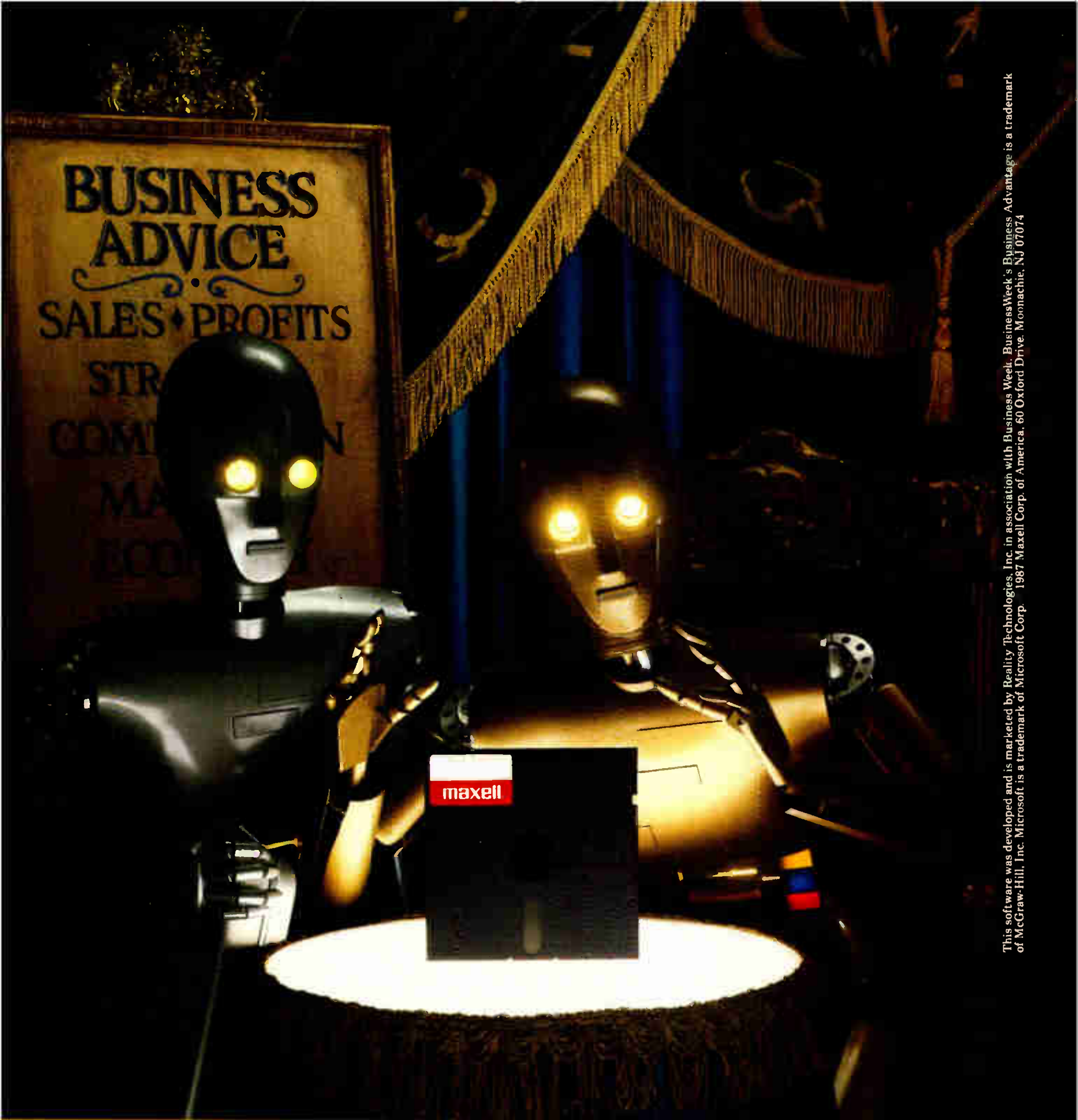
As the work on the new benchmarks progresses, we're actively soliciting help from two outside sources. We're already working with recognized experts in the field: You'll see some of their best work in an upcoming In Depth section.

The other source is you. We want BYTE's new benchmarks to serve *your* changing needs—to give *you* the kind of information you need to make informed judgments about the welter of new hardware and software on both sides of the Intel/Motorola schism.

Your comments and opinions are always welcome by mail and phone or, better yet, via the benchmarking conference and the very active benchmarking topic in the supermicros conference on BIX: BIX is perhaps the best place for discussions of benchmarking because the electronic medium makes it almost ridiculously easy to share preliminary code and to gather a wide range of opinions quickly. On BIX, helped by the collective expertise of the participants, the new benchmarks can evolve quickly and with a high probability of success.

We invite your participation.

—Fred Langa
Executive Editor
(BIX name "flanga")



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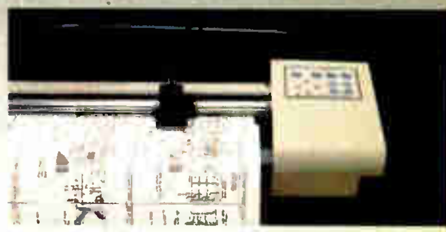

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Staff-written highlights of developments in technology and the microcomputer industry.

Experimental Speedup Card Puts Mac Plus on the Fast Track

A prototype accelerator board for the Macintosh Plus may enable that machine to crunch numbers 200 times faster than is currently possible. Different versions of the speedup board will operate at different speeds; the fastest will be built around a 25-megahertz Motorola 68020 CPU. Other versions will execute at slower speeds, depending on whether a 12-, 16-, or 20-MHz 68020 is used. All versions will also include a 20-MHz 68881 coprocessor, Zylink and Altair multiple gate array chip sets, and five PAL chips. The card is being developed concurrently in San Francisco and Mexico by a small company called Whizzard Works.

"We can clearly see a minimum performance improvement of 10 or 12 times for normal processing with the 25-MHz board," Whizzard Works president Howard Waldron told Microbytes Daily. "We are a little in doubt of what the upper limit should be, but I wouldn't be surprised to see up to 200 times for straight number-crunching operations." Waldron claimed that the 12-MHz version of the board will have a minimum performance that is 3 times greater than the standard Mac Plus for normal processing, while the 16-MHz card will have "something in the range of 5 times for normal processing and 100 times for number crunching."

Waldron, who wants to patent his method of attaching the accelerator card to the Mac's on-board CPU, said the board incorporates ROM caching for increased speed, and all wait states have been eliminated. Both 12- and 16-MHz boards will have 4 megabytes of 120-nanosecond dynamic RAM, while 20- and 25-MHz boards will have 2 megabytes of 100-ns CMOS memory.

The unnamed accelerator board has been through several critical trouble-shooting stages. When we last spoke with Waldron, he was planning to run off eight beta boards—two for each frequency range—before offering the card as an OEM product.

High-Speed PCs Pose Problem for Some Low-Cost Graphics Cards

High-speed personal computers and inexpensive EGA cards don't always mix, as some system integrators and users are finding out. But the blame can't be put on the EGA cards in every case, say adapter vendors, because cheaply engineered high-speed machines are sometimes a contributing factor as well. The most common manifestation of the problem that users are experiencing is an error condition on power-up. In these instances, the system intermittently recognizes the ROM BIOS. The solution, say users, is to keep resetting the machine until the card catches hold. Sometimes, allowing the machine to heat up for a while helps.

The cause of the problem, according to manufacturers contacted by Microbytes Daily, is twofold. On the one hand, some low-grade EGA cards aren't built with enough tolerance to handle the higher CPU and bus speeds. On the other hand, many clone makers are cutting corners to achieve higher speeds and lower costs. Consequently, bus speeds are running greater than the 8-MHz level defined by de facto PC standards—and low-tolerance adapter cards just can't keep up. "Controlling the bus speeds while increasing the CPU clock speed is a more complicated engineering task and costs more money because additional chips are required," says Mir Ali of Advanced Micro Research Inc. (Redwood City, CA). "Some of the Taiwanese and other clones run the bus and everything else faster, and that usually kills compatibility." Most big-brand personal computers, including IBM, Compaq, PC's Limited, and Tandy, adhere to an 8-MHz bus speed.

continued

Nanobytes

Real-time software engineers need their own specialized software, Ready Systems (Palo Alto, CA) president Aryeh Finegold says, so the company came out with an integrated set of design tools for real-time embedded software systems. With CARDtools (the CARD stands for computer-aided real-time design), an engineer could design a system around, say, a 68000 microprocessor, then check and verify its performance, and then "substitute" another processor, say, an 80386, and compare the system performance. "We can tell you way before you commit to a line of code what will happen in the environment," Finegold said. CARDtools, which includes tools for control map building, user-interface prototyping, a graphics editor, and a program-design language editor and analyzer, works on the IBM PC AT and compatibles. Prices start at $10,000. . . . Doing the job right means using the right tools. With that in mind, James River Corp. (Groveton, NH) has worked up a new coated **paper** specifically designed for use with **laser printers**. The Laser Ultra paper is coated on two sides and can be used to produce high-contrast master images for camera-ready copy and pasteups. In addition to being resistant to curling, the paper's high "wax-holdout" property prevents it from absorbing rubber cement, wax, and other art-department adhesives. . . . Early indications point to **Bitstream Inc.** (Cambridge, MA), home of renowned typographer Matthew Carter, setting the font standard for PostScript-compatible page-description languages. Clone developers, including Phoenix Technologies, Control-C Software, Bauer Enter-

continued

prises, and Eicon Technology, will provide their own character generators, while Bitstream will provide its Fontware Quality Enhancement Module. The module, a 30K-byte program with hooks that allow it to be integrated into PostScript interpreters, controls typographic features.... At a rather moribund LaserActive '87, a show spotlighting CD-ROMs, WORMs, videodisks, and optical-storage systems, **Optical Media International** (Los Gatos, CA) introduced a complete **CD-ROM publishing workstation** based on an IBM PC AT. The deskTOPIX system lets publishers go from raw data to videotape, write-once optical disk, or direct to a CD mastering system, and from there to a finished platter. The setup includes an AT, a hard disk drive that holds up to 8000 megabytes, an 8000-megabyte write-once optical disk drive, software that lets a hard disk drive act as a CD-ROM for development purposes, a file-production system that conforms files to the High Sierra format, a 2.2-gigabyte tape drive, and CD-ROM disk drives. Prices start at $12,995.... And now some quips and quotes from the Seybold seminar on desktop publishing: "When we look back at 1987, PostScript will be the biggest Polish joke of the year," said Atex cofounder Charles Ying. To which Apple cofounder Steve Jobs replied, "With all due respect to you, Charles, you don't know what you are talking about." "PostScript has won, but it may be the Apple II of page-description languages; there may be something that follows it," said Bill Hilliard of Phoenix Technologies. But why all this talk about PostScript compatibility?, some asked. "The issue isn't PostScript compatibility," said Andy Johnson-Laird of PostScript cloner Control-C Software. The issue, he said, is "LaserWriter compatibility." Phoenix's Hilliard talked about the same thing. "Our target is to be functionally compatible with the Apple LaserWriter," he said when telling us about Phoenix's PostScript-compatible, uh, LaserWriter-compatible interpreter.

PC's Limited (Austin, TX) spokesperson Gary Gastineau acknowledged that his company has noticed problems with several low-priced EGA cards. "Yes, we've seen that problem," he said, "and for us, the problem is on the [EGA] card." Gastineau said the company began noticing the power-up problem when evaluating EGA cards for its 80386 PC, a machine with switchable 8-/12-MHz bus speeds. According to Gastineau, some low-cost EGA cards that worked fine at 8-MHz bus speeds would not work at 12 MHz. However, he pointed out that most higher-quality EGA cards did work at 12 MHz without any problems. "The higher-end manufacturers have been building enough margin into their boards to accommodate the higher bus speeds," he said. Manufacturers stress that CPU clock speed itself isn't really a factor. "As long as you keep to the 8-MHz bus speed, you can run the CPU at any speed you want," says Ali.

For an EGA card to operate properly at the higher speeds, it should have 120-ns or faster RAM; many "lower-quality" cards have 150-ns RAM. Additionally, the EGA ROM may not be fast enough.

Apparently the problem is widespread enough that some adapter makers have been getting worried calls from OEM customers and users. A spokesperson for Video Seven (Fremont, CA) said that because of many requests from customers, an engineer has been assigned to investigate how much the bus speed can be increased without interfering with the card. So far, Video Seven's have exhibited enough tolerance for bus speeds greater than 8 MHz.

For the most part, manufacturers agree that users should be careful when buying extremely low-priced cards, especially if there is no guarantee or any way of testing the card. "You're not going to know if it works unless you plug it in," says Gastineau.

Matsushita Plans WORM, Erasable Drives

Matsushita, the large Japanese parent company of Panasonic, plans to offer an optical write-once, or WORM (write once, read many), drive soon. Although the company would not disclose details such as pricing or availability dates, it did say that the drive would use 5¼-inch disks with capacities of 200 megabytes. The write-once disk drive, which will be branded Panasonic, will probably be similar to the drive that Matsushita manufactures for IBM.

Matsushita will deliver a prototype of an erasable optical disk drive next year, probably in the third quarter, a company spokesperson said. It will probably be competing with products from Sony, Philips, and Kodak. Matsushita has invested heavily in the phase-change scheme, so that's probably the technology that will be incorporated in the drive it brings to market. In phase-change technology, molecules of tellurium suboxide change from an amorphous noncrystalline state to a crystalline state and back again, depending on the type of laser beam applied. But the company is also studying other approaches, including magneto-optical (which Sony is using) and dye-polymer technologies. One hurdle all the pioneers of erasable optical drives will have to leap is the slowness of the units, caused partially by the size of the optical disk head, which is much bigger than a head in a typical magnetic drive.

CAD Program Uses AI Techniques, Regular-Language Front End

An experimental CAD program that provides a natural-language front end for system designers has been developed by a team of engineering researchers at the University of Southern California's School of Engineering. According to Dr. Alice Parker, an associate professor of electrical engineering and leader of the project, the Advanced Design Automation (ADAM for short) program will be used to create high-level integrated circuits and complex digital systems. The program applies artificial intelligence techniques to traditional engineering problems to aid designers in the early phases of a design project, from system specification to completion of the functional design. Up to now, these steps have had minimal computer support.

"Most people use a natural-language system to simply query a database," Parker told Microbytes. "With ADAM, we are using English to enter information about specifications and then building designs. We are pulling information out of English and putting

continued

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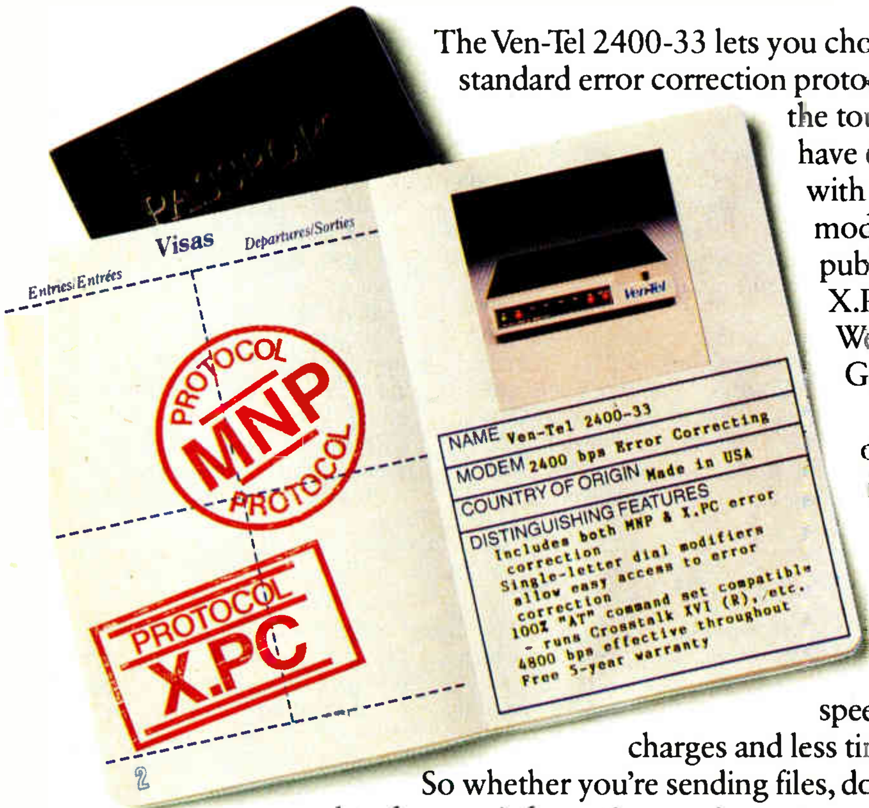

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it into a block diagram."

As information is entered into the program, ambiguities are detected and returned to the user for clarification. A database that describes the design is then automatically created. Parker added that "conventional CAD databases can tell you how a digital design is constructed and how the parts are connected. But the ADAM database can actually tell you how the design will behave."

One module looks at the specification information and plans the steps of the design process. It also tells the designer what should be done, and in what order. An automatic pipeline design component enables the program "to begin a functional specification and end up with the hardware required to accomplish that specification while staying within the user's constraints," said Parker. "We were the first to do this," she said. In doing so, the program quickly evaluates more design possibilities than the designer could evaluate manually. Furthermore, she claimed, the designs are more intricate and complex, since the software keeps track of many more details than a designer can.

The program—written mainly in C, although some LISP and Prolog code is used—runs under Berkeley Unix on a Sun workstation. So far, Parker and her associates have had success particularly with designs that involve signal processing. Over the next year, however, Parker wants to expand the vocabulary of the system and the range of patterns it can use in sentences. She estimated that it will be 4 or 5 years before a fully implemented, commercially acceptable version of the program can be developed, but an experimental version may be available within 2 years.

Telecommuting Project: Transporting Information, Not People

A pioneer test to study the effectiveness of "telecommuting" is scheduled to get under way in California this month. The 2-year California Pilot Telecommuting Project will initially involve 200 state employees, although the project's director, David Fleming, told Microbytes that it will grow throughout the 2-year span.

Instead of physically commuting to their offices each day, employees in the program will work from their houses or from neighborhood offices using personal computers, telephones, and terminals. The California General Services Division, which Fleming works for, will provide telecommunication equipment for the neighborhood offices, while individual state departments will provide computers for those employees who don't already have them at home. For the most part, employees will still report to the office at least once a week or as needed.

"Our mission is to establish the technology as a work option in state government," Fleming said. "Our goal is to identify the most effective methods in terms of cost, staffing, reduced energy consumption, traffic patterns, and air quality."

Participating departments will include General Services, Transportation and Highways, Franchise Tax Board, Fish and Game, and the Energy Commission. Fleming added that the categories of participating workers cuts across all levels, including clerical, professional, and management jobs. He said that the project will not focus on any one job but will attempt to identify those parts of a job that don't have to be done at a main office.

So far, most of the work has been done in identifying those people who are interested in telecommuting. Fleming started by asking for volunteers. Project personnel then worked closely with each volunteer's supervisor to determine whether the person and the job were appropriate for telecommuting. "The manager/employee relationship is critical," he explained. "Telecommuting is based on mutual trust."

"What we want to be able to do," Fleming said, "is transport ideas and information instead of people."

Amiga Program Converts Text to Hand Signs

A program to help teach sign language to people with hearing impairments and to those who interact with them has been developed by an Ohio State University researcher. SpeechSign, which is written in C, runs on the Commodore Amiga and makes full use of the graphics and sound capabilities of the computer.

Key to the effectiveness of the program are a series of images generated from scanned photographs of a person's hands. In each photo, the person creates an individual "letter" of the sign-language alphabet. Those images are scanned and stored on disk, then loaded into memory and displayed when a particular "letter" is needed.

When the program is started, two windows appear at the top of the screen, and a control panel appears in the lower half. In one of the upper windows, the scanned hand images appear; in the other, the face of a "stick figure" is displayed.

The control panel contains the primary data-entry line, where the user types in English sentences to be converted to sign language; below that is a line that displays the phonetic equivalent of the sentence. The control panel also lets the user manipulate the speed at which the hands will "spell out" the sentence, the volume level and pitch of the voice output, and whether the "speaker" is male or female. Once the English sentence is entered, voice output "speaks" the sentence. The sign window then begins finger-spelling the sentence while the stick-figure face "mouths" the appropriate letters.

"With this system," said Manjula Waldron, a professor of engineering graphics at OSU, "you can teach yourself sign language at your own speed." Waldron said it wasn't until the Amiga graphics and sound capabilities came along that it was economically feasible to develop a program like SpeechSign.

Currently, the program is not commercially available, but versions of it have been used by speech specialists at OSU, Stanford University, and the University of Minnesota.

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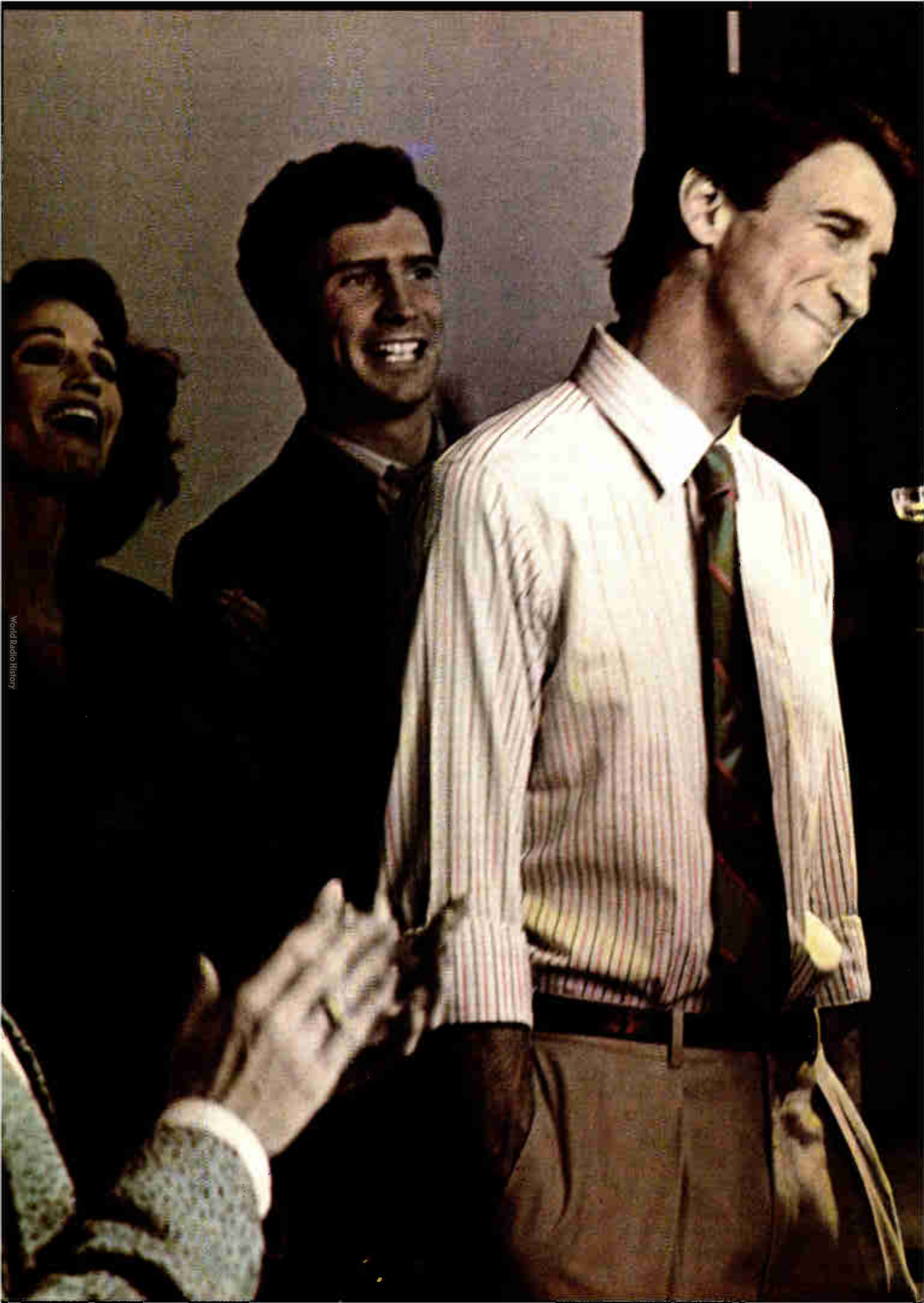


LETTERS

and Review Feedback

Modules Not Included

I recently purchased a software product called Generic CADD by Generic Software. I based my decision mostly on "A CAD for All Incomes" (August), where Phillip Robinson reviewed six different CAD packages.

In the article, the information pertaining to Generic CADD 2.01 had an editor's note at the end, stating that the new version (3.0) included several features, such as autodimensioning, solid fill, and cross-hatching, all the features I had been looking for in a reasonably priced CAD program. When I started using version 3.0, however, it became obvious that the supposedly included features were actually add-on modules that must be purchased separately.

Judy Trogadis
Toronto, Ontario, Canada

Our mistake. Autodimensioning is available with the add-on module Auto-Dimensioning for $49.95, and you must purchase Drafting Enhancements-2, also $49.95, to get solid fill and cross-hatching.

To set the record straight, you must also purchase AutoConvert, $49.95, for DXF file transfers, and Generic IGES, $249.95, for IGES file transfers.—Eds.

QuickBASIC and TSRs

In the review "BackComm and Side-Talk" by Rob Fixmer (August), an editor's note includes the comment that "Microsoft technical support does not recommend using QuickBASIC with any terminate-and-stay-resident program."

I find this ironic, because efficient and careful use of QuickBASIC (which I like) virtually requires a program like Key-works, which I use.

QuickBASIC compiles only to the default drive. If the source files are to be kept on a different drive or directory, then every time a file is loaded, the drive or path has to be typed in again. Working on a hard disk or network in a subdirectory may require typing 10 or 20 characters repeatedly. A simple macro is vital for efficiency. It also helps the sore fingers when recompiling six or seven programs with a revised common section.

QuickBASIC is generally a delight to use, and it has only a few bugs, but the nuisance of dealing with alternate drives and paths would result in a rebellion if I could not use a TSR program.

Mike Firth
Dallas, TX

Building a Better Arrowhead

When I received my August copy of BYTE, I hurriedly coded into Turbo Pascal several fractals listed on pages 126 and 127 of "Creating Fractals" by William A. McWorter Jr. and Jane Morrill Tazelaar. I was most fascinated by Mandelbrot's Arrowhead—which, unfortunately, didn't much resemble an arrowhead. In fact, it only developed into two sawtooth edges at 30-degree angles from each other.

With some tinkering (and much luck), I found that simply providing 12 birth cells (the original four in the article repeated three times) provided a very clear arrowhead shape to the fractal. I am now forced to wonder if there is a more "correct" version of the fractal—and what it is.

Another item of note in my tinkering was a variation of the arrowhead created by setting $D=4$ and I to $\{0,1,2,3,0,1,2,3,\ldots\}$. The shape is a fairly clear arrowhead that seems to be tilted at a 45-degree angle. Its form almost suggests a three-dimensional nature. Very weird.

Donald A. Tieberg
Arlington Heights, IL

Forth and the NC4016

The New Generation columns "High-Tech Horsepower" (July) and "Head to Head" (August) listed some comparisons of various personal computers running six benchmarks that were given in the July article. Table 1 is a comparison of the times for the first benchmark (an algorithm that computes the twenty-fourth Fibonacci number 100 times) on the machines listed in the August article, versus times I have achieved on two systems using the Novix NC4016 Forth Engine.

I ran the Fibonacci benchmark on the Silicon Composers PC4000 PC-compatible board and its stand-alone Delta board. The PC4000 was running at 5 megahertz, and the Delta board at 4 MHz. Both were using cmForth as their

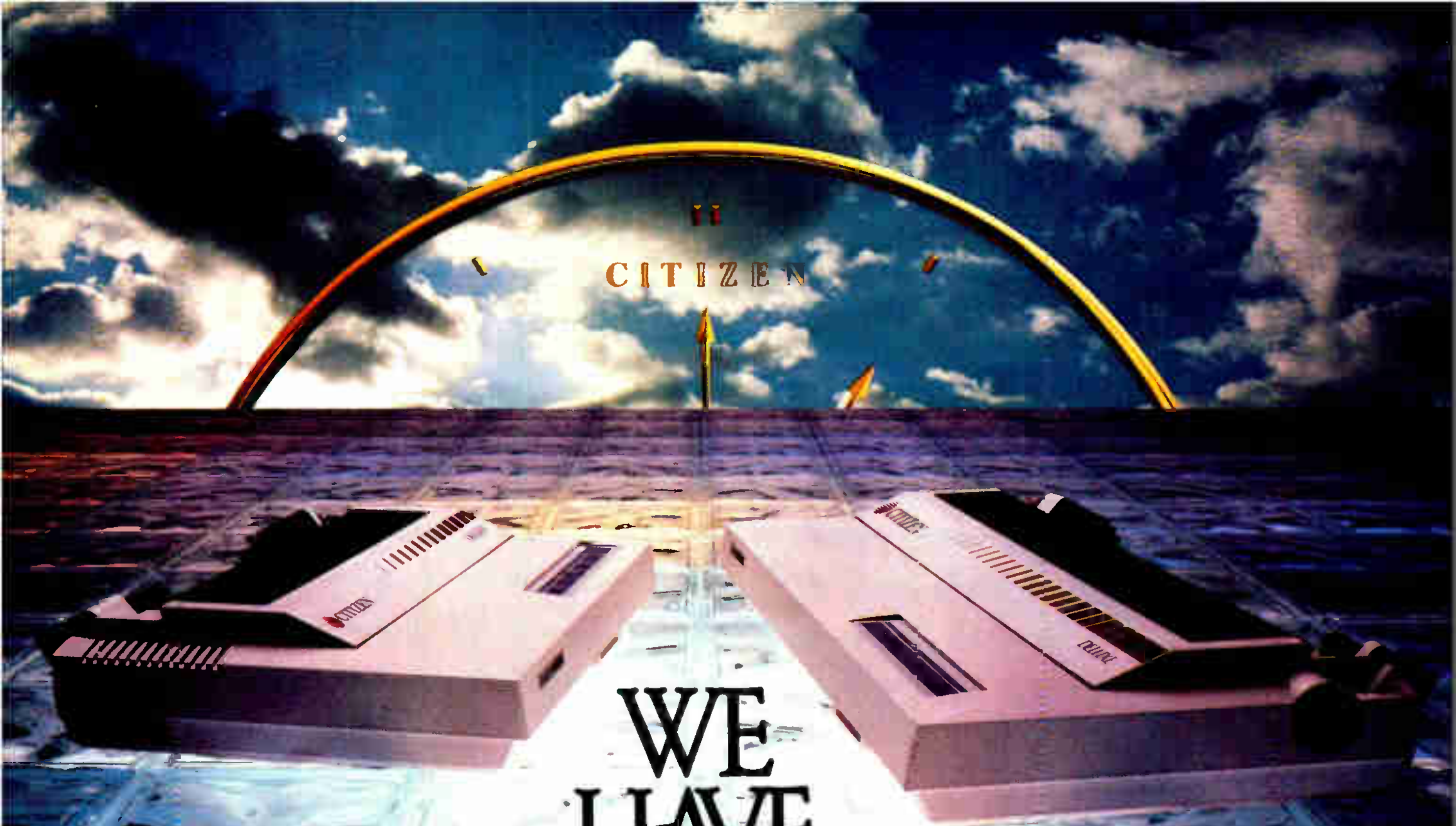
continued

Table 1: *Fibonacci results in cmForth.*

	System	Time (seconds)
Mac SE	7.83-MHz 68000 CPU 7.83-MHz 68881 FPU	264.00
IBM PC AT with FPU	8-MHz 80286 CPU 8-MHz 80287 FPU	120.96
Mac II	15.67-MHz 68020 CPU 15.67-MHz 68881 FPU	83.70
Mac SE with HyperCharger	15.67-MHz 68020 CPU 7.83-MHz 68881 FPU	71.60
IBM PS/2 Model 80	16-MHz 80386 CPU 16-MHz 80387 FPU	57.40
Compaq Deskpro 386	16-MHz 80386 CPU 8-MHz 80287 FPU	53.10
Delta board	4-MHz NC4016 CPU	28.20
PC4000	5-MHz NC4016 CPU	22.60

LETTERS POLICY: *To be considered for publication, a letter must be typed double-spaced on one side of the paper and must include your name and address. Comments and ideas should be expressed as clearly and concisely as possible. Listings and tables may be printed along with a letter if they are short and legible.*

Because BYTE receives hundreds of letters each month, not all of them can be published. Letters cannot be returned to authors. Generally, it takes four months from the time BYTE receives a letter until it is published.



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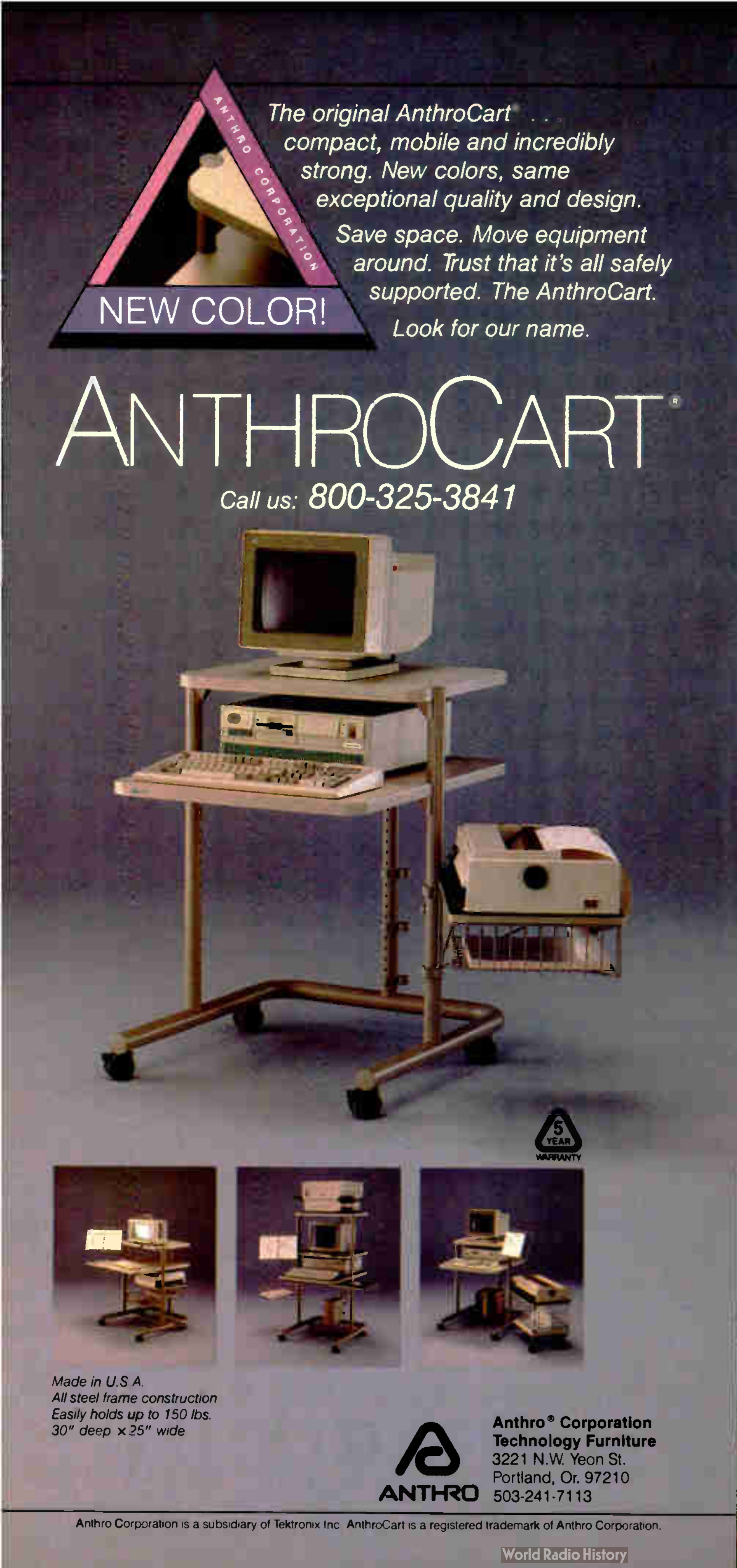

operating language. The code for the BYTE benchmarks was written in C. The listing below shows the code for the benchmark in C and cmForth.

continued

```
Fibonacci benchmark in c.

#define NTIMES 100
/*number of times to
compute Fibonacci value*/
#define NUMBER 24
/*biggest one we can
compute with 16 bits*/

main ()
/*compute Fibonacci value*/
          {
          int i;
          unsigned value,
                   fib():

printf("Fibonacci (%d
iterations:",NTIMES);

for (i = 1; i,=NTIMES; 1++)
  value = fib(NUMBER);
printf("Fibonacci (%d) = %u.
\n",NUMBER,value);
exit(0);
{

unsigned fib(x)
/*compute Fibonacci number
          recursively* /
int x;
     {
     if (x<2)
       return (fib(x-1) +
               fib (x-2));
      else
          return fib (x+1)   +
               fib(x-2));
          else
            return (1);
          {

Fibonacci benchmark in
cmFORTH

100 CONSTANT NTIMES (NUMBER
    OF TIMES TO COMPUTE FIB
      VALUE)
 24 CONSTANT NUM (BIGGEST
      ONE WE CAN COMPUTE IN
      16 BITS)

: FIB (U1 - u2) RECURSIVE
   DUP 2> IF DUP 1 - FIB
   SWAP 2 - FIB +
ELSE DROP 1
          THEN ;

: FIBTEST (-)
  CR NTIMES U.."ITERATIONS:"
  O ( MAKE SURE SOMETHING IS
     ON STACK)
NTIMES 1 - FOR DROP NUM FIB
          NEXT
  CR ."Fibonacci
       ("NUM 2 U.R.")= "U.;
```

As you can see, the NC4016 running at a clock rate four times as slow as a Deskpro 386 executes this benchmark nearly twice as fast. Also, the cmForth implementation is much more concise and, to me at least, less cryptic compared to the C version. And, of course, the word FIB can be run interactively and used independently of FIBTEST.

With this benchmark, the power of Forth and the NC4016 is directly shown. Just imagine what can be done with an NC4016 running at 16 MHz.

Douglas Ross
Goddard Space Flight Center
Greenbelt, MD

File-Transferring Device

Thanks to the publication of a letter to the editor, written by John McIntire of the International Livestock Centre for Africa (August, page 16), I am able to provide Mr. McIntire with the information he requires.

Mr. McIntire wishes to transfer his files from a Xerox 630 Memorywriter to a Hewlett-Packard Vectra microcomputer. Interpreter Inc. (11455 West Ave., Wheatridge, CO 80033, (800) 232-4687) has developed a device that will transfer the files to Writepower software, by Samna, for use on the HP Vectra. I hope you will publish this information for anyone else who may need it.

Tom Crosby
Xerox Corp.
Rochester, NY

Chronic Acceleratoritis

I am writing to complain about the speed of the latest compilers, computers, and—worst of all—*accelerator cards.* I am a full-time freelance Macintosh developer, working in Pascal and 68000 machine code. What this means is that much of my time is spent idly watching my compiler compile, my assembler assemble, or my linker link.

Things used to be great. I'd set the machine in motion and then pop downstairs for a cup of tea. Any reasonable-size program, and I'd have time for lunch. I used to read novels while working. I'd manage a chapter about every three or four compiles on average (admittedly, it made the narrative of the book somewhat disjointed, but it passed the time). I used to look forward to those pauses.

But not any more. First, it was faster compilers. Then faster computers. And now it's accelerator cards to accelerate the faster computers to even faster speeds. I now set the machine going, blink, and the damned thing's sitting there waiting for *me* to catch *it* up. My work-to-rest ratio is now about 999 to 1. It used to be more like 2 to 1, or even 1 to 1 on a good day. I can't even go to the bathroom while the machine compiles without hearing an impatient "ready when you are" beep.

Let me give you an example. While developing Crystal Quest (a shareware game I've put out for a bit of fun), compiling, assembling, and linking took around 25 minutes on my Mac Plus (with a hard disk drive) using compiler *x* and assembler *y*. That was enough time to make a cup of tea, feed the cat, eat a sandwich, *and* go to the bathroom. Then I got a Mac SE and started using Apple's own MPW development system. Bad news. The time was now down to about 4 minutes, 30 seconds—only enough time for the cup of tea.

But then came the crushing blow. I was stupid enough to ask the company for whom I am currently doing contract work for a HyperCharger accelerator card. Even worse, the company agreed and bought me one. Why I ever committed this folly, I'll never know. The same process now takes a little over a minute—not enough time to get halfway down the stairs toward the kitchen. I've inadvertently decreased my rest time by a factor of more than 20. I'm now too thirsty, too hungry, and too crippled up with bladder-ache to work.

I am seriously considering forming a developer's union to ban fast, efficient compilers, speedy computers, and, above all, accelerator cards. I am also thinking of developing and marketing such developers' godsends as crippled compilers, 1-MHz 6502 computers that interpret 68000 code from a BASIC program, and decelerator cards. The decelerator card would go into the expansion slot of your computer and keep on pestering the CPU with useless requests for transfers of massive amounts of data. It would induce more wait states than a queue to an airline check-in desk. Every now and again (or possibly quite often), it would simply jam the whole system out of spite and sit there for a few minutes until it calmed down and let the CPU have its bus back.

The result would be wonderful. You could tell the machine to start compiling and then trot off for a quick skiing holiday in the Alps. With a really long program, you might even find enough time to start an entirely new career in airship reconditioning while the machine does a link. You would end the day feeling fulfilled and ready to pleasantly relax next to your purring cat—unquestionably a vast improvement over what has become a race between my heartbeat and the CPU clock.

I'm sure there must be other developers out there with the same symptoms of chronic acceleratoritis. Please write to

continued

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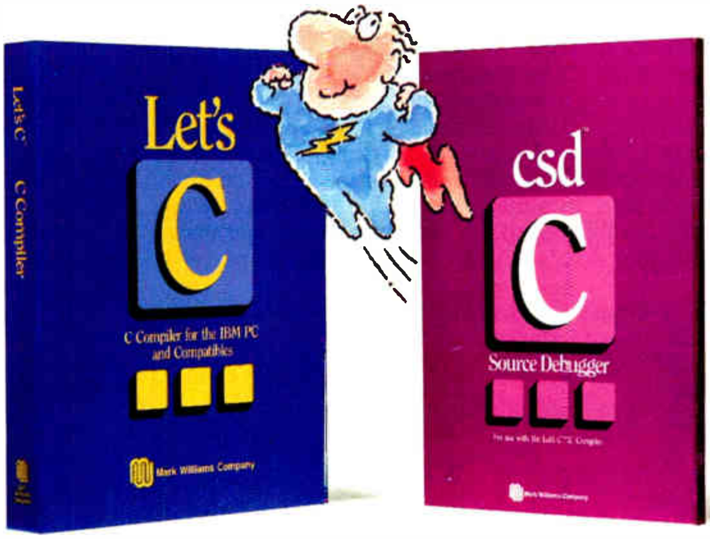

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–Jonathon Sachs, *Micro/Systems Journal*, April, 1986

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- Full Kernighan & Ritchie C and extensions
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Circle 168 on Reader Service Card

me and console me. Tell me that I'm not the only one. I need the reassurance before my neurons ignite.

Patrick L. Buckland
Ventnor, Isle of Wight, U.K.

Environment Device Driver

I noticed in the September "Best of BIX" that some people were wondering about something I had thought about a long time ago: a global environment that could be accessed by different applications programs.

At one time, I thought such a thing would be useful for processes that wanted to return more than just a 1-byte termination code. To make a long story short, I finally wrote a character device driver to implement a logical device called ENV, which allows any application to access the "root" environment as if it were a file.

Because the root environment doesn't even exist at the driver's load time, finding the root environment is tricky. When initialized, the driver sets a flag that says that the root environment's address is unknown.

When the drive is accessed (after COMMAND.COM has loaded), it checks this flag. If the environment address is unknown, the driver goes looking for it by searching for the `COMSPEC=` string. The driver knows that this string is somewhere after its own ending address and that the string begins on a paragraph boundary. Once the root environment is found, its address is saved and the address unknown flag is cleared.

My friends thought it was pretty cute, and it was a nice first exercise in writing device drivers for me, but having finally solved all the problems, I've found that I don't have anything *really* useful to do with it.

So, if any readers have an interest in using this environment device driver, they can give me a call at (714) 544-0790 during business hours (West Coast). I'll see what I can do about getting them a copy of the driver.

Steve Barsky
Tustin, CA

Nonsquare Display Devices

In the article "Vector-to-Raster Algorithms" (September), Dick Pountain describes J. Michener's algorithm to generate the points for a circle. This procedure is very accurate; however, it has a major shortcoming, in that it doesn't address the problem of nonsquare display devices.

To correct this problem, I first simplified J. Michener's algorithm, so that the `Error` value calculation was cleaner. After that, I added "scaling factors" for the height and width of the display pixels.

Assuming that `Radius`, `CtrX`, and `CtrY` are values passed to a circle-generating routine, here is a simpler form of Michener's circle algorithm:

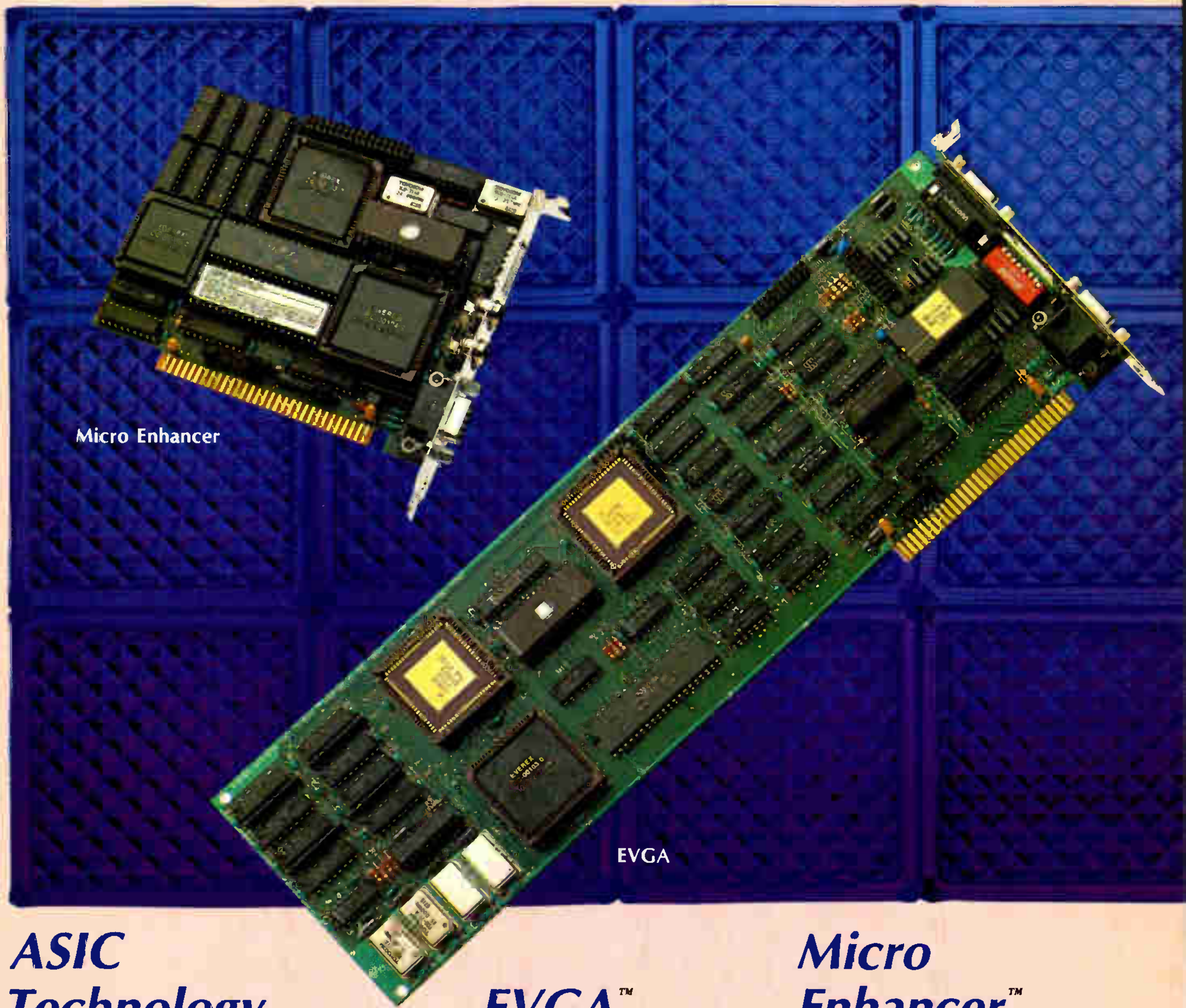
```
 X      <-- Radius
 Y      <-- 0
 XDelta <-- 2 * x - 1
 YDelta <-- 1
 Error  <-- 0

WHILE (X <=Y)
 Plot_8 (CtrX, CtrY, X, Y)
 Error  <-- Error + YDelta
       YDelta <-- YDelta + 2
 Y      <-- Y + 1
 IF (Error >= X) THEN
      Error  <-- Error - XDelta
        XDelta <-- XDelta - 2
    X         <-- X - 1
 ENDIF
ENDWHILE
```

The `Error` value is here taken to be the difference between the radius² using integer points to approximate the circle, and the radius² of the ideal circle.

To find this difference, the following table is used to derive some rules about

continued

Everex—the #1



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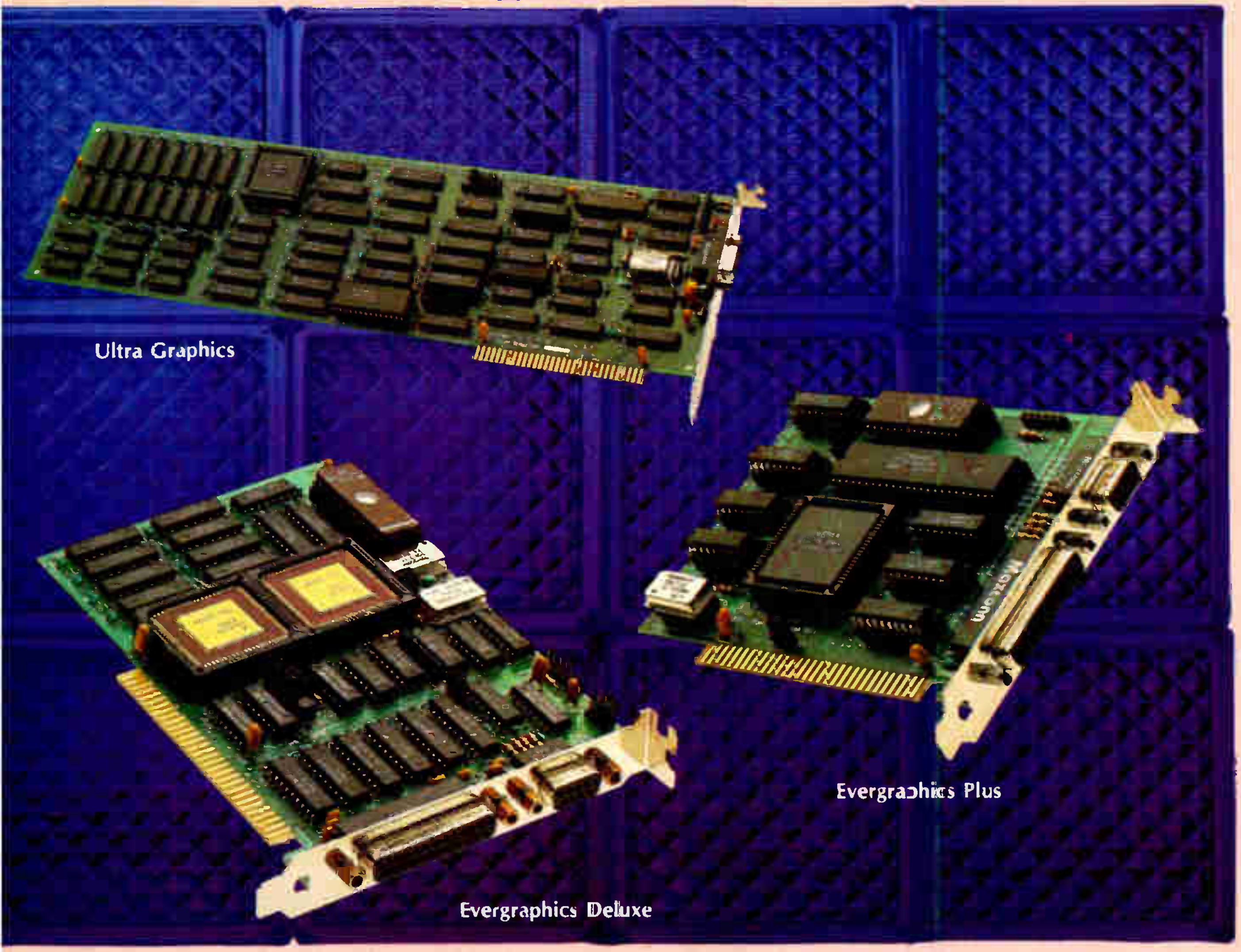

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differences between squares.

N	N²	Delta	Step
0	0	-	-
1	1	1	-
2	4	3	2
3	9	5	2
4	16	7	2
5	25	9	2

This set of rules applies where Delta is the difference between $(N)^2$ and $(N-1)^2$, and Step is the difference between succeeding Deltas.

Since Y is an ascending value, its Delta is between it and the next higher value. Because X is a descending value, its Delta is between it and the next lower value. In either case, the Step value is always 2.

The next step is to allow for nonsquare display devices. This is done by "scaling" the X and Y values so that changes in (X,Y) offsets reflect the differences in their sizes.

For instance, assume that a display device has pixels that are 1½ times taller than they are wide. Thus, its Y-scale is 3, and its X-scale is 2. Going four pixels up is the same as going six pixels across.

This results in the following X and Y scale tables:

N	X	X²	X-Delta	X-Step
0	0	0	-	-
1	2	4	4	-
2	4	16	12	8
3	6	36	20	8
4	8	64	28	8

N	Y	Y²	Y-Delta	Y-Step
0	0	0	-	-
1	3	9	9	-
2	6	36	27	18
3	9	81	45	18
4	12	144	63	18

From the numbers in these tables, the formula for the Step values can be seen to be:

Step <-- 2 × (Scale Factor) × (Scale Factor)

Using these rules to extend the previous procedure, the algorithm in the following listing is derived.

Having developed these algorithms myself, I hope they are original. If they

continued

```
XScD2    <-- XScale / 2
   {used for rounding}
YScD2    <-- YScale / 2
   {used for rounding}
XScSqr   <-- XScale * XScale
   {used for the step value}
YScSqr   <-- YScale * YScale
   {used for the step value}
XMid     <-- (CtrX + XScD2) /
   XScale     {circle center}
YMid     <-- (CtrY + YScD2) /
   YScale     {circle center}

X        <-- (Radius + XScD2)
                  / XScale
Y        <-- 0
XDelta   <-- (2 * X - 1)
     * XScSqr
YDelta   <-- YScSqr
Xstep    <-- 2 * XScSqr
YStep    <-- 2 * YScSqr

Error    <-- (X * X * XScSqr)
       - (Radius * Radius)
TestVal <-- Xdelta / 2
    {indicator of diagonal
               step required}

WHILE (XDelta >= YDelta)
    Plot_4 (XMid, YMid, X, Y)
         Error   <-- Error   +
                    YDelta
```

continued

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```
    YDelta <-- YDelta +
                     YStep
    Y      <-- Y + 1
  IF (Error > TestVal)  THEN
   Error   <-- Error - XDelta
   XDelta  <-- XDelta - XStep
   X    <-- X - 1
   TestVal <-- XDelta / 2
 ENDIF
ENDWHILE

 {Procedure is reversed for
the quadrant's second half}

 Error   <-- Negative (Error)
 TestVal <-- YDelta / 2

 WHILE (X > 0)
    Plot_4 (XMid, YMid, X, Y)
    Error  <-- Error + XDelta
    XDelta <-- XDelta - XStep
    X      <-- X - 1
    IF (Error > TestVal) THEN
     Error    <-- Error -
               YDelta
      YDelta   <-- YDelta +
               YStep
      Y       <-- Y + 1
      TestVal <-- YDelta / 2
    ENDIF
 ENDWHILE
```

are "known" algorithms then I direct congratulations to the original author(s).

Richard J. Miner
Tempe, AZ

WYSIWYG?

David P. Guest questions WYSIWYG as the only way of working with desktop publishing (Letters, September, page 22). Even if having a screen with a next-to-perfect view of your finished product is a great help, I much prefer to work in a context where I can actually see, change, and delete the control codes that are formatting my output.

Tore Simonsen
Ytre Enebakk, Norway

Letter from Laos

John T. Godfrey's letter, "Easy as π" (Letters, May, page 20), was interesting. I found it somewhat more instructive pedagogically to do the iterative approach to π by the following program:

```
10 A=2
20 FOR K=1 TO 20 : B = SQR(2 -
   SQR(4-A*A))
30 PRINT B*2^K
40 A=B : NEXT K
```

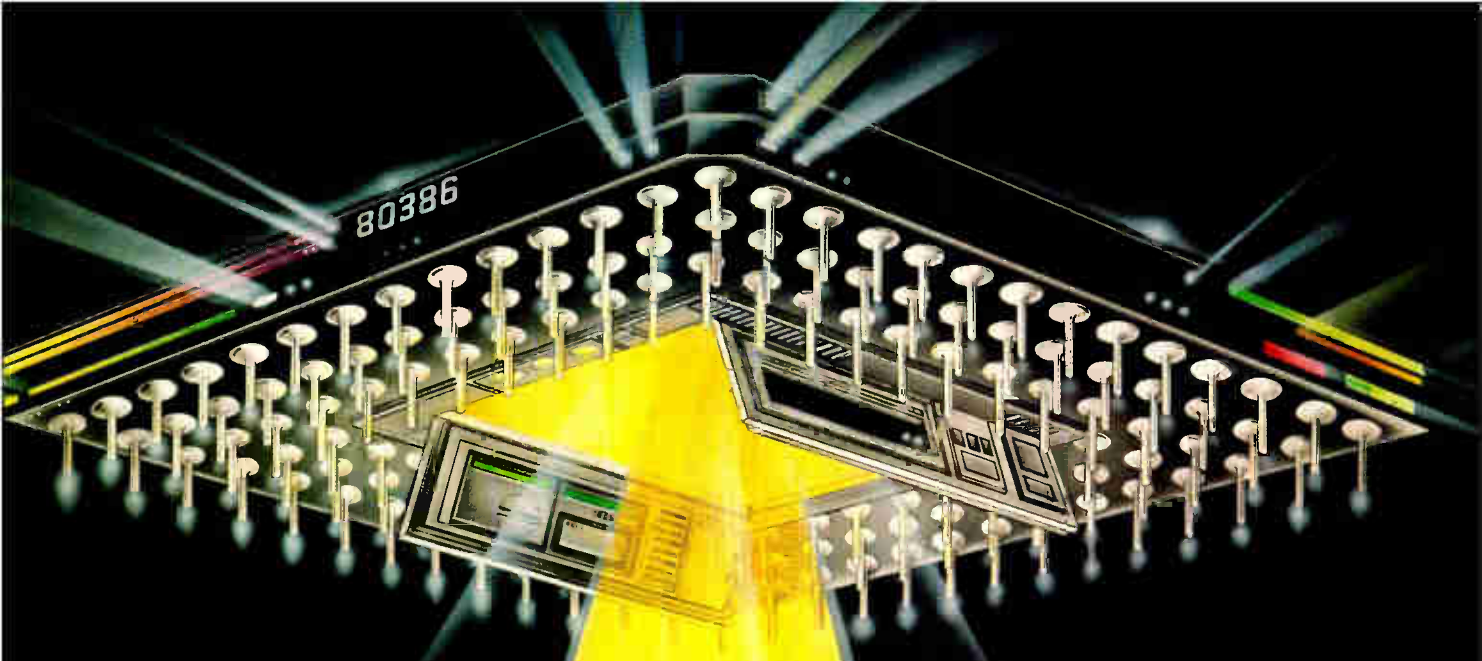
Here, A is the length of the chord in any general arc of a circle of unit radius, and B is the length of the chord in one half of the arc. A=2 gives the initial condition of the arc, the semicircle. K keeps the count of the successive bisections of the arc; and the sum of the chord lengths, which progressively approaches the circumference of the circle, is printed.

Running the program on my pocket computer gives π correct to the sixth place of a decimal in the tenth iteration. Thereafter, the values printed become erratic—fluctuating above and below π—presumably, due to errors in the ever-smaller values of B involving computation or two square roots. On the nineteenth iteration, the value returned (printed) is suddenly zero. This brings out the limitations in achieving reliable computations when increasingly small and large (disparate) numbers are involved.

In the first algorithm in Mr. Godfrey's letter, the value of P (π) to the ninth decimal place remains constant after the seventeenth iteration, as multiplication of numbers of disparate magnitudes is not involved.

S. N. Vinze
Vientiane, Laos

continued



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FIXES

The following lines of code for listing 1, KAREX1, in the article "Karmarkar's Algorithm" by Andrew M. Rockett and John C. Stevenson in the September issue contained mistakes and are herewith presented in their corrected form.

```
228 FOR C = 1 TO N: A0(C) =
      1/N : XNEW(C) = A0(C)
.
.
.
334    I = R + 1
.
.
.
357 FOR R = 1 TO N :
     FOR C = 1 TO N :
      FOR J = 1 TO
       K1:B3(R,C)=B3(R,C)
             +B2(R,J)*B(J,C):
       NEXT J:
     NEXT C :
    NEXT R
.
.
.
388 FOR C=1 TO N : AA = AA +
      XNEW(C) : NEXT C
```

Michael J. Sorens' article, "Programming Insight: Teaching Old Screens New Tricks," in the September issue, contained incorrectly punctuated Pascal code fragments.

In each case where a double quotation mark (") is followed by either an alphabetic or numeric character string, which is in turn followed by a single quotation mark ('), as in

```
BrightControl = "[1m';
```

the correct punctuation would be to use single quotation marks both before and after the character string, as in the following:

```
BrightControl = '[1m';
```

In cases where a double quotation mark appears by itself, as in

```
if (ExistingStyle = ") then
```

the correct usage would be two single quotation marks, as in

```
if (ExistingStyle = '') then
```

Additionally, in the final line of code fragment M on page 131, the word `ScreenImage` should read `^ScreenImage`.

Reviewer's Notebook in the October issue contained errors in the units of data transfer for the ALR 386/2 Model 40, Compaq Deskpro 386, and IBM PS/2 Model 80. The correct rates are all in K bytes per second, not K bits per second.

The October What's New item on NeuralWorks (page 45) reported what was an introductory price of $99. The price of NeuralWorks is now $495. For more information, contact NeuralWare Inc., 103 Buckskin Court, Sewickley, PA 15143, (412) 741-7699.

Kyocera wrote to inform us that "although the review of the F-1010 printer (October) said 'there is no provision for storing the cap,' there *is* a place to store the waste bottle cap—approximately 3 inches to the right of the bottle."

The telephone number for Canon U.S.A. Inc. was printed incorrectly in the October issue. The correct telephone number is (800) 221-2200 (in Utah, (800) 662-2500). ■

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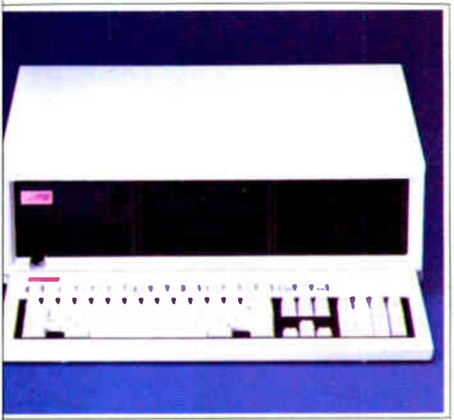

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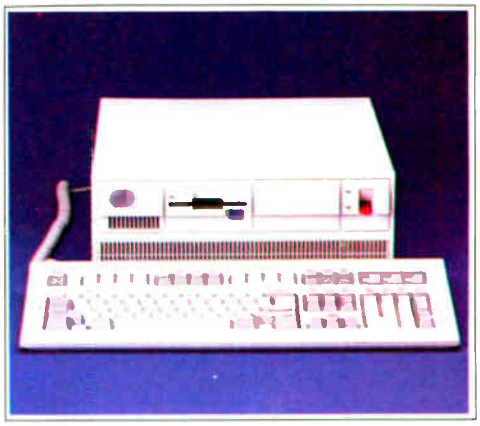

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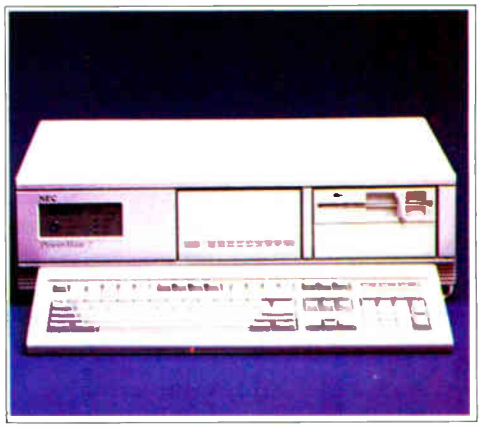

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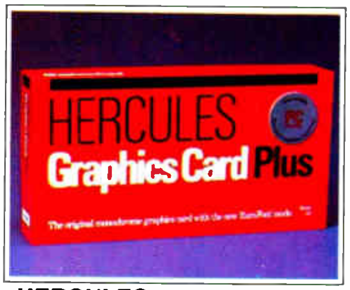

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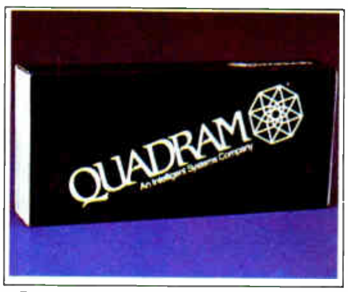

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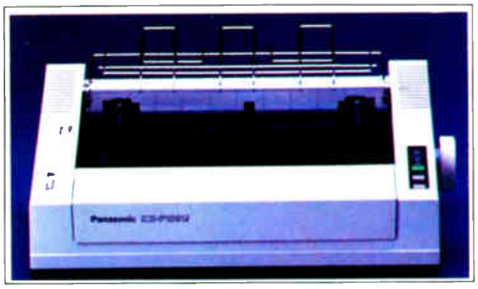

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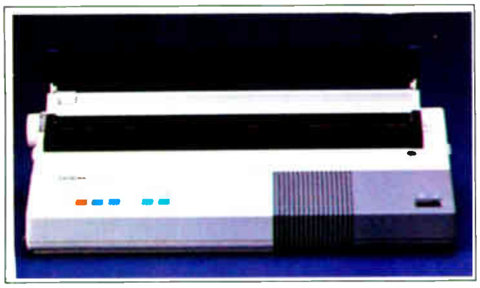

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- Friction and Pin Feed

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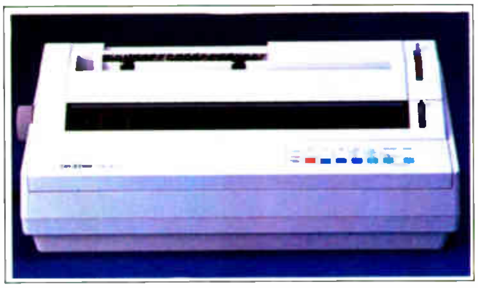

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- 2 Color Printing
- Friction and Forms Tractor

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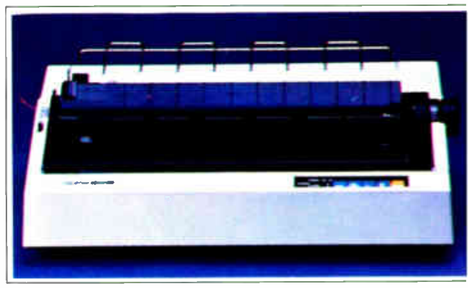

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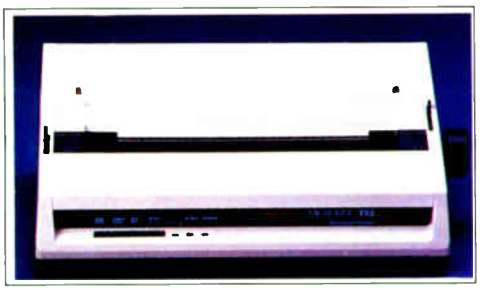

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- 80 column, 8K Buffer

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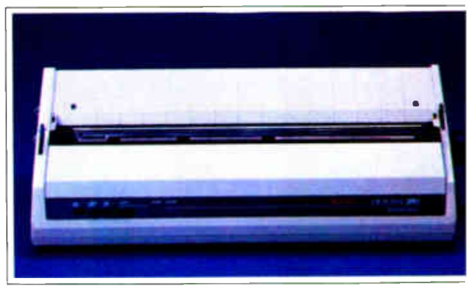

OKIDATA ML-293
- Dual 9 Pin Dot-Matrix
- 240 cps Draft/100 cps NLQ
- 136 column, 8K Buffer

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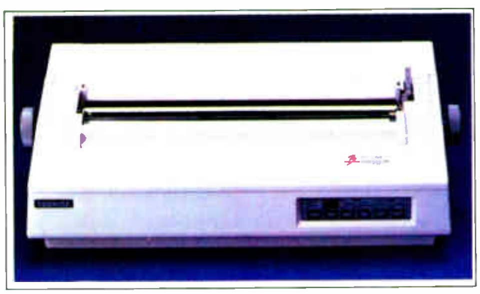
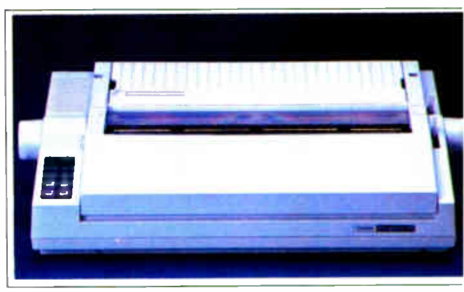


TOSHIBA P351-II
- 24 Wire Print Head
- 288 cps Draft/100 cps NLQ
- 136 column

No. TB351S **$889**



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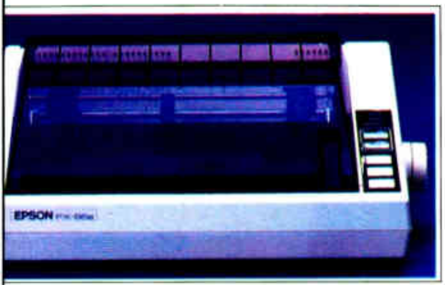

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9 Wire Dot Matrix
Selectype Control Panel
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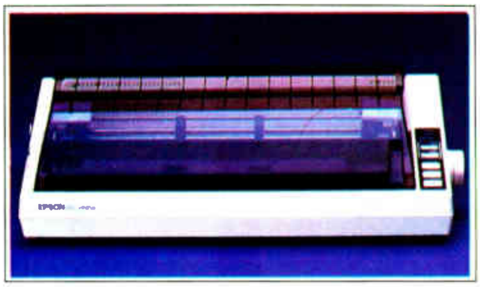

EPSON FX-286E
- 240 cps Draft/40 cps NLQ
- 132 Column, 8K Buffer
- Friction/Tractor Feed

No. EPFX286E
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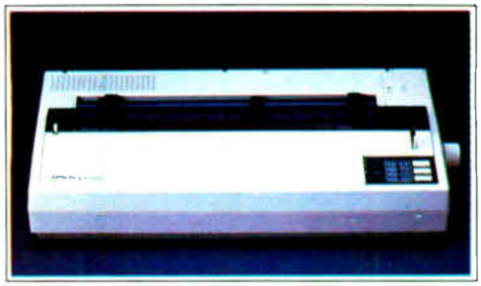

EPSON EX-1000
- 9 Pin Dot Matrix
- 300 CPS Draft/50 CPS NLQ
- 132 Column, 8K Buffer

No. EPEX1000
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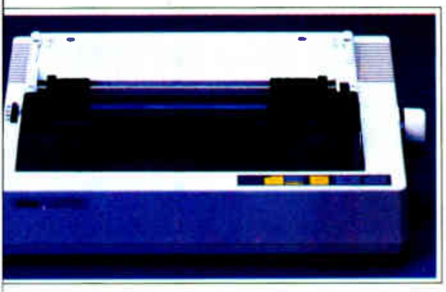

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120 cps Draft/30 cps NLQ
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Friction and Tractor Feed
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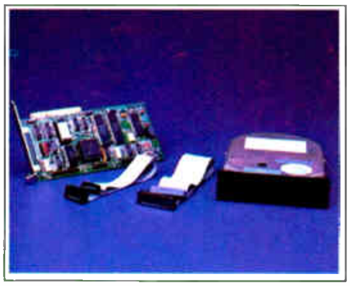

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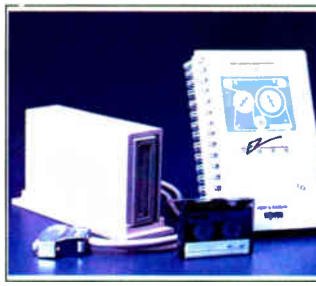

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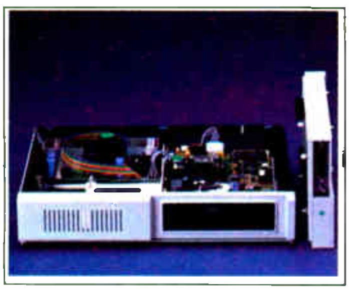

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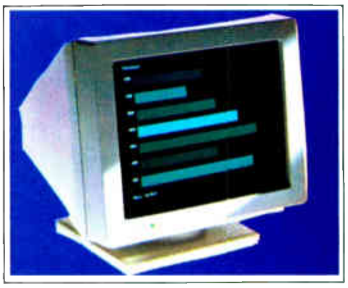

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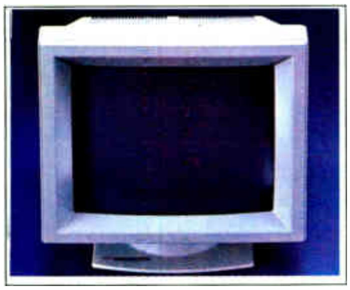

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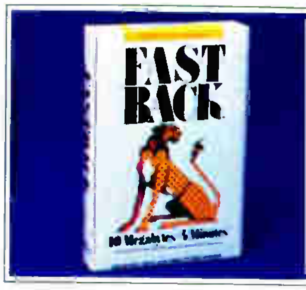

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No. ICMR02

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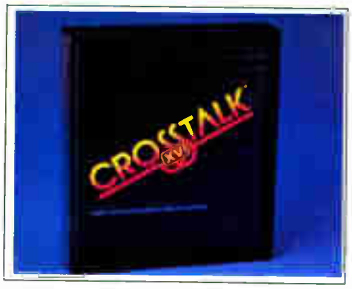

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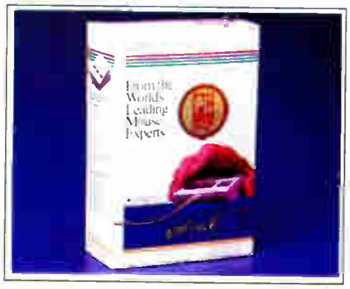

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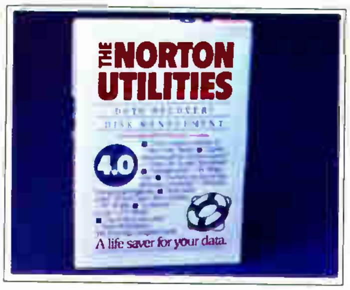

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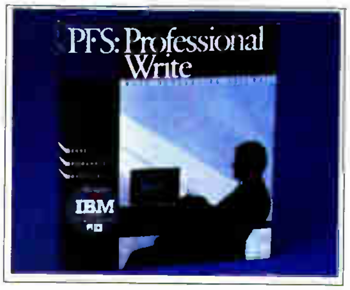

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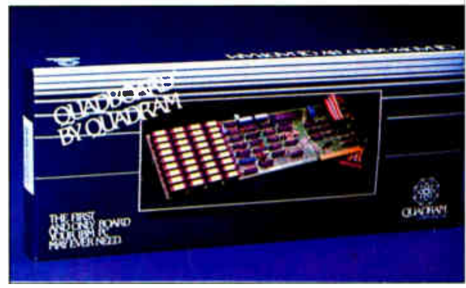

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CHAOS MANOR MAIL

Conducted by Jerry Pournelle

Now, an Atari Defense

Dear Jerry,

I don't want to start another fight. But I felt I had to respond to Ali Ozer's letter regarding the Amiga and Atari operating systems (Chaos Manor Mail, September, page 32). Mr. Ozer is woefully uninformed, as are many people, about the design of the Atari operating system. He appears to conclude that there is no good reason for the ease with which programs can be ported from MS-DOS to the ST, other than the fact that the ST is a primitive device that avoids the subtleties of a multitasking OS.

The fact is, several significant features of the ST promote porting from the IBM PC environment. The floppy disk format, file structure, and directory organization are virtually identical to that of MS-DOS, right down to the file-allocation tables (they are file-compatible out of the box, and full media compatibility is easily achieved). The high-level GEMDOS calls have the same identification numbers as their MS-DOS counterparts. The keyboards have most of the same key codes. Finally, the GEM implementation provides a particularly familiar environment for programmers who have used it on the IBM PC.

Back to multitasking for a moment. The ST does indeed have a time-slicing event manager. This is what allows me to have desk accessories such as text editors, terminal emulators, and alarm clocks available while I work on my spreadsheet concurrently—to say nothing of background tasks such as print spooling, smart-caching, and timed backups.

Is this "true" multitasking? No. The event manager is passive, not active, and it relies on the polite behavior of the various programs. And desk accessories are fundamentally, although not functionally, different than applications programs. Theoretically, I suppose you could download a YMODEM batch in one task, compile and link a megabyte of source code in another, and play chess in the foreground, provided the programs were all well behaved. Unfortunately, many are not—a problem not unique to the ST.

In any case, the facilities for time-slicing on the ST are significant and, from a programmer's point of view, easy to manage. The ST exceeds the Macintosh in this one regard, and I hardly consider the Mac's OS to be primitive. Somehow, I think it will be a while before OS/2 gets out the door. But if multitasking is sorely needed, several alternative OS packages are available for the ST, some of which even support multiple terminals (e.g., Unix emulators, OS/9, and Micro-RTX). In summary, a programmer has no more business polling the keyboard in a loop on the ST than he or she does on the Amiga.

As to the 40-folder limitation, that subject has been beaten to death. This is a bug in the OS, hardly a design feature. The problem is in the number of folders accessed since boot-up; due to a garbage-collection strike in a sandwiched buffer, saturation can occur. I have about 70 folders on my hard disk, and I have never experienced the problem. But if I do, several public domain patches are available that cure the problem. I doubt if anyone would claim that the Amiga OS is bug-free, so we all just move on.

I agree wholeheartedly with Mr. Ozer that programmers need to invest more effort in writing applications that adapt to their environment, rather than the other way around. As operating systems become smarter, it will be easier for programmers to let them be the boss. For now, MS-DOS isn't there; even the Amiga isn't there. But the Mac, the ST, and the Amiga are all steps in the right direction.

Paul B. Loux
Denver, CO

You aren't starting a fight, and you've said it better than I could.—Jerry

More on Mac Clones

Dear Jerry,

I was intrigued by the letter in your August column from Richard H. Goodyear (page 268) and his observation of the lack of a Macintosh clone on the market. His letter implied that business people have a personal dislike for the Macintosh computer and that this was the reason for the lack of a clone. This line of reasoning is faulty at best, and it perpetuates the misguided stereotype of the selfish business persona.

The Macintosh has several unique characteristics that make it much more difficult to replicate than the IBM line of

continued

personal computers. The first and most obvious of these is the graphic interface incorporated into the firmware of the design. This covers several points, from the strict copyright of source code to the visual design of the interface itself. I don't know how large a firm Phoenix is, but on a comparable scale it would take a Microsoft- or Lotus-size software house to provide the necessary resources for such a venture.

In terms of firmware replication, Apple offers several levels of service more than IBM does. Both systems provide the BIOS type of functions to provide basic control of the hardware. However, Apple provides an additional set of interface routines—the Toolbox managers—to standardize the operating characteristics of all hardware and to standardize the visual interface.

A clone maker must provide for an interface that could take a similar piece of hardware and drive it in a way that would make the applications and data function from a low-level read and write perspective; provide a graphic interface to control these functions in a comparable fashion; and provide an interface that, while functionally compatible, would not violate the implied visual copyright the courts have said exists.

The hardware of the Macintosh also provides a challenge to the clone maker. The drive controller is a descendant of the Integrated Woz Machine provided in the Apple II systems. Since Apple won't provide the license for this to third parties, it must be emulated either in software, through other hardware logic, or both. The 800K-byte floppy disk drive specifications could probably be created from available components, as could the 60-hertz screen, although these are not readily available. So, unless very large quantities could be assured, the OEM would probably be paying premium prices for initial quantities.

All of this points to the fact that at the moment it is probably too costly to design and market a Macintosh clone. The IBM machines provided that marketing opportunity through IBM's policy of maintaining a high-cost, high-image, high-contact focus on its customers. That market saw the development of several BIOS structures of compatible nature and the development of intelligent consumers who did not want the blanket service IBM was providing.

It appears that the general market likes the Macintosh, since Apple sells enough of them, so it is not as if a clone would not be appreciated. However, if the Macintoshes were overpriced, then, in all likelihood, clones would have been created already. Apple provides a moderate amount of service, but the Macintosh does not require the intense handholding that an IBM PC–style machine does. The interface acts as a buffer against the technology that sends the beginner into shock. Therefore, Apple's price reflects more directly the cost of the technology in the box, and less the support components outside the box.

Many other reasons and supporting facts surround this issue. The point is, it is not impossible to create a Macintosh clone—just that, for the moment, it is improbable. The business people have made a decision not on personal prejudice, but on a good amount of common sense.

Thomas J. Esser
Menomonee Falls, WI

I'm not sure that flogging heck out of the CPU chip by making it do the display and the disk control is all that great a notion in this era of inexpensive chips, especially if you then sell the machine for a lot of money, as Apple did with the Mac, but I see your point.—Jerry ■

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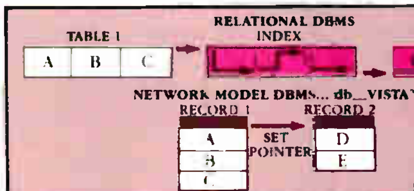

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ASK BYTE

Conducted by Steve Ciarcia

Once More Through the Sieve
Dear Steve,

In the May 1986 "Ask BYTE," James L. Barnett asked you whether the Sieve of Eratosthenes is "some classic mathematical joke." You responded with the correct reference to Donald E. Knuth's book, *The Art of Computer Programming, Volume 2: Semi-Numerical Algorithms* (Addison-Wesley, 1969). However, Mr. Barnett is right. The Sieve of Eratosthenes benchmark is an erroneous implementation of the algorithm for counting prime numbers from 2 to *n*.

Let $p(n)$ denote the number of primes from 2 to *n*. Please compare: $p(10)=4$ and $p(100)=25$, and not 8 and 45, respectively, as provided by the published Sieve benchmarks. I suggest that the Sieve of Eratosthenes benchmark should be changed to the mathematically correct version, to have Eratosthenes and other mathematicians on your side.

Listing 1, a correct version of the Sieve of Eratosthenes, is written in Turbo Pascal. This program is interactive, but I've kept input error-trapping features to a minimum. It computes $p(n)$ for *n* from 2 to `MaxInt-1 = 32766`. The comparison of $p(n)$ to $n/ln(n)$ at the end of the program refers to a well-known theorem in number theory: that $p(n)/(n/ln(n))$ approaches *l* as *n* approaches infinity.

Rastislav Telgarsky
Dept. of Mathematics
University of Texas
El Paso, TX

BYTE's first article on the Sieve of Eratosthenes, by Jim Gilbreath, appeared in the September 1981 issue. Another article, "Eratosthenes Revisited: Once More through the Sieve," by Jim and Gary Gilbreath, appeared in the January 1983 issue.

The Gilbreath version of the Sieve, which has been used as a benchmark program by several magazines—including BYTE—appears to be almost exactly what Knuth had in mind in the exercise and short description of the answer in his book. The main difference is that both your and Gilbreath's programs do more counting than necessary to identify all the primes within the given range. It is necessary to flag multiples of primes only up to `sqrt(Nmax)`. *The additional counting is a result of the desire to identify and count all the primes in one pass rather than make one pass to set the flags and another to count them.*

Some confusion seems to exist over what Gilbreath's program counts; it is not as obvious as in your more straightforward program. "Once More through the Sieve" explains the operation of this algorithm quite well, but I have written a program in Microsoft QuickBASIC (see listing 2) that shows a direct comparison between your proposed implementation and Gilbreath's implementation. I think you will agree that they both accomplish the same thing by slightly different paths.

First, the principle that Eratosthenes developed, as implemented in your program, is that if you begin with the first prime after 1, you can find all primes by eliminating all multiples of each remaining number in turn. So, after eliminating all multiples of 2, the next number is 3; after eliminating all multiples of 3, the next number is 5, and so on. You continue until all nonprimes up to the desired limit have been eliminated. I have modified your algorithm to save the primes in an array and included it as the second half of listing 2. This allows direct comparison of the results with Gilbreath's method. After all, the question to be resolved is whether both programs count the same items.

My modifications create arrays `prime1` *and* `prime2` *of size 4000 to save all primes for* `size` *up to 32,767. The program also tests* `sizechk=size/2` *before an element is nulled. This was necessary because the product* `i*j` *is sometimes greater than* `size`, *in both methods, causing an overflow or out-of-bounds error. Both of these changes slow the program considerably, and they are not proposed as permanent additions to benchmark.*

The Gilbreath method is the first half of the program. Note that the `size` *variable input in the third line of the program is the size of the highest number to be investigated, not necessarily the number of elements in the array. In the original Gilbreath program, it would be the size of the flag array.*

Gilbreath makes use of the fact that 2 is the first prime, and all other even numbers are nonprime. Then he creates an array of flags the size `(Nmax-3)/2`, *where* `Nmax` *is the largest number to be checked, as in your program. Here is the important factor: Each element* `i` *in the flags array is a pointer to a number with the value* `2*i+3`. *There is really no array present for these numbers, because it isn't needed. If we look at a small section of the flags array, along with the virtual array of candidate primes, after several passes we see what's shown in table 1.*

Thus, for `size=10` *in the original Gilbreath method, we get 8 primes, as you*

continued

Listing 1: *Professor Telgarsky's version of the Sieve of Eratosthenes in Turbo Pascal.*

```
program Sieve_of_Eratosthenes;    { R. Telgarsky }
var
  c,d,i,j,n : integer;
  prime : array[2..MaxInt] of boolean;
  r : real;
  ch : char;
```

continued

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```
begin
  repeat
       ClrScr;
       GotoXY(30,1);
       Write('The Sieve of Eratosthenes:');
       GotoXY(10,2);
       Write('the algorithm to compute the number of primes from
                                    2 to n');
       GotoXY(17,5);
       Write('Enter a number not larger than 32766: n= ');
       {$I-} ReadLn(n);  {$I+}
       if IOResult <> 0 then exit;
       if (n<2) or (n>MaxInt-1) then exit;
       GotoXY (34,7);
       Write('Computing...');
{--------Here the Sieve of Eratosthenes begins--------}
       for i:= 2 to n do prime[i]:=true;   { initialize the
                                    array }
       c:=0;                     { set count to zero   }
       i:=2;                     { start with first prime }
       while i<=n do             { i loop          }
       begin
            if prime[i] = true then
            begin
 { Write(i,' '); }       { if you wish         }
  c := c+1;
  for j := 2 to n div i do prime[i*j]:= false;
            end;
            i := i+1;
       end;
{--------Here the Sieve of Eratosthenes ends--------}
       GotoXY(17,12);
       Write('The number of primes p(n) from 2 to ',n,' is ',c);
       GotoXY(17,14);
       r := n/ln(n);
       GotoXY(17,16);
       Write('The ratio n/ln(n) is ',r:2:2);
       d := Round(Abs(c-r)*100/c);
       GotoXY(17,18);
       Write('The difference between p(n) and n/ln(n)
                                    is ',d,' % ');
       GotoXY(17,24);
       Write('Press <ESC> to quit or any character to repeat.');
       Read(Kbd,ch);
       ClrScr;
  until ch = #27;
end.
```

Listing 2: *A program to compare the technique in listing 1 to the technique used by the BYTE Sieve of Eratosthenes (originally written by Jim Gilbreath). This program is written in QuickBASIC.*

```
' QuickBASIC program to compare the Byte Sieve algorithm
' with the more obvious implementation of the Sieve of
' Eratosthenes. Start by defining all variables as integer
' up to s. Save t for floating-point timer.
defint a-s
true = 1
false = 0
input "Input Size, 32764 or less ",size
size = (size-3)/2
print "BYTE Sieve program, BYTE, Sept. 1981, page 188"
dim prime1(4000), prime2(4000)
rem $dynamic

dim flags(size+3)

'Initialize the flag array
for i=0 to size
```

continued

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```
  flags(i)=true
next

'Now set the flags
j=0
t0=timer
prime1(0)=2          'Initialize the first value to make the array
sizechk=size/4       'consistent with the second method
count=1
for i=0 to size
  if flags(i) = true then
       prime1(count) = i+i+3
       if (0.5*i)+(0.5*prime1(count)) <= sizechk then
                                                k=i+prime1(count)
       while k <= size
             flags(k) = false
             k = k + prime1(count)
       wend
       count = count+1
  end if
next i
count = count - 1
t1=timer
tdt = t1 - t0
print "Time to count ";count+1;" primes was ";tdt;" seconds"
print

' Professor Telgarsky's version converted from Turbo
' Pascal to QuickBASIC
print " Professor Telgarsky's version"
' Initialize the flag array
size = 2 * size + 3        '16383
redim flags (size+3)           '16384
for i=0 to size
  flags(i) = true            'Set all flags true
next

'Now set the flags and save the primes
k=0
count=0
t0=timer
i=2
sizechk = size/2
while i <= size
  if flags(i) = true then
       prime2(count) = i
       count=count+1
       for j=2 to (size)/i
            if (0.5*i)*j <= sizechk then flags(i*j) = false
       next j
  end if
  i = i+1
wend
t1=timer
tdt = t1-t0
count = count-1              'Because it was incremented AFTER the
                                    last prime was found.
print " Time to count ";count+1;" primes was ";tdt;" seconds"

'Now compare the results of the two methods
for k1 = 0 to count+1
  if prime1(k1) <> prime2(k1) then
       print k1, prime1(k1), prime2(k1)
  end if
next k1
print
print "Comparison complete"
print "Last prime was ";prime1(count)
end
```

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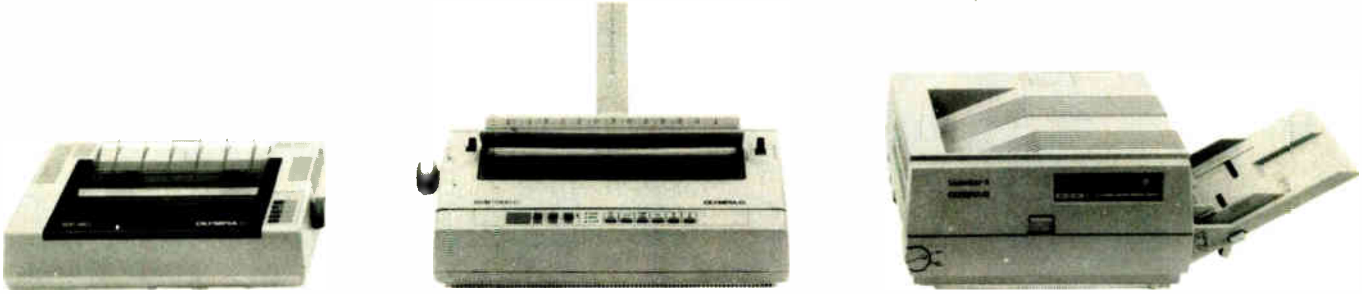

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Table 1: *After several passes of Gilbreath's Sieve, the first 10 elements (as indexed by* `i` *of the* `flag` *array) are set to the values shown in the second column. The* `flag` *array entries "point" to numbers with the value* `2*i+3`*, and this equation is shown carried out in column 3. As you can see, the first 10 elements actually identify the primes between 0 and 21.*

i	flag	2*i+3
0	T	3
1	T	5
2	T	7
3	F	9
4	T	11
5	T	13
6	T	15
7	T	17
8	T	19
9	F	21

found; but this is 8 primes in the range of numbers from 2 to 21, not 0 to 9 or 1 to 10. When the Gilbreath program is run for 8192 elements, it really counts all primes less than 16,384.

If you run the program below and input 16,384 for `size`*, it is reduced by the equation* `size=(size-3)/2` *for the first part of the program, then restored to the original value for the second part. The result will be a count of the primes up to 16,384 for both cases, and the last prime printed is the same for both methods.*

The last loop in the program compares the two arrays of primes and prints any elements that don't match. If you want a list of primes, you can leave out the `if prime1(...` *and following* `end if` *statements.*—Steve

CIRCUIT CELLAR FEEDBACK

Miscellaneous Help Wanted

Dear Steve,

How would I get into interfacing computers and writing some small programs to run an Icon-based Home Control System (HCS)? I would also like to know how I could log onto the networks in the U.S. from this information-starved location. Finally, I am interested in the design of the AVMUX (described in the February 1986 "Circuit Cellar"). Can I interface this with the HCS?

O. R. J. D'Souza
Ruwi, Sultanate of Oman

continued

The best advice I can give you to "get into interfacing" is to read as much as you can in your areas of interest and pick some simple beginning projects to build your confidence and ability.

You probably should obtain some general software programming books that teach basic structured techniques and some machine-specific books (i.e., programming on the IBM PC). Almost any major book distributor would have plenty of good titles. Ads in BYTE list sources for good technical computer books.

As far as logging onto the networks here in the U.S., I suspect the cheapest way is through the international telephone system. Unfortunately, that may prove intolerable for various reasons—especially line quality. The BYTE Information Exchange (BIX) is available through local postal telephone and telegraph companies; BYTE lists access information. If you are near a university with a moderate-size computer center, you may want to contact it to see if it has any network accesses. BITNET is one such worldwide information system that allows mail and file sending across it at a very low cost.

I am assuming that you want to actually develop the icon-based software for driving the AVMUX and the HCS. Writing an interface of that nature can be a complex task, but it is simplified if much of the actual graphics drivers are already written. One inexpensive toolkit is the Turbo Pascal Graphics package from Borland (4585 Scotts Valley Dr., Scotts Valley, CA 95066), which contains well-written tools for all kinds of graphics applications on the IBM PC and compatibles. In a nutshell, you need to write a series of driver routines, some that interface to the hardware to perform the low-level tasks of setting switches and control information, the mid-level tasks that coordinate the sequence of low-level activities, and the high-level tasks that are the main choices of action and control from the user's perspective.—Steve ■

Between Circuit Cellar Feedback, personal questions, and Ask BYTE, I receive hundreds of letters each month. As you might have noticed, in Ask BYTE I have listed my own paid staff. We answer many more letters than you see published, and it often takes a lot of research.

If you would like to share your knowledge of microcomputer hardware with other BYTE readers, joining the Circuit Cellar/Ask BYTE staff would give you the opportunity. We're looking for additional researchers to answer letters and gather Circuit Cellar project material.

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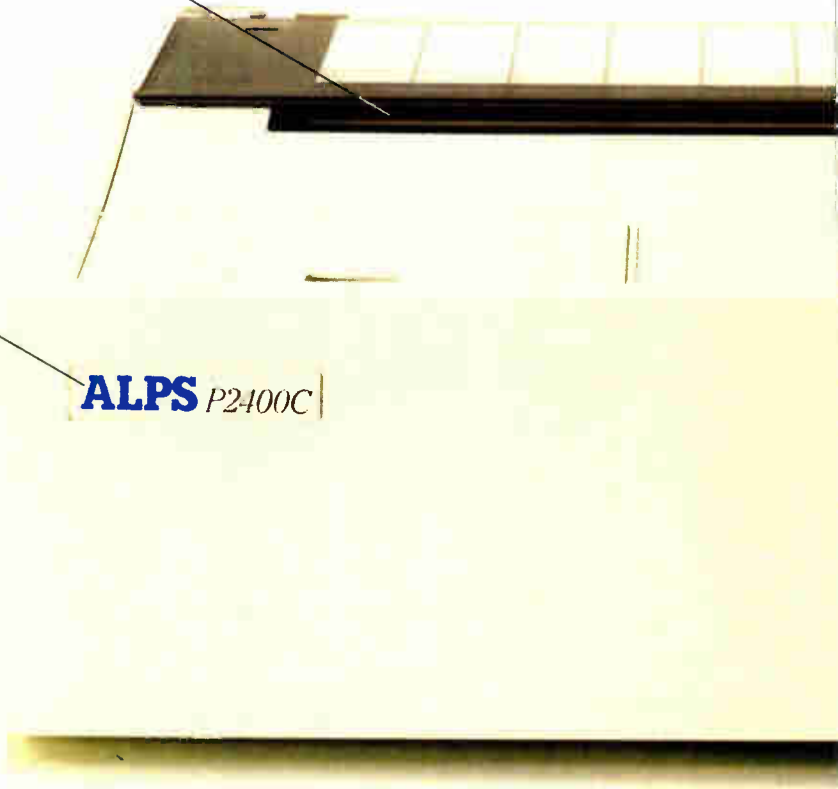

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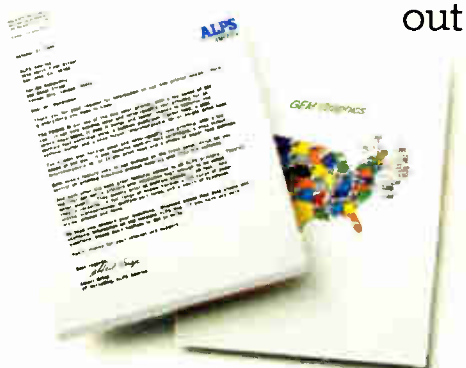

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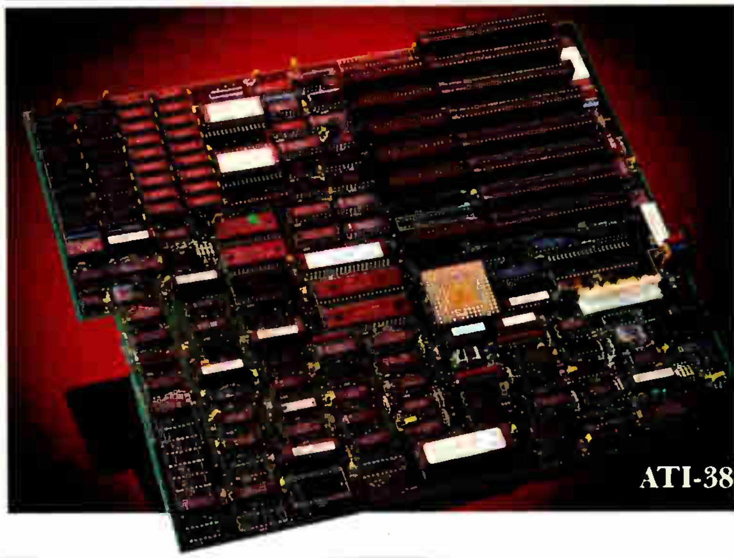

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BOOK REVIEWS

DIGITAL SIGNAL PROCESSING
R. A. Roberts and C. T. Mullis
Addison-Wesley
Reading, MA: 1987
ISBN 0-201-16350-0
578 pages, $44.95

PROLOG PROGRAMMING: APPLICATIONS FOR DATABASE SYSTEMS, EXPERT SYSTEMS, AND NATURAL LANGUAGE SYSTEMS
Claudia Marcus
Addison-Wesley
Reading, MA: 1986
ISBN 0-201-14647-9
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Glenview, Il: 1987
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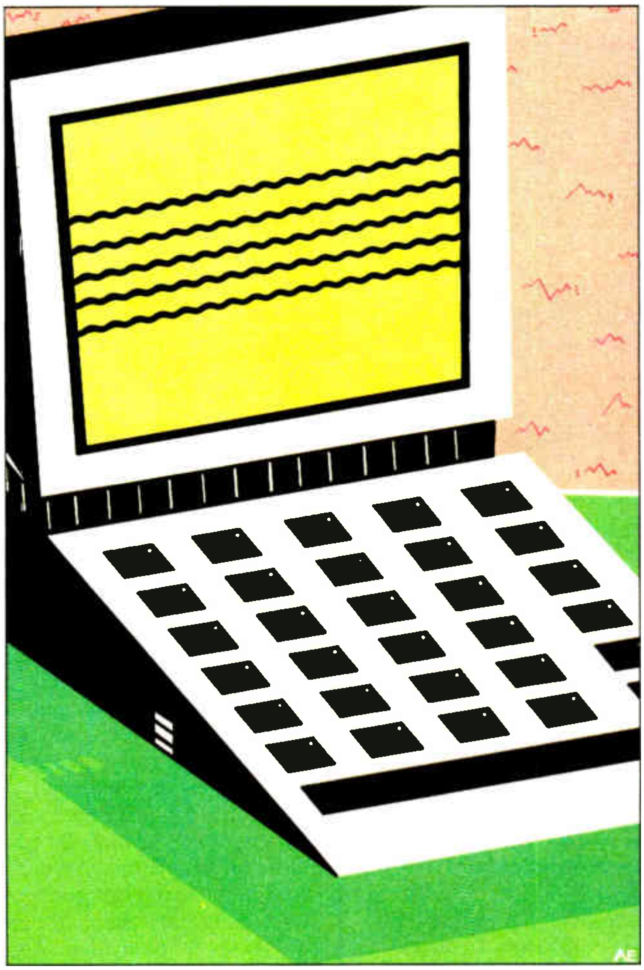


DIGITAL SIGNAL PROCESSING

Reviewed by John V. Olson

Digital Signal Processing by R. A. Roberts and C. T. Mullis presents a broad selection of topics relating to digital signal analysis in what has become the traditional approach in engineering. The material is sufficient for a two-semester college course at the junior- or senior-year level.

The authors begin with the definition of discrete-time signals and the systems that produce them. Unlike other texts that attempt to justify the use of discrete mathematics by showing the connection to sampled analog signals, this book starts with a discussion of a discrete sequence of numbers as a signal without encumbering the reader with the possible sources of such a signal sequence.

Fundamentals for All

The first four chapters review the fundamental concepts of linear systems, time-invariant systems, Fourier transforms, and Z transforms. Roberts and Mullis present extensions and applications clearly, and the classic transform theorems are tabulated for easy reference. The applications themselves are succinct. The authors discuss in detail the distinction between Fourier transforms that are continuous in time and frequency and those that are discrete.

Next, the authors discuss the sampling theorem, a core concept of digital signal processing. They develop the sampling theorem through discussion and example until the complete theorem is stated. This approach works well if students are careful to work their way through the material. A subsequent chapter shows the development of several of the most common algorithms for calculating the fast Fourier transform.

Problem Applications

The rest of the book applies transform techniques to engineering problems. The bulk of the material is connected in one way or another to the task of filtering signals to remove noise. Simple low- and high-pass filters are treated as examples in several of the introductory sections. These intuitive ideas are developed more fully in a single chapter that covers the design philosophy of both finite-impulse response and infinite-impulse response filters. The discussion here is brief, but complete. A great deal of work outside the classroom is required for the student to master this material.

Next, Roberts and Mullis turn to the development of a least-squares approach to filter design, an important and powerful technique not usually discussed in books at this level. Students who master this material will be prepared for a more extensive course on adaptive algorithms and Kalman filters. A final chapter on spectral estimation focuses on the characteristics of auto-regressive sequences and the estimation of their spectra.

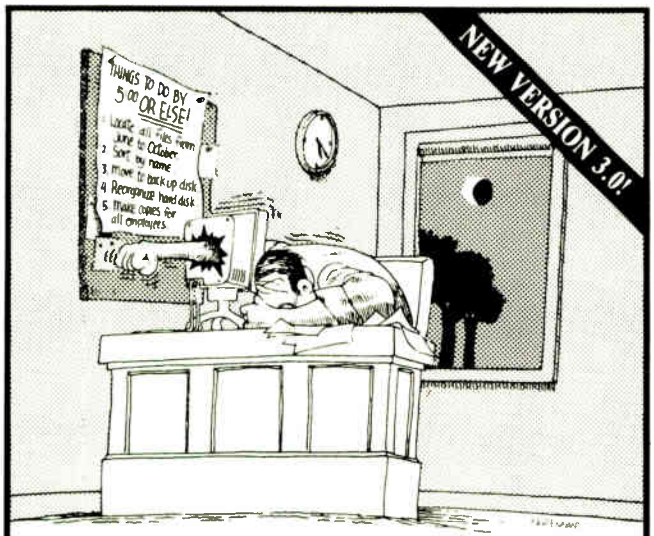
Finally, three chapters are devoted to a discussion of the implementation of digital filters in hardware. Included here are discussions of finite-length register effects, such as the quantization noise associated with A/D conversion and round-off noise. The last chapter covers the design of general digital-processing structures and discusses the problems in interpolation, decimation, and multirate filters.

An Effective Approach

Throughout the book, the authors develop ideas with a design motivation; they work through numerous examples that develop the student's intuition and finish with a complete statement of

continued

Illustration by Andrea Eberbach



the concept at hand. This is a very effective approach, especially in an engineering context, where the emphasis is more on design and implementation and less on the rigorous sequential development of theorem and proof. The material in each chapter is supported with numerous problems that students can use to evaluate and extend their understanding of the material. The mathematical context is modern and lucid, the notation and concepts of linear algebra are especially effective in the formulation of signal analysis, and the authors' presentation is clear, concise, and consistent. The material is arranged in a modern format, unencumbered by the mathematical orientation popular in books written 10 years ago.

Digital Signal Processing breaks new ground in its coverage of recent developments in the application of least-squares techniques to filter and system design and in its discussion of spectral estimation. While I found the signal flow graphs used to describe the processes under discussion a liability due to their cumbersome complexity, they are presented as a supplement to aid analysis and understanding and do not block the comprehension of the material. Whether used as a primary text or as supplementary reading, this book should find its place on the shelves of students and instructors alike.

John V. Olson (1543 Scenic Loop, Fairbanks, AK 99709) is an associate professor of physics at the University of Alaska.

PROLOG PROGRAMMING: APPLICATIONS FOR DATABASE SYSTEMS, EXPERT SYSTEMS, AND NATURAL LANGUAGE SYSTEMS

Reviewed by Alex Lane

Prolog Programming by Claudia Marcus is a serious attempt to show how Prolog performs as an applications language. This is in response to skeptical queries about the practical applicability of the powerful and flexible Prolog language.

Since Marcus is the principal technical writer at Arity Corp., you might wonder whether the book was written to promote Arity/Prolog or whether any of the applications in the book depend on a language extension found only in Arity products. However, aside from a 20-page appendix summarizing the features of Arity/Prolog, the author scrupulously maintains her neutrality. As a result, the book can be used with any Prolog that implements the Edinburgh, or DEC-10, syntax.

Prolog Programming: Applications for Database Systems, Expert Systems, and Natural Language Systems wastes little time discussing language issues. Instead, it quickly gets down to the writing of topical Prolog applications. In her preface, Marcus targets the book's audience as programmers who are somewhat familiar with traditional programming languages, such as C and Pascal, and who want to start writing Prolog applications without delay. She gives fair warning that the broad range of her chosen subjects limits the depth of her explanations.

After a pair of brief introductory chapters, Marcus focuses on databases, expert systems, and natural-language systems. She begins by examining Prolog's internal database, discussing database scoping, hash tables, and binary and balanced trees with brief examples. Next, she devotes a chapter to developing a relational database in Prolog with examples that contrast Prolog queries of the database to those made in Structured Query Language (SQL).

Unfortunately, Marcus has little time or space to dwell on explanations of SQL, so beyond a citation to a book containing a description of SQL, she provides little information to help those in new conceptual territory. References to SQL, however, con-

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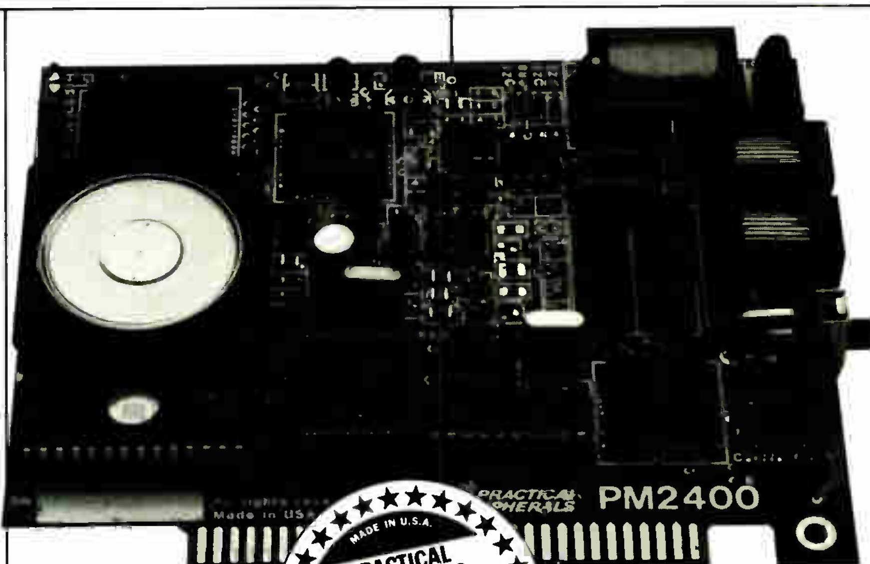

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tinue to plague the rest of the chapter as the author discusses SQL predicates and the transformation of SQL queries into Prolog questions. A few pages after the first reference to SQL, the concept of normalization flashes past as the reader is handed a one-liner about there being five "normal forms," a citation to another database text, and the reassuring news that "only the first normal form will be dealt with here."

The book seems pressured like this most of the time. In fact, unless Marcus is actually leading the reader through the building of an application, the pace of her text is breathtaking. She introduces new concepts and terms in rapid succession. For example, three important Prolog terms—matching, unification, and instantiation—are presented and defined in less than a page in the introduction. Another half-page is devoted to one of the toughest of Prolog concepts—the cut—and its use is discussed only briefly over half a dozen pages. Clearly, the reader will benefit from prior familiarity with the subjects in this book.

Discussion of Expert Systems

Expert systems are covered in two chapters. The first is devoted to techniques for building expert systems; the second, to writing an expert-system shell. After a too-brief explanation of expert-system components in the first chapter, Marcus settles down to discuss the use of production rules (`IF...THEN` rules) to solve the grocery-bagging problem from Patrick Henry Winston's *Artificial Intelligence* (2nd ed., Addison-Wesley, 1980).

After developing all the rules, Marcus shows the reader how Prolog goes about proving its goals. She discusses the differences between backward- and forward-chaining expert systems, then goes on to consider a second method of defining knowledge—frames—and develops a more sophisticated expert system that gives advice on financial investments and explains its reasoning. The chapter ends with a valuable discussion of uncertainty and considers Bayesian, fuzzy, and standard confidence factors and their manipulation.

The second chapter on expert systems builds on the first one. Marcus describes a rule-based expert-system shell that bears some resemblance to Teknowledge's M1 shell. After developing a rule language and showing how the rule language is translated into Prolog, she examines how Prolog finds solutions. The shell is put through its first paces with a small (seven-rule) application that attempts to find the reason why a computer won't boot. The same shell is then used to develop a rock-climbing expert system whose rules occupy 14 pages of the book.

Natural-Language Systems

The author's approach to natural-language systems is roughly the same as for expert systems; one chapter is devoted to language-processing techniques, and another is devoted to natural-language processing. I found the first chapter's routines and explanation of tokenization clear and portable to a variety of applications.

Marcus then shows how the Prolog reader—the mechanism by which Prolog accepts terms from the keyboard—and Prolog's facility for operator definition permit the creation of systems that can directly parse an expression like `define bird is-an animal with song`. The chapter closes with a section devoted to definite-clause grammars (DCGs), which are a built-in extension of context-free grammars and are capable of parsing the more complex expressions or catching errors in statements that the reader would reject.

The final chapter focuses on a simple natural-language system that processes questions and answers about airline flight schedules. Marcus goes through a definition of the natural language and building of the parser, explains what the system does to answer user queries, and shows how the system can generate

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Appendixes at the back of the book contain a summary of Arity/Prolog, source code listings for the major applications developed in the book, and a short bibliography of the book's subject areas. Both the index and the table of contents are helpful.

Time and Space

Throughout the book, the author's running commentary on the details of the code under discussion is adequate. However, when Marcus discusses generalities, her treatment becomes superficial and unsatisfying. For example, a comparison of Prolog and C data representations using a concrete example and an excerpt of C code turns out to be a near one-shot instance of relating new Prolog concepts to familiar old ideas.

If the author of this book is guilty of anything, it is of trying to cover too much material in too little space. The compromises made to achieve this goal make the book maddeningly shallow when it's not actually building code. This makes *Prolog Programming* of limited value as a major source for understanding the background behind the applications areas it discusses. However, readers who are tired of books on Prolog theory and who want some exposure to applications will find this book useful.

Alex Lane (1873 Bartram Rd., Jacksonville, FL 32207), a registered professional engineer, is the moderator of the Prolog conference on BIX. He can be contacted as "a.lane" on BIX.

OPENING WINDOWS

Reviewed by Thomas M. Houser

Opening Windows describes Microsoft Windows for the MS-DOS operating system. Of two possible approaches to a discussion of the windowing system—the user's side and the programmer's side—Bill O'Brien uses the former.

The author's territory is basically that of Microsoft's manuals, but if you need a lot of direction and require an introduction to Microsoft Windows with a few MS-DOS pointers thrown in, this may be the book for you. It may just happen to have that answer you can't find in the Microsoft manuals.

The author claims that *Opening Windows* contains many helpful hints not found in the user's manuals. Microsoft's manuals, however, are tutorial rather than simply reference manuals, and they seem adequate. If you are interested in the programmatic interface to Microsoft Windows, for example, O'Brien's book will not help.

Most of the text describes the vanguard applications that Microsoft provides to showcase its windowing package: a terminal emulator, a word processor, and a paint program.

Getting Started

The first few chapters walk through the installation procedure and describe the MS-DOS executive window. The menu bar at the top of this window contains some standard MS-DOS functions to manipulate files. O'Brien covers the basic windowing controls and explains how to pull down a menu and how to use a scroll bar.

The introduction includes thoughts about the use of a mouse, which O'Brien recommends. However, he always refers to the keyboard equivalents when describing an operation.

Applications

The remainder of the book covers the applications that Microsoft has included with the Windows system. Users will have to buy this system to run applications that may be developed in the future. Some of the applications, if not exciting, are at least

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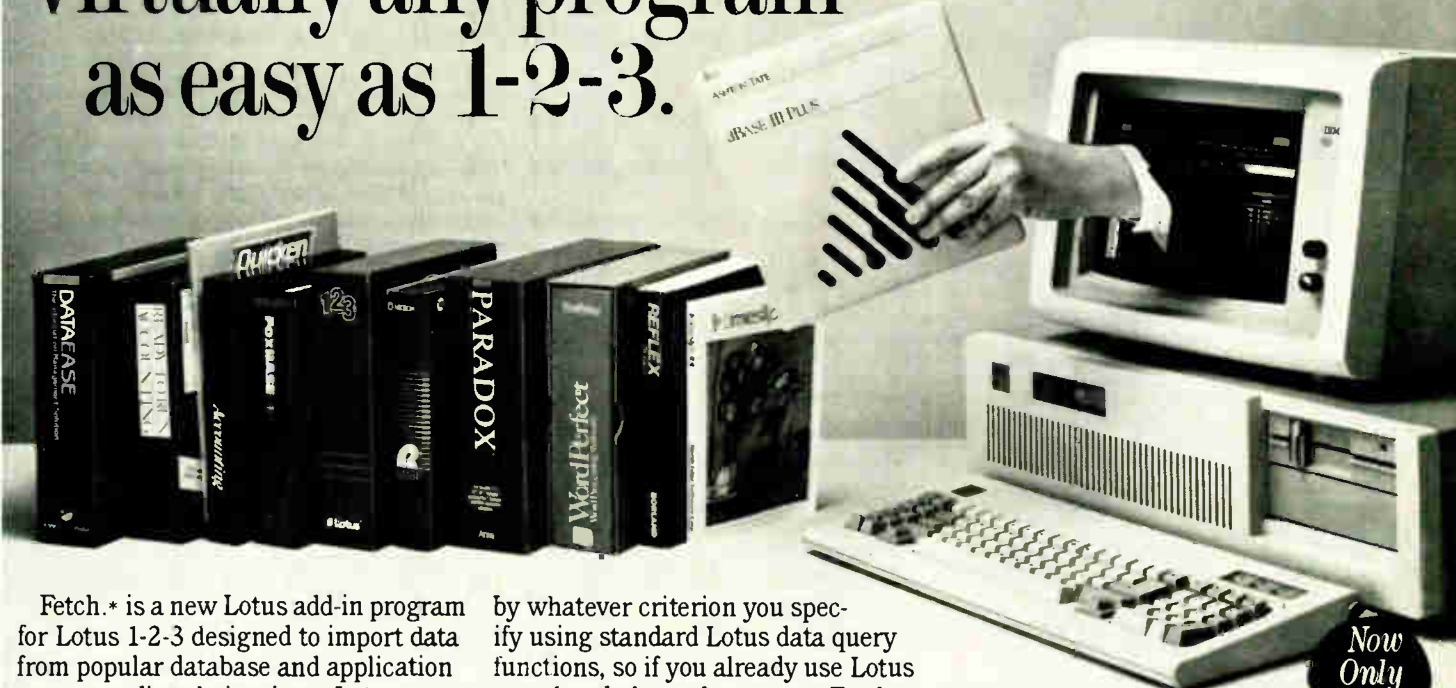

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mainstream, utilitarian offerings worthy of consideration.

The first application O'Brien pursues can be considered a meta-application: It controls the environment in which other applications run. Called Control, it is used to set things like the cursor blink rate and the time interval necessary for double-click operations to work.

The second application O'Brien follows is Desk Accessories, a collection of simple applications that includes a calculator, a note-cards file, a calendar program, and a game called Reversi. O'Brien describes Desk Accessories well, but I think you should be able to learn and use them interactively simply with the on-screen cues. During the discussion of Desk Accessories, O'Brien introduces the "clipboard," a mechanism for applications to interchange data.

At this point, O'Brien includes a chapter on how to move, size, and "iconize" windows (i.e., convert a window to an icon). To arrange windows side by side, you have to play a bit, and you have to realize that you must place the Move icon to the side of the screen to split the screen vertically between two windows. The only other anomaly is that Size and Move don't work unless there is more than one window on the screen. The model used by Microsoft is called "tiled" windows, meaning they don't overlap. O'Brien explains the concept but doesn't use the term. Because this is a tutorial on a rather new subject, the inclusion of a window lexicon would have been helpful.

The next two applications O'Brien covers should be mentioned together: Windows Write and Paint, a word processor and a MacPaint look-alike program, respectively. They work together so that you can create pictures and incorporate them into a text document. These are the most sophisticated applications in the package, and they constitute the largest chapters in the book.

Although the Write program takes up the largest chapter in the book and seems to be the most complicated, O'Brien claims in the introduction to the chapter that most of the functions should "require little or no explanation."

The last application he covers is a terminal emulator, a communications program that lets you use modems and serial direct connection to talk to other machines.

Helpful Explanations

The appendix contains information that is less obvious to the user and, therefore, more useful. O'Brien covers the contents of the `win.ini` start-up configuration file. An explanation of `pif` (the program information file) is also included. Although you shouldn't be concerned about this file type, its inclusion in the book indicates what is needed to run old applications under Microsoft Windows.

Strictly a Tutorial

Opening Windows is strictly a how-to tutorial on Microsoft Windows. O'Brien does not try to evaluate it or compare it to other windowing systems. Although he does a good job of describing the subject, this book does not go much beyond what Microsoft provides.

It is unfortunate that Microsoft has not included any help windows for any of the applications with its products, especially if these are to be the paradigm for application writers. Nonetheless, given a short list of heuristics like "point and click" or "point and click twice," most readers can learn Microsoft Windows by exploration, interactively. The instant feedback and visual cues provided by the program are superior to explanations. ■

Thomas M. Houser (2625 Northeast Seavy Place, Corvallis, OR 97330) is on the technical staff at Hewlett-Packard. He has 15 years of experience in technical applications and systems software.

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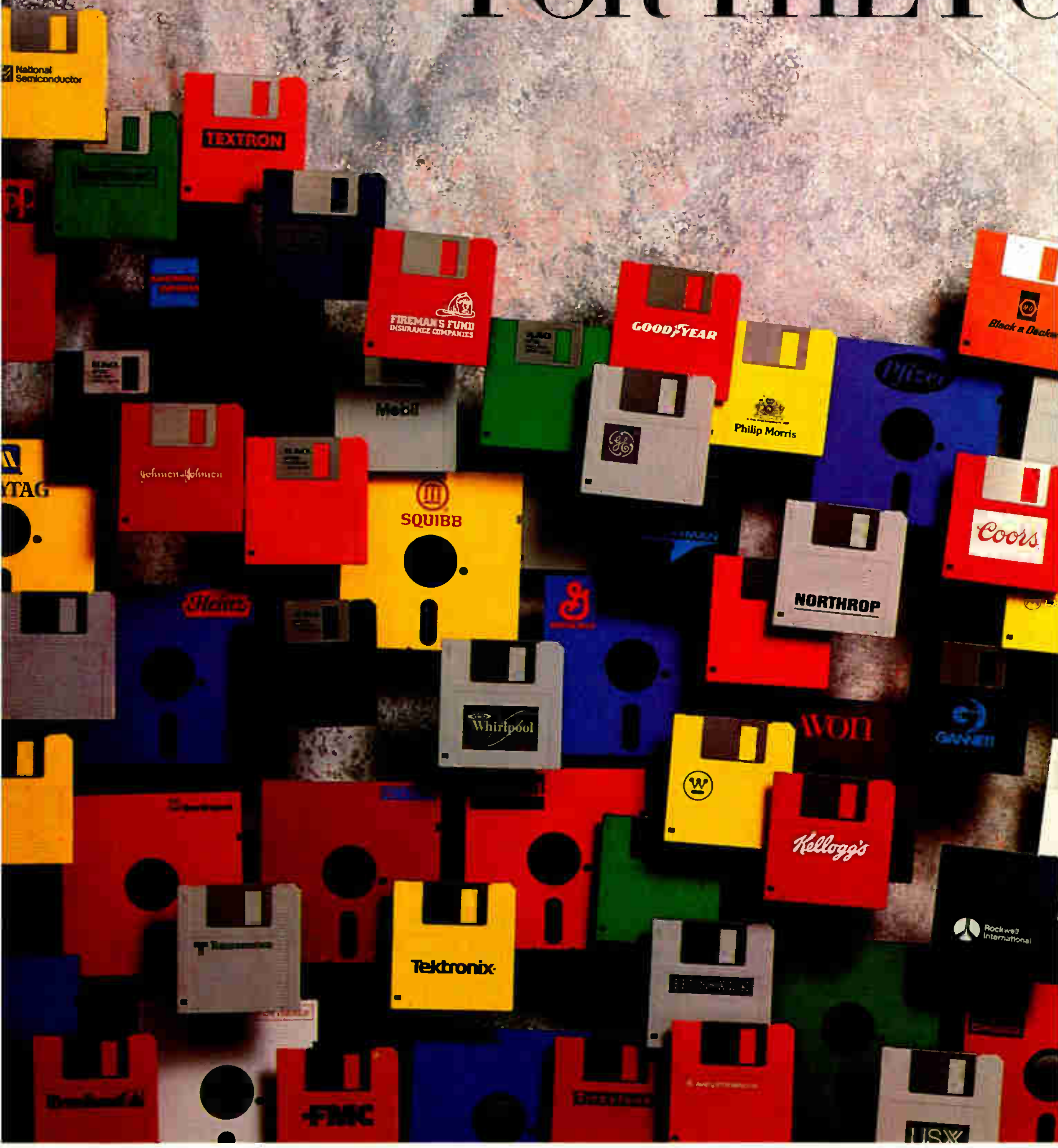

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Circle 152 on Reader Service Card

QNX vs. OS/2 UNIX

QNX: Bend it, shape it, any way you want it.

ARCHITECTURE If the micro world were not so varied, QNX would not be so successful. After all, it is the operating system which enhances or limits the potential capabilities of applications. QNX owes its success (over 30,000 systems sold since 1982) to the tremendous power and flexibility provided by its modular architecture.

Based on message-passing, QNX is radically more innovative than UNIX or OS/2. Written by a small team of dedicated designers, it provides a fully integrated multi-user, multi-tasking, networked operating system in a lean 148K. By comparison, both OS/2 and UNIX, written by many hands, are huge and cumbersome. Both are examples of a monolithic operating system design fashionable over 20 years ago.

MULTI-USER OS/2 is multi-tasking but NOT multi-user. For OS/2, this inherent deficiency is a serious handicap for terminal and remote access. QNX is both multi-tasking AND multi-user, allowing up to 16 terminals and modems to connect to any computer.

INTEGRATED NETWORKING Neither UNIX nor OS/2 can provide integrated networking. With truly distributed processing and resource sharing, QNX makes all resources (processors, disks, printers and modems anywhere on the network) available to any user. Systems may be single computers, or, by simply adding micros without changes to user software, they can grow to large transparent multi-processor environments. QNX is the mainframe you build micro by micro.

PC's, AT's and PS/2's OS/2 and UNIX severely restrict hardware that can be used: you must replace all your PC's with AT's. In contrast, QNX runs superbly on PC's and literally soars on AT's and PS/2's. You can run your unmodified QNX applications on any mix of machines, either standalone or in a QNX local area network, in real mode on PC's or in protected mode on AT's. Only QNX lets you run multi-user/multi-tasking with networking on all classes of machines.

REAL TIME QNX real-time performance leaves both OS/2 and UNIX wallowing at the gate. In fact, QNX is in use at thousands of real-time sites, right now.

DOS SUPPORT QNX allows you to run PC-DOS applications as single-user tasks, for both PC's and AT's in real or protected mode. With OS/2, 128K of the DOS memory is consumed to enable this facility. Within QNX protected mode, a full 640K can be used for PC-DOS

ANY WAY YOU WANT IT QNX has the power and flexibility you need. Call for details and a demo disk.

THE ONLY MULTI-USER, MULTI-TASKING, NETWORKING, REAL-TIME OPERATING SYSTEM FOR THE IBM PC, AT, PS/2, THE HP VECTRA, AND COMPATIBLES.

Multi-User	10 (16) serial terminals per PC (AT).	**C Compiler**	Standard Kernighan and Ritchie.
Multi-Tasking	40 (64) tasks per PC (AT).	**Flexibility**	Single PC, networked PC's, single PC with terminals, networked PC's with terminals. No central servers. Full sharing of disks, devices and CPU's.
Networking	2.5 Megabit token ring. 255 PC's and/or AT's per network. 10,000 tasks per network. Thousands of users per network.		
Real Time	2,800 task switches/sec (AT).	**PC-DOS**	PC-DOS runs as a QNX task.
Message Passing	Fast intertask communication between tasks on any machine.	**Cost**	From US $450. Runtime pricing available.

QNX

For further information or a free demonstration diskette, please telephone (613) 591-0931.

Quantum Software Systems Ltd. • Kanata South Business Park • 175 Terrence Matthews Crescent • Kanata, Ontario, Canada • K2M 1W8

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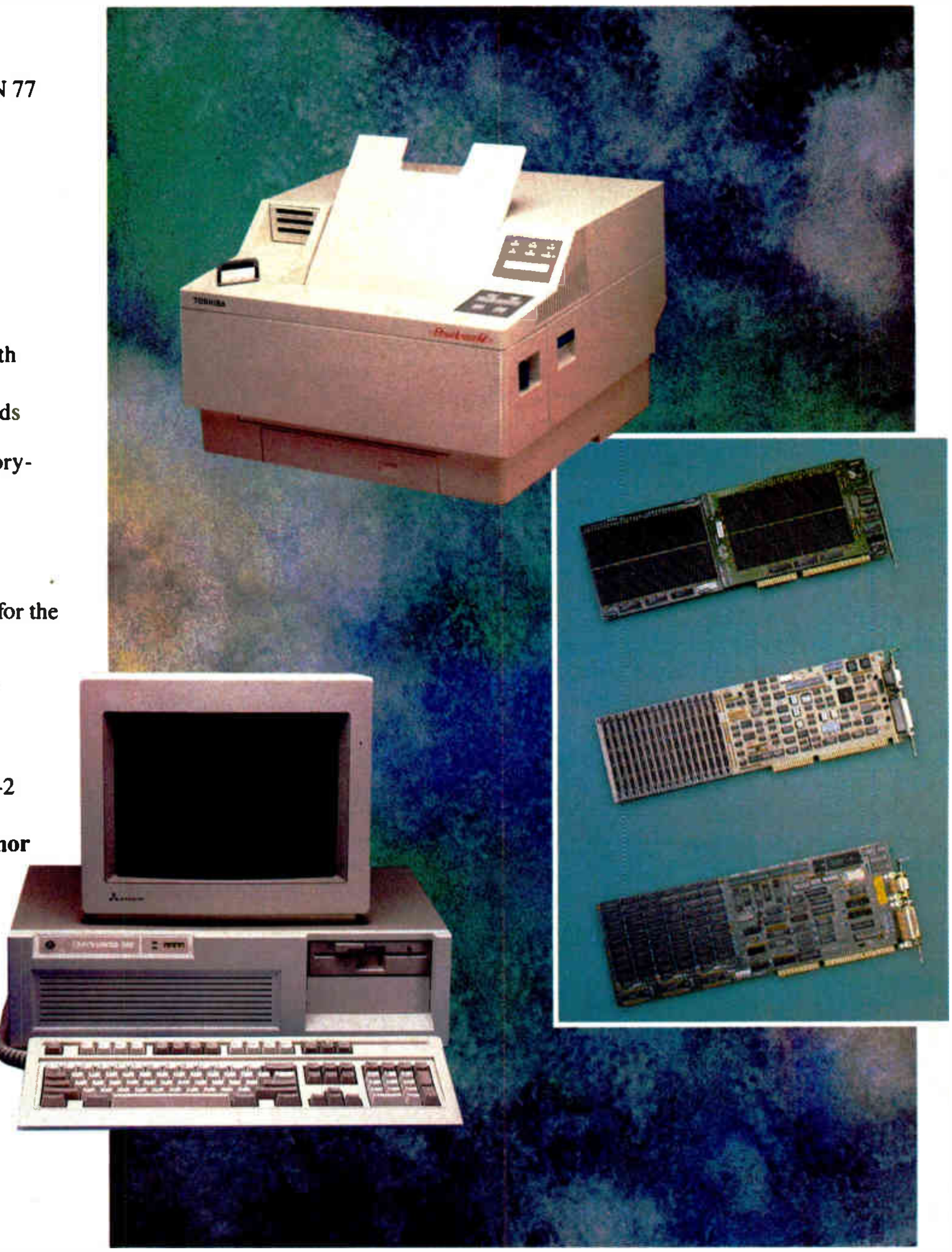
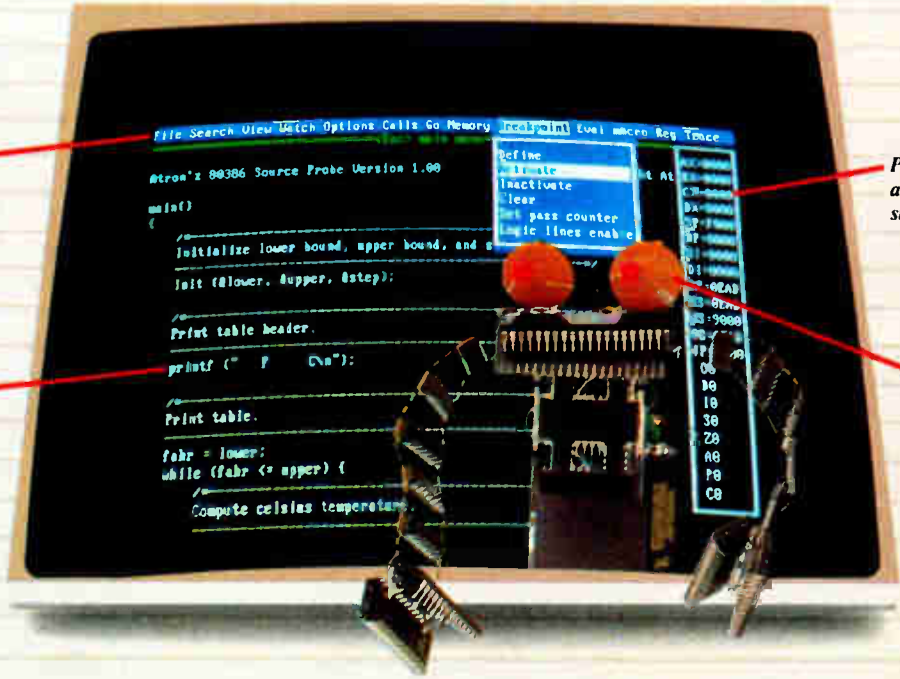


IT'S TIME TO DO SOME SERIOUS 386 BUGBUSTING!



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

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

THIS BUG'S FOR YOU

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

THIS DEBUGGER'S FOR YOU

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

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

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

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

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

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

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

atron

BUGBUSTERS

A division of Northwest Instrument Systems, Inc.
20665 Fourth Street • Saratoga, CA 95070
408/741-5900

*Versions for COMPAQ, PS/2-80s and compatibles. Copyright © 1987 by Atron. 386 PROBE is a trademark of Atron. Call 44-2-855-888 in the UK and 49-8-985-8020 in West Germany. TRBA

Circle 26 on Reader Service Card

Windows-Compatible Technical Illustrator

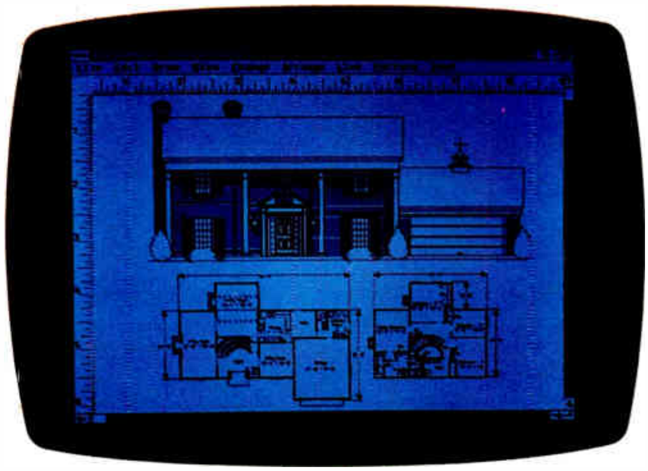
Micrografx's Designer traces scanned images and constructs architectural designs, mechanical drawings, electrical schematics, and engineering specifications.

In scanning images, you can import, save, or merge bit-mapped images from scanners or paint programs. You can also trace over bit-mapped images to create resolution-independent representations; and you can stretch, color, crop, and zoom bit maps. You can select and manipulate individual points on a polygon or curve, including stretching, deleting, and inserting. Other capabilities include smoothing and unsmoothing for curves and polylines, rotating text and graphics in increments as small as 1 degree, defining up to 3.6 million colors and up to 64 layers, and selecting symbols. Line widths start at 1/1000 inch and are accurately represented at any zoom level, according to Micrografx. You can fillet and chamfer corners, and specify the degree of rounding or beveling.

Designer's user interface is based on Windows 2.0 and is compatible with it and Windows/386. It supports multitasking, pull-down menus, dialog boxes, mice, and digitizers. You can run overlapping implementations of Designer simultaneously with other Windows applications. It is also file-compatible with Windows Graph, Windows Draw, In*A*Vision, and Windows ClipArt.

The program is bundled with Windows Convert, an AutoCAD translator, and with the General ClipArt Library, which contains over 300 symbols.

To run Designer, you need an IBM PC or compatible with at least 512K bytes of RAM, two floppy disk drives, a graphics card and monitor, and a printer. Micrografx recommends using a hard disk drive, a mouse, an EGA or VGA graphics card, and 640K bytes of RAM.
Price: $695.
Contact: Micrografx Inc., 1820 North Greenville Ave., Richardson, TX 75081, (214) 234-1769.
Inquiry 751.



An architectural image created with Designer.

Mac Transputer System

If you own a Macintosh II or SE, you can add modular parallel processing to your system with Levco's TransLink. The system consists of a TransLink board for your Mac, a variety of transputer processor modules, and a set of software-development tools.

Individual transputers are mounted on credit-card-size modules that plug into the TransLink card. Levco claims that a Mac II equipped with 20-MHz T-800 transputers has performance improvement from the Mac's 2.5 MIPS (million instructions per second) to over 200 MIPS.

Separate TransLink starter kits are available for both the Macintosh II and Macintosh SE. The kits include a single transputer module (15-MHz processor and 256K bytes of RAM), a TransLink card, and the Software Toolkit. A variety of individual Transputer modules are also available.
Price: Mac II starter kit, $2499; Mac SE starter kit, $1899; transputer modules, $1299 to $3499.
Contact: Levco Corp., 6160 Lusk Blvd., Suite C-203, San Diego, CA 92121, (619) 457-2011.
Inquiry 752.

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.

Color Rendering on AutoCAD Images

AutoShade creates perspective, specular reflection, and full-color hard-copy output of drawings created using the three-dimensional capabilities of AutoCAD 2.6. The program uses the color of drawing elements in AutoCAD as the basis for color in the finished rendering. AutoShade also supports monochrome and color implementations of PostScript, and you can generate a 256-color output file or a continuous-output file with a floating-point representation of up to 16 million colors.

AutoShade runs on the IBM PC with MS-DOS or PC-DOS 2.0 or higher and a monochrome Hercules Graphics Card, CGA, EGA, or the Professional Graphics Controller.
Price: $500.
Contact: AutoDesk Inc., 2320 Marinship Way, Sausalito, CA 94965, (415) 332-2344.
Inquiry 753.

Handy Copy Holder

The Copy Display Hinge is a nonmagnetic, space-saving copy holder that mounts on the side of your video display with double-stick foam tape. It folds out of the way when not in use, and holds items up to ⅛-inch thick using the Linear Paper Display, a device that temporarily grips paper without damaging it.
Price: $19.95.
Contact: D. L. West Manufacturing Inc., 5170 South Julian, Suite 318, Tucson, AZ 85706, (602) 889-2301.
Inquiry 754.

continued

HP's High-Speed 24-pin Printer

The HP RuggedWriter 480 prints up to 480 characters per second in draft mode, and either 240 cps (at 12 characters per inch) or 200 cps (at 10 cpi) in near-letter-quality mode. This 24-pin dot-matrix printer is designed for heavy use in a business environment, and it has independent paper paths for hand-fed sheets, multiple cut-sheets, or standard fanfold computer paper.

The RuggedWriter can print up to four-part forms, has an automatic paper-loading feature, and last-form tear-off that eliminates wasted sheets or forms. Front-panel switches let you select bold, italic, or normal fonts as well as the print quality. Printer emulation is switchable between Epson LQ-1000 or HP Printer Command Language (PCL).

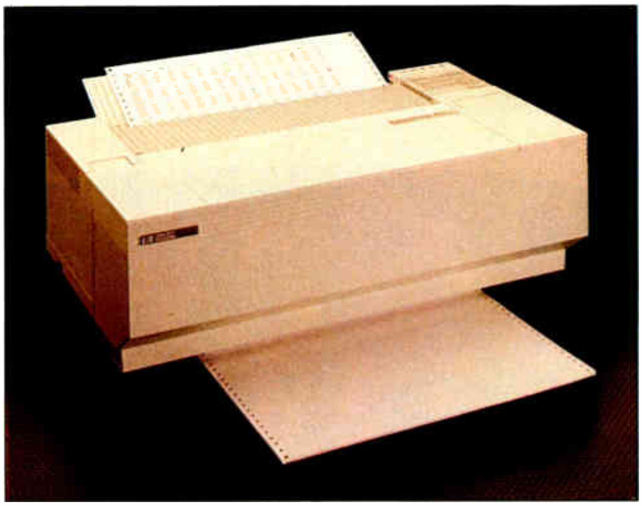
Draft and Courier fonts are standard, and an optional plug-in font cartridge ($150) includes Times Roman Proportional, Helvetica 10, Letter Gothic 12, and Prestige Elite 12.

Both Centronics parallel and RS-232C serial interfaces are standard; a combination RS-232C/HP-IB (IEEE-488) interface is an additional $200. Other options for the RuggedWriter include a cut-sheet feeder ($250), a desktop stand ($79), and a floor stand ($279). Replacement ribbons are $15 and have a rated life of 5 million characters.

Price: $1695.

Contact: Inquiries Manager, Hewlett-Packard Co., 1820 Embarcadero Rd., Palo Alto, CA 94303. Or call the Hewlett-Packard sales office listed in the telephone directory (white pages).

Inquiry 755.



The 24-pin HP RuggedWriter prints at up to 480 cps.

Low-Cost LAN

Trans-M's low-cost Net-127 PC Network uses bus topology and features peer-to-peer architecture, so you don't need a file server. The network is centered on individual 8-bit half-slot boards that plug into an IBM PC, XT, AT, or compatible. Net-127 can daisy-chain up to 127 microcomputers together using ordinary telephone (twisted-pair) wire. The network transfers data at 250,000 bps, and stations can be up to 1000 feet apart.

Net-127 includes two empty sockets on each network card for your own custom ROMs that you can use for applications such as diskless workstations. You'll need MS-DOS version 3.1 or higher to run Net-127. It supports all MS-DOS commands, including print spooling. Net-127 also lets you partition hard disks into virtual drives as well as share hardware resources throughout the network. The system software that runs Net-127 needs only 32K bytes of RAM, and Trans-M claims the system is compatible with most RAM-resident software.

Each Net-127 package includes a network card, network operating system software, and a 25-foot cable that uses standard RJ-11 telephone plugs.

Price: $249.95 per node.

Contact: Trans-M Corp., 28 Blacksmith Dr., Medfield, MA 02052, (617) 359-5144.

Inquiry 756.

A Couple of Cords

The range of expansion and adapter cords for the IBM PS/2 series and the new Macintoshes continues to grow. Curtis Manufacturing has introduced both a keyboard/mouse and a color/monochrome monitor expansion cable that work with the PS/2 Models 30, 50, 60, and 80.

The EC-9 Keyboard/Mouse Extension Cable is a fully shielded, coiled cable that extends from 3 to 9 feet. The cable has mini-DIN 6-pin male and female connectors.

The IBM PS/2 Color or Monochrome Cable is a 6-foot fully shielded cable, with high-density D connectors, and 15 pins, male and female.

Price: $39.95 each.

Contact: Curtis Manufacturing, 305 Union St., Peterborough, NH 03458 (603), 924-3821.

Inquiry 757.

Meanwhile, NEC has a new custom cable that lets you attach any of NEC's MultiSync monitors to the Apple Macintosh II. The cable is 6 feet long and adapts 9 pins to 15 pins.

Price: $19.95.

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

Inquiry 758.

Modem Protection

The Model TLP-2 is Kalglo Electronics' telephone-line/modem voltage surge protector that's designed to protect your modem against phone-line voltage surges. The company claims that the TLP-2 can dissipate up to 6000 volts, 14,000 amps, and 142 joules of surge energy to ground. It uses two stages: Stage 1 is MOV-based, and Stage 2 uses gas discharge tubes. It's capable of reacting to surges in 1 nanosecond.

The TLP-2 plugs into any standard three-prong AC outlet and has two standard modular telephone jacks—one for the modem and one for the telephone line.

Price: $39.95.

Contact: Kalglo Electronics Co., Colony Drive Industrial Park, 6584 Ruch Rd., East Allen Township, Bethlehem, PA 18017-9359, (800) 524-0400; in Pennsylvania, (215) 837-0700.

Inquiry 759.

If you want to make sure that someone doesn't pick up an extension and ruin your data transfer, you need one of Data Spec's Data Interrupt Eliminators. When you use one of these devices, any extension picked up while the modem (or phone) is in use is disabled. Besides protecting modem data from interruptions, you can also use the DIE as a privacy device for normal telephone conversations.

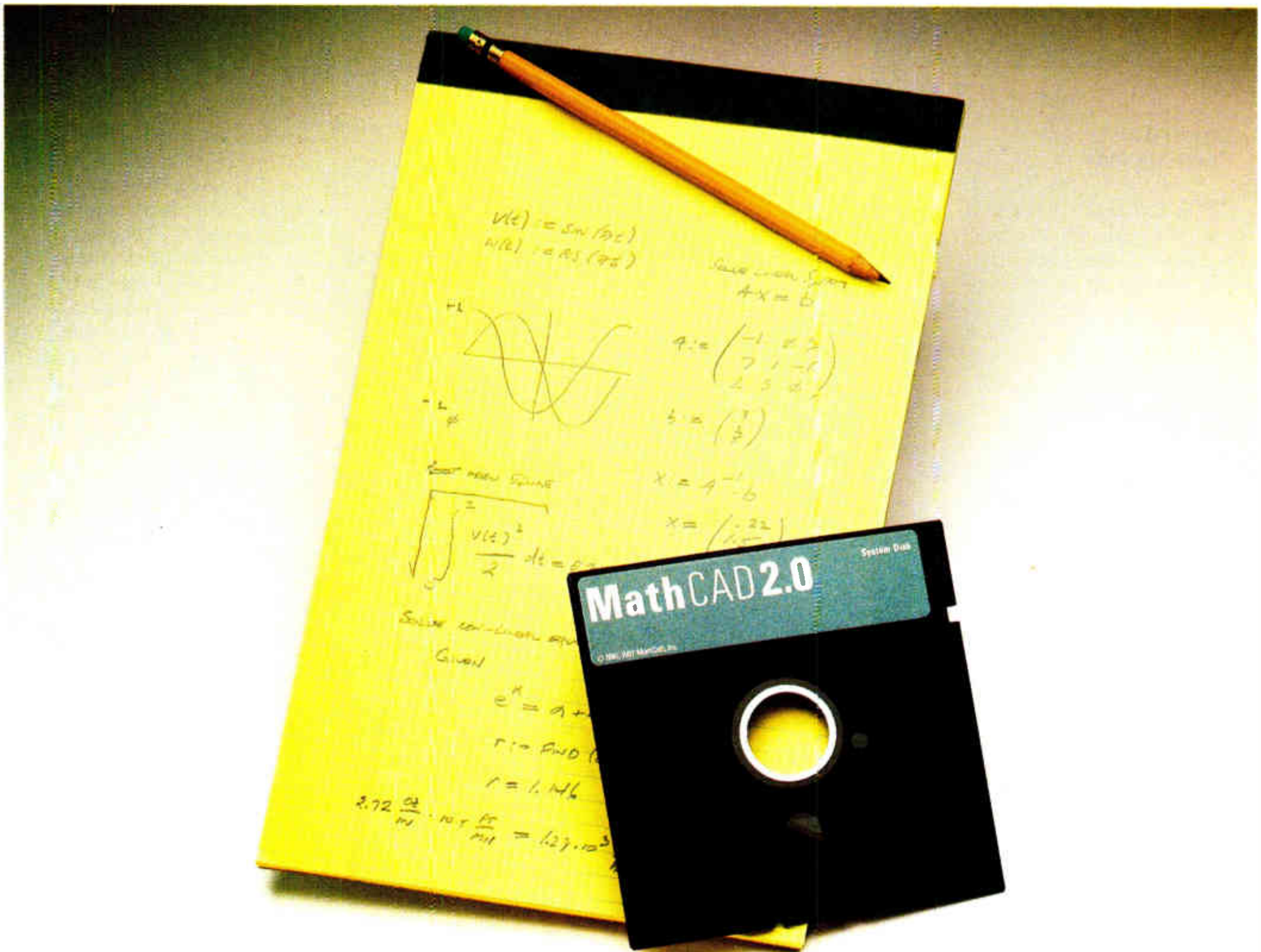
Data Interrupt Eliminators are available in four configurations: Model MP600 is a stand-alone in-line unit; Model MP620 is a standard surface-mounted modular version; Model MP630 replaces the standard telephone modular wall plate; and Model MP640 is used for wall-mounted telephones.

Price: $9.95 to $13.95.

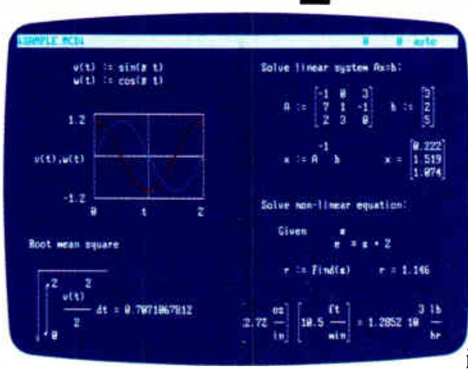
Contact: Data Spec, 20120 Plummer St., P.O. Box 4029, Chatsworth, CA 91313, (818) 701-5848.

Inquiry 760.

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 scratch-pad – 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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- Additional printer and plotter support
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If you're tired of doing calculations by hand or writing and debugging programs, come on over to our pad. MathCAD. The Electronic Scratchpad.

Call for a detailed spec sheet and the name of a MathCAD dealer near you. **1-800-MathCAD** (In MA: 617-577-1017).

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

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

MathCAD®

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

Circle 171 on Reader Service Card

Lower-Cost Portable Mac

The Dynamac GP is a new lower-cost version of the company's Apple-authorized portable Macintosh, which internally uses Apple's own circuit boards. The GP, which operates only on AC power, comes with a 512-row by 342-column gas-plasma screen, 1 megabyte of RAM, an internal 800K-byte floppy disk drive, and a mouse. Back panel connections include two serial ports, an external keyboard port, a SCSI port, an external disk drive port, and an external speaker connector.

Options for the GP include 1-, 1.5-, and 3-megabyte RAM expansions ($549, $695, and $1549), 20- and 40-megabyte internal hard disk drives ($849 and $1495), and a 300-/1200-bps internal modem ($295). There are also two different soft carrying cases and a hard plastic foam-lined case.
Price: $3995.
Contact: Dynamac Computer Products Inc., 1536 Cole Blvd., Suite 252, Golden, CO 80401, (303) 233-7626.
Inquiry 761.

The Dynamac GP is a transportable Macintosh.

Two Network Managers

Lanscope combines network administration, network and user activity reporting, resource management, software license metering, user productivity tools, and workstation menus.

Lanscope is written primarily in C, with portions written in assembly language. Connect Computer reports that the first release of Lanscope runs on Novell's Advanced NetWare LAN operating system. Future releases, the company reports, will run on other network operating systems.

A database holds information on each user, resource, and workstation. When it is necessary to make changes to the network, the network administrator simply makes the change to the database, and Lanscope automatically recognizes the change.

Lanscope performs network and user activity reporting automatically with a monitoring feature. You can output network information and activity data in a standard data format.

Lanscope's database includes a metering system for controlling software licenses. When all available copies of the software are in use, the program notifies additional users that no copies are available.

Lanscope includes hot-key utilities, which enable you to control network print spooling without leaving the application you're working in. You can also lock your keyboard when you leave it unattended; you'll need a password to regain access.

The Lanscope menu manager provides control over hardware and software resources that each user on the network can access. The menu manager also lets you combine local workstation and network menus into one overall user menu, and each user's menu can offer all applications available locally and on the network.

To run Lanscope you need at each workstation version 3.0 or higher of MS-DOS or PC-DOS, a network interface card, the shell or redirector of the LAN operating system you're using, and at least 640K bytes of RAM. Licenses are available on a per-workstation, per-server, per-multiple-servers, and per-site basis. Limited source code licenses are available.
Price: $1295 for the complete system; eight-user version, $795; a limited version is available for $495.
Contact: Connect Computer Company Inc., 9855 West 78th St., Suite 220, Eden Prairie, MN 55344, (612) 944-0181.
Inquiry 762.

LANWatch monitors traffic on Ethernets by capturing packets as they pass by and storing them for examination. It displays the traffic as it occurs and zooms in to show the full content of any packet. You can choose individual packets for capture and use filters to locate problems associated with a particular node.

The program operates in display and examine modes. In display mode it captures all the packets going by, stores them in a buffer, and displays them on-screen. Each line on the screen shows information about a single packet, and the packets that scroll off the screen are retained in a buffer of 254 packets. When the buffer is full, it discards the earliest packets, but retains the most recent 254. A time file shows how much time elapsed between when LANWatch was started and when the packet was received. The time is followed by the length of the packet and the protocol type.

Display mode has background, viewing, load, and save filters that allow you to select a subset of packets for display, storage, and retrieval. You can also create your own filter specification.

In examine mode, you scroll among the stored packets, and you can zoom in to inspect individual packets. The full packet header is displayed, and the data in the packet is displayed in both hexadecimal and ASCII.

LANWatch also compiles statistics on how many packets of each protocol type have been sent on the network.

To run LANWatch you need a PC with a standard Ethernet card. According to FTP Software, no special hardware is required, and your PC does not need to be dedicated to running LANWatch. FTP also reports that LANWatch is compatible with most PC Ethernet cards.
Price: $1200.
Contact: FTP Software, P.O. Box 150, Kendall Square Branch, Boston, MA 02142, (617) 868-4878.
Inquiry 763.

Protocol Conversion Board

Connecticut microComputer's UB1 is a universal IEEE-488/RS-232C/RS-422 interface. Measuring 6½ by 3 by 1 inch, the UB1 uses no computer slots, needs no software driver, works with any computer language, and is completely transparent.

You can configure the UB1 to provide IEEE-488 (GPIB) control from an RS-232C or RS-422 computer port, to in-

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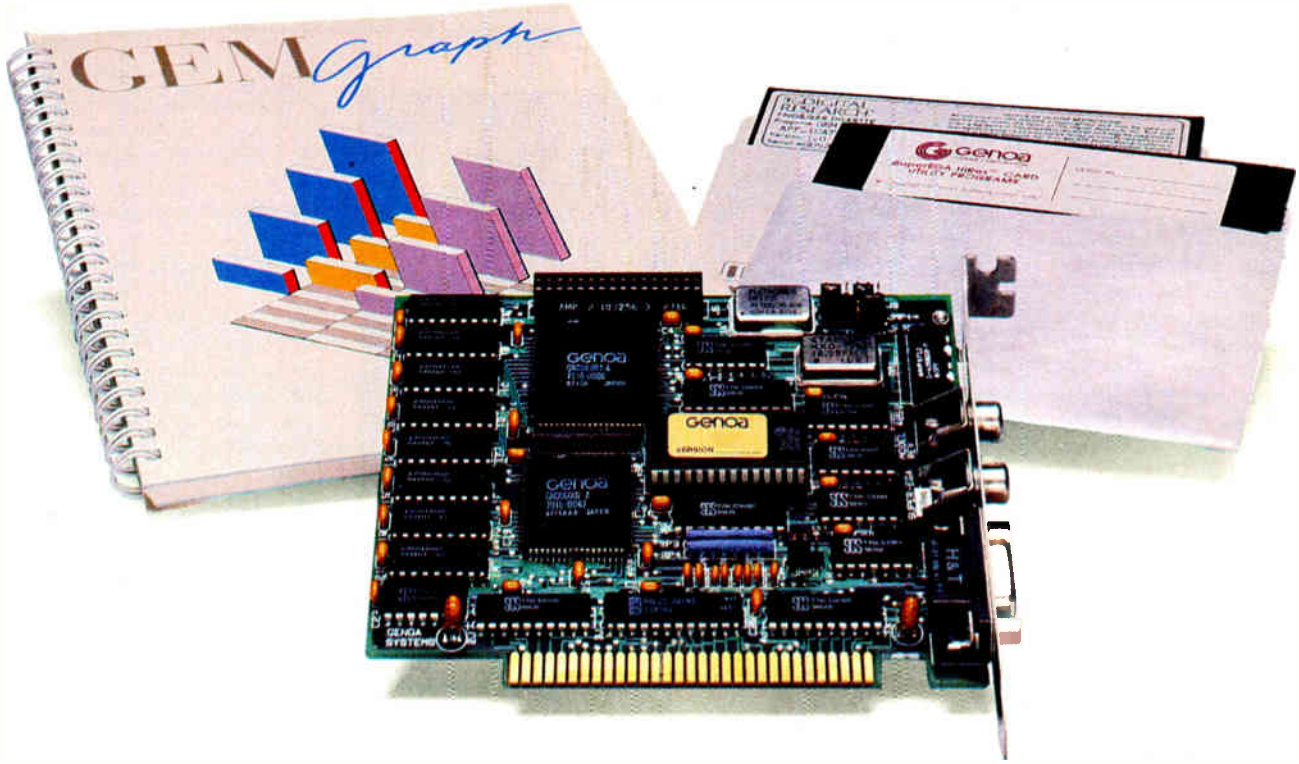

A GEM of a Deal

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!

What a combination—a quick, easy way to turn your spreadsheets and database files into stunning graphs, and SuperEGA HiRes+, the *only* Multisync-compatible 16-color EGA card with 800 x 600 resolution!

What can you do with the graphics card that brings you a full-page, readable display for Desktop Publishing? Run your spreadsheets in 132 x 60 columns. Run most VGA applications. Run Ventura,™ Pagemaker,™ AutoCAD,™ Windows,™ and more—all in dazzling 800 x 600 resolution!

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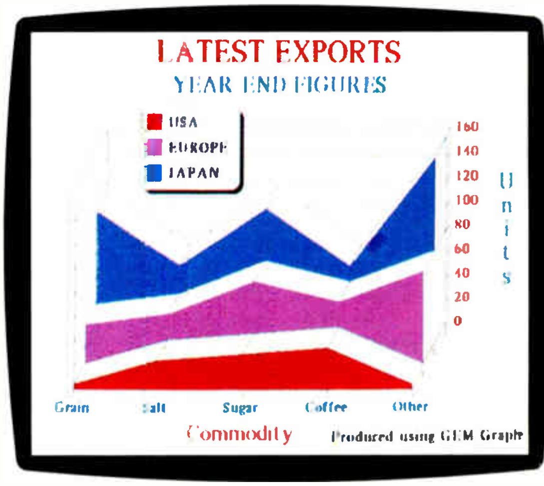

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Genoa
SYSTEMS CORPORATION
Circle 115 on Reader Service Card

terface RS-232C or RS-422 instruments to the GPIB, or to operate as a transparent bus extender. The unit has all handshaking-control and data-transfer routines in firmware, has a switch-selectable address, and operates at up to 115,200 bps.
Price: $295.
Contact: Connecticut micro-Computer Inc., P.O. Box 186, Brookfield, CT 06804, (203) 354-9395.
Inquiry 764.

AST's 386 Machine

The Premium/386 is AST's newest high-performance desktop computer that's the company's entry into the 80386-based computer sweepstakes. AST says the Premium's major asset is a unique bus that provides the critical multimaster functionality of the PS/2's Micro Channel bus, yet retains compatibility with existing AT-class machines. The system includes a special bus master disk controller with optional high-speed disk caching.

The Premium/386 runs at 20 MHz with one wait state. It includes a 40-megabyte full-height hard disk, a 1.2-megabyte floppy disk drive, and 1 megabyte of 32-bit, static-column RAM (expandable to 13 megabytes). There are two RS-232C serial ports and a parallel printer port. Internally, the Premium/386 has one 32-bit slot for memory, three 16-bit AT-compatible slots supporting multimaster functionality, one standard 8-/16-bit AT-style slot, and two 8-bit XT-style slots.

A 101-style keyboard is included. The system unit measures 6¼ by 19¼ by 16½ inches. Options include 70- and 130-megabyte hard disks, and both color and monochrome graphics cards and displays.
Price: $5600.
Contact: AST Research Inc., 2121 Alton Ave., Irvine, CA 92714, (714) 863-1333.
Inquiry 765.

The AST Premium/386 has a Micro Channel-like bus.

BlowUp PC

Without using printer escape codes, BlowUp PC lets you press just two keys to interrupt the program you're in and capture, modify, and print the screen currently in the computer's memory. BlowUp PC supports computer systems and software programs that use the CGA and the IBM monochrome display and printer adapter in a two-display system.

BlowUp PC interrupts even copy-protected programs to print graphics. It features a gray-scale conversion program for colors and lets you crop all or any portion of graphics or text screens. An Autoscale function maintains a constant height-to-width ratio of an image from the captured screen to the printed page. You can also condense, mirror, rotate, and enlarge all or any portion of the screen, and generate positive and negative images of the screens. Interex reports that BlowUp PC supports up to 36 printers, and a custom configuration program allows you to customize the program for additional printers you need supported.

System requirements include an IBM PC, XT, AT, or compatible with MS-DOS or PC-DOS 2.0 or higher, 256K bytes of RAM, a floppy disk drive, a CGA, IBM monochrome display and printer adapter card, and a parallel or serial dot-matrix printer.
Price: $59.95.
Contact: Interex, 717 South Emporia, Wichita, KS 67211-2307, (316) 264-6118.
Inquiry 766.

A Buddy for Your PC

Do you often forget in which directory you placed your files? PC-Buddy gives you access to your files by just choosing a file's name from a menu. PC-Buddy also password-protects individual programs or submenus. You can also ask what files in a specific list have been backed up.

PC-Buddy makes it possible for you to change your current DOS command-based computer system into a menu-based system, so you can check directories, edit a file, or search for a file on your hard disk, without exiting to DOS.

PC-Buddy runs on the IBM PC, XT, AT, and compatibles with 256K bytes of RAM, MS-DOS or PC-DOS 2.0 or higher, at least one floppy disk drive and one hard disk drive, and a color or monochrome monitor.
Price: $49.95.
Contact: Automated Ideas Inc., 2375 West 12th Ave., Hialeah, FL 33010, (800) 451-5016; in Florida, (305) 885-0338.
Inquiry 767.

The echoBOX Emulates Keys

The echoBOX is a programmable external keypad for the IBM PC, XT, AT, and compatibles that plugs in between your keyboard and computer. There are 12 keys on the echoBOX, along with a Shift key to give you a total of 24 programmable macros.

If you have the model for the PC and XT you can store up to 950 keystrokes. The echoBOX for the AT stores up to 650 keystrokes. All keystrokes are stored in the unit's own internal nonvolatile memory, and the echoBOX doesn't require any software or take up any RAM space.

Programming a macro is a simple matter of flipping the RUN/PGM switch to PGM, pressing the key you want to program, entering the keystrokes on your keyboard, and flipping the switch back to RUN. Multiple 1-second pauses can be programmed in by using the echoBOX's Shift key while programming. In addition, you can change macros at any time.
Price: $189.95.
Contact: Inmar Inc., 1223 Peoples Ave., Troy, NY 12180, (800) 634-6692; in New York state, (518) 271-6692.
Inquiry 768.

continued

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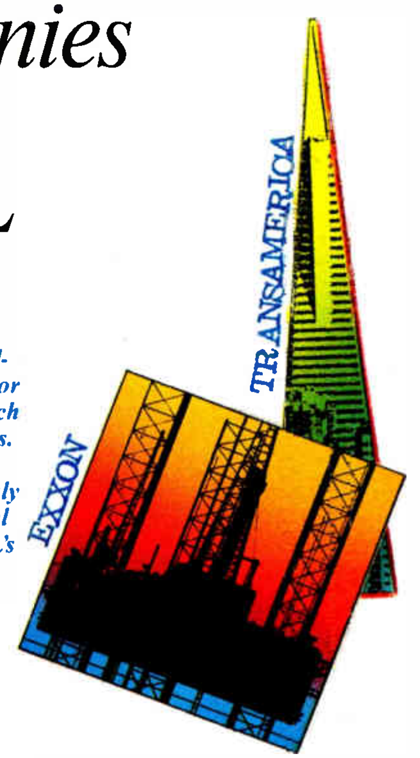

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Option Research Specialist
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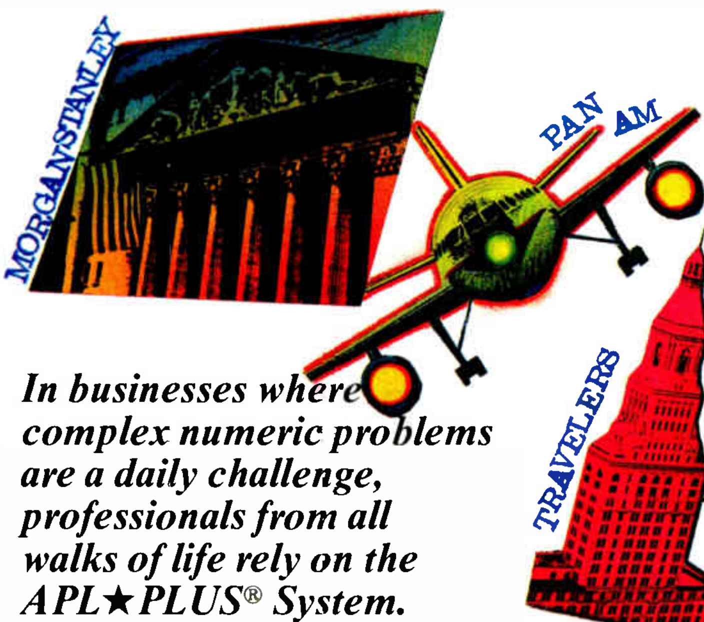

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Manager, Systems Development
Pan American World Airways

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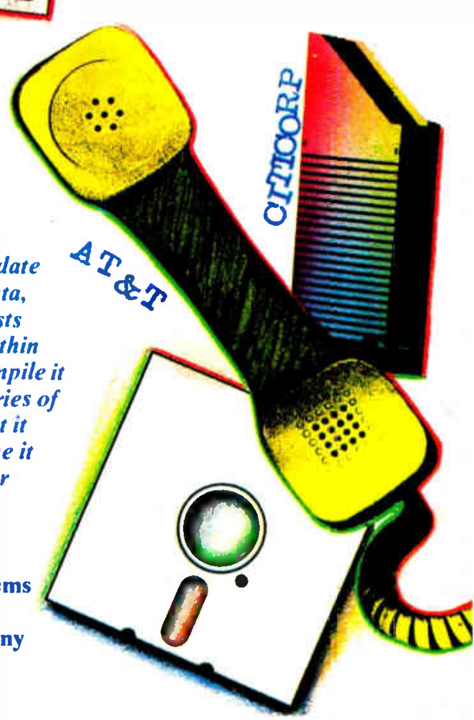

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Manager, Business Systems Development
General Electric Company

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Top companies according to the April 17, 1987 issue of *Business Week*.

*U.S. suggested retail for DOS version. International prices slightly higher.

Circle 331 on Reader Service Card

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

Desktop Display Shows Two Pages

Designed for serious users of IBM PC-compatible desktop-publishing packages, Verticom's 2Page lets you do full two-page, side-by-side layout and editing on its 19-inch monochrome monitor. The monitor uses a 64-hertz non-interlaced vertical frame rate and a horizontal frequency of 63.65 kilohertz to display a resolution of 1280 by 960 square pixels. Using paper-white P104 phosphors, the display also has a true 1-to-1 aspect ratio.

2Page's full-length add-in card fits the IBM PC, XT, AT, and compatibles, and has 512K bytes of its own addressable RAM for display memory, font storage, or second-frame display. It's also fully CGA-compatible. A Microsoft InPort Device Interface is included for connecting a Microsoft Mouse or other external devices.

With drivers for Microsoft Windows and GEM, 2Page supports Aldus PageMaker, Ventura Publisher, and other major desktop-publishing packages. A software driver is also included for AutoCAD. 2Page comes with a tilt-and-swivel base, weighs 60 pounds, and uses 100 watts of power.
Price: $2395.
Contact: Verticom Inc., 545 Weddell Dr., Sunnyvale, CA 94089-2114, (800) 433-5760; in California, (408) 747-1222.
Inquiry 769.

Automatic Software Testing

Check*Mate creates scripts for testing on-line databases, electronic mail systems, public and private data networks, multiuser programs, and other software written in Microsoft C. The program captures keystrokes and the user's responses as he or she steps through a test sequence. You can also run large groups of test scripts unattended, according to Cinnabar, with a built-in log system reporting and summarizing the test results.

A pause feature lets you stop a test and single-step through the execution of the test. A trace facility records communications traffic for error diagnosis.

The program runs on the IBM PC and compatibles and connects to the system under test through one or two asynchronous communications lines.
Price: $2995.
Contact: Cinnabar Software, 2704 Rio Grande, Suite 1, Austin, TX 78705-4089, (512) 477-3212.
Inquiry 770.

RCA's PC Link modem receives and stores Telex messages.

Equalizer Tolerates Faults

The Equalizer 2 Fault-Tolerant Systems Adapter is designed for you if your computing needs require full-time availability of system resources. The Equalizer 2 requires two PC AT-compatible systems, and includes two circuit boards, each of which is plugged into one of the systems. The systems, which can be up to 1000 feet apart, are then connected together and operate in parallel as a fault-tolerant system. Each AT handles foreground operations while simultaneously sharing/receiving data from the other computer transparently in the background. The status of each system is continuously monitored by the other, and disk shadowing happens simultaneously.

Additional features of the Equalizer 2 include an on-board voltage-sensing circuit that monitors the computer's power supply and automatically switches operation to the other computer if voltage drops below a certain level. An uninterruptible power supply (UPS) is required for each computer for full fault-tolerant operation, and the Equalizer 2 also has a UPS monitor that prevents the system from crashing, even if several power outages occur in a short period of time. The system also has multiple timers to detect software loop errors and monitor system operation, as well as a password security system.
Price: $8995.
Contact: Atlantic Microsystems Inc., 8A Industrial Way, Salem, NH 03079, (603) 898-3778.
Inquiry 771.

Mac SE Turbo Attack

MacMemory's Turbo SE is a low-cost 16-MHz 68000-based accelerator board designed especially for the Macintosh SE. The company says it will increase the speed of your Mac by at least 200 percent, and that adding an optional 68881 math coprocessor to the board will speed up numerical operations by up to a factor of 60.

According to MacMemory, the use of a 68000 processor instead of a 68020 ensures full compatibility with existing Macintosh applications. The Turbo SE plugs into the SE's internal expansion port. Installation also involves unplugging each of the Mac SE's RAM modules and moving them to the Turbo SE board. You can also move the Mac SE ROMs to the Turbo SE board, which the company says will double the speed of all ROM-based operations.
Price: $599.
Contact: MacMemory Inc., 2480 North First St., San Jose, CA 95131, (800) 862-2636; in California, (800) 922-0140.
Inquiry 772.

Telex Modem Operates Solo

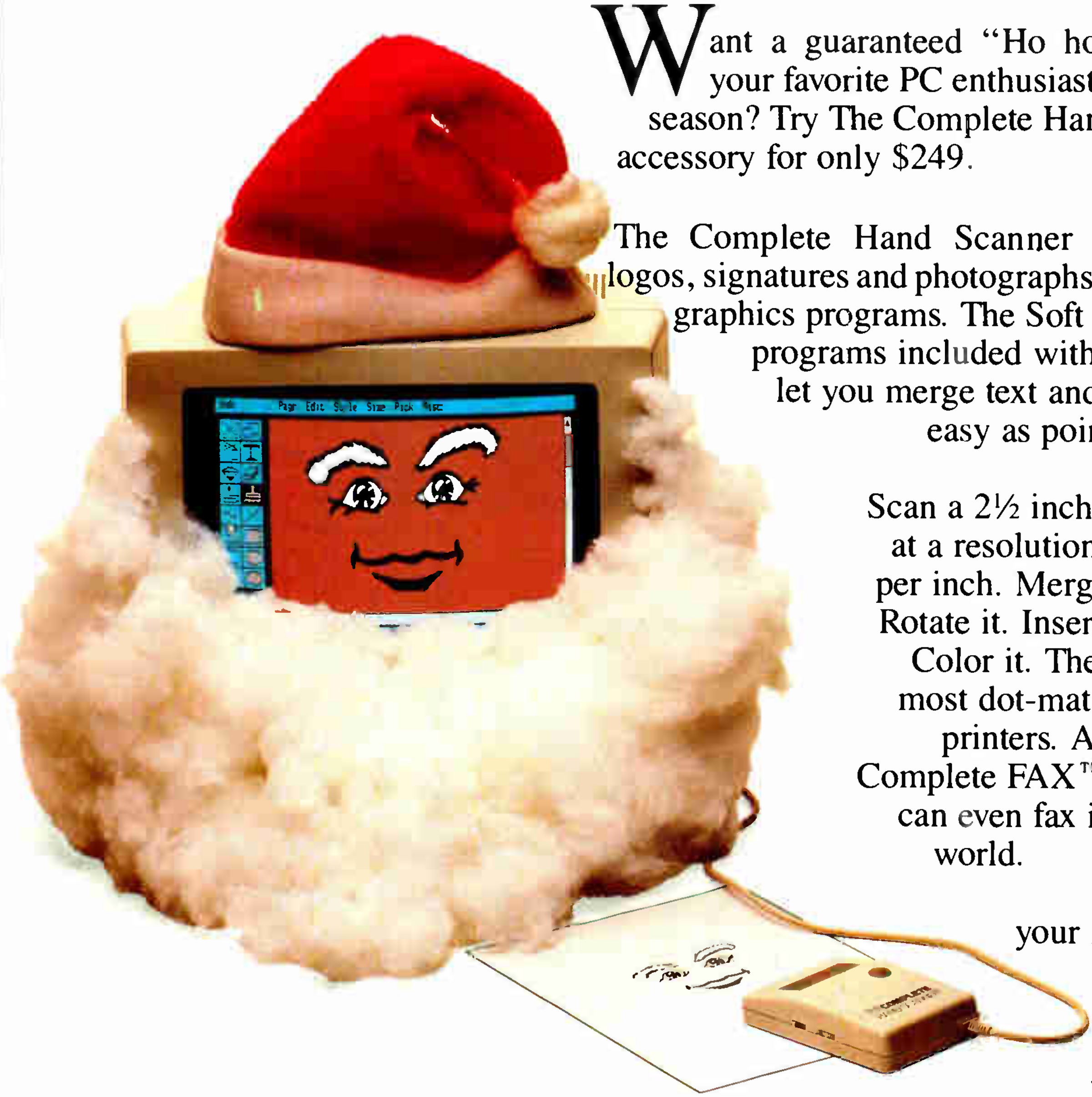
You don't need a large and noisy Telex machine to receive missives though the worldwide Telex network if you use the PC Link modem from RCA Global Communications. You don't even need to turn your computer on.

The PC Link is an external auto-answer 300-/1200-bps modem that will hook up to any computer's RS-232C serial port. The unit has 256K bytes of internal memory that will store incoming Telex messages even if your computer is turned off, and it will notify you with an LED when a message is received.

The modem has its own auxiliary serial port for hooking up a printer dedicated to Telex messages. In addition, the modem's buffer has a back-up battery that will hold messages for up to 5 hours if AC power fails.
Price: $390.
Contact: RCA Global Communications Inc., 201 Centennial Ave., Piscataway, NJ 08854, (201) 885-2236.
Inquiry 773.

continued

SHOW HO HO!



Want a guaranteed "Ho ho ho!" from your favorite PC enthusiast this holiday season? Try The Complete Hand Scanner™ accessory for only $249.

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*The Complete PC Products are available at MicroAge Computer Stores and other quality resellers. To order by phone, call R + R Direct at (800)654-7587.

TI Unveils Color LISP System

Two months after launching its Explorer II symbolic processing workstations, Texas Instruments has produced color versions. The Explorer II color systems feature 16-inch integral color monitors with 1024- by 808-pixel resolution capable of displaying 256 colors simultaneously from a palette of 16.7 million.

The standard Color System Interface Board (CSIB) provides a bit-mapped color frame buffer and controller that supports a variety of functions to offload the system's main proprietary processor and to simplify programming. The CSIB also supports Explorer II configurations with a main monochrome console and a secondary color monitor.

Software includes the Color Window System, Color Graphics Editor, Color Map Editor, and special microcode for performance enhancement. If you own an Explorer II monochrome system, you can upgrade to color by trading in your present monitor.
Price: Starting at $57,400; upgrade: $12,950.
Contact: Texas Instruments, Data Systems Group, P.O. Box 809063, DSG-157, Dallas, TX 75380-9063, (800) 527-3500.
Inquiry 774.

The color TI Explorer II.

MIDI Starter System

Designed for novice musicians and computer-music hobbyists, Music Quest's MIDI Starter System includes nearly everything you need (except a MIDI keyboard or MIDI guitar) to enter the world of MIDI. The package includes a MIDI interface card for the IBM PC, XT, AT, and compatibles, a sequencer, and editor/librarians for the Casio CZ and Yamaha DX 21/27/100 series synthesizers.

The interface card is also compatible with the Roland MPU-401 and the Voyetra OP-4000/4001 MIDI interfaces, and it supports most of the popular MIDI software packages that are currently available.
Price: $199.
Contact: Music Quest Inc., 1700 Alma Dr., Suite 260, Plano, TX 75075, (214) 881-7408.
Inquiry 775.

Real-Time Performance Analyzer

Softaid has brought out a real-time program tracer and software performance analyzer for its Icebox line of in-circuit emulators. The TraceAlyzer monitors how many times each instruction in a target system is executed and can accumulate up to 16 million counts per instruction. Rather than statistically sampling the target, the program counts the execution of every instruction, even routines that are run just once.

The TraceAlyzer board works with 8086, 8088, 8085, Z80, Z280, and 64180 processors and supports target clocks running at up to 10 MHz. The unit produces a histogram of program activity versus address range. Softaid says this identifies program bottlenecks quickly and lets you know where code should be optimized.

The TraceAlyzer captures address, data, and status signals from the target system; instructions are then shown disassembled in the mnemonics of the target processor. You can exclude any area of a program from the trace.
Price: $1495.
Contact: Softaid Inc., 8930 Route 108, Columbia, MD 21045, (301) 964-8455; outside Maryland, (800) 433-8812.
Inquiry 776.

Twin Turbo for More PC Speed

Orchid Technology's TwinTurbo 12 is a two-card 12-MHz accelerator system that's designed for IBM PC, XT, or compatible systems. The first card, a standard half-slot circuit board, replaces your computer's 8088 with an 80286 processor running at 12 MHz. It also has 8K bytes of on-board RAM that's used for caching.

The TwinTurbo 12's second card is an internally mounted board that doesn't require a slot. It boosts the speed of a standard 4.77-MHz motherboard clock by up to 50 percent, allowing the TwinTurbo 12 to run even faster than normal.

Orchid says the TwinTurbo 12 is fully compatible with all standard PC or XT compatibles, as well as all standard applications software.
Price: $645.
Contact: Orchid Technology, 45365 Northport Loop W, Fremont, CA 94538, (415) 683-0300.
Inquiry 777.

80386 Memory Manager

386-to-the-Max lets you utilize up to a megabyte of memory when running programs under MS-DOS or PC-DOS 3.0 or higher. You can access it as either extended or expanded memory or combine the two. You can also automatically fill in DOS memory above the video buffers and make it available to DOS through standard memory allocations. Using a command-line option read at start-up, you can change the ratio between expanded and extended memory without having to change any memory-board switches.

The program fully emulates the Lotus/Intel/Microsoft Expanded Memory Specification (LIM/EMS) using the 80386 microprocessor's hardware paging tables and all available extended memory. No separate expanded memory board is required, according to Qualitas.

With 386-to-the-Max you can automatically fill in DOS memory below the video buffers. For example, a 512K-byte system with a monochrome display adapter would have an additional 192K bytes of RAM available to DOS.
Price: $49.95.
Contact: Qualitas Inc., 8314 Thoreau Dr., Bethesda, MD 20817-3164, (301) 469-8848.
Inquiry 778.

continued

SHOW AND TELL

Introducing The Complete Personal Communications™ family: hand scanner, fax and personal voice mail for your PC.

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For only $499 you can forget the dedicated phone line and long walk to the fax room. Introducing your personal facsimile machine: The Complete FAX™ board.

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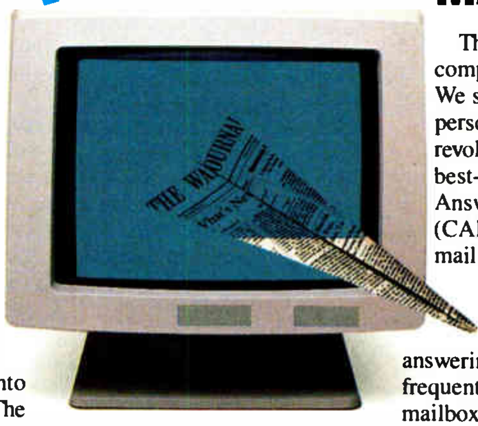
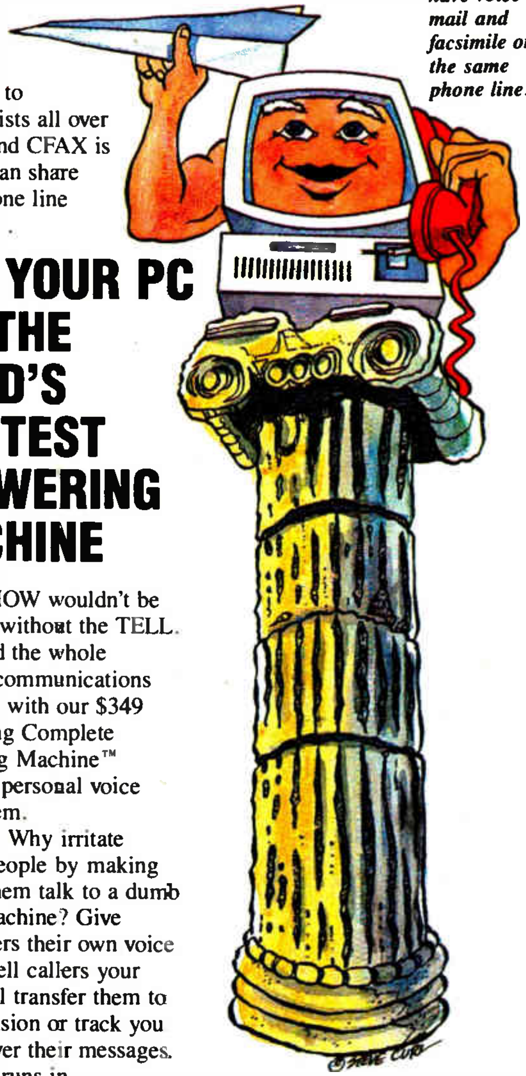
Desktop publishing will never be the same. For only $249 you can capture logos, signatures and photographs into popular graphics programs. The Soft Stationery™ program included with the scanner lets you merge text and graphics as easy as point-and-click.

Scan a 2½ inch wide image at a resolution of 200 dots per inch. Merge it. Crop it. Rotate it. Insert it. Scale it. Color it. Then print it with your dot-matrix or laser printer. You can even . . .



Now you can have voice mail and facsimile on the same phone line.



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Circle 66 on Reader Service Card

Leading Edge's AT Clone

The successor to the widely popular Model D, the Leading Edge Model D2 is, according to the company, a fully compatible PC AT-type system with a long list of standard features. The D2 is based on an 80286 processor running at 10 MHz with a single wait state. The clock speed is also switchable down to 8 MHz or 6 MHz. It includes 640K bytes of 120-nanosecond RAM (expandable to 1 megabyte on the motherboard), a 200-watt power supply, four 16-bit slots, and two 8-bit slots. There's also a socket for an 80287 math coprocessor.

The Model D2 comes standard with a 1.2-megabyte 5¼-inch floppy disk drive, and its controller will also handle both 3½-inch floppy disk drives as well as standard XT- and AT-style hard disk drives. The built-in video controller is EGA-compatible, and it automatically switches to MDA, CGA, and Hercules emulation. The standard monochrome monitor is available in either green or amber phosphor and has a 12-inch non-glare screen.

A 101-key keyboard is included, as are serial and parallel ports. The D2 is shipped with MS-DOS 3.2, GWBASIC 3.2, and the Leading Edge Word Processor with spelling correction. The D2 measures 16 by 15½ by 6 inches. A 30-megabyte hard disk drive with 60-ms average access speed is optional. The unit's standard warranty is 20 months.

Price: $1495; with hard disk drive, $1995.

Contact: Leading Edge Hardware Products Inc., 225 Turnpike St., Canton, MA 02021, (800) 872-5323; in Massachusetts, (617) 828-8150.

Inquiry 779.

The Leading Edge Model D2: an AT compatible for $1495.

HP's New Vectra Crop

Hewlett-Packard has fattened its personal-computer offerings by bringing out five new models of the Vectra series. The lineup ranges all the way from a low-cost 8086 PC XT-compatible box to a high-end 80386-based system.

At the low end, the Vectra CS models, which use NEC's V-30 processor, come in two configurations. The Model 10 has 640K bytes of RAM and a 360K-byte 5¼-inch floppy disk drive. But, like all the Vectras, it can use 1.44-megabyte 3½-inch drives. The Model 20 adds a 20-megabyte hard disk drive.

The Vectra ES machines, beefed-up versions of the up-to-now current Vectra PC, use an Intel 8-MHz 80286 processor and come with 640K bytes of RAM (expandable to 8 megabytes using an HP plug-in board based on the new LIM/EMS 4.0 specification). A 1.2-megabyte floppy disk drive is standard. You can choose between the unadorned Model 10 and the Model 20 with a 20-megabyte hard disk drive.

HP also brought out 80286-based models that run at 12 MHz. Called the ES/12s, they come in three versions. There's the Model 10, the Model 20 with a 20-megabyte hard disk drive, and the Model 40 with a 40-megabyte hard disk drive.

On the high ground, HP has three 80386-based systems. The RS/16 PC comes with 1 megabyte of RAM, a 1.2-megabyte floppy disk drive, and a 40-megabyte hard disk drive. The RS/20 comes in several versions. The first has a megabyte of main memory, a 1.2-megabyte floppy disk drive, and a 40-megabyte hard disk drive. Next is a model with 2 megabytes of main memory, one floppy disk drive, and a 100-megabyte hard disk drive. The same model is also available with a 155-megabyte or 310-megabyte hard disk drive.

All the new machines come with HP Vectra DOS 3.2 and, according to HP, are designed to be compatible with Microsoft's OS/2. HP claims it has improved the performance of the new Vectras by including disk-cache software in each system.

Price: CS Model 10, $1195; Model 20, $1895; ES Model 10, $2595; Model 20, $2795; ES/12, $2995 to $4195; RS/16, $6495; RS/20, $7495 to $11,995.

Contact: Inquiries Manager, Hewlett-Packard Co., 1820 Embarcadero Rd., Palo Alto, CA 94303, or call the HP sales office listed in the telephone directory (white pages).

Inquiry 780.

A Loaded 386

According to Advanced Logic Research, its top-of-the-line 80386-based computer system is designed to compete head-on with IBM's PS/2, with pricing that the company says is 50 percent less than a comparably equipped PS/2.

ALR's new 386/2 Model R66 is available in both 16- and 20-MHz versions, and accepts either an 80287 or 80387 math coprocessor on the motherboard. One megabyte of 32-bit RAM is standard, expandable to 2 megabytes on the motherboard. The Model R66 includes a 66-megabyte hard disk drive with a 28-ms average access speed. The disk uses an RLL (run length limited) controller using a 1-to-1 interleave. ALR claims its controller transfers data at 390 kilobytes per second.

The R66 includes a Phoenix BIOS, eight expansion slots, a 1.2-megabyte floppy disk drive, serial and parallel ports, and a 101-key keyboard. A monitor and controller are optional.

Price: 16 MHz, $3490; 20 MHz, $3985.

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

Inquiry 781.

continued

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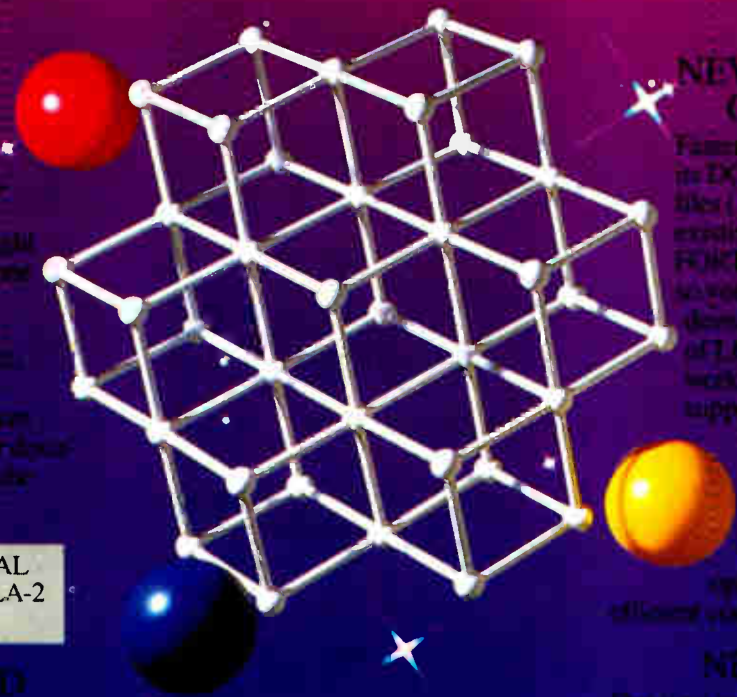

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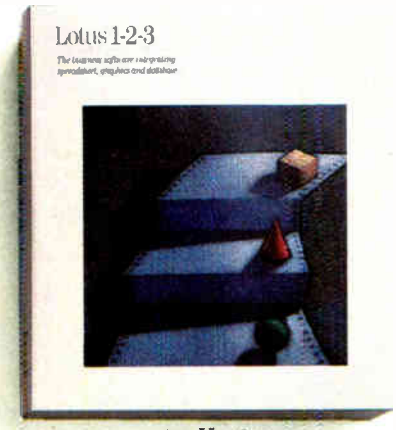
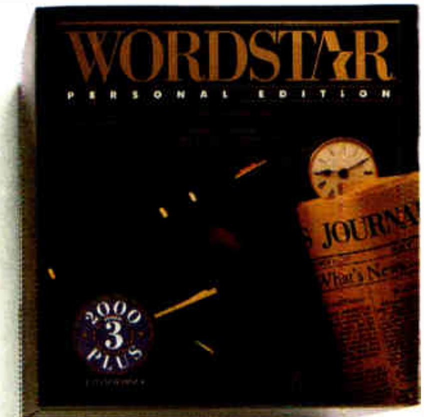
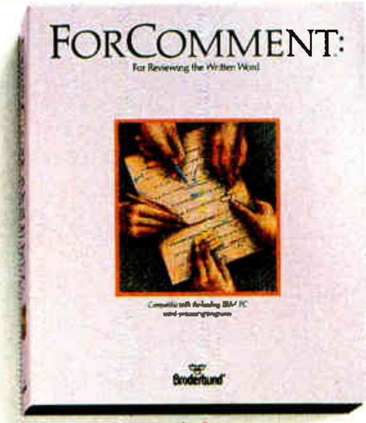


123 Ver. 2.x
Display more data with no loss of speed; pop up graphs on same screen as spreadsheet.

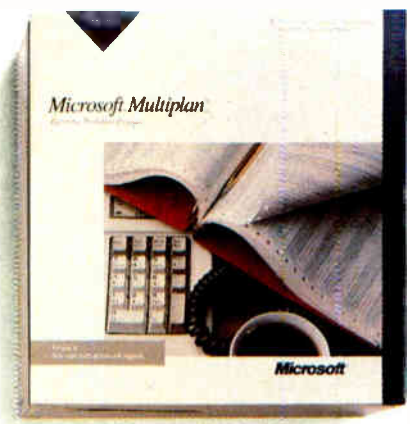


Wordstar 2000 Plus Ver. 3
Display sub/superscripts, italics, boldface, strikethrough.

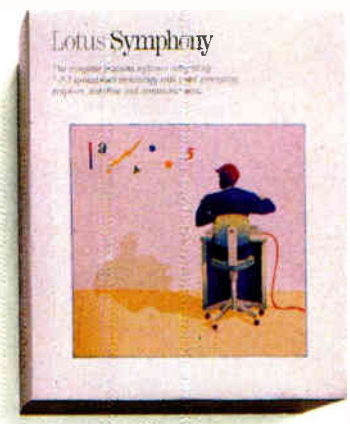


For Comment
Display more text with no loss of speed.

WordMARC
Display foreign characters at text mode speeds.

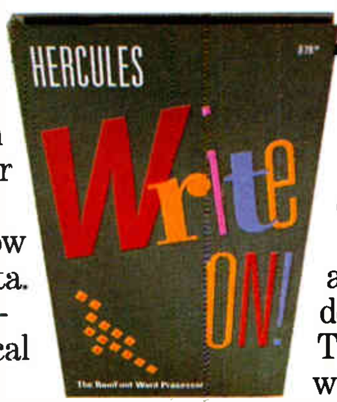


Microsoft Multiplan
Display more data with no loss of speed.



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.™

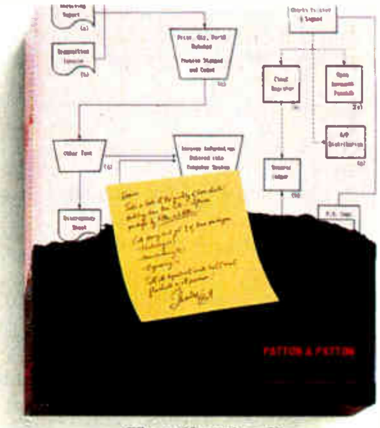
Spreadsheets show nearly twice the data. Word processors display foreign, technical and other special characters. All with no loss of scrolling speed–in fact, it often improves.

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.

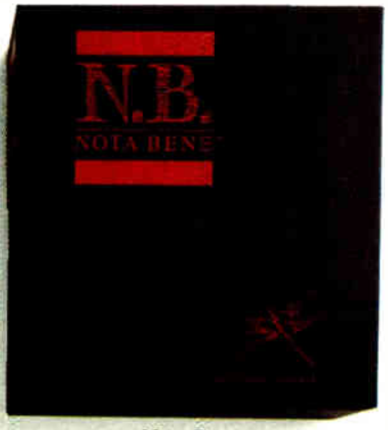
ow Some of the Having RamFont.

Brief
Display more text with no loss of speed.

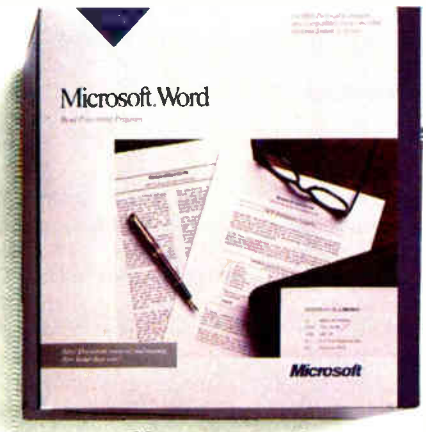
Framework II
Display more data with no loss of speed; display boldface and italics in the word processor.



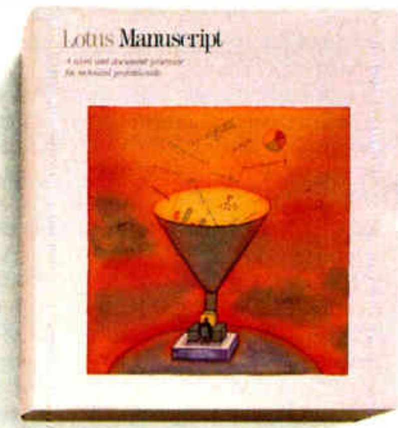
Flow Charting II
Display special symbols at text mode speeds.



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.

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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 124 on Reader Service Card (Dealers: 125)

PERIPHERALS

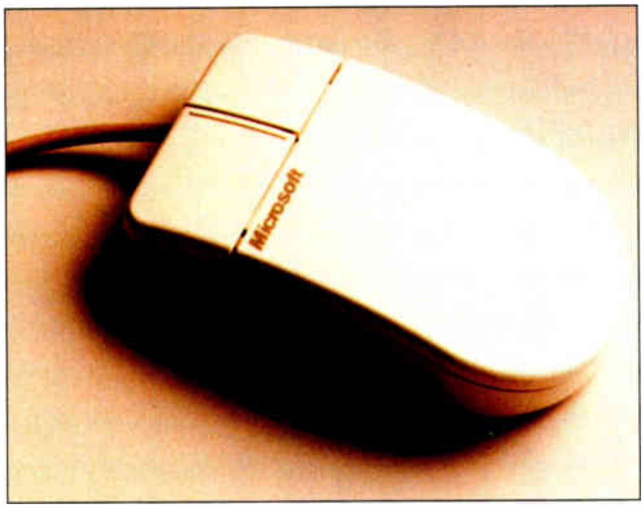
New Mouse from Microsoft

According to the folks at Microsoft, its new mouse line has been totally redesigned for comfort and intuitive ease of use. The new electronic rodent is smaller than its predecessor and proportionally shaped. The traction ball is positioned toward the front of the device, moving the unit's center of balance under your fingertips. One of the two microswitch buttons is larger to let you easily hit the correct one without looking. Like its ancestor, the new mouse doesn't require a special mouse pad, and you can adjust its sensitivity via a pop-up menu.

The mouse comes in three versions: One is bundled with Microsoft Paintbrush and a variety of custom menus for popular applications packages. A second, along with the menus, includes Microsoft Windows version 2.0 and ZSoft's PC Paintbrush. The third has the menus and Easy-CAD, a low-cost CAD program.

The new Microsoft Mouse is compatible with the IBM PC, XT, AT, and 100 percent compatibles. On the graphics side, it will work with EGA, CGA, VGA, and Hercules adapters. The mouse comes with adapters that connect it to the serial port of both PC and AT compatibles, as well as to the mouse port of the IBM PS/2 series. A bus version is also available.

Price: $150 to $200.
Contact: Microsoft Corp., 16011 Northeast 36th Way, P.O. Box 97017, Redmond, WA 98073-9717, (206) 882-8080.
Inquiry 782.



Microsoft's new Mouse is smaller and better balanced.

Small Footprint Laser

The BlaserStar 2 is Blaser Industries' latest incarnation of its laser printer for PCs and compatibles. The unit sports a footprint of 17 by 18 inches with no protrusions, including the input and output trays. Printing at 8 pages per minute, the BlaserStar 2 emulates the HP LaserJet II, HP LaserJet Plus, Diablo 630, and Epson FX-80.

With a megabyte of memory standard, the unit can print a full page of 300- by 300-dpi graphics with an eight-level gray scale. You can expand the memory to 4 megabytes. The print engine is rated at 600,000 pages and is coupled with toner kits rated for 15,000 pages. The input bin holds 250 sheets, while the output bin can hold up to 100 sheets and automatically collates the copies face down.

Both parallel and serial ports are standard, as are 20 resident fonts. It also supports downloadable and cartridge fonts. BlaserStar 2 can hold up to 128 forms as macros, which you can overlay on text pages. You can change all standard settings from the front panel. A 16-character LCD display shows the status.

Price: $2195.
Contact: Blaser Industries, 6383 Arizona Circle, Los Angeles, CA 90045, (800) 322-3399.
Inquiry 783.

Box II Rolled Out

Iomega has introduced a new line of both internal and external 5¼-inch 20-megabyte removable-disk cartridge-drive products. The Bernoulli Box II replaces the original 8-inch line and is designed for the IBM PC, XT, AT, and compatibles, and the PS/2.

The internal versions of the Bernoulli Box II consist of a single-drive system. You can add on a slave drive later if you wish. The external versions consist of a single-drive, 20-megabyte system, and a dual drive, 40-megabyte system. The external drives are "zero footprint," and they fit between the system unit and the monitor of your computer.

The company also offers an upgrade kit that lets you expand your single-dive external system to a dual-drive system. Also available is new backup software that lets single-drive Bernoulli Box II users make image backups from cartridge to cartridge.

Price: Internal single drive, $1299; internal drive upgrade kit, $900; external single drive, $1599; external dual drive, $2499; external slave drive upgrade, $1200.
Contact: Iomega Corp., 1821 West 4000 S, Roy, UT 84067, (801) 778-3170.
Inquiry 784.

Lightweight Color from DEC

The LJ250 (serial interface) and LJ252 (parallel interface) printers are Digital Equipment Corp.'s newest color printers. They each weigh under 10 pounds and use nonimpact technology to print graphics in up to seven primary colors at 180 by 180 dpi, and up to 255 colors at 90 by 90 dpi.

For text-only documents, the printer's maximum speed is 167 characters per second. Internal character sets include DEC's Technical Character Set and the ISO, NRC, Digital Supplemental, and IBM character sets.

Price: $1695.
Contact: Digital Equipment Corp., 146 Main St., Maynard, MA 01754-2571, (617) 897-5111.
Inquiry 785.

Mac SE Expansion Chassis

If the single expansion slot in the Macintosh SE isn't enough for you, or if you want to use Mac II cards in your SE, a Texas company named Second Wave has a solution for you.

ExpanSE expands the single-option-card capability of the SE by providing an external expansion chassis that accommodates four SE option cards. ExpanSE II lets you use up to eight Macintosh II cards with your SE.

A 60-watt power supply is included in the ExpanSE. It also comes with an interface card and all the cables you'll need. The ExpanSE has a 130-watt power supply with fan cooling, an SE-to-NuBus interface card, and cables.

Price: $995 and $1195.
Contact: Second Wave Inc., 8760A Research Blvd, Suite 316, Austin, TX 78758, (512) 335-9283.
Inquiry 786.

continued

These aren't vacation snapshots to pass around. These color pictures from Kodak mean business. They are, in fact, digitized images transmitted quickly and accurately over ordinary phone lines from one Kodak SV9600 still video transceiver to another, displayed within seconds on a monitor, with quality prints made by a Kodak SV6500 color video printer.

The transceiver and printer are members of a family of new Kodak products that capture, store, display, and transmit high-quality still video images in continuous-tone color.

Individually, linked together, or integrated into existing communications and imaging systems, they can enhance the efficiency of image handling in the workplace.

For more information about Kodak still video products and the name of a dealer who can arrange a demonstration, call **1 800 44KODAK (1 800 445-6325), Ext 110.** *Or, send the coupon below.*

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- ☐ *KODAK SV7400 Still Video Recorder*
- ☐ *KODAK SV6500 Color Video Printer*
- ☐ *KODAK SV5000 Video Transfer Stand*
- ☐ *KODAK SV1300 Color Monitor*

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BY

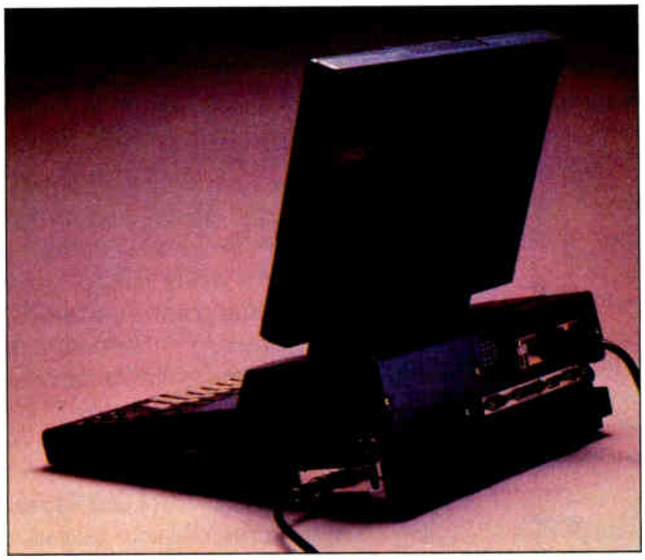
ADD-INS

The WonUnder of Toshiba

If you need to expand your Toshiba T3100 portable computer, you may find the answer in Connect Computer's WonUnder. The assembly is a single-card expansion unit for the portable that lets you mount standard PC expansion cards on the bottom of the Toshiba.

WonUnder has two components: a metal card carrier that mounts on the bottom of the T3100 and an interface card that plugs into the computer's expansion port. You can use nearly any PC expansion card that's two-third-length or less. Even with the WonUnder mounted, the T3100 will still fit in its carrying case. The company says a unit that accepts 16-bit AT-style cards will be available in the near future. WonUnder models for the Toshiba T1100 Plus and Zenith laptops will also be available soon.

You can install WonUnder yourself, or Connect Computer will do it for you.
Price: $349; installation, $50.
Contact: Connect Computer, 9855 West 78th St., Eden Prairie, MN 55344, (612) 944-0181.
Inquiry 787.



WonUnder adds an expansion slot to your Toshiba T3100.

Mach 10 Accelerates to 20

Microsoft has produced the successor to its Mach 10 accelerator card. Unlike the 10's 8086 processor, the all-new Mach 20 uses an 80286 processor running at 8 MHz. It also includes 16K bytes of on-board cache memory that provides the processor with fast access to frequently used data. Included speed-selection software lets you switch the Mach 20 down to standard 4.77-MHz speed for software that requires it.

A Mach 20 option is Memory Plus, which supports up to 3.5 megabytes of LIM/EMS memory. Microsoft says Memory Plus will also allow Mach 20 users to run OS/2, which will require a minimum of 1.5 megabytes of RAM. Memory Plus comes with 512K bytes of RAM, which is accessed via a 16-bit bus. It attaches to the end of the Mach 20 board.

Another option is Disk Plus. This board plugs directly into a connector on the Mach 20 board and frees the slot normally needed by your PC's standard floppy disk controller. Disk Plus supports both 1.2-megabyte and 360K-byte 5¼-inch floppy disk drives, as well as 1.44-megabyte and 720K-byte 3½-inch drives.

The Mach 20 board also includes Microsoft's proprietary InPort chip and its 9-pin mini connector. The interface supports the Microsoft Mouse and other InPort-equipped input devices.
Price: $495; Memory Plus with 512K, $395; Disk Plus, $99.
Contact: Microsoft Corp., 16011 Northeast 36th Way, Box 97017-9717, Redmond, WA 98073, (206) 882-8080.
Inquiry 788.

Nonvolatile Electronic Disk

Wizdom Computer's EDISK EPROM/RAM memory card for the IBM PC, XT, AT, and compatibles emulates up to two floppy disk drives. Designed for harsh environments, secure software, portable applications, or dedicated controllers, this electronic disk eliminates the need for writing special software for diskless systems.

EDISK can be formatted using the standard MS-DOS FORMAT command and can be assigned as disk drives A to E. When you configure it as drive A, it automatically becomes your system's boot disk.

According to Wizdom Computer, the unique feature of EDISK is its on-line rewrite capability. You can overwrite more than 50 percent of the disk as if it were a standard floppy disk before the EPROM disk has to be reformatted. Special interface software minimizes the rewrites on high-activity areas of the disk such as the directory. You can use an optional EPROM for the directory and FAT sectors to further minimize EPROM rewrites.

EDISK's battery-backed RAM can hold data for over 3 months with the power off. And both EPROM and RAM can coexist on the same card. The unit is available as a 180K-byte read-only disk, and as either a 360K-byte or 720K-byte read/write disk.
Price: $290 to $580.
Contact: Wizdom Computer, P.O. Box 121, Lynden, WA 98264, (604) 852-1155.
Inquiry 789.

Photo Quality for Your AT

A pair of bit-mapped display controllers for ATs and compatibles from Univision Technologies provide ultra-high-quality graphics for applications such as medical imaging, surveillance, publishing, and CAD. First is the UDC-803, a full-length card for ATs and compatibles that supports resolutions of 1600 by 1280 pixels by 8 or 4 bits. Its video-display rate is 180 MHz. Then there's the UDC-800, which generates resolutions of up to 2048 by 1536 by 8 with a video-display rate of 200 MHz.

Both boards use the Intel 82786 graphics coprocessor along with 4 megabytes of video RAM. The boards perform graphics operations such as polygon line drawing and bit-block transfer at speeds of up to 2.5 million pixels per second. The UDC-803 includes drivers for MIT's X Windows and AutoCAD. The UDC-800 supports Microsoft Windows. Both boards include initialization and diagnostic software.
Price: UDC-803, $3995; UDC-800, $6995.
Contact: Univision Technologies Inc., 12 Cambridge St., Burlington, MA 01803, (617) 273-5388.
Inquiry 790.

continued

SmarTerm 240. DEC terminal emulation. True connectivity.

Mainframe-PC links are the current vogue. One terminal emulator is ahead of the connectivity trend.

SmarTerm® 240 affords users exact four-color emulation of a DEC® VT241 terminal on an IBM® or compatible PC. Along with delivering full-screen ReGIS® and Tektronix® 4010/4014 graphics, SmarTerm 240 offers precise VT220, VT102, VT100, and VT52 text emulation.

Three error-free file transfer protocols, including Kermit and Xmodem, are provided. If judged as a communications stand-alone, SmarTerm 240 could well be the premier PC-to-the-rest-of-the-World connectivity package.

SmarTerm 240's user-interface is state-of-the-industry. Its user-support is without peer.

This program's full collection of features add up to more power for connecting people to mainframes. Which helped earn it *Digital Review's* 1987 Target Award for the Best Connectivity Software Product.

Contact your dealer or call us at 608-273-6000 for more reasons why your choice for DEC terminal emulation should be SmarTerm. Period.

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Programmer's Reference Guides

Designed for programmers using Z80 or 8051 assembly language or C, AVDOC provides on-line access to information about those languages or chips. Topics, which you pick with the cursor, show in windows on the screen. After calling up the information you need, you can return to your work by hitting the Escape key.

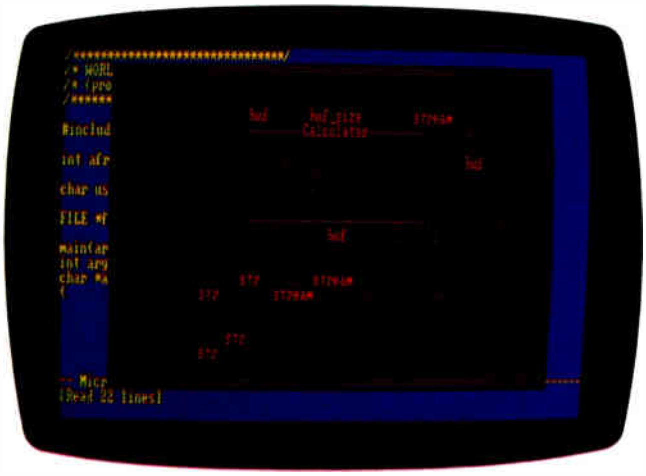
AVDOC also has a pop-up calculator that computes decimal, hexadecimal, octal, and ASCII values.

This TSR program, which runs on the IBM PC and compatibles, takes up 60K bytes of memory.
Price: $49.
Contact: Avocet Systems, 120 Union St., P.O. Box 490, Rockport, ME 04856, (800) 448-8500, or (207) 236-9055.
Inquiry 791.

Geometric Tools for Pascal Programmers

TurboGeometry Library includes over 150 geometric routines that you can use in creating graphic designs. The routines find the intersection of lines, polygons, circles, arcs, and planes; determine the coefficients of the equations of lines, circles, arcs, and planes; convert the coefficients of one equation to another; find the distance between points, lines, circles, arcs, and planes; create perspective drawings; perform two- and three-dimensional transformations; and more.

The program runs on the IBM PC, XT, AT, and compatibles with at least 256K bytes of RAM. Disk Software recommends using a hard disk drive, and you'll need an EGA or CGA for graphics display. The company also reports that a Macintosh version will be available by the end of the year.
Price: $99.95.
Contact: Disk Software Inc., 2116 East Arapaho, Suite 487, Richardson, TX 75081, (214) 423-7288.
Inquiry 792.



AVDOC pops up data in assembly language and C.

386 Operating System

Theos 386 runs in 80386 protected mode, enabling it to address up to 4 gigabytes of physical memory and up to 64 terabytes of virtual memory. A debugger, linker, and EXEC job control are included; BASIC and C compilers are optional. Its C compiler includes functions and utilities for creating a data bridge between Theos and Unix, as Theos 386 is not directly compatible with either DOS or Unix.

The operating system supports up to 128 users, each with 4 gigabytes of addressable memory, and up to 999 tasks, with 23 files per task.

Theos will be available in January, according to the manufacturers.
Price: $799 (run-time); bundled with BASIC: $1299; with BASIC and C, $1199.
Contact: Theos Software, 1777 Botelho Dr., Suite 360, Walnut Creek, CA 94596-5022, (415) 935-1118.
Inquiry 793.

Mac Common LISP

Coral Software claims its version of Common LISP for the Macintosh II is a complete implementation of the language that lets programmers develop applications on microcomputers. Written in conjunction with Franz Inc., Allegro CL has the same features found in other Franz LISP products, including Common Loops, Flavors, and Common Windows.

Allegro CL for the Mac II has an incremental native-code compiler, a programmable EMACS-style editor, and debugging tools, such as a windows-based inspector, all of which are integrated into the Mac user interface.
Price: $599.95.
Contact: Coral Software Corp., P.O. Box 307, Cambridge, MA 02142, (617) 547-2662.
Inquiry 794.

32-bit Operating System

C Executive for the 80386 is a board-level, ROM-able, real-time, multitasking operating system that supports 12 CPU architectures, including Intel 8080, 8086, 80286, Motorola 6809, 68000, and 68020. It is written in C, except for time-critical sections such as context switching, task scheduling, and interrupt handling, which are written in assembly language. C Executive's call mechanism doesn't require programs in C to use hardware traps or interface libraries. In addition, CE-FILE, an optional file system, is also available in an 80386 version.

C Executive runs on IBM PC XTs or ATs with an 80386. The binary package includes MetaWare's C compiler and Phar Lap's assembler, linker and librarian.
Price: $575 for binary package; $5000 for source code; $250 for optional file system.
Contact: JMI Software Consultants Inc., 904 Sheble Lane, P.O. Box 481, Spring House, PA 19477, (215) 628-0846.
Inquiry 795.

dBASE Debugger

The source-code level dBASE II Plus and Fox-BASE 2.0 debugger, dBUG, lets you debug while running applications. You can enter breakpoints, which allow the program to execute until it encounters the breakpoint. It then suspends and displays the source code. You can view variables along with their values, and you can set trace points for any variable or field.

The program provides over 30 debugging commands along with separate windows for source code, debugger commands, variables, calling sequence, and dBASE output.

To run dBUG, you need an IBM PC or compatible with MS-DOS or PC-DOS 2.0 or higher, 512K bytes of RAM (640K bytes is recommended), and two floppy disk drives.
Price: $195.
Contact: HJS Research Inc., Cedar Ct., Suite 6162, Monmouth Junction, NJ 08852, (800) 323-1809; in California, (213) 492-1750.
Inquiry 796.

continued

4TH IN A SERIES

Is Escort Scared or Smart?

Cincinnati Microwave, the maker of Escort and Passport radar detectors, has ignored DAK's third, one-on-one Maxon versus Escort radar challenge. I think they're hiding behind 'independent' magazine reviews and refusing to meet us on the true field of battle. And now, I think I've finally figured out why. I believe they're in a NO WIN SITUATION! Read On.

By Drew Kaplan

It's time to attack. No more Mr. Nice Guy for me. I've done everything I can to get them out for a conflict.

I've offered $10,000, then $20,000, if they could beat Maxon's lowest price $99⁹⁰ detector (now on sale for just $79⁹⁰) by more than 10 feet. I've even offered to print the results in my next catalog, win, lose or draw.

In a minute, I'm going to introduce Maxon's revolutionary new Micro-Detector that is CORDLESS and built to **trounce** Escort and Passport, but first let's see what we can do to compare detectors.

IS THIS FAIR? YOU DECIDE

In their recent ads, Cincinnati Microwave quotes what Car and Driver Magazine's April '87 issue says about Passport, "At $295 direct from the factory, it's the most expensive piece of electronic protection in the group, but it's worth every nickel in roadgoing peace of mind."

Well, wouldn't you think that Passport obliterated every other detector by a country mile? And, don't you think everyone is going to go out and find the magazine and read the **WHOLE** review???

Well, look what else Car and Driver said **in the same article** (and not quoted in Passport ad), "As it turned out, the top five brands are so close in their "Overall Sensitivity" scores that a minor juggling of the X/K-band weighting formula would upset the apple cart." Wow, imagine that!

So, Passport didn't beat everyone by a mile. In fact, on the X Band tests, it appears that it came in 3rd in a Dead-Ahead Trap, 3rd in an Over-the-Hill Trap, and 3rd in an Around-the Corner Trap.

But in choosing Passport as best, Car and Driver says, ". . an 'excellent' appraisal of support systems (cords, lights, alarms etc.) is well worth several hundred feet of warning distance..".

Which brings me back to the point I've been trying to make since I first challenged Escort. Today, a good detector can often sniff out police radar as much as 60 seconds ahead.

Traveling at 55 mph, you only cover about 80 feet a second. So, whether there's a 10' or even 100' difference in sensitivity, with today's detectors it just doesn't make much difference.

READ THIS

So, if Passport or Escort lose to the $79⁹⁰ Maxon, it would be catastrophic for their advertising. And, even if they beat Maxon by a second or two, are they worth double or even triple the price?

So, that's why I think they're in a **no win situation**. Without the magazine's loving editorial comments, we'd be down to **who won** and by **how many feet**?

And while they may or may not be scared of losing to Maxon, so far, they sure seem to be smart enough to stay out of a footage contest.

MAGAZINE ROUND UP

Popular Mechanics Magazine in November '86, in their Around A Corner Test said, "The low ranked . . .and Passport had to be rounding the bend and pointing at the radar gun before they'd detect it. Too late then!" (Not quoted by Passport.)

Although in July, after Cincinnati Microwave complained, Popular Mechanics said in an Around A Corner Test, "Consistent with the results of our previous test, Passport was easily the best of the minis." (Quoted in Passport Ads.)

Speaking of 'consistent', the magazines aren't consistent even from issue to issue.

By the way, in July's test they hated Maxon, but at least they said, "No detector in this group had to round the corner before sniffing out Smokey."

Road and Track Magazine (September '86) top rated Passport even though Maxon (a recommended buy) appears to have beaten Passport in Uninterrupted Alert, and Passport beat Maxon in initial alert.

So, when you get right down to which detector protects you, an **on-the-road test** without all the loving editorial 'quotable remarks' seems to be the only way to go.

We need to win or at least tie, to prove to the world that our challenge is for real, and not, as Cincinnati Microwave said, "an advertising gambit". But, speaking of advertising gambits, read this!

PROTECTION FROM RASHID $5? WHOOPEE

Last year, Cincinnati Microwave announced to the world, in virtually every magazine I picked up, that all radar detectors but theirs would be obsolete.

It seemed that a K band collision avoidance system called Rashid VRSS would knock out everyone's detectors.

Well, I said then that the $558 system that recommends cutting a 6½" hole in your grill for installation, wasn't going to take over the highways.

But Cincinnati Microwave kept advertising about Rashid. (My opinion of an advertising gambit). It's been a year and nobody I've talked with has run into a Rashid. I challenged Cincinnati Microwave to prove that there were even 500 on the road in the whole U.S., but they've been silent. (I wonder why???)

Anyway, just to prove that we had the technical expertise, Maxon has developed and implemented an Anti-Rashid circuit in the new Micro-Detector.

It's added about $5 to your cost which **we all think is a waste**, but at least we won't get any more letters saying that the only reason we think it's worthless is because Maxon doesn't have it.

TRUE BREAKTHROUGH NO. FIVE

Unlike the questionable value Anti-Rashid circuit from Cincinnati Microwave, Maxon has now leapt ahead. Now you can have a micro detector that operates from 6 AA rechargeable batteries (included).

Now you can forget plugging your radar detector into your cigarette lighter. A revolutionary circuit design gives you cordless freedom and **improved** protection.

Maxon is using a circuit used in jet fighters and other military applications which replaces the traditional Gunn diode oscillator with a DRO (Di-electrically Resonated Oscillator).

The efficient DRO circuit is much more stable when subjected to temperature extremes and vibration (hence its use in the military, especially aircraft). Its only disadvantage is that it costs more.

The new detector also has incredible "support systems". Its bright LEDs, dim themselves at night. And speaking of dimming, they can be switched off so you can't be spotted from the rear.

And, as for the separate X and K warning tones, not only is the volume adjustable, 'Mute' lets you silence the alarms without adjusting volume. They will automatically reset after the alert passes.

You can plug the Micro into your cigarette lighter, you can run it for about 8 hours on its rechargeable batteries, and it automatically recharges from your cigarette lighter overnight or while you use it plugged in during the day.

OK, now it's time to prove that Maxon is Number One. Cincinnati Microwave, eat our dust!

A $20,000 Challenge To Escort

Let's cut through the Radar Detector Glut. We challenge Escort & Passport to a one-on-one Distance and Falsing 'duel to the death' on the highway of their choice. If they win, the $20,000 check pictured below is theirs.

By Drew Kaplan

We've put up our $20,000. We challenge Escort to take on Maxon's Dual Superheterodyne RD-1 $99⁹⁰ detector (right) (Now just $79⁹⁰), Maxon's new Mini RD25 $99⁹⁰ detector (middle) or Maxon's Cordless Micro-Trouncer $149⁹⁰ radar detector (left) on the road of their choice in a one-on-one conflict.

The real question today is: 1) How many feet of sensing difference, if any, is there between Maxon's Detectors and Escort's or Passport's? And 2) Which is more accurate at interpreting real radar versus false signals?

So Escort, you pick the road (continental U.S. please). You pick the equipment to create the false signals. And finally, you pick the radar gun.

Maxon and DAK will come to your highway with engineers and equipment to verify the results.

And, we'll have the $20,000 check (pictured) to hand over if you win!

BOB SAYS MAXON IS BETTER

Here's how it started. Maxon is a mammoth electronics prime manufacturer. They actually make all types of sophisticated electronic products for some of the biggest U.S. Electronics Companies. (No, they don't make Escort's.)

Bob Thetford, the president of Maxon Systems Inc. and a friend of mine, was explaining their anti-falsing Dual Superheterodyne Radar detector to me. I said "You know Bob, I think Escort really has the market locked up." He said, "Our new designs can beat theirs".

. . .Next Page Please

. . .Challenge Continued

So, since I've never been one to be in second place, I said, "Would you bet $20,000 that you can beat Escort?" And, as they say, the rest is history.

By the way, Bob is about 6'9" tall, so if we can't beat Escort, we can sure scare the you know what out of them. But, Bob and his engineers are deadly serious about this 'duel'. And you can bet that our $20,000 is serious.

We only ask the following. 1) The public be invited to watch. 2) Maxon's Engineers as well as Escort's check the radar gun and monitor the test and the results.

3) The same car be used in all tests. 4) We'd like an answer from Escort no later than December 31, 1987, and 60 days notice of the time and place of the conflict to alert the public. And, 5) If Escort can prove that there are even 500 Rashid units in operation, we will present them with a check for $5,000 at the conflict.

HOW'S THIS FOR FAIR?

Cincinnati Microwave will be deemed the winner and given the check if **either** Escort beats Maxon's RD-1 or RD-25 by 10 feet in both uninterrupted and initial alerts or **equals** the Micro-Trouncer, **OR** if Passport beats Maxon's RD-1 or RD-25 by 2 seconds at 55mph in both uninterrupted and initial alerts or **equals** the Micro-Trouncer. So, DAK wins only if we beat **both** the $295 Passport and $245 Escort Radar Detectors.

SO, WHAT'S DUAL SUPERHETERODYNE?

OK, so far we've set up the conflict. Now let me tell you about the new dual superheterodyne technology that lets Maxon leap ahead of the pack.

It's a technology that tests each suspected radar signal 4 separate times before it notifies you, and yet it explodes into action in just 1/4 of one second. (1/10th second for the Micro-Trouncer.)

Just imagine the sophistication of devices that can test a signal 4 times in less than a 1/4 of one second. Wow!

But, using Maxon is easy. These long range detectors have all the bells and whistles with **separate** audible sounds for X and K radar signals.

LED Bar Graph Meters accurately **show the radar signal's strength**. And, you won't have to look at a needle in a meter.

Keep your eyes on the road, you'll see these meters with your peripheral vision.

You'll have a very high level of protection. Maxon's Dual Conversion Scanning Superheterodyne circuitry combined with **die-cast aluminum** ridge guide wideband horn internal antennas, really ferret out radar signals.

And the key word is 'radar', not trash. The 4 test check system that operates in 1/4 second gives you protection from signals from other detectors, intrusion systems and garage door openers.

So, when the lights and X or K band sounds explode into action, take care, there's very likely police radar nearby. You'll have full volume control, and a City/Highway button.

Maxon detectors are backed by Maxon's standard limited warranty.

Note from Drew: 1) Use of radar detectors is illegal in some states.

2) Speeding is dangerous. Use your detector to help keep you safe when you forget, not to get away with speeding.

DON'T WASTE MONEY

As I've said, **good** radar detectors today are very similar. The RD-1 is great. It is much smaller than Escort at just 3½" wide, 4¾" deep and 1½" tall.

If you want an even smaller detector, the RD-25 at just 2⅞" wide, 4½" deep and 1" tall, with its included windshield mount and identical specs is for you.

If you want the very best, or if you want to forget cords and be able to slip a

4½" wide, 3¼" deep, ¾" tall (It mounts sideways to the rest) detector into your shirt pocket, choose the Micro-Trouncer.

I'd love to tell you that the Micro-Trouncer is light years ahead in detection, because its circuitry certainly is.

But, I'd be into advertising gambitland if I claimed that 1 or 2 seconds of improvement over Maxon's other detectors or even over Escort and Passport really make a significant difference.

Caution: Cincinnati Microwave is right. There are many cheap imports that aren't very good. My quarrel with them is that except for themselves, I don't know who they think is any good!

CHECK OUT RADAR YOURSELF RISK FREE

Put a detector on your visor, dash or windshield. When it sounds, look around for the police. There's a good chance you'll be saving money in fines and **higher insurance rates.**

If you aren't 100% satisfied, simply return it in its original box within 30 days for a courteous refund.

(RD-1 Pictured to Right.) To get your Maxon, Dual Superheterodyne, Anti-Falsing Radar Detector risk free with your credit card, call toll free or send your check for DAK's **$79⁹⁰** sale price ($4 P&H). Order No. 6138.

Note: An optional suction cup windshield mount and extra coiled power cord (we can't afford to throw them in for free) is just **$5⁹⁰** ($2 P&H) Or. No. 4800.

(RD-25 Pictured in Middle.) To get your Maxon, Dual Superheterodyne, Anti-Falsing **Mini** Radar Detector complete with 2 Power Cords, Window Suction Cup, Dash and Visor Mounts risk free with your credit card, call toll free or send your check for just **$99⁹⁰** ($4 P&H) Order No. 6139. CA res add tax.

(Micro-Trouncer Pictured to Left.) To order Maxon's Top-Of-The-Line, DRO Circuit Radar Detector with Mute, 4 Second LED Meter Hold, Dark Switch, Cordless Battery Operation (6 AA Ni-Cad Batteries Included) with Windshield, Dash, and Visor mounts and 2 power/charging Cords risk free with your credit card, call toll free or send your check for this revolutionary $249 suggested retail detector at DAK's market breaking price of just **$149⁹⁰** ($6 P&H) Order No. 6140.

OK Escort, it's up to you. We've got $20,000 that says you can't beat Maxon on the road. Your answer, please?

Escort and Passport are registered trademarks of Cincinnati Microwave. Rashid VRSS. and Rashid Radar Safety Brake are registered trademarks of Vehicle Radar Safety Systems, Inc.

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SOFTWARE • SCIENTIFIC AND ENGINEERING

ChemLibrary

The Egg, a WYSIWYG (what you see is what you get) scientific word-processing program, now includes ChemLibrary, a database of chemical structures.

Structures include organic, inorganic, and biochemical, as well as many common structure skeletons that you can edit to produce the needed structure. A sampling of sugars is provided in prospective format, along with the common nucleic acids.

The Egg requires an IBM PC or compatible with 256K bytes of RAM, MS-DOS or PC-DOS 2.0, one disk drive, and a color graphics or Hercules card.
Price: $495 for The Egg; $125 for ChemLibrary.
Contact: Elsevier Scientific Software, 52 Vanderbilt Ave., New York, NY 10017, (212) 916-1250.
Inquiry 797.

Digital Signal Analysis Spreadsheet

DaDiSP is a spreadsheet for digital signal analysis that lets you solve mathematical problems, manage and analyze data, and display graphic solutions. With DaDiSP, you create individual signal-processing steps by typing a formula into a window. Worksheets enable you to build a custom library of analysis templates that you can store and modify for new tasks.

You can perform over 150 data-manipulation and data-analysis functions, including signal arithmetic and calculus, signal editing, waveform generation, Fourier analysis, and peak finding. It supports real and complex arithmetic. DSP reports that the program carries engineering units through compound calculations.

It also supports a variety of peripherals, including RS-232C and IEEE-488 add-ons. DaDiSP runs on the IBM PC and compatibles, as well as on 32-bit workstations. On the PC, you'll need at least 512K bytes of RAM (640K bytes is recommended); a Hercules, CGA, or EGA graphics card; MS-DOS or PC-DOS 2.0 or higher; and two floppy disk drives or a floppy disk drive and one hard disk. The company also recommends an 8087 or 80287 math coprocessor.
Price: $795 for PC version; $2295 to $4995 for 32-bit workstation versions.
Contact: DSP Development Corp., One Kendall Square, Cambridge, MA 02139, (617) 577-1133.
Inquiry 798.

Logic Simulation

After describing a logic circuit and sequence of binary input signals to the program, LSP will compute the resulting binary output signals of any or all nodes for the circuit at specified times. The program contains built-in models for combinatorial gates such as AND, OR, and NAND, sequential devices such as D, JK, and toggle flip-flops, as well as tristate devices. The program provides for zero, one, don't know, and high-impedance states, each of which is propagated through the circuit.

You can define signals, synchronous and asynchronous inputs, and outputs by common names. You can also assign a delay time ranging from 1 to 255. You can mix types of inputs in a single design and edit them with the built-in input signal editor. The output of LSP is a timing diagram showing the binary states of each selected signal as a function of time.

The program supports unlimited-keystroke macros, according to BV. Auto-execute and batch-mode capabilities let you execute LSP autonomously and unattended by taking instructions from a file.

The program runs on the IBM PC and compatibles with 256K bytes of RAM and on Macs with 512K bytes.
Price: $95.
Contact: BV Engineering, 2200 Business Way, Suite 207, Riverside, CA 92501, (714) 781-0252.
Inquiry 799.

Equation-Processing Software

Equator evaluates equations either from those you enter or from the Pulse exchange library for engineering equations. You can enter Greek letters and symbols of up to eight characters. The program automatically decodes, and recognizes functions and standard constants.

Graphs of the results or of other text data files can be plotted with linear or logarithmic axes on the screen or on an HP7470-type plotter. The program calculates optimum ranges for the axes that you can use or redefine before plotting the graph.

The program uses a menu-driven command structure and a context-sensitive help system. It runs on the IBM PC and compatibles with MS-DOS or PC-DOS 2.0 or higher and 512K bytes of RAM.
Price: $79.
Contact: Pulse Research, P.O. Box 696, Shelburne, VT 05482, (802) 985-2928.
Inquiry 800.

Optimize Experiments

Simplex-V version 2.2 is a menu-driven program that assists you in making your experimental design strategies more efficient. It lets you increase the yield of a synthetic reaction, improve the efficiency of an extraction process, and reduce the cost of an existing reaction or process. You can adjust up to 12 continuous variables simultaneously using a modified sequential simplex algorithm.

Version 2.2 can accept up to four responses, use an optional starting simplex that you define, and produce ASCII files that you can export to word-processing and other programs. The multiple responses are scaled and combined into a single additive or multiplicative objective function.

Simplex-V runs on the IBM PC, XT, AT, and compatibles with MS-DOS or PC-DOS 2.0 or higher and 128K bytes of RAM. Graphics are available if you have a CGA or equivalent graphics card.
Price: $295.
Contact: Statistical Programs, 9941 Rowlett, Suite 6, Houston, TX 77075, (713) 947-1551.
Inquiry 801.

Expecting a Flood?

Hydropeak offers you data on flood flows for any station on any river in the United States, according to US West. The information is based on the U.S. Geological Survey peak values file from WATSTORE. A summary is presented on each gage, along with separate screens for the annual and partial duration series data, including a translation of the discharge and stage codes necessary to interpret them. A rank screen with discharge, plotting position, and exceedance probability is also offered.

A search facility enables you to locate a gage, review the information, and choose from four formats, including ASCII tabular, Lotus, card record, and binary.

Hydropeak runs on IBM PCs with at least 640K bytes of RAM and a CD-ROM drive.
Price: $395 for one state, with discounts for each state purchased thereafter.
Contact: US West Knowledge Engineering Inc., 4380 South Syracuse, Suite 600, Denver, CO 80237, (800) 222-0920; in Colorado, (303) 694-4200.
Inquiry 802.

continued

```
DECLARE FUNCTION Filter$ (Txt$, FilterMask$)
'
' ======================== STRTONUM =========================
' Convert a number that contains non-numeric characters to
' a clean number.
' ===========================================================

' Input a line:
line INPUT "Enter a number with commas: "A$(error 1)

' Look for only valid numeric characters (0123456789.-) in the
' input string:
CleanNum$ = Filter$(A$, "0123456789.")

' Convert the string to a number:
PRINT "The number's value = "; VAL(CleanNum$)
END

'
'
' ========================= FILTER ==========================
'       Takes unwanted characters out of a string by
'       comparing them with a filter string containing
'       only acceptable numeric characters
' ===========================================================
'
FUNCTION Filter$ (Txt$, FilterMask%)(error 2)
(error 3) TxtLength = LEN(Txt$)

     FOR I = 1 TO TxtLength%
(error 4) C$ = MID$(Txt$, 1, 1)     ' Isolate each character in
                                    ' the string.
          ' If the character is in the filter string, save it:
          IF INSTR(FilterMask%, C$) <> 0 THEN
               Temp$ = Temp$ + C$
          END IF
     NEXT I

     Filter$ = Temp$
END FUNCTION
```

Get this program up and running in 5 minutes. Or your money back.

We don't expect to make many refunds, though. Thanks to a revolutionary breakthrough we call "instant programming." For the first time, you can run, test, debug, then continue running your BASIC program, and see the results instantly. All without a compile step interrupting your progress. Or your train of thought.

Try new Microsoft® QuickBASIC 4.0 on the program above. Or, on any program you'd like. If you can't go from paper to perfect execution faster than you ever imagined, return it within 30 days for a full refund. No questions asked.

But we're betting you'll enjoy a unique programming experience.

In our program, for example, Microsoft QuickBASIC 4.0's instant syntax checking will find the missing ";" (error 1) the instant you type in the line.

Of course, other BASICs will catch errors like this. Eventually. But none will catch the fact that integer variable *FilterMask%* (error 2) should be a string variable.

Let alone give you the incredible ability to edit and continue. For example, you can step through the FOR loop, go back and correct *TxtLength*'s missing "%" (error 3), then resume execution from that very statement.

Or allow you to monitor the changing value of *Temp$* until you locate the especially subtle error number 4—the proper function call is *MID$ (Txt$,* I, *1)*—and, via our on-line help, confirm the fix by displaying MID$'s syntax at the touch of a key.

What's more, at $99, Microsoft QuickBASIC 4.0 boasts a sophisticated collection of professional features. From language extensions like records, recursion, huge arrays and true functions. To high-performance executable code that runs faster than output from the former speed champ. Our very own Microsoft QuickBASIC 3.0.

For the name of your nearest Microsoft dealer call (800) 541-1261, Dept. A42. Because without Microsoft QuickBASIC 4.0, you're waiting too long to see the results of your programming efforts.

And in this day and age, who wants to have a wait problem.

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SOFTWARE • BUSINESS AND OTHER

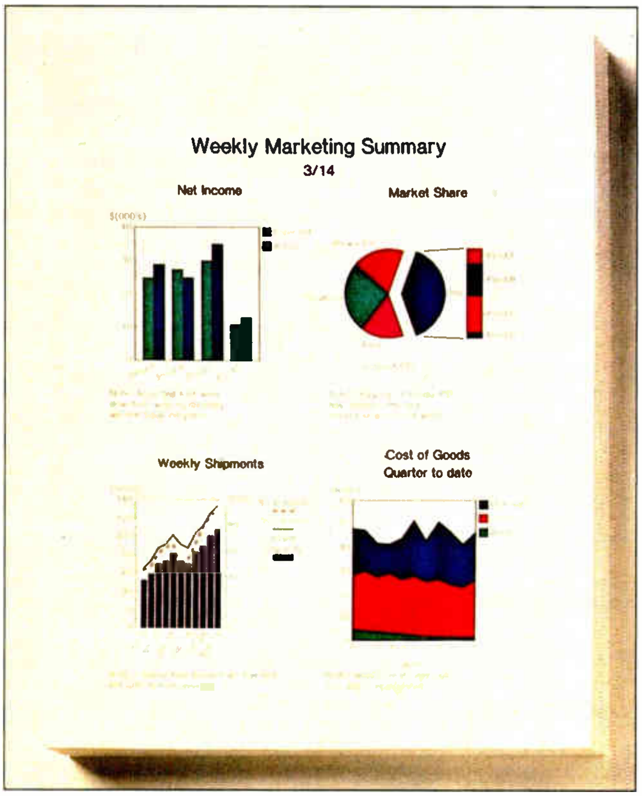
Graphwriter II

Graphwriter II, a program for creating charts from spreadsheet and database data with a Lotus 1-2-3-style interface can link directly to any data source, update and output charts automatically, and place multiple charts on a page. You can also view and select data from the data source, and you have more file handling and output options. You can also export Graphwriter II charts to Freelance Plus or to Lotus Manuscript.

You have a choice of 24 chart types, some of which include line, pie, *x*, *y* scatter, text, bar, Gantt, and bubble. The program positions the chart elements on the page according to default style settings, so you don't have to make design decisions on layout, legends, or graph labels.

Some of the options for customizing and editing charts include adding three-dimensional effects, placing multiple charts on a page, and changing colors, fill patterns, fonts, and text sizes. Graphwriter II is compatible with WKS, WK1, WRK, WR1, DIF, ASCII, SYLK, and dBASE files. Compatible output devices include dot-matrix and laser printers, plotters, color printers, and image recorder cameras. You can also produce charts for paper, 35mm slides, and overhead transparencies.

Graphwriter II runs on the IBM PC, XT, AT, PS/2s, and 3270. You need a minimum of 512K bytes of RAM, a hard disk drive, and a Hercules monochrome card, a CGA, EGA, VGA, or MGA.
Price: $495.
Contact: Lotus Development Corp., 55 Cambridge Parkway, Cambridge, MA 02142, (617) 577-8500.
Inquiry 803.



Graphwriter II lets you create multiple charts on a page.

What If You Need a Loan?

Precision Data's What If program is broken into two parts: a mortgage-calculating system and a loan and investment program.

The mortgage part of the program figures conventional, variable-rate, and balloon-rate mortgages. You can display mortgage amount, monthly payments, interest rates, terms, total interest, total amount, and effective rate.

The loan section figures loan financing and analyzes your existing or potential investments. You can calculate your principal, regular payments, last payments, remaining balance and annual interest rate, and you can compute terms of the loan. The program also prepares amortization schedules for all three mortgage types and loan financing.

In analyzing investments you can determine the future value of the investment in general or the total with regular deposits, and you can compute the amount of regular deposits to figure a future value. The program can also tell you what your initial investment should be and how much you need to invest for withdrawals, and it will figure interest rates and give you an earned interest table.

What If runs on the IBM PC and compatibles with at least 128K bytes of RAM and MS-DOS or PC-DOS. You also need a 132-column printer for output.
Price: $79 for the package; $49.95 for either the mortgage portion or the loan and investment portion.
Contact: Precision Data Inc., 206 West Michigan St., Mt. Pleasant, MI 48858, (517) 772-5055.
Inquiry 804.

Go Fetch with 1-2-3

Fetch, a Lotus 1-2-3 add-in, lets you perform queried data imports and exports from any database from within 1-2-3. You can also take data from a 1-2-3 spreadsheet and send it to a new file in almost any format, or you can append it to an existing data file.

The program is macro-driven and contains 1-2-3 templates, including a Custom Report Generator template.

Fetch works with files created with dBASE II and III, R:base System V, Reflex, PCFile, comma-delineated ASCII, and other applications programs.

To run Fetch you need a copy of Lotus 1-2-3 version 2.0 or higher and at least 60K bytes of additional RAM on an IBM PC or compatible.
Price: $99.95.
Contact: Manusoft Corp., 8570 West Washington Blvd., Culver City, CA 90232, (213) 559-1561.
Inquiry 805.

Financial Planning

Brentmark's Number-Cruncher-I, formerly in a template version, is now available as a stand-alone program. It includes coverage of 44 topics in categories such as valuation, tools of estate planning, charity, techniques of estate planning, and present and future value computations. Topics include Section 6166 installment payments of estate tax, Section 303 stock redemptions, special use valuation, split interests, and charitable remainder trusts.

The program runs on the IBM PC, XT, AT, and compatibles with at least 256K bytes of RAM and MS-DOS or PC-DOS 2.0 or higher.
Price: $199.
Contact: Brentmark Software, P.O. Box 9886, Newark, DE 19714-9886, (302) 366-8160.
Inquiry 806.

continued

1987 Expanding Scenery disk coverage: East Coast, Japan, & Europe

1986 - Flight Simulator II for the 68000 computers

1985 - High-performance Jet flight simulator for the IBM, Commodore 64, and Apple II computers

1982/1983 - Microsoft Flight Simulator & Flight Simulator II

1979 - 3D graphics applied to the original FS1 Flight Simulator for the new Apple II and TRS-80 computers

1977 - SubLOGIC's 3D graphics package in BASIC and M6800 Assembly Language

Ten Years of Technology and Dedication

Some say our technology has helped us define the state of the art in flight simulation. We believe our ten years of dedication have gotten us where we are today.

SubLOGIC's first black & white 3D graphics routines, developed in 1977, paved the way for our introduction to flight simulation and aerial combat gaming theory. Our second-generation Flight Simulator II was so well conceived that even we find it difficult to improve upon. Jet's spectacular land and sea battle scenarios set another classic milestone in state-of-the-art simulation gaming. Scenery concepts incorporated into SubLOGIC flight simulation products right from the start continue to evolve as we introduce new, more beautifully detailed areas of the world to explore. And coming in 1988 - a flight control yoke for even more realism!

We invite you to help us celebrate our first decade of success, and share in our anticipation of the next ten years to come. SubLOGIC tenth-anniversary promotional shirts and posters are available at your dealer or directly from SubLOGIC. See your dealer, or write or call us for more information.

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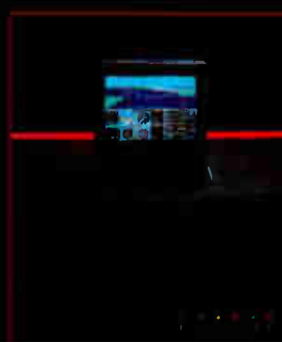

SOFTWARE • BUSINESS AND OTHER

When LANs Have Wings

Wings, a program for NETBIOS-compatible LANs, works as a distributed communications server that doesn't require a dedicated PC. The vendor says the software lets you use any workstation as a terminal, use any modem on the LAN from any workstation, connect to other computers (including minicomputers), and move files to and from different computers. It also lets you take control of a remote PC or LAN if that system has Wings.

The program enables a computer to emulate VT-100, VT-102, VT-52, IBM 3101, DG D220, ADM 3A, or TeleVideo 912 terminals.

File-transfer protocols include XMODEM, ZMODEM, Kermit, SmartCom II, XON/XOFF, delay-after-line, and a proprietary protocol with wild cards and automatic file compression.

Each copy comes with a program called Line Expert, which the company says is an expert system that deals with asynchronous communications.

To use the program, you need an IBM PC, XT, AT, or compatible with DOS 2.0 or higher, 256K bytes of RAM (Line Expert needs 512K bytes), one disk drive, a serial card, an asynchronous modem, and a NETBIOS-type network.
Price: $599.95 for five users; $99.95 for each extra user.
Contact: Concept Development Systems Inc., 2778 Hargrove Rd., Suite 349, Vinings, GA 30080-3048, (404) 434-4813.
Inquiry 807.

Wings operates as a distributed communications server.

GOfer the Text Finder

GOfer is a RAM-resident, pop-up search program that runs on the IBM PC and compatibles in conjunction with a variety of word processors.

GOfer works without prior indexing, file conversion, or keywording. It will let you search for particular text from within a document or editing package. You can begin a search with a word or phrase or perform complex searches, including Boolean AND/OR/NAND logic and "how close" parameters. Once GOfer has located the text, you can then insert it into the document you're working on, even if it is a file created with a different word-processing system. You can also direct the found text to your printer or write all finds to another file. Microlytics reports that GOfer searches through multiple files at rates up to 16K bytes per second or 1 megabyte per minute on standard ATs.

You can also load GOfer from DOS, without keeping it RAM-resident. Some of the word processors it works with include Microsoft Word, WordStar, WordStar 2000, MultiMate Advantage II, XyWrite III, WordPerfect, Q&A Write, and DisplayWrite III and IV. You can also search Ventura and dBASE files. Microlytics reports that the program will work on-line with electronic mail services.

GOfer runs on the IBM PC and compatibles and PS/2s. It requires 79K bytes of RAM and is not copy-protected.
Price: $79.95.
Contact: Microlytics Inc., Techniplex, 300 Main St., East Rochester, NY 14445, (716) 248-9150.
Inquiry 808.

Memory-Resident Writer's Guide

Writer's Handbook, a memory-resident program for the IBM PC and compatibles and for Macintoshes, can help with grammar, punctuation, spelling, foreign phrases, and other aspects of writing. The program serves as a companion to a word processor.

You call up the Writer's Handbook with one keystroke. You can then either scroll through menus—which cover such topics as rules of grammar, abbreviations, signs and symbols, and "computerese"—or get right to the information you want by using the program's search function.

Writer's Handbook requires at least 128K bytes of memory. To use it on an IBM PC or workalike, you need DOS 2.0 or higher.
Price: $29.95.
Contact: Digital Learning Systems, 4 Century Dr., Parsippany, NJ 07054, (201) 538-6640.
Inquiry 809.

DOS Help

HelpmateDOS, an on-line utility for the IBM PC and compatibles, calls up references, hints, examples, and comments about 88 MS-DOS commands and related topics. You only have to type `Help` at the DOS prompt to get a menu that lists DOS commands (version 2.0 and higher) and other topics. You then pick a command by typing its name or using the cursor keys to point to it. The program brings up from one to five documentation screens, depending on the command's complexity.

Some of the topics include batch files, AUTOEXEC and CONFIG files, wild cards, and a glossary. You'll need at least 256K bytes of RAM and one floppy disk drive.
Price: $39.95.
Contact: Helpmate Software, 8660-D Miramar Rd., Suite 135, San Diego, CA 92126, (619) 693-5050.
Inquiry 810.

ImageStudio

ImageStudio lets you manipulate the gray-level information of images generated by high-resolution scanners. In addition to a gray-map editor and filters, it also includes paintbrush, water drops, charcoal, and finger design tools providing airbrush, edge-softening, and paint-smearing effects.

ImageStudio supports 64 gray levels; the gray-map editor lets you change brightness and contrast and create posterization, solarization, and negative effects. You can view the images magnified 25, 50, 100, 200, 400, and 1600 times, and you can get multiple views of the same image.

ImageStudio runs on the Macintosh Plus, SE, and II, with an external disk drive.
Price: $49.95.
Contact: Letraset USA, 40 Eisenhower Dr., Paramus, NJ 07653, (800) 631-1603; in New Jersey, (201) 845-6100.
Inquiry 867.

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Complete w/Color Graphics Card, 14" RGB Color Monitor.

EGA $1299
Complete w/EGA Card & EGA 14" Monitor.

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Complete w/Color Graphics Card, 14" RGB Color Monitor.

EGA $1299
Complete w/EGA Card & EGA 14" Monitor.

XT TURBO SYSTEM 900-10

■ Speed: 4.77 + 10 MHz (Switchable by Turbo Buttons) ■ AT Jr. Case ■ XT Size with At Features ■ Reset Button ■ Turbo Button ■ Keyboard Lock ■ Power LED ■ Hard Drive LED ■ 150 Watt Power Supply ■ CPU 8088-1 Microprocessor ■ 640K AT 120NS ■ 2-360KB Toshiba Floppy Disk Drive ■ AT Style Keyboard ■ Multi I/O Serial Port, Parallel Port, Game Port, Clock Calendar ■ Floppy Controller - Controls 2 Internal Drives

MONO $729
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COLOR $929
Complete w/Color Graphics Card, 14" RGB Color Monitor.

EGA $1149
Complete w/EGA Card & 14" EGA Monitor.

XT TURBO SYSTEM 900

■ XT Slide Out Case ■ 150W Power ■ AT Style Keyboard ■ 1-360KB Toshiba Floppy Drive ■ 640K Dynamic Ram ■ Floppy Controller - Controls 2 Internal Drives ■ Phoenix Bios (Amer. Recognized) ■ Speed: 4.77-8 Motherboard ■ CPU 8088-2 Microprocessor

MONO $549
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COLOR $749
Complete with Color Graphics Card, 14" RGB Color Monitor

BAREBONE $429
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DeltaGold Series

The DeltaGold line of microcomputers consists of the 8088-1 Elite; the Prestige, based on an 80286 microprocessor; and the Premier, based on an 80386 microprocessor.

The Elite's 8088 runs at 10 MHz. It comes with 256K bytes of RAM (expandable to 768K bytes on the motherboard), two 5-inch 360K-byte floppy disk drives, and four full-size expansion slots. It also features a 12-inch monitor on a tilt/swivel base, a Hercules-compatible MGA/CGA/Plantronics graphics card, and parallel and serial ports.

The 80286-based Prestige comes with 512K bytes of RAM (expandable to 1 megabyte on the motherboard), one 5½-inch 1.2-megabyte floppy disk drive, and a 12-inch monitor on a tilt/swivel base. It also includes four 16-bit and two 8-bit expansion slots, and a Hercules-compatible MGA/color video adapter.

The Premier features an 80386 microprocessor and 1 megabyte of memory on the motherboard (expandable to 16 megabytes). It also comes with one 32-bit, five 16-bit, and two 8-bit expansion slots, an EGA color monitor, and an EGA video adapter. A 40-megabyte Seagate ST-412 hard disk drive is provided.

Each model includes MS-DOS 3.2 and GWBASIC. Both the Elite and the Prestige also come with DeltaGold Connection, an integrated program with spreadsheet, word-processing, database, and communications capabilities.

Price: Elite, $1195; Prestige, $1995; Premier, $4995.
Contact: Delta Computer Corp., P.O. Box 809, Mansfield, MA 02048, (617) 339-5575.
Inquiry 919.

Minitel Emulation

Baseline claims that MacTell is the first Macintosh communications program available in the U.S. that provides Minitel emulation. MacTell features a script language and provides all standard file-transfer protocols.

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MacTell runs on Macintoshes with at least 512K bytes of RAM.
Price: $97.
Contact: Baseline Inc., 838 Broadway, New York, NY 10003, (212) 254-8235; in California, (213) 659-3830.
Inquiry 918.

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WorldPort 2400 is a pocket-size external modem that provides communications at 300, 1200, or 2400 bits per second. It is compatible with the Hayes AT

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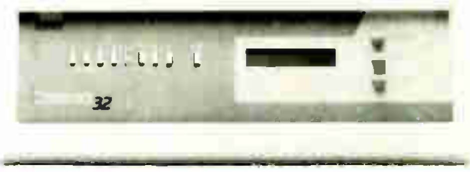

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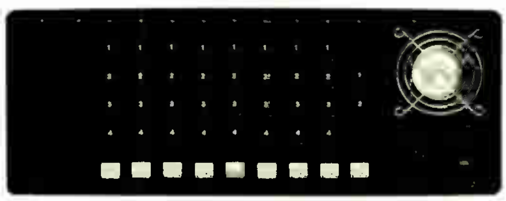

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command set and features auto-dial and auto-answer capabilities, as well as both pulse and tone dialing. You can store up to 20 commands in its nonvolatile memory.

The WorldPort 2400 supports CCITT V.22bis and Bell 212A/103, as well as CCITT V.21 (300 bps) and V.22 (1200 bps) standards. It is powered by either a 9-volt battery, an AC adapter, or through your computer's RS-232C port. An RJ-11 modular jack is provided.

Other features include an internal speaker and an LED array that enables you to monitor call progress, carrier detection, speed, and batteries. The WorldPort 2400 measures 4 by 2.4 by 1 inch.
Price: $359.
Contact: Touchbase Systems, 16 Green Acre Lane, Northport, NY 11768, (516) 261-0423.
Inquiry 920.

Ivy's 80386-based Microcomputers

Ivy's 386 series includes two 80386-based microcomputers and a graphics workstation. The Model 40 and Model 80 both include an Intel 80386 microprocessor running at either 16 or 20 MHz, a 1.2-megabyte floppy disk drive, and 2 megabytes of RAM on the motherboard. One 32-bit, five 16-bit, and two 8-bit slots are provided, as is an 80387 math-coprocessor socket. Also included are a 220-watt power supply, a clock, and a 101-key keyboard. The Model 40 comes with a 40-megabyte hard disk drive; the Model 80, an 80-megabyte hard disk drive.

The Ivy 386 GWS adds Hercules-compatible graphics to the system with an add-in card and a 14-inch amber display on a tilt-and-swivel base.

Options include monochrome monitors, color monitors, and a 40-megabyte tape drive.
Price: Model 40, $2995; Model 80, $3495; GWS, $995; monochrome monitor, $255; EGA color monitor, $695; 40-megabyte tape drive, $495.
Contact: Ivy Microcomputer Corp., 15 Ararat St., Worcester, MA 01606, (617) 853-6914.
Inquiry 921.

Animated Color Video

Virtual Video Producer lets you place text, titles, and animated or static digital video images over motion video, still video images, or computer-generated backgrounds.

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Virtual Video Producer runs on the IBM PC and compatibles with MS-DOS or PC-DOS 3.0 or higher, 640K bytes of RAM, and a composite video monitor. It requires an AT&T ICB. An optional add-on that supports the Texas Instruments Speech Board is available.
Price: $795; Speech Board add-on, $700.
Contact: V_Graph Inc., P.O. Box 105, Westtown, PA 19395, (215) 399-1521.
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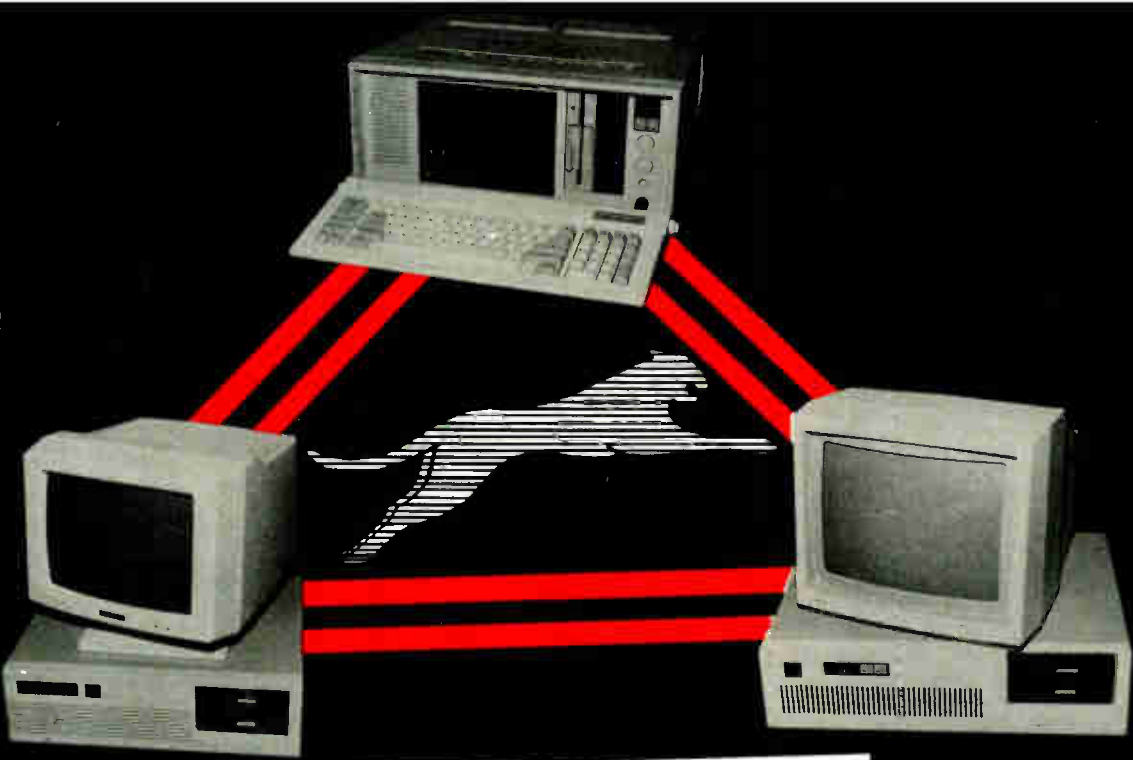

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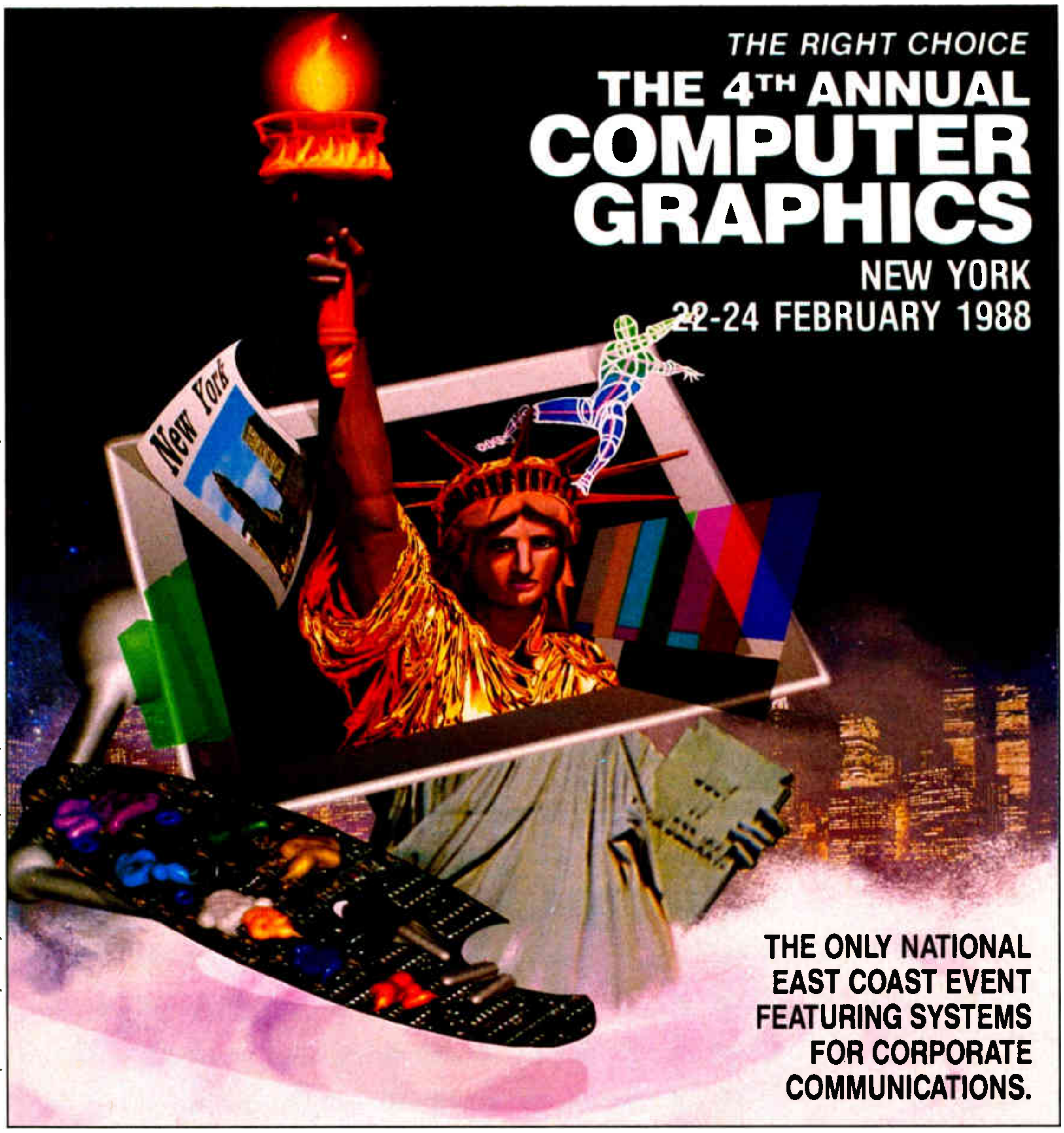

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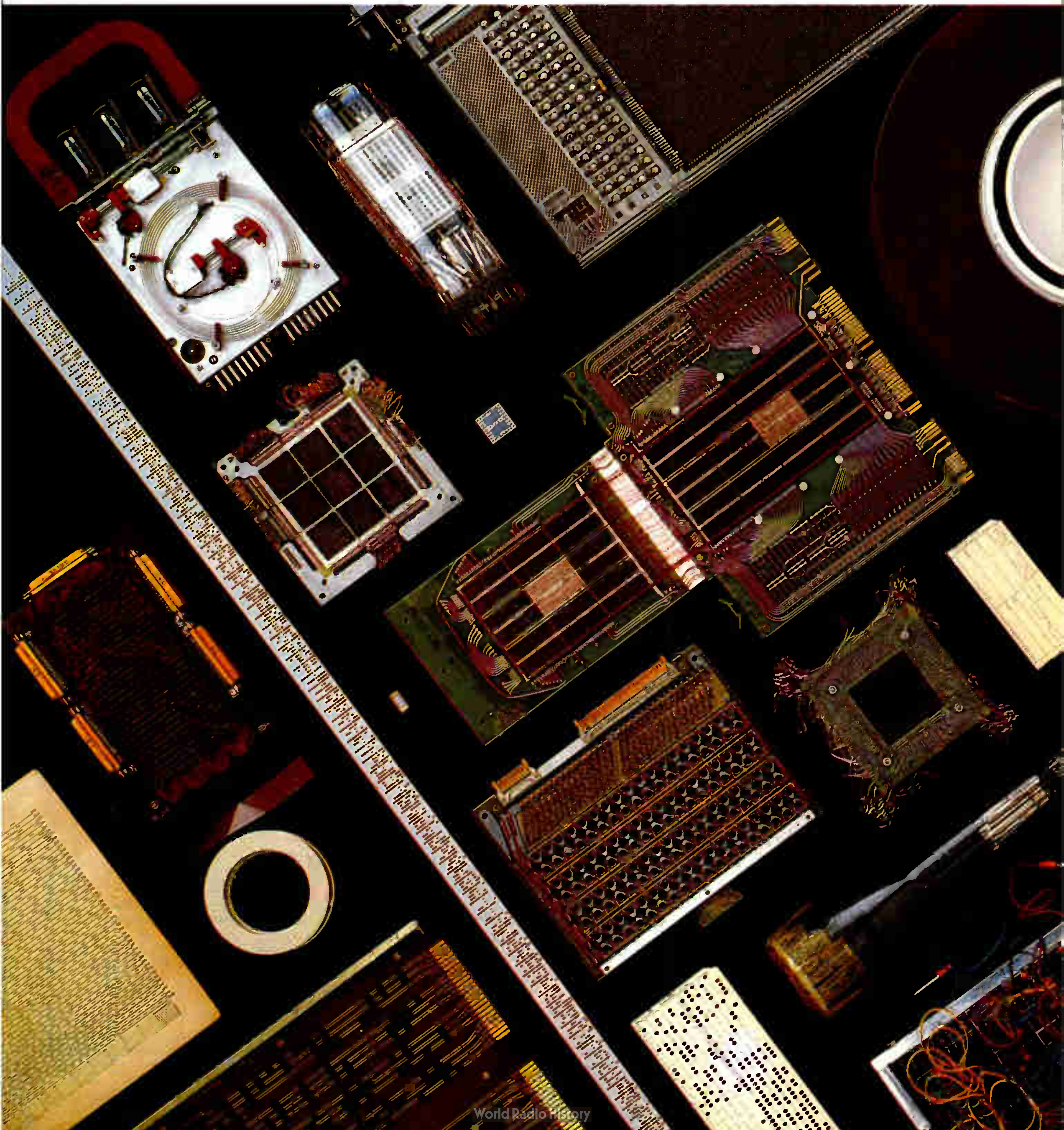

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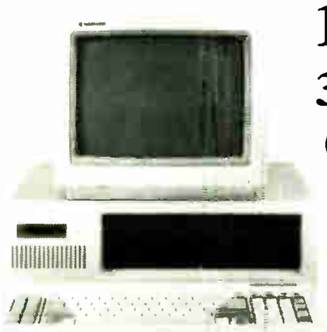

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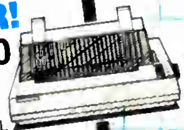

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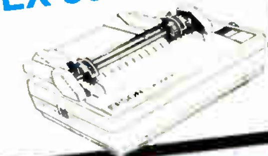

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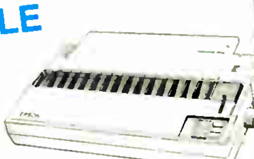

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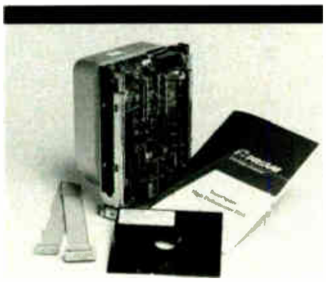

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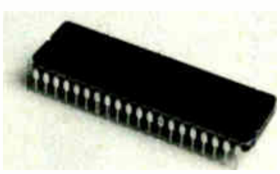

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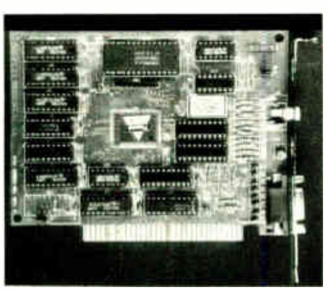

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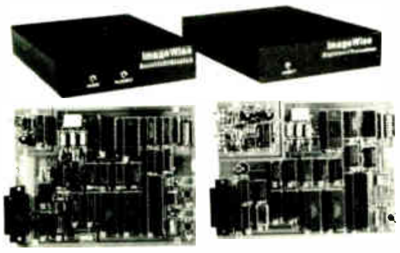

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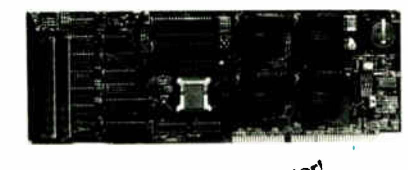
- Video processing, disk upload/download, and display utilities provided for PC DOS and MS-DOS machines

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 129 IC's on a standard AT to be reduced to 20 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 5⅛")
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

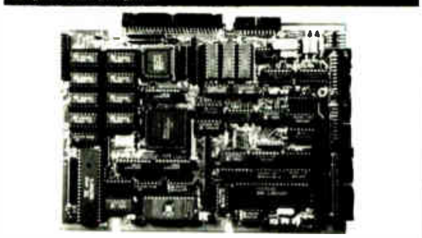
The **OEM-286** is available in both 8 and 10 Mhz versions and comes with the Award BIOS.

OEM-286 FEATURES

- 100% AT compatible
- 80286 Microprocessor, 8 or 10 Mhz
- 80287 Co-Processor optional
- 64 Kbytes of ROM, can accommodate 128 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
- 24 bits bi-directional parallel I/O
- 19-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 Microsystems 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

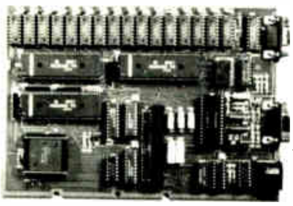
SOFTWARE COMPATIBILITY
- CP/M, ZRDOS, ZCPR3 Compatible

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 as described above with Z-System software including ZRDOS, ZCPR3, editor, utilities, ZAS assembler, and ZDM debugger. BIOS and ROM monitor sources, and BIOS for SCSI hard disk. Supplied on two 5¼" SB180 format DSDD disks.	$499.00

SB180 — $299.00
Single Board Computer

SB180-1	SB180 - 6.144 MHz single board computer w/256K bytes RAM and ROM monitor. Add $50.00 for 9 MHz	$299.00
SB180-1-20	Same as above w/ZCPR3, ZRDOS, BIOS and ROM sources	$399.00
COMM180-S	SCSI Hard Disk Interface	$150.00
SB180-1	**OEM 100 QUANTITY PRICE**	$195.00

GT180 — $395.00
Graphics Display System



The **GT180** has both TTL RGB (red-green-blue intensity) and analog RGB outputs, is totally compatible with virtually all standard and multiscan CRT monitors, and has a connector for an IBM PC keyboard.

The **GT180** offers these features:
- Advanced graphics controller provides intelligent link between computer and user
- Only 5.75" 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-ZMSG/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
Term-Mite Smart Terminal

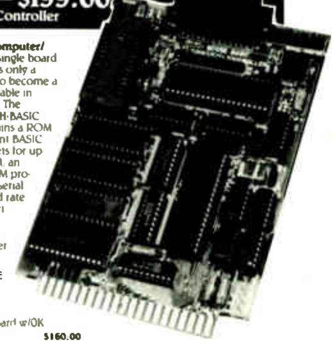
Why pay $500 or more for a smart terminal? The **TERM-MITE ST** offers you all of the following on a single board for less than ½ the price.

- Dimensions: 4" x 6½"
- 128 displayable characters
- 24 lines x 80 characters
- Separate transmit & receiver baud rates(110-19,200bps)
- CRT refresh at 50 - 60 Hz
- Supports scanned and encoded keyboards
- 11 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 neccessary for stand-alone operation with parallel keyboard

BCC22	TERM-MITE Smart Terminal Board	$249.00
BCC22K	PARALLEL Encoded ASCII KEYBOARD plugs directly into TERM-MITE	$ 79.00

BCC52 — $199.00
BASIC 52 Computer/Controller



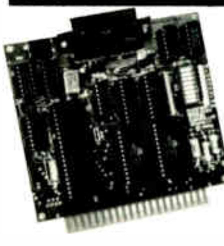
The MICROMINT **BCC52 Computer/Controller** is a stand-alone single board microcomputer which needs only a power supply and terminal to become a complete system programmable in BASIC or machine language. The **BCC52** uses the Intel 8052AH-BASIC microprocessor which contains a ROM resident 8K byte floating 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
$199.00
OEM 100 QUANTITY PRICE
$149.00

BCC53
Multi Function Expansion Board w/0K adds 6 ports and 62K bytes **$160.00**

***NOW AVAILABLE IN INDUSTRIAL TEMPERATURE RANGE – CALL FOR INFORMATION**

BCC11 — $139.00
Basic Controller



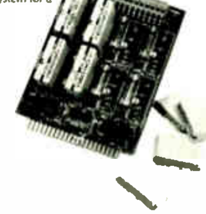
Features
- Uses Z8 single chip microcomputer
- On board tiny basic interpreter
- 2 on board parallel ports & serial port
- 6 interrupts (4 external)
- Just connect a CRT and write control programs in Basic
- 6K Bytes of RAM or EPROM memory on board
- Baud rates 110-9600 bps
- Data and address bus available for 56K memory and I/O expansion
- Consumes only 1.5 watts at +5, +12 & −12V

BCC11*
BASIC System Controller
$139.00

***NOW AVAILABLE IN INDUSTRIAL TEMPERATURE RANGE – CALL FOR INFORMATION**

BCC40 — $159.00
Power I/O Expansion Board

The MICROMINT **BCC40 POWER I/O Expansion Board** provides on/off control and monitoring of eight 115-230 VAC or 5-48VDC devices. Up to 16 POWER I/O boards may be used in a system for a total of 64 inputs and 64 outputs.



BCC40
POWER I/O Expansion Board (with no power modules) **$159.00**
with 8 Output Modules **$249.99**
with 8 Input Modules **$229.99**

BCC52 & BCC11
Software and Accessories

BCC52-ROM A	ROM A Utilities-BASIC extensions	$ 49.95
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	$ 69.00
BCC52-8K-CLK	SMARTIME BCC52 Clock w/8K RAM and ROM C	$ 79.00
BCC53	Multi Function Exp. Board w/0K – adds 6 ports and 62K Byte	$160.00
BCC08	Serial I/O Expansion Board	$149.00
BCC09	RS-232 to 20ma Converter	$ 55.00
BCC13	8 Bit, 8 channel A/D Board	$129.00
BCC30	12 Bit, 16 channel A/D Board	$197.00
BCC25-4	4x20 LCD Display	$159.00
BCC25-8	8x40 LCD Display	$229.00
BCC22K	Parallel Enclosed ASCII keyboard	$ 79.00
MOTHER BOARDS – CARD GAGES – POWER SUPPLIES		
MB02	5 Slot mini-mother board (not compatible with CC01, CC02)	$ 69.00
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CC01	10 inch Card Cage for one MB08	$ 59.00
CC02	19 inch Card Cage for two MB08s	$ 79.00
UPS11	Universal Power Supply – used for single board applications 9A @ 5V, 3A @ +12V and 1A @ −5V	$ 19.00
UPS05	Card Cage Power Supply – designed for a 2 or 3 board system 1A @ 5V, 3A @ +12V, 1A @ −12V	$ 79.00
UPS10	Heavy Duty Switching Power Supply – used for an entire BCC system 5.5A @ 5V, 7A @ +12V, 3A @ −12V	$ 69.00
UPS21	21 Volt Programming Power Supply – used for EPROM programming on the BCC52 21V +/− 2% @ 200ma	$ 49.00

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BYTE editors offer hands-on views of new products.

Toshiba PageLaser12

The Toshiba PageLaser12 ($3699) is a 12-page-per-minute laser printer that features 300 by 300 dot-per-inch resolution, serial and parallel connections, 512K bytes of memory (expandable to 2 megabytes), and emulations for the Diablo 630, IBM 5152 Graphics, Qume Sprint 11, and Toshiba P351 printers.

The printer is based on Toshiba's own laser-printer engine. The standard duty cycle is 25,000 pages per month, with a printer life expectancy of 600,000 pages. The life cycle can be extended to 1.2 million pages with the purchase of an optional service kit.

Setting up the PageLaser12 is slightly more messy and complicated than compared to other laser printers that use the Canon engine. You must install the toner cartridge (6-pack for $169), good for 5000 pages; the drum cartridge ($299), 25,000 pages; the developer kit ($219), 40,000 pages; and, finally, the fuser ($99), 80,000 pages.

The three resident type fonts are Line Printer, Prestige Elite, and Courier. Also, three slots on the front panel accept optional font and emulation cartridges. The cartridges are credit-card size and contain the font or emulation information on ROM chips. Included with the printer is the Hewlett-Packard LaserJet 500 Plus cartridge. Eleven Hewlett-Packard–compatible font cartridges are available.

The printer configuration is displayed on a 16-character LCD on the front panel, and it can be changed by pressing the membrane switches and scrolling through a menu of configuration selections. Because the LCD is 16 characters wide, menu selections and error messages are displayed in English. You don't need to look at a manual to decipher code numbers as, for example, on the Hewlett-Packard printers.

When I ran the standard BYTE benchmark for laser printers, the PageLaser 12 printed the 96K-byte, 30-page text document in 3 minutes and 9.4 seconds. This makes it one of the fastest laser printers I have used. (For an explanation of the BYTE laser-printer benchmarks, see "Laser Printer Times Four" by Wayne Rash Jr. in the October BYTE.)

—Stan Wszola

The Facts:

Toshiba PageLaser 12 $3699	Toshiba America Inc. Information Systems Division 9740 Irvine Blvd. Irvine, CA 92718 (714) 380-3000

Options:
Dual cassette sheet feeder, $899; envelope feeder, $999; paper output jogger/collator, $99; universal/legal paper tray, $99; 1.5-megabyte memory-expansion board, $749; 11 type font cartridges, $149 to $249.
Inquiry 851.

Lahey Personal FORTRAN 77

Lahey Computer Systems' new Personal FORTRAN 77 compiler for the IBM PC and compatibles, called LP77 ($95), is a full implementation of the FORTRAN 77 standard (ANSI X3.9-1978). LP77 is similar to Lahey's F77L compiler ($477), except that generated code, data, and stack space are limited to 64K bytes. LP77 does not come with a linker, but it uses the MS-DOS or PC-DOS linker (LINK.EXE). LP77 requires 256K bytes of RAM and a math coprocessor.

LP77 is supplied on a single 5¼-inch floppy disk. Extensions to the FORTRAN 77 standard are highlighted in the reference manual. While the documentation is complete, it is intended for experienced FORTRAN programmers.

LP77 uses the DOS linker to create the executable (.EXE) file from your compiled source code. It provides a batch file that automatically invokes the compiler and DOS linker and then executes your program. You simply call the batch file and supply the name of your source code file. Of course, you can perform these operations separately if you prefer.

LP77 has good error diagnostics and directs you to sections in the manual that might explain a detected error. It also includes a version of the Source On-Line Debugger (SOLD), which is supplied with F77L. You can use SOLD to step through the execution of your program and to trace and display values of variables and arrays. I found SOLD helpful in finding a numerical error in a program I had written.

Lahey Computer Systems offers telephone technical support and an electronic bulletin board where you can post inquiries and download fixes and updates. You can also purchase the LP77 Toolkit Library for $49.95, which provides 15 additional subroutines and functions for use with LP77, like DOS or BIOS interrupt handling, stack management for assembly language routines, bit shifting, and DOS command execution.

According to Tom Lahey, LP77 is intended for the educational market and for professional programmers working

continued

with smaller applications or who want to have a version of FORTRAN at home. If you are working with arrays greater than 64K bytes, which is often the case in engineering and scientific applications, you'll need a more expensive compiler, like F77L, Microsoft, or Ryan-McFarland FORTRAN. LP77 is a good choice if you're just starting to learn FORTRAN or don't have the need for larger data and stack space.

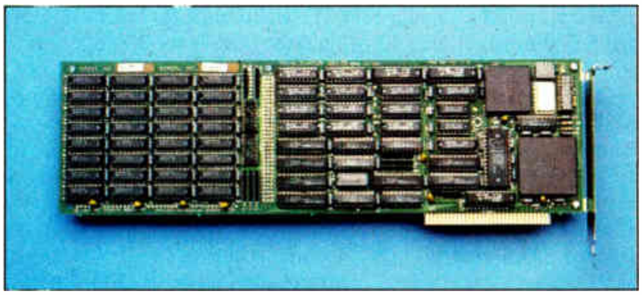
—Nick Baran

The Facts:

Lahey Personal FORTRAN 77 (LP77) $95	Lahey Computer Systems Inc. 917 Tahoe Blvd., Suite 203 Incline Village, NV 89450 (702) 831-2500

Requirements:
IBM PC, XT, AT, or compatible; MS-DOS 2.0 or higher; 256K bytes of RAM; math coprocessor (8087/80287).
Inquiry 852.

PC-Elevator 386



The PC-Elevator 386 is an unusual 16-megahertz 80386 add-in board for the IBM PC, XT, or AT. The base unit ($1995) comes with 1 megabyte of on-board 100-nanosecond memory, a socket for an optional 80387 coprocessor ($795), disk caching and EMS (Expanded Memory Specification) memory management software, and a bus for attaching up to 16 megabytes of memory via optional daughtercards ($2000 for each 4-megabyte daughtercard).

What makes the PC-Elevator 386 unusual is its ease of installation. You run an included setup utility and then plug the board into any empty, full-length XT-style slot. The setup utility examines your current hardware. On-screen graphics show you how to set the board's DIP switches. The utility copies driver software onto your hard disk and automatically adds the new drivers to your existing CONFIG.SYS file. The entire setup process takes only 15 minutes.

Once the board is installed, you can run your system from either the original CPU (in which case your hardware operates exactly as before) or from the 80386. To boot the 80386, you run a short program called Up, which commandeers some DOS interrupts. The 80386 then handles computation and memory access, while your original CPU continues to handle I/O. In effect, PC-Elevator turns your original computer into a dedicated I/O subsystem serving the 80386.

The PC-Elevator speeds up computationally intensive tasks enormously, but the overhead of the 32-to-8-bit conversion actually can make I/O-intensive tasks run slower than on an unmodified machine. This is because the 386 communicates with only its memory and coprocessor via a 32-bit-wide data path; it talks to everything else via the 8-bit-wide XT bus.

I installed a PC-Elevator 386 (equipped with an 80387 coprocessor and 1 megabyte of RAM) on an 8-MHz "turbo" XT clone and a zero-wait-state 8-MHz AT clone. In the XT clone, computationally intensive tasks ran an average of 81 percent faster than on the unmodified machine. On the AT clone, CPU-bound tasks ran about 55 percent faster than on the unmodified machine. Computationally, the PC-Elevator 386 is in the same league as such machines as the Compaq Deskpro 386.

But I/O performance was mixed, at best. The bundled disk-cache software helped the PC-Elevator work well on the relatively slow XT clone. Overall disk throughput was 25 percent better than that of the unmodified, cacheless machine. But on the inherently faster AT, the cache was less effective in making up for the I/O bottleneck. Overall file I/O was about 7 percent slower. On both machines, screen handling was very slow, making word processing a chore. Text scrolled 41 percent slower on the XT and 49 percent slower on the AT.

PC-Elevator's software works by hooking into DOS interrupts, and as a result, I ran into problems with some terminate-but-stay-resident programs. (Applied Reasoning says it tries to correct incompatibilities as soon as it learns of them.)

I also ran into some trouble running timing-sensitive communications software at 1200 bits per second from the PC-Elevator in my AT clone. (You can avoid this problem by running sensitive software on the original CPU or in PC-Elevator's "slow" mode.)

—Fred Langa

The Facts:

PC-Elevator 386 $1995	Applied Reasoning Corp. 86 Sherman St. Cambridge, MA 02140 (617) 492-0700

Requirements:
IBM PC, XT, AT, or compatible with one empty full-length slot.
Options:
80387 coprocessor, $795; 4-megabyte daughtercards, $2000 each.
Inquiry 853.

BiTurbo STATA

According to Computing Resource Center, BiTurbo STATA ($640) is faster than the original statistics package because all the program code and the current data set are memory-resident; previous versions of the product have used code overlays to maximize the memory available for data sets. Since STATA supports the LIM (Lotus/Intel/Microsoft) and AST expanded-memory specifications, having code and data in memory is feasible for general statistical work. For applications involving fewer than 1500 observations on 99 variables, BiTurbo STATA will run in 640K bytes of RAM.

CRC continues to sell a code-overlay version of STATA and will keep both versions identical in terms of features.

I tested a beta version of BiTurbo STATA, which completed a complicated regression-analysis demonstration in 21 seconds; regular version 1.5a took 44 seconds. When running user-defined programs written in STATA's own programming language, the speedup achieved using BiTurbo was even more significant. BiTurbo ran the STATKIT

continued

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 Micro-Way 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 Micro-Way product you choose, you can be assured of the same excellent pre- and post-sales support that has made Micro-Way the world leader in PC numerics and high performance PC upgrades. For more information, please call the Technical Support Department at

617-746-7341

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 Micro-Way'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

MATH COPROCESSORS

80387-16 16 MHz $495
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80287-8 8 MHz $259
80287-6 6 MHz $179
8087-2 8 MHz $154
8087 5 MHz $99

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Circle 192 on Reader Service Card

demonstration in 38 seconds; regular STATA 1.5a ran it in 92 seconds. (Tests were done on an 8-MHz IBM PC AT compatible with an 80287 numeric coprocessor, 640K bytes of RAM, and a 20-megabyte hard disk drive.)

Other recently announced features common to BiTurbo and regular STATA 1.5 are the automatic inclusion of the graphics module, faster execution in an 80x87 environment, output to PostScript devices, and a new graphics presentation option for "star plots."

Star plots provide a convenient way to compare objects. Each radial axis on the star corresponds to a particular characteristic of the object; the length of each axis corresponds to the magnitude of a particular characteristic. Using a star plot of 53 printers, for instance, using throughput, print quality, and cost characteristics, you can quickly identify similar models, and models that resemble a predetermined ideal shape.

—George A. Stewart

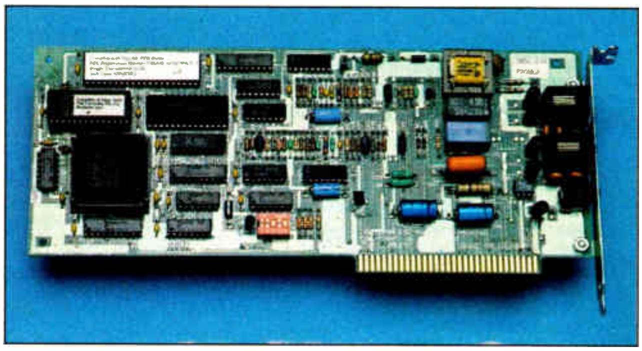
The Facts:

BiTurbo STATA, $640;
STATA, $590;
BiTurbo STATA (beta version), $50 to owners of regular STATA 1.5a

Computing Resource Center
10801 National Blvd.
Los Angeles, CA 90064
(800) 782-8272

Requirements:
IBM PC or compatible; 256K bytes of RAM; two floppy disk drives or a hard disk drive; PC-DOS or MS-DOS 2.0 or higher; 80x87 recommended but not required; expanded memory (LIM and AST/Ashton-Tate/Quadram specifications) supported but not required; graphics adapter (CGA, EGA, or Hercules) recommended but not required.
Inquiry 854.

The Complete Answering Machine



The Complete Answering Machine (CAM) ($349) turns your IBM PC or compatible into a voice-mail and telephone-answering system. Each user is assigned a personal "voice mailbox" for leaving and retrieving messages and can record a personalized greeting similar to what you hear on a standard answering machine. Callers can leave and retrieve messages provided they have a Touch-Tone telephone. Messages can be forwarded to other mailboxes on the system or saved on disk for later recall. Using its own microprocessor, CAM digitizes the caller's voice and stores it on disk. A 1-minute message requires approximately 180K bytes of disk storage.

The CAM package includes an add-in board that fits in an expansion slot of your PC, four disks of software, a manual, and a telephone cord with modular connectors. CAM is memory-resident and takes about 100K bytes of internal memory; it operates in the background, letting you use the PC for other functions and still receive incoming calls.

What differentiates this system from a standard answering machine is that you can have multiple voice mailboxes that can be accessed directly by the caller. For example, if you have several people in an office, each person would be assigned a mailbox with a unique identification number and password. An incoming caller is instructed by the recorded greeting to press the phone button corresponding to the desired mailbox ID number ("If you want to leave a message for Mr. X, please dial 7, followed by the pound symbol").

The caller then accesses the specified mailbox and hears the personalized message of the owner of that mailbox. After a beep, the caller can leave a message. You can set up special mailboxes for frequent callers or maintain a "library" of messages on disk, which you can use for different circumstances. A special mailbox is provided for the "system administrator."

When you're away from the office, you can call and play back messages or leave messages for other people in your office. You can modify passwords or change messages remotely. A feature I've not yet tested lets you program CAM to call another phone at a specific time to play back messages.

The user manual is confusing at first, but with a little research and perhaps a phone call to the vendor, it's fairly straightforward to install the system. The package comes with a phone template that indicates the commands actuated by each phone button. A wallet-size reference card is also supplied.

—Nick Baran

The Facts:

The Complete Answering Machine $349	The Complete PC 521 Cottonwood Dr. Milpitas, CA 95035 (408) 434-0145

Requirements:
IBM PC, XT, AT, or compatible with a hard disk drive, 384K bytes of RAM (540K bytes recommended); a Touch-Tone phone with standard RJ-11 or RJ-14 connector; PC-DOS 3.10 or higher; clock/calendar recommended.
Inquiry 855.

Flash-Up

Everybody talks about user interfaces, but hardly anybody could do anything about them until now. Flash-Up, an $89 utility program, lets you modify the interface of almost any type of software package for the IBM PC.

This cross between a keyboard-macro program, a menu manager, and a Post-it note program lets you link a single key to a keyboard macro or a window. The window can be a menu of other windows or macros, or you can set them to appear only in certain contexts. With Flash-Up, you can add a friendly menu interface or a context-sensitive help system to even the most surly command-line software.

Flash-Up appears to consist of a window editor and a window manager, linked together in a memory-resident program. With the window editor, you can design what a window looks like, what the menu choices of a window will do, and under what circumstances the window will appear. The window manager monitors DOS calls for the keyboard and the screen, and it calls the appropriate window if conditions match the ones you selected.

With Flash-Up, you can, for example, set up several help screens attached to the F1 key, and each help screen will appear only under the proper context. Or, you can set up the Control-K key to initiate a WordStar-style menu of block operations.

Software Bottling also provides a Toolbox, which includes a memory-resident run-time program that contains only the window manager. The $49 price of the Toolbox lets you make unlimited copies of the run-time program, which can then be distributed with your libraries of windows and macros.

As a memory-resident program, Flash-Up is not without its minor problems, of course. It may have to be loaded in a certain sequence with other memory-resident software. On my system, Flash-Up wouldn't recognize specific key combinations. But there always seemed to be a way to get around these problems, and, if not, Software Bottling has a 30-day money-back guarantee.

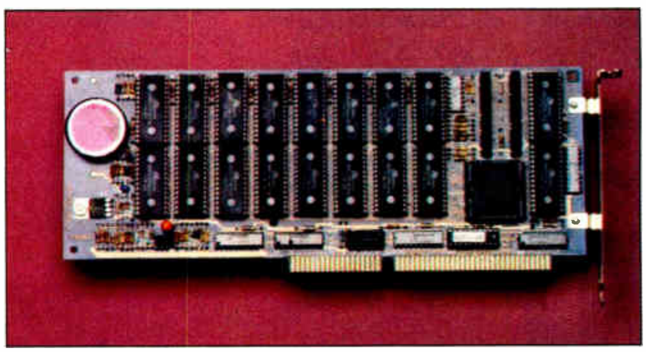
—Rich Malloy

The Facts:

Flash-Up $89	The Software Bottling Co. 6600 Long Island Expressway Maspeth, NY 11378 (718) 458-3700

Requirements:
IBM PC, XT, AT, or compatible; 128K bytes of RAM; MS-DOS or PC-DOS 2.0 or higher.
Inquiry 856.

Awesome I/O Card

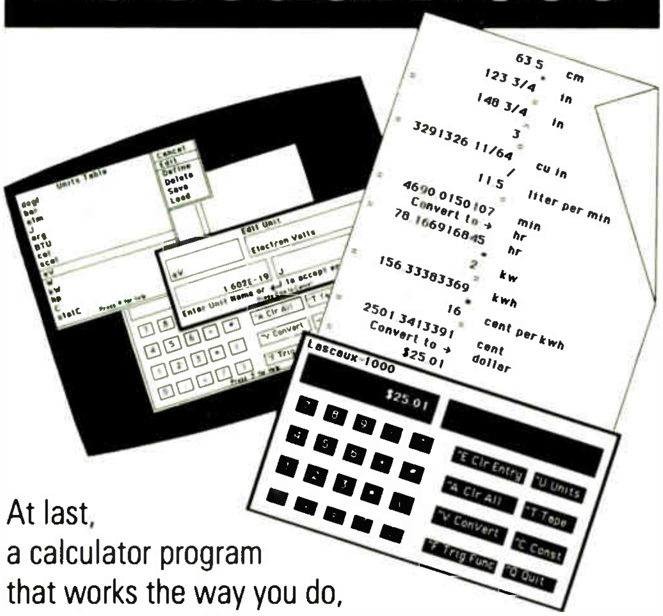


The Awesome I/O card is designed to improve the throughput, capacity, and reliability of your hard disk. Using on-board nonvolatile CMOS RAM (256K or 512K bytes, 100 nanoseconds) managed by an intelligent control unit called the Heuristic Adaptive I/O Controller, the Awesome I/O card determines and caches your most frequently used hard disk data.

Since the RAM is battery-backed, Awesome I/O "remembers" your access patterns, even after you've shut the machine off. Additionally, you can configure the Awesome I/O to employ a proprietary form of ECC (error-correction coding) that can detect and correct bit errors in up to 4096 contiguous bits (an entire sector).

Awesome I/O uses no cabling to your existing hard disk drive; you plug the board into an empty slot in your PC or

continued



PS/2 compatible. (Versions of the board are available for XT, AT, and PS/2 machines. I tested the board on my Microserve Pro-Plus AT Turbo running at 10 MHz.) You run an installation program that analyzes your hard disk so that the card can use the best interleave and spiral factor (spiraling increases data transfer when the system has to access data that crosses track boundaries), then you select how you want your disk partitioned.

You can opt for a variety of configurations, from a single large partition (the board handles up to 512 megabytes in a partition) to multiple partitions of equal size (up to 16). You can also choose to have data on a given partition stored in compressed form that increases capacity between 50 and 60 percent. (The installation program tells you that keeping data in a partition in compressed form does result in a throughput penalty, though just how much of a penalty is left as a secret.)

Finally, you load a device-driver file onto your booting disk and enter the driver's name into a line in your CONFIG.SYS file. (This driver is necessary only if you set up one partition as a large partition [i.e., bigger than 32 megabytes] or if you've divided the disk into more than two partitions.)

I divided my hard disk into two partitions (they appeared as drives C: and D:). I turned off compression/compaction for the C: partition and turned it on for the D: partition. To test Awesome I/O's throughput, I modified BYTE's Fileio benchmark so that it created a 655,340-byte file and performed 5000 random reads and writes on it.

On both the C: and D: partitions, execution time was approximately 150 seconds. (The compacted partition, D:, appeared to have the same throughput as the C: partition. Apparently, the card's compaction algorithm is quite good.) The same benchmark on an identical machine without Awesome I/O took approximately 410 seconds.

The Awesome I/O card is currently available only with 512K bytes of on-board CMOS RAM. The company reports that these options will be available this month: the shadow disk option ($169), which monitors the data being sent to one drive and mirrors it on another (for users who demand a fault-tolerant environment); an extended/expanded disk accelerator option ($79), which lets you use extended or expanded memory for disk caching; a high-speed archive partition option ($79); a backup utility that can back up 20 megabytes in less than 5 minutes ($79); and DES encryption ($99).

—Rick Grehan

The Facts:

Awesome I/O
XT version, $744;
AT version, $844;
PS/2 (Micro Channel) version, $1198

CSSL Inc.
90 Electric Ave., Suite 202
Seal Beach, CA 90740
(213) 493-2471

Requirements:
IBM PC XT, AT, PS/2, or compatible; PC-DOS 3.0-3.3; Compaq MS-DOS 3.1, 3.2, and 3.21; or Wyse MS-DOS 3.2.
Inquiry 857.

MacScheme + Toolsmith

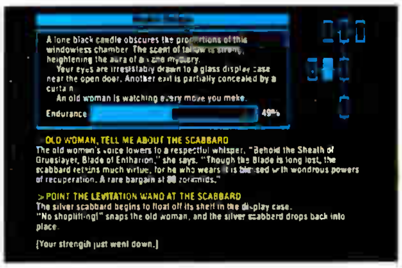
MacScheme + Toolsmith ($395) is an interactive development environment for the Macintosh that lets you create stand-alone, double-clickable applications that you can distribute without royalties. The MacScheme compiler is based on the Scheme

continued

The *Zork Trilogy* has become a legend in its time, selling nearly one million copies! Now the legend continues with an extraordinary new Zorkian universe that breaks ground in computer gaming. For the first time, the character-building and combat of role-playing games joins the masterly prose and puzzles of Infocom's interactive fiction.

Beyond Zork's sophisticated new interface makes interaction more natural than ever, plunging you into a world teeming with magic and peril. The vast and varied Southlands of Quendor come alive as you seek fantastic treasure and combat the vicious monsters who haunt the streets and wastelands.

Challenge yourself to a quest that's far beyond anything you've ever experienced. *Beyond Zork.* The incredible new interactive story from the master storytellers at Infocom.



One glance at Beyond Zork *will show you that it's unlike any interactive story you've seen before. On-screen mapping. Window displays. A character that grows in strength and power. You get all the excitement of role-playing games, skillfully blended with the fabulous puzzles and award-winning prose of Infocom's interactive fiction.*

Screen shown is for the Commodore 128 version.

INFOCOM™

125 CambridgePark Drive, Cambridge, MA 02140

Beyond Zork *is available at your local dealer for the Apple II series, Macintosh, Commodore 128, Amiga, IBM PC and 100% compatibles, and Atari ST. To order direct, call 1-800-262-6868. Coming soon: Apple IIGS.*

Zork *is a registered trademark of Infocom, Inc.*

Circle 134 on Reader Service Card

programming language and provides full lexical closures and procedures used as first-class data objects, tail recursion, and continuations. This gives you the ability to write programs in an object-oriented manner. Toolsmith is a software system that extends the base of the MacScheme language to make it easier to write programs for the Macintosh.

Toolsmith provides high- and low-level interfaces to the Macintosh Toolbox. The high-level interface consists of classes of objects that package standard behavior for simple menus, windows, editors, and scrollers. For example, a window object knows how to display and move itself on the screen.

The low-level interface to the Macintosh Toolbox consists of a library of Scheme versions of data definitions and Toolbox traps. They are organized according to the volume and chapter number in which they appear in *Inside Macintosh*. The source code for Toolsmith is included with the package.

Toolsmith also provides a programmable interrupt system that converts the Macintosh programming model from a polling model to an interrupt model. Toolsmith's event handler lets you construct objects that respond to their own events without having to rely on other parts of the program. This separation of event-handling routines from the development environment lets you debug your applications without leaving the environment.

Toolsmith supports concurrent programming. Task switching is scheduled by an interrupt handler for null events. You define the tasks you want scheduled and set a variable that determines how long each task will run before it is suspended and the next task is run. Support for critical sections is provided.

A programming example for a text editor is included with the package to illustrate some of the features of Toolsmith. Menu objects are created for the Apple, File, Edit, and Style menus with Toolsmith's `make-menu` procedure. Object-oriented techniques are illustrated with a `make-document` procedure that inherits the behavior of a window object, adds some behavior of its own, and passes handling of events inside the window to an editor object. A concurrent task is created to blink the insertion point in the active window. I created stand-alone byte code and native code versions of the text editor example and compared their speeds running on a Macintosh Plus. In the byte code version, a 2-to-3-second pause occurred between clicking on the menu selection and having the menu pop up. The native code version's menus took about a half second to pop up.

MacScheme + Toolsmith contains a source code debugger; a graphics library for drawing rectangles, circles, ovals, lines, and points; and a snapshot facility for saving the current state of your environment. By combining the interactive nature and power of the Scheme programming language with a good interface to the Macintosh, an applications builder, and native code compiler, Semantic Microsystems is striving to provide a good environment for developing applications that run at an acceptable speed.

—Eva White

The Facts:

MacScheme + Toolsmith
$395

Semantic Microsystems
4470 Southwest Hall, Suite 340
Beaverton, OR 97005
(503) 643-4539

Requirements:
Apple Macintosh, Macintosh Plus, Macintosh SE, or Macintosh II; 1 megabyte of RAM; 800K-byte floppy disk drive.
Inquiry 858.

Price Break!

PCDOS $295. Source Code $295.

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Vermont Creative Software

21 Elm Ave., Richford, VT 05476

Circle 310 on Reader Service Card

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Circle 348 on Reader Service Card (Dealers: 349)

Gregg Williams

HyperCard

HyperCard extends the Macintosh user interface and makes everybody a programmer

Many people are confused by Apple's new program, HyperCard. If you ask six different HyperCard users what it is, you might get answers like these:

"I don't know, exactly," person A says. "But I started playing with it, and I found I could keep my address book in it. I also keep my appointment book and to-do list with it. You can get from one of these things to another just by clicking on a little picture of it."

Person B is more certain. "It's something you have to have on disk to run these commercial programs they call 'stackware.' I use it to run this really great personal finance program I bought at a computer store."

"It lets you write your own programs," says person C. "I just wrote one that spells out words when my daughter clicks on them with the mouse."

Person D publishes an in-house newsletter. "It's really helped me organize my Macintosh clip art. I can link related pieces of artwork together—and it can find them very fast."

"I'm a teacher," says person E. "I bought a stackware program that controls a laser disk with all the images from the National Gallery of Art. I can't program, but I can rearrange the images in the order I want for my class."

"Our company writes Mac software," person F says, "and we just canned a product we were working on—mostly because HyperCard already does the same thing. HyperCard's not too great on database management, though, so we're adding some new commands to HyperCard that will make it better for that. I guess we'll end up marketing it as stackware."

Because HyperCard can be such different things to different people, it is hard to describe it accurately. To quote Apple's press release, "HyperCard is a personal toolkit that gives users the power to use, customize, and create new information using. . .text, graphics, video, music, voice, and animation. In addition, it offers an easy-to-use English-language-based scripting language [called HyperTalk] that gives users an opportunity to write their own programs." Apple calls it system software, meaning software that doesn't do anything by itself, but which must be present to provide support for other programs. Some third-party software developers call it unfair competition that destroys the market for their products. Both groups are partly right—and partly wrong.

Apple intends to make HyperCard as much a part of the Mac as a one-button mouse or a desktop with icons on it. To do this, they are bundling HyperCard free with every Macintosh Plus, Mac SE, and Mac II they sell (you need at least 1 megabyte of memory, the 128K-byte ROM, and either two 800K-byte floppy disk drives or one floppy disk drive plus a hard disk drive). Current Macintosh users can buy HyperCard (four disks and a manual) for $49.

Overview

You can think of HyperCard as a stack of 3-by-5-inch index cards. A group of related cards and the file that contains them are collectively called a *stack*. You will also hear such a file being called "stackware" because, with HyperCard as an engine "underneath" it, a stack looks exactly like your average Macintosh application. A card can contain text and graphics in very rich combinations, and information can belong to either the entire stack or a single card.

HyperCard stores text in *fields*, which can be any of several types. A field contains text of one font, size, and style. The bad news is that you can't alter the font, size, or style of individual words or sentences—all the text in a field must be the same. The good news is that one of the field styles is a scrolling text window, meaning that any HyperCard "card" can hold as much text as you want.

Another important element of a card is that it can contain *buttons*. Yes, these look like the same buttons you find throughout all Macintosh applications: rounded-rectangle buttons, radio buttons, check boxes, and so forth. Things happen when you click a button—anything from going to the next card to returning to the Home stack (a "Grand Central Station" within HyperCard that you can always return to—see figure 1) to playing a piece of music or a digitized voice file. Buttons, which always have a rectangular "active area," can also be invisible (Apple calls them transparent); these can affect the stack's behavior without the user ever knowing that they're present.

Cards are 342 pixels high by 512 pixels wide—the same size as a Mac Plus screen—and contain any graphics and text you want. Through powerful extensibility built into HyperCard itself (discussed later), you can also attach animation, sound, and music to a card, and you can control just about any device that you can connect to a Macintosh.

The "About HyperCard. . ." box is two screens long and filled with names, but a few stand out. HyperCard is the brainchild of Bill Atkinson (creator of the Mac's internal QuickDraw code and of MacPaint), with additional programming and support by Dan Winkler (HyperTalk), Carol

continued

Gregg Williams is the senior technical editor of Features at BYTE magazine. You can reach him at One Phoenix Mill Lane, Peterborough, NH 03458.

Kaehler (help files), Ted Kaehler and Mark Lentczner (sound support), Adam Paal (printer support), and Chris Espinosa and Mike Holm (product managers).

To make HyperCard practical in terms of size and speed, Atkinson developed proprietary algorithms for quick text searching and for the compression and decompression of graphic images. As an example of how fast it is, I created an "address book" stack with 4277 addresses and phone numbers on it (the stack was 778K bytes); HyperCard found the desired data on the last card in the stack in exactly 2 seconds.

The Six Faces of HyperCard

Atkinson designed HyperCard so that it appears simple to novice users and powerful to sophisticated users. You can use HyperCard at one of five levels (with a sixth level available to programmers).

At the lower levels, menus shorten and disappear to make HyperCard look simpler. You can change the level you're in by clicking the appropriate radio button in the "User Preferences" card, which is the last one in the Home stack.

The first level is Browsing, which lets you look through stacks created by others. It's very simple, and you can't do anything harmful to the stack. In both this level and the next, the cursor is a small pointing hand called the *browse tool*, and you can browse through the cards by clicking on icons and by using the arrow keys and certain command keys.

At this and all other levels, you can also interact with HyperCard through the *Message Box*. When you type commands into the Message Box, HyperCard acts on them; the messages can be anything from `go to last card` to `find "New York" in field "City"` to `go to stack "Projects"`.

The second level, Typing, lets you add new cards and change the text in a card's fields. One of the many simple stacks that Apple includes with HyperCard is an Address stack containing name-and-address cards. With a single menu selection, you can create a new card. Then, by clicking in the card's fields and typing, you can create a new entry. By selecting the "Find..." menu item, typing in what you want to search for, and pressing Return, you can search for any name and address. If you click on the small telephone icon by the phone number on the card, HyperCard will even dial the number for you.

Things get interesting in the remaining four levels (Painting, Authoring, Scripting, and what I call Metascripting) so much so that I'm devoting entire sections to them below. But first, let's look more closely at the components of a card.

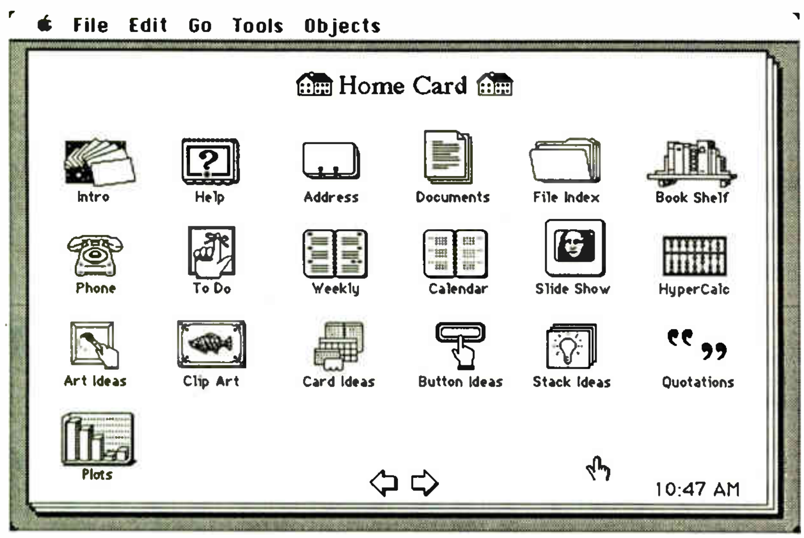

Figure 1: *The Home stack. Apple supplies HyperCard with 20 stacks, any of which you can jump to by clicking on its icon. Other cards in the Home stack contain global information, like your user level and the different search paths it should use when looking for files.*

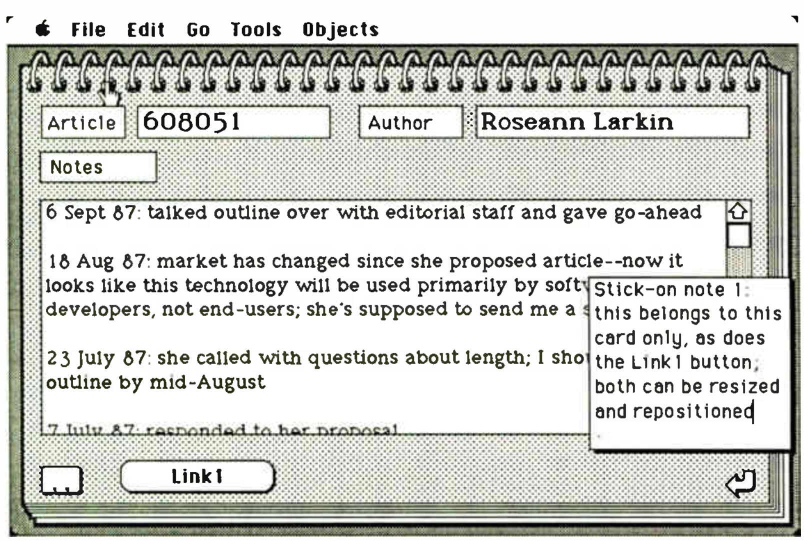

Figure 2: *The Projects stack. This stack was created by the author to keep track of ongoing projects within BYTE. The two icons in the bottom corners and the four text fields belong to the background and are shared by all the cards in the stack. The "Link1" button and "stick-on note" field belong to this card only. See figure 3 for an exploded view of this card's components.*

Card Layers

Cards are more complicated than they appear. Pictures (MacPaint-like images), buttons, and fields may belong to both a shared *background* and an individual card. Items that belong to the background appear on and are shared by every card using that background. Those that belong to the card itself are on that card only.

Take, for example, a simplified version of the Projects stack that I created to keep track of manuscripts coming in to BYTE (see figure 2). The article number, author, and notes fields are background fields, as are the address-card and return-arrow buttons on the bottom row, so they will be present on each card in this stack. (The Projects stack uses only one background, but stacks can contain cards that use different backgrounds.) On

continued

The DAISYWHEEL makes points, the OKIDATA LASER drives them home.

Tinker · Taylor · North, PC

August 29, 1987

U.S. Patent Office
1840 Pennsylvania Avenue
Washington, D.C. 20301

Sirs,

Based on the accompanying documents, I formally request a patent for the manufacture, sale and licensing of "Food for Thought," a series of edible, educational "magazines" for children printed on sheets of dried fruit. Below, please find a complete chronological diary of the inception, development, and testing of this product:

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- August 1, 1986 - Surveyed market to see what is available in the way of edible books of any sort; found out that there is no such category in either book stores or food stores.
- August 28, 1986 - Produced prototype; working name "Edi-Books"; used food coloring to write text; some blurring problems, worked on consistency of dye.
- October 1, 1986 - Results of first laboratory test encouraging; new formula had no effect on taste, texture or nutritional value of fruit.
- October 10, 1986 - Sent samples for Food and Drug Administration approval; also sent samples to independent laboratory for further testing.
- October 15, 1986 - Independent laboratory testing successful; entire process had no ill effects on the dried fruit "paper".
- October 31, 1986 - Delivered samples to marketing consultant in preparation for upcoming meeting.
- December 10, 1986 - Met with marketing consultant; estimated sales potential in the high seven figures for the first year; left an agreement with payment options.
- December 15, 1986 - Contacted three package design firms; mailed existing materials, samples, and confidentiality agreement.
- December 27, 1986 - One design firm called and backed out of project; cited potential conflict with educational book group client.
- December 29, 1986 - Officially changed name of product to "Food for Thought."

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- **Jan 2, 1985** - Initial idea; first attempts at printing story.
- **Jan 22** - Redefined formula for dried fruit. Shopped for food processing plant.
- **Feb 15** - Researched market - no direct competition.
- **Feb 21** - Registered letter to self; contents: sketches, specs, bids, names, formulas.
- **Mar 27** - Sent samples to Food & Drug Admin. for tests.
- **Sep 19, 1986** - Safety tests initiated; insurance research started.
- **Sep 26** - Registered name and trademark for product: "SMART SNACKS."
- **Oct 11** - Financial backing obtained.
- **Oct 26** - Safety test results back; package design approved.
- **Nov 17** - Market reseach results back; insurance coverage obtained.
- **Dec 9** - Contacted patent attorney; met with three ad agencies
- **Dec 11** - Delivered samples & documentation to attorney.
- **Dec 27** - Presentation to Board of Examiners and Offices of Patents.

U.S. Patent Office
1840 Pennsylvania Avenue
Washington, D.C. 20301

September 7, 1987

Dear Sirs,

With the attached notes and drawings as background, I am officially seeking a patent for the manufacture, sale and licensing of the product **"SMART SNACKS,"** *the edible "books" that help kids grow intellectually and physically.*

"SMART SNACKS" *are children's stories printed on pages of dried fruit, so a child can eat one after he or she reads one.*

My client conceived, developed and tested this unique product between January 2, 1985 and December 26, 1986. The chronological details are contained elsewhere in this document. The timeline for the process is presented here:

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the other hand, the "Link1" button and the "stick-on note" field belong to this card only.

Figure 3 shows the different layers of the Projects stack. As you can see, each button and field is in a sublayer that has its own identification number—the button or field closest to the picture is always numbered 1, and buttons or fields closer to the top layer are numbered 2, 3, 4, and so on. Depending on their properties, items that are in higher layers will cover lower ones, and they will also intercept mouse movements and clicks.

Painting

Bill Atkinson was certainly not going to create a painting subsystem within HyperCard without making some improvements to the tool set in his original MacPaint. HyperCard makes a palette of painting tools available when your user level is Painting or higher. Figure 4 shows the Tools and Patterns menus, both of which you can access from the menu bar or "tear off" and place conveniently on the screen (this new feature is especially useful on the Mac II or any Mac with a large display).

The Painting subsystem contains a number of new tools (like the regular polygon tool in the bottom center of the Tools menu) and new capabilities (like the ability to rotate and flip lasso-selected shapes). There are too many to mention here, but they are useful and deserve study.

Because the visible card image results from multiple layers of items, Atkinson had to create a more complex bit map that stores images using multiple bits per pixel. A pixel is no longer limited to the values of black and white; it can now also be transparent. So, for example, you can hide background details by painting over them with white in the card layer, and you can reveal the image underneath by erasing what looks like a blank (white) area.

Authoring

At the Authoring level, you can interact with buttons and fields in several ways. First, you can cause a button to point to any other card in any stack accessible from your Macintosh (even stacks on remote file servers); Apple calls this *linking* cards. Second, you can reuse predefined buttons that are supplied with HyperCard. Third, you can manipulate buttons and fields by clicking on them with the button and field tools, respectively (available from the Tools menu, shown in figure 4).

As an example of using a button to link your current card to another one, let's say that I need to get to my to-do list whenever I talk to, for instance, Roseann Larkin. I can easily create a button for her Projects card as follows:

- I go to her card and select "New Button" from the Objects menu. HyperCard gives me a highlighted rounded-rectangle button named "New Button."
- I then double-click on this button, which gets me its Button Info box. I rename the button "To Do" (see figure 5a).
- When I click on the LinkTo button, HyperCard returns me to the current card and gives me a dialog box that "floats" above whatever card image I display. I can then go back to my Home stack, then to my To-Do card (which is actually card 33 of the stack Datebook). By then, my screen looks like figure 5b.
- I finish by clicking the "This Card" button. This takes me back to my Projects card and causes HyperCard to link my To-Do button to the To-Do card in the Datebook stack. On a 2-megabyte Mac Plus with a SCSI hard disk drive, this entire process takes about 16 seconds.

Now, whenever I click on this button, I go to the To-Do card in my Datebook stack (this takes about 3 seconds). If I had chosen the "This Stack" button above, I would have been linked to whatever card is card 1 of the Datebook stack at the time the button is clicked (not what I wanted here, but useful in other circumstances).

One of the most interesting button options is the transparent style of the button. You can place a transparent, rectangular button of any size on the screen. Since it

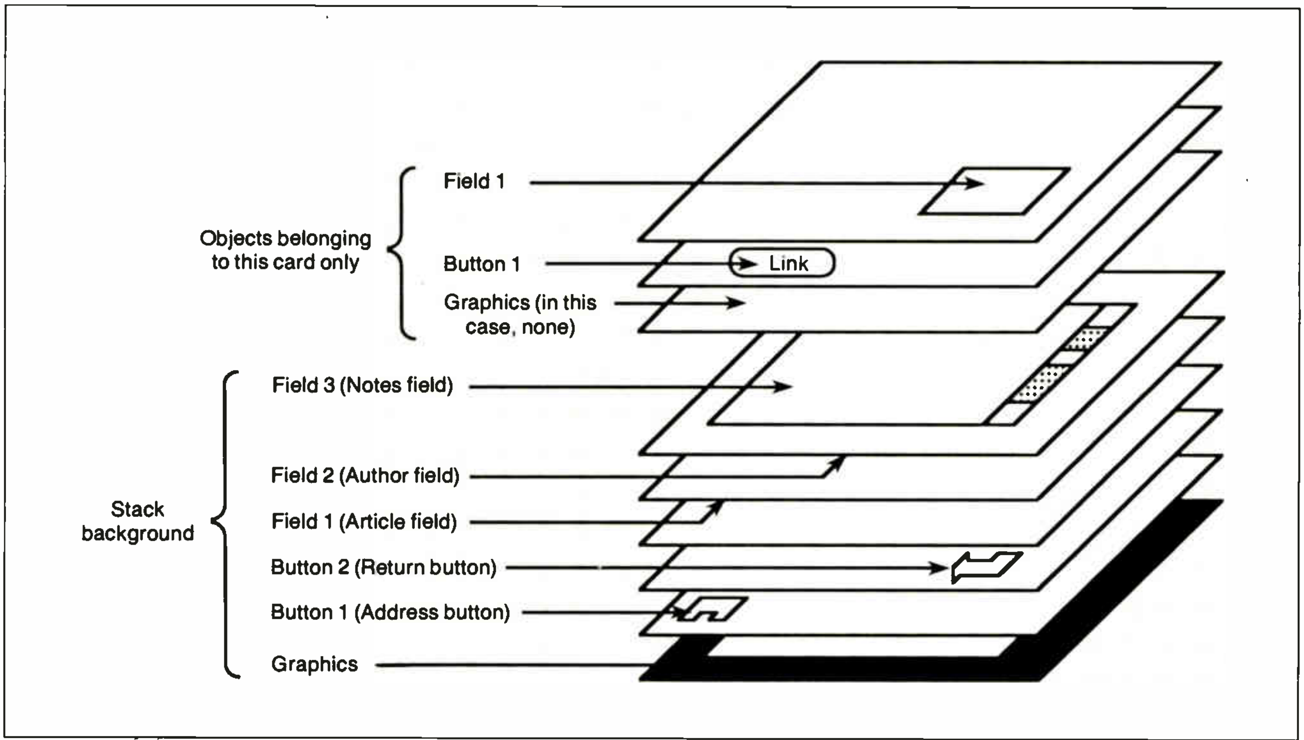


Figure 3: *Card layers. This exploded view shows the logical units that combine to make a card. All background items are "under" their foreground counterparts and can be occluded by them (as is the case with the card's "stick-on note" field covering the background "Notes" scrolling field.*

is invisible, you can see through it to whatever graphics, buttons, and fields are underneath. You can do some amazing things with this. For example, Apple supplies a Clip Art stack with invisible buttons over various subareas. The result is that you can click on a hat in the image, for example, and the invisible button takes you to the next image with a hat in it. There's no magic here, though; someone manually linked each button to the next appropriate image.

You can do more sophisticated things by cutting and pasting buttons from the "Button Ideas" stack, which contains several screens' worth of useful buttons. (HyperCard includes 20 example stacks that either do something useful or give you resources you can use, like this stack of buttons.) Some buttons take you to the next, previous, first, last, or any random card in the stack. Others have names like "Dial," "Sort," and "Show Cards."

Finally, you can use the button and field tools to manipulate buttons and fields. Once you have selected a button or tool (i.e., it is enclosed in the "marching ants" animated outline), you can move it by dragging it from its middle or resize it by dragging it from any corner. If you call up its dialog box (by double-clicking on it or selecting the "Button Info..." or "Field Info..." menu items), you can then access a number of properties, including its visual appearance and its script (described below).

Scripting

Scripting is the level at which you can examine and change the small programs, called *scripts*, that execute when you click a button. These scripts are written in an English-like language, HyperTalk, that is simple, elegant, and very powerful.

Take, for example, the "Dial" button on cards in the Address stack. It looks for a valid phone number, first in a highlighted section of text, then in the Message Box; it then jumps to the Phone stack, dials the number, and returns. The script that does this is:

```
on mouseUp
  get the selection
  if it is empty then ask "Dial¬
    what number?"
  if it is not empty then
    push this card
    visual effect zoom open
    go to stack "Phone"
    dial it
    pop card
  end if
end mouseUp
```

The script is largely self-explanatory. The on mouseUp...end mouseUp pair specifies when the enclosed commands are to be executed; the mouseUp event occurs when you release an already-pressed-down mouse button. The variable it contains the result, if any, of the previous command. The push command saves your place before you go to a new stack, and pop card returns you. The visual effect command is a nice touch that lets you specify one of 17 visual transitions from one card to the next.

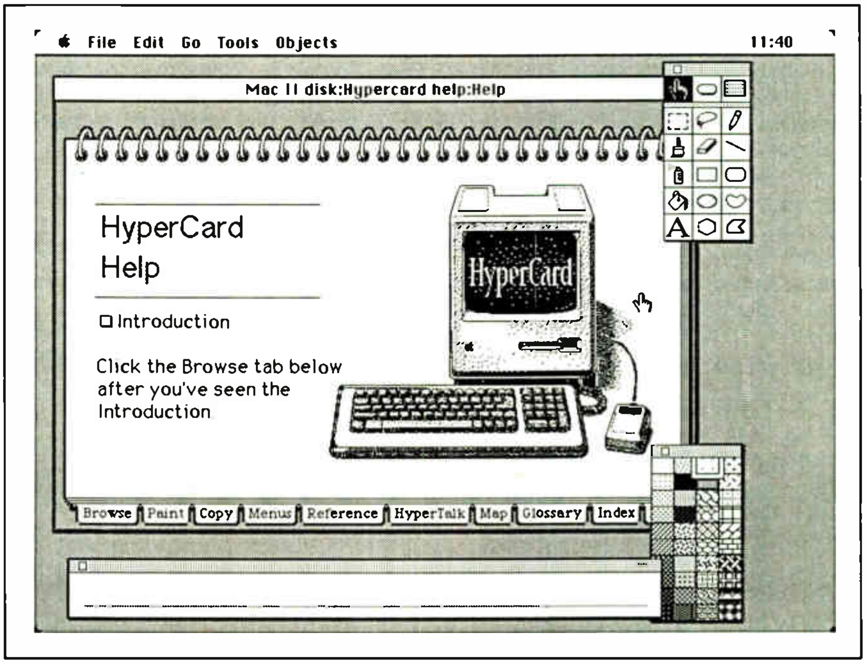


Figure 4: *HyperCard on a big-screen Macintosh. If you have a display screen that is larger than a HyperCard card (this image comes from a Mac II), the card appears in a fixed-size window, and you can use the extra space to show the Message Box (bottom center), the Tools menu (top right), and the Patterns Menu (bottom right). The last two items, new to the Macintosh, are "tear-off menus" that can be called from the menu bar, as usual, or from an arbitrary position on the screen. Note that these three windows and the HyperCard window "float" above the background and can overlap.*

Inside HyperTalk

HyperTalk scripts are event-oriented: They execute when a certain event occurs. Some events are generated internally (like idle, which is generated when nothing else is happening). Others are generated when the user presses a key (tabKey), manipulates the mouse (mouseDown), or chooses a menu entry (newField). In addition, scripts themselves can generate events (doMenu "Delete Card").

Actually, these "events" ripple through HyperCard as *messages*. When a message is generated somewhere within HyperCard, it searches through the scripts of selected objects and stops when it finds a region of code (called a *message handler*) that it satisfies. There are five kinds of objects in HyperCard—stacks, backgrounds, cards, buttons, and fields—and each of them can have its own script.

If an object gets a message it doesn't understand, it passes the message to another object according to the hierarchy of HyperCard objects. Ignoring the shaded boxes for the moment, figure 6 shows the order in which a message searches for a message handler that it will satisfy. In the most common case of a mouse event, for example, its message searches first the button or field it was over when it occurred, then the card containing the button or field, then the card's background, the card's stack, the Home stack, and, finally, HyperCard itself. If none of those recognize the message, HyperCard issues a dialog box that says Can't understand <message name>.

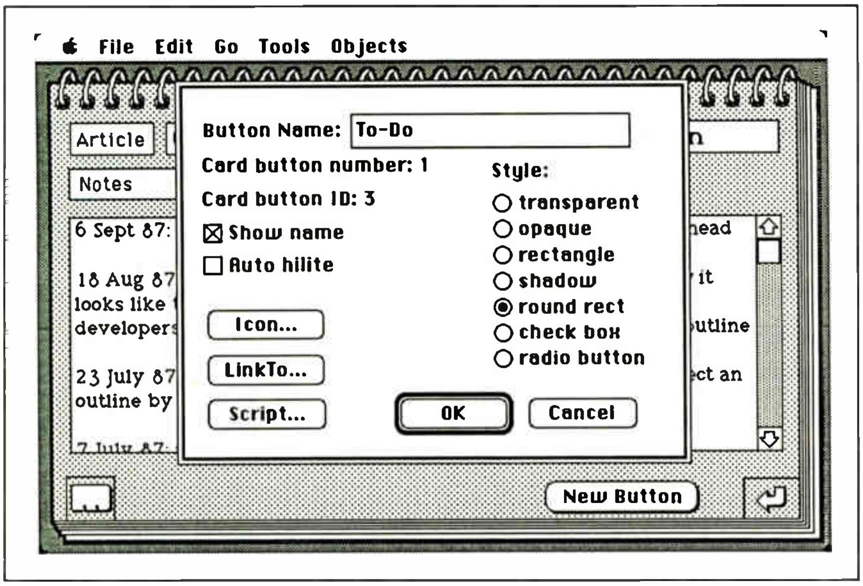
These elements make HyperTalk a simple *object-oriented language* (OOL). It operates on different kinds of objects that interact by sending each other messages. The HyperTalk message handlers are equivalent to an OOL's *methods*, and the inheritance path makes it possible for certain objects to "inherit" message handlers from another object or to override them with ones of their own. Even though HyperTalk lacks the ability to create new

continued

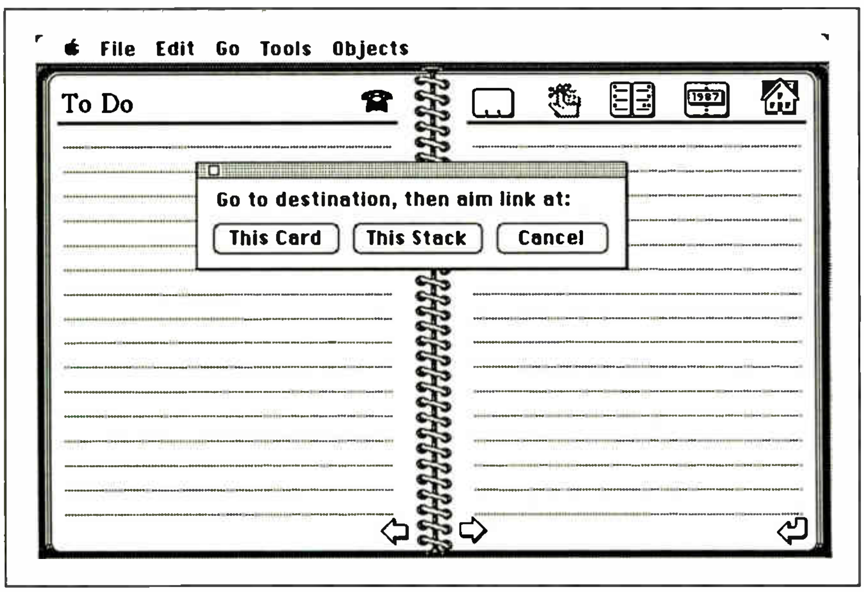
classes and its object hierarchy is not a pure OOL hierarchy, HyperTalk will do more to introduce thousands of people to object-oriented programming than previous OOLs have.

HyperTalk is full of commands (46 of them), control structures (6), functions (49), properties (58), constants (11), and operators (21); all were carefully chosen to work synergistically with one another. It includes procedures and functions with named parameters and local and global variables. All variables are stored as strings and interpreted as strings or numbers according to context; all named things are stored in a case-insensitive way. Variables default to being local to the message handler in which they occur; to be global, they have to be declared as such in each handler that wants to use them.

So far, two books document the HyperTalk language. The first is *The Complete HyperCard Handbook*, by Danny Goodman (Bantam Computer Books, $29.95). It is huge—720 pages—and contains both tutorial and reference information about HyperTalk and other aspects of HyperCard. Apple's *HyperCard Script Language Guide* is currently available from APDA (Apple Programmer's and Developer's Association), 290 Southwest 43rd St., Renton, WA 98055, (206) 251-6548, for $19.95. It gives more rigorous definitions for HyperTalk but contains little tutorial material.



a



b

Figure 5: *Linking a new button to a destination. Every button can call up a "button info" dialog box (a) that allows you to modify the button's appearance and behavior. By clicking on the "LinkTo" button, then moving to the desired destination and clicking the "This Card" button (b), you can cause the new button (which will be renamed "To Do") to jump HyperCard to the destination when it is selected.*

Metascripting

There's no official name for this hidden, sixth way of using HyperCard, so I'm calling it *metascripting* because of the way it extends scripting (or, in other words, programming). Metascripting enables a Macintosh programmer to add new commands to HyperTalk.

Here is how you do it: You write the appropriate code in C, Pascal, or assembly language, compile it without a header as a code resource of type XCMD (for message handlers) or XFCN (for functions), and paste it into the resource fork of your stack, the Home stack, the System file, or HyperCard itself. Then, when you use that resource's name in a HyperTalk script, HyperCard executes the XCMD or XFCN resource with the same name.

(For more information on XCMD and XFCN resources, contact APDA or visit the stackware section of any of the major telecommunications networks. BIX (BYTE Information Exchange) contains many interesting stacks and numerous technical documents in the Stackware area of the Listings conference. In particular, file XCMDINFO.PIT contains everything you need to know to program XCMDs and XFCNs in either C or Pascal.)

Through such extensions, many people can use HyperCard, especially those with no technical background, to organize and manipulate any data they find useful: sound, voice, animation, music-synthesizer data—whatever. Sources at Apple have also indicated that the company will eventually make it possible for Mac software developers to develop nonstack applications that can read and write stacks.

Technical Details

Bill Atkinson says that he and his colleagues worked hard to develop special algorithms to speed up the searching of cards, reduce the stored size of graphic images while maintaining quick storage and retrieval times, and speed the printing of graphic images to the LaserWriter printer. Though Apple wants to keep these algorithms secret, Atkinson and Dan Winkler (the designer of HyperTalk) made a few comments about the graphics and search algorithms.

The graphics compression routine uses "a family of encoding techniques" on

continued

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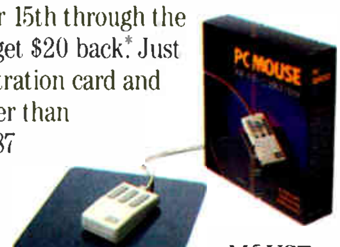

MOUSE SYSTEMS

Circle 198 on Reader Service Card

each line of the image and keeps the one that encodes that line the most compactly—that is, different lines may be encoded using different methods. Atkinson also hinted that the compression methods take into account adjacent pixels in the preceding and following lines, not just (as is usually the case) the adjacent pixels on the same line. He also said that these methods have resulted in up to a 30x-size compression of graphic images.

HyperCard always treats stacks as disk-based files. Although it uses extra memory to cache recently manipulated cards, it doesn't depend on having them in memory for its speed. HyperCard maintains a string of "hint bits" (i.e., a hashed value) for each card and keeps that data in memory. When it searches for a given string, it compares the hint-bit data of the target word with the hint-bit data for all the cards, retrieving and searching the full text of only those cards that might contain the target word.

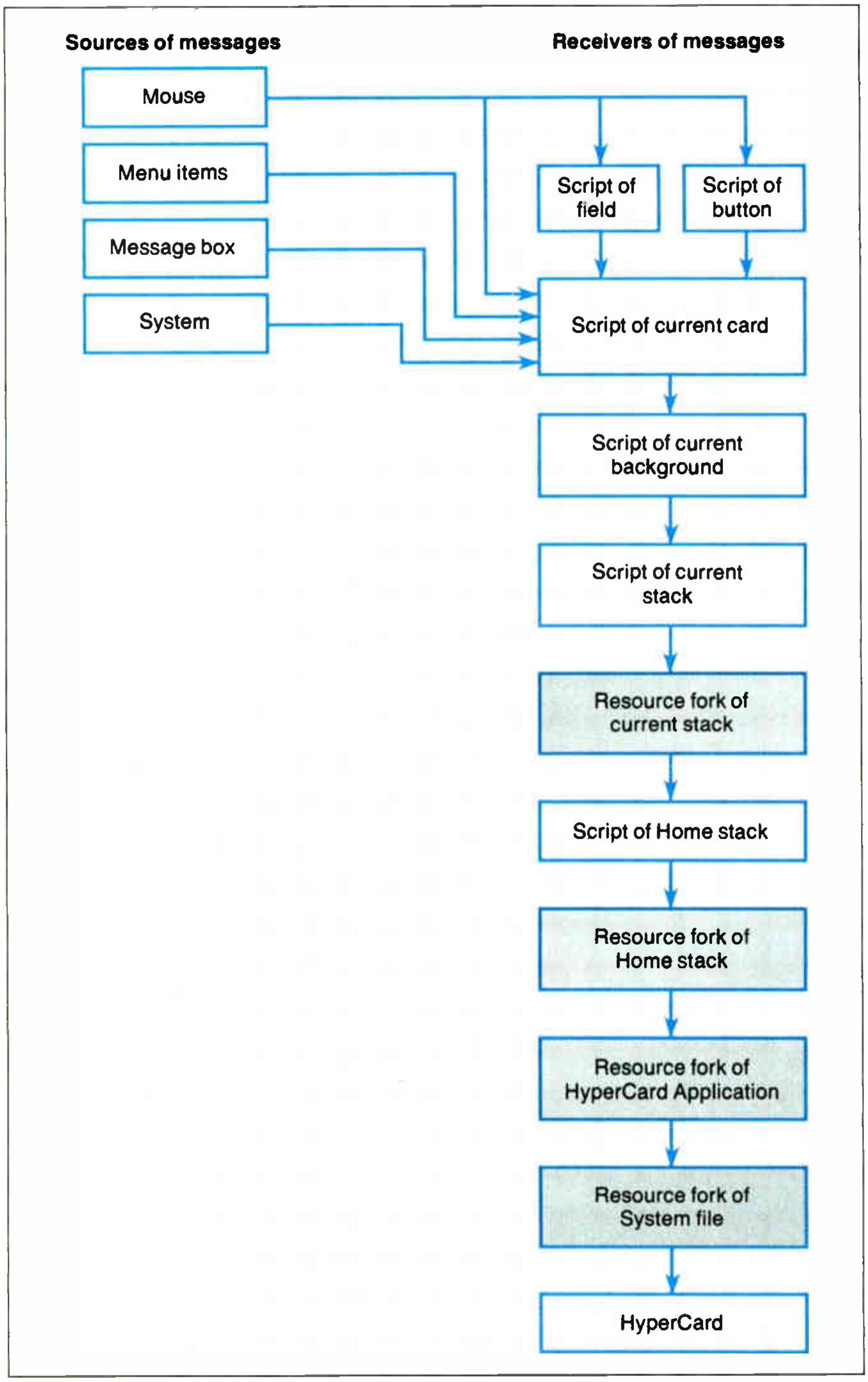

Figure 6: *Inheritance hierarchy within HyperCard. This figure shows the order in which messages search for a message handler that they can satisfy. Shaded fields denote the resource forks of certain files, where custom-defined commands and functions may reside.*

Performance

I spent several hours creating some very large stacks (775K bytes to 2.78 megabytes) and manipulating them on a 2-megabyte Mac Plus with a Data Frame XP20 SCSI hard disk drive. Since I used the first shipping version of HyperCard, version 1.0.1, I believe I can legitimately comment on its performance. I eventually settled on a stack that, in its most compact form, contained 792K bytes of information. This stack contained 973 BIX messages of various lengths (using a scrolling-text background field) and containing "real-world" data, stored one message per card.

In this stack, search times for a target word contained only in the last few messages (cards 971 to 973) usually ranged from under 1 second to about 3.5 seconds, with most searches being in the 1- to 2-second range. However, in one case, HyperCard took 23 to 30 seconds in successive attempts to find one target word. According to Dan Winkler of Apple, this was probably a worst-case example in which the target word encoded to the same value as another commonly used word, thus forcing a large number of card retrievals from disk.

You can also search for an arbitrary character string, but this is much slower. For example, HyperCard found a word in one of the last cards in 3.5 seconds, but when asked to find the word as a string of characters, it took 28 seconds (though this is still a very reasonable time for searching a 792K-byte file).

Also, after creating a 2.78-megabyte address stack, HyperCard repeatedly crashed when I tried to compact it. Dan Winkler acknowledged that Bill Atkinson has found and corrected a bug in version 1.0.1 that causes problems "only with very large stacks." Later versions (which should be shipping by the time you read this) will have that bug fixed.

Although HyperCard will run on a 1-megabyte Mac Plus with two 800K-byte floppy disk drives, a hard disk drive and extra memory are almost essential. HyperCard and the Home stack (the only stack required to be present) total 427K bytes, and the excellent tutorial Help stacks (three of them) total 738K bytes. You need the extra memory so you can keep HyperCard and your other applications constantly available through the use of either Switcher or MultiFinder. With enough memory and hard disk space, HyperCard is a joy to use.

Limitations

HyperCard will meet the needs of many people, but it is not the ultimate data-manipulation program. Database-management applications, for example, need not fear that HyperCard will make them obsolete. HyperCard knows only how to search for a single word or a character string; it ignores the case of words in all its searches, it can't search for strings that have wild-card characters in them, nor can it search for a combination of items (though it shouldn't be too hard to write a script to do that). HyperCard also has no built-in command to do a search-and-replace operation.

Another imperfection is that, unlike most Mac applications, HyperCard has *modes*. For example, when you are in button mode (using the button tool from the Tools menu), you can't move fields or type text into them. More annoyingly, if you're in foreground mode, you have to explicitly switch to background mode to ensure that new buttons and fields will belong to the background instead of to the current card. Atkinson acknowledged HyperCard's problem with modes, but he said that it has no mode problems at the Browsing and Typing levels that many novices will confine themselves to.

Another interesting limitation is that HyperCard abandons the window metaphor and takes over the entire screen (unless you're using a Macintosh with a large screen). Sometimes I found myself feeling somewhat claustrophobic and wanting to see more than one card at a time (which would be easier if cards were displayed through windows). Also, cutting and pasting multiple fields or buttons can become tedious because you can only cut and paste one at a time.

Granted, HyperCard isn't perfect yet—but it's far closer to perfection than the original 128K-byte Macintoshes were when they first came out. One can quibble about minor flaws in HyperCard, but overall, it's already a very useful, fast, and elegant product, and Bill Atkinson has promised enhancements—including multicolored cards—sometime in the future.

Final Words

Years ago, new automated dialing circuitry in the telephone system allowed the expansion of phone service past the limit imposed by the finite number of human operators—in effect, you became your own operator. HyperCard has a similar potential: to allow the creation of a far larger number of useful programs than is possible from the work of a finite number of professional software developers. We will become our own programmers, and we will be able to create new programs and modify existing ones to meet our needs. ■

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NEW GENERATION

by Tom Thompson

Fast Math

A first look at Motorola's 68882 math coprocessor

It's safe to say that the development of Motorola's 68030 CPU chip has captured the attention of the computer industry. However, Motorola is also working on a successor to its 68881 math coprocessor chip, the 68882. This new chip conforms to the IEEE 754 standard for floating-point arithmetic, and it provides floating-point math and transcendental functions in hardware—the same as the 68881. The 68882 performs better while being software- and pin-compatible with the 68881.

Through the courtesy of Trevor Marshall at Definicon Systems, I was able to borrow a preliminary version of the 68882 to evaluate. I chose two different computer systems in which to test the chip: a Definicon DSI-785/16 PC plug-in board with a 68020 running at 25 megahertz, and a Mac II, whose 68020 runs at 16 MHz. I first ran benchmark programs with the 68881 in the system and noted the times. Next, I powered down the system, removed the 68881 from its socket, and inserted the 68882 in its place. I then ran the benchmark programs again.

Table 1: *Results of the benchmark tests. All times are in seconds, with the exception of the Whetstone benchmark, which represents Whetstones per second. Consulair Mac C had no* asin *or* atan *functions, so the Fbench program could not be run. "Change" indicates the improvement in execution speed compared to the 68881.*

MAC II RUNNING AT 16 MHZ

Benchmark	C language									FORTRAN language		
	Consulair Mac C/68020 version 5.04			Manz Aztec C version 3.40B			Apple MPW C version 2.0			Absoft MacFORTRAN/020 version 2.3		
	68882	68881	Change	68882	68881	Change	68882	68881	Change	68882	68881	Change
Fbench	N/A	N/A	N/A	5.72	7.15	+20%	5.52	6.25	+11%			
Float	2.16	2.63	+18%	1.83	2.33	+21%	0.55	0.65	+15%			
Savage	5.12	5.43	+6%	3.52	3.68	+4%	3.35	3.42	+2%			
Whetstone	606,060	548,790	+9%	734,791	582,560	+21%	746,913	697,674	+7%			
SLINPACK										254	325	+22%
DLINPACK										277	348	+20%

DEFINICON DSI-785/16 BOARD RUNNING AT 25 MHZ

Benchmark	C language			FORTRAN language		
	Silicon Valley Software MC68020 C compiler version 2.6			Silicon Valley Software FORTRAN 77 version 2.6		
	68882	68881	Change	68882	68881	Change
Fbench	3.70	4.26	+13%			
Float	0.70	0.86	+19%			
Savage	2.64	2.93	+10%			
Whetstone	1,573,977	1,270,649	+19%			
SLINPACK				87	123	+29%
DLINPACK				102	139	+27%

Notes:

For the Definicon board, the 68020 loader was invoked with the -t option, which times the program executed.

SLINPACK is the single-precision version of the LINPACK program; DLINPACK is the double-precision version.

For LINPACK tests, the time it took the program to run was measured.

To perform the tests, I ran a set of benchmark programs in C and FORTRAN, using compilers that generated 68020- and 68881-specific code because no compiler that generates 68882-specific code was available. I used the standard BYTE Float program and the *Dr. Dobb's Journal of Software Tools* Savage programs to look at the 68882's basic floating-point and transcendental math capabilities. Also in C is the Whetstone floating-point benchmark and John Walker's Fbench program. The Fbench uses optical-ray tracing with many trigonometric functions. Finally, in FORTRAN, I used Argonne National Laboratory's LINPACK programs that use numerous floating-point math operations. Although the LINPACK provides a variety of measurements, I measured the programs' run time.

Table 1 shows the results. As you can see, performance improved anywhere from a few percent to nearly 30 percent, depending on the program. Interestingly, the larger programs reported better times. Motorola explains that the 68882 math functions aren't any faster than the 68881's, but the 68882 has been designed for improved throughput. Its pipelined architecture and dual-ported registers allow data transfers in and out of the chip while still performing computations. This makes the 68882 sensitive to the position of floating-point instructions within program code; the ideal arrangement is interleave data transfers with floating-point instructions.

The larger benchmark programs happen to have executable code interspersed with 68881 instructions that allow the 68882 to operate in parallel to the CPU and achieve better performance. In the smaller programs, clusters of floating-point instructions have the CPU waiting for the 68882 to complete the previous instruction before beginning the next.

The implications of the results are clear: Compiler writers should design their compilers to generate code that maximizes the performance of the 68882. This means unrolling code loops with floating-point instructions and not striving for minimum code size during floating-point code generation.

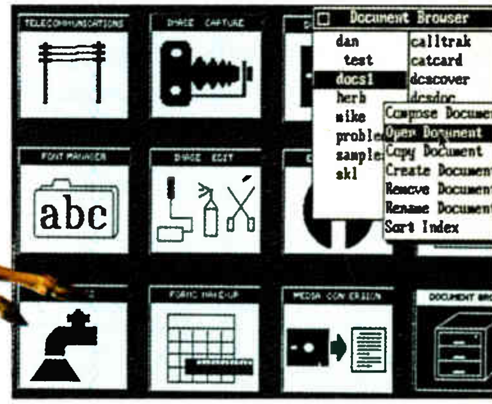
Motorola claims that floating-point performance can be doubled using the 68882 combined with the proper code. One thing is for sure: I detected a performance boost for floating-point programs not optimized for the 68882 simply by having the 68882 in the system. ■

Tom Thompson is a BYTE technical editor. You can reach him at One Phoenix Mill Lane, Peterborough, NH 03458, or on BIX as "tom_thompson."

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.

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High-Speed Memory Boards for ATs

Barry Nance

Upgrade your AT or clone's memory without downgrading performance

When you decide to upgrade the memory in your computer, makers of add-in memory boards for IBM PC ATs and compatibles give you an impressive array of cards to choose from. These boards distinguish themselves by the size and type of RAM chips they use, the way the memory is accessed (expanded versus extended), the speed at which they operate, and the applications they support.

I reviewed 15 add-in memory cards for ATs and compatibles to identify these differences. These boards have two things in common: They provide memory (expanded, extended, or both) beyond the 640K-byte threshold, and they are designed to work in AT compatibles running at speeds above 8 megahertz.

The testing for this review was performed with an ATronics International AT clone (Eden BIOS) running at 12 MHz, with one wait state and 1 megabyte of motherboard memory (640K bytes of conventional memory and 384K bytes of extended memory). The machine is an ordinary AT clone in all other respects—EGA card, parallel/serial adapters, and fixed/floppy disk controller.

For software, Lotus 1-2-3 (version 2.01) and the expanded-memory device driver supplied with each card were used for those boards supporting expanded memory. I used Microsoft's RAMDrive.SYS (bundled with version 1.03 of Microsoft Windows) to test each board's extended memory. Finally, I used two CPU-intensive programs to test each board's effect on overall processor speed. Tables 1 and 2 show the results of the evaluations—table 1 for hardware and software characteristics, table 2 for benchmark test results and price information.

Barry Nance is a computer programmer and moderator for the Technology Group on BIX. He can be reached at 900 Asylum Ave., Hartford, CT 06105, or on BIX as "barryn."

Three Kinds of Memory

Currently, three kinds of memory are found in AT machines: conventional, expanded, and extended.

Conventional memory is memory that DOS manages and in which applications programs run. It's limited to 640K bytes. Both the ROM BIOS and DOS are coded to use this memory in real mode.

While in real mode, CPU addresses are limited to a length of 20 bits, giving an address range of 1 megabyte. The memory from the 640K-byte boundary up to the 1-megabyte threshold is called system memory and is reserved for things like video-display buffers and the ROM BIOS code itself.

Expanded memory (EMS) is still real-mode memory, but it provides usable memory beyond the 640K-byte threshold through a mechanism known as bank switching. A "window" in an unused portion of the system-memory area is used to hold one segment or another of memory for an application to use. The standards and conventions for using this window properly are detailed in the document *The Lotus/Intel/Microsoft Expanded Memory Specification*.

Release 2 of Lotus 1-2-3 is an application that uses expanded memory. Xenix and OS/2 are operating systems that do not use expanded memory.

Enhanced Expanded Memory Specification (EEMS) is a memory specification designed by AST/Quadram/Ashton-Tate. It also provides a bank-switched window through which specially written software, like Quarterdeck's DESQview, can exceed the 640K-byte barrier.

Extended memory starts at the 1-megabyte boundary and extends as far as 16 megabytes. Since it takes a 24-bit address to access memory in this range, the 80286 CPU in an AT (or clone) must be switched into what's called protected mode in order to use extended memory. Examples of applications that can switch into protected mode to use extended memory include Framework II, AutoCAD, the VDisk RAM disk, and Xenix.

The Boards

When looking for a memory board for your system, you should keep in mind a number of basic considerations. Table 1 shows the variations among the boards in the following areas.

Installed Memory: The amount of memory on the board as shipped to BYTE from the manufacturer.

Maximum Memory: Many boards are capable of holding a maximum of 4 megabytes of RAM. The Limbo I, RAM 2000, MemoPlus AT, and AT Mega Memory have a maximum capacity of 2 megabytes. The JustRAM-AT and AT__Meg will each support 8 megabytes, and the Elite 16 and Captain 286 will hold a full 16 megabytes, the most memory that can be used in an AT or clone. Depending on your memory requirements, more than one board may be necessary to satisfy your needs.

You should also note that memory-board manufacturers sometimes have a full line of memory-board products. If you see an item here that seems like what you want except that it doesn't hold enough memory, check with the manufacturer—the company may have a product that is similar but that can put more RAM on the card.

Piggyback: The Elephant, BocaRAM AT, AboveBoard 286, and JustRAM-AT support piggyback memory modules that plug into the memory card itself. The ability to increase the memory on the card in this manner becomes an important consideration if you're cramped for slots and the piggyback board adds too much width to the memory card, causing it to overflow into an adjacent slot.

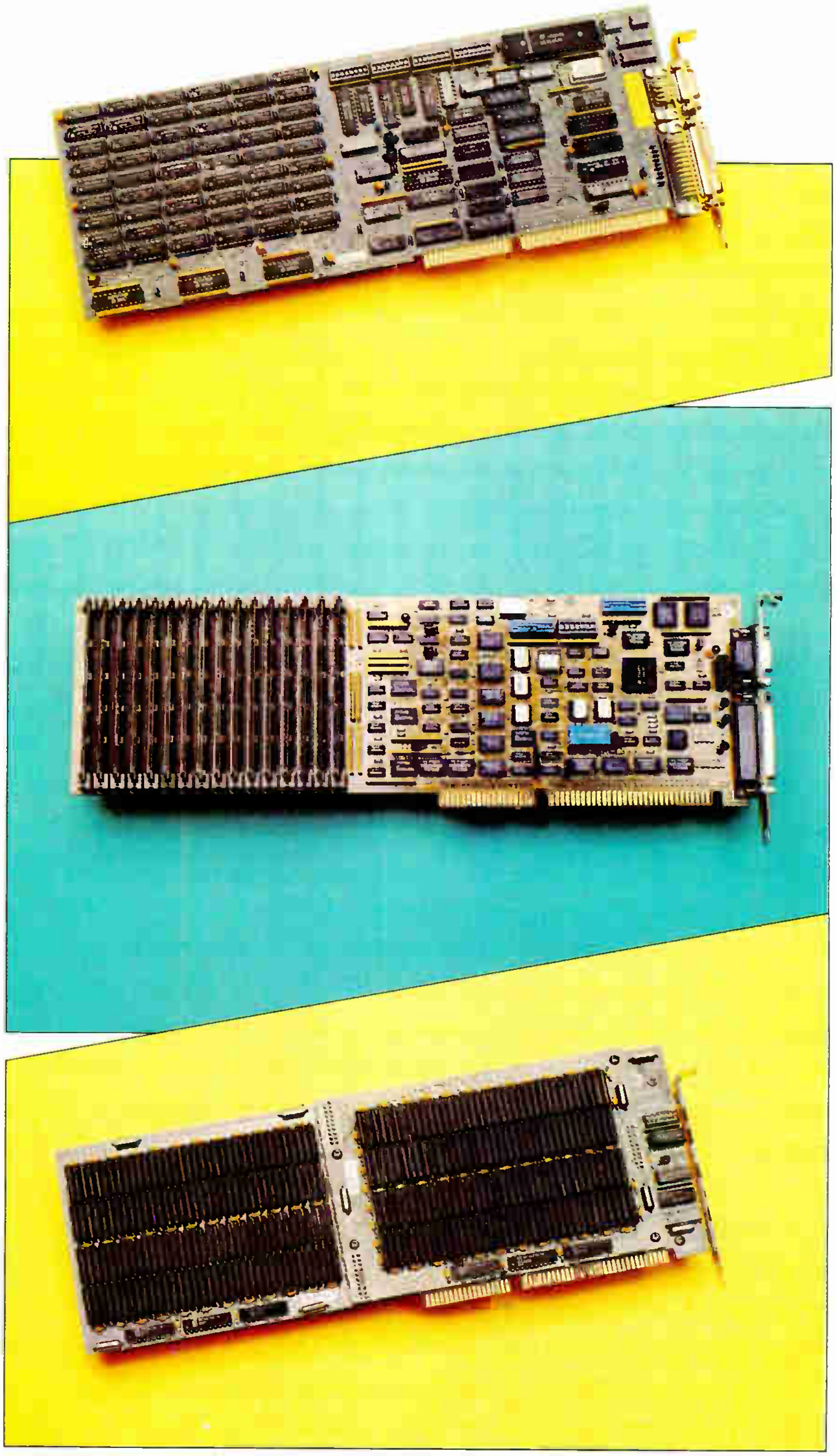
Monolithic Systems refers to its piggyback card for the JustRAM-AT as a "mezzanine card." The JustRAM-AT card is the only piggybacked board tested that does not take up two slots.

Chip Type: RAM-chip technology is advancing in quantum leaps. Some boards use chips that probably look familiar to you, a rectangular block of silicon with a double row of pins on the bottom, with a capacity of 256K bits of memory. These are noted in table 1 as "256K dual-pin." This sort of chip is almost always an item that you can add to the board yourself. However, for space-saving reasons, some manufacturers use 256K-bit chips that have a single row of pins and that "stand on their side" in a zigzag pattern ("256K soldered ZIP" in table 1).

Finally, some manufacturers use 1-megabit chips on their memory boards. A row of nine chips comes on a ribbon-size card that has a single row of pins. The chips are installed by inserting the small card's pins into the memory card. Often, a cradle supports the small nine-chip card (a SIMM, or single in-line memory module) in place. Ordinarily, individual chips cannot be replaced on these nine-chip cards, of course—the entire row/card is replaced or added as a unit.

Chip Speed: This proved to be an elusive measure of RAM-chip performance. While the memory chips used on the boards had stated ratings ranging from 80 nanoseconds (Elephant and Combo) to 150 ns (BocaRAM AT, AboveBoard 286, and AT Mega Memory), some of the

continued



These three boards show the differences in memory packaging available on AT-compatible memory boards. From top to bottom, the Cheetah Combo uses fast-access-speed 256K-bit dual-pin RAM chips. The Captain 286 uses 256K-bit or 1-megabit single in-line memory modules, and the JustRAM-AT is populated with 256K-bit ZIP memory.

Photos by Paul Avis

Table 1: *Hardware and software characteristics. Pricing information was supplied by the manufacturers.*

Company	Board	Installed Memory (megabytes)	Maximum Memory (megabytes)	Piggyback?	Base Price	Price as Tested	Price with Maximum Memory	Chip Type	Chip Speed
American Micronics	Elephant	5	5	Yes	$420 (0K)	$2380	$2380	256K dual-pin	80 ns
Apparat	Limbo I	2	2	No	$199 (64K)	$479	$479	256K dual-pin	120 ns
Boca Research	BocaRAM AT	4	4	Yes	$225 (0K)	$995	$995	256K dual-pin	150 ns
Cheetah International	Cheetah Combo	1.5	1.5	No	$395 (0K)	$654	$654	256K dual-pin	80 ns
Computer Elektronik Infosys	Mem-AT+	2	3	No	$469 (0K)	$901	$1117	256K dual-pin	120 ns
Club AT	Maxi-Magic EMS	1	2	No	$99 (0K)	$236	$372	256K dual-pin	100 ns
Intel	AboveBoard 286	2	4	Yes[1]	$545 (512K)	$1095	$2090	256K dual-pin	150 ns
Micron Technology	King's Bishop	4	4	No	$1095 (4M)	$1095	$1095	256K soldered ZIP	120 ns
Monolithic Systems	JustRAM-AT	8	8	Yes	$1850 (4M)	$3350	$3350	256K soldered ZIP	100 ns
Newer Technology	attention!	4	4	No	$1095 (4M)	$1095	$1095	256K soldered ZIP	100 ns
PBJ	AT_Meg	4	8	No	$280 (0K)	$1280	$2280	1-megabyte SIMM	100 ns
Profit Systems	Elite 16	.5	16	No	$695 (512K)	$695	$7850	256K or 1-megabyte SIMM	120 ns
Suntek	MemoPlus AT	2	2	No	$125 (0K)	$399	$399	256K dual-pin	120 ns
Tecmar	Captain 286	4	16	No	$645 (128K)	$2245	$8995	256K or 1-megabyte SIMM	120 ns
Vutek	AT Mega Memory	2	2	No	$279[2] (0K)			256K dual-pin	150 ns

[1] A piggyback board was not available for review.
[2] Vutek does not normally sell board populated with memory. The price of RAM added to the board is set by the distributor or dealer adding the memory.

Warranty	User Manual	Backfill	EMS	EEMS	Extended Memory	384K Offset	Switches and Jumpers	Software	Features and Notes
2 years	18 pages; somewhat technical	Yes	In SW	No	Yes	Yes	PAL chips; needs chip puller	None	EMS supported only via separate Above Disk software.
Lifetime	35 pages; easy to follow	Yes	In HW	No	No	No	Two switch blocks	EMS driver; Apparat utilities	8-bit card.
2 years	50 pages; easy to follow	Yes	In HW	No	Yes	No	Two switch blocks; two jumpers	Installation aid; EMS driver; RAM disk; print spooler; RAM diagnostics	
1 year	66 pages; inconsistent w/ setup program	Yes	No	No	Yes	Yes	5 switch blocks	Switch block setup program; FORCE (forces DOS to use fast memory)	Can backfill down to 256K with fast memory.
2 years	15 pages; not oriented to end users	Yes	In SW	No	Yes	No	2 switch blocks	EMS driver; print spooler	Chip sockets are gold-filled.
1 year	77 pages; easy to follow	Yes	In HW	No	Yes	No	2 switch blocks; 1 jumper	Installation aid, EMS driver; RAM disk; disk spooler	
5 years	105 pages; easy to follow; highly explanatory	Yes	In HW	No	Yes	No	None	EMS driver; RAM disk; print spooler; RAM diagnostics	Configures itself via software. Supports EMS 4.0.
1 year	29 pages; easy to follow	Yes	In SW	No	Yes	No	1 switch block	FOCUS EMS driver; RAM disk; print spooler; RAM diagnostics	
5 years	30 pages; easy to follow	Yes	In HW	No	Yes	No	2 switch blocks; 1 jumper	EMS driver; RAM disk; EMS utility; keyboard utility; Golden Bow's V Cache	Specially designed for fast machines.
1 year	32 pages; easy to follow	Yes	In SW	No	Yes	Yes	1 switch block	FOCUS EMS driver ($50 option); RAM disk; print spcoler; RAM diagnostics	32-megabyte board also available.
2 years	17 pages; essentials; easy to follow	Yes	In SW	No	Yes	Optional	1 switch block; 2 jumpers	EMS driver; RAM disk	1-year warranty on chips.
5 years	74 pages; easy to follow	Yes	In HW	Yes	Yes	Yes	Dial for board ID; no switches	AutoRAM memory manager (EMS/EEMS/Extended memory driver)	Memory modules lack a supporting cradle; $1000 for a 2-megabyte upgrade. Supports EMS 4.0.
1 year	25 pages; essentials	Yes	In HW	No	Yes	Yes	2 switch blocks	EMS driver; RAM disk; print spooler	
2 years	150 pages; easy to follow	Yes	In HW	No	Yes	No	3 switch blocks; 8 jumpers	EMS driver; RAM disk; print spooler; RAM diagnostics; TecDesk Utilities	Parallel/serial ports; $1445 for 2-megabyte version.
2 years	15 pages; essentials	Yes	No	No	Yes	No	2 switch blocks	None	

boards with supposedly "slower" RAM actually performed better than boards with "faster" RAM.

This paradox is cleared up when you recall that both the slow and the fast memory chips come from the same manufacturing process. The "slower" ones are rated that way because they fail certain tests during quality control. "Faster" chips are those that passed the tests. (Putting faster-rated chips into a machine will not cause it to run faster.)

Another consideration is that add-in memory is accessed via the bus, which can (and usually does) run at a different rate from that of the CPU. A 12-MHz CPU may access add-in memory at a bus speed of 8 MHz, for example.

Warranty: These ranged from 1 year to "lifetime." Most are from 2 to 5 years.

User Manual: Clear, step-by-step instructions can save hours when you install the board. Most of the reviewed cards came with manuals that not only explained how to set up and install the board, but also defined and discussed the differences between types of memory.

Each manual was evaluated in terms of how well it would lead a neophyte through the process of setting switches, setting jumpers, installing the software, and (where appropriate) adding RAM chips to a board.

Backfill: All the cards reviewed provide the means to use a portion of the card's memory as conventional memory, to turn a 512K-byte machine into a 640K-byte machine. Cheetah's Combo is unique in its approach to conventional memory—if you wish, you can reset a jumper on the AT motherboard and tell the Combo board to act like conventional memory starting at the 256K-byte boundary. With Cheetah's no-wait-state option and some software supplied with the board, you can force programs to run in Cheetah's fast (80-ns) memory and thereby realize some performance gains in the applications you use.

EMS: Almost all the boards support EMS (and, in one case, EEMS). In some, this support is provided through software emulation of EMS; in others, it's accomplished in hardware. Hardware implementation of EMS is significantly faster than software emulation, basically because it's quicker to set values in an I/O port than it is to move a block of memory into the EMS bank-switched window.

In the case of software emulation, the entire board is configured as extended memory and the software acts as a go-between, letting an application (e.g., Lotus 1-2-3) see the extended memory through an expanded-memory window. The device drivers that perform software emulation of EMS reside in conventional DOS memory, taking up valuable memory space there.

EEMS: Of these 15 boards, only the Elite 16 from Profit Systems supports EEMS. In the realm of add-in memory cards, EEMS is rarer than EMS, although products like DESQview can make special use of EEMS.

Extended Memory: Only the Limbo I has no provision for extended memory. Applications and utilities like Xenix, Novell NET$OS, and many RAM disks are written to take advantage of extended memory in an AT; also, of course, OS/2 makes use of extended memory.

384K Offset: Some AT clones come with 1 megabyte of RAM: 640K bytes for DOS use and 384K bytes of "preexisting" extended memory (the test machine for this review is such a clone). The majority of the cards tested did not have a facility for setting their starting address at the 1.375-megabyte boundary, which means that the motherboard's 384K bytes

continued

Table 2: *Benchmark results. Explanations of* ATIME *and DSeg-12 are found within the article. In general, a lower value for* ATIME *and a higher value for DSeg-12 indicate better performance.*

Company	Board	Megabytes Installed	ATIME	DSeg-12
Vutek	AT Mega Memory	2	1.996	892
Apparat	Limbo I	2	2.005	895
PBJ	AT_Meg	4	2.035	862
Tecmar	Captain 286	4	2.049	860
Cheetah International	Combo	1.5	2.055	860
Monolithic Systems	JustRAM-AT	8	2.115	846
Newer Technology	attention!	4	2.118	842
Boca Research	BocaRAM AT	4	2.121	842
Profit Systems	Elite 16	0.5	2.131	842
Suntek	MemoPlus AT	2	2.138	850
Club AT	Maxi-Magic EMS	1	2.210	838
Micron Technology	King's Bishop	4	2.210	838
Intel	AboveBoard 286	2	2.268	836
Computer Elektronik Infosys	Mem-AT+	2	2.277	832
American Micronics	Elephant	5	2.280	834

Case History #47582

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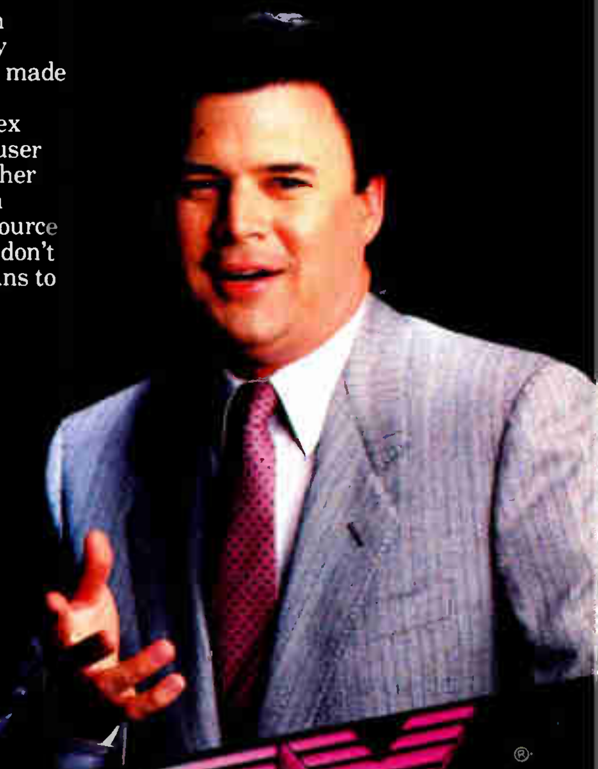

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BYTE 12/1/87

Update on EMS 4.0

In 1985, Lotus, Intel, and Microsoft joined forces to create the Expanded Memory Specification (EMS), a scheme for getting around the 640K-byte usable RAM limit inherent in MS-DOS. EMS 3.2 allows programs (with proper drivers) to use up to 8 megabytes of RAM for active data storage.

The use of the memory is limited, however, to data accessed by a single program, a RAM disk, or a print spooler. AST developed the Enhanced Expanded Memory Specification (EEMS) to address some of the limitations of EMS 3.2, at a cost of limited compatibility between programs making use of EMS and those using EEMS.

In August of this year, EMS version 4.0 was announced. This was developed in conjunction with AST and will unite the EMS and EEMS standards, as well as add features found in neither of the earlier standards. EMS 4.0 allows programs to address up to 32 megabytes of RAM.

Improvements to the specifications for the Expanded Memory Manager (EMM) allow multiple resident programs, print spoolers, RAM disks, and applications programs to run simultaneously in expanded memory. While Microsoft stresses that EMS 4.0 is not a multitasking system, the design of the EMM will not prevent applications from multitasking in expanded memory.

EMS 4.0 is compatible with memory boards designed for EMS 3.2. The update requires a new set of EMS drivers from hardware and software vendors. Applications programs written to run with EMS 3.2 will run under EMS 4.0, but they cannot take advantage of the new feature set. To take advantage of the new features of EMS 4.0, EMS drivers for the applications programs will have to be rewritten for the new specification.

At this time, it is unclear how many companies will choose to write new drivers, since the developers of EMS 4.0 make it clear that the new specification is considerably more complex and difficult to write drivers for than was the old.

[Editor's note: *For more on the Expanded Memory Specification, see "Lotus/Intel/Microsoft Expanded Memory" by Ray Duncan in BYTE's 1986* Inside the IBM PCs.]

of extended memory had to be disabled to use most of the memory cards.

If you're contemplating the purchase of a 4-megabyte card, the 384K bytes may seem like a pittance (and easily dispensed with). However, make sure there is some way (a jumper on the motherboard, usually) to bypass the 384K bytes; otherwise, you'll have the problem of overlapping memory segments, a problem that can cause the system to hang.

Switches and Jumpers: Whether you're an absolute neophyte at installing printed circuit cards or simply pressed for time, you'll appreciate having to set as few switches and jumpers on the memory card as possible. The AboveBoard 286 and Elite 16 have no switches or jumpers. The King's Bishop, attention!, and AT_Meg have one switch block, while the others have two, three, or five blocks of switches, with various jumpers as well.

The Elephant board has a different approach to configuration: It has no switches or jumpers, but various programmable-array-logic chips can be installed to indicate different memory configurations.

Software: If the differences in hardware design aren't enough to help you decide which board to get, the software supplied with them might tip the scales. The Elephant and AT Mega Memory come with no software, while most manufacturers offer EMS drivers, RAM disks, print spoolers, and RAM diagnostics. Tecmar's software (TecDesk) for the Captain 286 is the most extensive, requiring a separate user's manual, while Monolithic System packages the Golden Bow software product V Cache with its JustRAM-AT board.

Price: The cost of RAM chips is a major part of the price of each board. Table 1 gives three prices: price for the "base" configuration, often with 0K bytes of RAM installed; price of the board in the configuration reviewed; and price of the board with the maximum supported RAM installed. In most cases, these three prices do not exhaust the possible pricing of the board, since most are available with a broad range of installed memory.

Testing the Boards

Why would the installation of a memory board have an effect on overall CPU performance? In basic terms, it's because the direct-memory-access memory-refresh cycles take longer if more RAM is in the machine. Since this is an area where board design can cause some system degradation, I measured general CPU/memory performance with a pair of programs written for this review. Note that you have to take into account the amount of memory on each board in order to use the timing information; the figures are not absolute.

For the benchmarking aspect of this review, two programs were written to reveal the performance of each memory board. The first takes advantage of the fact that the boards were installed in an AT clone; the program enables Interrupt 70h (the AT's real-time interval clock), which ticks at 1024 times per second. This high-resolution interval timer in the AT is accurate to three decimal places.

The Int 70h ticks were counted while the CPU performed essentially a do-nothing loop for a given number of iterations. After the completion of the loop, the number of ticks was divided by 1024, giving elapsed time in seconds. The resulting value for each memory board is given in the `ATIME` column in table 2. The smaller the number, the better. For comparison purposes, the value of `ATIME` with no memory board installed was 1.990. [Editor's note: *Source code listings for ATIME can be found on BIX in ibm.at/software #702.*]

The second program takes advantage of an inherent timing loop in all Turbo Pascal programs. For the Delay() intrinsic procedure to be able to do accurate wait-loops, the initialization code of each Turbo Pascal program performs a timing test on the CPU's processing speed and sets an integer variable at location DSeg:$0012 accordingly.

The DSeg-12 program merely displays this integer value when it's run. A nominal value on a 12-MHz machine with no memory cards installed is 905; the higher the number, the better. The program to find DSeg-12's value is

```
Program DSeg12;
begin
  Var speed : integer
absolute dseg : $0012;
writeln
('Current value of "dseg:0012h" =
', speed);
end.
```

Memory as Commodity

Each board maker supplies a basic, staple commodity for your AT or AT clone—more memory. As you've seen, there are significant differences in the ways these boards provide that extra memory. When you decide to step up to megabyte memory and leave the 640K-byte barrier behind, you'll be prepared to choose a board that's right for you.

As you make your buying decision, I

Company Information

American Micronics Inc.
17811 Skypark Circle, Suite H
Irvine, CA 92714
(714) 261-2428
Inquiry 898.

Apparat Inc.
6801 South Dayton
Englewood, CO 80112
(303) 799-0819
Inquiry 899.

Boca Research Inc.
6401 Congress Ave.
Boca Raton, FL 33431
(305) 997-6227
Inquiry 900.

Cheetah International Inc.
107 Community Blvd., Suite 5
Longview, TX 75602
(800) 243-3824
Inquiry 901.

Club AT Inc.
46707 Fremont Blvd.
Fremont, CA 94539
(415) 490-2201
Inquiry 902.

Computer Elektronik Infosys
Trade Ventures International
512-A Herndon Parkway
Herndon, VA 22070
(703) 435-3800
Inquiry 903.

Intel Corp.
5200 Northeast Elam Young Parkway
Hillsboro, OR 97124
(800) 538-3373
Inquiry 904.

Micron Technology Inc.
2805 East Columbia Rd.
Boise, ID 83706
(208) 383-4000
Inquiry 905.

Monolithic Systems Corp.
84 Inverness Circle E
Englewood, CO 80112
(303) 790-7400
Inquiry 906.

Newer Technology
251 Whittier
Wichita, KS 67207
(316) 685-4904
Inquiry 907.

*PBJ Inc.
503 East 40th St.
Paterson, NJ 07504
(201) 523-8663
Inquiry 908.

Profit Systems Inc.
30150 Telegraph Rd.
Birmingham, MI 48010
(313) 647-5010
Inquiry 909.

Suntek Information Systems Inc.
5369 Randall Place
Fremont, CA 94538
(415) 657-0567
Inquiry 910.

Tecmar Inc.
6225 Cochran Rd.
Solon, OH 44139
(216) 349-1009
Inquiry 911.

Vutek Systems Inc.
10855 Sorrento Valley Rd.
San Diego, CA 92121
(619) 587-2800
Inquiry 912.

*Make inquiries to: Computer Plus, 435 King St., Littleton, MA 01460, (617) 486-3193.

suggest you keep the following factors in mind:

1. You never have enough memory (OS/2 is knocking on the door!). A board that holds less memory will not satisfy your needs for as long as you expect it will.
2. You never have too many slots. A board whose piggyback card slops over into the next slot will someday be thought of as a slot-stealer.
3. You never have enough processing speed. A board whose design (or emulation of EMS in software) degrades your CPU rate will have you muttering while you stare at the screen, waiting for some application to finish its job.
4. You can never say that you've purchased your last software package. If you say (for example) that you don't need EMS, it's Murphy's law that your next application will proudly state on the label that it "uses EMS to give you extra workspace."

Don't necessarily buy the most expensive board. On the other hand, don't short-change yourself—try to plan for your needs over the long term, and then add a fudge factor as a contingency against that as-yet-unannounced application that is exactly what you need but "requires OS/2 and *x* megabytes of memory." ■

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Circle 290 on Reader Service Card

Curtis Franklin Jr.

Memory-Expansion Boards for the IBM PC AT

Comments on memory upgrades from the BYTE Information Exchange

They seem so straightforward. How complicated can a simple memory expansion be? The following excerpts from the ibm.at conference on BIX, the BYTE Information Exchange, illustrate some of the subtle considerations to bear in mind when planning a memory upgrade. [For more information on the terms and technologies discussed, see the preceding Group Review.]

EXPANDED-MEMORY CONFUSION

ibm.at/hardware #1860, from ereiman (Enid Reiman).

Title: RAMpage AT
I have an NEC APC IV AT clone with 640K of RAM and a RAMpage AT board populated with 2 megs. I use DESQview. Because I want to run FoxBASE Plus 2.0 (360K) and WordPerfect (208K) in two windows with FoxBASE processing in the background, I've got to get into "high" memory. DESQview says to disable RAM down to, ideally, 256K and set up the RAMpage board to backfill 364K of nonpaged (or paged, I can never remember which is which) memory, and I'm all set. The problem is that NEC says I can't disable memory on the motherboard. This means that my 2-meg RAMpage board can be converted to an ashtray or a wall hanging, because it is doing me no good at all.

Question: What board do I buy that will give me the RAM or its equivalent so that I can run the humongous memory-eater programs in DESQview windows? At present, I'm using DESQview 1.3 and am waiting for my upgrade to 2.0 to come any day. Advice and recommendations will be greatly appreciated.

---

ibm.at/hardware #1861, from dmick (Dan Mick).
A comment to message 1860.

Some clear discussion on this *would* be appreciated here, too. I can't understand why you'd need to use the board's RAM instead of system RAM. Surely they perform the same function in the lower address space? Or it's a silly limitation on the card's addressing scheme, maybe? (Not asking you, but whoever can answer this; if you know, please expound a bit on the whys and wherefores of "backfilling.")

---

ibm.at/hardware #1863, from dmick.

EEMS needs a 64K page somewhere between A000 (640K) and F000, but that shouldn't affect RAM below the 640K mark. The 64K page is what is actually addressed by the application when it gets at EEMS. The EEMS hardware maps different 64K pages (living in never-never land on the board) into that 64K area upon request via INT 67H (or is it 69H? I keep forgetting.). Oh, and they may not be 64K pages. Sometimes they're smaller, and I can't keep straight which is which for EMS and EEMS, either. But that "bridge" area isn't in normal DOS memory.

---

ibm.at/hardware #1864, from feenberg (Daniel Feenberg).
A comment to message 1861.

The RAMpage board can page memory in the lower 640K if it can be disabled on the motherboard. This makes for faster task switching.

---

ibm.at/hardware #1865, from rbrukardt (Randall Brukardt).
A comment to message 1863.

But that bridge area can be in normal DOS memory in EEMS; that's how they can use it for background processing. My own opinion is that the solution to this problem is to buy an AT clone that can disable the RAM on the motherboard (very few these days, I'm afraid). Otherwise, he's out of luck.
Randy.

---

ibm.at/hardware #1870, from matt.trask (Matt Trask).
A comment to message 1863.

The page size is 16K, and it's EMS that requires a 64K page above A000; EEMS (that's *double* E) allows page swapping anywhere in the 1-meg address space.

HIGH-SPEED MEMORY BOARDS

ibm.at/hardware #1882, from irae (Ira Emus).

Title: Expanded-memory cards for a 10-MHz AT?
Has anyone had any experience with either the Everex RAM 2000 or the Boca Research BocaRAM/AT? We need to buy an expanded-memory board for a 10-MHz AT clone (Multitech). I've always heard that the Intel is best, but it costs $550, and the others cost $360 to $400. Prices include 2 megs of 120-ns RAM.
Ira

---

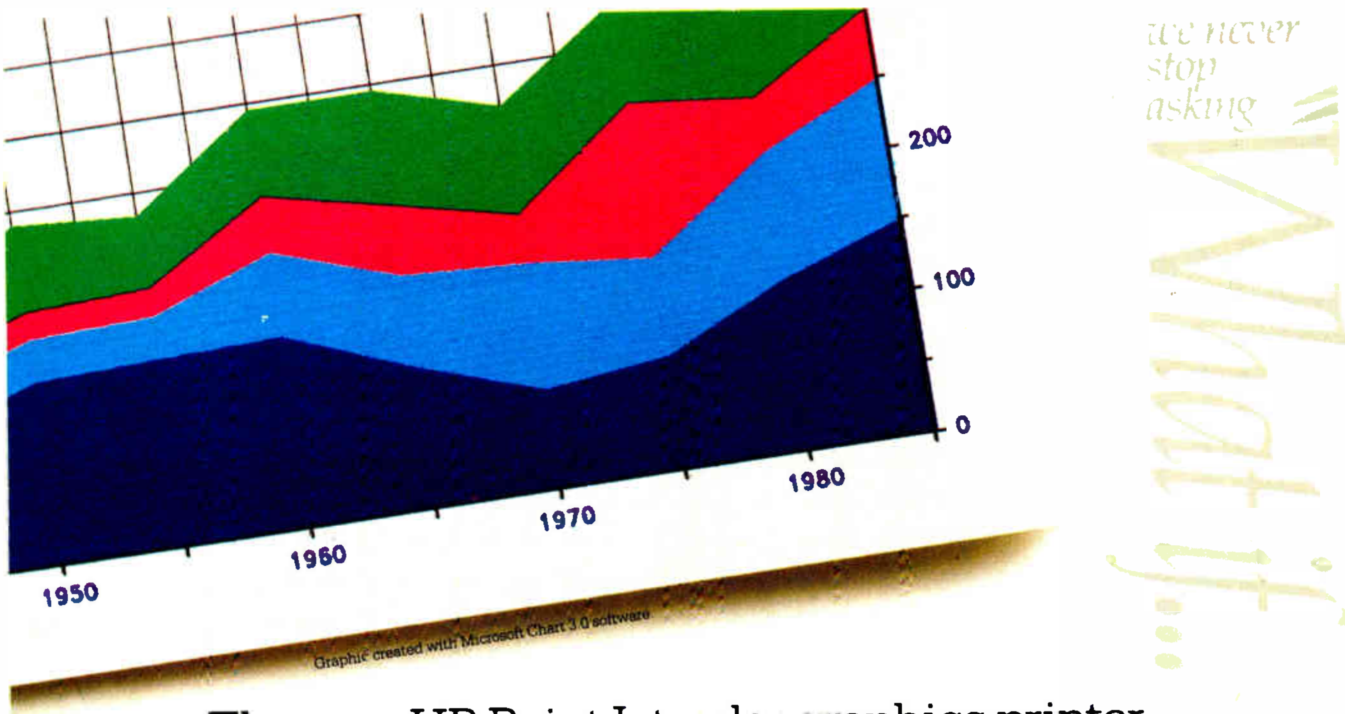
ibm.at/hardware #1883, from barryn (Barry Nance).
A comment to message 1882.

Don't know if this helps, but I recently bought a memory card from PC Source for $109 (0K). The card is made by Suntek, and it has switches for setting the amount of "paged" vs. "nonpaged" memory. The card holds 2 megs when fully populated. It comes with a disk of software that includes expanded-memory support.

I haven't tried the expanded switch settings and software; I bought it to use as extended memory (above and beyond the 1-meg boundary). So far, the 1 meg of 120-ns chips on the board have performed well, even though I'm running my AT clone at 12 MHz.

PC Source sells 120-ns chips for about $35 a row. So, for about $250 total, I figure it's a bargain. You might want to give PC

continued



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Source a call and ask about the expanded-memory support available with the Suntek card, just to ensure compatibility with what you want to do.

---

ibm.at/hardware #1885, from bredd (Brandt Redd).
A comment to message 1882.

We've got a BocaRAM/AT. It didn't work correctly in our 12-MHz PC's Limited PC. Ironically, it works perfectly in our 16-MHz PC's Limited 386. The bus speed on the 386 is only 8 MHz, however. They claim that the board works at speeds up to 16 MHz, but we haven't had luck at 12 MHz. I don't know how it would be at 10 MHz.

---

ibm.at/hardware #1951, from petewhite (Pete White).

Title: Recommendations?
Anyone want to recommend a good place to purchase a decent memory board for an 80286 10-MHz system? Board *must* support EEMS; I want it to test DESQview. New or used, as long as it's EEMS.

---

ibm.at/hardware #1952, from barryn.
A comment to message 1951.

Pete, have you ever dealt with PC Source? They sell the Suntek memory board for $109 (0K) and a row of 120-ns 256K memory chips for about $35. I have a Suntek in my 12-MHz AT right now, and it's doing nicely. I have it configured for extended memory, but the documentation says it does expanded memory as well (and it comes with an EEMS.Sys driver program).

---

ibm.at/hardware #1953, from petewhite.
A comment to message 1952.

Address and telephone number, please? Or is it easily magazine-identifiable? It's easy now to check with the DESQview conference and see if they support it <grin>. Gee, and I already have DESQview "utilities" on the Cul-De-Sac!

---

ibm.at/hardware #1954, from barryn.
A comment to message 1953.

It's "easily magazine-identifiable." Look in any issue of PC Week or BYTE. They advertise pretty steadily.

MISSING MEMORY

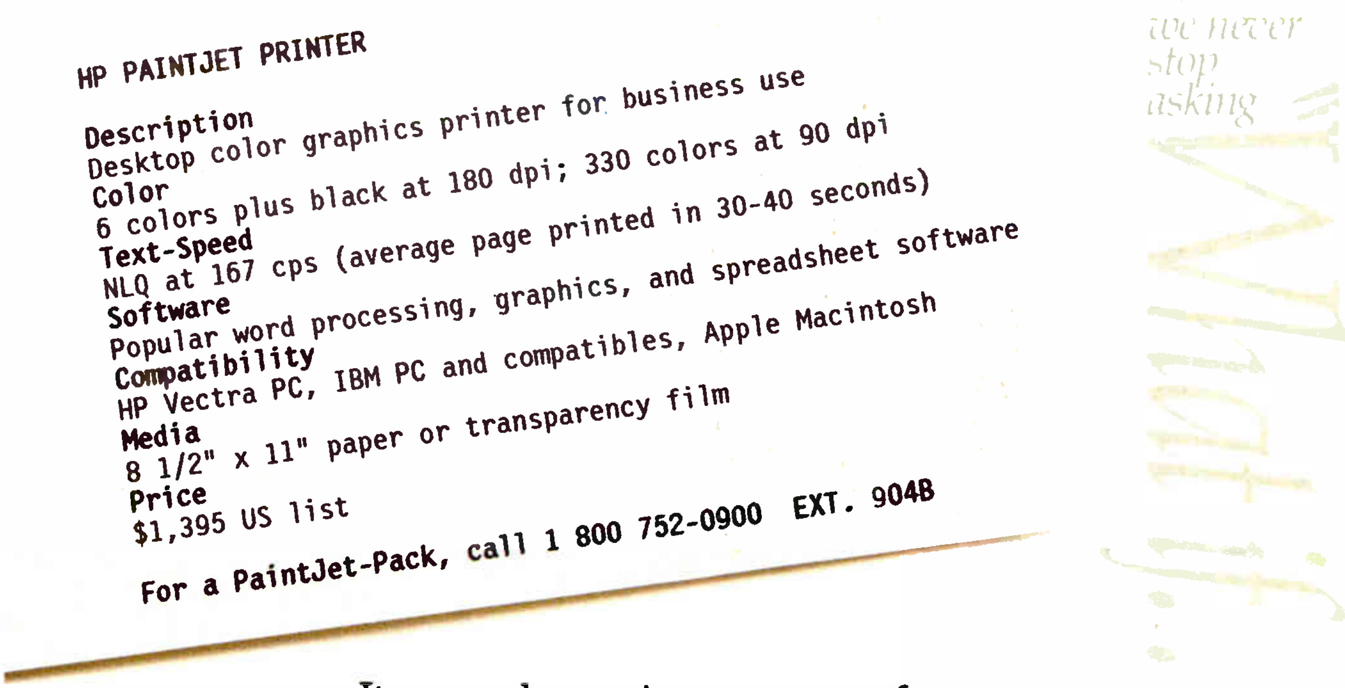
ibm.at/software #648, from wheelock (Bruce N. Wheelock).

I must be missing something obvious. CHKDSK reports 655,360 bytes of total memory for my system, but I've got 1 meg of RAM. Do I have something set wrong, or is CHKDSK just one of those lame programs that can't see anything above 640K? Is there a program on BIX that can give me a report on the full megabyte?
/Bruce/ (wheelock)

---

ibm.at/software #649, from barryn.
A comment to message 648.

I believe your memory layout (like mine) is from 0 to 640K of RAM, followed by 384K of system memory (ROM BIOS, video, etc.),



BIX PRODUCT FOCUS

followed by xxxxK of extended memory, which starts at the 1-meg boundary. If so, CHKDSK will see only the first 640K. The remaining 384K of extended memory can be used as a RAM disk for now and eventually will be usable by OS/2 for programs that can run in extended memory.

---

ibm.at/software #650, from mced (Ed McNierny, Lotus Development Corp.).

Two things:
(a) Most "lame" programs can't see memory above 640K because they can't use it under DOS, and so there's no point in trying to find something you can't use.
(b) Most computers that come with 1024K installed map 640K of it normally and then map the remaining 384K starting at the 1-meg address. Since addresses above 1 meg can be generated only by programs running in protected mode (disk caches, VDISK, and the like) and CHKDSK is running firmly in real mode, that memory is not visible.
Ed

USING MEMORY OVER 640K

ibm.at/software #651, from golkowski (Gerald Olkowski).

Title: Memory
A question, then. On a true-blue AT, my post-memory check goes to 1024K. This I visually verified: 512K on the motherboard and 512K on the expansion board. Using IBM software, is there *anything* I can use the memory from 640K to 1 meg for? VDISK will use only extended memory or real memory. Sounds like another IBM kicker to me.
Jerry

---

ibm.at/software #652, from barryn.
A comment to message 651.

Title: Using the memory from 640K to 1 meg
As you mention, a RAM disk can be put up there. And I think there's some third-party software, such as DESQview, that will use extended memory to hold software in a "swapped-out" mode (DESQview is a DOS extension for doing multitasking). Later, OS/2 will allow/manage the use of extended memory for programs that are written to run in protected mode.

Finally, you might be interested in pm_at.asm (about 30K) and its companion, protect.inc. Both are in the FROMBYTE86 area of the listings conference. They provide source code, in assembler, to show how to switch an AT into (and back out of!) protected mode.

---

ibm.at/software #654, from golkowski.
A comment to message 652.

Barry, a RAM disk (at least the IBM VDISK) exists either in the area under 640K (the default) or above 1 meg. Peter Norton's books show that the memory from 640K to 1 meg is populated with the BIOS routines, video maps, and some other junk. That doesn't quite make sense to me, however. What would a PC with 512K look like, a hole in the memory map? Where I come from, they taught me that that was a fatal error. The protected-mode memory that you mention is, I think, above 1 meg, which doesn't do it for me.
Jerry

continued

ibm.at/software #657, from rnelson (Ross Nelson).
A comment to message 654.

If your PC has 1 meg, it either has 512K starting at 0x00000 and 512K at 0x10000, or 640K at 0x00000 and 384K at 0x10000. The memory above 1 meg (either 384K or 512K) *can* be used by VDISK.

ibm.at/hardware #2018, from cwills (Cheyenne Wills).

I need to expand the memory of my aging PC AT (yep, it's blue) from 512K (full motherboard) to 640K. I would like to be able to expand this memory board to 1 meg (or better) for when OS/2 comes out. My question is this: Since I need only 128K now (but would like to expand now or later), do I get a board with EMS or extended- or expanded-memory capabilities? I would like the board to have EMS support now since some products that I have would use the extra memory, but I would like to use the same memory board later for OS/2.
Thanks.

ibm.at/hardware #2019, from nickb (Nicholas Braak).
A comment to message 2018.

Try the BocaRAM/AT card. It backfills the 128K, has options for 2-meg EMS or 4-meg extended, works with 12-MHz machines, and costs about $200 unpopulated.
== Nick B ==

ibm.at/hardware #2021, from barryn.
A comment to message 2018.

Most memory boards, but not all, are capable of extended memory, expanded memory, and backfilling from 512K to 640K. Did you see my earlier comment in this topic about the Suntek board? As Pete White will tell you, there are even a few boards that will do EEMS. (-:

ibm.at/hardware #2024, from thomdir (Thomas Drewke).
A comment to message 2018.

In my opinion, buy the new LIM EMS standard, no matter what; it will continue to be useful. Others may not. Just don't buy a fully loaded board, but rather add the RAM chips yourself. Buy a board that supports LIM EMS in hardware, not in software emulation. Buy it with 0K included, and install your own chips at one-fourth the price.

ibm.at/hardware #2026, from barryn.
A comment to message 2024.

<...rather add the RAM chips yourself

Unless, of course, you get one of the new technology boards with the already-soldered SIP chips in place.

ibm.at/hardware #2027, from irae.
A comment to message 2024.

It's becoming unclear that you are better off buying the chips separately. It seems possible to buy brand-name cards, Boca and Everex, that do hardware EMS for about $360 with 2 megs. And that way if you have problems, only one person to blame.
Ira

ibm.at/hardware #2029, from barryn.
A comment to message 2027.

Another consideration when buying a memory card: Some boards will slow down your computer more than others. The speed differential I'm talking about doesn't depend on whether you're using the board to do EMS or extended memory; the mere presence of the board on your CPU's bus will cause some degradation of processing power. How much? Well, I'm writing a benchmark program even as we speak to measure this very thing. I'll upload it when it's finished.

[Editor's note: *For more on the benchmark and for results from high-speed memory boards, see "High-Speed Memory Boards for ATs" by Barry Nance on page 124 of this issue.*]

ibm.at/hardware #2028, from jerblu (Jerry Blumenthal).

Title: AST and JRAM-P3
I just took delivery of an AST 286. My old PC does not need the extra 2 megs on the JRAM-P3 board now installed in it. Does anyone know if I can use that 2 megs in the AST, and if it may cause problems?

ibm.at/hardware #2030, from barryn.
A comment to message 2028.

The AST 286 runs at 10 MHz, doesn't it? I don't know much about the JRAM-P3, but if the chips are 120-ns (or faster), you should be able to use them in the AST computer.

ibm.at/hardware #2032, from irae.
A comment to message 2028.

There should be no problem as long as the memory on the JRAM-P3 was fast enough, but I think the AST requires 100- or 120-ns RAM, and the JRAM-P3 probably has 150- or 200-ns RAM.

ibm.at/hardware #2035, from jerblu.
A comment to message 2032.

How do I tell the speed of the chips?

ibm.at/hardware #2037, from irae.
A comment to message 2035.

Look at the printing on top, and you will probably see things like

-2	-200	200 ns
-15	-150	150 ns
-10	-100	100 ns

If it's not obvious from looking, post what's on the chips and someone will know.

ibm.at/hardware #2042, from matt.trask.
A comment to message 2037.

Some of the older chips (NEC, I think) used a brain-damaged method of indicating chip speed, something like -1 is 150, -2 is 200, -3 is 250, etc. ■

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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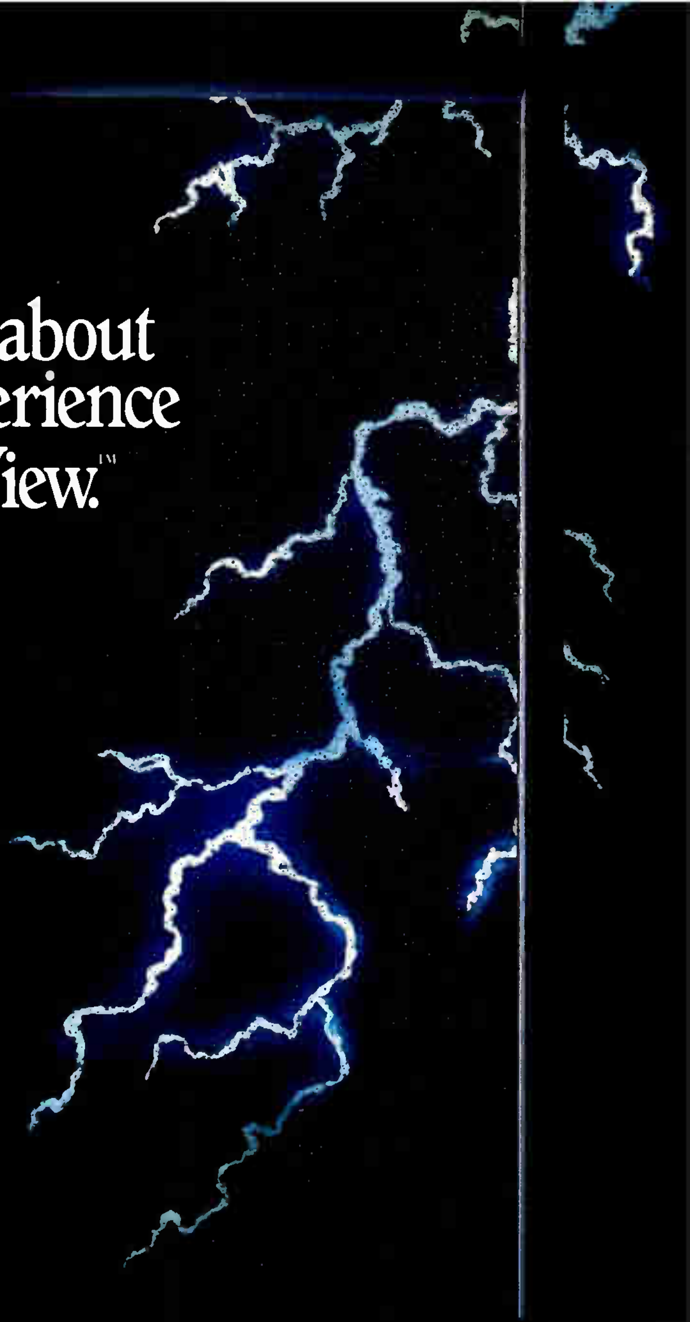

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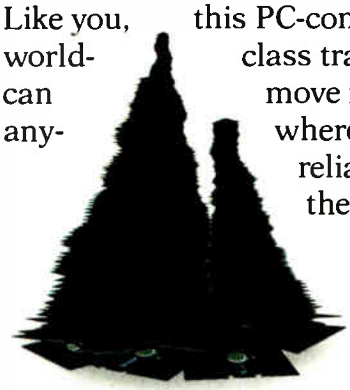

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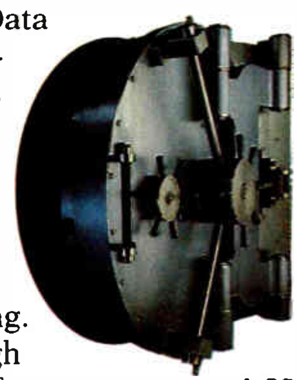

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Size
5¾ by 19½ by 16¾ inches; 42 pounds

Components
Processor: Intel 80386, running at 16 MHz, with compatibility speeds of 12 MHz, 8 MHz, and 4.77 MHz; socket for 80287-8 math coprocessor
Memory: 1 megabyte of static RAM standard, expandable to 6 megabytes on SRAM board (maximum system memory is 16 megabytes)
Mass storage: One 1.2-megabyte floppy disk drive; one half-height CDC 40-megabyte hard disk drive
Display: EGA
Keyboard: 101 keys in IBM enhanced keyboard layout
I/O interfaces: Two serial ports, one DB-9 and one DB-25; one parallel port, DB-25; one DB-15 joystick port. Eight slots: five 16-bit; two 8-bit; one 32-bit (used by the static RAM board)
Software: Setup program in ROM; Split Disk Software (for creating multiple DOS partitions on disks larger than 32 megabytes)

Options
80287-8 math coprocessor: $399.95
1-megabyte, 32-bit SRAM SIMM add-on: $499.95
MS-DOS 3.21 (GWBASIC included): $95.95

Documentation
128-page *PC's Limited 386 Series Owner's Manual*; 22-page *DIO-500 Multi-I/O Card User's Manual*; 86-page *Video Seven VEGA User's Manual*

Price
System as reviewed (not including 80287) with 40-megabyte hard disk drive: $4299
EGA system with a 70-megabyte hard disk drive: $5199
EGA system with a 150-megabyte hard disk drive and ESDI controller: $6499
Monochrome system with graphics display adapter and monitor, one additional parallel port, and 40-megabyte hard disk drive: $4299
Monochrome system with a 70-megabyte hard disk drive: $4699
Monochrome system with a 150-megabyte hard disk drive and ESDI controller: $5999

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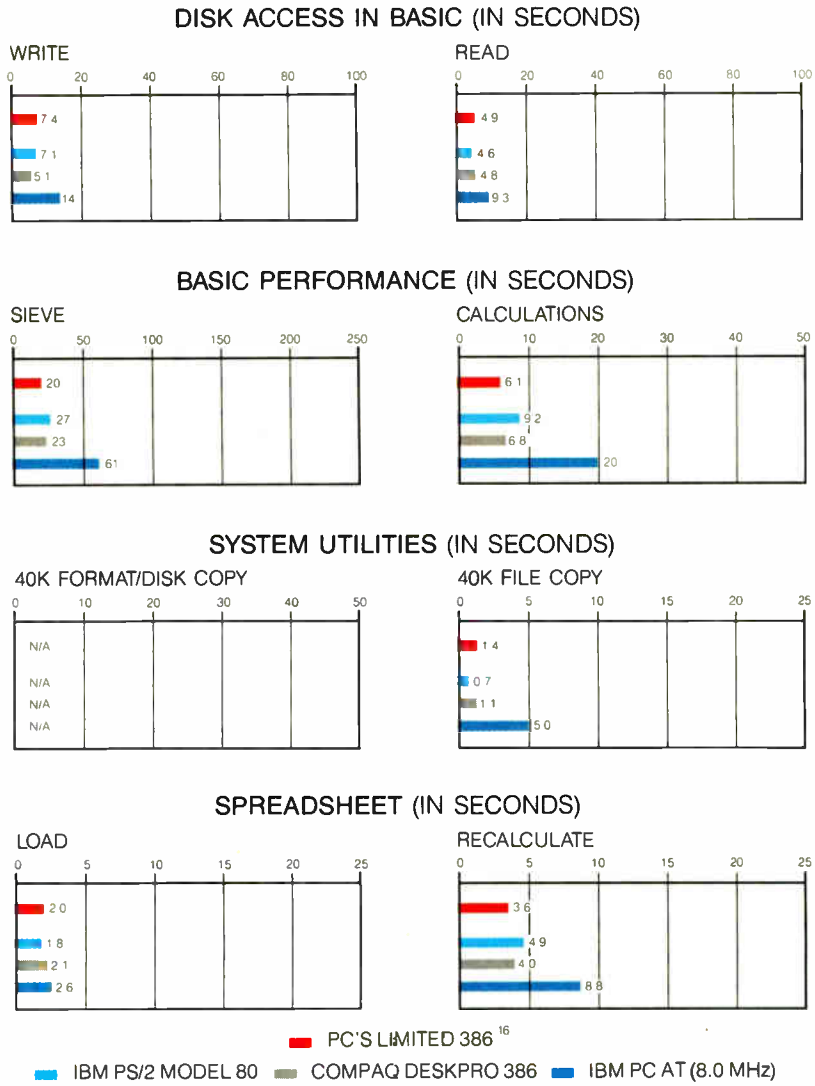

Test	PC'S Limited 16-MHz 80287-8	IBM PC AT 8-MHz 80287	Model 80 16-MHz 80387	Compaq 8-MHz 80287	Compaq 16-MHz 80387
Dhrystone*	4378	1590	3626	3748	3748
Fibonacci	46.78	126.22	57.26	53.12	53.11
Float	7.11	10.98	1.62	6.80	1.43
Savage	21.69	37.30	9.49	21.53	8.95
Sieve	5.33	24.60	6.45	5.99	5.98
Sort	6.63	43.17	7.74	5.58	5.58

*Higher figures 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's Limited 386[16], 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 BYTE). All times are in seconds, except for the Dhrystone, which is in Dhrystones per second.

The BASIC benchmarks show a much narrower range of results. The 386[16] was faster than both the Compaq Deskpro and the Model 80 in the Sieve and Calculations tests, and it fell only slightly short in the Disk Write and 40K File Copy tests.

All the software I tried worked with the system. I used the following programs: DESQview 2.0 (with Expanded Memory Manager 386 1.10), Kermit 2.29B, Lotus 1-2-3 version 2.0, PC Paintbrush 1.0, Q&A 1.1, Reflex 1.14, SideKick 1.56A, Smalltalk/V 1.2, SuperKey 1.16A, Turbo C 1.0, Turbo Pascal 3.0, Microsoft Windows 1.01, Microsoft Word 3.1, and WordStar 3.3 and 4.0. Because of Lotus 1-2-3's floppy-disk-based copy-protection scheme, I had to start that program under the system's slower compatibility speed. Once it was running, however, I could immediately return the system to full speed from the keyboard.

I also successfully installed the following hardware: the Paradise AutoSwitch EGA card, the Cheetah Card (with 2.5 megabytes of memory), the Evercom II 2400-bit-per-second internal modem, the Intel Above Board/AT, and a Microsoft serial Mouse.

However, while testing these options and running the benchmarks, I discovered a few problems and incompatibilities. For example, I could not make extended memory on the Cheetah Card work with the first unit I received for review. Also, although DESQview 2.0 generally worked correctly, I could not enter the ROM Setup program from it. Every time I tried, the display was trashed.

PC's Limited determined that the keyboard-controller chip in my unit was one of a small batch of incorrect controller chips that had accidentally been shipped. Because the keyboard controller also manages processor shutdowns and is involved with memory-bank switching, the wrong controller could produce some of the memory problems I was seeing. So, the company sent me a new keyboard-controller chip. It did not help. PC's Limited then declared my first unit a lemon and promptly sent me a new one. This second review unit contained an 80287 math coprocessor but was otherwise identical to the first.

Initially, the Cheetah Card did not work in the second review system, but I cleaned the contacts on both the slot I was using and on the board, and then it ran fine. The problem with DESQview and the ROM Setup program seems to be a genuine incompatibility, albeit a minor one; apparently, the two programs use the same memory locations. [Editor's note: *PC's Limited has determined that the conflict between DESQview and the ROM Setup program revolves around the use of keyboard buffers and interrupt calls. DESQview will run on the 386[16] as long as you do not attempt to run the ROM Setup program from within it.*]

Under the Hood

Inside the box is an ample 200-watt power supply. It is preset for the U.S. standard of 115 volts and 60 hertz, but it can be changed to the European 230 V and 50 Hz.

The motherboard itself is a fairly small 9 by 13 inches. It has connectors for the keyboard lock, the speaker, a battery, and the SmartVu display. There are no jumpers or switches. In fact, the motherboard holds a modest 32 chips. The memory goes on the Static Memory Board (SMB), which must be plugged into the sole 32-bit expansion slot.

A great many of the system's functions are performed by the CPU and the chip set from Chips and Technologies. The system uses six of the seven chips in the Chips and Technologies standard set for 80386-based systems; that set's memory-controller chip is not used here because PC's Limited uses a proprietary memory architecture.

The 80386 CPU is socketed and runs at 16 MHz. However, in the ROM Setup program you can choose between two compatibility speeds: 80286 (8 MHz) and 8088 (4.77 MHz). You can toggle between the current compatibility speed and full speed at any time from the keyboard by typing Control-Alt-\. Switching speeds generates distinct tones through the speaker, and the SmartVu display indicates 386, 286, or 8088. The system achieves compatibility speeds not by actually changing the clock rate, but rather by idling the CPU part of the time.

The motherboard has a socket for an 80287 math coprocessor chip rather than for an 80387. PC's Limited sells an 8-MHz 80287-8 as a $400 option. (PC's Limited representatives said that currently there are no plans for using the 80387 math coprocessor chip.) Unfortunately, the socket is under the hard disk drive, so you have to either install the 80287 with great care or remove the motherboard; neither method is particularly easy.

Access to the SRAM on the SMB is made through a proprietary 32-bit bus. The slot for this bus looks like a normal 96-pin AT slot that has been flipped so that the connector is toward the front of the system unit rather than toward the back. This slot can be used only by the SMB.

The CPU communicates with I/O cards and all other devices except the SMB through the 16-bit AT bus. While in the ROM Setup program, you can set this bus to run at either 8 or 12 MHz. While many expansion cards require the slower 8-MHz rate, all the ones I tested worked correctly at the higher speed.

As mentioned earlier, the 32-bit slot is always used by the SMB. One of the five 16-bit slots holds the disk controller. The two 8-bit slots hold the EGA adapter and a DIO-500 Multi-I/O Card. The two serial ports (one DB-9 and one DB-25), the parallel port, and the joystick port are on one 8-bit, half-length DIO card. DIP switches on the card let you configure the ports. The system also includes a DB-9–to–DB-25 adapter cable. In addition, the second serial port and the joystick port on the DIO card each use a slot opening in the back of the system for the connectors, thus consuming more slots.

BIOS and RAM

The 32-bit SMB can hold from 1 to 6 megabytes of SRAM. Each megabyte consists of four single in-line memory modules (SIMMs) that mount perpendicularly to the board. Each SIMM contains eight 32K-bit by 8-bit, 100-ns SRAM chips. Because it is static memory, the processor does not need to refresh it.

As the eight chips of each SIMM imply, there is no parity checking on the SRAM memory; the PC's Limited engineers thought it was unnecessary because single-bit errors would be very rare in this system. SRAM is generally less susceptible to transient noise and other error-inducing factors than dynamic RAM (DRAM) is.

The 100-ns (access time) SRAM memory can run with no wait states where DRAM with 100-ns access time cannot. This is because the crucial time for a memory chip is not its access time, but rather its cycle time. The cycle time is the access time plus the time required before the memory can be accessed again. The cycle time for DRAMs is often close to twice their access time; SRAM cycle time is faster because SRAMs do not need to be refreshed. Also, the 32-bit bus employs proprietary logic to help manage the SRAM memory without any wait states.

PC's Limited sells 1-megabyte SRAM SIMMs for $500. While more expensive than DRAM, SRAM offers a significant speed advantage.

You also can put AT-compatible DRAM memory cards in the system. If you do, though, you must use the ROM Setup program to enable memory refresh and parity checking. Depending on the board, you may also need to set the bus speed to 8 MHz. When you're not using DRAM memory boards, you can turn off memory refresh from the ROM Setup program and recover about 4 percent of the CPU's time.

The BIOS is stored in 128K bytes of

continued

ROM on four chips. Unlike the SRAM, these are 150-ns parts and run with one wait state. The ROM sits on the 32-bit bus. The system fetches 1 byte of each 32-bit access from each chip. Because the ROM chips run with one wait state, code in ROM will run more slowly on this machine than on other systems, such as the Compaq, that copy their ROM into RAM at start-up.

The ROM BIOS (version B02, dated 6/8/87) was done by PC's Limited. While it is compatible with the IBM BIOS, a few of its routines start at addresses that are different from the IBM standard.

Disk Drives

The hard disk drive bay in the center of the system has a rail mount for only one full-height or half-height device. The left-hand floppy disk drive bay has three half-height slots, but there are external access openings for the top two drives only. The floppy disk drive is a standard Mitsubishi 1.2-megabyte, 5¼-inch, AT-compatible drive.

The disk controller card fills one 16-bit slot and handles both the floppy disk drive and the hard disk drive. It uses standard Western Digital chips and has cabling for up to two hard disk drives and two floppy disk drives.

The hard disk drive in my evaluation unit was a 5¼-inch, half-height, 40-megabyte drive from Control Data Corp. According to the CORETEST, its average access time was a respectable 25.5 milliseconds. PC's Limited provides its own disk-partitioning program and a one-sheet instruction guide, but I used FDISK from both PC-DOS 3.3 and MS-DOS 3.2 without difficulty.

Video and Keyboard

You can buy the 386^{16} with either a monochrome or an EGA monitor. The evaluation unit came with a Mitsubishi EGA-compatible monitor. The EGA card is a Video Seven Vega card that also provides CGA and Hercules graphics modes. The card comes with configuration and diagnostics software.

One interesting ROM Setup option is the fast EGA mode. When this is on, calls to EGA BIOS routines are routed to other routines that come with the system. These new routines fetch data 32 bits at a time instead of 8 bits at a time. In graphics applications, this can speed screen-redraw time. This option can be disabled, but all the software I tried worked correctly with it on.

The 386^{16} comes with a Fujitsu keyboard. The key action has audible key clicks and a solid but not stiff feel. It has 12 function keys across the top and indicator lights on the Scroll Lock, Num Lock, and Caps Lock keys. The space bar was very stiff; unless I hit it dead center, it did not work.

Software and Documentation

PC's Limited provides no operating system with the machine. A Setup program in ROM takes the place of the typical DOS Setup program.

The system comes correctly configured. When I disconnected the battery and erased the CMOS RAM while taking the system apart, the next boot-up presented me with the usual error messages. Hitting F1 as instructed dropped me into the ROM-based Setup. It prompted me for each correct parameter and was easy to use without a manual.

You can enter the Setup program at any time by typing Control-Alt-Enter. You can set the special system options from the Setup program; you can also park the hard disk head. When you are done, you can return to the program you left; you lose the contents of the screen you left behind, however.

The 386^{16} comes with the *PC's Limited 386 Series Owner's Manual*. This is a reasonably useful and informative book, but it could be much better. The lack of an index is a major flaw. Also, the manual makes no mention of setting the I/O ports. This information is in the small *DIO-500 Multi-I/O Card User's Manual*, but the *Owner's Manual* should at least refer you to it.

The DIO-500 booklet has the minimum amount of information required to configure the board and is useful if you are already familiar with how I/O ports function. The manual for the Video Seven Vega EGA card, on the other hand, is well written and includes many useful diagrams and pictures.

A Joy to Use

Despite the problems I encountered with my first review unit, the 386^{16} was a joy to use, and I was reluctant to return it. It was so fast that I quickly got spoiled; my 8-MHz AT compatible now seems sluggish. In addition, the 386^{16} has a great price.

I found a few compatibility problems, such as my troubles with DESQview, and quality-control issues, such as the faulty keyboard-controller chip in the early unit I received. However, the ASAP support plan and the quick responses of the PC's Limited support personnel have made me confident that any problems will be resolved.

If you want a fast 80386-based, AT-compatible system and you don't feel the need to follow the new PS/2 standard, for my money the PC's Limited 386^{16} is one of the best buys around. ■

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Last year, we introduced the COMPAQ DESKPRO 386,™ the most advanced personal computer in the world. Now the world has two new benchmarks from the leader in high-performance personal computing. The new 20-MHz COMPAQ DESKPRO 386/20 and the 20-lb., 20-MHz COMPAQ PORTABLE 386 deliver system performance that can rival minicomputers.* Plus they introduce advanced capabilities, without obsoleting your investment in software, hardware and training.

Our new computers employ an industry-standard 20-MHz 80386 microprocessor and sophisticated 32-bit architecture.

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most powerful PC's and off.

and the new 20-MHz COMPAQ PORTABLE 386™

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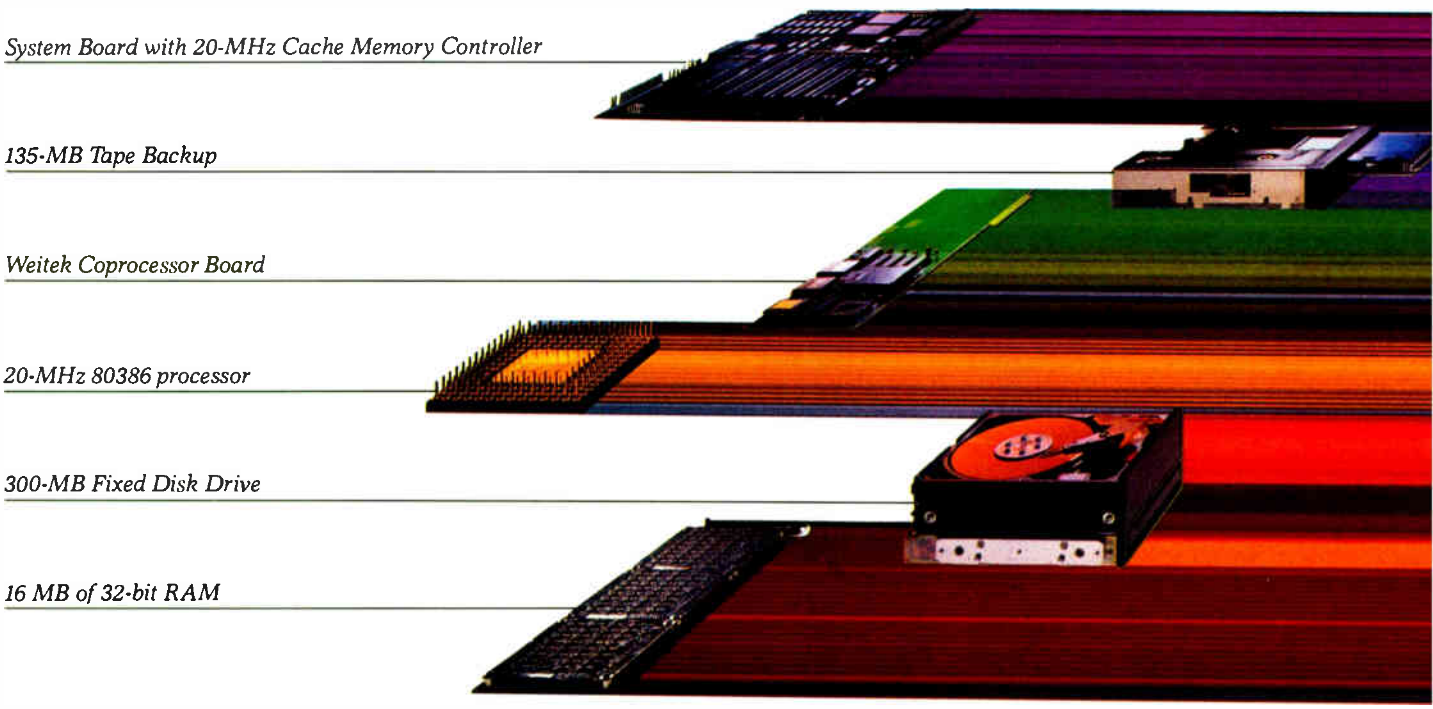
The question wasn't
but how to get the



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The COMPAQ DESKPRO 386/20 is an impressive 50% faster than 16-MHz 386-based personal computers. Even more impressive is the fact that it's up to 25% faster than other 20-MHz 386's. That's because the processor is just one small part of how the COMPAQ DESKPRO 386/20 outperforms every other PC in the world today and even many minicomputers.

The big reason is the new COMPAQ Flexible Advanced Systems Architecture, which optimizes overall system throughput while maintaining full compatibility with industry-standard peripherals. It does this by combining an advanced memory caching scheme with memory and peripheral buses that operate concurrently.

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how to get to 20 MHz,
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erals operating at the industry-standard 8 MHz.

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As tasks become more complex and users demand more advanced capabilities, Compaq responds by raising the standard of performance in personal computing.

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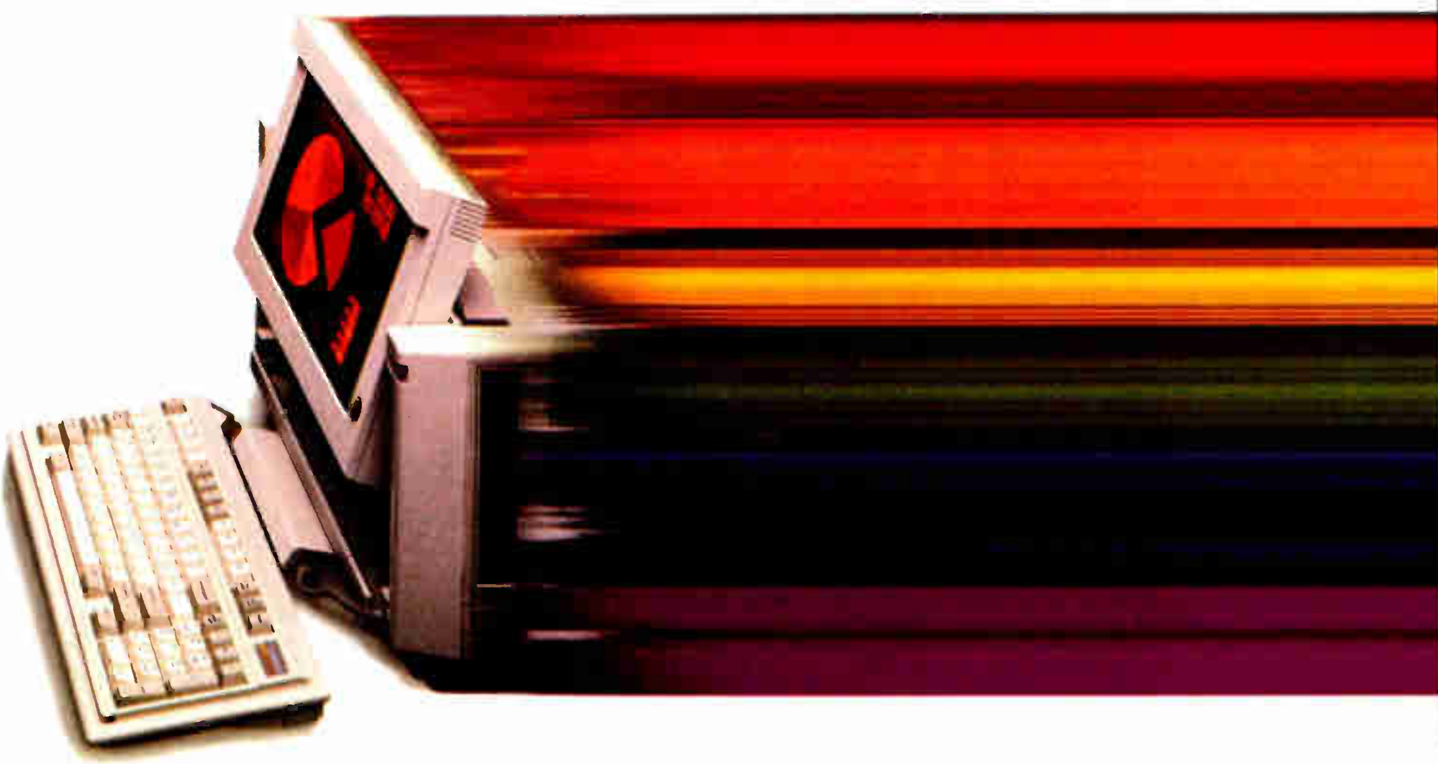
Everyone expected Compaq
But no one



Pound for pound, it is the world's most powerful computer

Compaq has long been recognized as the world leader in both 80386 technology and portable computing. So it isn't surprising that we would combine the two.

But no one expected the new COMPAQ PORTABLE 386 to run at 20 MHz. And no one even dreamed that it would offer 100 megabytes of storage, disk caching, and much, much more.

Our newest 20-lb. portable computer goes far beyond an 80386 microprocessor with a handle. It's not just the most advanced portable in the world. Pound for pound, it's the world's most powerful computer. Period.

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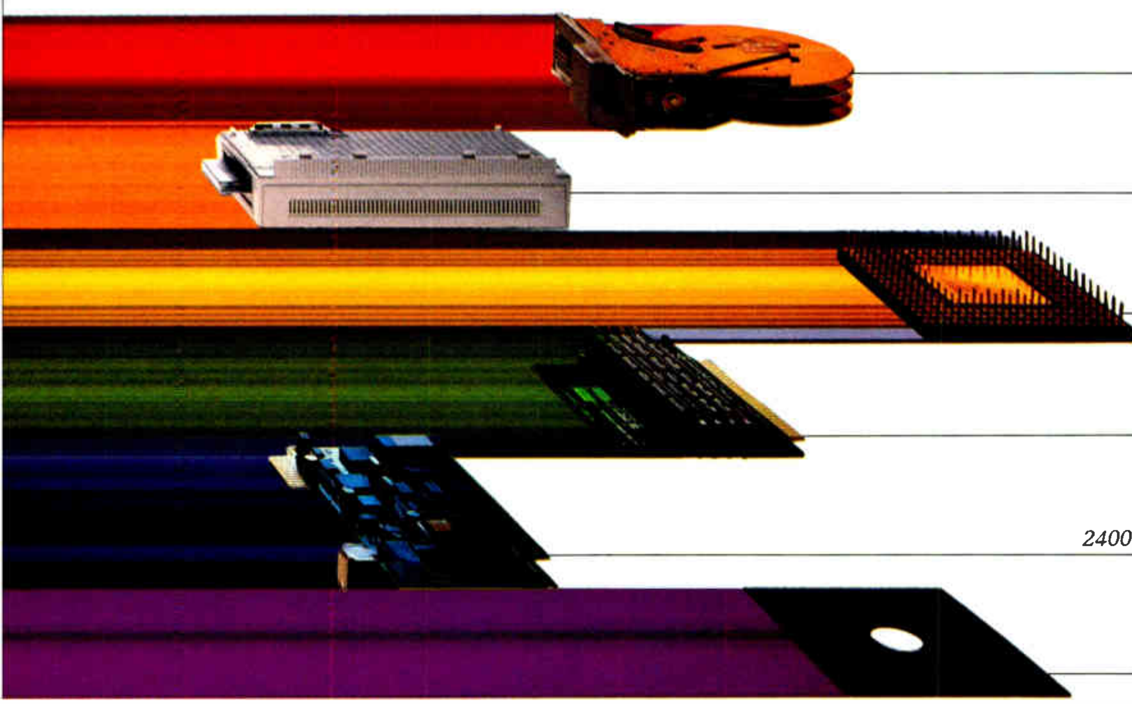
:o introduce a 386 portable PC. :xpected all this.



applications is increased even more when you add an optional 20-MHz 80387 coprocessor.

Memory? Get one megabyte of 32-bit, high-speed RAM standard or go as high as 10 MB internally. And like all of the COMPAQ 386-based PC's, it features the COMPAQ Expanded Memory Manager.

With our high-performance 100-megabyte internal fixed disk drive, you can actually fit 500 lbs. of data-filled pages into a 20-lb. PC, unsurpassed storage for a portable. If that's too much for you, we also offer a 40-megabyte model.

We've become famous for building desktop computer capabilities into our portables without leaving anything out. The COMPAQ PORTABLE 386 is more proof. It has a high-resolution, 640 × 400, 10-inch plasma display; a full-size, portable enhanced keyboard; two industry-standard expansion slots in a lightweight, optional plug-on unit; a choice between an optional 2400- or 1200-baud Hayes®-compatible modem; a full-size 5¼-inch 1.2-MB diskette drive; even an optional 40-MB tape backup.

These features, combined with the ultimate in portable performance, make the COMPAQ PORTABLE 386 the *biggest* PC this *small*.

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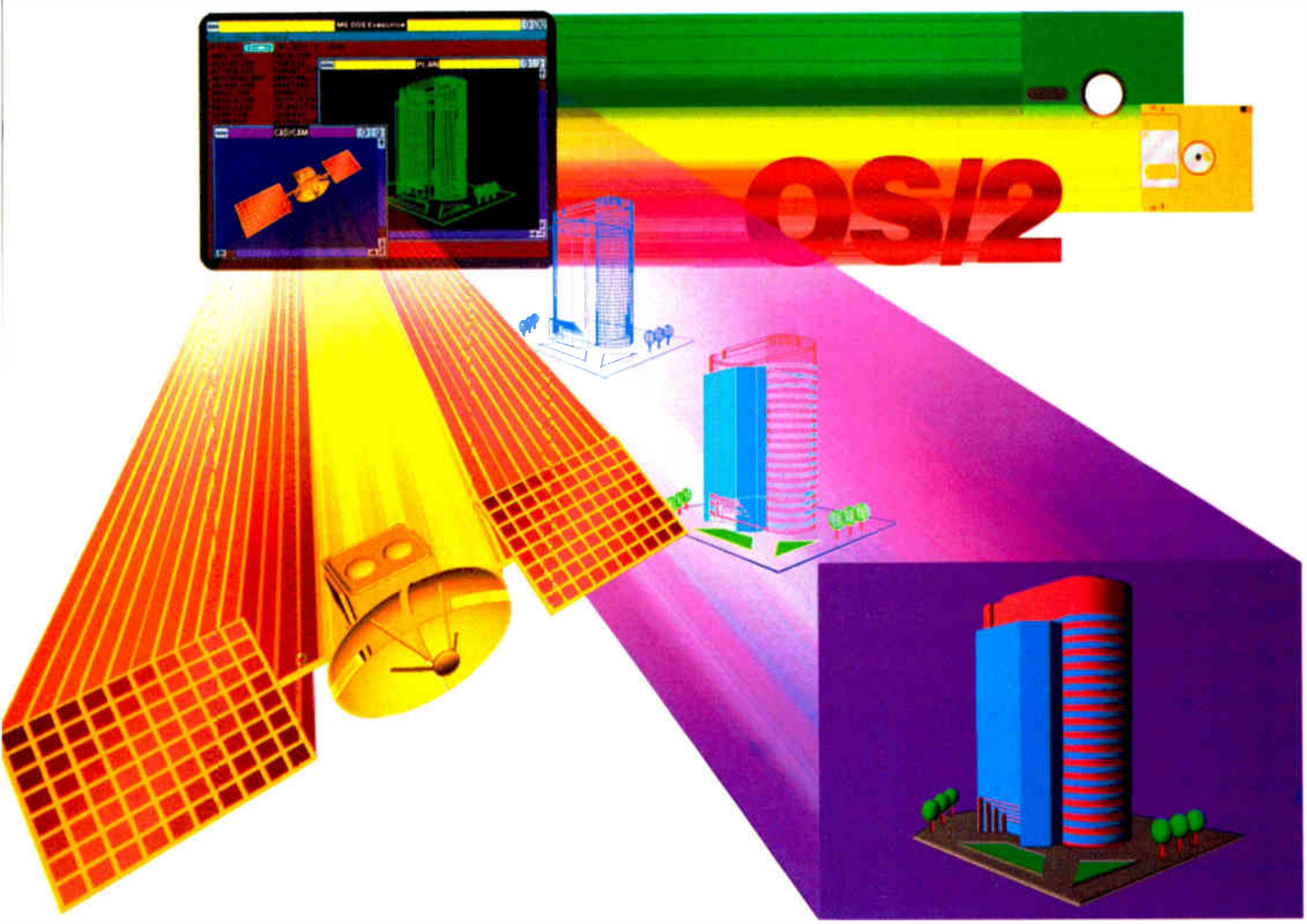
PORTABLE 386™

Compaq moves you ahead without leaving you behind.



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The Zenith Z-183

John Unger

A hard disk drive makes Zenith's latest laptop better, but still not the best

The Zenith Z-183 is a redesigned version of the original Z-181 laptop, with the addition of a 10-megabyte hard disk drive. It's priced at $3499.

In a previous review, I compared the Z-181 with three other laptops. [Editor's note: *See "Four Portable Computers" in the February BYTE.*] The Z-181 was noteworthy because of its backlit, supertwist LCD display, but it was somewhat lacking in the area of performance; it used an 80C88 microprocessor that ran at a slow clock rate of 4.77 megahertz.

The new Zenith Z-183 laptop incorporates several features not available on the original Z-181. The most significant change has been the replacement of one of the Z-181's dual 3½-inch floppy disk drives with a JVC 10-megabyte hard disk drive. Other improvements include an 80C88 microprocessor that has dual clock speeds of 4.77 and 8 MHz; new components to reduce overall power consumption; an improved, larger-capacity battery pack; and, not least of all, a handle.

My review unit came with the standard 640K bytes of RAM and an optional 1200-bit-per-second internal modem ($399). [Editor's note: *Zenith has also released a new version of the Z-181 that incorporates the Z-183's improvements, excluding the internal hard disk drive. The new Z-181 does, however, let you hook up an AC-powered 20-megabyte external hard disk drive.*]

A Case for Growth

The internal improvements of the Z-183 have had some external costs. The laptop has grown a bit in its transition from the original Z-181 to the Z-183. It will still fit on your lap, but not as comfortably as before. The system's size has increased nearly 2 inches in depth and ½ inch in width and height. More significantly, the inclusion of the hard disk drive and a larger battery pack has increased the computer's weight from 12 pounds to almost 16 pounds.

Zenith has improved the keyboard by making some subtle but meaningful changes in its layout. Four editing keys are now located at the lower right corner of the keyboard in a cross configuration. They function as arrow keys normally, and they change to Home, End, PageUp, and PageDown when you use them in conjunction with a special Function key. This setup is reasonably convenient when used with WordPerfect and other editors. The Control key is in the more standard position, just to the left of the *A* key, and the Return and Shift keys are larger than those on the Z-181.

On the left side of the Z-183, toward the back, is a circular connector that can be used for plugging in an optional external numeric keypad or keyboard. You must change the setting on a DIP switch located on the bottom of the case to enable the keyboard connector. Zenith's optional ZKB-2 keyboard, with a full 101 keys, is the only one guaranteed to work properly with this port, so you take your chances if you plug your desktop computer's keyboard into the connector, even if it fits.

Fortunately, Zenith chose not to fool with the Z-181's excellent screen. The backlit, supertwist LCD displays a full 25 lines of 80 characters and CGA graphics in 320 by 200 and 640 by 200 resolutions. You still have to juggle the contrast and backlighting controls in certain lighting conditions (such as bright sunlight or a dark room) to get the best display, especially for software that emulates CGA text and graphics. The Z-183 displays colors as shades of blue-gray and tends to either wash out light areas or blend the dark areas, depending on how you adjust the contrast.

Large but Sluggish Storage

Putting a hard disk drive in a portable computer requires some concessions. The first and most obvious compromise is battery life. When I kept hard disk usage to a minimum (for example, working on a single text file), I was able to run the Z-183 for up to 5 or 6 hours on one battery charge with the standard 2.5-amp-hour battery pack.

continued

John Unger (P.O. Box 95, Hamilton, VA 22068) is a geophysicist for the U.S. government. He writes graphics software and uses computers to study the structure of the earth's crust.

Zenith Z-183

Company
Zenith Data Systems
1000 Milwaukee Ave.
Glenview, IL 60025
(800) 842-9000
(312) 391-7000 (in Illinois)

Size
13½ by 14 by 3½ inches; 15½ pounds (with internal modem installed); screen size: 8 by 6 inches

Components
Processor: 80C88, switchable between 4.77 and 8 MHz
Memory: 640K bytes on system board standard; optional 1 megabyte of internal EMS RAM
Mass storage: One 10-megabyte internal hard disk drive; one 720K-byte double-sided, double-density 3½-inch floppy disk drive
Display: 25-row by 80-column supertwist LCD with electroluminescent backlighting; emulates IBM CGA to give 320- by 200-pixel and 640- by 200-pixel monochrome graphics in shades of blue-gray
Keyboard: 78 keys, including 12 function keys; special editing-key cluster; embedded numeric keypad selectable on ASCII keyboard
I/O interfaces: RS-232C serial port, 9-pin male D-shell; Centronics-compatible parallel port, 25-pin female D-shell; RGB/composite monochrome 9-pin video port, IBM PC-compatible; port for external floppy disk drive or bar-code reader; standard telephone jack for optional internal 1200-bps modem; port for optional external keypad or keyboard
Battery power: Internal 12-volt nickel-cadmium, rechargeable, 2.5-amp-hour; approximate lifetime: 4 to 5 hours

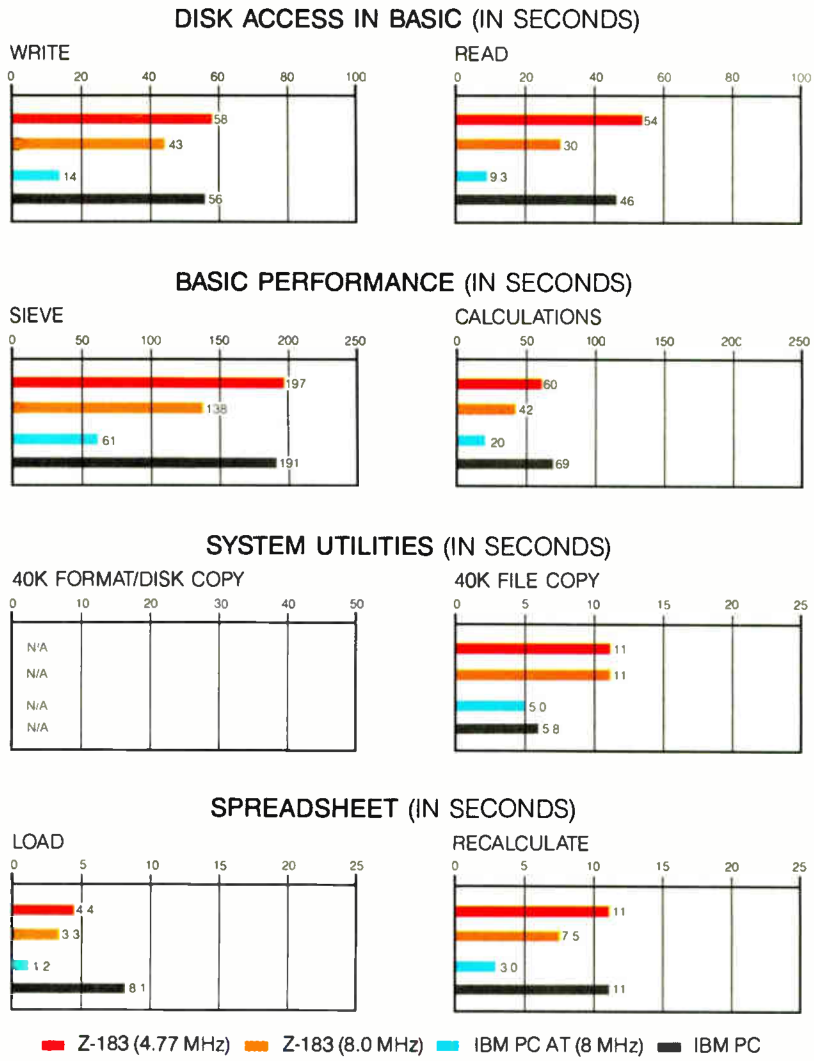
Software
MS-DOS 3.2

Options
Carrying case: $59
300-/1200-bps internal modem: $399
2400-bps internal modem: $549
Automobile cigarette-lighter power adapter: $19
4-amp-hour battery pack: $129
ZKB-2 full-size keyboard: $149
Numeric keypad: $130 (approximate)
LapLink: $130

Documentation
Z-180 PC Series Computers Owner's Manual; MS-DOS 3.2 User's Guide and User's Reference Manual; MS-DOS version 3.2 Quick Reference Guide

Price
$3499

Inquiry 884.



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 bencnmark 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. (The IBM PC AT and the Zenith Z-183 loaded from the hard disk.) All BASIC benchmark programs were run with MS-DOS 3.2 and GWBASIC 2.02.

However, when I was doing work that involved fairly frequent access to the hard disk (running disk-access benchmarks repeatedly, or compiling and running C programs), the battery life dropped to around 3 to 4 hours. Zenith offers an optional 4-amp-hour battery pack, which, according to the company, should extend your portable computing time by about 2 hours, depending on how much you access the hard disk.

Another, and perhaps for some a more severe, restriction is the extremely slow access time and data-transfer rate of the hard disk drive. The CORETEST program from CORE Inc. showed that the 3½-inch hard disk drive has an average access time of 112 milliseconds and a data-transfer rate of 55K bytes per second. A standard IBM XT 10-megabyte hard disk drive has an average access time of about 70 ms. According to a technical representative at Zenith, the performance problem is related to design considerations for a portable computer. The Z-183 is shock-mounted, and the heads automatically retract and park after about 5 seconds of inactivity. This protects the disk surfaces if the computer experiences a sudden shock while it is in use—a good feature. However, this sort of ruggedized construction can contribute to slow performance.

Also, the Z-183's hard disk drive is one of the noisiest I have ever worked with.

Faster, But Still Not Fastest

A shortcoming of the old Z-181 was its relatively lethargic performance. Zenith has improved that by providing the Z-183 with a dual-speed 80C88 microprocessor. You change the processor's clock speed from 4.77 to 8 MHz by removing a rubber plug that covers a DIP switch in the bottom of the computer and flipping one of the switches. This procedure is somewhat inconvenient, compared to other computers that let you change speeds with simple key combinations or software commands. On the other hand, once you have the switch in the 8-MHz position, you might as well leave it there. None of the software that I used—including WordPerfect 4.2, ProComm 2.4.2, Condor 3 2.11.11, R:base System V, Turbo C 1.0, and Microsoft C 4.0—required the slower clock rate to function properly.

At 8 MHz, the Z-183 performs CPU-intensive tasks in about 70 percent of the time it takes at 4.77 MHz, but its performance still lags behind that of the Toshiba T1100 Plus, which uses an 80C86 processor that can run at 4.77 or 7.16 MHz, and the NEC MultiSpeed, which has a V30 chip running at 4.77 or 9.54 MHz. At 8 MHz, the Z-183 ran the BYTE Sieve and Calculations benchmarks in 138 and 41.9 seconds, respectively (see the graph on page 146), as compared to 94 and 30 seconds for the T1100 Plus at 7.16 MHz and 68 and 22 seconds for the MultiSpeed at 9.54 MHz.

The optional 300-/1200-bps modem in my review unit was easy to install and functioned perfectly. It is fully compatible with the Hayes Smartmodem 1200B. Later this year, Zenith plans to introduce an internal memory expansion that will add 1 megabyte of Expanded Memory Specification (EMS) RAM to the Z-183. This additional memory could be used as a disk cache, which would help speed up the performance somewhat. At the time of writing this review, Zenith had not yet announced a price for the memory upgrade.

Software, Service, and Documents

With the system's software (MS-DOS 3.2), Zenith includes an easy-to-use file-

continued

transfer utility program called PCXFER, which lets you transfer files from the Z-183 to another microcomputer.

By agreement with Zenith, Businessland Inc. will sell and service the Z-181 and Z-183 laptops. Zenith will also continue to market the laptops through its own national network. The Z-183 comes with a one-year limited warranty on all parts and labor. For service, Zenith encourages you to take your computer to the dealer you bought it from or to the nearest authorized Zenith service center. Buyers who live too far from either location can call Zenith to get a return-authorization number and then ship the unit to the company for service.

The *Z-180 PC Series Computers Owner's Manual* is a considerable improvement over the slim volume that came with the original Z-181, especially in terms of its technical coverage of the hardware and software. In fact, the new manual has only limited information to tell beginning computer users about their new systems.

Easy on the Eyes, Not on the Arms

With its 10-megabyte hard disk drive and dual-speed processor, the Zenith Z-183 adds performance to a portable machine that already has one of the best LCD screens on the market. The improvements to the keyboard are worthwhile and enhance the machine's productivity.

However, Zenith should have taken the extra step of using a faster CPU, such as a true 16-bit 80C86 microprocessor, rather than the 80C88; and a faster hard disk drive would have been a welcome addition. The Z-183 still lags behind the Toshiba T1100 Plus and NEC MultiSpeed laptops in CPU-intensive performance.

Also, the size and weight of the computer are about the maximum you can have and still call the machine a laptop computer: 15½ pounds is a lot to lug around an airport when you are also struggling with a briefcase and carry-on luggage. To a certain extent, that's the price you pay for the convenience of a hard disk drive and the increased power it provides. If you need a battery-powered laptop portable with a hard disk drive, your options are limited, and the Z-183 is a good choice. ■

[Editor's note: *At press time, Zenith announced that it will discontinue the 10-megabyte hard disk drive in the Z-183 and substitute a 20-megabyte hard disk drive (with the same access time). According to the company, the new unit will sell for the same price. Zenith will no longer provide PCXFER, but it will offer Traveling Software's LapLink for $130. An optional 2400-bps modem will also be available for $549.*]

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Atari's Mega 4

Jim Kent

A new version of the ST with 4 megabytes of RAM and a graphics coprocessor

The Atari Mega 4 is an improved ST in a new box. Along with 4 megabytes of RAM, a blitter (bit-block transfer) chip, an expansion slot, and new ROMs, the Mega 4 has an 8-megahertz 68000 processor, an internal 760K-byte 3½-inch floppy disk drive, and a 10-megabyte hard disk drive/direct memory access port. It also comes with either a 640- by 400-pixel monochrome screen or (with the color monitor) a choice of 640 by 200 pixels in 4 colors or 320 by 200 pixels in 16 colors.

The Mega 4 uses the TOS operating system and the GEM Desktop ROM-based system software. With a color monitor, the Mega 4 costs $2599.95. (See the box on page 154 for details on the different configurations and their prices.)

The Box

Except for its loud fan, the Mega 4's box with its detachable keyboard is a big improvement over the 1040ST. [Editor's note: *See "The Atari 1040ST" by Dave Menconi in the February BYTE.*] The monitor now sits on top of the system unit. The biggest improvement is the keyboard itself, which is laid out just like the 1040ST's but has a less spongy, cleaner action. The keyboard is attached to the CPU with a coiled phone cord that stretches to a length of about 8 feet. The footprint of the CPU and monitor is reasonably small, about 14 inches square. Overall, the packaging takes up considerably less desk space than the 1040ST does.

My review system came with an SH204 20-megabyte hard disk drive. This large, heavy disk drive's cable is so short that you can place the drive only to the left of or behind the machine. According to Atari, the new SH205 hard disk drive, which will be available later this year, will fit underneath the Mega system box.

The Blitter

The most interesting new feature of the Mega 4 is the Atari blitter. This piece of custom silicon speeds up graphics operations, especially rectangle fills and moves, and text moves. Software that makes graphics calls through the GEM VDI or the Line A traps, or that uses BIOS calls for text, will speed up noticeably. [Editor's note: *For more information on the GEM VDI and the Line A traps, see "Atari ST Software Development" by Michael Rothman in the September 1986 BYTE.*] GEM-based programs, particularly First Word and the GEM Desktop itself, are more pleasant to use with the blitter.

The Atari blitter can perform the standard Boolean operations (e.g., move, or, and, and xor) on a source and a destination bit map. More important, it can shift the source so the screen can be quickly scrolled one pixel at a time. It has a 16-word pattern mask for halftones and patterns.

An esoteric but potentially powerful feature of this blitter is the smudge bit. When this bit is set, the blitter uses the four least-significant bits of the shifted source as an index into the pattern buffer. I've used this to create a full-screen ×4 zoom in $\frac{1}{50}$ second, about twice as fast as it can be done with the 68000. [Editor's note: *Source code (nonexecutable) listings for scrollzoom.c and zoomblit.asm in C and assembly language 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, or author, or issue date. Some archived files may contain numerous listings for a single article. A description of the file also accompanies each entry.*]

Normally, the blitter and the 68000 take turns of 64 bus cycles each. In hog mode, the blitter grabs all the cycles. However, this leaves the 68000 unavailable to service keyboard and other interrupts. You don't want to miss keyboard interrupts because you'll lose your type-ahead, so it's better to operate the blitter in shared-bus mode. The processor can restart the blitter early, before the 68000's 64 cycles are up. This gives the

continued

Jim Kent works at Dancing Flame and is the moderator of the atari.st conference on BIX. He can be reached at 739a 16th Ave., San Francisco, CA 94118 or on BIX as "jim_kent."

Atari Mega 4

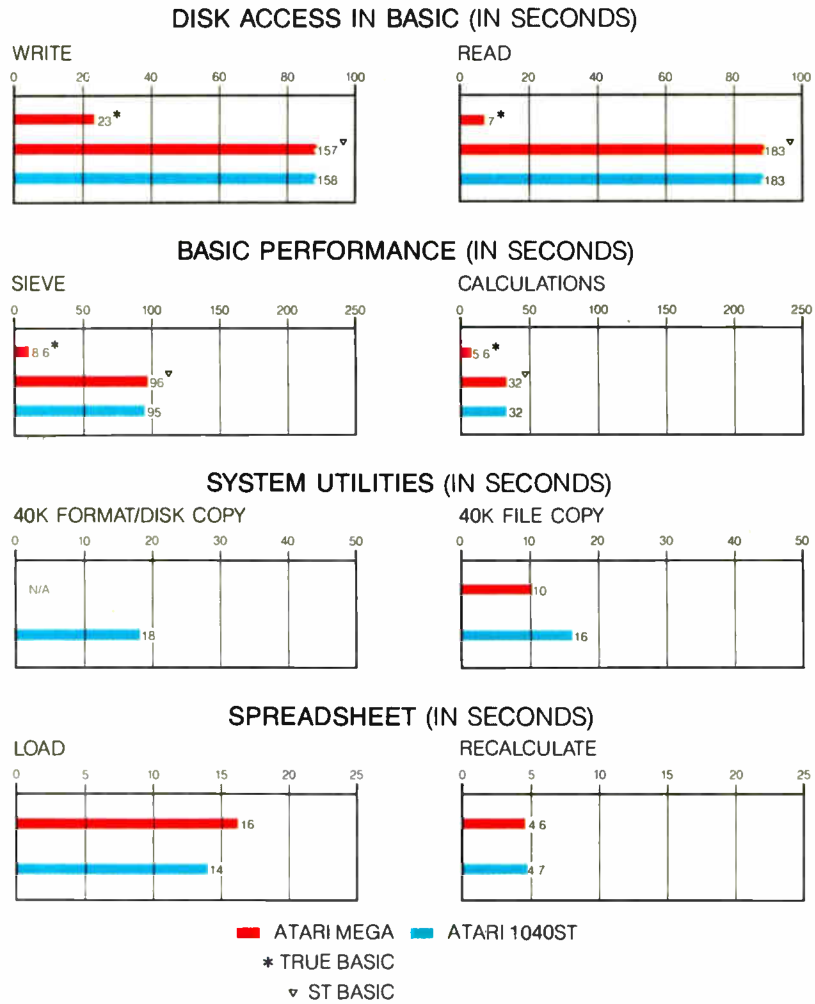
Company
Atari Corp.
1196 Borregas Ave.
Sunnyvale, CA 94086
(408) 745-2000

Components
Processor: 8-MHz 68000; custom bit blitter graphics coprocessor
Memory: 4 megabytes of RAM (2 megabytes in the Mega 2); 196K bytes of ROM
Mass storage: Internal 720K-byte double-sided 3½-inch floppy disk drive; 10-MHz DMA port can be used to connect Atari 20-megabyte or third-party hard disk drives; port for additional external floppy disk drive
Display: Monochrome 640- by 400-pixel display with black-and-white monitor; color 640- by 200-pixel display in 4 colors or 320- by 200-pixel display in 16 colors out of 512 with color monitor. Screen uses 32,000 bytes and may be located on the start of any 256-byte page of memory.
Keyboard: 94-key IBM Selectric-style QWERTY keyboard with numeric keypad, cursor controls, and rhomboid function keys
Sound: Three independent sound channels with envelop/volume/frequency control
Expansion and ports: Internal expansion slot with full access to the 68000 bus; Centronics parallel port; DB-25 serial port with IBM PC pin-outs; MIDI in and MIDI out; 10-MHz DMA port for hard disk drive, laser printer, or other high-speed peripherals; mouse/joystick 0 port; joystick 1; 128K-byte external ROM cartridge slot

Options
SF314 external double-sided floppy disk drive: $299
SH205 external 20-megabyte hard disk drive: $899

Price
Mega 2 with monochrome monitor: $1699
Mega 2 with color monitor: $1899
Mega 4 with monochrome monitor: $2399
Mega 4 with color monitor: $2599

Inquiry 885.



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 System Utilities graphs show how long it takes to format and copy a 40K-byte file using the system utilities. The Spreadsheet tests load and recalculate a 25-row by 25-column ACalC spreadsheet. The Atari ST tests were performed using TOS in ROM, Atari ST BASIC, and the ACalC spreadsheet. The Mega 4 tests were identical except for the addition of the True BASIC benchmarks.

68000 a chance to service interrupts every 64 memory cycles (256 processor cycles), while letting the blitter operate at about 90 percent of hog speed.

The blitter is controlled with 16 read/write registers. It can manipulate bit maps as large as 512K by 64K pixels anywhere within its 8-megabyte address space. In addition to the usual offset to be added to the screen address at the end of each line, the Mega 4's blitter has an offset to be added at the end of each word. This is to cope with rendering single-bit-plane sources (such as text) onto the color screen, where adjacent words in a bit plane may be 4 and 8 bytes apart, depending on the resolution.

The ROMs and Slot

The Mega 4's new set of ROMs primarily provides support for the blitter. Rectangle drawing is significantly faster with the blitter enabled. Other graphics operations, such as line drawing, are faster because of better coding. Atari has also taken the opportunity to fix the RTS/CTS bug in the serial driver. (This bug caused the loss of characters when reading ASCII files from another computer through the modem port.)

TOS clears all free memory to zero when starting up a program. In the old ROMs, this was done inefficiently. The new ROMs start up a program on a 4-

megabyte machine about 1 second faster than the old ones did on a 1-megabyte unit.

The ROMs haven't improved the file system; there's still a limit of 40 folders on a hard disk. However, Atari has distributed a program to increase this limit to 200 folders.

The Mega 4 has a single 64-pin expansion bus located inside the CPU unit. Essentially, it's a tap into the existing 68000 bus. This should be a boon to third-party hardware developers and custom hardware hackers, who previously had to content themselves with the cartridge slot.

System Performance and Reliability

I used the Mega 4 for about 2 weeks for software development. I replaced the GEM Desktop with a third-party Unix-like shell. A third-party disk cacher improved the speed of the hard disk drive. This, plus a copious RAM disk for intermediate files and a decent C compiler, cut my edit/compile/link times to less than 3 minutes on a 110K-byte application assembled from 95 source files. This compares favorably to using IBM PC ATs and some of the 68020-based workstations.

A significant feature of the Mega 4 and other ST systems is hardware memory protection. Memory protection increases system reliability by making it harder for one faulty piece of software to destroy the operating system. The protection hardware also makes it much easier to debug programs because it stops the program as soon as it addresses memory not available to it, and this is often the first sign of a bug. The lower 2K bytes of the system's memory map and anything past the end of RAM are protected. The Mega 4 lacks only multitasking to make it an ideal programming workstation.

To give a broader perspective on the BASIC benchmarks, I've included the results for True BASIC as well as for Atari's ST BASIC. True BASIC is 20 times faster than ST BASIC in some tests.

Atari is bundling less software with its systems these days. Gone are NEOchrome, Atari Logo, and First Word. All that's left is Atari's GEM-based ST BASIC. Fortunately, lots of good unbundled software runs as well or better on the Mega 4 than on the 1040ST, including ST Writer, CAD-3D, NEOchrome, DEGAS, DEGAS Elite, Aegis Animator, Flicker, Megamax C, Chat, and GFA BASIC. In fact, of the more than 50 programs and utilities that I use in a typical week, only one (a public domain terminal package) failed on the Mega 4.

A Satisfying Upgrade

In the Mega 4, Atari has brought us another 68000 box with a lot of memory. Even though there are significant differ-

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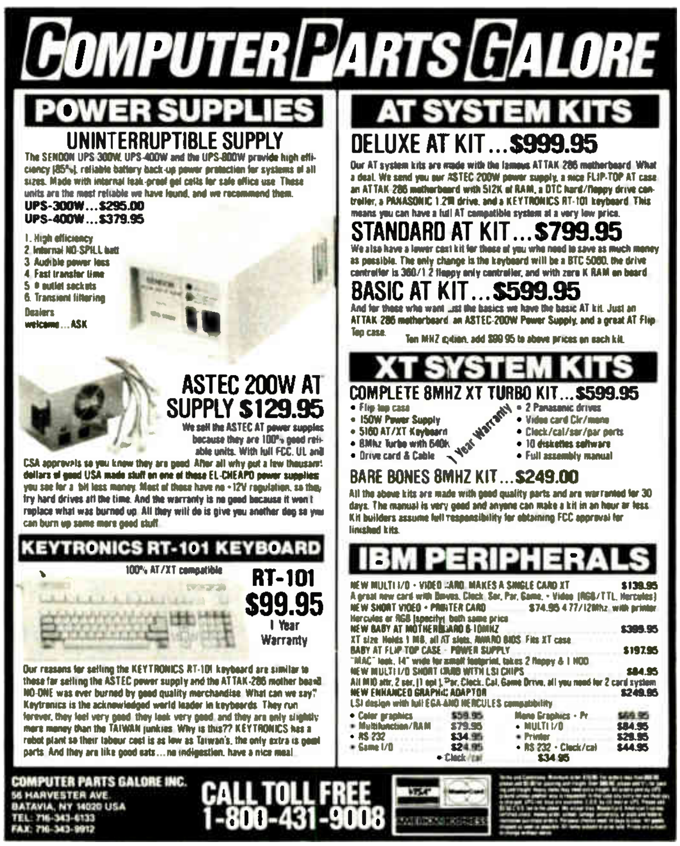

ences between this model and the earlier 520STs and 1040STs, I was pleasantly surprised to find that most of my software and all my peripherals for the 520ST worked for the Mega 4 as well.

The Mega 4's box fits more neatly on my desk, and the keyboard is more ergonomic than that of previous ST machines. The blitter chip speeds up both graphics- and text-oriented applications significantly. Although the Megas are more expensive than the previous STs, ST owners will find them a satisfying upgrade path.

Once Atari's laser printer becomes available (Atari promises it "by the end of the year"), the Mega 4 will be ideally suited to desktop-publishing applications. Moreover, as the PC world switches to 3½-inch floppy disk drives, an often overlooked fact about the ST family, including the Mega 4, becomes important: It can read and write to 3½-inch 760K-byte floppy disks formatted on an IBM. If you want the speed and programming ease of an 8-MHz 68000 and the benefits of crisp, fast graphics wthout being completely isolated from the PC mainstream, the Mega 4 is a viable option. ■

VIEWS FROM BIX: ATARI MEGA 4

atari.st/reviews #2, from Steven Grimm.

I have just two nitpicks for your otherwise excellent review. First, the 40-folder limit doesn't actually prevent you from having more than 40 folders on your system; it's the maximum number that can be accessed during one work session (i.e., between reboots). So, if you have 50 folders, 20 of which are for games and 30 of which are for programming, you'll probably never notice the limit at all.

atari.st/reviews #4, from Jim Omura.

I had a chance to use a Mega ST a few weeks ago, and Al Page noted that he thought the disk drive of the bare Mega is a tad low. If you tilt the keyboard up, it gets in the way of the slot and it's cumbersome to change disks. Anyway, we thought that if you stick the computer on top of the new hard disk drive, this problem would be alleviated. And then again, a couple of issues of BYTE can do this as well.

atari.st/reviews #14, from Tom Jeffries.

I would like it if the incredible size/power ratio was clear, but maybe you have to be there to see it. I sit in front of my tiny little Mega right next to this humongous XT clone that's at least five times as big, with 640K bytes and an 8088. It looks like a stone-age tool in comparison. One thing: You state that it is only possible to put the SH204 on the left side. Mine sits on the right side with no problem. There's no cord to spare, but it fits. Maybe they are shipping shorter cables with the SH204 now.

atari.st/reviews #17, from David Betz.

Yes, it is nice to have such a small machine with such a large amount of memory. Is there any chance that the price will drop before introduction? It doesn't seem reasonable to have to pay $1200 extra for 3 megabytes of extra memory. The 1040ST costs less than $1000 and is most of what the Mega 4 is except for the extra memory and blitter. Could those really cost $1200? The blitter upgrade was only supposed to be around $100, as I remember it.

atari.st/reviews #18, from Jim Omura.

Well, the Mega construction is definitely more expensive than the extra memory and blitter. Still, there does seem to be a "healthier profit margin."

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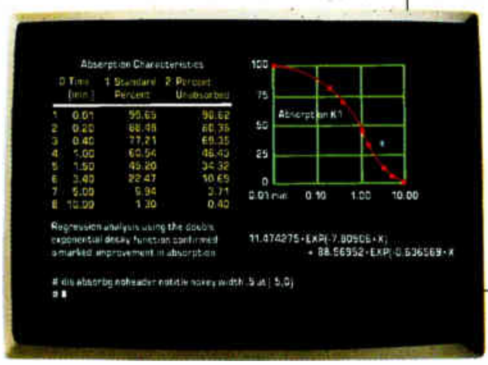

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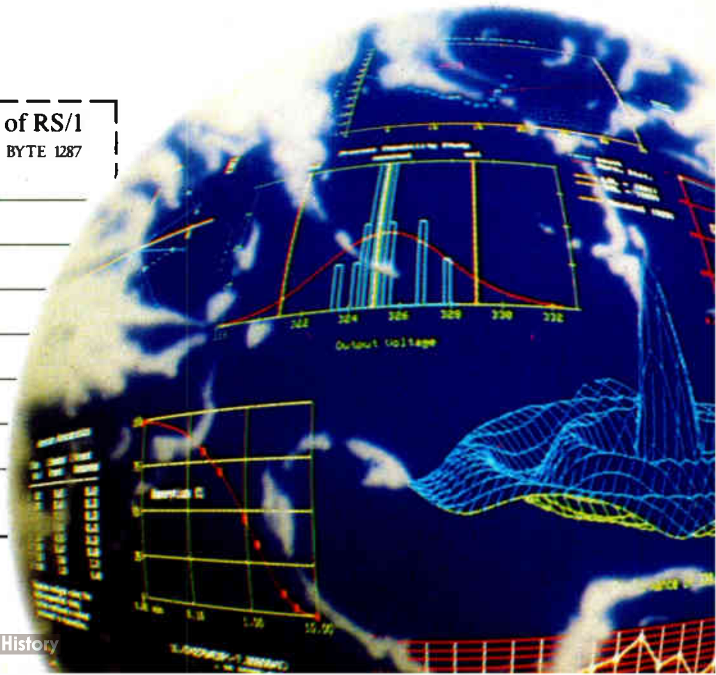

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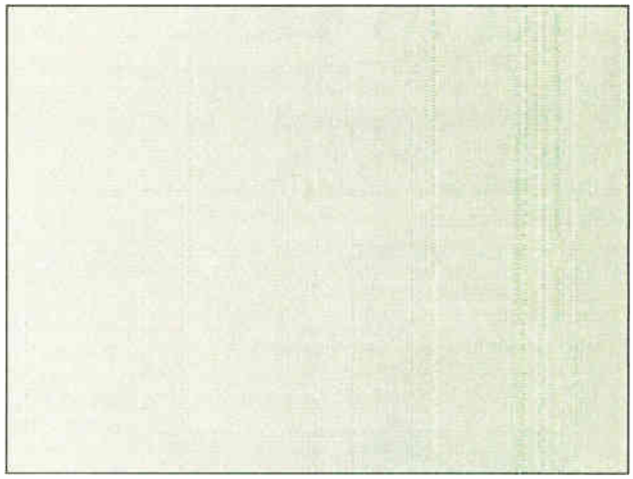

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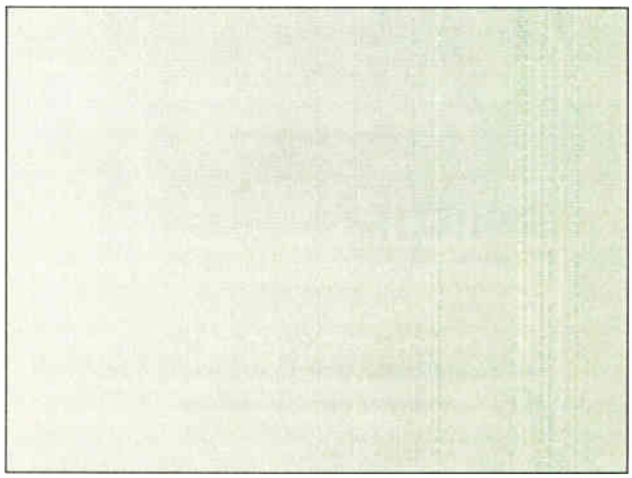
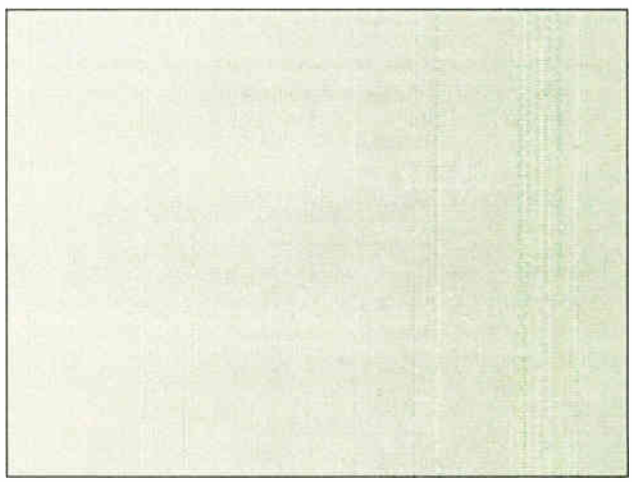


No graphics library.



No on-line help for the C language or library routines.

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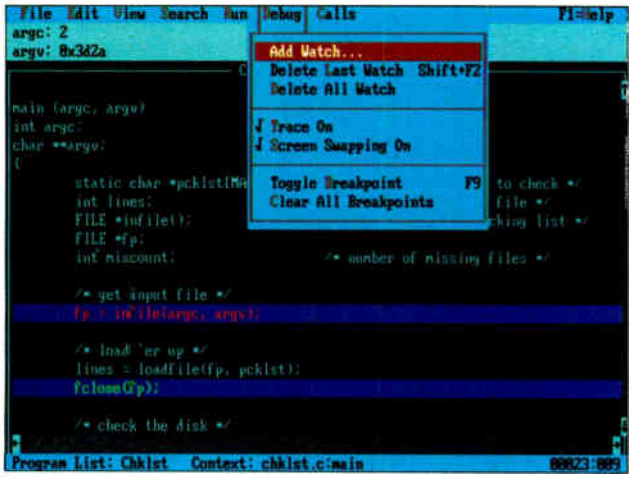

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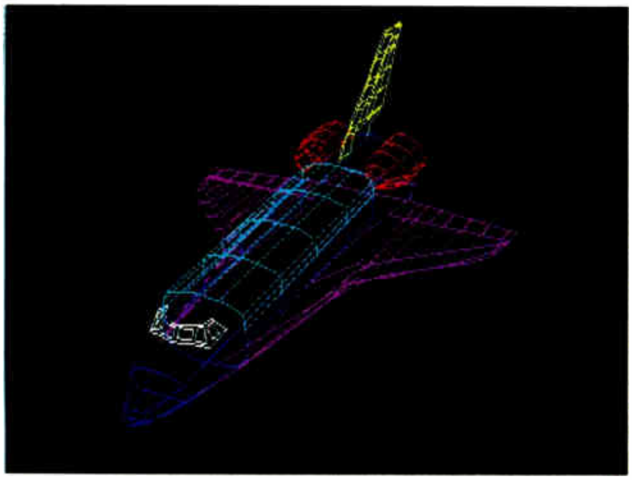

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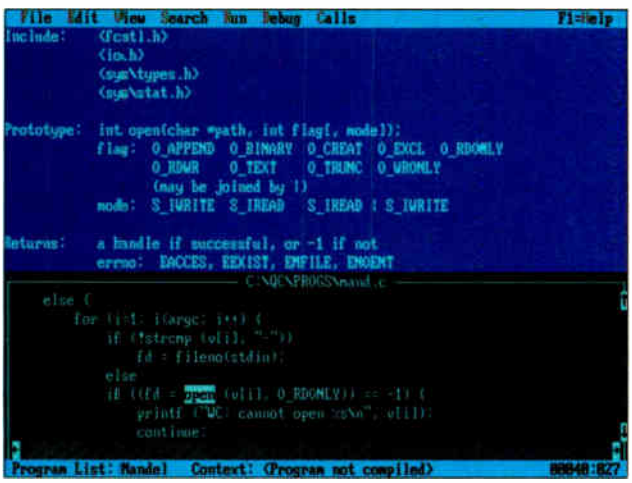

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Integrated debugger and editor	Yes	—
Source-level debugging	Yes	—
Watch local & global variables	Yes	—
Set breakpoints	Yes	—
Stack tracing	Yes	—
Editor and Environment		
WordStar® compatible	Yes	Yes
Context-sensitive help for C language	Yes	—
Context-sensitive help for C functions	Yes	—
Brace, bracket & parenthesis matching	Yes	—
Mouse support	Yes	—
Support for EGA 43-line mode	Yes	—
Documentation		
Complete C language reference	Yes	—
Examples for every library routine	Yes	—
Compiler		
Completely Microsoft CodeView compatible	Yes	—
Automatic enregistering	Yes	Yes
Integrated MAKE		
Automatically generates .MAK file	Yes	—
In-memory MAKE compatible with stand-alone MAKE	Yes	—
Include file dependencies	Yes	Yes
Libraries		
Graphics library included	Yes	—
CGA & EGA and VGA support	Yes	—
Library source code available	Yes ($150)	Yes ($150)
Microsoft C Optimizing Compiler 5.0 compatible	Yes	—
Microsoft LINK vs. Turbo Link		
Links programs up to 640K	Yes	—
Supports overlays	Yes	—
Directory searching for library files	Yes	—

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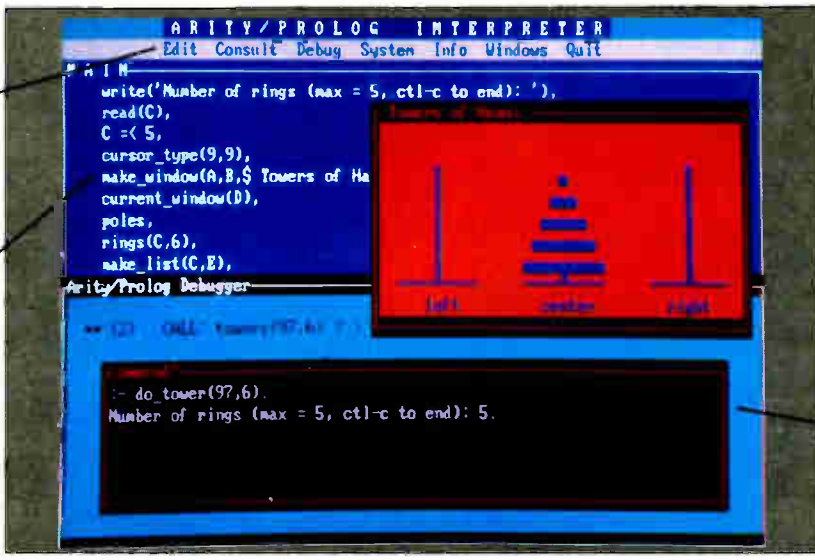

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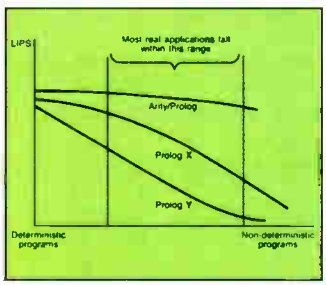

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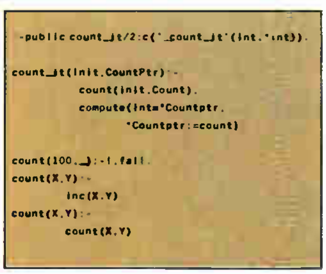

```
-public count_jt/2:c('_count_jt'(int,*int)).

count_jt(init,CountPtr):-
        count(init,Count),
        compute(int=*Countptr,
                *Countptr:=count)

count(100,_):-!,fail.
count(X,Y):-
        inc(X,Y)
count(X,Y):-
        count(X,Y)
```

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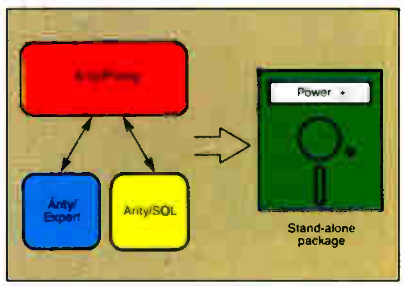

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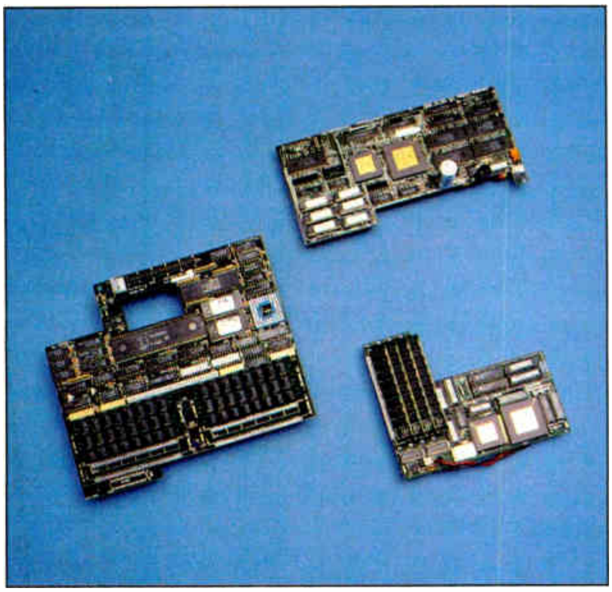
Three Accelerator Boards for the Macintosh Plus

Chris Crawford

Hardware add-ons that significantly boost the Mac's performance



Clockwise from top right: Radius Accelerator; TSI-020, designed by Novy Systems; and MacMemory TurboMax.

An accelerator board is an add-on device that increases the processing speed of a personal computer. Although the Macintosh Plus has no slots, you can add an accelerator board that attaches directly to the 68000 CPU. This allows another, faster CPU to take control of the system. The three boards examined for this review are MacMemory's TurboMax ($1499), Total Systems Integration's TSI-020 ($1095), and Radius Inc.'s Radius Accelerator ($995).

Accelerator boards use some combination of three basic strategies to increase the speed of the Macintosh. First, they can use a higher clock speed for the CPU than the 7.8 megahertz used in the Macintosh Plus. The boards under review operate at twice the speed of the Mac's CPU (15.6 MHz, which I'll round to 16 MHz for simplicity), thus doubling the effective speed of the machine. To fully utilize the increased speed of the processor, however, these boards must have their own on-board RAM, also running at 16 MHz.

The second strategy is to use a 68020 processor in place of the 68000. The primary advantage of the 68020 is that it has a 32-bit data bus; this lets it access data twice as fast as the 16-bit 68000. Again, this requires the use of 32-bit RAM, as the RAM in the Mac Plus is on a 16-bit bus. A variety of other improvements in the 68020 allow it to run nearly twice as fast as a 68000 at the same clock speed.

Last, accelerator boards may use a 68881 floating-point unit (FPU). The FPU dramatically increases the speed of handling floating-point computations. This makes the 68881 of great value to applications that use lots of floating-point computations, such as three-dimensional display computations, engineering and scientific applications, and large spreadsheets. However, it has almost no value for applications that don't use many floating-point computations, such as desktop publishing, word processing, telecommunications, and software development. For this review, all the accelerator boards had the optional FPU installed.

All the boards tested used some combination of these three approaches to improve the performance of the Macintosh Plus. The different techniques used by the boards' designers have given their creations different characteristics.

With a few exceptions, noted below, these generalizations apply to all the boards: They run at 16 MHz; they cannot be used in conjunction with other expansion boards; they offer a 68020 (except MacMemory's TurboMax, which uses a 68000) and an optional 68881; they require a fan; and the installations are reversible. All three accelerators use a Killy or Killy-type clip—a large plastic clip that snaps over the 68000 and passes the signals to pins on top of the clip—to connect their boards to the Mac Plus motherboard.

[Editor's note: *MacMemory and Radius require a dealer technician to install their accelerator boards. There are good reasons for this. First, you're exposed to high-voltage components inside the Mac when you install these boards. If you plan to do the job yourself, you must make sure the Mac's high-voltage power supply is properly discharged before attempting to install the accelerator board. Second, you can damage your Macintosh if the installation is done improperly. TSI also offers to install the board at no charge if you send your computer to the company. Note that the reviewer did successfully install and test all three boards, so the key point here is that extreme care must be used if you install one yourself. However, due to the risk to your computer, BYTE recommends that even a technically competent user should have a technician install the board.*]

The MacMemory TurboMax

The TurboMax accelerator from MacMemory is the only board in this group to use a 68000 CPU. It has a socket for a 16-MHz 68881, and the basic board comes

continued

Chris Crawford (5251 Sierra Rd., San Jose, CA 95132) is a freelance game designer whose published games include Patton versus Rommel, Balance of Power, and Trust and Betrayal. He can be contacted on BIX as "ccrawfor."

	TurboMax	TSI-020	Radius Accelerator
Type	Macintosh Plus accelerator board	Macintosh Plus accelerator board	Macintosh Plus accelerator board
Company	MacMemory Inc. 2480 North First St. San Jose, CA 95131 (800) 862-2636 In CA: (408) 922-0140	Total Systems Integration (TSI) 99 West 10th Ave., Suite 333 Eugene, OR 97401 (800) 874-2288 (503) 345-7395	Radius 404 East Plumeria Dr. San Jose, CA 95134 (408) 434-1010
Size	6½ inches by 8 inches	6 inches by 5 inches	8½ inches by 4 inches
Features	16-MHz 68000; 1.5 megabytes of RAM; recoverable RAM disk, print spooler DA, SCSI drive utility application; SCSI port; 12.5 watts; fan; support PROM; separate power supply; bracket for internal hard disk drive	16-MHz 68020; 1 megabyte of 32-bit RAM; RAM disk, DA and application to configure board or system; demonstration program; software to patch Microsoft FORTRAN and BASIC libraries; 2.2 watts	16-MHz 68020; 32K bytes of static RAM; 6 watts; fan; support PROM
Hardware Required	Macintosh Plus or 512KE	Macintosh Plus or 512E	Macintosh Plus
Software Required	System 3.2/Finder 5.3 or higher	System 3.2/Finder 5.3 or higher	System 3.2/Finder 5.3 or higher
Documentation	42-page *TurboMax Owner's Manual*; 28-page MaxRAM *MaxPrint* user manual for RAM disk and printer spooler	11-page *Installation and Operation Manual*	8-page *User's Manual*
Options	16-MHz 68881 FPU: $399 2-megabyte memory expansion: $899 40-megabyte internal hard disk drive: $1999	12-MHz 68881 FPU: $295 16-MHz 68881 FPU: $395 High-speed kit (to upgrade a 12-MHz board to 16 MHz): $125 Internal auxiliary power supply and fan: $129 Toolkit (includes case popper, Torx screwdriver, and wrist grounding strap): $21	
Price	$1499	12-MHz board, no RAM: $695 12-MHz board with 1 megabyte of 32-bit RAM: $975 12-MHz board with 4 megabytes of 32-bit RAM: $1895 16-MHz board, no RAM: $895 16-MHz board with 1 megabyte of 32-bit RAM: $1175 16-MHz board with 4 megabytes of 32-bit RAM: $2095	$995 With 68881 FPU: $1390
	Inquiry 886.	**Inquiry 887.**	**Inquiry 888.**

with 1.5 megabytes of 16-bit RAM and support PROM for a recoverable RAM disk. A rather loud fan is also provided with the board.

Although its performance cannot equal that of the 68020-based boards, the TurboMax provides a solution to the 68020 software-compatibility issue that's important to users wedded to particular applications; the most notable application in this area is MacWrite 4.5. However, with the introduction of the Macintosh II, most publishers with 68020-incompatible programs are scrambling to fix their products. Apple itself has released MacWrite version 4.6, which is 68020-compatible. There are also some problems with sound, but most of the vendors provide some sort of workaround in this area.

MacMemory insists that installation be done by an appropriately trained technician, but anyone with basic hardware skills can do the job. The toughest part is soldering a wire onto a transformer lug. However, the *Installation Manual*'s diagrams should provide more detail: It took several minutes of carefully scrutinizing the manual and the power supply to determine exactly where a voltage adjustment pot was located. The procedure described for discharging the CRT is incorrect and will damage the power-supply board.

This board is especially attractive to owners of 512KE Macs because it provides 1.5 megabytes of RAM, boosting total RAM size to 2 megabytes, and because it also provides a fast SCSI port. For $1499, you can upgrade a 512KE to the functional equivalent of a Macintosh Plus with an extra megabyte of RAM and twice the speed. The TurboMax is compatible with the Big Picture large-screen display from E-Machines Inc.

The TSI-020

The TSI-020 is designed by Novy Systems Inc., and the 12- and 16-MHz ver-

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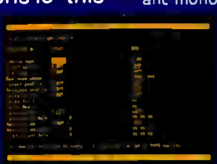

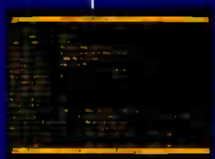

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Table 1: *The results of the C language benchmarks. The C benchmarks are described in "A Closer Look" by Richard Grehan in the September BYTE. Lightspeed C version 2.01 was used to compile the programs. All times are in seconds, except for the Dhrystone, which is in Dhrystones per second. Dhrystone version 1.1 was used for 50,000 iterations using no register variables. Due to technical problems, no results were obtained for the Savage benchmark with the Radius Accelerator.*

	Mac Plus	TurboMax	TSI-020	Radius
Dhrystone*	704	1724	2941	2777
Fibonacci	247	104	41	67
Float	136	29	24	28
Sieve	56	24	10	10
Savage	2183	53	44	N/A
Sort	89	38	20	20

*Higher figure denotes faster performance.

Table 2: *Write and Read show how long it takes to write and then read a 64K-byte sequential text file from a hard disk with no caching. Sieve runs one iteration of the Sieve of Eratosthenes. Calculations performs 10,000 multiplication and division operations. The Spreadsheet test recalculates a 25-by 25-cell Multiplan (1.02) spreadsheet. All times are in seconds. Tests on the Mac Plus were performed using System 3.2/Finder 5.3 and Microsoft BASIC version 2.1(b). SuperMac Technology's DataFrame XP20 hard disk drive was used for the disk tests.*

	Mac Plus	TurboMax	TSI-020	Radius
Write	15.3	9.0	7.1	7.0
Read	14.7	6.0	3.9	5.3
Sieve	83.0	37.0	22.3	22.2
Calculations	22.9	10.0	6.3	6.1
Spreadsheet Recalculate	8.1	4.20	2.60	2.60

Table 3: *Two real-world application benchmarks. For the Compile Program benchmark, a 6000-line Pascal source code was compiled using MPW version 1.0.1. For the Scroll Document benchmark, a 35-page MacWrite (version 4.5) document was scrolled through in page mode from beginning to end.*

	Mac Plus	TurboMax	TSI-020	Radius
Compile Program	398	207	144	177
Scroll Document	97	58	32	36

sions of the board are marketed by Total Systems Integration (TSI). This is a high-performance, no-frills board: In an area of less than 22 square inches, Novy has packed a 68020 processor, a socket for a 68881 FPU, a megabyte of 32-bit RAM, and all the necessary support logic. The benchmark tests clearly show this board to be the top performer of the group under review.

TSI offers the board at several speeds, RAM configurations, and prices. In addition to the 16-MHz board that I tested, the company also offers 20- and 24-MHz boards.

Installation is straightforward, the simplest of all the boards in the group: You clip a power-supply cord to two spots on the Mac's analog board, clip the accelerator board over the 68000 CPU, and you're set. However, the spots to attach the power-supply cable are located far back on the analog board, and it's virtually impossible to connect them without touching a high-voltage component. Be absolutely sure that no high voltages remain in the video circuitry before installing the power cable.

The system does not come with a fan; TSI offers a power supply and fan only as an option. A fan is, however, absolutely necessary. As an experiment, I used the board for two days in cool weather with only a flapper fan; my power-supply board overheated and had to be replaced. So, although no fan is provided with the board, you should not operate the accelerator board without a fan in place.

TSI includes a disk of utilities that give you quite a bit of control over the operation of the board. Using either a desk accessory or a standard applications program, you can specify six attributes of the operation of the board: enable/disable the 68020 instruction cache; disable/enable the FPU; use 68020-compatible AppleTalk; use 68020-compatible sound drivers; intercept the MacWrite 4.5 traps; and disable the motherboard's 16-bit RAM. Another option lets you copy the ROM into the fast 32-bit RAM to speed up system operation. When 68000 compatibility is absolutely essential, you can disable the accelerator board and use the native Macintosh Plus CPU by depressing the interrupt button on the Mac's programmer switch when you boot the computer.

This is the best board of the group. It offers the fastest performance, the greatest control over its functions, and a good price.

The Radius Accelerator

The Radius Accelerator offers a 68020 CPU, a socket for the 68881, and support PROM that allows MacWrite 4.5 to operate. The major difference between this board and the others is that it provides only a 32K-byte 32-bit RAM cache. Thus, the 16-MHz 32-bit 68020 spends some of its time sitting around waiting for 8-MHz, 16-bit RAM. However, the performance impact of such a small cache is offset by its fast zero-wait-state RAM.

The benchmarks show that the Radius Accelerator performed quite well in comparison to the TSI-020. However, these comparisons should be weighed carefully. Most benchmark tests are small programs that run quite well in the tiny 32K-byte cache. On the larger, more demanding real-world applications, the Radius Accelerator fell behind the TSI-020.

Installing the Radius Accelerator is essentially no more difficult than installing any of the other boards, but Radius, like MacMemory, insists that it be carried out by a trained technician with Apple-Level-One certification. The instructions are vague about how to orient the boards during installation, and there are very few diagrams to help clarify areas of confusion. Perhaps this is why Radius insists that trained technicians perform the installation.

The Radius Accelerator comes with a fan, quieter than MacMemory's. This is the lowest-priced board of the group. Its cost-to-performance ratio is excellent, but if your primary use of the board would be with large programs (e.g., for software development), you should take careful note of its poorer performance with such applications.

The Benchmarks

I used three groups of benchmark tests on these boards. The first group is a set of six standard BYTE benchmark programs used to compare the performance of 68020 systems (see table 1). These programs were compiled using Lightspeed C version 2.01. Note that this version of the Lightspeed C compiler does not produce code optimized for the 68020, nor does it access the 68881; this was a deliberate decision on my part. While it is true that such optimized code would run faster, it is equally true that, for the next few years, few users will have access to programs using such optimized codes.

The second group of benchmark tests is part of the standard set of BASIC programs that BYTE uses to compare the performance of new computer systems (see table 2). For purposes of uniformity with previous BYTE reviews, I used Microsoft Multiplan 1.02, but this created a minor flaw in the test. Multiplan does not use Apple's SANE package for calculating floating-point numbers, and the SANE package provides the software traps used to activate the 68881 FPU. Thus, this benchmark does not reflect the performance that the 68881 provides. Users of Microsoft Excel or other spreadsheets that use the FPU should experience much more dramatic improvements in performance in all the boards equipped with a 68881.

The third group of benchmark tests is comprised of two real-world applications-intensive tests (see table 3). Most benchmark tests deliberately single out a component of system performance and test that component in isolation from other system components. If, for example, the hard disk drive creates most of the delays in a typical situation, then quadrupling the speed of the processor (as some of these boards do) will not quadruple overall system performance. My intention with this third set of benchmarks was to test the performance of the boards in situations closer to what a user might experience. These two tests, while neither rigorous nor replicable by others, at least suggest the actual performance improvement that you would get with these boards.

The first applications test is for programmers. I carried out a complete recompilation of a large program (about 6000 lines of Pascal code) using the MPW version 1.0.1. Programmers will be happy to note the approximately 200 percent reduction in compilation times. The second applications test is for writers. I loaded a 35-page MacWrite document and timed how long it took to page-scroll (a screen at a time, as opposed to a line at a time) from the beginning to the end of the document.

The tests were carried out with an otherwise standard Macintosh Plus using a DataFrame 20XP hard disk drive, System 3.2, and Finder 5.3.

What Price Performance?

Accelerator boards are worthwhile. The benchmark results indicate dramatic improvements in performance, and there were other benefits as well, many too tiny to quantify. Windows snap open briskly; multiple windows are easier to use; the process of redrawing a window is much faster. When quitting an application, the Finder returns with startling speed.

For a cost between $995 and $1499, these boards turn a Macintosh Plus into a machine whose speed comes close to or exceeds that of a Macintosh II. There are other issues to consider, of course: future expandability, software compatibility, the introduction of a fan, the hazards of installation, and so forth. But on the fundamental question of speed, there can be no doubt: These boards yield improvements of 200 percent to 400 percent in most applications. The choice of whether or not to add an accelerator board, and whose to add, is up to you. ■

VIEWS FROM BIX: MAC ACCELERATOR BOARDS

macintosh/prod.discussn #779, from David Betz.

I kind of like the Radius board's approach of providing a fast cache instead of on-board memory. It lets you access the slow 16-bit memory as if it were fast memory. Are there known problems with the Radius board?

macintosh/prod.discussn #780, from Larry Loeb, comment to 779.

I've got to investigate that cache more. I've had funny crashes happen (specifically with RedRyder 10's beta...) and I'm not sure why everything freezes. But freeze it does.

macintosh/prod.discussn #781, from David Betz, comment to 780.

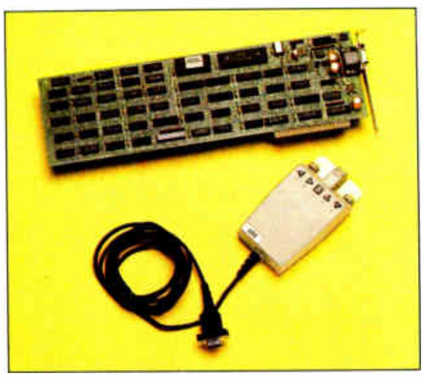
I had lots of problems when I had the Radius board installed in my SE, but I figured it was due to RedRyder version 9.4. It doesn't seem to work well with *any* of the '020 boards.

macintosh/prod.discussn #782, from Chris Crawford, comment to 779.

It only allows you to access the slow 16-bit RAM as if it were fast RAM on multiple passes. If your program code and data fit into 32K bytes, you're fine, but if you're using more RAM than that, the cache starts to lose its utility. For really big applications, like MPW, its utility is really diminished.

Saba Handscan

John McCormick



The Saba Handscan is a hand-held OCR (optical character recognition) scanner that reads a line at a time and transmits it for incorporation into applications programs such as word processors, databases, and spreadsheets. It is available for the IBM PC, XT, AT, or compatibles (or for the IBM PS/2 Model 30) with 512K bytes of RAM (640K bytes recommended), two floppy disk drives (a hard disk drive is recommended), a full-length expansion slot, and MS-DOS 2.1 or higher. At $649, the Handscan is better

continued

Saba Handscan

Type
Hand-held OCR scanner

Company
Saba Technologies
9300 Southwest Gemini Dr.
Beaverton, OR 97005
(800) 654-5274
(503) 641-8520 (in Oregon)

Size
Scanning unit: 3 by 5 by 1⅜ inches
Expansion board: 13 by 1⅞ by ⅞ inches

Features
Hand-held unit with scan button and four programmable function keys; interface card; seven 5¼-inch floppy disks, not copy-protected, including proprietary software for character recognition, a substitution table, and fonts

Hardware Required
IBM PC, XT, AT or compatible, or IBM PS/2 Model 30; 512K bytes of RAM (640K bytes recommended); two floppy disk drives or one floppy disk drive and one hard disk drive (recommended); one full-length expansion slot

Software Required
MS-DOS 2.1 or higher

Documentation
212-page spiral-bound manual with several foldout pages

Price
$649

Inquiry 889.

suited for some office applications than larger flatbed and sheet-feed scanners that cost thousands of dollars.

The Mouse That Reads

The Handscan is a mouse-like input device with five buttons: a square scan button in the middle, and a set of two triangular function keys on either side. The function keys are programmable; you can assign one to insert carriage returns, one for tabs, one for erasing cells from a spreadsheet, and so on. These keys are arranged facing in different directions, so you can tell them apart by touch.

The unit has an illumination source and a scanner head with a two-position plastic lens, which you can switch for standard or small type. The lighted image is reflected from a front-surface mirror to the surface of a photodiode, which senses the light and dark areas. The Handscan digitizes this information and sends it over an 8-foot cord to a full-size expansion board that you insert into your computer. The Handscan software then uses pattern matching to determine the characters being scanned.

A Fistful of Fonts

Handscan comes with seven floppy disks, which include the proprietary software that does the actual character recognition. However, the biggest part of the software package—six disks—consists of fonts. Saba claims that the unit recognizes over 200 fonts from several dozen popular printers. Handscan uses samples of these fonts in its pattern matching, and Saba recommends that you have a hard disk to store them on.

Installing the software on a hard disk is easy, but it takes a bit of time because you must select from a menu the general kind of fonts to be scanned (daisy-wheel or dot-matrix) and then the specific fonts to be stored on the hard disk. After you make your selections, the software prompts you to insert the correct combination of font disks. The software automatically copies the selected fonts.

The software is installed as a memory-resident program that takes up 147K bytes of RAM. You hit a hot-key combination, and the unit is ready to scan. Another RAM-resident program, which takes up an additional 53K bytes, lets you turn on and off such Handscan options as audible alarms and numbers-only mode.

Using the Handscan software as a memory-resident program lets you insert scanned data directly into documents, worksheets, and so on, though its sizeable memory requirement may be a problem if you use other memory-resident programs or a large applications program. You can also use the Handscan to enter data or commands at the DOS prompt.

I used version 2.0 of the Handscan software and experienced no problems with it during this review.

Scanning by Hand

Setting up the Handscan is also easy, thanks to a 212-page spiral-bound manual with clear installation instructions, an adequate index, a small glossary, a good troubleshooting guide, and a two-page quick-start section in the front.

Attached to the front of the Handscan is a clear plastic guide with a horizontal line. The line should pass through the center of a line of characters for proper recognition. With that in mind, using the Handscan is very simple. You place the scanner head on a blank area to the left of the line of text or numbers to be scanned and press the square scan button. Then you guide the scanner across the line while keeping the guideline as close to the center of the text as possible. Since the guide wheels on the bottom of the scanner move only in the same direction as the text, this is not too difficult, but it requires careful attention to the line being scanned.

Even if you fail to keep the text exactly centered, however, it poses little or no problem for the Handscan, which often scanned for me with 100 percent accuracy even when the guideline wandered from the top of the characters to the bottom of the line as I moved the unit. When you come to the end of the information you wish to scan, you release the scan button and then reposition the scanner head at the next line to be scanned.

When you use Handscan with databases, spreadsheets, or word processors, the scanned text starts appearing at the cursor location, so inserting text into most programs is very simple. The unit worked successfully with the programs I tried, including Microsoft Word 3.1, WordPerfect 4.1, WordStar 3.31, Lotus 1-2-3 version 2.0, and dBASE III Plus 1.1.

The Handscan software features a substitution table that lets you substitute any scanned character for another. For example, commas in numbers can be dropped as the numbers are entered into spreadsheet cells. This feature plus the programmable function keys let you enter information from specific sections of a document in just the format your application needs, without having to take your hand from the Handscan.

Although I tried other fonts, I found that Courier 10 (a very common type font) would let me scan most of the documents I came across while testing the unit.

How Fast Can It Scan?

The benchmark tests that I conducted for the review "Text Scanners for the IBM PC" in the April BYTE are not fully applicable to the Handscan, which is meant to scan only one line at a time. (The time to move to the next scan line is entirely up to the human operator.)

However, using a Tandy 1200 operating at 4.77 MHz with 640K bytes of RAM and a 10-megabyte hard disk drive (the same machine used for the benchmark tests in the April review), I was able to achieve a maximum speed of about 370 characters per minute with the Handscan. Again, this is not an achievable full-page rate because you must reposition the scanner by hand before each scan.

To evaluate the error rate, I scanned a freshly printed test sheet printed by a

Tandy DWP-510 daisy-wheel printer with Courier 10 font and consisting of 2430 uppercase and lowercase letters and the special characters !@#$%^&*(). Scanning the entire test sheet took 6:01 (minutes: seconds) with 52 errors. Twenty of these errors were a substitution of the number 0 for the letter O, 20 more were the substitution of the number 1 for the letter l, and the rest were mostly omitted special characters.

Except for the 1 and 0 substitutions, the errors varied depending on how fast and how accurately I moved the scanner. Thus, the accuracy can be improved with practice or by slightly slowing down the scanning rate.

For comparison, the $5695 CompuScan PCS 230 read the test page in 1:16 with seven errors, while the $1800 Canon IX-12 took 2:30 with 114 errors (mostly case and special-character errors).

A Handy Scanner

The Handscan is not intended for (nor very good at) full-page scanning, but it really shines when used for its intended purpose: scanning small blocks or lines of data produced in a standard font such as Courier 10 and entering them into IBM PC applications programs.

You can use the Handscan to scan items like invoices or shipping labels, no matter where the text or numbers are located on different forms. With a full-page scanner, scanning letters, mailing labels, or invoices requires extensive software manipulation to select just the desired information in the proper sequence for entry into databases.

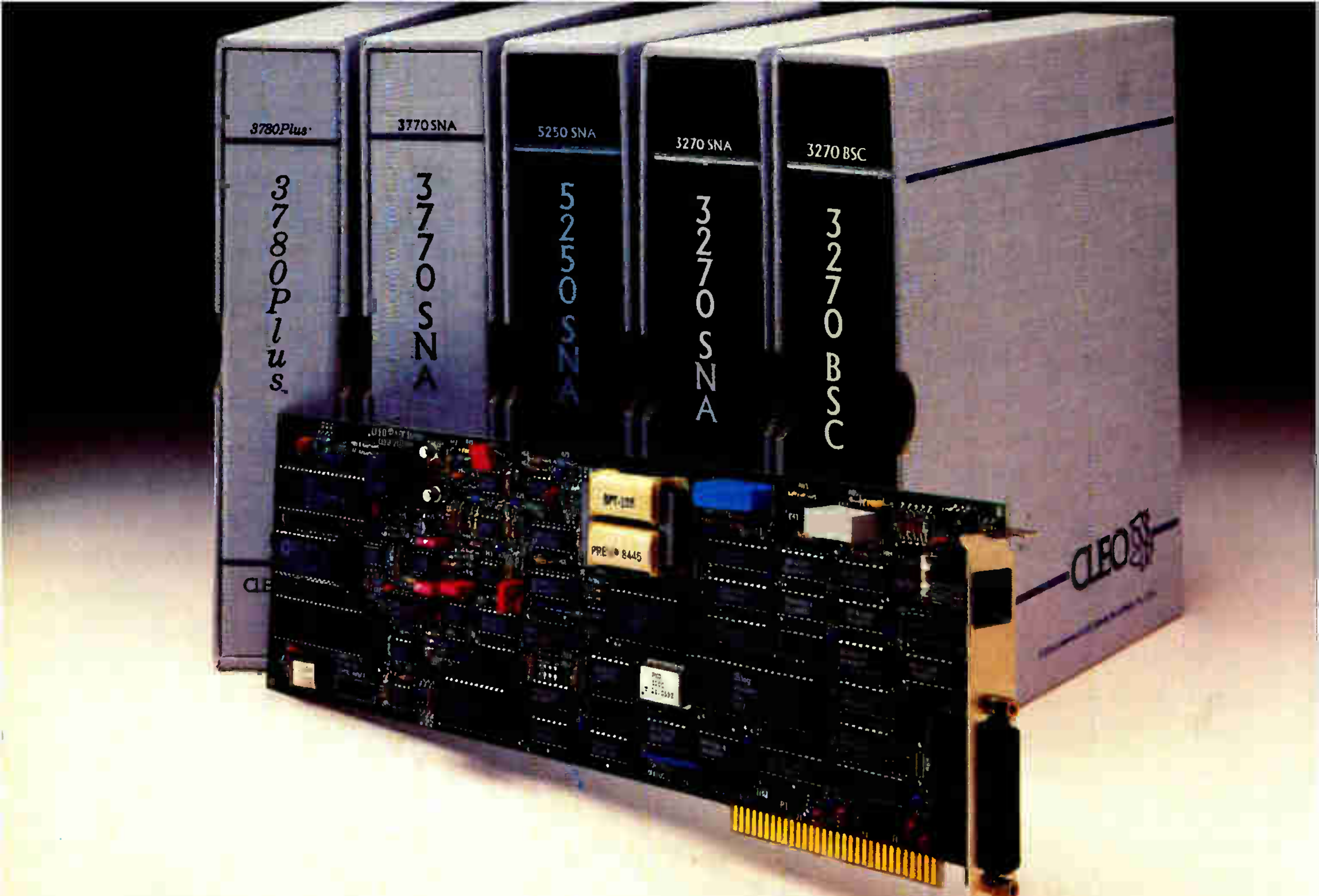
Small, irregular, or flimsy documents will jam sheet feeders, but they don't faze the Handscan.

Finally, invoices and other forms almost always contain vertical and horizontal lines that can cause OCR recognition problems for many scanners, but the Handscan operator can just skip over these portions of the document.

For example, I could scan addresses from a wide variety of randomly selected business letters. Although I occasionally had to rescan one or more lines, the Handscan and its OCR software were able to deal with a wide range of typewriter fonts, even though I had set the scanner to read only Courier 10.

Since this sort of document scanning is a requirement for many businesses, and since the Handscan is inexpensive compared to any other OCR machine, it is a cost-effective product that will be useful in many offices. ■

John McCormick (RD #1, Box 99, Mahaffey, PA 15757) is a freelance writer and computer consultant.



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Three PC-based Desktop-Publishing Programs

James Cavuoto

A trio of packages with a range of prices, features, and philosophies

Aldus Corp.'s PageMaker 1.0 ($695), Xerox's Ventura Publisher 1.1 ($895), and Digital Research's GEM Desktop Publisher 1.0 ($395) are desktop-publishing programs for IBM PC-DOS graphics environments. Each has the capability to produce documents that incorporate text files from a word processor and graphic images from bit-mapped or object-oriented graphics programs. The programs can output documents on many different laser and dot-matrix printers using typeset-style fonts, multiple-column layouts, and other design attributes of professional publications.

All these programs make use of a graphics environment; PageMaker runs under Microsoft Windows, and Ventura Publisher and GEM Publisher use Digital Research's GEM. But all are available with run-time versions of the operating environment for users who prefer to run their programs from the DOS command line.

PageMaker requires an AT-class machine (primarily because Microsoft Windows 1.03 places heavy demands on processor time and disk access), while the two GEM-based products run acceptably on an XT-class computer. You'll also need 512K bytes of RAM and a graphics display adapter such as the Hercules, EGA, or CGA cards. Each program also supports a number of full-page displays, such as the Wyse WY-700, Conographic 2800, and Moniterm Viking. A mouse or other pointing device, although technically not required, is practically essential for even the most casual user.

I tested the programs on an 8-megahertz PC's Limited AT clone with 1 megabyte of RAM, a 30-megabyte hard disk drive, a Conographic ConoVision 2800 graphics card (which also emulates Hercules Graphics), and a JLaser card with 2 megabytes of additional memory.

PageMaker

Aldus PageMaker has a somewhat different approach toward desktop publishing than the other two packages. Ventura Publisher and GEM Desktop Publisher take a document-oriented approach to page layout; PageMaker, however, exploits a page-oriented layout scheme that gives you control over the placement and orientation of each element on each page of a document. This highly interactive approach to page layout works well for newsletters, brochures, advertisements, and other publications that require high-quality graphics and that have pages of differing formats.

You begin by specifying a page size; the program supports letter, legal, tabloid (11 by 17 inches), European, and custom paper size up to 17 by 22 inches. Document setup also includes the orientation (landscape or portrait), page margins, and number of pages. Once this is set up, PageMaker displays the page (or portion of a page) currently being worked on, a toolbox, sliders for scrolling, and page-number icons.

You can go to any page by pointing at the appropriately numbered icon. You can also go to one of two master pages, for left- and right-hand document pages. Anything you place on the right master page will appear on every odd-numbered page of your document; elements on the left master page will appear on each even-numbered page. This feature is useful for placing headers, footers, logos, page numbers, and other recurring elements.

Other features of the PageMaker screen include graduated horizontal and vertical rules in several units of measurement (e.g., inches, millimeters, and picas), dotted lines that indicate the currently active column guides, and user-customizable guide rules that can be placed anywhere on the page to aid alignment. PageMaker offers several views of the page, including a full-page reduced view, and 50 percent, 75 percent, actual size, and 200 percent enlargement. You can also select a facing-page option, which lets you work with two side-by-side pages at a time.

Once you have set up the number and placement of columns, you can begin placing text on any page by importing text files produced with WordStar, Microsoft Word, MultiMate, WordPerfect, XyWrite, and Windows Write or standard text files in ASCII or DCA (Document Content Architecture) format. When importing text, PageMaker recognizes and retains certain formats, such as first-line indent, left and right indents, tabs (but not expanded tabs), and type specifications such as font, point size, line spacing, and character weight, to the extent the word processor supports these features. PageMaker ignores page-oriented formatting commands such as right margins, headers, footers, and page numbers.

When importing text, PageMaker presents a list box with eligible files in the current directory. You select a file, position the cursor within one of the columns on the page, and click the mouse. The text flows into the column, conforming to the left and right column guides currently in effect, and lines are broken according to the hyphenation rules you request.

If the file is too large or too small for the column, you can stretch or shrink the column or place the overflow in another, linked column. When a text block is adjusted, text flow is readjusted among all linked text blocks.

You can edit text with the internal text editor, which has a variety of keyboard shortcuts to make text editing easy; it is limited, however, and lengthy blocks of

continued

James Cavuoto (21150 Hawthorne Blvd., Suite 104, Torrance, CA 90503) is editor and publisher of microPublishing Report, *a desktop-publishing industry newsletter.*

	Aldus PageMaker 1.0	Xerox Ventura Publisher 1.1	GEM Desktop Publisher 1.0
Type	Desktop-publishing software	Desktop-publishing software	Desktop-publishing software
Company	Aldus Corp. 411 First St. S, Suite 200 Seattle, WA 98104 (206) 622-5500	Xerox Corp. P.O. Box 24 Rochester, NY 14692 (800) 832-6979	Digital Research Inc. Box DRI Monterey, CA 93942 (408) 649-3896
Format	Five 5¼-inch floppy disks; also available on 3½-inch floppy disks	Eleven 5¼-inch floppy disks	Two 5¼-inch or one 3½-inch floppy disk; five 5¼-inch or three 3½-inch disks for GEM Desktop
Computer	IBM AT or compatible with at least 512K bytes of RAM and a hard disk drive; Microsoft Windows-compatible graphics display; mouse	IBM XT, AT, or compatible with at least 512K bytes of RAM and a hard disk drive; graphics display adapter; mouse	IBM PC, XT, AT, or compatible or IBM PS/2 with at least 512K bytes of RAM; a hard disk drive (recommended); GEM-compatible graphics display adapter; mouse
Software Required	Microsoft Windows version 1.03 (run-time version provided)	DOS 2.1 or higher	DOS 2.1 or higher; GEM Desktop version 2.2 (bundled with program)
Documentation	148-page reference manual; 310-page user's manual; quick-reference guide	516-page reference manual; 262-page training guide and workbook; quick-reference manual	184-page user's manual
Price	$695	$895	$395
	Inquiry 893.	**Inquiry 894.**	**Inquiry 895.**

text are more efficiently produced with a fully featured word processor.

PageMaker's typographic tools are extremely flexible. For any selected portion of text, you can specify the type of justification (left, center, or right), the tightness of the word spacing, and the use of kerning (the amount of white space between certain letter pairs, such as AV). You can also manually kern two letters closer to or farther away from each other.

The program's hyphenation capability is among the best in the business; it relies on an internal dictionary that holds the preferred hyphenation points of nearly every word in the English language. You can override any of PageMaker's hyphenation decisions, however, or instruct the program to inform you before it breaks a word.

PageMaker Graphics

You place graphic images on a PageMaker page in much the same manner as you place text. PageMaker can import graphic images from AutoCAD, Windows Paint and Draw, Lotus 1-2-3, Symphony, PC Paintbrush, PC Paint, and In a Vision. It also supports images stored in EPS (encapsulated PostScript) or TIFF (Tag Image File) format. As a result, you can incorporate professional-quality black-and-white photographs into your PageMaker documents, although the final appearance of those photos will depend on the output device you use. Since the TIFF format can handle graphic images with multiple shades of gray, a photograph output by PageMaker on a high-resolution device can look every bit as good as the photos in Time, Newsweek, or BYTE.

PageMaker's graphics functions include tools for drawing lines, rectangles, circles, and ellipses. A wide variety of rule weights, borders, and fill patterns is also available. You can choose from among three types of double rules, one triple rule, five types of broken rules, eight different thicknesses of single rules, and a reverse (white on black) rule. You can also specify the degree of roundness of the corners in rounded rectangles.

Although you cannot edit graphic images once you've placed them on a page, you can crop and scale them by using either the pointer tool or the cropper to drag on one of eight handles in the window border around the graphic. Both proportional scaling (where the *x* and *y* axes are scaled equally) and anamorphic (or distorted) scaling are supported.

PageMaker accommodates documents up to 128 pages long, but creating such a document would be time-consuming because of the program's page-by-page orientation. Also, as mentioned earlier, the program's reliance on Microsoft Windows makes it somewhat sluggish—it can often take several seconds to redraw the screen after editing an image or turning the page.

Aside from this, PageMaker's performance is very good. Menu options, keyboard shortcuts, and mouse actions are all very logical and easy to learn. Output speed is quite acceptable, ranging from a few seconds to a minute or so per typical page. Installation, though somewhat time-consuming, is relatively straightforward.

PageMaker supports any output device that runs under Windows, including Hewlett-Packard's LaserJet, the Apple LaserWriter, and many others. A PageMaker document is in effect tied to the printer when the document is created. If you change the target printer, you must usually reformat the document.

PageMaker's documentation package is excellent in all respects, particularly in its design. The 310-page user's manual presents a very well thought-out tutorial and discusses general guidelines for desktop publishing, such as how to plan a publication, the flow of work, making the most of a word processor, and "back-end" processes such as dealing with an offset printer or high-speed duplicator. The user's manual is peppered with insightful tips and instructive design examples. The reference manual is more formal, and it goes into sufficient detail about each menu option and advanced feature.

Ventura Publisher

While PageMaker excels at giving you free rein over every individual element on every page of the document, Ventura Publisher excels at producing lengthy publications whose page structure varies little throughout a document. You establish rules for the placement and positioning of text; Ventura then follows them automatically, breaking lines and columns and formatting text elements according to your rules.

Each Ventura Publisher document represents a composite of several files, including text, graphics, and style sheets. Document files do not hold text or graphics. Rather, they hold pointers to the DOS files holding text, graphics, and styles.

This strategy has two implications. First, the format of a document is not cast in stone; you can create an entirely different document by merely calling out a different style sheet. Second, updating a publication is simple; any time you edit the text file used by a document (with an external word processor), you automatically update the document as well.

Ventura offers you three views of the page: reduced view, which shows a mock-up of the entire page, normal (100 percent) view, and enlarged (200 percent) view. A facing-pages option, similar to PageMaker's, is also available. Sliders for scrolling are present on the right and bottom of the screen. Ventura offers a toolbox with four icons for the four modes of the program: frame mode, paragraph-tagging mode, text-editing mode, and graphics-drawing mode. An assignment list below the toolbox shows the available files, paragraph styles, or character-formatting options, depending on the mode you're in.

Although Ventura Publisher is based on the GEM operating environment, Xerox has taken great pains to distance its product from GEM; it uses the GEM environment, but not the actual GEM desktop. The GEM utilities operate behind the scenes, so most users need not even know they are in GEM.

As with PageMaker, you begin the layout process in Ventura Publisher by specifying the default margins and number of columns used on each page. This default page structure is called the *underlying page*. If you wish, you can set up different underlying pages for left- and right-hand pages.

You can place text and graphics on the underlying page so that it flows automatically from page to page until it is all used up; you might want to do this with a 64-page book chapter. You can also construct rectangular frames that hold text and graphics on top of the underlying page. In this case, text stops flowing when it reaches the bottom of the frame, allowing you to continue placement in another frame on the same or a following page. This approach is useful for newsletters or newspapers that have multiple articles on each page. If a graphics frame or a portion of a frame blocks text flow, text jumps over or around the occlusion (a feature not found in PageMaker).

Frames and their contents can be inserted, moved, copied to another location, or deleted; Ventura will instantaneously repaginate the entire document if necessary.

As with PageMaker's Windows environment, Ventura Publisher's GEM environment provides list boxes from which you select a file, file filter, or subdirectory from the DOS tree structure.

Ventura Publisher can import text files from WordStar, Microsoft Word, MultiMate, WordPerfect, XyWrite, and Xerox Writer. Plain ASCII files are also supported, as are DCA-format text files. You can also create or edit text within Ventura Publisher, but this function is limited, and it is more useful for making small corrections or adding captions than for heavy-duty word processing.

Doing It with Style Sheets

The most worthwhile feature of Ventura Publisher is its support of style sheets—preformed templates that describe the look of a document. Each style sheet consists of as many as 128 paragraph tags that apply to different portions of text, such as headlines, body text, or captions. Each tag contains several attributes, such as font choice, point size, column width, justification, and spacing. Rules and boxes of varying weights can be automatically associated with any tag. You apply a tag to a paragraph (or to multiple paragraphs) of text by selecting the paragraph and then pointing to one of the available tags in a style sheet. The text immediately takes on the attributes assigned to the tag.

You can change specifications for an existing tag by simply selecting new specifications from a menu. All the portions of text in the document that have that tag name, including text portions that are not on the screen, immediately conform to the change. You can also load a different style sheet to an existing document; this causes the document to reformat itself according to the specifications in the new style sheet.

The layout and pagination functions in Ventura Publisher are the best I've seen in any microcomputer product. A full page of text normally flows in a fraction of a second on an AT or a few seconds on an XT. For the user's standpoint, an entire 100-page document can be paginated in as little time as it takes to flow a single page, since Ventura performs text flow for pages not on-screen in the background during idle time.

Ventura Graphics

You can place graphics into Ventura Publisher with equal simplicity and speed: You point to the frame, point to the graphic file, and voilà. Once you've placed a graphic in a frame, you can crop, scale, or pan it.

The program supports images created with PC Paintbrush, GEM Paint, GEM Draw, Lotus 1-2-3, AutoCAD, Mentor Graphics, and Video Show. Ventura also supports numerous standard graphics formats, including Hewlett-Packard Graphics Language, GSS's Computer Graphics Metafile, Macintosh Paint and PICT formats, and encapsulated PostScript. Scanners supported include Microtek, Dest, Datacopy, Hewlett-Packard, Advanced Vision Research, and compatible vendors. Unfortunately, Ventura does not support the TIFF format, so producing professional-quality photographs is not as easy as with PageMaker (although it can be done).

Ventura Publisher's built-in graphics functions let you create lines, boxes, shades, and circles, though not quite as easily as with PageMaker's graphics toolbox. For example, you can't constrain the line-drawing tool to make drawing vertical or horizontal lines easier.

Ventura Publisher supports several features that are useful in a technical publishing environment, such as automatic numbering of sections, figures, tables, and footnotes; automatic generation of indexes and tables of contents; captions anchored to figures (above, below, left, or right); leader dots in tabs; and running headers and footers with variables for page number, chapter number, and paragraph tags.

Ventura Publisher allows documents of over 150 pages on computers with 640K bytes of memory, and a binding function lets you assemble several individual documents (chapters) into a very large publication. Ventura automatically renumbers pages and recreates the index and table of contents to reflect the sequence of chapters in the publication, and it can perform batch printing of the entire publication.

Multifaceted Output

Ventura Publisher currently supports PostScript, Interpress, Hewlett-Packard LaserJet Plus, Xerox 4045, and Cordata laser printers, as well as laser printers that use the JLaser card, and the Xerox 4020 color ink-jet printer. Dot-matrix printers are also supported but are not recommended because of their lack of

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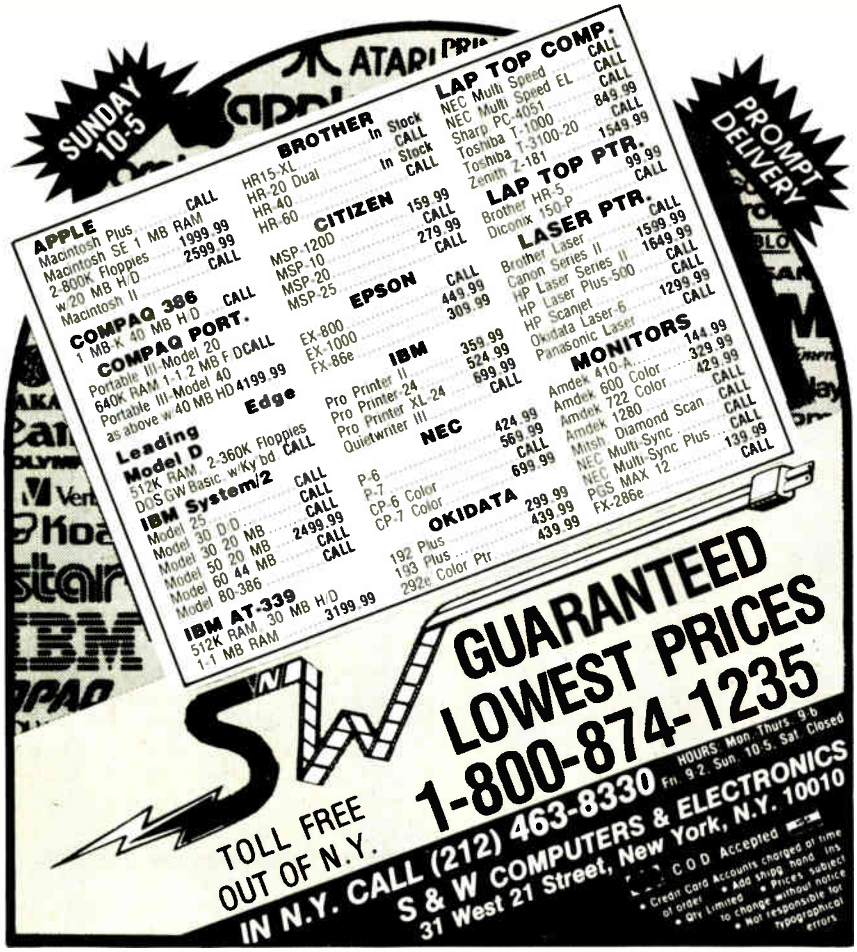

speed. Nearly any font and any point size available on the selected output device can be used with Ventura Publisher, and you don't have to reformat a document if you change the output device—a notable advantage over PageMaker.

Ventura Publisher is a very well thought-out product, as evidenced by a host of seemingly minor features, such as letting you remove interparagraph spacing or extra leading when it falls at the top of a column, letting you mix and match different units of measurement, and remembering user preferences in various option boxes.

However, the strength of Ventura Publisher—its powerful style sheets—can also be a problem. The sheer number of typographic and ruling options associated with each tag can be bewildering to a novice. Moreover, beginning users may not realize that a seemingly innocuous and localized change to type specifications will wreak havoc on other documents. Changing the attributes of a given tag in one location not only changes the attributes of all the other similarly named tags in the current document, but it also changes the way previous documents using the same style sheet will look the next time you open them. Since Ventura chapter files do not contain absolute specifications but rather point to a style-sheet file, existing documents on disk take on a rather volatile nature.

Ventura Publisher's documentation is also less helpful than PageMaker's. The reference manual is skimpy in several of the more complicated areas of the program's operation, such as the multi-chapter batch operation. The training guide and workbook does a creditable job of getting the beginning user up to speed, but neither manual is designed as well as the PageMaker documentation. A spiral-bound quick reference, however, is well-produced and quite handy.

GEM Desktop Publisher

GEM Desktop Publisher has many things in common with Ventura Publisher, not the least of which is its use of the GEM environment. But in most respects, the Digital Research product falls far short of Ventura's capabilities; it even appears more complex in some aspects.

As with Ventura, the layout process consists of creating rectangular frames on pages, selecting a text file from the disk, and selecting a style sheet. There is no underlying page in GEM Desktop Publisher; you must place rectangles on the page to hold text and graphics.

The program accepts text files from WordStar, WordPerfect, MultiMate, and GEM Write, as well as ASCII- and DCA-

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format files. GEM Publisher requires these text files to have certain file extensions, such as .TXT for ASCII and .STR for WordStar, so you must remember to rename your text files accordingly before starting GEM Publisher.

If you make updates and style-sheet assignments within GEM Publisher, the program does not update the original text file. Instead, it creates a copy of each imported text file, giving it the extension .ASC, and this copy holds the revised text and formatting information. If you want to edit this file outside of GEM Desktop Publisher, you must use your text editor or word processor in ASCII mode only, without adding any non-GEM formatting codes.

With GEM Desktop Publisher, your documents can be up to 100 pages long. To create a document, you draw a rectangle on the first page, load in a text file, and format the body text and other text elements (e.g., headings and subheads) by creating new styles—the equivalent of Ventura Publisher's tags. You can vary character attributes such as type style and size, paragraph attributes such as spacing and indents, and tab settings.

GEM Publisher's style sheets lack most of the powerful formatting options of Ventura Publisher. For example, they do not let you associate ruling lines with paragraph styles. They lack the flexible page-, line-, and column-break features that help make Ventura documents a snap to produce. Also absent are the automatic special effects, such as bullets and large first characters. And you cannot specify that a heading extend across multiple columns, as you can in Ventura; instead, you must create a separate rectangle to hold the heading.

The typographic features of GEM Publisher are also very limited compared to PageMaker and Ventura Publisher. The most glaring omission is the lack of automatic hyphenation; this tends to make printed columns appear too loose when they're fully justified. The program provides no control over kerning or letter spacing, although you can vary the line spacing. Choice of fonts is also limited to two basic families, Dutch and Swiss, in a handful of sizes.

Graphics are placed on the page in a manner similar to both PageMaker and Ventura, but the only graphics formats supported are DRI's .IMG (for pixel-oriented) and GEM-format (for object-oriented) graphics. Graphics can be cropped or scaled but not both; if you want to use only a portion of an image, you must use the image at 100 percent of its original size.

Installing GEM Publisher is time-consuming. The program itself takes only about 10 minutes, but you must first in-

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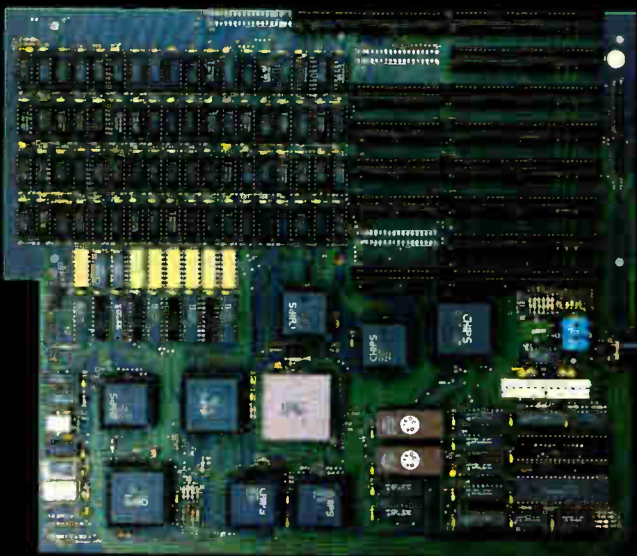

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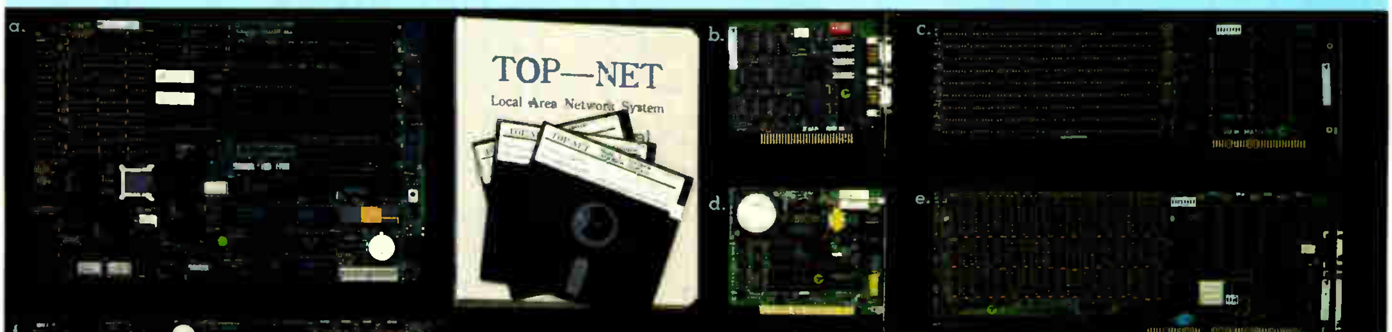

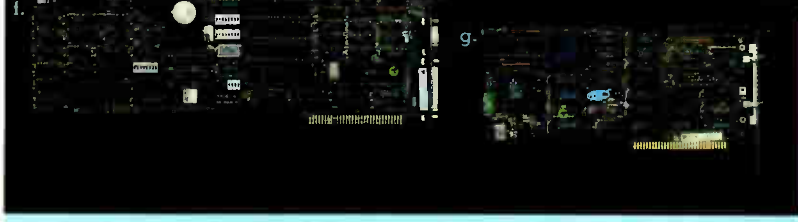

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stall the GEM Desktop on your system; this involves studying a second manual and sifting through a second set of last-minute additions, error-correction sheets, warnings, and read-me-first files.

GEM Desktop Publisher supports only a half-dozen printers, although additional device drivers are available from Digital Research for a small fee. When you go to print a document, GEM Publisher creates another separate type of file, and you must exit the program and switch to a separate GEM output program.

The program's documentation does not cater to the novice user. The single tutorial chapter is inadequate, leaving the reader with no clear idea of how to create a variety of business documents. GEM Publisher comes with only a few sample documents and gives little advice on how to use them as templates.

GEM Publisher has some worthwhile features. It offers a host of keyboard shortcuts for editing text, scrolling the screen in one of four directions, and accessing most menu options. You can also customize these keyboard commands to your own tastes. A `Show Position` command puts measurements on-screen as you draw rectangles. An invisible text grid forces subheads and body text to align across page and column boundaries. As with Ventura Publisher, text that you add to a document containing a graphic will flow around the graphic.

If you already own GEM Write, GEM Draw Plus, or GEM Graph, you might consider GEM Desktop Publisher as a way to add rudimentary page layout to your integrated system. Other users will find that it doesn't fit in well with serious business applications.

Which One Is for You?

PageMaker is a very good buy if you need an easy-to-use product that can produce top-notch designs. It is particularly appropriate for newsletter editors and professionals who have had previous experience with graphic design.

For advanced desktop-publishing users, the features and on-screen performance of Ventura Publisher would be hard to find anywhere else. This product will probably occupy the top spot in high-performance desktop publishing for some time to come.

Digital Research is touting GEM Publisher as an easy-to-use alternative to Xerox's Ventura Publisher. Ventura is indeed more complex; it has far more features and therefore far more menu choices and commands. But provided that an expert has created the style sheet beforehand, novice users will actually find Ventura easier to load and use than GEM Desktop Publisher. ■

VIEWS FROM BIX: DESKTOP PUBLISHING

desktop.pub/reviews #2, from Ira Emus.

You *can* draw straight lines with Ventura Publisher's line-drawing tool, although it is not obvious how. It involves using the Grid Settings option in the Graphics menu. I, too, wish Ventura had better graphics, but, with enough thought, you can make Ventura Publisher do almost anything.

Ventura Publisher still seems to have some problems, but it gives me the ability to format manuals at around 100 pages per hour, after style-sheet development and given decent text files.

desktop.pub/reviews #3, from Larry Chandler.

Just last week I upgraded from GEM Desktop Publisher to Ventura Publisher. I like GEM DP and use it every day for line drawing, word charts, and graphs, as well as a desktop, but I needed such things as the automatic table of contents and index features that Ventura offers.

As an aside, I moved a GEM DP file to Ventura and found that most of my tags and in-text format codes copied with no errors. They must use a similar tagging format. GEM has only two typefaces (fonts) unless you pay extra for a font maker, while the Ventura package gives you 42 for PostScript.

desktop.pub/reviews #4, from Steve Rindsberg.

I have used Ventura (original and current versions) to produce several newsletters and other documents. In my limited experience, Ventura does a grand job of printing on my Apple LaserWriter what will later come out of the typesetter, though I've been stung several times: While PageMaker lets me know when my text is too long for the area I'm putting it into, Ventura simply tosses my extra text off into the ozone without so much as a by-your-leave.

However, Ventura was a delight when I upgraded from version 1.0 to 1.1: $35 bought a definitely improved program, new disks, and a new manual. That's *very* fair pricing.

I use Ventura Publisher on two machines, one with an EGA and another with a Hercules card. The EGA is definitely the way to go. Layouts on the Hercules are best done with the rulers. Scaling by eye (even rough-ins) is a fairly extensive waste of time; everything on-screen is considerably taller than it will appear in print.

FastCAD 1.10

by Phillip Robinson

FastCAD 1.10 from Evolution Computing is a direct competitor of AutoCAD and VersaCAD in the high end of the CAD market for the IBM PC and compatibles. It is a bit less expensive—just under $2300, while versions of the others sell for about $2500 to $2850—and is significantly faster, particularly in regenerating a drawing display and in zooming operations that produce new views of the drawing.

Part of the reason for its speed is that FastCAD was written entirely in assembly language by a single programmer; AutoCAD and VersaCAD were written largely in compiled languages by teams of programmers. This assembly language base also yields compact files: FastCAD can run on just two floppy disk drives, while AutoCAD and VersaCAD require systems with a hard disk drive.

I found FastCAD easier to learn than either of the market-leading CAD packages; the program provides a choice of typed commands, on-screen icons for some operations, and pull-down menus. It does not offer the full wealth of features, such as three-dimensional capabilities, that the more established programs offer, but updates are coming quickly and regularly (version 1.03 appeared in May, and 1.10 appeared in August), and these continue to add to FastCAD's already impressive list of skills.

Hardware Requirements and Installation

FastCAD comes on four disks, a slim library for a CAD program, and you need only two of them to get started. The program works with an IBM PC, XT, AT, or compatible (including 386-based compatibles) with at least 512K bytes of RAM and two floppy disk drives. It also requires an 8087, 80287, or 80387 math coprocessor chip, unlike some other CAD programs that only recommend such a chip. FastCAD's repertoire of drivers for display adapters, graphics input devices, and printers and plotters covers most of the popular I/O devices.

I tested FastCAD on a variety of systems, but the primary machine that I used was an ITT XTRA 286/ATW (an AT clone) running at 10 megahertz under DOS 3.1. The computer contained 640K bytes of RAM, an EGA-compatible graphics adapter, and an 80287-10 coprocessor. I also used a Logitech C-7 Mouse (the low-power CMOS version) and an Apple LaserWriter Plus printer (for quick PostScript plots). For comparison, I ran AutoCAD on the same machine.

The only problem I encountered with this particular hardware configuration was that ITT's EGA emulator card caused FastCAD's text screen to blank; that is, when I flipped from the graphics display of FastCAD to the listing or plotting display, the screen went blank. The system didn't crash—I could perform the regular operations and could return to the graphics display—but I couldn't see what I was doing. The same blank screen popped up again when I was leaving FastCAD.

According to the technical-support staff at Evolution, this problem is caused by a missing statement in the firmware of some EGA emulator cards manufactured in Taiwan. I could not verify the exact cause, but I had no problem with FastCAD on other EGA emulator cards, including the one that came in my TeleVideo TeleCAT 286 and a couple of EGA clone boards that bore no name.

Version 1.10 of FastCAD comes with two different installation disks, one for 8086/8088 systems and the other for 80286/80386 systems. The latter, according to the company, takes advantage of the newer instructions to add 10 to 15 percent more drawing speed, particularly for spline curves. The batch commands for installation make it easy to set up floppy or hard disk drive systems, and the necessary program files occupy less than 150K bytes. In fact, the main .EXE file is only 103K bytes; drivers and configuration files take up the rest of the required memory. The batch commands also cut installation time to less than 15 minutes.

Easy-to-Use Interface

Evolution Computing also makes a program called EasyCAD, a $169.95 entry-level CAD program touted for its simplicity and clarity. Although FastCAD is significantly more powerful than EasyCAD, it tries to retain that easy-to-learn level.

When you first start the program, you'll wait less than 3 seconds to see the main display, a drawing area surrounded by menus and icons. At the bottom is a command line where you can enter commands or numeric responses to prompts. At the top is a line of pull-down menu titles. On the left is a column of 16 color boxes, representing the color choices in the program, and on the right is a column of icons for zooming, windowing, and other frequent operations.

You can perform an operation by typing it on the command line, by using the mouse to reach the command within a pull-down menu, or by clicking on the icon that represents the operation. One confusing aspect of FastCAD is that, in some cases, the typed command differs from the menu name of the command. For example, the text equivalent for the copy menu's `CIRC ARRAY` (circular array) is `CARY`.

The icons let you zoom in, out, to the drawing's extents, and in on a selected region, and they let you reset the drawing center. They allow you to choose the working layer (FastCAD offers 255 possible layers, but only 32 are represented within the icon) and the line styles (from 16 possibilities) and cross-hatching styles (64 possibilities). These choices appear as Macintosh-style dialog boxes.

Windowing icons let you size, move, select, add, and eliminate windows. FastCAD offers both a `Grid` command (for which you can set the size) and a `Snap` command (which you can also tailor), and there are icons to toggle each on and off. Help is available from the question-mark icon, and a Values icon lets you choose some miscellaneous options such as viewing the frame of a spline and selecting absolute, relative, or polar tracking when drawing.

FastCAD can display four windows at once on the same two-dimensional drawing. Each window can be independently zoomed and positioned within the full image, and you can even draw from one window to another, an unusual and very handy feature. The windows cannot overlap, but you can size them and position them however you wish.

Powerful Commands

FastCAD has a hefty complement of file commands, beginning with the regular save and load drawing commands and extending to running DOS commands from inside the program, compressing drawing files, and installing new menus and scripts (this is explained later). The `Plot` command lets you select magnification factor, drawing scale, and which view to plot. (FastCAD lets you save seven particular center-position and zoom-level views of a drawing; you can jump to any of these views with a single command.) You can also save the current drawing as a pattern file; it can then be used as a template for other drawings.

The viewing commands include some of the same zooms you find in the icons, plus `Zoom Last` (to the previous view) and `Pan` (by selecting a displacement of the drawing). This same menu lets you show all layers or hide all but the current working layer. It also includes the Redraw command, which regenerates the entire display from the base file.

FastCAD drawings are stored as descriptions of a collection of objects with floating-point number values for their sizes and positions. This aids in generating almost endless levels of zoom for FastCAD. By using assembly language for speed, FastCAD can recreate an entire display from this fundamental information in a matter of seconds.

AutoCAD, on the other hand, keeps both the base file and an intermediate file, called the 32K file, which represents the drawing as a special bit collection. This 32K file has more detail than can be shown on most displays and thus must be manipulated again to produce a final screen image. AutoCAD contains both Redraw and Regen commands. Redraw just goes back to the 32K file and updates it to the screen; Regen, which corresponds directly to the Redraw command in FastCAD, goes all the way to the base file to update the display. FastCAD's Redraw command clocks in with times similar to AutoCAD's Redraw, even though it is actually doing the work of AutoCAD's Regen.

To compare actual drawing times, I transferred five drawings between AutoCAD and FastCAD. (Two of the drawings are the well-known Nozzle and Shuttle that are supplied with AutoCAD.) The results, shown in table 1, indicate that FastCAD can regenerate a drawing about as fast as (and in some cases faster than) AutoCAD can update the display from its 32K file using its Redraw command. My tests also show that FastCAD's drawing regeneration is 3½ to 9 times faster than AutoCAD's, depending on the drawing.

For drawing, FastCAD offers the standard retinue of point, line, circle, arc, text, box, polygon, and spline, along with filleting, chamfering, and arrows. Many of these constructs also offer you a variety of creative paths. For example, arcs can be built from Center, Radius, Start, and End Angle; Center, Start Point, and End Angle; or three points. When drawing any object, you can use the digitizer to enter points, or you can type coordinates (including relative and absolute) on the command line. I found the arrows more difficult to work with than in some other CAD programs. Unlike other CAD programs, FastCAD does not let you simply add arrowheads to plain lines. Instead, you must select the arrowed line, which is handled as a separate entity.

When you specify the points to measure, FastCAD can enter horizontal, vertical, parallel, or angular dimensions to your drawing and can dynamically update those dimensions when the drawing changes. It can also measure distances, areas, and bearings. Text can be modified for its height, angle, font, spacing, and justification. The color menu column on the left of the screen lets you change colors at any time.

A special menu of drawing-modifier commands lets you accurately refer to exact points on existing objects within a drawing. You can align to vertical reference points, horizontals, centers, midpoints, endpoints, and so on. Here's where the power lies for professional, accurate drawing. The menu items, however, are not self-explanatory; some, in fact, such as EPT for endpoint and INT for intersection, are cryptic, although the manual provides adequate explanations.

You can also copy objects, either one at a time or by making circular-array or repeat-array copies of them. You can group objects, ungroup them, or turn them into stored parts for later use.

Editing commands include erase, move, scale, rotate, connect, mirror, break, bend, trim, stretch, polygon edit, origin, fill, front, change, and list. Listing flips you to the text display for a complete breakdown of the base file on an object. The editing commands let you select objects for action in a variety of ways. You can choose by a surrounding window, by layer, by type, or by color, or you can choose each or all objects in a drawing. You can also choose the same option as for your last operation: For most FastCAD operations, immediate repeat use is allowed without recourse to the menus.

Once you select objects, you can combine the selections with secondary selections through Boolean operations such as And, Or, and Not, all through a dialog box. For example, you could select all blue objects and then specify only objects that aren't text for a change to yellow.

Macros, Menus, and Scripts

FastCAD offers a variety of ways to customize and extend the power of the original program. All FastCAD operations are text commands applied to the base file. By using FastCAD macros, you can change the names of commands or even place several commands under a single heading. A simple example in the FastCAD manual suggests that you could use the regular polygon command as rpoly 4 and assign it to the macro square to create that as a new command.

Because the pull-down menus in FastCAD are also stored as ASCII text files, you can add these new commands to the current menus or create your own menus just by using a text editor outside of FastCAD. Scripts, text files of FastCAD commands along with parameters (responses to command prompts), can be loaded and run to set up a drawing environment or to automate repetitive tasks. Because the FastCAD commands include flow-control and delay statements, the macros and scripts are essentially a programming language that can be used to create drawing slide shows and to enhance FastCAD's power.

Where there is not yet any IGES (Initial Graphics Exchange Specification) output from FastCAD, the program is accompanied by separate translation programs for moving FastCAD's drawing files to AutoCAD data-transfer format (DXF) and vice versa (as well as for interchanging files with EasyCAD). The translations are not perfect, which you'll soon see if you draw something in AutoCAD, export it to DXF, translate the DXF to a FastCAD file, and then read it into FastCAD. Text will change its justification and position, some complex ob-

continued

FastCAD 1.10

Type
Computer-aided-design program

Company
Evolution Computing
437 South 48th St., Suite 106
Tempe, AZ 85281
(602) 967-8633

Format
Four 5¼-inch floppy disks; not copy-protected; also available on 3½-inch floppy disks

Language
Assembly language

Computer
IBM PC, XT, AT, or compatible (including 386-based AT compatibles) with at least 512K bytes of RAM, two floppy disk drives, an 8087/80287/80387 coprocessor, a graphics display adapter, a graphics input device (such as a mouse, tablet, or digitizer), and a plotter or graphics printer

Software Required
DOS 2.0 or higher

Documentation
500-page loose-leaf binder

Price
$2295

Inquiry 896.

Table 1: *The drawings were done on a 10-MHz AT-compatible computer with an 80287-10 coprocessor. FastCAD's* Redraw *command is the equivalent of AutoCAD's* Regen *command. All times are in seconds.*

Drawing	FastCAD 1.10	AutoCAD 2.6	
	Redraw	Regen	Redraw
Nozzle	2.2	9.6	1.8
Shuttle	1.5	5.2	1.2
Stair	1.2	5.9	1.4
Pump	1.0	5.9	1.3
Tablet	6.0	54.4	9.0

jects will be disintegrated into simpler objects, and so forth. The same thing happens when moving files in the other direction. This is common in PC-based CAD, demonstrating that the weakness is not in the FastCAD translators specifically, but in the interchange standards. However, Evolution Computing says it is working on IGES support.

Drawing Conclusions

FastCAD lacks some important features, such as three-dimensional abilities (which Evolution says it's working on), attached report generators like VersaCAD's Bill of Materials, and external but related programs such as AutoShade. It doesn't have protection for visible layers, nor are its modifier commands as easy to understand as the snap and drawing-control commands of the other CAD packages. It also doesn't offer some of the little enhancements, like the ability to create and modify hatch patterns; and although its icons are a nice feature, other programs can simulate them through the use of tablet overlays. Finally, because it is a newcomer, FastCAD doesn't have a throng of third-party developers extending and enhancing the main program.

In FastCAD's favor are the lucid interface, scripts and macros, multiple windows with drawing between views, powerful Boolean selection principles for editing, its small size (which lets you keep some RAM-resident utilities, unlike more memory-hungry programs), and, most of all, its speed. In addition, Evolution offers free technical support over the phone for registered users. If you want to squeeze every bit of speed out of your machine, if you find AutoCAD intimidating, or if you don't need the specialized add-ons offered for AutoCAD and other more established contenders, then FastCAD is right for you. ■

Phillip Robinson is a contributing editor for BYTE and an editor of Desktop Engineering News *and* The Architect's PC. *He can be reached at* Desktop Engineering News, *P.O. Box 40180, Berkeley, CA 94704, or on BIX as "robinson."*

Carbon Copy Plus

Rusel DeMaria

Carbon Copy Plus 4.0 from Meridian Technology is a comprehensive telecommunications software package. The most complex feature of the $195 program is its ability to give one computer access to, or even control of, another computer running the same package. Carbon Copy Plus also includes a terminal-emulation program, a highly adaptive script language for automated log-ons, and support for the Kermit and XMODEM file-transfer protocols.

File transfer, terminal emulation, and automatic log-on capabilities are fairly common telecommunications features. Master/slave remote control is not, so I'll list some of its uses.

Suppose your computer at work has a 40-megabyte hard disk drive and a large financial-modeling spreadsheet, and your home computer has only a floppy disk drive and a printer. Using Carbon Copy Plus, you can call up your work computer from your home and have it run the spreadsheet application. The program's screen output goes through the phone lines to your home computer's screen, and printer output can go to your home printer.

Another important use of remote-control software is for software and system support. By linking with and controlling a distant customer's installation, a software developer or consultant can make necessary changes or updates to a client's system. The consultant can also tutor the client in the use of the software, since the host computer's keyboard and screen remain active during the remote access. Carbon Copy Plus even allows direct communication between the remote and host operators in a "chat window" or by phone if the modem hookup allows it.

You can also use Carbon Copy Plus to control remote power-on devices, such as Dynatech's Turn-On.

For remote-control operations, you need two copies of the Carbon Copy Plus package. You can't simply copy the programs and share them, because the two computers have to be running packages with different serial numbers. (You need only one copy of the program to use the terminal-emulation feature.) Both computers must have at least 256K bytes of RAM, a floppy disk drive, and a Hayes-compatible modem (unless they are to be hard-wired). The program requires MS-DOS or PC-DOS version 2.0 or higher.

Remote-Access System

Carbon Copy Plus's remote-access package contains a master module, called CCHELP.EXE, and a slave module, called CC.EXE. The slave module runs on a host computer and allows a remote computer to gain control of the host computer. CCHELP.EXE runs on the remote computer; it lets a remote operator run programs on the host through a transparent interaction with the host's slave program. The remote operator can also communicate with the host computer operator.

You can run the master module as either a 145K-byte memory-resident program or an ordinary application, depending on a command-line parameter setting. CCHELP.EXE has a number of convenience features to ease the use of the remote-control capability, including a customized phone directory with point and dial capabilities (you specify a number by moving the cursor to it); a built-in password table; an optional session log; printer spooling and redirection (to local, remote, or both systems); and screen capture.

Other setting options include redial delay, number of redial attempts, answer/ring count, reboot on exit from a Carbon Copy Plus session, call-back (which hangs up and then calls a specified number at the start of a session), and number of password

continued

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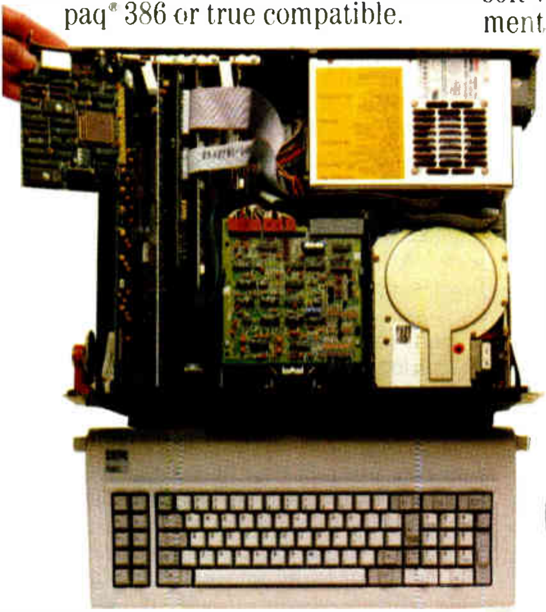

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Carbon Copy Plus 4.0

Type
PC-to-PC communications, remote-control, terminal-emulation, and file-transfer program

Company
Meridian Technology Inc.
7 Corporate Park, Suite 100
Irvine, CA 92714
(714) 261-1199

Format
One 5¼-inch or 3½-inch floppy disk; not copy-protected, but serial-number-protected

Computer
IBM PC, XT, AT, or full compatible with at least 256K bytes of RAM, at least one floppy disk drive, and a Hayes-compatible modem

Software Required
MS-DOS or PC-DOS 2.0 or higher

Language
Assembly language

Documentation
150-page owner's manual

Price
$195 per copy; requires two copies for remote control

Inquiry 897.

attempts allowed before disconnection. (Note that many of these values must also be stored in advance in the slave computer's Carbon Copy Plus files.)

The slave module operates as a 44K-byte memory-resident program. An incoming call activates the program's slave mode, in which keyboard input comes from the remote computer and screen output is transmitted to the remote user. A user-defined hot-key sequence activates the program's pop-up menu, used for configuring the program (e.g., setting limits on remote access and setting up passwords).

Because Carbon Copy Plus supports graphics (CGA now; EGA in version 4.1, which was due from Meridian in November) and passwords, the slave computer must know the graphics capabilities and passwords that the remote computer uses. You specify this information with a configuration utility.

Not So Fast, Master

Although Carbon Copy Plus works very well, a word of warning is in order: When you use Carbon Copy Plus to run applications remotely, all data flow takes place at 1200 bits per second, 2400 bps, or whatever rate your modems can handle. Programs that do a lot of screen output—especially graphics—are necessarily sluggish under these conditions; 5 to 10 seconds is typical for a color graphics screen using 1200-bps communications. Animated screens are unlikely to produce pleasing results at this speed.

Recognizing that this bottleneck can be annoying, especially when you're not interested in the full graphics images, Carbon Copy Plus has two solutions. One method turns off the full graphics synchronization, so that the slave computer can continue its processing while the graphics image is being sent to and drawn on the master computer; this makes a slight improvement. Another option simply reduces the amount of graphics data being sent: Every other pixel is blanked, cutting the transmission time approximately in half.

Terminal Emulation

Carbon Copy Plus's terminal emulation features a point-and-dial directory with automatic script execution (e.g., for log-ons), automatic calling from a DOS command, and XMODEM and Kermit file transfers (including batch transfers). It also provides six forms of terminal emulation: DEC VT-100 and VT-52, TeleVideo TVI-920, IBM 3101, TTY (standard ASCII communications), and a special mode called Monitor, in which incoming control codes are represented on the screen as displayable character sequences. A carriage return, for instance, is displayed as `^M`, meaning Control-M.

Carbon Copy Plus's terminal emulation is adequate for day-to-day telecommunication needs. It works well with bulletin board systems like BIX, MCI Mail, GEnie, and CompuServe. The script language—generally compatible with DCA's Crosstalk XVI scripts—offers a versatile means of controlling communications sessions, automatic log-ons, user inputs, and scripts that execute commands at specified times. It features `IF ...THEN` conditionals, keyboard inputs, complete control of communications parameters, and more. In all, 55 commands are supported, and most of them have multiple parameters.

Installation and Use

Installing Carbon Copy Plus involves several steps, including making a working copy, initializing that copy, and then copying the resultant files to a hard disk (if desired). After that, you set the various communications parameters, call tables, password tables, and other options through the menu-driven installation program (which is available at any time for further modifications).

It is important that you follow the installation steps carefully as outlined in the manual; the meaning of many of the switch settings and options is not obvious, and you need the explanations in the manual to set them correctly. The entire installation process took me about 15 minutes for each computer.

The documentation is thorough, although at times it assumes too much on the part of the reader. In addition, it is not well-organized. The manual is divided into two separate sections, each of which has its own index and table of contents. This can be confusing and makes it difficult to cross-reference between related features in the remote-access and terminal-emulation sections.

I tested version 4.0 of Carbon Copy Plus using an IBM PC AT with 640K bytes of RAM, an Intel Above Board 2-megabyte memory-expansion card, a 30-megabyte hard disk drive, and a US-Robotics Courier 2400 external modem. To test the package's master/slave capabilities, I used a second 640K-byte IBM PC AT with a CORE 72-megabyte hard disk drive, an AST RAMpage card, and a Hayes 1200 external modem.

In the remote-control tests, I used Lotus 1-2-3, GRASP (a presentation graphics package from Paul Mace Software, Ashland OR), and the Leading Edge Word Processor version 3.2, among other packages. All the packages worked properly under remote control, subject to the constraints imposed by telecommunications speeds.

Typically, you initiate Carbon Copy Plus remote sessions from the remote computer using `CCHELP`. Once the connection is established, the host computer automatically prompts the remote user for a password and then attempts to locate the password in its internal password table. If the password is valid, the host computer goes into slave mode, giving the remote computer master access to the system. Alternatively, you can set up the system to call back a prestored number once the password has been checked; this gives an extra measure of security.

Once the session is established, the remote user has complete control of the host system, although that control can be limited in various ways through the password tables: Access levels include full access to DOS commands; no DOS command access; and access to DOS in the current directory only, but with no file deletion or renaming.

During a remote-control session, printer output can be directed to either or both systems; thus, programs can print files from one computer to a printer at-

continued

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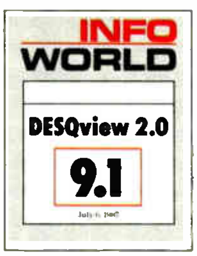

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Quarterdeck Office Systems • 150 Pico Boulevard, Santa Monica, CA 90405 • (213) 392-9851 tached to another computer. To save connect time, printer redirection can work in conjunction with print spooling. In addition, a complete log of the Carbon Copy Plus session can be toggled on and off.

Smoothing Over the Rough Spots

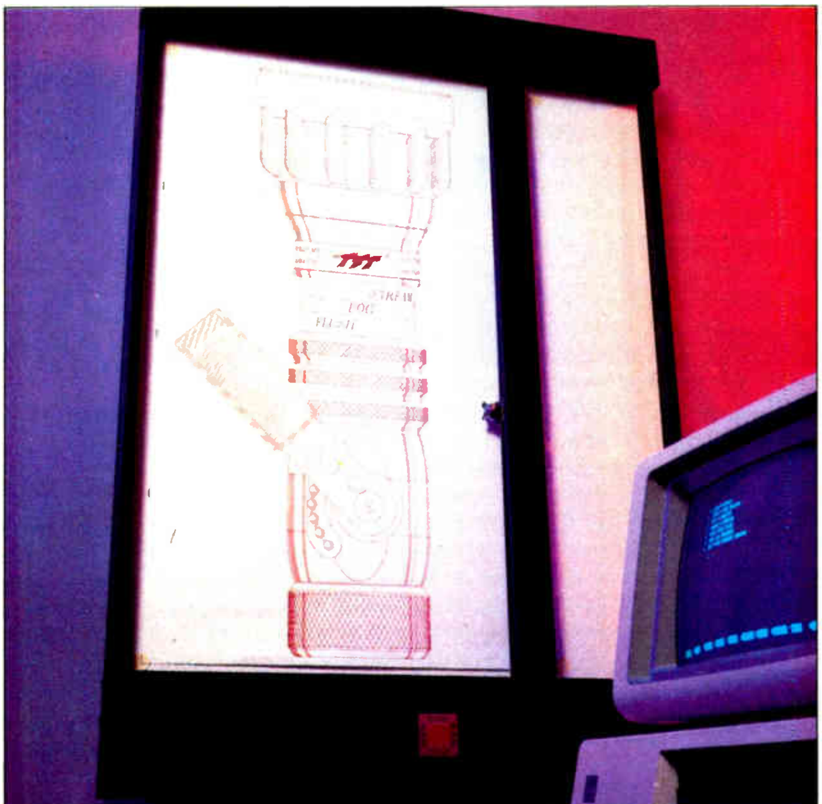
Remote-control software can be confusing, simply because applications aren't written with the needs of a remote user in mind. Carbon Copy Plus does a good job of smoothing over the difficulties with features like the chat mode, DOS command access, passwords, printer redirection, and the graphics speedup options. The inclusion of a terminal-emulation package with file-transfer capabilities makes Carbon Copy Plus a very broad-range telecommunications system.

I would recommend Carbon Copy Plus if you're looking for a comprehensive telecommunications system; on the other hand, if you already have satisfactory terminal-emulation and file-transfer software, or if you don't need them, you might be satisfied with one of the packages that are restricted to remote control, such as Norton-Lambert's Close-Up. ■

ACKNOWLEDGMENT

I would like to thank George R. Fontaine for his valuable contributions to this review.

Rusel DeMaria is a freelance writer and author of the soon-to-be-published Public-Domain Software: Untapped Resources for the Business User *(Redwood City, CA: M&C Publishing). He can be contacted at 109 Akea Place, Kula, HI 96790.*



VIEWS FROM BIX: CARBON COPY PLUS

telecomm.pgms/reviews #2, from Barry Nance.

Carbon Copy Plus supports a great number of modems besides Hayes-compatible modems (see the full screen list that it presents when you run CCINSTALL). It definitely works well with Hayes modems, but the support is there for several other types. Just this morning I used Carbon Copy Plus on an Anchor Automation Lightning 2400; the client site was using a Codex modem.

One more thought: using CCINSTALL on the fly (between invocations of CCHELP) to change communication parameters is really fairly quick.

telecomm.pgms/reviews #3, from Steve Moshier.

I wonder if Carbon Copy Plus is any better than the host mode in ProComm—that seems to work fine except for programs that want to write directly to the video RAM instead of using the BIOS.

telecomm.pgms/reviews #4, from Barry Nance.

Yep. Carbon Copy Plus is better than any regular communications program's host mode; it's specially designed to take care of "direct-to-screen" applications. It uses a fairly intelligent protocol (that only it understands, of course) to establish a rapport between the two PCs, so that everything that happens on one machine is echoed exactly on the other.

One of the nice features of this protocol (that you really appreciate at 1200 bps and even at 2400 bps) is that Carbon Copy Plus performs compression on the screen data as it's being transmitted. For example, if an application puts four rows of blanks on the screen, with a blue background, the material that gets transmitted across the line consists of a single blue blank along with a repeat factor. Nice design.

32-bit memory board, upgradeable to 13 MB using SIMM modules ensures your investment in future operating systems and applications without requiring additional slots.

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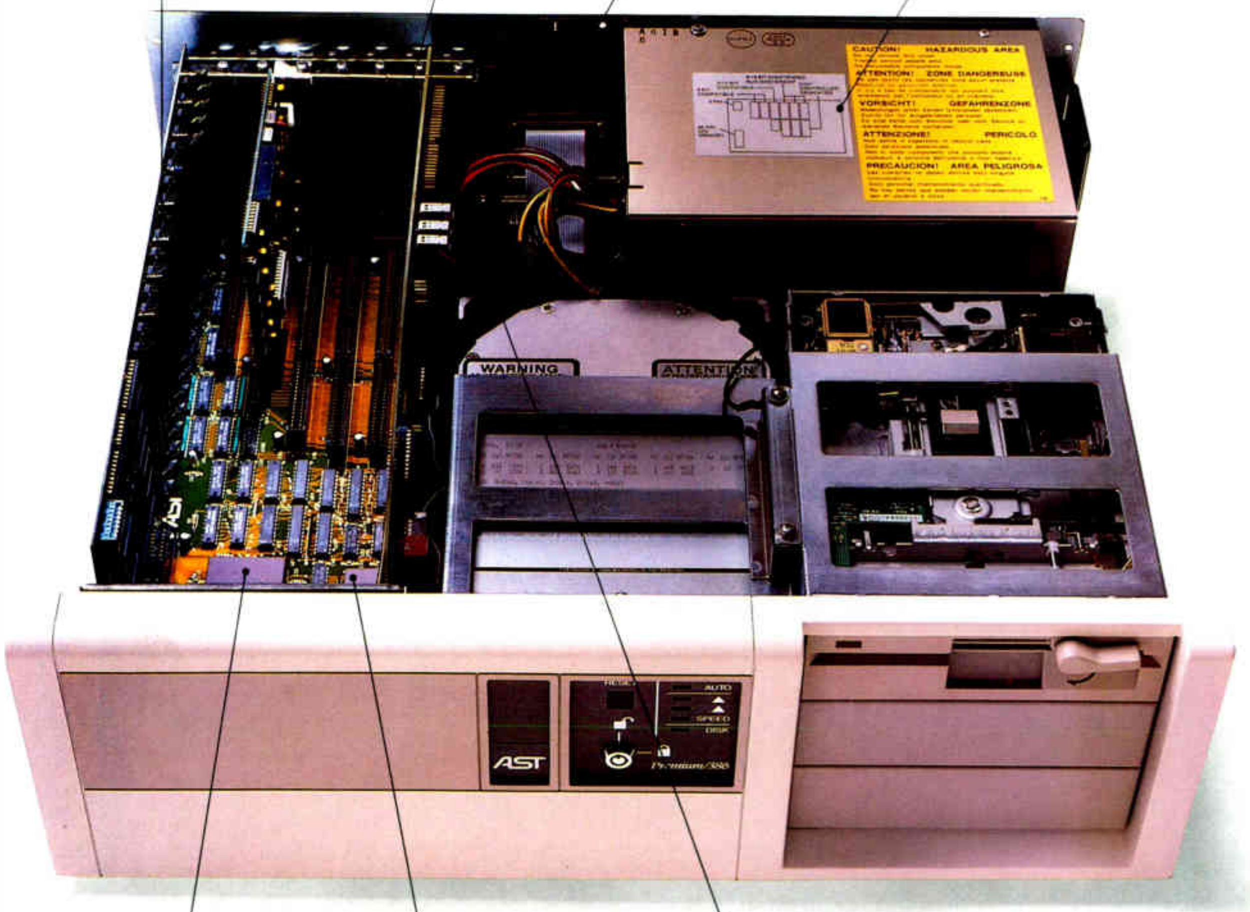

20 MHz, 80386 processor for high performance, AT-compatible desktop computing.

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High-speed ESDI Bus Master Disk Controller enhances the performance of the AST Premium/386. Offers users one of the highest performing 80386-based, AT-compatible desktop systems available.

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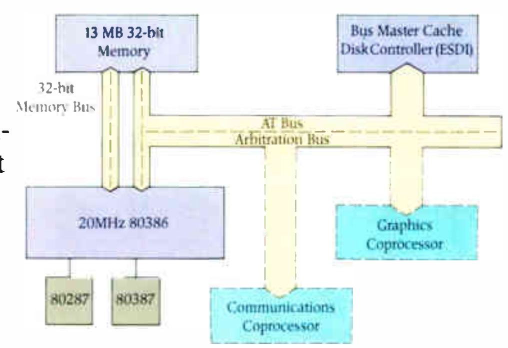
AST Premium/386 Architecture



AST's Multimaster Bus technology allows direct access to main memory for faster overall system throughput.

Bus Master Disk Controller. AST's Bus Master Disk Controller actually supervises the transfer of data from its memory across the bus to the system memory without involvement of the CPU or motherboard DMA devices.

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The same compatibility is true with hardware. AST Premium/386 operates with your current multifunction and data communications cards, as well as newer, more powerful board-level peripherals designed for AST's Multimaster Bus. The savings add up when you consider all of the existing software programs, enhancement boards, drives, monitors and keyboards you already own.

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*According to IMS America Ltd's National Computer Retail Report, a monthly audit (for the month ending May 31, 1987) of computer specialty stores in the U.S. The report tracks purchases by those resellers. Published in Computer Reseller News August 17, 1987.

Marshal Pascal and Pascal-2

Mark Bridger

Pascal compilers for the IBM PC that compete directly with Turbo Pascal

Although many professional programmers have turned to C as their coding language, interest in Pascal has remained high. This is due in part to its nearly universal acceptance in high schools and colleges as a teaching language for structured programming. Unfortunately, the specifications for Pascal ignore many of the features needed for commercial or even recreational programming, and compiler writers often add these enhancements in nonstandard ways, leading to incompatibilities between different versions.

Marshal Pascal ($189) from Marshal Language Systems and Pascal-2 ($395) from Oregon Software attempt to thread a careful path: to preserve the simplicity of standard Pascal while judiciously adding enhancements. These implementations compete directly with Turbo Pascal version 3.0 ($99.95) from Borland International. (Borland's Turbo Pascal 4.0 should be out by the time you read this review. See the editor's note on page 190.) Turbo Pascal has done much for the popularity of Pascal, but Marshal Language Systems and Oregon Software hope to woo Turbo users who feel a need to upgrade to a more powerful compiler.

Pascal-2 version 2.1J requires an IBM PC, XT, AT, or compatible with 320K bytes of RAM (512K bytes recommended), MS-DOS or PC-DOS 2.0 or higher, the Microsoft Linker 3.0 or higher, and 1.5 megabytes of disk storage. (A hard disk drive and a 360K-byte floppy disk drive are recommended.) Marshal Pascal version 2.01 also requires an IBM PC, XT, AT, or compatible, with a minimum of 256K bytes of RAM, PC-DOS 2.0 or higher, and two 360K-byte floppy disk drives or a hard disk drive. For this review, I used an 8-megahertz Compaq Deskpro with 640K bytes of RAM, a 30-megabyte hard disk drive, and an 80287 chip.

Both Marshal Pascal and Pascal-2 satisfy the requirements of ISO (International Standards Organization) level 0—the Pascal specified by Jensen and Wirth. Both compilers display warning messages when they encounter enhanced constructions not conforming to level 0. In addition, Pascal-2 complies with the ISO level-1 standard, which includes implementation of conformant arrays (array parameters of unspecified length).

Comparison of Enhancements

The most common enhancement to Pascal is the addition of strings and string handling. Both of the compilers reviewed support strings of up to 255 bytes and some form of the following operations: concatenation, length, insertion or deletion of one string within another, and determining the position of one string in another. Pascal-2 also has the procedures `val` and `str`, which convert reals or integers to or from strings. These are useful in checking keyboard input of numbers to prevent program crashes.

In standard Pascal, functions can return only simple variable types (e.g., `integer`, `real`, `char`, and `Boolean`) as values. Marshal and Pascal-2, however, can return any type (other than `file`) as a function value. Both products let you pass procedures and functions as parameters to other procedures and functions.

Marshal Pascal and Pascal-2 support the use of structured constants, which is a simple way of declaring constants of a structured type. For example,

```
type s1 = packed array [1..4] of
  char;
s2 = record
   strg: s1;
   numb: real;
end;
const
   c1 = s1('a', 'b', 'c', 'd');
   c2 = s2('abcd', 38.5);
```

This provides a convenient way of initializing structured variables by setting them equal to previously declared structured constants.

Marshal goes one step further in the extension of constants: Operations on constants are allowed in declarations. For example, if `Length` and `Width` are declared constants, the declaration `Matrix = array[1..Length*Width]` is legal.

Both compilers support the `otherwise` option in a `case` construction. Both also let you designate integers to any base between 2 (binary) and 16 (hexadecimal). Marshal's `write` can print integer output in either binary, octal, decimal, or hexadecimal; Pascal-2 can output in only decimal and hexadecimal.

ISO Pascal level 1 specifies the declaration of conformant arrays that let you pass arrays of different sizes to the same function or procedure. For example, a procedure that performs a matrix operation such as row reduction might want to accept matrices of any size. Marshal Pascal does not have conformant arrays implemented in the current version, but it has a compiler switch that allows relaxation of array index checking. Pascal-2 implements conformant arrays, and it also allows the procedural type declaration `univ` to relax type checking entirely in procedure calls.

Pascal-2 also provides a handy—and potentially dangerous—function, `loophole`. This function allows the assignment of the value of a variable *A* to a variable *B*, even if the variables are of different types, as long as their types require the same number of bits of memory. Thus, if *A* is a 4-byte integer and *B* is a `packed array[1..4] of char`, then

continued

Mark Bridger is president of Bridge Software and an associate professor of mathematics at Northeastern University in Boston. He can be reached at 31 Champa St., Newton, MA 02164.

Marshal Pascal version 2.01	Pascal-2 version 2.1J
Type Pascal compiler	**Type** Pascal compiler
Company Marshal Language Systems 1670 Terrace Rd. Walnut Creek, CA 94595 (415) 930-9039	**Company** Oregon Software Inc. 6915 Southwest Macadam Ave. Portland, Oregon 97219 (503) 245-2202
Format Three double-sided, double-density 5¼-inch floppy disks	**Format** Four double-sided, double-density 5¼-inch floppy disks
Computer IBM PC, XT, AT, or compatible with at least 256K bytes of RAM; two 360K-byte floppy disk drives or a hard disk drive	**Computer** IBM PC, XT, AT, or compatible with at least 320K bytes of RAM (512K bytes recommended); 1.5 megabytes of disk storage (hard disk drive and 360K-byte floppy disk recommended)
Software Required PC-DOS 2.0 or higher	**Software Required** MS-DOS or PC-DOS 2.0 or higher; Microsoft Linker 3.0 or higher
Documentation 150 pages in a three-ring binder	**Documentation** 200 pages in a three-ring binder
Price $189	**Price** $395
Inquiry 891.	**Inquiry 890.**

`A:= loophole(integer, B)` assigns the bit pattern of *B* to *A*.

In Marshal Pascal, integers are two bytes, ranging from −32,768 to 32,767. Pascal-2, on the other hand, has 4-byte integers standard, with a range of −2,147,483,647 to 2,147,483,647; you can also declare a special unsigned integer type, 0..4,294,967,295. Marshal provides a separate Pascal file that, when included in a program, gives support for 4-byte (long) integers. This is rather unwieldy because the file requires a different notation for the standard +, −, *, and `div` operations.

Marshal Pascal provides two other enhancements. The first is the control structure: `loop, exit, end`. The second is the use of the Return key to exit from a procedure or function. These constructs provide safe alternatives to the `goto` statement.

Both Pascals protect the counting variable in a `for` loop. This variable must be local to the procedure containing the loop and must not be changed within the loop. Any violation of these rules produces a compiler error.

Neither compiler supports the type `byte`. Pascal-2 allows the Boolean operators `and`, `or`, and `not` to operate on integers; this can be done in Marshal, but it requires an elaborate trick using records (the procedure is described in the documentation). Neither Pascal directly supports shift operations on integers.

File Handling and DOS Access

Both of the compilers support random-access files, as well as DOS functions that return the existence and size of a file and rename or delete files. The compilers handle opening files, closing files, and assigning DOS filenames to file variables easily, although somewhat differently.

Pascal-2 provides three functions for I/O error trapping. One function turns off the system error handling, to let your program handle the errors. The other two determine the status of the last I/O operation and return the error code. Pascal-2 also provides various file-security locks for protecting files during simultaneous access in a multiuser environment. These locks are specified by using compiler switches.

Both compilers have procedures for accessing DOS's date and time functions as well as the DOS command line. Pascal-2 also provides a procedure for executing a DOS subtask (a DOS command such as `DIR`, or even another executable program) from within a Pascal program. Marshal Pascal's functions `LoadProg` and `RetProg` permit loading and returning from executable programs. You must be sure to set the calling program's stack to make room for the stack of the program loaded.

Sophisticated programming often requires access to the DOS and ROM BIOS functions and interrupts, as well as to system memory. Pascal-2 provides this access; the version of Marshal Pascal that I reviewed provided access only to DOS functions. Both compilers had straightforward ways of `PEEK`ing and `POK`ing arbitrary memory locations. Marshal lets the `write` statement print the values (memory location) of pointers—a useful debugging feature. Pascal-2 gives access to the IBM PC's ports.

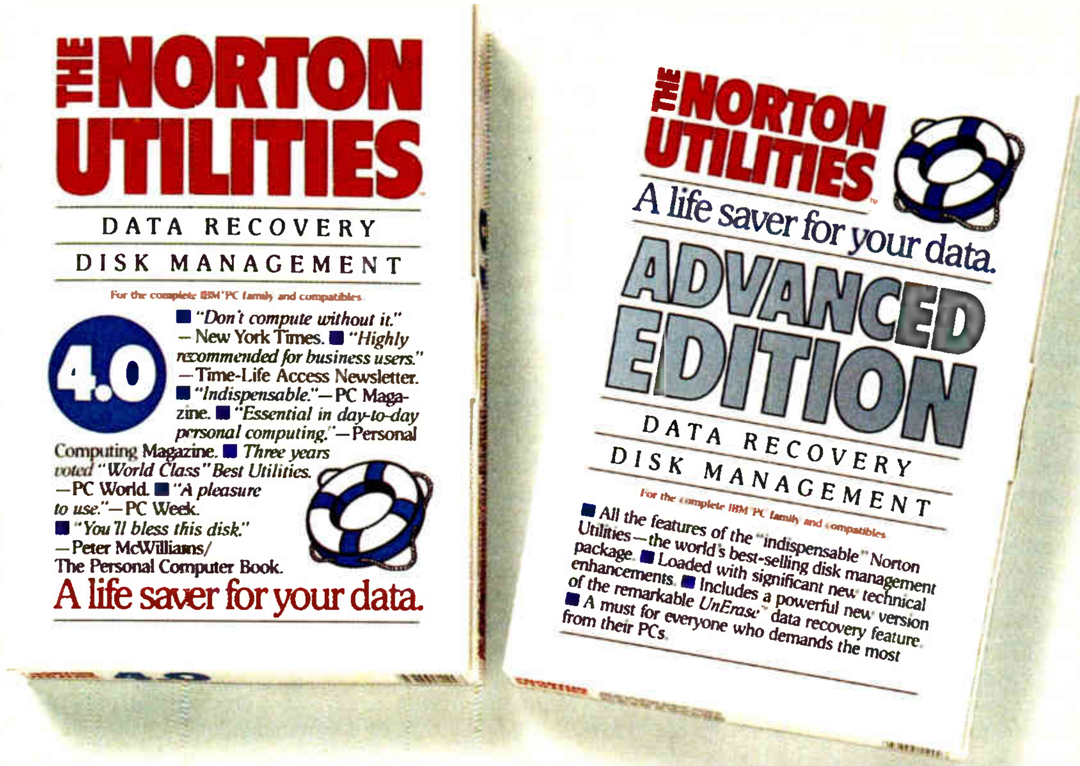
Both compilers let you link Pascal code with assembly language code. Assembly language programs are declared external in the Pascal code. The subprogram is assembled to produce an object file, and then the calling program is linked with the object program to create the final executable file.

Pascal-2 uses the Microsoft Linker and can link its programs with object code produced by Microsoft C, FORTRAN, or assembly language. Marshal Pascal uses its own linker (not compatible with Microsoft's), but it can link with assembled programs provided they are first fed through a supplied preparation program called FOB. Both instruction manuals give examples of assembly language code that is linkable with their respective Pascals.

Compiler Options

Both Pascals let the user give the compiler instructions via compiler switches. Such a switch is embedded in the text using a comment-like syntax. Some of the choices are:

- *Heap size.* In the small heap, data, stack, and heap space share a common 64K-byte segment; the large heap is limited only by the amount of available memory. Using the large heap can slow down memory access because pointers must carry both segment and offset information.
- *Code size.* In the small-code model, the actual compiled and linked code must reside in one segment, so it is limited to 64K bytes. The large-code model allows any size code. As with the large heap, this can slow program execution somewhat.
- *Type of reals.* You can choose between single-precision (4-byte) reals and double-precision (IEEE or 8-byte) reals.
- *Use of the 8087.* Both compilers come with two libraries. One library uses the 8087; the other emulates its operation. Pascal-2 uses the 8087 if the compiler senses that it is present. If you run a program that was compiled and linked with the emulation library on a machine that has a floating-point coprocessor, the floating-point hardware is used instead of



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the emulation. Marshal has a function `Is87`, which determines whether an 8087 is present. The libraries that use the 8087 contain in-line 8087 instructions.

• *Creation of cross-reference files.* When this switch is on, compilation creates not only object code but also a file that contains a listing of variables and the line number of each reference to each variable, including its definition and each assignment to it.

• *Creation of assembly code listing.* When this option is chosen, the compiler creates a file containing the assembly language for the object code produced. A quick perusal of the assembly listings produced by both compilers for a simple program reveals that Marshal Pascal makes frequent use of the stack and registers, while Pascal-2 uses memory accesses more often. This is a possible indicator of Marshal's better optimization (for speed).

Both Pascals support separate compilation of subprograms. This lets you create object files for various groups of procedures and link them to the main body when creating the final, completed program. Thus, if only a few procedures need to be changed, you don't have to recompile the whole program.

To inform the compiler that what is to come is not a complete program, Pascal-2 uses the directive `$NoMain`, and Marshal uses a header module. The compiler then produces the object code to be linked later. With Pascal-2, any shared global identifiers must be declared in the same order in all modules that use them; with Marshal Pascal, no common global identifiers are possible using this separate compilation technique—subprocedures can communicate only through passed parameters.

However, Marshal Pascal provides a second method of separate compilation, similar to that of Modula 2: definition and implementation modules. When you use this technique, each unit or module must be accompanied by a separate definition file containing a declaration of all identifiers that the module is to share with other modules. The module itself is called the implementation, and it contains the code using the identifiers in the definition.

After all the definition and implementation modules are compiled, the link step creates the finished program. This whole technique is fairly sophisticated, and it is worthwhile only in creating large programs with many small pieces whose variables must be carefully shared.

Special Features

Marshal Pascal is a four-pass compiler that does a high degree of code optimization. You can specify how the code is to be optimized by using embedded compiler switches. The degree of optimization is determined by the switch `$ZN`, where `N` is a number between 0 and 63; the larger `N` is, the more optimization is attempted (and the longer the compile time). There is also an `FN` switch, where `N=0` selects optimization for compact code size and `N=1` selects optimization for speed. At the default setting of Z31 and F1, the Sieve benchmark ran at 10.6 seconds; at a setting of Z63 and F1, it ran at 6.2 seconds.

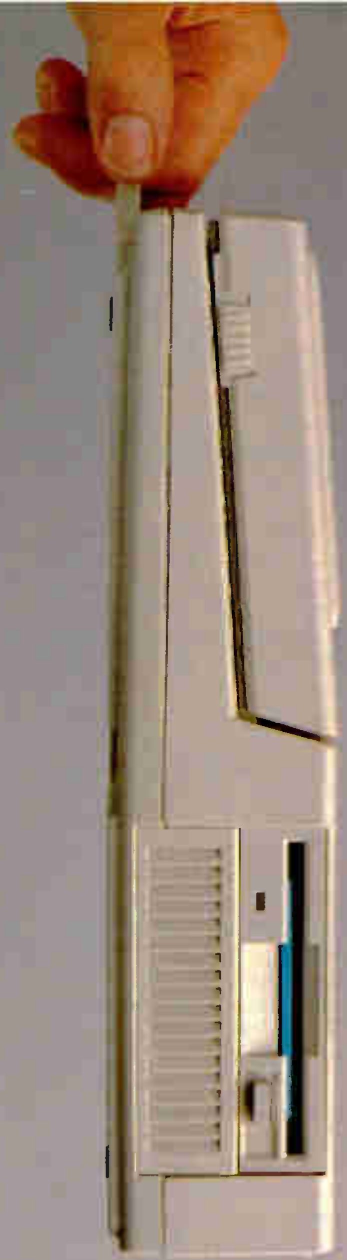
Marshal also comes with an object-code librarian. This utility lets you combine separately compiled object modules into libraries—i.e., single files that contain all the code of the modules. When the linker is instructed to link with this li-

continued

Table 1: *Benchmark results. Sieve runs one iteration of the Sieve of Eratosthenes. Calculations performs 10,000 multiplication and division operations using single-precision numbers. Float tests the compiler's transcendental functions library, computing sines, cosines, logs, and exponentials over a range of arguments. Calculations87 and Float87 are the double-precision, 8087 versions of the Calculations and Float tests. Transfer does a simple character-by-character copy of one text file into another (24,000 bytes of text). To ensure uniformity, all three compilers used a file buffer size of 512 bytes. Heap Test initializes and disposes of Pascal heap pointers. Each pointer points to 9999 bytes (to avoid easy word boundaries). My machine's memory could support only 49 of these with Pascal-2, so I used that many. Times are in seconds; file sizes are in bytes.*

	Pascal-2	Marshal Pascal	Turbo 3.0
Sieve			
Compile	10.3	5.5	0.5
Link	4.1	9.3	N/A
Run*	25.4	10.6	15.2
Code	14,486	2,848	16,713
Calculations			
Compile	9.2	4.6	0.5
Link	4.6	13.5	N/A
Run*	151.0	30.0	30.0
Code	33,634	6,944	11,682
Calculations87			
Compile	9.2	4.9	0.5
Link	4.7	12.8	N/A
Run	2.0	2.1	6.7
Code	17,586	4,910	10,329
Float			
Compile	9.2	5.7	0.5
Link	5.6	12.9	N/A
Run*	335.0	90.0	65.0
Code	32,692	7,646	11,596
Float87			
Compile	9.2	5.7	0.5
Link	5.6	13.4	N/A
Run	3.7	2.0	2.9
Code	16,644	7,446	10,241
Transfer			
Compile	9.3	5.3	0.5
Link	5.6	9.6	N/A
Run	8.8	6.5	6.4
Code	22,896	3,618	11,591
Heap Test			
Compile	14.8	5.7	0.5
Link	4.6	9.0	N/A
Run* (49 pointers)	20.3	2.0	0.5
Code	25,522	4,394	11,999

* Timed on a 4.77-MHz IBM PC with 640K bytes of RAM and without an 8087



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brary, it extracts the modules that are actually called by the program.

Marshal Pascal is currently supplied with a shell-type program called Thor and a text editor called Thor-Edit that make Marshal Pascal pleasant to use. When Thor is loaded, it displays a menu that lets you edit, compile/link, display directories, run a DOS subtask, or invoke the librarian. Thor can go directly to the line of a compilation error and, using Thor-Edit's split-screen mode, display the error messages in one half of the screen with the cursor at the offending line in the other half.

Marshal Language Systems is currently working on a Turbo Translator package that, according to the company, will implement all features of the Turbo Pascal language, including bit manipulation, block read/write, and graphics. Free updates are promised to all Marshal Pascal owners when Turbo Translator becomes available.

In addition to its variable and procedural cross-reference generators, Pascal-2 provides a full Pascal software debugger, with the ability to set and remove breakpoints, step through a program, and read out the values of variables. Its runtime error messages report the name of the procedure containing the error, as well as the hierarchy of procedures calling it. There is also a profiling utility that counts the number of times procedures are called when a program is run. The utility PASMAT will reformat Pascal source code according to user specifications (e.g., indenting, capitalization, comment format, number of statements per line, and margins).

PASMAC, an assembly language preprocessor, aids in the creation of linkable machine code. Parameters are declared in a Pascal-like syntax, as are subprocedure names and registers to be saved. PASMAC combines these with the actual assembler operations to produce assembly code. The output from PASMAC can then be sent to Microsoft's Macro Assembler (MASM) for assembly.

Pascal-2 also provides the Intel Common Elementary Function Library (CEL), which contains many useful mathematical procedures and functions not provided by standard Pascal.

Which Do You Choose?

Using the Marshal, Pascal-2, and Turbo Pascal version 3.0 compilers, I compared the compilation/link times, run times, and type code size for five different programs. The dramatic winner in compilation time is Turbo Pascal (see table 1). It is lightning-fast, and it doesn't require a link step. Except for the 8087 category, where they are nearly the same, Marshal beats Pascal-2 in running speed. Marshal is a clear winner in code size; in fact, it produces the smallest code of any compiler I have seen. This is due partly to its optimization but mostly, I believe, to the efficiency with which its linker selects its routines from the library. [Editor's note: *Source-code (nonexecutable) listings for the 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.*]

Both Marshal Pascal and Pascal-2 are high-quality products, fairly compatible with Turbo Pascal, and with adequate documentation. Whether you should buy Pascal-2, Marshal Pascal, or Turbo Pascal depends on your programming needs.

For writing small to medium programs (up to 3000 lines), Turbo Pascal is the most reasonable choice. It is small, fast, and inexpensive. But when you get to large programs or programs that require massive amounts of real number crunching using the 8087, Turbo's limitations begin to show. Its 64K-byte code-size limitation means that long programs must use cumbersome and slow overlays. [Editor's note: *According to Borland, Turbo Pascal 4.0 will address the shortcomings of Turbo Pascal 3.0. For a description of a preliminary version of Turbo Pascal 4.0, see "Short Takes" in the November BYTE.*]

For large programs, then, you should consider Pascal-2 and Marshal Pascal. Pascal-2 has more extensions and better debugging facilities and utilities than Marshal Pascal, and it is implemented on a variety of machines other than the IBM PC, including VAX, PDP, Apollo, and Sun. Oregon Software plans to have linker-compatible versions of C, C++, and Modula 2 for the PC soon. Pascal-2 is consistent with ISO Pascal levels 0 and 1, yet it has a lot of extra language and debugging features. On the other hand, at $395 it's rather expensive, and it also requires 1.5 megabytes of disk storage.

While the current version of Marshal Pascal does not have quite so many language enhancements as Pascal-2, it lets you write large programs, and its capabilities may be enough for your needs. Marshal Pascal stands out in terms of code speed and code size. It's also a comparatively better value, since its $189 price includes an integrated text editor, a librarian, and a soon-to-be-released Turbo Translator. ■

SCO Xenix 386

Edwin J. Lau

SCO Xenix 386 version 2.2, developed jointly by SCO and Microsoft, is a release of the Unix operating system for 80386-based personal computers. Unix has become a standard in the scientific/engineering marketplace on a variety of superminicomputers as well as on workstations and it runs on machines ranging from high-speed Crays down to personal computers. However, between 50 percent and 70 percent of the installed base of Unix systems are Xenix systems.

Xenix, Microsoft's enhanced version of Unix, is a multiuser/multitasking operating system touted by Microsoft as an alternative to its OS/2 (which is single-user/multitasking). Xenix provides a full complement of operating-system facilities, including interprocess communication, a hierarchical file system that allows simultaneous access to files from multiple processes, and generalized process scheduling.

Until the introduction of the IBM PC AT, PC hardware was relatively weak in processing power and memory, and very little hardware existed to support the advanced operating system features that Xenix required. The PC was therefore only marginally successful as a mainstream Unix box. These factors, coupled with IBM's standardization of PC DOS, and with the fact that (until recently) most users did not need multitasking, prevented serious consideration of Xenix in both the PC and Unix markets. With the introduction of SCO Xenix for the Intel 386, will this system at last come into its own?

The Hardware

For this review, I used a Compaq Deskpro 386 with 1 megabyte of main memory, a 1.2-megabyte floppy disk drive, a 40-megabyte hard disk drive, and a monochrome graphics monitor. I used the machine primarily as a DOS system with two 20-megabyte hard disk drive partitions, one of which was inactive.

The system's documentation states that the minimum amount of memory required to run Xenix 386 is 1 megabyte. Where a serious software development environment exists, the manual recommends 2 megabytes. If you're going to use the operating system, development system, and the text-processing system, the manual suggests a 20-megabyte hard disk drive. I increased the Deskpro's memory to 2 megabytes and installed Xenix on the Deskpro's inactive partition.

The Software

For this review, I examined the SCO Xenix 386 2.2 operating system with the development system and the text-processing system. These three software packages are available separately or bundled; see the box at right for details.

A standard—and important—component of the operating system and development system for Xenix 386 is the Unix shell. The shell is the user command interface to the operating system, and it provides a means for initiating system utilities. SCO Xenix provides three shells: sh (Bourne shell), csh (C shell), and vsh (visual shell).

The preferred shell for normal command-line interaction is csh. Traditional csh strengths are its ability to save command-line history, its ability to edit and reissue past command lines, and its job-control capabilities. Not all of csh's traditional strengths are available in this release of the system.

Traditionally, sh has been the preferred shell for writing scripts. While it does not provide the extensive command-line facilities of csh, it nevertheless provides an easily understood syntax for writing scripts of sh commands.

Unlike the other shells, vsh is specific to Xenix (both 286 and 386 versions); it is not part of standard Unix. It provides a simple windowing environment for the execution of a subset of the command utilities available in Xenix.

The development system provides program development tools, including a C compiler with lint, lex, and yacc (which stands for "yet another compiler compiler"), as well as a DOS cross-development environment for creating MS-DOS-compatible .EXE files. The C compiler generates native 80386 code and can use full 32-bit addressing. The lint tool checks C language usage and syntax more strictly than the C compiler does; the errors it detects are likely to include the use of nonportable aspects of the language or outright bugs. The lex tool is a generalized lexical analyzer, and yacc is a parser generator.

The development system also provides program maintenance tools such as SCCS (Source-Code Control System) and make (a utility designed to manage all the files associated with a development project). Also included are the standard Unix debuggers adb ("another debugger") and sdb ("symbolic debugger").

In the area of data communications, the operating system includes uucp and Micnet. The uucp package provides a means for command execution, log-in, mail, and file transfers between remote machines. It communicates through the RS-232C serial interface on Xenix and can be used through the serial interfaces on most other Unix systems. Micnet is another communications package implemented via RS-232C ports. It is similar to uucp, providing for remote-command execution, file transfer, and mail between machines on the network. You can use uucp on top of Micnet.

The SCO Computer Graphics Interface (CGI) also comes as part of the development system. Through subroutines and device drivers, SCO CGI gives you a route for developing device-independent applications programs.

CGI incorporates such capabilities as device-independent coordinate transformations, graphics input from a mouse or a tablet, status inquiry, metafile generation (which lets you exchange pictures between applications), bit-map manipulation, and pixel output. Its graphics output primitives include arcs, bars, circles, pie slices, and polylines. Primitive attribute specifications include alignment, color, character height, fill pattern, line style, and rotation. CGI also provides different text modes, such as alpha text, which is used for combining text and graphics; graphics text, used for controlling text attributes like graphics; and cursor text, for cursor positioning and text input. CGI is consistent with the evolving ANSI/ISO standard for computer graphics virtual device interfaces.

The text-processing system programs are used in document preparation. The system provides nroff (the standard Unix text-processing system), which includes the mm macros; tbl; eqn; diction; and style. The mm macros are written using native nroff commands and provide a means for specifying common formats of text, including section headings, chapter headings, footnotes, and so on. You use tbl and eqn to generate tables and mathematics within a document.

These tools are based on a batch model of document preparation. In this model, a document is created as a pure ASCII text file with explicitly embedded directives for how text is to be formatted. Typically, DOS word processors automatically embed formatting information in the file as it is created. Under the Xenix/Unix word processors, you must manually place the formatting directives in the text of the document.

The diction program scans a document and outputs those sentences that contain bad diction. (The offending word or phrase is bracketed.) The style program is an automated document-grading system that provides feedback on sentence complexity and grammatical structure.

In this version of Xenix, the designers

continued

SCO Xenix 386 version 2.2

Type
Multiuser/multitasking operating system, program development system, and text-processing system

Company
The Santa Cruz Operation Inc.
P.O. Box 1900
Santa Cruz, CA 95061
(800) 626-8649

Format
16 5¼-inch floppy disks: eight disks for the Operating System four disks for the Development System, two disks for the Computer Graphics Interface, and two disks for the Text Processing System; also available on 3½-inch floppy disks

Computer
Compaq Deskpro 386, AT 386-compatible, or PS/2 Model 80 with at least 1 megabyte of RAM (2 megabytes recommended), a 1.2-megabyte floppy disk drive, and a 20-megabyte hard disk drive

Documentation
Run Time Environment Manual; User's Guide; User's Reference; Programmer's Guide I; Programmer's Guide II; Programmer's Reference; Computer Graphics Interface Manual; Text Processing Guide

Price
Complete SCO Xenix System: $1495
For the IBM PS/2 Model 80: $1695
Unbundled prices:
SCO 386 Xenix Operating System: $695
For the IBM PS/2 Model 80: $795
SCO 386 Xenix Development System: $695
For the IBM PS/2 Model 80: $795
SCO Xenix Text Processing System (Xenix 286-compatible): $195

Inquiry 892.

recompiled the kernel to take advantage of native 80386 instructions. However, they did not recompile all the utilities. SCO gave me a list of the utilities that were recompiled, and it appears that the company concentrated on the program development tools (including the editors `ex`, `edit`, `vi`, and `view`) and other important utilities (such as `sh`). SCO also said that it recompiled a number of files in the `/lib` and `/usr/lib` directories.

Observations

Installing SCO Xenix 386 was painless. It involved paging through a series of menus and answering mostly straightforward questions. However, two places in the documentation need clarification.

The first area of confusion involves directions for installing Xenix on a machine that is already running MS-DOS or PC-DOS. Chapter 2 of the *Run Time Environment Manual* says that if you have to install both DOS and Xenix on the same hard disk, you should turn to chapter 3 of the *Manual* and to the `fdisk` manual page in the *User's Reference*. But when I turned to chapter 3's section on installing Xenix on a DOS system, it directed me to "follow the installation procedure outlined in chapter 2 of the *Run Time Environment Manual.*" After carefully reading both chapters a number of times, I was able to format the disk correctly for both DOS and Xenix.

The second place that needs clarification is the description of the `badtrk` program (described in the Miscellaneous Command section of the *Manual*). This program finds and lists the location of bad tracks on the hard disk; it is also used to add entries to a bad-track table. The manual states that if `badtrk` finds bad tracks on the disk and "if your disk comes with a flaw map, you should enter any flaws from it into the bad-track table." It also states that "if your disk is not furnished with a flaw map, or you are finished making changes to the bad-track table," then you can exit `badtrk`.

The documentation does not say what the bad-track table is and whether or not it is kept on the hard disk. It is also not clear about what to do if you do not know whether the disk has a flaw map or not. During the installation process, `badtrk` found a number of bad tracks on my hard disk. I made the assumption that my disk didn't have a flaw map. A subsequent call to SCO provided clarification; the company said that the flaw map was the list of bad sectors commonly found pasted to the outside of a hard disk. Thus, recording the bad-track information is optional.

After installing the base system, I used the `custom` utility (described in the Normal Command section of the manual) to install the program development tools and the text-processing system. It is a convenient and easy way to install and deinstall the various subsystems.

Following the installation of the optional subsystems, I created a user log-in using the `mkuser` utility. This utility is a convenient aid for those who are not familiar with how the system associates passwords, home directories, and shells with a particular user. My log-in shell was `csh`, and I created my home directory on a file system different from the root-file system. After creating the user log-in, I began to develop programs to measure the performance of the system.

Table 1: *Benchmark results comparing Xenix 386 and Compaq DOS, both on a Compaq 386, and Sun OS on a Sun-3/260. All times are in milliseconds.*

Benchmark	Xenix	Sun-3/260	DOS
1. `getpid()`	.093	.050	N/A[1]
2. Fork 32K-byte data and exit	.36	.69	N/A[1]
3. Write 4K-byte block	12.5	4	58
4. Write 64K-byte block	349	96	356
5. Read 4K-byte block	24	2.4	48
6. Read 64K-byte block	375	74	484
7. Write 1K-byte to screen 1 char at a time	60	116	716 (with ansi.sys) 766 (without ansi.sys)
8. Write 1K-byte to screen 64 char at a time	55	40	352 (with ansi.sys) 342 (without ansi.sys)

[1] These benchmarks use calls that are unique to Unix and Xenix and cannot be run under Compaq DOS.

Interacting with the system, I found that although Xenix 386 had most of the basic features you would expect from a Unix system, its shell programs lacked a number of items found in shells of other Unix systems. Take the `csh` command-history mechanism, for example. The usefulness of Xenix 386's version is limited because the system cannot save the history file during log-out; this is an ability that can be very useful in environments where complex command interaction with the system exceeds a single log-in session. The history feature helps both as a timesaver (because you don't have to retype complex commands) and as an audit trail of commands.

Another missing feature is the abbreviated job identifier, `%`. Under other Unix systems, when you place a job into the background (via `&`), the system associates an identifier with the job. The first job placed in the background is identified by `%1`, the second by `%2`, and so on. These identifiers reduce the need to remember explicit process ID numbers for the background jobs. On other Unix systems, then, to kill a process placed in the background, you need only type `kill -9 %n`, where *n* is the job number (not its ID) and 9 is the signal to kill the process. In Xenix 386, you must give the ID explicitly; to kill the process with ID 47, for example, you must indicate `kill -9 47`.

A more serious problem lies in the way SCO Xenix handles the execution of shell scripts. In most Unix systems, the first line of a shell script specifies its type (i.e., C shell or Bourne shell). For example, assuming the shells are in the `/bin` directory, the line `#!/bin/sh` would specify the Bourne shell, and `#!/bin/csh` would specify the C shell. Hence, when running under `csh`, you could invoke a Bourne-shell script by giving `#!/bin/sh` as the first line of the script; you can start a `csh` script under the Bourne shell in a similar fashion.

Under Xenix 386, however, you specify a Bourne shell script by a blank first line, and you cannot specify within a shell script that it is a C shell script. To execute the script of a different shell from the one you are in, you have to explicitly start up the other shell by entering the shell's name as a prefix to the script you want to execute.

The software tools in the program development system are all that I would ex-

continued

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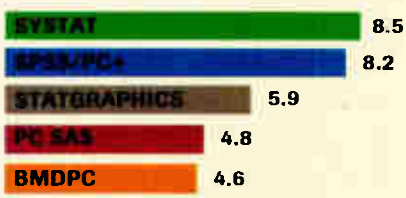

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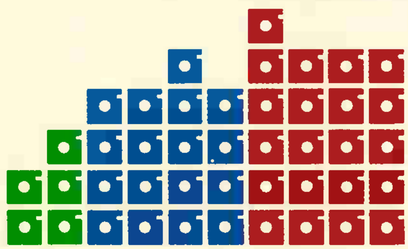

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pect from a basic Unix system. However, the debugger tools offered for Xenix fall short of those currently available in the MS-DOS/PC-DOS environment, as well as some of the more recent Unix ports. For example, in Microsoft's latest release of its C compiler ($495), you also receive CodeView, a window-oriented source-language debugger with a user interface that is much easier to work with than that of `sdb`. SCO has claimed that `sdb` is essentially CodeView without the windowed interface, but the user interface of `sdb` is line-oriented, much like the MS-DOS DEBUG program. Debuggers similar to CodeView are already available on Unix from other vendors (e.g., `dbx` from Sun and `xdb` from HP).

SCO states that Xenix 386 "is a fully AT&T 5.3-licensed implementation of Unix System V." But AT&T announced in its licensing documentation that the major new features of 5.3 are the Remote File System (RFS) and streams. (These two features are to play important roles in the management of networked Xenix systems.) Neither of these features is included, nor available as options, in Xenix 386 version 2.2.

Finally, the Text Processing System ($195) includes tools familiar to most Unix users. I used `nroff`, the `mm` macros, and `spell` for drafts of this review, and they performed as I expected.

Performance

An effective Unix system must be able to provide (among other things) adequate I/O bandwidth and system services with limited overhead. To evaluate the effectiveness of Xenix 386 as a multiuser/multitasking system, I developed a number of C language benchmark programs to look at I/O bandwidth and system overhead. The results are in table 1, along with the results of the benchmarks for Sun OS (a Unix-based operating system) on a Sun-3/260 and, where possible, for Compaq DOS version 3.1 on the Deskpro 386 using the Microsoft 4.0 C compiler. [Editor's note: *Source code (nonexecutable) listings are available under the names X386B1.C through X386B6.C 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 accompanies each entry.*]

The Sun system is based on the Motorola 68020 processor running at 25 megahertz and has a 64K-byte write-back cache. The system I used had 8 megabytes of main memory, a high-resolution monochrome monitor, and a surface-mount device disk subsystem providing about 280 megabytes of storage. (The Sun system costs approximately $50,000; Xenix with the Compaq 386 is about $7200.)

To evaluate Xenix 386 as a multiuser/multitasking operating system, I ran the benchmarks on both the Sun and the Compaq with the operating systems in multiuser configuration. No processes were active during the execution of the benchmark programs other than the normal system processes that manage the multiuser/multitasking aspects of the system. Hence, the execution figures shown in table 1 do not account for interference caused by other user processes.

Benchmark 1 makes the system call `getpid()`, which returns the process ID of the calling task. This gives a rough measure of the overhead that a process incurs when it makes a call to the operating system. The Sun system is about twice as fast as Xenix. A couple of factors help explain the variation: The 25-MHz clock rate of the Sun is 59 percent faster than the 16-MHz 80386 in the Compaq; and the cache memory on the Sun lets it run virtually flat out, while the Compaq incurs two wait states when the processor fetches outside of a page or when there are intervening idle cycles between fetches.

For benchmark 2, I created a child process that has a global array of 32K bytes and exits immediately on dispatch. This benchmark provides some feel for the cost of process creation. Here, Xenix was almost twice as fast as the Sun system, indicating that Xenix has far less overhead than the Sun OS in this area. Process creation is a complex job requiring replication of process information, table manipulation, and interaction with the system's memory management. The systems are very different with respect to process information: Xenix is derived from Unix System III/System V, and the Sun OS is derived from Berkeley 4.x.

Benchmarks 3 through 6, reading and writing 4K-byte and 64K-byte blocks, measure the file I/O performance of the systems. Here, the Sun system performed substantially better than either Xenix or DOS on the Compaq. All three operating systems provide some level of file-block buffering in memory. The Sun OS and Xenix have more sophisticated caches than DOS. The speed of the Sun OS file operations is likely the result of not only its faster processor and memory, but also of its highly tuned file system; it is based on the Berkeley Fast File System. Also, data read or written by the Sun OS probably goes to the memory cache rather than to the disk.

Xenix was faster than DOS in all four cases. The margin between Xenix and DOS for the 64K-byte block write is narrower than the other disk I/O figures, probably because Xenix has to write the data to disk as well as to the memory buffers. DOS also buffers, but it performs a write-through on file-write operations. (For DOS, I set the `buffers=` line in the CONFIG.SYS file to 50.)

Finally, benchmarks 7 and 8 write 1K-byte characters to the screen. Benchmark 7 uses the `printf` statement to write the characters one at a time, while benchmark 8 writes 64 characters at a time. I output the characters to the monitor on the Compaq. On the Sun, I sent the output to a PC emulating a dumb terminal connected to the system via Ethernet.

As expected, writing 64 bytes at a time was more efficient than writing one character at a time in all cases. The results for Xenix on the Compaq were impressive; Xenix was substantially faster than Compaq DOS. Xenix on the Compaq was faster for benchmark 7 (one character at a time) and a little slower for benchmark 8. A judgment is difficult in this case because of the extra layer of overhead incurred using Ethernet, and also because Ethernet is more efficient with larger data packets.

Impression

SCO Xenix's performance is equal to or better than DOS's performance. Also, Xenix provides substantially richer operating system facilities. It is not, however, 100 percent compatible with AT&T 5.3 Unix because of its lack of streams and RFS. While Xenix on the Compaq 386 is slower than some of the newer mainstream Unix boxes, it is substantially less expensive (e.g., a Sun-3/260 is approximately seven times the price of a Compaq 386 with Xenix).

How well Xenix 386 is accepted as the multiuser alternative to OS/2 remains to be seen. Since OS/2 has promised a DOS compatibility box, issues of DOS compatibility cloud the horizon; SCO has indicated, however, that it plans to offer VPix (the "DOS under Unix" product from Phoenix Technologies) sometime in the near future as an option for Xenix 386. On the other hand, as a multitasking/multiuser operating system for the 386 AT machines, Xenix 386 exploits the 80386 processor—something OS/2 may never do. ■

Edwin J. Lau (3945 Freedom Circle, Suite 760, Santa Clara, CA 95054) works at Clustrix Corporation. He has a Ph.D. from the University of California at Berkeley and has worked extensively on computer architecture, performance evaluation, and operating systems.

VIEWS FROM BIX: XENIX

os386/reviews #3, from Gary Kendall.

The performance items tested don't really indicate the ability of the machine to perform under the load of multiple users and/or processes. It would have been enlightening to compare Xenix 286 and Xenix 386 running on the same hardware and note differences in swapping, terminal response, etc. I'd be interested to know if the 80386 can perform 1200-bps ASCII file transfers using the XON/XOFF protocol while three or four other users are running spreadsheets, nroff, make, etc.

Did [SCO] fix the confusion with disk-block sizes among the various utilities that have to deal with them? The fdisk and divvy utilities assumed blocks were 1024 bytes, while dd, tar, and dump still thought blocks were 512 bytes. After running a few of those, run /bin/df and see if you can guess how much free space you have. Did they fix the C shell? It used to break to the outermost switch level when a breaksw was encountered at the innermost level of nested switches. Do they still refuse to supply you with /bin/[idn]check and /bin/clri, insisting that "those programs are obsolete and have been replaced by fsck"? Try to recover files and/or i-nodes without them.

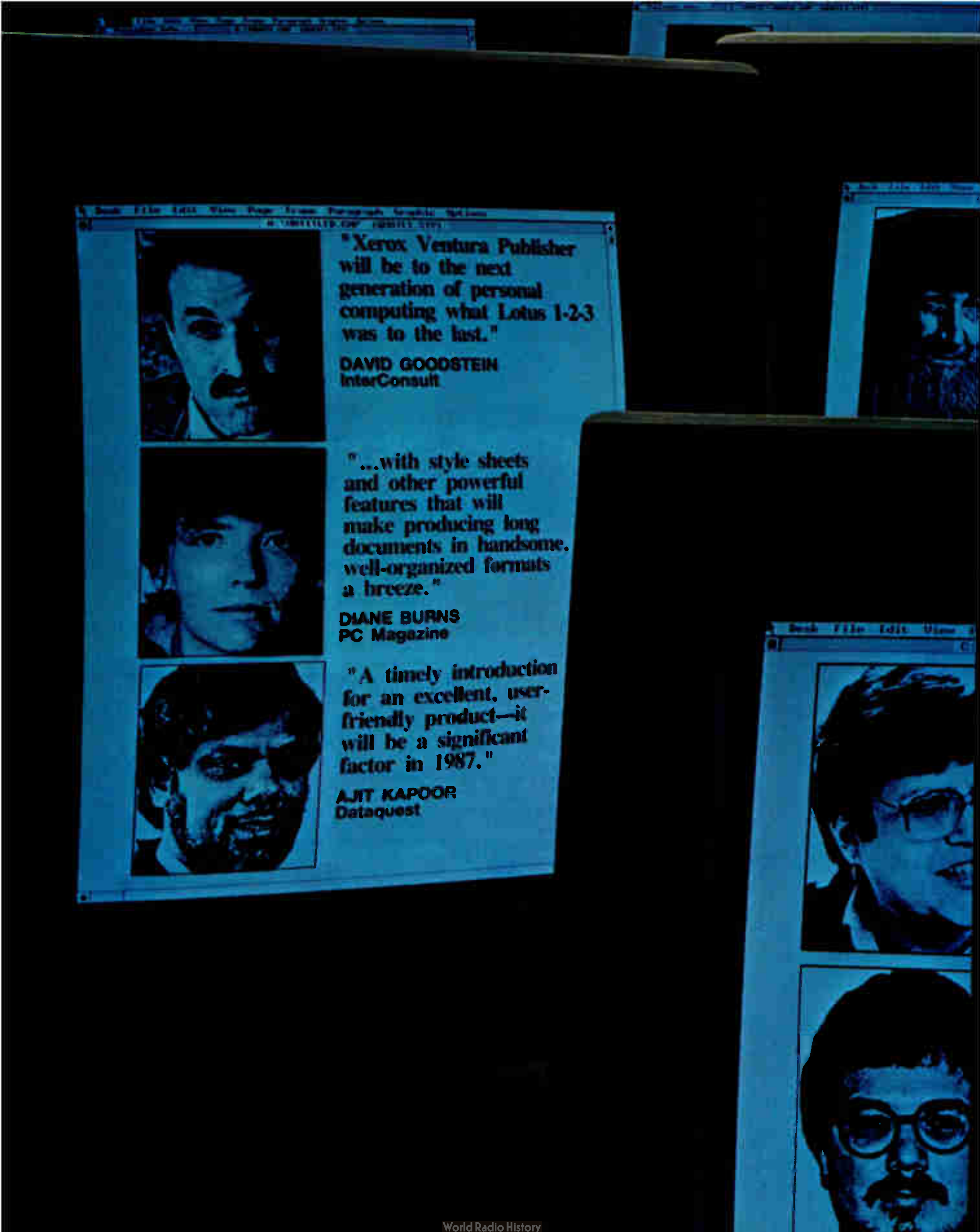
os386/reviews #7, from Daniel Heiniger.

Multiuser performance, that's what I wanted to know. I tried out IBM's version of Xenix for the AT with two users (or two processes, if you like) assigned 800K bytes each (my system has 2 megabytes). Each process waited for a user to press keys. When either user pressed one, he waited 15 seconds or so to get his process swapped back in. So Xenix failed miserably.

os386/reviews #8, from Craig Jackson.

The reviewer compares Xenix 386 to other versions of Unix without being specific about which versions. The C shell now comes with most versions of Unix, but there are a number of versions of the C shell. There is a rather old one commonly distributed with USG Unix; it dates from the 4.1 BSD days. A newer version of the C shell appeared with 4.2 BSD.

The critical thing to remember is that whatever Unix the reviewer may have used in the past is just one variant of the Unix family. Berkeley Unix may have lots of users (mostly students), but many people have never seen it. Don't forget that the most common form of Unix (by number of copies in use) is Xenix 286.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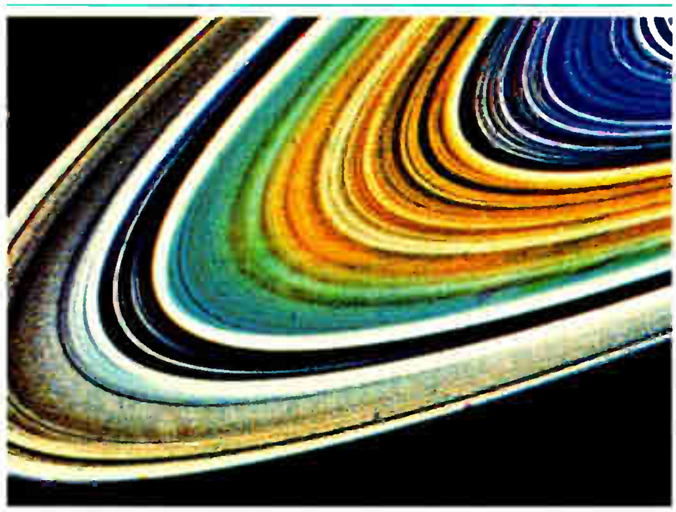

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The Old Shell Game

Jerry Pournelle

Zenith's answer to the PCjr prompts some questions about DOS shells

Sometimes the only way to write a book is to get away from it all. For the past couple of weeks, I've been holed up in Silicon Valley pounding out a few thousand words a day. Naturally, when I fled Chaos Manor I didn't take anything from the enormous stacks of software and equipment awaiting review, but it doesn't matter. The stuff catches up with me anyway. Moreover, I did look in on the Seybold Conference on Desktop Publishing, so there's plenty to write about.

Zenith eaZy PC

Zenith's answer to the IBM PCjr was introduced with fanfare at COMDEX last spring. Zenith's top brass were all there. So was Bill Gates of Microsoft, because the big shtick of the eaZy PC (and that's the last time I'm going to spell it that way) is supposed to be a hardware/software combination that makes it simple for beginners to use. Bill Gates was so happy with the DOS shell Microsoft provided for the EZPC that he told the press Microsoft would probably license it for other uses.

I hope that doesn't happen. In my opinion, the EZPC's DOS shell may be marginally less worthless than the machine itself, but it's a close call.

I'm no great fan of DOS shells to begin with. But a tutorial for beginners that teaches you commands no less mysterious than those DOS employs, deliberately uses nonstandard notation (like [FOO] rather than <FOO> to indicate that FOO is a directory), and in general is at least as hard to use as DOS has undertaken a useless task.

One of Pournelle's laws is that a job not worth doing is not worth doing well. They followed that rule. The tutorial is confusing, its documents are puzzling, and since it's about a shell rather than about DOS, you can't even go to a third-party book for help.

For all that, the silly DOS shell may be more useful than the computer.

The EZPC costs $999 for a system with one floppy disk drive. Never mind that that's enough to buy a full-up XT clone; what's more absurd is for that price you get so little: a monochrome monitor, 512K bytes of memory, a mouse port, and a printer port. No serial port. No socket for a math chip. No PCompatible slots—in fact, no slots at all.

If you want a serial port, you must pay $399 for a daughterboard that converts the machine to 640K bytes of memory, adds a serial port, and gives you a 300-/1200-baud modem. Incidentally, the mouse port is sort of addressed to COM2:, but it has been deliberately crippled so you can't use it as a serial port. (I told you it was Zenith's answer to the PCjr.)

Once you've bought the expansion card, you've done all the expanding you can. You can't even add a second floppy disk drive. (The two-floppy version costs $1199.) Of course, you could pay $1699 for an EZPC system with one floppy disk drive and a 20-megabyte hard disk drive—but you'd still have to pay the extra $399 to get 640K bytes of memory and a serial port.

I suppose everyone knows that in general I'm a fan of Zenith equipment. When I came up here to write, I brought Zelda the Z-248, because she's fast, rugged, reasonably lightweight, and very reliable. On trips, I carry a Z-183 portable. I'm looking forward to the Zenith 386 machines. I was prepared to like the EZPC—until I turned it on.

I'd sure hate for the guy who designed that machine to work on any of Zenith's other new products.

So What Should Beginners Do?

It's easy to make fun of the EZPC, but the machine did attempt to address a serious question. The computer revolution has succeeded beyond the wildest dreams of even people like me. There are well-off professional people in the U.S. who can't drive, but not many; and I think there are none who can't use a telephone. The time isn't far off when computers will be as necessary as cars and telephones combined. Thus, it really is important to have systems that make it easy for beginners to get into computing.

Alan Kay's research at Xerox's Palo Alto Research Center resulted in some fundamental new ideas about how people interact with computers. A number of machines, including Niklaus Wirth's Lilith, Apple's Macintosh, and the Xerox Star series, were designed around the PARC concepts.

Although I think Wirth's Lilith was most successful in implementing what Kay had in mind, the concept tends to be known as the "Macintosh interface" because of the Macintosh's popularity, the aggressiveness of Apple lawyers, and the reluctance of some of Apple's victims to waste time in court. (Someday I'm going to add a new box to this column: rumors I want to start. The first one would be that Apple intends to sue Xerox for "look and feel.")

The PARC interface is much easier to learn than CP/M and its wildly successful mutant stepchild DOS. It's not necessarily easier to *use*. DOS has a number of very nonintuitive commands, but once you know them, it's fairly powerful; and I put it to you that it's no more difficult to copy all the files on a floppy disk to a hard disk by typing `COPY A:*.* C:` than it is to drag a disk icon from one place to another.

However, no one in their right mind

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.

There's quite a lot to the science part of desktop publishing, but there are also pretty good books on the subject.

would argue that DOS is particularly easy to learn. It's especially bad for raw beginners who are faced with the infamous A> prompt and no other information. Thus, we have a plethora of programs calling themselves DOS managers and technically known as DOS shells.

"Shell" is a bit pretentious here: it's stolen from Unix, but a Unix shell can literally do *anything* Unix can; DOS shells are nowhere near that powerful. What they do is replace the confusing DOS command structure with something that purports to be more intelligible. Most are memory-resident and have menu options. Some attempt to make your PC work like a Macintosh: they're complete with little pull-down menus and suchlike. Some even use icons.

Some people swear by DOS shells. I'm not one of them. In my judgment, learning a DOS shell is a bit like learning to drive with a Hydra-Matic transmission back in the days when nearly every car had a stick shift: it was easier to learn, all right, but once you learned, there weren't many cars you could drive. The DOS-shell situation is actually worse since there are so many shells, and the ability to use one of them isn't going to help much with the others.

This brings us to Pournelle's DOS rule: if you're going to live in the DOS environment, learn DOS. Few of the "menu" shells have all the DOS features, and so what if one does? You still won't be able to use anyone else's machine, and your shell will be out of date with each new DOS revision. When you drive a car, your windshield doesn't have a little heads-up menu display of

LEFT RIGHT ACCELERATE BRAKE

and so forth. Icons would be even worse. Go on and learn DOS. It's nowhere near as difficult as learning to drive. Better yet, if you crash your computer, your insurance company doesn't raise your rates.

Of course, beginners might shuck the question entirely and go with some other machine, like a Macintosh, Atari ST, or Amiga; but that's another discussion for another time.

Incidentally, in the above I've said "you," but of course I know better. BYTE readers aren't likely to need advice on how to get started—but you are likely to be asked for help. When anyone asks me that, I say, "Get Van Wolverton's *Running MS-DOS*, Chris Devoney's *PC-DOS User's Guide*, and slug it out. It'll take a few hours, but it's no more difficult than the driving manuals."

Whatever you do, don't hand beginners one of the shells that's ostensibly intended for them but is in fact designed to turn them into "power users." A good example is Maxam Plus from Maxamedia, which is an on-line tutorial/shell that's powerful, explains much that DOS manuals leave obscure, and is written in language that will send a beginner fleeing into the night. If beginners have to be intimidated, it may as well be by DOS itself.

The next step is to set up an AUTOEXEC.BAT file that gives the new user a sane prompt showing the directory path (I like mine to show the time of day as well); install The Norton Utilities in their own subdirectory and put that subdirectory in the path invoked on boot-up; and get out of the way. If you really have to get a DOS shell, get Norton Commander. It isn't all that good, and users soon tire of it, but it's at least as good as any of the others I've seen.

Two final notes. First, Maxam Plus is a pretty good tutorial on how to become a "power user"; I just don't recommend that beginners be allowed in the same room with the manual. Second, my comments on shells and such aren't intended to apply to Digital Research's GEM, which has its own strengths and weaknesses and needs more discussion than I have space for in this column.

Desktop Publishing

Two things happened in 1987: desktop publishing became one of the most important branches of microcomputing, and the Seybold Conference on Desktop Publishing became not merely important, but essential for anyone seriously interested in the subject. Between the exhibits and the panels, you learn more than you can in the rest of the year. Certainly I did.

One thing I learned is that there's a great deal more to know about desktop publishing than I ever suspected. I suppose I shouldn't be surprised. Publishing may not be considered one of the classic professions, like law or medicine, but it's close; and like the classic professions, it has its roots in both art and science. (Science is what you can teach a colleague through a book, letter, or report; art requires at least talent and practice and often needs personal instruction.)

There's quite a lot to the science part of desktop publishing, but there are also pretty good books on the subject. Once you've learned what's in these books, you're not done: good page composition really is an art, and it'll take practice to get things looking right.

The output of even the best desktop-publishing system isn't going to compete with top-quality work composed by an artist assisted with photographic cuts and a letterpress. On the other hand, it may be good enough for a lot of what you want.

The best illustration comes from Frank Romano, publisher of the magazine *Typeworld* and author of the authoritative (and highly recommended) reference book *The Typencyclopedia: A User's Guide to Better Typography* (R.R. Bowker, 1984, $34.95). Romano told the conference about the time when the first Compugraphic phototypesetting equipment was introduced to a typographers' convention. It was in Chicago in June 1968, with the wind blowing from the stockyards. People saw the output of the system.

"That's crap!" they cried.

"It costs only $8000."

"Say, that's not bad crap!"

Similarly, the best desktop-publishing systems may have output that would make any good typophile blush, but it's pretty good crap, and for many of us, it may be, well, good enough.

PC or Mac?

Just as VisiCalc saved the Apple II's bacon back in the early days, desktop publishing saved the Macintosh. The parallel is nearly exact: Wozniak had no notion of VisiCalc when he designed the Apple II, and Jobs had no ideas about desktop publishing when he dictated the specs for the Macintosh. In both cases, other technologies matured at just the right time, and the machines were in the right place to take advantage of them.

In a word, there's been more development of desktop-publishing concepts, software, and hardware for the Macintosh than for PCompatibles. On the other hand, the Mac systems cost more; and the DOS software developers are catching up fast. You don't have to buy a Macintosh to get into desktop publishing; but getting a Mac and an Applewriter is certainly the simplest (but most expensive) way to do it. There are alternatives.

By coincidence, as I was traveling north to the Seybold Conference on Desktop Publishing, my son Alex and his Australian friend Dave Moore were using the Mannesmann Tally MT-910 laser printer from Chaos Manor to print the

continued

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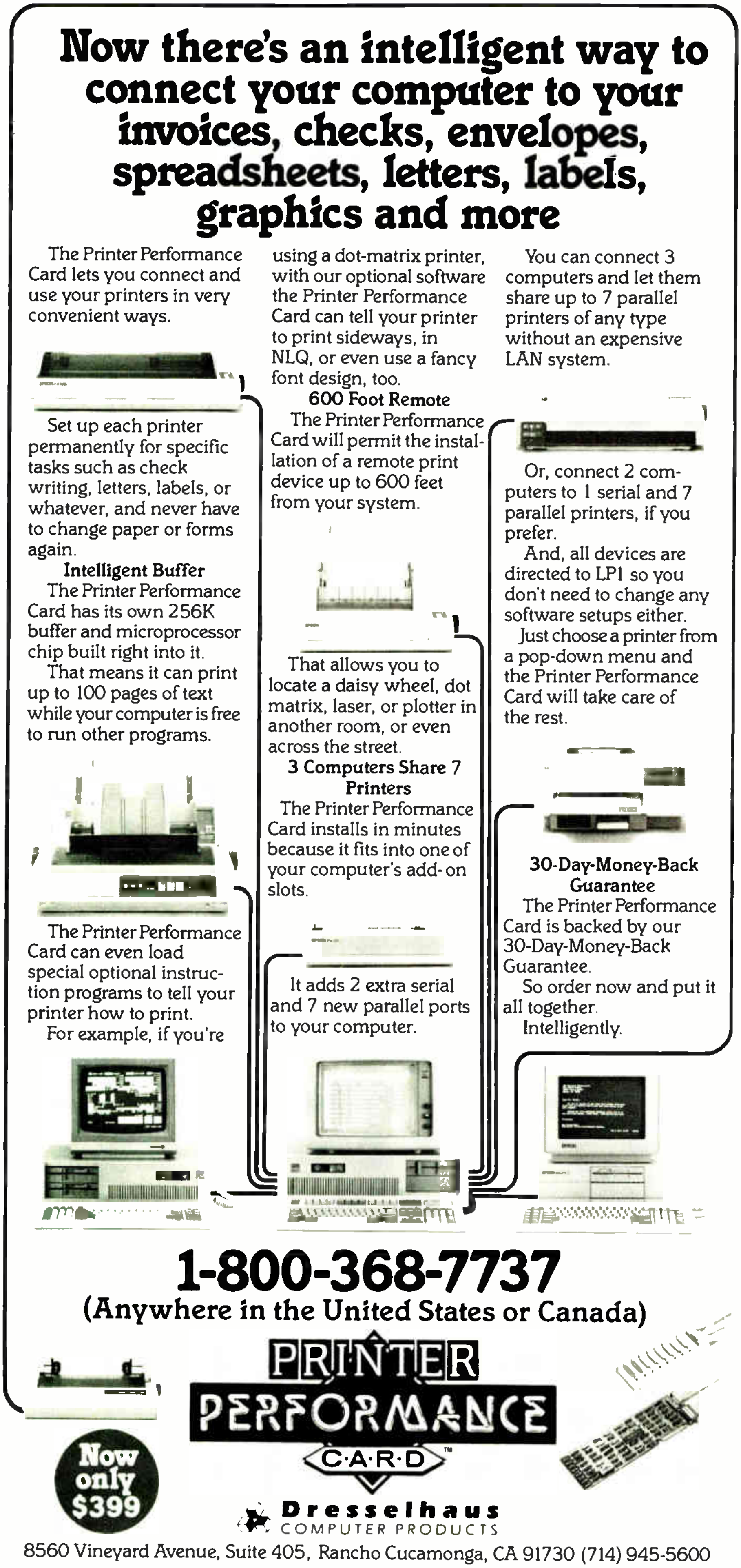

manuals for the latest version of FTL Modula-2. Herewith, Alex Pournelle and Dave Moore on the MT-910.

Some History and Background

A few years ago, all quality printing was done on daisy-wheel printers. The output was handsome, but printing documents of any serious length was tedious at best. To speed things up, most users hot-rodded their printers by covering the paper-out sensor, installing custom cardboard paper guides, and so on.

Modified or not, almost all printers had to be pampered. Even if they didn't jam, overheat, run out of ribbon without stopping, or blithely type 10 pages on the platen, the printout still had to be restacked, its perforated edges torn off, and the pages torn apart. Each printer had only one type style, and few users knew what fonts were.

Quality dot-matrix printers changed that, being less expensive and much faster than daisy-wheel printers. They also let you print in italic and boldface. Then we got laser printers, and fonts became a fact of life.

Hardware makes progress ratchet-style. After you first use an AT, the idea of going back to PC speed is well-nigh unthinkable. Printers are no exception. The LaserJet made the noise and bother of a Diablo intolerable. (Of course, if new equipment keeps coming out at the current rate, the entire earth will be covered by old computer parts by 2000. It's already happened at Chaos Manor.)

Similarly, people's ideas of acceptable print have changed. The grainy characters of early dot-matrix printers were too poor for business correspondence. Now, even though the best dot-matrix printers can turn out perfectly readable business letters, everyone would rather use laser printers. It's not surprising because laser-printer quality is darned good and makes even first-draft memos look professional. (Microsoft's QuickBASIC manual was printed from laser-printed copy.)

However, not all laser printers are good enough to do books. Unlike dot-matrix or daisy-wheel printers, which turn out characters one at a time, laser printers have to store a whole page before they can print it. At 300 dots per inch, one page needs at least 900K bytes. The original Hewlett-Packard LaserJet held much less, and the Apple LaserWriter was news because it could hold an entire legal-size page in memory. With memory prices in their current power dive, nearly all the new printers—including Mannesmann Tally's MT-910—let you upgrade to 2 or 4 megabytes.

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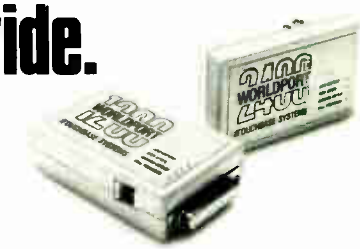

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I suspect the toner doesn't distribute correctly when first charged, or else the MT-910 has a critical-need detector.

Most of the low-priced laser printers aren't expandable. Many use the computer itself as part of their "smarts." They may be a good buy, but you should understand another Pournelle law: you always need more computer capability than you bought.

Page-Description Languages

Another thing that distinguished the LaserWriter was its built-in support of PostScript. Briefly, PostScript is a PDL (page-description language): a standard way for computers to tell printers what to put where. PDLs, like printer escape sequences, vary widely; unlike printer escape sequences, they promise portability between output devices.

PostScript has become the standard, and even the companies that developed their own PDLs generally offer PostScript as an option. Hewlett-Packard's PCL (Printer Control Language) is the next most popular choice. It's also simple enough that competitors copy it instead of buying a license to use it.

Adobe Systems, the inventors of PostScript, left plenty of room for its competitors. PostScript code runs only on laser printers built around the 68000 (the processor in the LaserWriter), and the license is expensive. At SIGGRAPH '87, we heard rumblings about several "CloneScripts" in development; if they're any good, they should help make PostScript universal.

The MT-910

Mannesmann Tally is a diversified German company that got its start building heavy-duty, battleship-tough dot-matrix printers. The MT-910, its first laser printer, is a fine entry worth careful consideration. It's based on a Kyocera (long known in the U.S. as Yashica) printer engine with a face-up and face-down stack tray, two paper trays, and a manual feed.

The dual-stack trays are one of those ratchet effects that will sell second-generation laser printers. The LaserJet requires your personal attention to load paper and to collate the output into the right order; the MT-910 stacks output face-down, in the right order, and feeds paper from one tray until it's empty and then uses the other. With 250 pages per tray, that's a whole ream of paper between reloads. You can also change the paper in one tray while the other is in use.

All these goodies come in a package that's anything but small. Without paper trays, the MT-910 is 21 inches long, 21 inches deep, and 16 inches tall. If you want to use the face-up paper trays plus bins, you need a 4-foot-wide space.

Whatever you put the printer on had better be sturdy. The MT-910 weighs 71 pounds, enough to qualify lifting it as an Olympic event. Two straps around the ends help you get it out of its crate—but you'll still want to enlist the help of a husky friend. Laser printers in general aren't light (and can't be tipped when moved), but this one is exceptional.

Once heaved into position, the MT-910 is a great printer. It warms up in about 30 seconds, is remarkably quiet, and runs at a rated top speed of 10 pages per minute (the original LaserJet was rated at 6 ppm).

For face-up printing (which puts your pages in reverse order), the printer uses a very flat paper path that keeps the pages from curling. Face-down (correct order) pages do curl because of their semicircular trip to the top of the printer. In fact, 20-pound copier paper curls so much that the pages tend to push each other up and over the top of the output tray. For double-sided copies on 20-pound paper, you have no choice: if the output isn't face-up, the paper will jam about every third page.

Face-up is also the default mode for manual feed, because letterhead and envelopes can't be curled. High-rag-content letterhead runs through the paper trays without incident (problematic on some other printers). The manual-feed tray has self-centering guides that make feeding odd-size paper or envelopes almost a joy.

Kyocera and Mannesmann Tally made this printer amazingly immune to brownouts. Next door to this office, on the same transformer, is an air conditioner that drops the AC line below 102 volts. When this happens, the MT-910 never loses data or gets confused, even though it has had plenty of provocation: the lights in the room blink off, and the house shakes whenever the air conditioner kicks in.

The printer has other niceties: a built-in life-cycle copy counter, plug-in interfaces, two font cartridge sockets (more on this later), and easy jam clearing.

Teething Problems

We had a few problems setting up the printer. The first was with the Centronics (parallel) interface plug-in board, which is supposed to slide along a set of guides and mate with a socket on the printer-controller board.

You choose your interface (serial or parallel) with the printer, so it's not installed when you take possession. The printer should complain if the interface isn't plugged in; but it doesn't. (The people at Mannesmann Tally said that their next ROM release should fix this problem.)

Because the socket is deep inside the printer, you need X-ray vision to be sure it's connected. We wasted hours checking the computer, the cable, and the printer itself before we thought of checking the interface. Recommendation: get your dealer to install and test the interface with your computer.

Once interfaced properly, the MT-910 is much friendlier than first-generation laser printers. The LaserJet and others use a 2-digit LED display that shows the machine's status in hexadecimal digits. The MT-910 has a 16-digit LCD status panel, a setup menu with yes/no questions, and error messages in English. It also saves your printer setup specs between sessions.

The Kyocera engine is more economical than the LaserJet's Canon; you refill the toner reservoir rather than throw away half the printer's works when the toner runs out. The MT-910 is shipped dry, so the first charge of toner has to fill the reservoir.

I suspect this is why we got occasional light copies after only 800 pages (one box of toner is supposedly good for 5000 copies). After we shook the printer (ever try shaking 71 pounds of printer?) to settle the toner, it behaved until we got more.

I suspect the stuff doesn't distribute correctly when first charged, or else it has a critical-need detector (a device that detects life-or-death jobs and generates a malfunction proportional to the need). New printers with new engines are especially hard to get supplies for. If you buy a laser printer, don't be caught short: keep at least one spare charge of toner on hand.

Another teething problem was with the font cartridges. The printer's status check is supposed to show which fonts are available. We didn't seat our cartridges properly, so the connection wasn't solid. The printer couldn't find them, and they didn't show up in the status check.

We have a final suggestion: laser printers should show how much memory they have on start-up. They should also have a memory-test option, because

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RAM goes bad in printers just as it does in computers.

Programming Niceties and Difficulties

The MT-910 emulates Hewlett-Packard's LaserJet Plus, the Epson FX series, the IBM Proprinter, the Diablo 630, and the Qume Sprint 11 Plus. We can only comment on the Hewlett-Packard emulation, which seems quite good. Dave wrote a text-formatting package that used the MT-910's Superset commands. The package is called Irish (as in setter); naturally, its command language is Gaelic.

We did not systematically try to break the Hewlett-Packard mode, but all the codes we sent it worked. These included form-drawing commands, sizing, graphics, and so on. On one occasion, though, we did manage to hang the printer—it wouldn't print, accept characters from the interface, or display an error status. It turned out we'd forgotten to take it out of graphics mode before sending text. Turning the power off and on fixed the problem but also brought up the question: Shouldn't smart printers have a reset button?

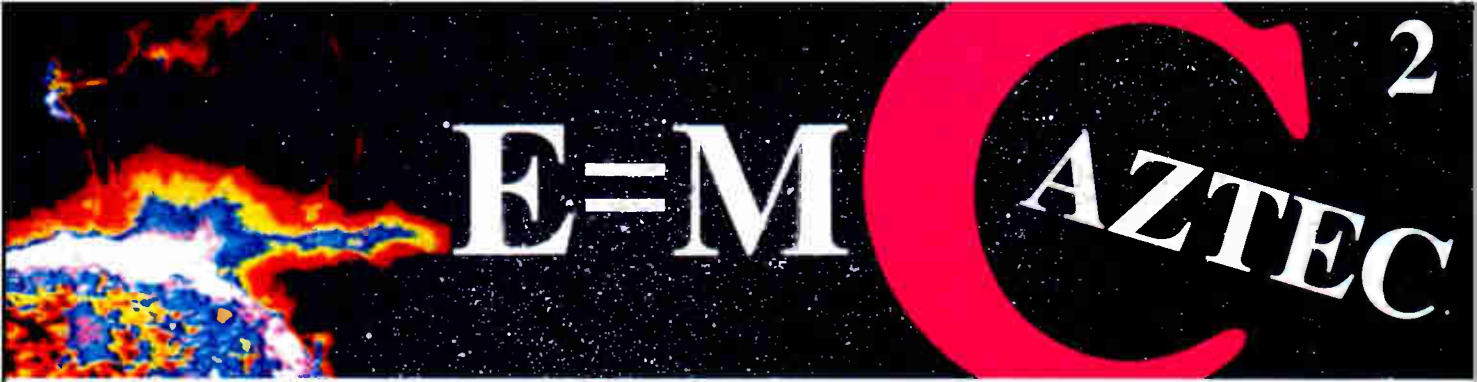
In its LaserJet Plus Superset mode, the MT-910 has a number of functions that are specific to the machine and provide additional features. For example, it can enlarge, underline, shadow, reverse, and bold characters without needing a new font for each enhancement. (A standard LaserJet needs a whole family of fonts to do the same.) Naturally, your software must know how to do this. We wrote our own.

The printer has two slots for font cartridges. They are *not* compatible with the LaserJet's font slot and are much smaller. However, Hewlett-Packard downloadable fonts should work (we didn't test them). The standard fonts are licensed from Bitstream.

The current cartridges contain only one font family, so documents with multiple fonts need a cartridge in each slot (or downloaded fonts). True, each family is a complete typeface: regular, bold, italic, shadow, and reverse require only one 2- by 3-inch cartridge. But if you wanted to use, say, both Helvetica (Swiss 721) and Times Roman (Dutch 801), you would have to buy two cartridges.

Any font can be used in any orientation; the printer will rotate characters in any increment of 90 degrees. This means the same cartridge works in portrait and landscape modes and also upside down and sideways. You might think you'll never need upside-down characters, but we wanted them in our new FTL Modula-

continued



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The programming examples are spotty. Shouldn't a $4000 printer come with a comprehensive $25 book on programming?

2 manual. The Dutch 801 font has an ugly opening-quote character that doesn't match the apostrophe used as a closing quote. So we commanded the printer to rotate the closing-quote character 180 degrees, then move it up into position and use that as the opening quote.

The Printer Manual

For once, a laser printer with a literate manual! Many printer manuals are the strange relative hidden away in the attic. This one deserves discussion. It gives author's credit (notice how few manuals do?), and the title (*Operator's Manual*) doesn't begin to describe what's in the book. The text covers programming, set-up, set-down (how many of us remember where the shipping restraints go?), troubleshooting, and care—in depth and in English. It also has a glossary of terms in the lingua arcana of laser-printer guts.

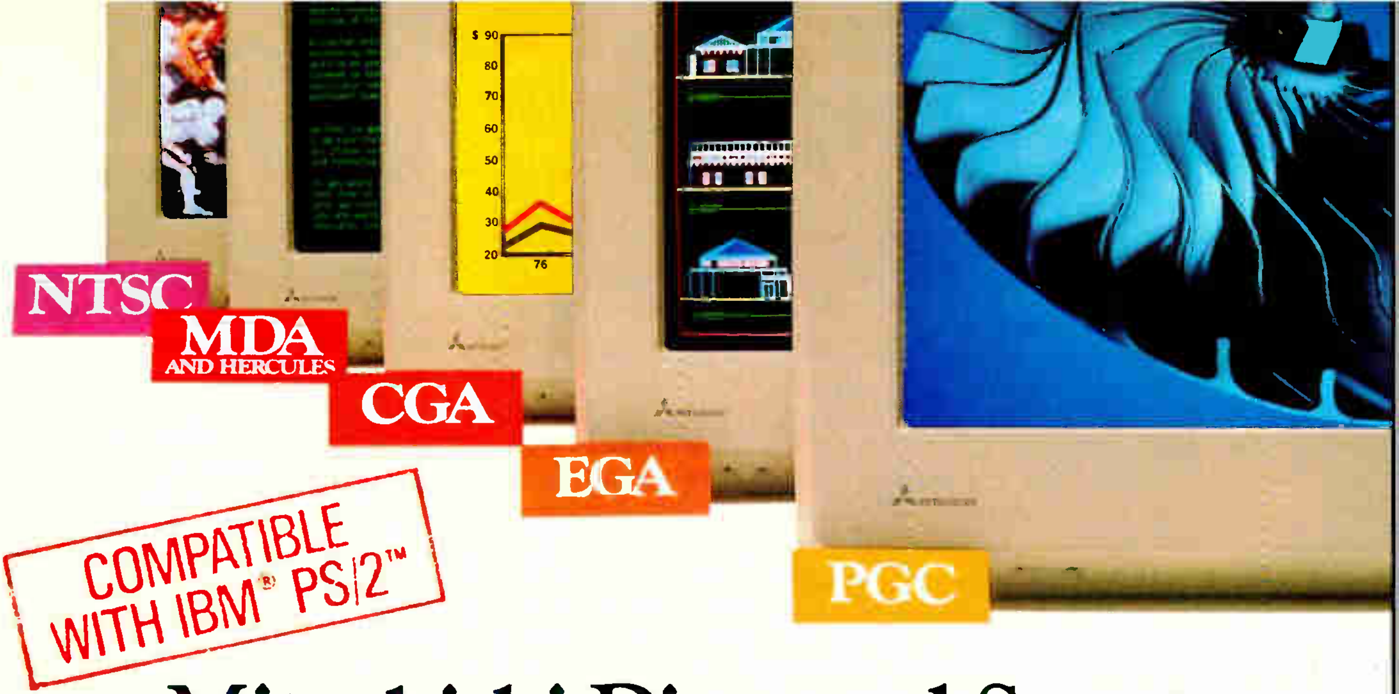
Maybe the most pleasant surprise in the manual is Appendix A: "How Your Laser Printer Works." So many manufacturers expect customers to treat their $4000 electronic gadgets like magic black boxes; it's nice that Mannesmann Tally credits its buyers with a little intelligence and curiosity.

However, the programming examples are spotty. The most complicated ones are, of course, for the LaserJet Plus emulation. I would not want to have to learn Hewlett-Packard commands from them alone. There are books on the subject. But shouldn't a $4000 printer come with a comprehensive $25 book on programming? Laser printers seem to inspire otherwise indifferent users to do specialized programming.

Font-spacing tables are another omission. Neither the manual nor the plug-in fonts come with a list of how wide each character is; Dave had to fashion several programs to find the spacing metrics. Mannesmann Tally's spacings are different from anyone else's, so we couldn't use Hewlett-Packard's tables. To be fair, this is one of our pet peeves about all kinds of printers.

All in all, the MT-910 is a solid work-

continued



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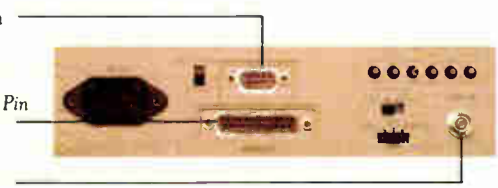

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horse printer. It runs fast, has a large paper capacity and a nice array of paper-handling features, and is inexpensive to supply. It isn't small or light, but it is quiet. It uses boxed toner but requires no more service than a Xerox copier. The major problems we had were with pale copies early on and with trying to correctly insert both the interface board and font cartridges.

This isn't an entry-level replacement for a daisy-wheel printer; it's a mid-priced, very fast (10 ppm), expandable printer that, although it doesn't offer PostScript, can (in Hewlett-Packard mode) do full-page graphics.

PostScript and Desktop Publishing

Jerry Pournelle here. I've one comment on Alex's exposition. The MT-910 is darned good, but its lack of PostScript capability is a serious limitation. If you're contemplating serious business-grade desktop publishing, you'd have to be out of your mind not to get a printer that speaks Adobe PostScript.

That could change. Although at present no PostScript clones are being shipped, several companies swear they'll have them Real Soon Now. They may have help from a different direction: Bitstream has announced the availability of fonts with the exact width metrics of Adobe PostScript.

That may take a bit of explaining.

PostScript was written by John Warnock and Charles Geschke, founders of Adobe Systems. The language itself was placed in the public domain. The Adobe implementation of that language wasn't. Printer makers must license that implementation and buy the ROM set to install in their printers. That adds between $400 and $900 cost per printer for the privilege of using Adobe PostScript. That license also buys the Adobe fonts.

Designing fonts is a black art that deserves more discussion than I have space for in this column. The important thing is that while the fonts themselves are, in general, not protected by copyright, their names are. What that means is that anyone could look up copies of the 1932 *London Times* and digitize and computerize the typeface the paper was printed in; but before anybody sold the font, they'd have to invent a different name for it than Times Roman, which is a copyrighted name—maybe something like London Dream. Similarly, you can do a clone of Helvetica, but you'll have to call it Swiss or some such.

Adobe, way back a year or two ago when desktop publishing was just starting, went out and licensed many of the best fonts, complete with their names,

continued

from companies like ITC and Linotype.

Now that PostScript has become the standard PDL—and so far there are no printers implementing any kind of PostScript other than the Adobe interpretation—it follows that if you want to print your pages on more than one printer, each of those printers must have, if not the same fonts, at least fonts that use exactly the same width metrics; otherwise, your lines won't be the same length on each printer, and at least one of the outputs will be ugly, ugly, ugly.

Bitstream, however, has gone out and "fontlerized" a whole bunch of typefaces, far more than Adobe ever did, often going back to the original type designer's specs; and since they've been careful to do the most popular fonts in Adobe metrics, it's now at least possible for one or another of the PostScript cloners to succeed.

Mannesmann Tally believes that Adobe charges too much for their licenses and intends to go with a PostScript clone. Company executives swear they'll have a PostScript update for the MT-910 well before the end of 1988.

Logitech Publisher Mouse

When Gutenberg designed his press, he tried to imitate illuminated manuscripts. He didn't succeed, but he did do some of the most beautiful print work the world has ever seen. It also took darned near as long to set up a book in Gutenberg type as it did for a monk to copy it.

Aldus Manutius, a Venetian businessman, had a different idea. He invented publishing for the rest of us. The story is told, incidentally, in the first volume of the *Journal of the National Association of Desktop Publishers* (P.O. Box 508, Kenmore Station, Boston, MA 02215-9998), which is a group well worth joining if you're seriously interested in the subject.

Anyway, that's where Aldus Corp., publisher of PageMaker, got its name. PageMaker isn't precisely in a class by itself—it does have competitors—but it does set the standards the others try to meet or exceed.

Logitech Publisher Mouse doesn't really try to compete with PageMaker. You get a Logitech mouse—still the best PCompatible mouse in the industry, in my judgment—and enough software to let you get a good start.

This product doesn't have all the features of the more advanced programs, although you can, with a lot of effort, duplicate what most of them do; but if you're interested only in restaurant menus, church bulletins, party invitations, general fliers, and the like, it may well be good enough for some time to come.

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TaxView Planner $79
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Inquiry 939.

Logitech Publisher Mouse comes with Point, a programming and text editor that will probably never be my favorite, but which, once again, is good enough for a lot of solid work. When we massaged Alex's contributions to this column, we needed an editor that knew how to search and replace on control and format characters, and we decided to experiment with Point. In about 6 minutes we had the editor up and running, and in 10 minutes we had the needed formatting taken care of. Point is fast, the help screens are reasonable, and the documents are, if not elegant, at least sufficient.

If you've been reading about desktop publishing and wondering what the shouting is all about, you can do a lot worse than get the Logitech Publisher Mouse and just play around with it. Recommended.

Winding Down

I'm completely out of space, and I haven't got well started on desktop publishing. Clearly, I'll have to continue next month. We've got PageMaker, The Office Publisher, and a bunch of nifty fonts from Bitstream.

Bitstream, by the way, has a neat little brochure full of samples of its best fonts; each sample is on a separate sheet not only printed in that font (with all its variations) but that also gives a brief history of the font, its origins, and best uses. I learned more about fonts from that brochure than from any other single thing I've seen.

I also learned that most PCompatible desktop publishers work with XyWrite. Sigh. Yet another text editor to learn. I have it; a review next month.

Tip of the month for Macintosh users: go get SoftView's TaxView Planner. It's really too late for 1987, of course, but from everything I've seen of it, TaxView Planner will save you one whack of a lot more than its cost in 1988. SoftView is the outfit that publishes MacInTax, which you have to have in order to use TaxView Planner. I've said before that MacInTax is worth buying a Macintosh to use.

The book of the month is *Publishing from the Desktop* by John Seybold and Fritz Dressler (Bantam Desktop Publishing Library, 1987). It combines much of the history of printing and publishing with insights into the microcomputer field. It isn't just recommended: if you're at all interested in desktop publishing, this book is essential.

The game of the month is Broderbund's Ancient Art of War at Sea. It's got a couple of user-interface problems I'll discuss another time, but if you like either war games or the Horatio Hornblower novels, you'll love this. Drop a hint and hope that it turns up in your Christmas stocking. ■

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."

Holiday Cheer

Ezra Shapiro

Looking for fun, our man falls in love and replaces his old rodent

Last year, I devoted my December column to software and hardware products that were such fun to use that I recommended them solely for the sheer joy they could provide to personal computing addicts. This year's batch is just as much fun, although I honestly haven't been able to find any neat games to round out the assortment.

This wasn't for lack of effort—I tried, I really did. I called the major publishers of entertainment software and promoted myself a huge stack of games for the IBM PC and the Macintosh: text adventures, graphical adventures, simulations, solitaire games, shoot-'em-ups—all the usual stuff.

I'd seen it all before. Nothing in the new crop was exciting enough to take my breath away. So if you're looking for pure pleasure with no redeeming social value, you're on your own. On the other hand, the products I discuss this month are all pretty special, even if they're useful.

The Right Touch

I've been enchanted with Macintosh graphics programs ever since MacPaint appeared, but I confess that none of them has been able to lure me away from traditional art supplies for recreational doodling. I do use SuperPaint and GraphicWorks when I need to create an illustration as part of a computer document, but I find that what I produce is usually somewhat stilted and stylized.

Some of this is due to the clumsiness of the mouse as a drawing tool, some is due to the problems of eye-hand coordination when you're drawing on the mouse pad and staring at the screen, and some is due to the constant changing of tools required to perform operations that are a cinch with a brush or a Conté crayon.

But there's finally a Macintosh program that's beginning to change my mind about all this, and I think I'm falling in love with it. The object of my affections is MacCalligraphy (Enzan-Hoshigumi, $149.95), the first paint program I've used that doesn't make me feel like an uncoordinated dolt. Although it has some significant limitations, it's probably the most enjoyable piece of software I've looked at in 1987.

MacCalligraphy is designed to simulate a brush dipped in ink, and, by Jove, it works. You can adjust the shape of the brush stroke, the length of the tail left at the end of a line when you've released the mouse button but are still moving the mouse, and the rate your "ink" is absorbed by the "paper" (actually, the rate at which pixels get spit onto the screen).

Moving the mouse slowly produces a fat, rich line. A quicker stroke results in a thinner, less even line. A jerky motion gives you a blotchy effect. After a while, you learn to draw with lazy, fluid arcs, as you would with a real brush.

The software was developed in Japan, and the metaphor it uses is that of Oriental calligraphy; your tool palette includes the ink stone, water dropper, and bamboo brushes of the traditional calligrapher. Grids are included for practicing roman or Oriental letterforms.

If you want to take a break for a few minutes, clicking on an icon of a tea bowl replaces your desktop with a courtyard scene for meditative contemplation. It's always the same courtyard, but the scene changes with the seasons, and subtle touches are varied to provide ongoing interest.

As a designer's program, MacCalligraphy is perfect for freehand artwork, lettering, and logo design, but you'll want to have one of the other graphics packages around for final tweaking. MacCalligraphy doesn't know about laser printers, scaled objects, fill patterns, distortions, typefaces, rulers, snap grids, and suchlike. In comparison to other paint programs, MacCalligraphy is a bit rudimentary. But what it does, it does well—better than anything else on the market.

The packaging alone would make MacCalligraphy an ideal gift. It's the only program I know that comes in a natural wood box, with 10 sheets of Japanese washi paper for printing your creations. The documentation, which is thorough and beautifully laid out on luxurious paper, is a work of art in its own right. It's written to teach both the philosophy of calligraphy and the use of the program; half an hour with the book will provide you with insight as well as technique.

I give the program high marks. I was so delighted with MacCalligraphy that I went out and bought a second copy as a present—and it takes a lot to get me to part with real cash for software.

An Unlikely Addition

I never would have dreamed of a spelling checker for spreadsheets, but it's an idea that makes solid sense. Over the past couple of years, I've been meeting more and more people who spend their entire lives inside Lotus 1-2-3; they start out by purchasing it for crunching numbers, of course, but they eventually wind up using it for word processing, graphics presentations, database management, and so on.

The need for spelling correction isn't limited to spreadsheet freaks alone; I've seen horrendous misspellings in worksheets that have been bolted into documents prepared with word processors that can import 1-2-3 files.

Spellin! (Turner Hall, $79.95) is an add-in spelling checker that works with 1-2-3 versions 2.0 and 2.01 and Symphony version 1.2. It's based on the Bor-

continued

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land Lightning engine, but the program's configuration as a Lotus add-in makes for some important differences.

Turbo Lightning will monitor your spelling as you type; Spellin! will not. However, Spellin! gobbles a bit less RAM (only about 100K bytes), and you can load and unload it from within 1-2-3 and Symphony; both features are a definite plus when you're coping with large worksheets. Also, Spellin! is compatible with other Lotus add-in products; I wish I could say the same about memory-resident programs loaded in at the DOS level.

You get just about everything you'd want from a spelling checker: a choice of main dictionaries (American or British), a custom dictionary for personal or professional terms, a standard change/change all/add/ignore/suggest menu that follows the Lotus interface, selective checking of either a range of cells or an entire worksheet, search and replace for text labels, case-sensitivity for capitalization errors, and a duplicated-word check.

Speed is nearly instantaneous, though a replace operation on a big spreadsheet can chew up time. Running Spellin! on my Tandon IBM PC AT clone at 8 megahertz, I found its performance quite impressive. And the price is reasonable.

If you make Lotus worksheets part of the way you do business, Spellin! will keep you from looking unprofessional at the most awkward moments. Recommended.

Building a Better...

When I moved my MS-DOS operations from my tired old Compaq Portable to the Tandon machine, I suddenly had more open slots than I had cards, which is an enviable situation. In a mad burst of slot-crazed euphoria, I decided to retire my Logitech serial mouse for the bus model. I've been working with it for a few months now, and it's been a high-resolution dream. I was all set to endorse it as my mouse of choice when I received FastTRAP (MicroSpeed, $149), a trackball device with some pretty nifty additions. Whoops—Logitech now has a serious competitor.

What's more, the FastTRAP isn't a mouse; the "TRAP" part of its name stands for "tri-axis pointer." The trackball sits in the lower center area of a small box, 7½ inches long by 4¼ inches wide by 2⅝ inches high.

Immediately above the trackball are three buttons, much like those on a regulation mouse. If you rest your palm on the trackball, you can depress the buttons with your fingertips. Directly above the center button lies a vertically mounted wheel; if you extend your hand about a half inch from the rest position, you can rotate the wheel with your index finger. MicroSpeed calls this a "trackwheel."

The underlying idea is pretty simple. In normal use, the trackball and the buttons serve as a direct replacement for a three-button mouse. The trackwheel is used to control the gain. At a low setting, the cursor crawls across the screen; at a higher setting, the cursor flies at the slightest touch. So what's this tri-axis stuff? Also pretty simple. With a driver written for FastTRAP, you can use the trackwheel to control a third dimension, say, a *z*-axis in a CAD package. Thus, you can construct three-dimensional orthographic drawings without having to switch modes. Think about that for a second; you're no longer restricted to working in two-dimensional planes.

FastTRAP comes with insanely thorough documentation and a full set of drivers, for installation either as part of your CONFIG.SYS or as a memory-resident program (loaded as a .COM file). MicroSpeed includes a small utility for writing your own command programs, so you can use FastTRAP with applications software that isn't designed for pointing devices.

The company recently started shipping a special driver for AutoCAD that uses the trackwheel to control AutoCAD's menus; you don't have to move the cursor away from your drawing to get to them. The selection of CAD packages that support FastTRAP in three-dimensional mode is growing daily; I suggest you call MicroSpeed for the current list.

I've been using the product for several weeks, and it's both faster and more convenient than a conventional mouse. Hand and arm motion is cut to a minimum. And with my desk covered with keyboards for both the Tandon and the Macintosh, a mouse pad for the Mac, and the usual paper clutter, the tiny footprint of FastTRAP makes it a lot handier than a second rodent. As it emulates the Microsoft Mouse just fine, thank you, I've had no trouble working with Windows applications or Microsoft Word.

I have only two gripes with the product. First, it's an RS-232C serial device, so I'm back to lusting for a second communications port. Second, I can't get one for my Mac Plus. Rumors from inside the company indicate that MicroSpeed is working on solutions to both problems. So I'm hoping to be a two-TRAP owner in the near future.

Map Mania

A year ago, I wrote about a wonderful program, Highways and Byways (from New Directions Software), that provides city-to-city route information for the traveler. You feed it your starting and end points, and it generates a text listing of the best route, point by point, optimized for either time or distance. I loved it, and I've been using it for planning auto trips ever since. Well, it has recently become the low-end product of the New Directions line. It's still the same program, but it has acquired two bigger siblings, called Corporate and Professional Maps. The original program is now called the Traveler's Map.

continued

Items Discussed

Digital Starter Set $950
Märklin Inc.
16988 West Victor Rd.
P.O. Box 319
New Berlin, WI 53151
(414) 784-8854
Inquiry 940.

FastTRAP $149
MicroSpeed Inc.
5307 Randall Place
Fremont, CA 94538
(415) 490-1403
Inquiry 941.

Highways and Byways
Traveler's Map ...... $49.95 or $129.95
Corporate Map .... $159.95 or $395.95
Professional Map.. $395.95 or $995.95
New Directions Software Inc.
5259 Sepulveda Blvd., Suite 9
Van Nuys, CA 91411
(818) 789-7839
Inquiry 942.

MacCalligraphy $149.95
Enzan-Hoshigumi (U.S.A.)
P.O. Box 131
Still River, MA 01467
(617) 456-8255
(800) 962-6686 for orders
Inquiry 943.

Spellin! $79.95
Turner Hall Publishing
10201 Torre Ave.
Cupertino, CA 95014
(408) 253-9600
Inquiry 944.

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All three versions generate the same sort of route listings. The Traveler's Map uses a database of only about 11,000 locations, which fills roughly a megabyte and a half of your hard disk and requires nothing more than an 8088-based MS-DOS computer.

The Corporate Map includes every city in the U.S., Canada, and Mexico with a population of 3000 or more, plus 250 airports, for a total of 20,000 locations. Its database fills 2½ megabytes of disk space. The Professional Map has 80,000 locations and consumes 4 megabytes of storage. A 286 machine (at least) is recommended for the larger databases.

Both the Corporate and Professional Maps generate a skeletal graphics map of a suggested route to complement the text listing. The Professional Map will also calculate the best route to connect up to 50 locations entered in random order, devise routes that avoid any obstacles to the clearance of your vehicle, and generate state-by-state mileage totals.

You can purchase any version as either a full national map or split into three regional editions (west, central, and east). The Traveler's Map sells for $129.95 (national) and $49.95 (regional). The Corporate Map weighs in at $395.95 and $159.95. The Professional Map is a hefty $995.95 and $395.95.

I've been playing with the Corporate Map, and it's a bit more than I really need. I'd recommend it only to people who spend a lot of time on the road; the Traveler's Map is a good buy and is completely adequate for most of us. I can only guess at the clientele for the Professional Map; beyond trucking firms and freight forwarders, my mind draws a blank. But it's all good stuff; easy to use, straightforward, and a godsend when you need it.

Whoo Whoooooo

Okay, okay. I promised fun, and here it is. This is a hardware product, far from my normal beat, and I haven't even tested an evaluation copy of it. But it's worth a mention; if it strikes your fancy, check it out.

Märklin, the German manufacturer of some of the world's finest HO-gauge electric trains, has gone digital. This year, the company is marketing something it calls the Digital Starter Set: two locomotives with several cars, a double oval of track, a central control unit, a transformer, two electric switches, and a decoder. This is high-priced, high-quality equipment. You're not going to be able to afford it if you're planning to save nickels from your weekly allowance; the Starter Set costs $950.

But if you've got a passion for model railroading and computers, this is the way to go. Digital technology means goodbye to the rat's nest of wires hanging underneath a layout; something like 80 locomotives and 270 other devices can be controlled through the track itself. And the control unit is a serial device; it can be run by any computer that has RS-232C output.

Running your trains is as easy as sending escape codes to your printer. The documentation for the set comes with instructions for programming it. It's uncomplicated, and you can write your program in any language you like.

When I first heard about the product, I was hoping Märklin was selling some sort of graphic interface, such as a Mac or Windows toolkit, but no go. You'll have to roll your own.

I've seen Märklin trains, and every one of them is an amazing miniaturization, well-built and finely detailed. Though I was tempted to try to obtain an evaluation unit, discretion got the better of me. I knew that someday I'd have to send it back, and I couldn't bear the thought. ■

How Farsighted Executives Are Using Their PC's For The Fun Of Profit.

By William J. Spink

For years now you've been hearing about the wonderful things personal computers will do for The Executive of the 80's—at least in theory.

But what's the *reality*? Can a PC help you enjoy your work more and show a greater profit, here and now? According to your peers, the answer is "yes."

"With just a few keystrokes," says Al Lynch, Director of Corporate Planning and Research for JCPenney Company, "I can screen companies, find possible acquisitions or 'scope-out' competitors. It's a real competitive edge."

Walt Casey, V.P. of Communications at ConAgra says, "I spend a lot of time each day poking into this and tracking that. It's *much* easier when you can immediately get the facts from a computer, rather than having to make a series of phone calls."

"One of Dow Jones News/Retrieval's services, QuickSearch, is a Godsend," adds Jim Posner, a respected retail consultant. "It gives me detailed corporate reports within minutes—I don't even have to leave the office.

Instant information: the executive advantage.

To lead in today's marketplace, you need information like *that*," Lynch says, snapping his fingers.

He recalls an example of how Dow Jones News/Retrieval®—the business and financial information service from Dow Jones & Company, Inc.—gave JCPenney Company a real advantage.

"Let's just say that a 'major player' in our industry was being acquired. Within a few hours we knew more about the takeover candidate than the bidder did. Honestly, we knew more than some investment bankers did.

Decision-making with the leading edge.

"Then we started getting the corporate insider trading data," Lynch continues. "It showed us some things that influenced a major deal.

Al Lynch
Director of Planning and Research, JCPenney Co.

Walt Casey
Vice President, Corp. Communications, ConAgra, Inc.

James Posner
President James Posner Assoc. Ltd.

"This service really makes a difference in the day-to-day running of your business. It can pay for itself very quickly."

Surprisingly easy.

All you need to access the service is a PC and modem. Using the service is "No problem," according to Posner.

"There's no difficulty using the service. I ask for pointed, specific information and get exactly what I need. It's much easier than manual research."

Walt Casey agrees. "Dow Jones News/Retrieval is simple enough for anyone who's at all comfortable with computers to use it effectively from their very first day online."

Making the right decision.

There are hundreds of online information services, many offering business data. How can you pick the best *one*?

"It was apparent from the first step that the most useful system was Dow Jones News/Retrieval," remembers Casey. "It offers so much of the information you're looking for—from general news and stock quotes, to data on our company and industry. It was the best single source."

"I've had other services, but Dow Jones News/Retrieval has the most useful business information in the right form," says Posner. "The time I spend 'playing' on the computer makes more money for me—and for my clients."

Now that's the *fun* of profit! ■

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MICROSOFT WINDOWS/386	195	125
PC-MOS 386	CALL	CALL
PHARLAP 386ASM/LINK	495	419
PHARLAP 386 DEBUG	195	155
SCO XENIX SYS V 386 (COMPLETE)	1495	1195
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APL* PLUS/PC	595	429
POCKET APL	95	79
SCREEN ACE *SPECIAL*	195	159

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ARITY STANDARD PROLOG	95	79
GOLDEN COMMON LISP	495	CALL
GCL 286 DEVELOPER	1190	CALL
LPA PROLOG PRO COMPILER	895	759
LPA PROLOG PRO INTERPRETER	395	339
MICROSOFT LISP	250	155
PC SCHEME	95	85
SMALLTALK V	99	85
STAR SAPPHIRE LISP	495	445
TURBO PROLOG	100	65
TURBO PROLOG TOOLBOX	100	65
VP EXPERT	100	89

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ADVANTAGE LINK	395	359
ASMLIB	149	125
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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
DB/LIB	99	89
FINALLY!	99	89
FLASH-UP	89	79
INSIDE TRACK	65	55
MACH 2	75	59
MS QUICKBASIC *REBATE*	99	65
QBASE	89	79
QUICK-TOOLS	130	109
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TRUE BASIC	100	69
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DATABASE TOOLBOX	100	65
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C/PAC (PFORCE, PRE-C) *SPECIAL*	495	279
C TOOLS PLUS/5.0 *NEW*	129	99
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DBASE MAC	495	CALL
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LIGHTSPEED C	175	125
LIGHTSPEED PASCAL	125	89
MAC C JR.	80	59
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MACTRAN 77	199	179
MASTERFORTH	350	315
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MC MAX *NEW*	295	CALL
TURBO PASCAL	100	65
NUMERICAL METHODS TOOLBOX	100	65
DATABASE TOOLBOX	100	65
Z BASIC	90	69

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Natural Language

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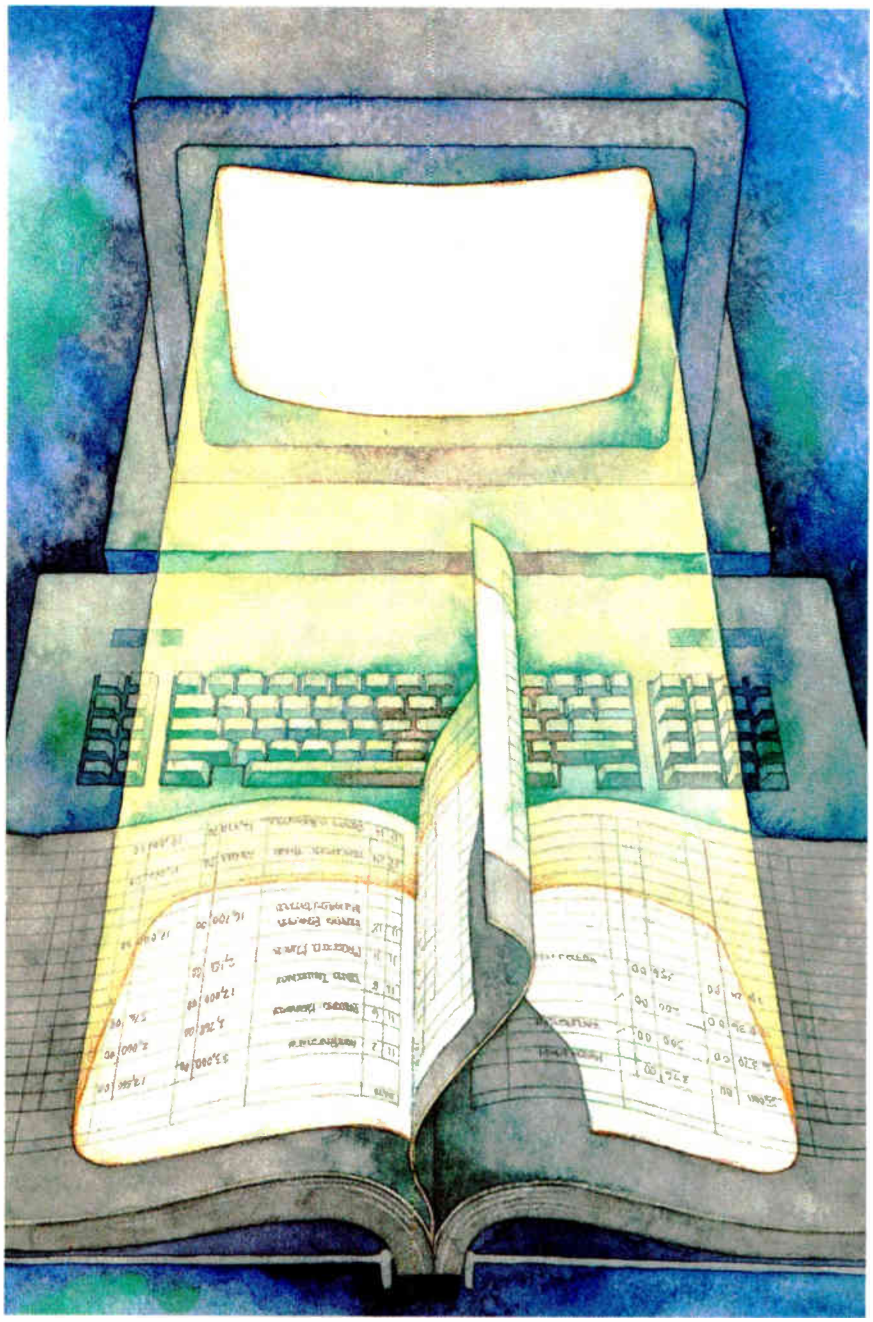
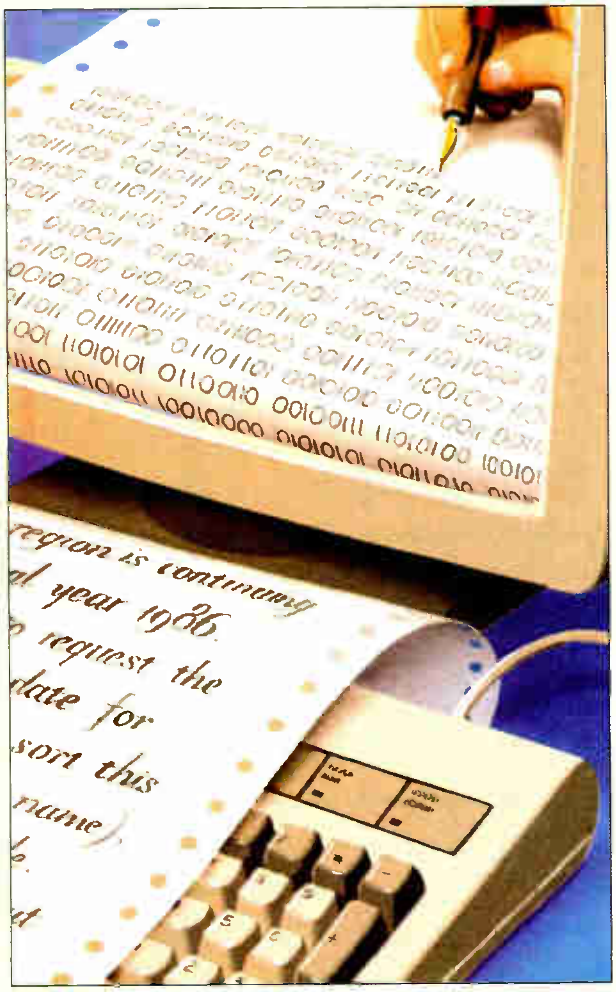


Introduction

Natural Language



Natural-language processing, getting computers to understand and communicate in everyday English (or French or Swahili), has long been restricted to the realms of science fiction. In the past, many attempts at natural-language-processing systems required so much memory and processing time that they were limited on even the largest mainframe computers. But today, when the performance of many microcomputers exceeds that of yesterday's mainframes, the opportunity for natural-language processing has become very real and exciting.

Often considered a subfield of artificial intelligence, natural-language processing is a field of study in its own right, and it is the focus of BYTE's In Depth section this month. We begin with the article "Natural-Language Processing" by Klaus K. Obermeier, a primer that mentions the several types of activities falling within this field. Perhaps the most popular activity is the design of front-end systems that can understand natural-language input and translate it into a form that a database program can understand. Other activities include natural-language translation—for example, from Russian to English—and natural-language generation, as in generating an appropriate business letter. Mr. Obermeier also describes some of the more prominent approaches to natural-language processing and speculates about what the future may hold.

Some interesting natural-language applications have already appeared on microcomputers. A sample of these programs is provided in the "Natural-Language Resource Guide."

Next, Matthew Zeidenberg's "Modeling the Brain" discusses connectionism, a neural-network approach to AI and natural-language processing. Although some researchers find the brain irrelevant to understanding the workings of the mind, others are trying to understand how the brain copes with the constant bombardment of stimuli as a basis for approaching the problems of cognitive science. The article discusses a parallel distributed-processing network as a possible model for the brain.

Moving from the abstract to the concrete, one of the most successful AI microcomputer programs to date is Q&A, a combination database and word processor with sophisticated natural-language-processing capabilities. Gary G. Hendrix and Brett A. Walter, the two people behind Q&A's natural-language interface, describe the technical considerations involved in designing "The Intelligent Assistant."

Of course, we would be remiss in covering natural-language processing if we didn't also mention the Prolog language. In "DOS in English," Alex Lane presents a very useful program written in the popular Turbo Prolog environment. The program, called NL-DOS, is a natural-language interface for DOS. With it, you can bypass many rather cryptic DOS commands and use plain English. Lane's program can be modified to handle a wide array of DOS commands and can be adapted to handle other applications as well.

And finally, in "Natural-Language Processing in C," Herbert Schildt presents some material adapted from his book *Artificial Intelligence Using C* (Osborne/McGraw-Hill, 1987). The technique he illustrates, top-down context-free recursive-descent parsing, is not unique to natural-language processing, but it is used in many computer-language compilers as well.

This section presents a brief glimpse of the technology currently in use and, perhaps, to come in our attempt to understand and implement natural-language processing on computers.

—Rich Malloy and Jane Morrill Tazelaar, Technical Editors

Natural-Language Processing

An introductory look at some of the technology used in this area of artificial intelligence

Klaus K. Obermeier

THERE ARE ALMOST as many definitions of natural-language processing (NLP) as there are researchers studying it. But for purposes of simplicity, I will define NLP as the ability of a computer to process the same language that humans use in normal discourse.

NLP is generally divided into six major areas: (1) natural-language interfaces to databases, (2) machine translation—that is, from one natural language to another, (3) text scanning/intelligent indexing programs for summarizing large amounts of text, (4) text generation for automated production of standardized documents, (5) speech systems to allow voice interaction with computers, and (6) tools for developing NLP systems for specific applications. According to the Clearinghouse for NLP at Battelle Columbus Laboratories, over 40 percent of research activity is devoted to developing natural-language interfaces to databases. Machine translation and NLP tools each account for 20 percent of the research. The remaining categories attract significantly less activity.

Approaches to NLP

The central problem for NLP systems is the transformation of a potentially ambiguous input phrase into an unambiguous form that can be used internally by a computer system. These internal representations, of course, vary from one application to another. As you can imagine, major problems arise if there is more than one potential interpretation of the input (as in "List all employees broken down by sex") or if the input is somehow incomplete (e.g., "if y cn rd ths u r smrt").

The transposition from the potentially ambiguous phrase to the internal representation is known as *parsing*. The word *parse* is actually derived from the Latin phrase *pars orationis* (part of speech). In NLP, parsing is usually a process of combining the symbols of a phrase into a group that can be replaced by another, more general symbol. This new symbol can in turn be combined into another group, and so on, until an allowable structure evolves.

Five different types of parsers have evolved: pattern-matching, grammar-based, semantic, knowledge-based, and neural-network parsers. Each one has a unique approach to NLP.

Pattern-Matching Approaches

Early natural-language programs were based on the idea that parsers can look for recurring linguistic patterns in a sentence without using any explicit grammatical formalism. During sentence analysis, the system merely looks for a possible match with a fixed number of patterns. If a match is found, the system performs a certain action (e.g., rearranging the input according to another pattern). The process is similar to template-matching programs in other areas of AI (e.g., vision).

ELIZA, the best-known pattern-matching program, was designed to simulate a Rogerian psychologist. The program, still popular today, was written by Joseph Weizenbaum in 1966. ELIZA consists of a set of patterns (see figure 1), with each pattern having a number of replies associated with it. When a particular pattern is matched, the program selects one of the given set of replies and makes any necessary substitutions in that reply.

Pattern-matching programs without a grammatical basis proved to be of limited use. They are useful only if partial analysis is required or if other components of the system can make up for the loss of syntactic information. The basic concept of pattern matching, however, has been further developed and was used in *semantic grammars*, which I will discuss later.

Grammar-Based Approaches

The term *grammar* refers to a set of rules that describes what sentences are part of a particular language. These rules are often called *rewrite rules* or *productions*. Two simple rewrite rules are as follows:

$$S \rightarrow NP\ VP$$
$$S \rightarrow VP$$

These rules stipulate that a sentence (S) must have a noun phrase (NP) and a verb phrase (VP), or just a verb phrase by itself. With these rules you can build a tree structure showing unambiguously how the words in a sentence interact (see figure 2). It is common practice to call the words at the ends of tree limbs *terminals*. The other symbols in the tree, which are

continued

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usually capitalized, are called *nonterminals*. Rewrite rules usually establish how a nonterminal can be rewritten as a string of terminals or other nonterminals.

The noted linguist Noam Chomsky devised four types of grammar, based on the types of rules they used. The simplest grammar, Type 3, is also known as a *finite-state* or *regular* grammar. It can produce only simple "sentences."

The Type 2 grammar is also known as a *context-free* grammar. In this grammar, the left side of each rewrite rule can consist of only a single nonterminal symbol. Note that this symbol can always be rewritten as the right side of the rule, regardless of the context in which that nonterminal appears. [Editor's note: *Most syntactic parsers use a context-free grammar. See "Natural-Language Processing in C" by Herbert Schildt on page 269.*]

```
Input Pattern:    (O YOU REMEMBER O)

Replies:          (DO YOU OFTEN THINK OF 4)
                  (DOES THINKING OF 4 BRING ANYTHING ELSE TO MIND)
                  (WHAT ELSE DO YOU REMEMBER)
                  (WHY DO YOU REMEMBER 4 JUST NOW)
                  (WHAT IS THE CONNECTION BETWEEN ME AND 4)

Sample Input:     DO YOU REMEMBER LAST WEEK

Sample Response:  WHAT IS THE CONNECTION BETWEEN ME
                  AND LAST WEEK
```

Figure 1: *ELIZA, one of the earliest natural-language-processing programs, uses a pattern-matching parser to create responses to user input. The listing here shows one of the patterns used by the program and its replies. The word "O" in the pattern will match with any number of words. The number 4 in the replies is substituted with the fourth element in the input pattern—that is, those words that correspond to the second O.*

```
Grammar:
     S → NP VP
     NP → DET NP1
     NP → NP1
     NP1 → ADJ NP1
     NP1 → NOUN
     VP → VERB ADV
     NOUN → program
     VERB → compiles
     ADJ → new
     DET → the
     ADV → slowly

Sentence:
     the new program compiles slowly
```

Tree:

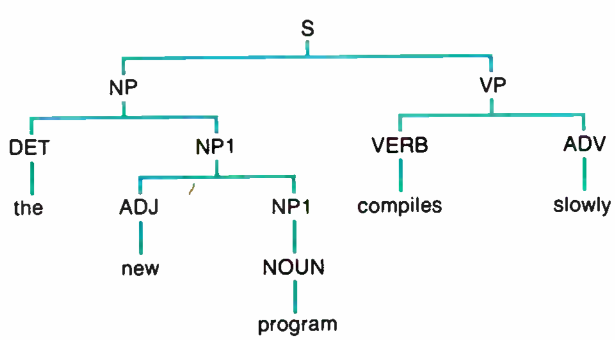

Figure 2: *A simple sentence, a simple set of rewrite rules, and a tree drawn of the sentence using those rules. The symbols or words at the ends of each limb are terminals. The other symbols are called nonterminals. In this grammar, which is context-free, a single nonterminal is rewritten as one or more other symbols.*

The next most complex grammar is a Type 1 or *context-sensitive* grammar. In this type, more than one symbol can appear on the left side of the rewrite rule. There is only one requirement for these rules: There must be more symbols on the right side than on the left.

The most complex grammar, Type 0, has rules that do not follow any set pattern or requirements. This grammar is very difficult to parse. Indeed, researchers have proved that a Turing machine is required to process languages with this grammar.

Chomsky's major contention was that a natural language such as English could not be completely described by a context-free grammar, but required either a context-sensitive or a Type 0 grammar. There is an ongoing dispute in linguistics, however, as to whether English does in fact conform to a context-free grammar.

One argument in support of English being a context-sensitive language involves the fact that singular nouns and plural nouns require singular verbs and plural verbs, respectively. For example, the grammar in figure 2 is a simple context-sensitive grammar. You can expand this grammar by adding two rewrite rules, both of which are allowable:

NOUN → programs
VERB → compile

Now, however, the grammar will allow a sentence that is not allowable in English:

The programs compiles slowly.

You can add additional rules to the grammar that would disallow such sentences, but these rules would destroy its present simplicity. Other problems are caused by the word "respectively" in sentences such as "Singular nouns and plural nouns require singular verbs and plural verbs, respectively."

Semantic Approaches

The central role of *meaning* in understanding language has led some researchers to rely on predominantly semantic rather than syntactic approaches. These researchers do not deny the need for some structural processing; rather, they use the syntactic analysis to complement their semantic considerations.

Two semantically oriented approaches to NLP are *case grammar* and *semantic grammar*.

Case grammar has been used in a number of NLP implementations since its development in 1968. The idea behind case grammar is that every sentence has an underlying representation of its meaning. This representation includes the verb and the various noun phrases related to the verb. For example, in the sentence "John opened the door with a key," we designate "John" as the *agent*, "door" as the *object*, and "key" as the *instrument* for the verb "opened." Note that the cases remain the same for the sentence "The door was opened by John with a key."

The founder of case theory, C. Fillmore, referred to the relationships between these nouns and the verb as *cases*. (You may recall that Latin and some modern languages have similar cases for nouns.) Fillmore postulated a number of cases, none of them occurring more than once in a sentence.

Semantic grammar consists of a lexicon and a series of rewrite rules. It is similar to a syntactic grammar, except that word classes (e.g., NOUN, VERB) are replaced by specific semantic classes (e.g., SHIPS, SHIP-PROPERTIES). The advantage of this approach is that the size of these semantic classes is much smaller than the size of an equivalent word class. This results in a much more efficient parsing strategy, since the program has to check a smaller number of possibilities. The disadvantage of semantic grammar is the difficulty of transferring rewrite rules from one domain of applications to another.

One of the most prominent implementations of semantic grammar was LADDER, developed in 1978 by Gary G. Hendrix. LADDER was designed as a natural-language interface to a database for the U.S. Navy. Figure 3 shows an example of some of the rewrite rules used by LADDER. Hendrix later went on to form the company Symantec and developed the database manager/word processor Q&A. [Editor's note: *See "The Intelligent Assistant" by Gary G. Hendrix and Brett A. Walter on page 251.*]

Knowledge-Based Approaches

Instead of relying solely on the structural or semantic information of a sentence, some NLP systems also have access to a knowledge base for a specific domain of knowledge. This contrasts with most grammar-based theories that look at NLP simply in terms of a set of rewrite rules for sentence-level processing.

One knowledge-based approach is called *word-expert parsing*. In this approach, the word is considered the basic linguistic unit. Linguistic knowledge is distributed among a group of procedural "experts" that know how the interpretation of a word changes in particular contexts.

One argument in favor of this approach is the fact that words have a rich linguistic and conceptual structure. Also, it is unlikely that language can be reduced solely to a number of rewrite rules, as implied by most grammar-based theories.

Another knowledge-based approach is called *conceptual dependency theory*. The central idea behind this theory is to create a *canonical* representation of a sentence, based on certain semantic primitives. A canonical representation is simply a basic way of representing the meaning of a sentence. Different sentences that mean the same thing will all have the same common canonical representation. For example, "Jean eats candy" and "The candy was eaten by Jean" both share the same canonical representation: "Jean ↔ INGEST ← candy."

In this theory, semantic primitives are the most basic entities used to describe the world. Individual words can always be analyzed further, but semantic primitives cannot.

The most prominent use of conceptual dependencies was done by Roger Schank in 1975. His idea of representing the meaning of a sentence such as "Jean eats candy" is to postulate primitive actions to represent semantic relationships. These primitive actions include INGEST ("take something to the inside of an animate object") and MOVE ("move a body part"). Schank's original theory postulated only seven primitive actions. Five of these were for physical actions (PROPEL, MOVE, INGEST, EXPEL, and GRASP). The remaining two were for describing state changes: PTRANS (physical transfer of location) and MTRANS (mental transfer of information).

In 1977, Schank integrated the theory of conceptual dependencies into his *script* theory. A script is a set of standardized, perhaps oversimplified knowledge used for processing natural language. For example, a script for a restaurant would contain certain basic facts, such as:

S—Customer

Entry conditions:
S is hungry.
S has money.

Results:
S has less money.
S is not hungry.
S is pleased (optional).

The script also contains other information, such as what kinds of people or things are found in the restaurant, and what types of actions these people or things are allowed to do.

Neural-Network Approach

A fairly recent approach to NLP involves setting up a network of neuron-like computing units. Each unit has a number of inputs, a small set of possible states, and an output that is a function of the inputs. Each input to the computing unit has a confidence value, which can vary from −1 to 1. When a computing unit is activated, it evaluates all its inputs and weighs them according to their respective confidence values. If certain conditions are met, the computing unit generates an output value that is used as input by other computing units. Note that only the confidence values of the inputs may be changed during "learning"; the connection pattern is "prewired."

This type of system is usually called a neural-network or *connectionist* approach. The fundamental premise of the approach is that the individual units do not transmit large amounts of data but compute simply by being connected to a large number of similar units.

The neural-network parsing model

continued

Rewrite rules:

S → what is SHIP-PROPERTY of SHIP?

SHIP-PROPERTY → the SHIP-PROP | SHIP-PROP

SHIP-PROP → speed | length | draft | beam | type

SHIP → SHIP-NAME | the fastest SHIP2 | ...

SHIP-NAME → Kennedy | Kitty Hawk | ...

Sample input:

WHAT IS THE LENGTH OF THE KENNEDY?

Figure 3: *Some of the rewrite rules used by the semantic grammar of the LADDER system. Note that semantic classes such as SHIP and SHIP-PROPERTY have replaced the word classes of figure 2. The pipe symbol "|" designates "OR."*

contains three levels of "neurons." The first level is the lexical level, which serves as the input level of the network. Here, the neurons are mapped to particular words. On the second level, the word-sense level, the inputs from the lexical level are combined to activate neurons that represent the meaning of the words. On the third, case-logical, level, the meanings are combined to form predicates and objects.

Neural-network parsing comes closest to modeling human linguistic information processing, based on neurological evidence. It is, however, still at the beginning stage of research. For a description of neural-network parsing, see "Toward Connectionist Parsing" by Small, Cottrell, and Shastri. [Editor's note: *See also "Modeling the Brain" by Matthew Zeidenberg on page 237*].

Parsing Techniques

Once a natural-language developer has decided on a particular parsing approach, he or she must then choose a parsing technique or formalism. Parsing techniques fall into two groups: *nondeterministic* and *deterministic*. The nondeterministic parsers can be further divided into *top-down* and *bottom-up* parsers. Other specialized parsing techniques are based on combinations of these three major types.

Top-down parsers try to match the grammar rules against the input, starting at the topmost rewrite rule (which usually involves the start symbol or sentence symbol S) and recursively moving toward lower, more specific rewrite rules. The parse is successful if a sentence can be constructed that matches the input sentence.

Top-down parsers are easy to write and modify. Rules that are more likely to be used can easily be placed ahead of less likely rules, enhancing performance. And the number of generated sentences can be arbitrarily limited.

Top-down parsers can be slow, however. If all the rules at a particular level fail, the parser *backtracks* up to the previous level to try another rule there. During backtracking, the same constituents may be analyzed many times. Top-down parsers also have trouble handling ill-formed input and require a separate module to decide which of several successful parses is the best.

Bottom-up parsers start by combining the lowest-level elements first and then building up larger constituents. For example, in the simple grammar in figure 2, the first steps of a bottom-up parser would be to substitute the nonterminal DET for *the*; ADJ for *new*; NOUN for *program*; and NP1 for ADJ NOUN.

Bottom-up parsers can at least partially parse ill-formed input. Also, scoring mechanisms can be applied to reduce the combinatorial explosion of possible parses. Since bottom-up parsers are not goal-directed, however, they generate numerous spurious parses. And the correctness of the parse can be determined only after all the parses are performed.

Deterministic parsing is different from top-down and bottom-up parsing in that there is no backtracking. Deterministic parsing is also called *wait-and-see parsing* (WASP). The technique creates new nodes in a bottom-up fashion but uses a limited look-ahead feature to determine which node to use. One advantage of a deterministic parser is increased speed because it avoids the combinatorial explosion of possible parses. The disadvantage is that the algorithm is based solely on syntactic information.

The best known of the deterministic NLP systems was PARSIFAL, created by M. Marcus in 1980. One result of PARSIFAL was a clear delineation of when such a parser would have to use nonsyntactic information to analyze input.

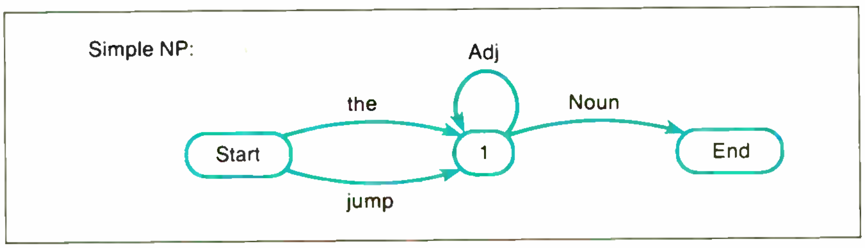

Figure 4: *A transition network for a simple noun phrase. The computer begins at the state labeled "Start" and moves to other states depending on how its input matches the labeled arcs. The arc labeled "jump" is always taken if tested. Note that this network performs the same function as the rules "NP" and "NP1" in the grammar of figure 2.*

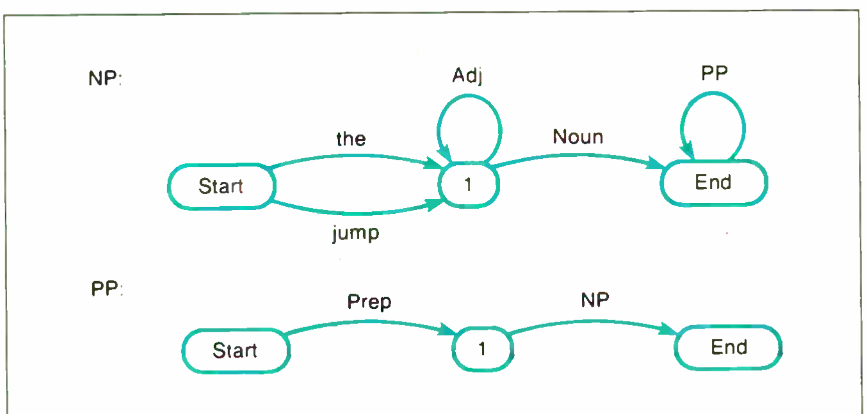

Figure 5: *A set of recursive transition networks for a noun phrase (NP) and a prepositional phrase (PP). These networks can be called by other networks or by each other.*

Augmented Transition Networks

Although first developed in 1970, the augmented transition network (ATN) is still the most widely used technique for NLP. But before I describe ATNs, I'll discuss *transition networks*.

A transition network consists of a series of states connected by arcs (see figure 4). Each arc is labeled by a word category (e.g., noun or verb) or a specific word. The program starts at a given state and then checks the next word in the input string for a match with one of the arcs. If a match is found, the program proceeds to the next arc, and thus "traverses the network."

The advantage of transition networks is that they can be easily implemented on a computer. Each state can be implemented as a function that checks its input against the arcs emanating from that state. If a match is found, the function (or state) at the end of that particular arc is called.

Recursive transition networks have an additional feature in that some arcs may be labeled with other, subordinate, transition networks (see figure 5). These arcs let a given network call another network or even call itself recursively. Usually these arcs are labeled with nonterminal

continued

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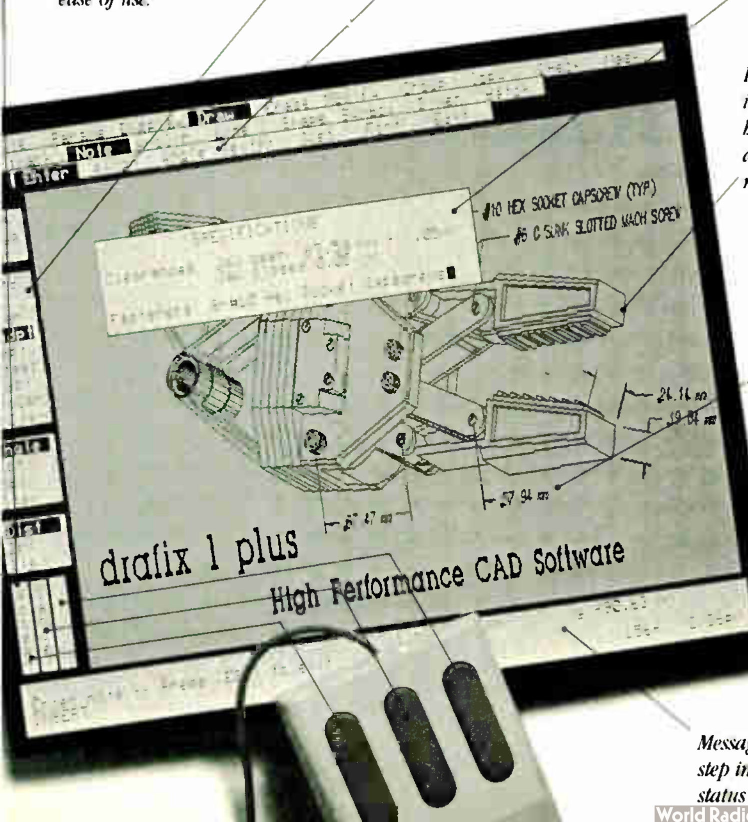

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The ATN remains the most widely used technique for natural-language processing.

symbols (e.g., PP for prepositional phrase). These networks are considerably more powerful than transition networks.

Even more powerful are *augmented transition networks*. ATNs are similar to recursive transition networks but have three additional features: *registers*, which can store conditions or information on a global basis, regardless of which particular subnetwork is being processed; *conditions*, which let arcs be selected if registers indicate certain conditions; and *actions*, which let arcs modify the structure of data.

Note that the arcs in an ATN can be labeled, not only with words, word classes, and nonterminals, but also with arbitrary tests that depend on the state of the global registers. These global registers and their associated tests make it possible for the program to go beyond checking only adjacent elements. Obviously, being able to store and act on these conditions makes possible a much more efficient parsing than earlier transition networks did. For example, the presence of a form of the verb "be" before the main verb in a sentence can set a trigger to check for the preposition "by," which in turn can corroborate evidence for a passive or an active sentence.

Although ATNs are powerful, they experience problems with ungrammatical sentences for which no relevant networks have been provided. If the program encounters a construction for which it does not have a structural description, it simply stops.

Chart Parsers

The chart-parsing idea was implicitly stated in a classic paper by J. Earley in 1970 on context-free parsing algorithms for compilers and compiler generators.

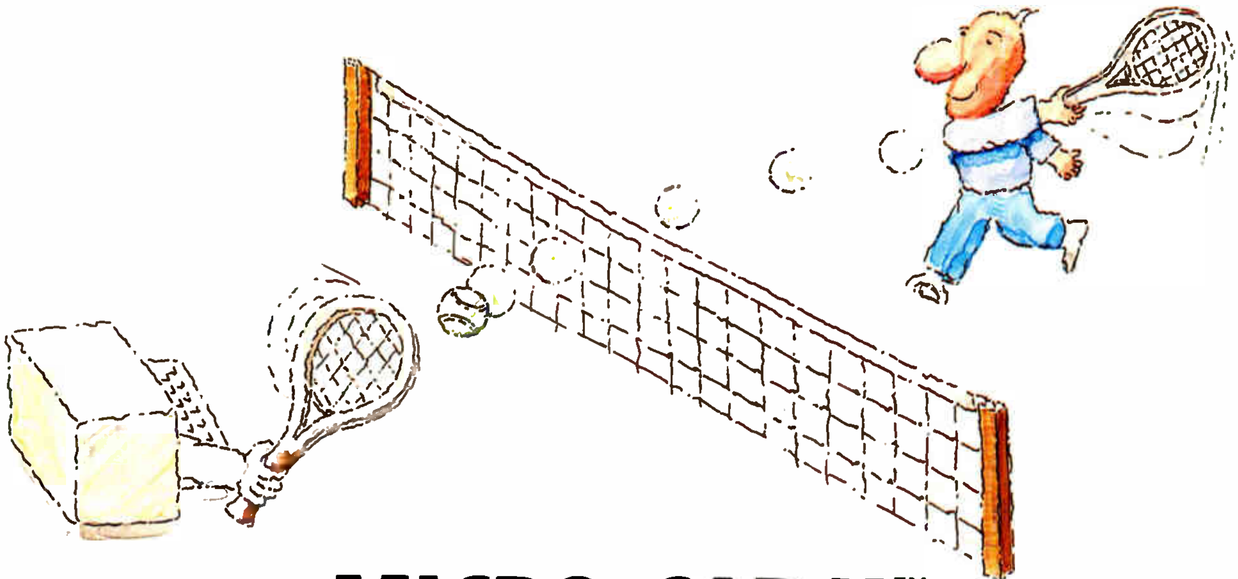
A chart parser combines the constituents of the input sentence according to the rules of a particular grammar. It combines these constituents as they are encountered and stores the output in a well-formed substring table (the chart). The parsing mechanism keeps track of the constituents it has built and the contexts in which they are expected. This means that no work needs to be duplicated for combining words that potentially are part of several parses. A chart parser combines the flexibility of control of a top-down parser with the data-driven processing power of a bottom-up parser.

One advantage of a chart parser is that it can be used with any of several grammatical formalisms, rule invocation strategies, and search strategies. With this flexibility, however, comes the disadvantage that the program must record all plausible and implausible parses, leading to increased storage requirements.

The Future

Market predictions are hard to make for an area of R&D as embryonic as NLP. Many of the scenarios that have been proposed feature an overly optimistic prognosis. A case in point is a prediction by the newsletter *Artificial Intelligence Markets* in August 1985 that revenues for NLP software would grow by 200 percent between 1984 and 1985. Actual growth was around 100 percent. For 1986, AIM predicted a mere 20 percent increase. AIM also predicted that approximately

continued



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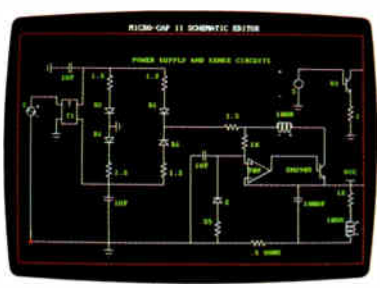

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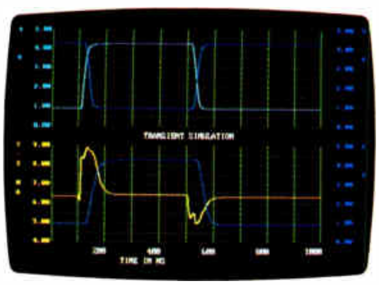

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450,000 personal computer software packages with integrated NLP capability will be shipped by 1990.

Numbers, however, can be misleading, success stories subjective, and claims often too optimistic. In brief, NLP technology is still too young to allow firm long-range predictions. But, comparing current market studies with the information from Battelle's Clearinghouse for NLP corroborates the above-mentioned trend toward the personal computer and integration in everyday applications software.

In the long run, progress will be influenced primarily by unforeseeable innovations in both software and hardware, and maybe netware.

Intelligent user interfaces of the future will require capabilities for both the understanding and the generation of natural language. The market potential for NLP products will further increase if a common standard can be established. This common standard would let users access different programs and databases through the same interface. NLP tools will become more popular, depending on the demand for better interfaces to many different software packages. Customization and integration will play a role, since the applications program is only as good as its interface.

A Science by Itself

NLP has been a controversial issue for the fields of both AI and linguistics. AI research was said to be practical but untheoretical, whereas research within linguistics was theoretical but impractical. The eclectic nature of NLP research has to give way to a more autonomous discipline dealing exclusively with the issue of natural-language understanding by biological and electronic organisms. Current NLP research is caught between the ideologies of the various academic disciplines. NLP systems of the future have to be based on more innovative linguistic and conceptual models if they are to become useful and accepted on a large scale. ■

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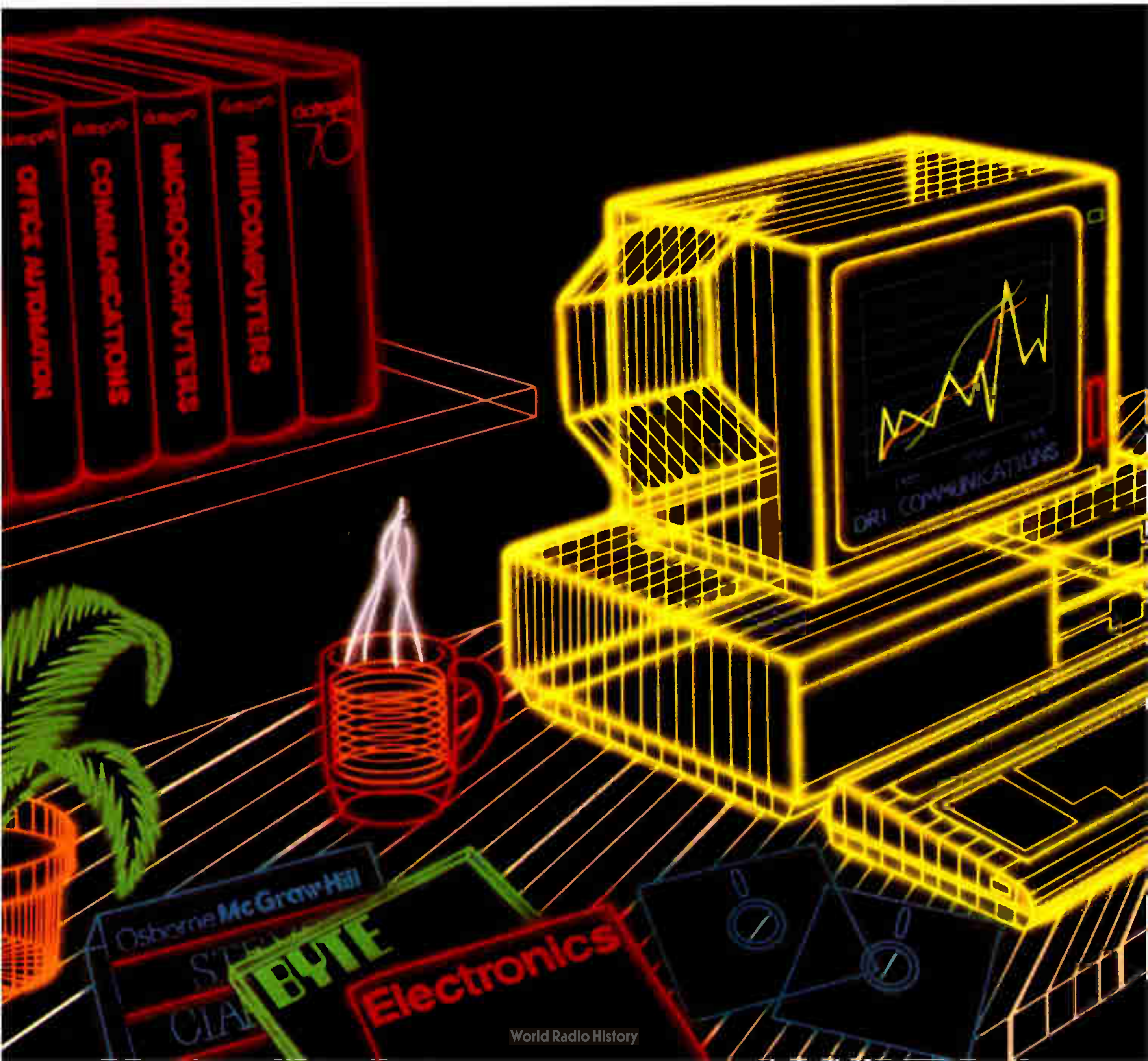

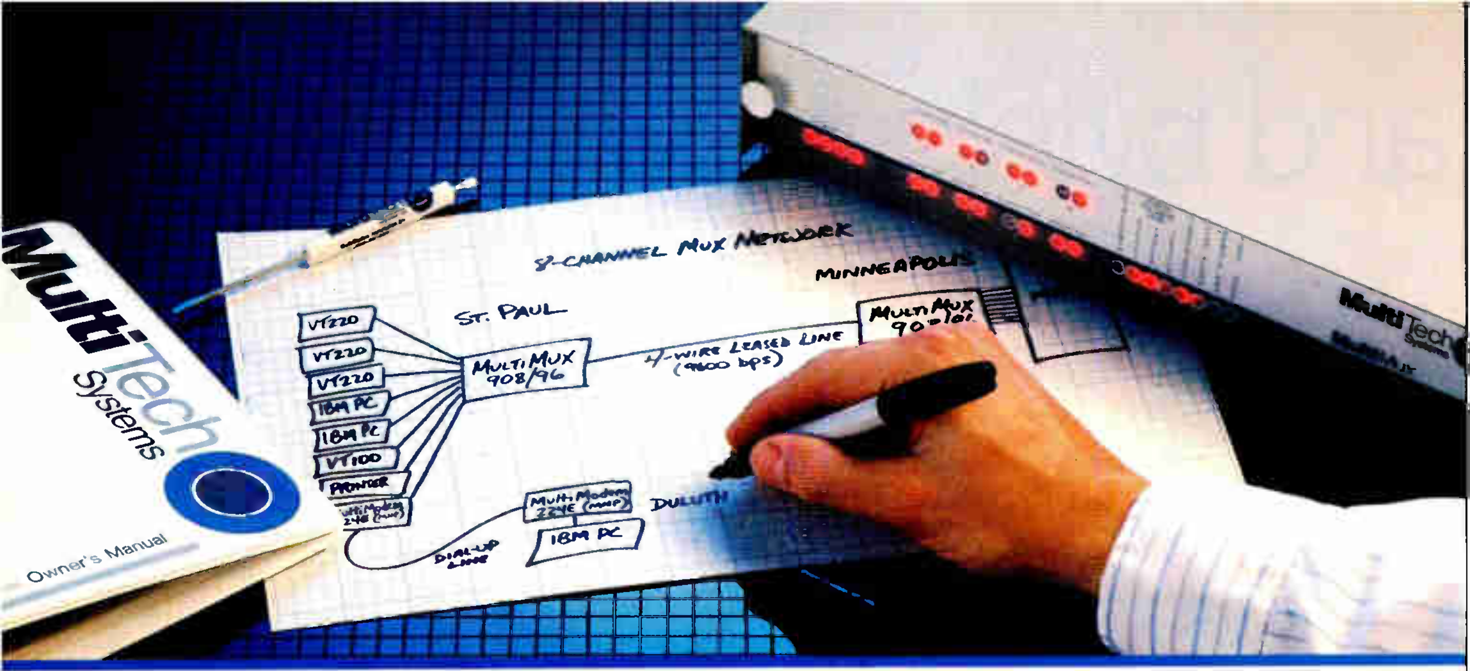

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Modeling the Brain

A neural-network approach to natural-language processing and similar problems may be the key to building systems that "learn"

Matthew Zeidenberg

THE IDEA OF simulating the brain formed the foundation for much of the early work in artificial intelligence. The brain was seen as a "neural network," that is, a set of nodes, or neurons, connected by communication lines. Lately, there has been a substantial revival in the use of neural-network models, or connectionism, as the field is often called (see reference 1). Connectionist models are applicable to a variety of cognitive-science problems, including natural-language processing, speech processing, and vision.

One major advocate of connectionism is Daniel W. Hillis. His Connection Machine is more brain-like than a traditional computer. Hillis points out that in a conventional computer, most of the silicon lies inactive most of the time. At any given time, only the CPU and a very small part—a few bytes—of the memory are active (see reference 2). The Connection Machine is composed of many processor/memory units, most of which are active at the same time. Douglas R. Hofstadter (see references 3 and 4) has long been an advocate of a similar view of cognition, with interacting actors in a cognitive process exchanging messages.

On the simplest level, the brain functions as follows: Neurons activate or inhibit the firing of other neurons. Whether or not a particular neuron fires depends on the inhibitory or excitatory inputs from all the neurons connected to it. Somehow, the activations of all the neurons, how they communicate with one another, and the nervous system's interactions with the environment determine your memories and thoughts—at least as far as philosophical materialists are concerned.

Of course, neurophysiologists, while still largely in the dark as to the operation of higher cognitive functions, have learned a great deal more about the brain than is evident in this simple model. Nevertheless, scientists in the 1950s were amazed at what simple systems of nodes with excitatory and inhibitory connections could do. (See the text box "The Perceptron Controversy" on page 240.)

In 1943, Warren S. McCulloch and Walter Pitts proved that any neural-network model in which a finite amount of information could define the state of an individual neuron could be modeled on a standard computer. The "finite amount of information" assumption is a big one: The number of bits needed to describe the state of a given neuron may be so large that it makes the simulation slow and impractical.

Is the Brain Relevant?

A strong school in AI feels that studying the brain is not the most fruitful road to understanding thought. The brain represents just one way of making a thinking machine, and certainly not the optimal way. Traditional AI sees thought as a series of problems to solve, and believes strongly that there is no philosophical reason why a computer can't solve them. The basis for this belief is the Church-Turing thesis, which roughly states that if a function is computable, you can compute it with a conventional computer—formally, a Turing machine. This thesis cannot be proved, but it is widely accepted because no one can think of a counterexample.

Daniel Dennett of Tufts University argues that neurophysiologists, working from the "bottom up"—that is, from the minute details up to the overall problem to be solved—in an attempt to understand human cognition, and computer scientists, working from the "top down," may ultimately both reach their goal. But he thinks the computer scientists will reach it first (see reference 5). The argument is: If I take a computer running a spreadsheet, and try to figure out what the program is doing by looking at the electrical currents inside, I won't progress as quickly as I would if I tried to write another program that also runs a spreadsheet.

In an approach that is in between those of the neurophysiologists and the more traditional AI researchers, David E. Rumelhart, James L. McClelland, and their colleagues don't dismiss the brain as irrelevant to the functioning of the mind. Rather, they feel that, by experimenting with neural networks, they can gain insight into how the brain copes with the problems it has to solve.

Parallelism

Another reason for studying brain-like models is their parallelism. The "circuit-

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Until we build effective parallel-processing hardware, connectionist models are unlikely to provide computationally efficient solutions to AI problems.

ry" of the brain is much slower than a computer's. In order for the brain to work as fast as it does—psychologists have shown that we can recognize objects in a split second—many neurons must work in parallel. In contrast, many AI programs run very slowly. The hope is: If we can find ways to run AI programs in parallel, they will run in a reasonable amount of time.

Parallel computation has been a busy area in computer science over the past 10 years. Most mainstream research on parallel computing is quite different from the neural-network approach. Researchers have studied algorithms for mesh-connected arrays of processors, pipelines, processors arranged in a tree-like fashion, and distributed systems of interconnected processors, to cite just a few.

Neural networks represent only one line of research in parallel computation. Basically, you must answer two fundamental questions in designing a parallel computer system: How do you connect the processors for communication purposes? And how much computing power and memory do you put in each processor? Many researchers find no reason to restrict themselves to neural-network models, which represent a very small subset of the possible parallel-computing models.

Nevertheless, neural-network researchers think that their models, by being most faithful to what we know about the brain, will show the most success. Unfortunately, neural networks have seldom been built in hardware; normally, they must be simulated in software. These simulations have typically been very slow, since one processor had to do the work of many. Until we build effective parallel-processing hardware, connectionist models are unlikely to provide computationally efficient solutions to AI problems.

The Connection Machine

One attempt to build a parallel computer is Hillis's Connection Machine, which has many small processors, each containing a small amount of memory. The machine has a fixed architecture—that is, certain processors are physically connected to certain others. Any pair of processors not physically connected can communicate in software via special processors called "routers," which exist to forward messages. It is critical that connections between processors be programmable so that the machine is not limited in the types of networks it can realize.

Hillis's machine can realize a wide variety of network models. It can adapt itself to the mesh-like architecture used in image processing, as well as to conventional semantic networks for knowledge representation. Recently, the Connection Machine has shown that it is well suited to database tasks, which are closely related to semantic networks. Hillis's company, Thinking Machines Corporation, has built a prototype of the machine, which it is marketing. The company provides a version of the popular AI programming language, LISP, that allows you access to the power of parallelism without having to know the details of the machine. On the Connection Machine, you can implement a neural network in hardware rather than in software, so the network will run much faster.

Varieties of Neural Networks

Most neural-network models owe something to perceptrons but are more general. The typical neural-network model consists of a set of nodes, or neurons, and connections (see figure 1). Each node contains a real number, which is its *activation*. Each connection also contains a real number, its *weight*. These numbers are usually positive and usually have a maximum value. Some of the units are connected to input and output. The weights represent the strength of the connection between two neurons.

Generally, a neural network is a dynamic system, moving from one state to the next. As such, it has a mathematical rule that takes the system from one state to the next. An infinite number of such rules are possible. However, we usually want to constrain our models to those that influence the activation of a given node based only on the activations of the nodes connected to it and the weights of the connections to those nodes.

Neural networks are not explicitly programmed like a conventional computer. Rather, they obey laws, or rules, like a physical system. You must program a conventional computer, but a neural network simply behaves. Neural-network designers view this as an advantage, since it provides a mechanism whereby intelligence can arise from physical law.

One of the simplest of these rules is a linear rule. You compute the activation of a given node as the sum of the products of the weight of each node it is connected to and the strength of that connection. Often such a rule is *thresholded*: Values that go above a certain threshold are cut off, to avoid arbitrarily large activation values. There are many variants of linear rules.

Another rule, suggested by D. O. Hebb (see reference 6) strengthens the connection between two nodes that are highly activated at the same time. Some versions of the Hebbian learning rule allow inputs, called teaching inputs, to in-

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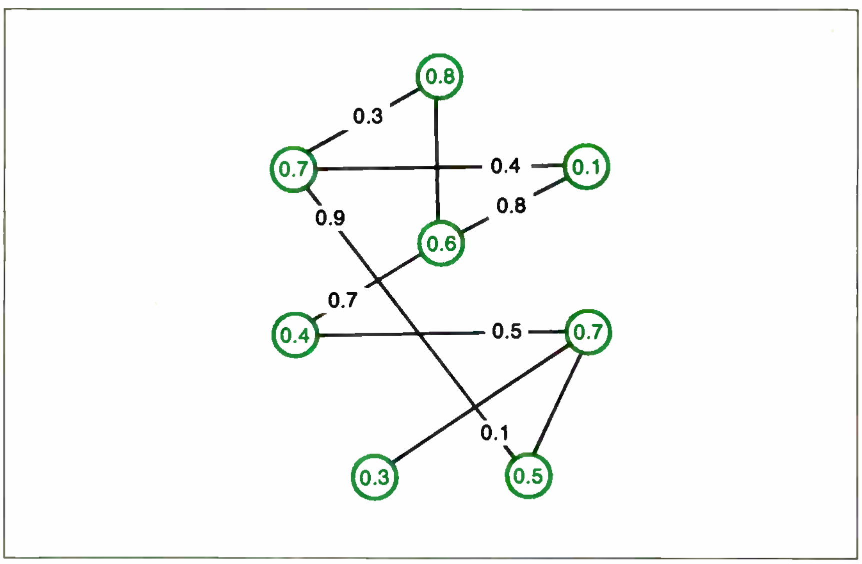
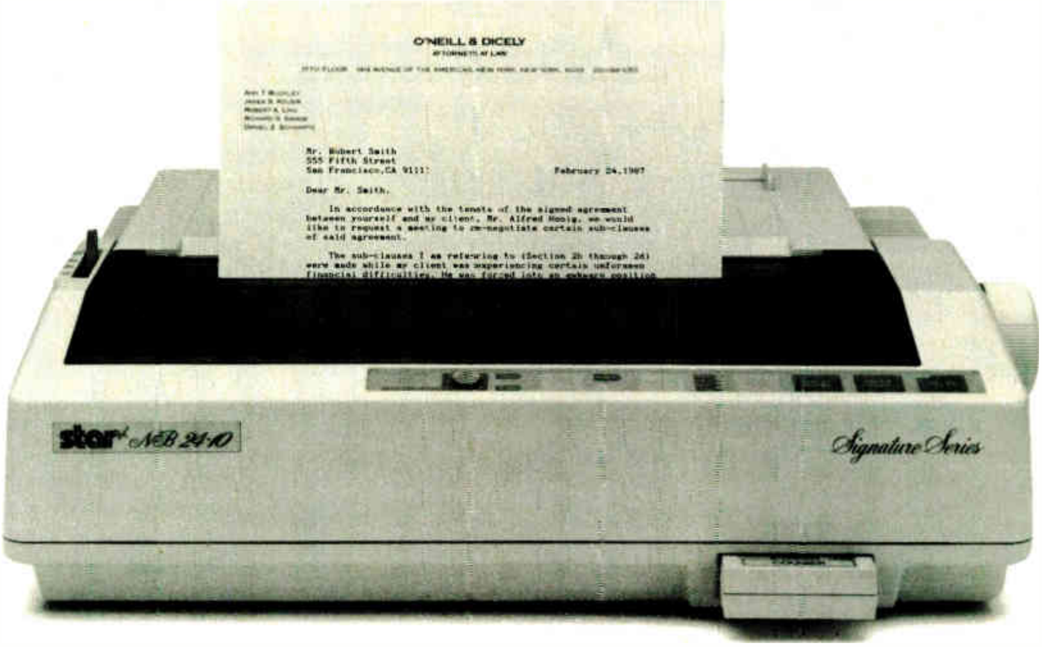


Figure 1: *In a typical neural network, every node has an activation, and every connection between nodes has a weight. A rule, which varies from network to network, governs the way in which weights and activations change over time.*



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The Perceptron Controversy

The 1950s brought substantial interest in what neural networks could do. After all, if we understood their behavior, we would be able to understand the brain and the mind. That was the hope. One of the most popular variants of the neural network was the "perceptron," invented by Frank Rosenblatt. The perceptron was a "perception machine."

Perception has always been the most difficult area in AI, and the area in which the least progress has been made. The ability to decipher the world, to break it up into meaningful parts, is a human ability of astonishing complexity.

Ironically, areas that people view as difficult—like playing chess or solving a chemical structure—are areas in which AI programs have had the most success, although they seldom equal the abilities of the best human experts.

Yet, the computer has not been programmed that can learn a language the way any infant does, or given a scene of any room, can recognize all the objects in the room. Thus, machines that can perceive have always held special interest.

What Is a Perceptron?

A perceptron is a neural-network model with an array of input units, each of which can take on the value 0 or 1. This array is called the *retina*, in analogy to human vision.

The perceptron also has another array of units called the *predicates*. Each predicate can be connected to any subset of the units in the retina and can compute any linear function of the values of these units.

Finally, the predicate units are connected to one or more decision units, which return a single answer—yes or no—depending on the values of the units in the retina. Thus, a perceptron can perform an elementary classification task—that is, it can classify input patterns by some property. Since perception is basically a classification problem (i.e., classifying objects as chairs, tables, or whatever), the hope was that the perceptron model, properly elaborated, could account for complex perception.

The Great Debate

The controversy over perceptrons continued for some time, and in 1969, Marvin Minsky and Seymour Papert wrote a formal analysis of perceptrons (see reference 7), or, more precisely, the single-layer perceptron, which squelched interest in them.

Minsky and Papert proved, mathematically, that there were certain functions of input that the single-layer perceptron could not compute. One of the simplest was the parity function, which tells if the number of ones in the input is even or odd. If the perceptron could not compute such a simple function, they reasoned, it could hardly perform the complex tasks required for perception and intelligence.

At the time, Minsky and Papert's work appeared to have destroyed perceptrons and perceptron-like models as viable lines of AI research. Little attention was paid to the fact that they directed their criticism at a very simple system, the single-layer perceptron.

If you add one more layer of units between the input units and the predicates, the computational power of the machine rises abruptly, and Minsky and Papert's critique no longer applies. And if you add multiple layers, it is difficult to characterize formally the network's behavior.

This difference was not well understood at the time, and Minsky and Papert's work put a strong damper on research. It didn't discourage everyone, however: Throughout this time, Steven Grossberg of Boston University continued detailed studies of brain-like systems.

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fluence the change in weight. This type of rule is a formalization of associationist psychology, which holds that associations are built up between things that occur together.

Competitive Learning

Learning is, perhaps, the most important phenomenon in psychology. Early neural-network researchers were anxious to show how networks could learn patterns in the input presented to them—that is, how they could come to perceive these patterns *on their own*.

One of the methods that various researchers have devised over the years is *competitive learning*. This method has a bottom level of input units that contains the pattern to be input to the system. The level above the input units consists of clusters of units. Each unit in a cluster competes with the other units in the cluster for the right to recognize an input pattern. Over a learning period, each unit in a cluster comes to recognize a subset of the patterns presented to it. Thus, each cluster represents a classification, or group, of input patterns.

In competitive learning, each unit in each cluster is connected to all the input units. The weights of the connections are initially set to random values. The random weights cause certain units in clusters to start responding more to particular input patterns, since the weights of the connections to particular input units are stronger to some than to others.

As the learning proceeds, the weights change. As particular units in the cluster become sensitive to particular units in the input pattern, the weights connecting the associated pairs of units increase, at the expense of unassociated pairs of units. Different units in the same cluster inhibit each other, so that only one unit in a cluster "wins" the right to recognize a given pattern.

Thus, over time, different units in a cluster come to "recognize" different properties of input patterns. For instance, a cluster of two units might separate all the input patterns into those that are mostly on (i.e., have most of their units highly activated) and those that are mostly off. Larger clusters would make more discriminating classifications.

There may be an additional level of clusters that uses the first level of clusters as its input pattern. This level could extract more complex features from the bottom-level input pattern.

Rumelhart and David Zipser applied the competitive-learning paradigm to letter and word recognition. Letters were represented by bits on a grid, which was the input pattern for the competitive-learning system. The system came to spontaneously recognize an "A" and a "B" in a fixed position on the grid.

This is very interesting, for it illustrates a potential mechanism by which people may have learned to recognize letters. This mechanism is completely general, since it presupposes nothing about the letters except that they can be distinguished from one another.

Boltzmann Machines

An important class of neural networks simulates the behavior of physical systems. Physical systems have a tendency to move into states of minimum potential energy. A simple example of this is a ball rolling into the valley between two hills. At the top of the hill, potential energy is high; in the valley, it is low.

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In a distributed network, nodes don't have a simple meaning; rather, an individual concept is represented by a pattern over all the nodes.

This process is called *relaxation*. John Hopfield has shown that a certain simple evolutionary rule for a neural network will lead to relaxation. Systems such as Hopfield's, which resemble thermodynamic systems like the atoms in a room, are called Boltzmann Machines, after Ludwig Boltzmann, a physicist who made major contributions to thermodynamics. Boltzmann Machines are widely used in a variety of neural-network applications.

In vision and in playing games, you can often formulate solutions to problems, such as recognizing a set of objects or discovering the best move, as constraint-satisfaction problems. For instance, in chess, the constraints are the possible ways that a piece can move, and the total "goodness" of the move, as measured by some formula, taking into account pieces captured, board position, and so on. Relaxation can correspond closely to constraint-satisfaction—a Boltzmann Machine can satisfy constraints automatically.

Distributed Representations

One important feature of many neural-network models is their *distributed* nature. A standard semantic network, like those used in early knowledge-representation schemes, consists of a set of nodes connected in some fashion. Each node represents a single word or concept. If the network is "thinking" of the word "cat," the node for "cat" is activated, and all other nodes are not. This is a *local* representation.

In contrast, in a distributed network, nodes don't have a simple meaning; rather, an individual concept is represented by a pattern over all the nodes. For instance, if there are 10 nodes, activating nodes 1, 3, 4, and 7 might represent the concept "gorilla," while activating nodes 2, 4, 5, and 7 might represent the closely related concept "chimp." Concepts that are closely related have similar representations.

A parallel distributed-processing (PDP) network, a neural network that uses distributed representation, offers the advantage of *automatic generalization*. If I want to represent the concept "gorillas are hairy," I strengthen the connection between all the nodes composing the concept "gorilla" and all the nodes composing the concept "hairy." As a result, since most of the nodes in "gorilla" are also used in "chimp," an association is also made between "chimp" and "hairy." This is how automatic generalization works. In a local representation, where "gorilla" and "chimp" are represented by separate nodes, a connection between "gorilla" and "hairy" would not imply a connection between "chimp" and "hairy."

Another advantage of a distributed representation is its insensitivity to damage. In a local representation, if the system loses the node representing "grandmother," it loses its concept of grandmother. People don't display disorders like this; there are no people who are completely normal except that they have lost their concept of grandmother. This has led to the opinion that the brain doesn't use local representation.

In a distributed representation, in order to lose a concept, you must lose *all* the nodes representing it. If you lose only one or two of the nodes, the concept may be degraded, but it's still there. This is closer to the type of memory loss seen in older adults: Memory is degraded in a uniform fashion.

Schemata

One criticism of neural-network models is that they're not as flexible at representing knowledge as standard methods are. The standard methods include the local semantic network, of which Marvin Minsky's *frame* and Roger Schank's *script* are varieties. For instance, a frame description of a bedroom would contain information about all the objects in that room and how they relate to one another. The relations between objects are represented by labeled links.

Cognitive psychologists, notably developmental psychologists like Jean Piaget, use the concept of a *schema*. A schema is a mirror—in the mind—of a real situation. As children, and as adults, we learn new associations and relations between objects and integrate them into our schemata.

It's not immediately clear how a neural-network model can account for knowledge represented in a schema; however, Rumelhart, Paul Smolensky, McClelland, and Geoffrey Hinton have shown that it's possible. They first gathered data from subjects about rooms—kitchens, bedrooms, offices, living rooms, and bathrooms. They took 40 words associated with rooms and asked each subject whether each word was associated with each room. Then, they set up a network that had each of the 40 words represented by a single node. They set the weight of a connection between two nodes to correspond to the extent to which the two tended to be used together when a single subject described a single room.

The network uses Hopfield's energy-minimization rule. When a single descriptor is "clamped on" (i.e., when its activation is permanently set to its maximum value), the system relaxes into one of five states, or rooms, since each room implies a constraint as to which words can occur together.

In the network, you don't explicitly define the schemata; you only set the associations between pairs of descriptors. The schema emerges out of the network as a natural consequence of its behavior. Thus, the schemata are not explicitly represented in the network, but rather are simply patterns of activation across a set of descriptors.

This system has several nice properties. First, it explains how schema are activated when you have incomplete information—that is, why you think "kitchen" when you see "refrigerator." This corresponds to the "clamping on" of a single descriptor.

Since schemata are patterns rather than single units, this system allows for more flexibility in representing things. A slightly different version of a particular object can correspond to a slight change in the weights. And closely related schemata, such as "woman" and "girl," can overlap. In a more elaborate scheme, each descriptor in a schema can itself be a schema. The number of connections you need, however, rises quickly.

Cognitive Hierarchies

Often neural-network models are ordered into hierarchies. Several levels exist in such a hierarchy, each composed of a set of units. Typically, units that receive input are at the bottom of the system, and units that give output are at the top. In a bottom-up system, units at each level connect to other units on their own level and influence units on levels above them. In a top-down system, units again connect to units on their own level but influence units on levels below.

Top down and bottom up are familiar concepts in cognitive science. For instance, in sentence perception, these terms refer to how different-size linguistic elements, the phoneme (sound), morpheme (word element), word, phrase, and sentence, interact with one other.

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The HEARSAY-II speech-recognition program from Carnegie Mellon was one of the first AI programs to integrate knowledge from several levels, storing its results in a global data structure called the blackboard.

Does the overall perception of a word help you to perceive all the letters in it, individually, in a top-down fashion? Most psychologists would say yes. For instance, psychologists have done experiments in which they show subjects nonwords like BCAK and PLAM; the subjects interpret these words as BACK and PALM. The theoretical explanation is that the units representing letters activate the units representing words in a manner that is somewhat insensitive to the letter's position in the word. The unit for the whole word actually influences the perception of the individual sound. Neural-network models exist that model this process and others like it.

For example, in McClelland's programmable blackboard model of reading, units for letters and units for words are connected by a grid. A connection in the grid between a letter and a word is set to a positive value if the letter is in the word, and to zero if it isn't. The letter units reinforce the word units in a bottom-up fashion, and the word units influence the activation of the letter units in a top-down fashion. Thus, the network converges to the perception of a single word at a time.

The programmable blackboard model does not handle the perception of individual letters, but you could readily add a third level to the system, a level of letter subfeatures. Information would pass up and down in the network, from letter subfeature to letter to word, and back down again.

A Parallel Reading Network

One problem in creating a reading network is that people tend to read more than one word at a time. Since a single network reads only one word, it can't handle this. If the network tries to read more than one word, you get "crosstalk"; that is, if the input words are "bank" and "lane," the network will perceive both the two inputs and "lank" and "bane" as well. As a solution, McClelland proposes duplicate copies of networks. Duplicate individual word-recognition networks would have programmable connections instead of hard-wired connections between letters and words.

In addition to programmable networks, you could have a hard-wired network that represents the relationships between letters and words. This network programs all the programmable networks via connections to them. Thus, you could represent knowledge centrally instead of

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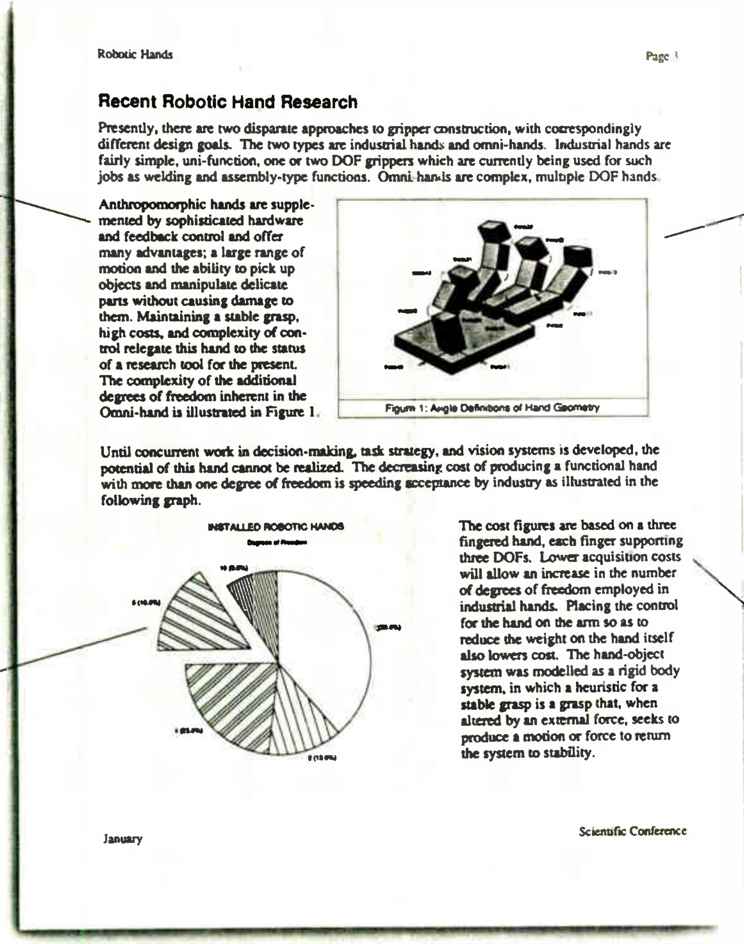
Robotic Hands Page 3

Recent Robotic Hand Research

Presently, there are two disparate approaches to gripper construction, with correspondingly different design goals. The two types are industrial hands and omni-hands. Industrial hands are fairly simple, uni-function, one or two DOF grippers which are currently being used for such jobs as welding and assembly-type functions. Omni-hands are complex, multiple DOF hands.

Anthropomorphic hands are supplemented by sophisticated hardware and feedback control and offer many advantages; a large range of motion and the ability to pick up objects and manipulate delicate parts without causing damage to them. Maintaining a stable grasp, high costs, and complexity of control relegate this hand to the status of a research tool for the present. The complexity of the additional degrees of freedom inherent in the Omni-hand is illustrated in Figure 1.

Figure 1: Angle Definitions of Hand Geometry

Until concurrent work in decision-making, task strategy, and vision systems is developed, the potential of this hand cannot be realized. The decreasing cost of producing a functional hand with more than one degree of freedom is speeding acceptance by industry as illustrated in the following graph.

INSTALLED ROBOTIC HANDS

The cost figures are based on a three fingered hand, each finger supporting three DOFs. Lower acquisition costs will allow an increase in the number of degrees of freedom employed in industrial hands. Placing the control for the hand on the arm so as to reduce the weight on the hand itself also lowers cost. The hand-object system was modelled as a rigid body system, in which a heuristic for a stable grasp is a grasp that, when altered by an external force, seeks to produce a motion or force to return the system to stability.

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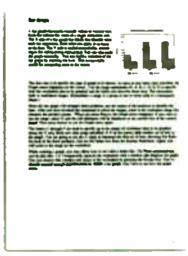

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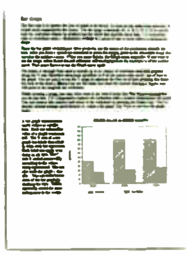

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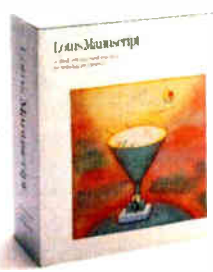

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having to duplicate it several times. You can save memory space by loading a programmable network with only knowledge relevant to processing the word it currently encounters. McClelland has worked out the details of his model thoroughly.

The programmable blackboard model accounts for psychological data concerning such things as parallelism in reading and word misperception. It shows how useful the psychological modeling approach to AI is: In explaining a good deal of psychological data with a model, we get a system that is quite good at the job at hand. McClelland has constructed a similar model of speech recognition and built a model of a higher-level process.

Processing Sentences

One important aspect of sentence understanding involves determining the various roles that the different parts of a sentence play. For instance, consider the following two sentences:

> The house rented for $2000.
> The man rented the car.

In the first sentence, the house is the thing rented; in the second, the man is the agent of the rental. Yet in the two sentences, the nouns "man" and "house" are in the same position. Somehow, the model must discern their different roles.

McClelland and Alan Kawamoto have developed a connectionist system to do this role assignment. Words are described by "semantic microfeatures"—basic dimensions that describe many objects and actions. For instance, two of the microfeatures describing nouns are *human* and *softness*, which have the values "human, nonhuman" and "soft, hard," respectively. Words are not directly represented in the system's networks, but in terms of the activations of units representing microfeatures.

The model has a group of units for each of the major roles that different nouns can play in an action. These roles are Agent (actor), Patient (acted upon), Instrument (thing used), and Modifier (adverbial word or clause). For instance, the sentence "The man ate the sandwich" would activate the microfeatures of "ate" and "man" in the set of units that corresponds to the Agent; this represents the fact that the Agent for the verb "ate" is "man."

The system is trained on a series of sentences. The correct role assignments for the training sentences are shown to the system. These assignments correspond to the activations of particular nodes. The system adjusts the connections between these nodes so that they reinforce one another.

After being trained on a sufficient number of sentences, the system can make correct role assignments for new sentences. It can even make accurate role assignments for sentences with some syntactic ambiguity. For instance, in the sentence "The man hit the boy with the mallet," the system figures out that "mallet" is the Instrument of "hit" instead of belonging to "boy," since "mallet" has microfeatures that fit in well with it being an Instrument.

The system also handles a number of other problems well, and generally does a good job in assigning roles. McClelland and Kawamoto are currently considering ways of expanding their system into a more complete language-understanding model—for instance, one that includes a network to parse sentences.

The Promise for the Future

Neural networks are good for a variety of natural-language processing tasks, including letter recognition, reading, and sentence understanding. They are also useful in storing knowledge in schemata and in retrieving items from memory. They are not a cure-all for what ails AI and cognitive psychology, but they do bring a strong and biologically plausible new direction to many important problems.

Eventually, a connectionist model will probably be built of the natural-language-understanding process, since, as psychologists have shown, it involves integrating knowledge from many domains, including phonetics, morphology, syntax, and semantics. Connectionist models are particularly good at integrating these types of knowledge. ■

ACKNOWLEDGMENT

I would like to thank Gregg Oden of the psychology department at the University of Wisconsin for introducing me to the subject of connectionism.

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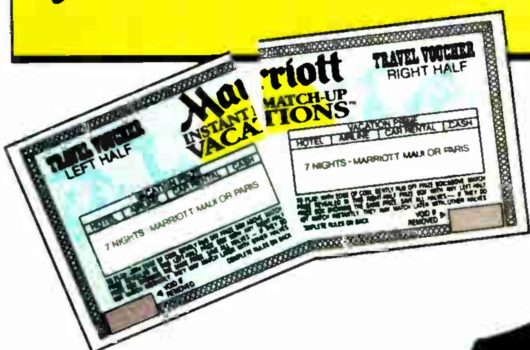

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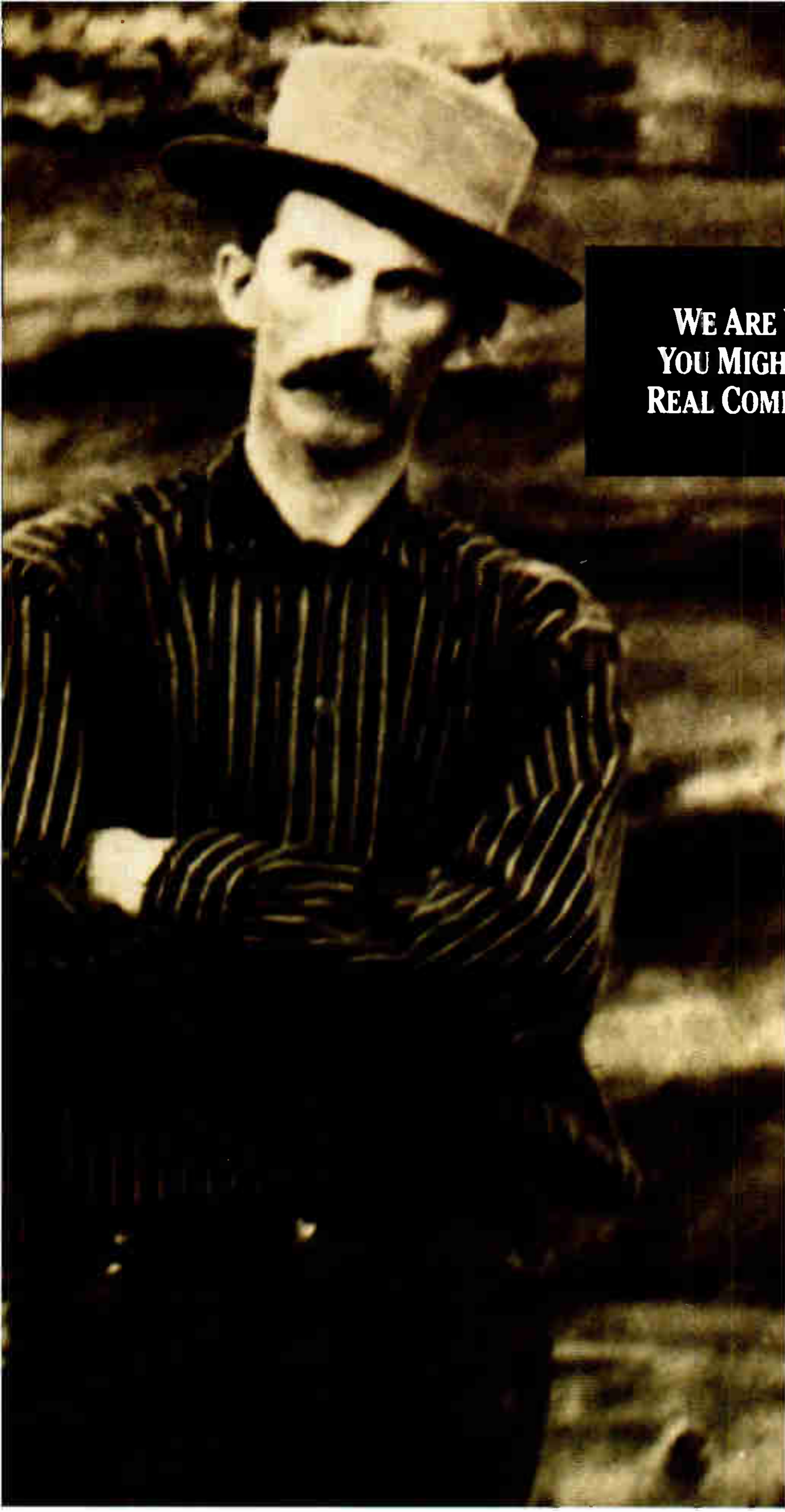

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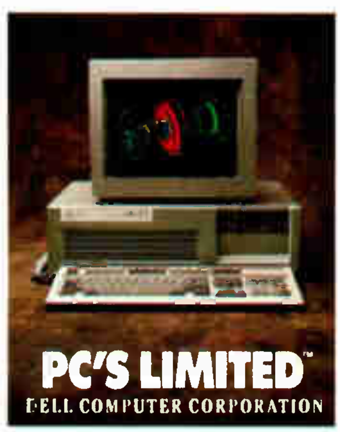

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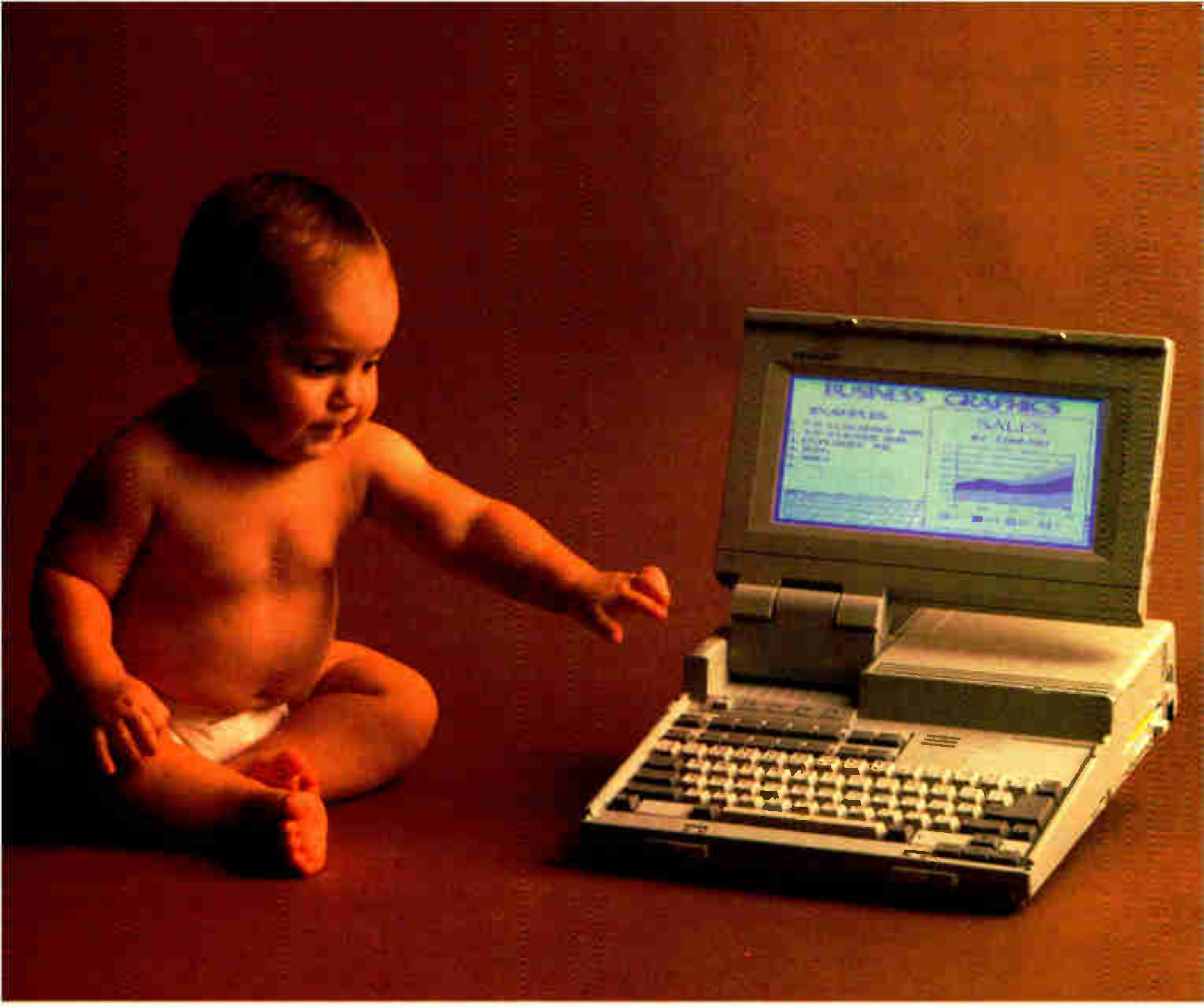

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The Intelligent Assistant

Technical considerations involved in designing Q&A's natural-language interface

Gary G. Hendrix and Brett A. Walter

IN 1985 SYMANTEC introduced Q&A, an integrated database manager and word processor for the IBM PC, XT, AT, and compatibles. Q&A features a natural-language interface, called the Intelligent Assistant (IA), that lets you interact with your data through questions and commands posed in a subset of ordinary English. A variety of factors, some business-oriented and some technical, influenced its design. This article discusses the technical design decisions behind the IA. [Editor's note: *For further information on Q&A, see the product preview "Q&A" by Jon R. Edwards in the January 1986 BYTE.*]

Q&A has its roots in research on natural-language processing (NLP) conducted at SRI International (formerly Stanford Research Institute) in Menlo Park, California, under the sponsorship of the Advanced Research Projects Agency of the United States Department of Defense. For many years, SRI and other laboratories have investigated how we might use computer systems to understand ordinary English, especially for practical applications such as retrieving data from large, complex databases.

Such applications are interesting because English interfaces potentially require far less training than conventional interfaces, and you can use them rapidly and accurately both in stressful situations and in situations where you may need to access data in unanticipated ways.

Design Decisions

The central design requirement of the IA was that it be *usable* by untrained novices for a wide range of single-file applications. Once we decided that usability was to be its main focus, other requirements began to flow. A design decision made to address one requirement would significantly affect the others; the larger design problem became to meet the following requirements collectively.

- *Accessibility*. The IA should let you access a wide spectrum of underlying functionality.
- *Habitability*. It should allow you to express yourself through English requests that come readily and comfortably to mind.
- *Verifiability*. The IA should let you verify that its interpretation of an English request agrees with what you mean.
- *Resilience*. It should gracefully recover from anomalies in your request, ambiguous requests, and unknown words, as well as from gaps in its own linguistic knowledge.
- *Performance*. It should process requests within a reasonable length of time on an 8088-based machine with a memory limitation of 512K bytes.
- *Adaptability*. The IA should be domain-independent and should adapt easily to new databases.
- *Synchronization*. It should automatically keep its vocabulary current with database updates.

Accessibility

The central issue in creating an NLP system is encoding enough linguistic knowledge in the computer for it to understand your requests. There are two aspects to this problem: accessibility and habitability.

Having adequate accessibility means that you can access the major functionality of the underlying system through some natural-language request. That is, for every important operation that Q&A can perform, there should be at least one way to request it in English. English is particularly useful for ad hoc database query and analysis and can also be helpful in manipulating individual records and updating the database. Ultimately, we decided to provide English access to such operations as

- *Retrieving records that meet specified selection criteria*. For example, "Get the forms for programmers earning over $30,000."
- *Producing tabular reports, either detailed or summary*. For example, "Show the address and phone number of each employee," or "What's the average salary for secretaries in each department?"
- *Performing mathematical calculations*. For example, "What's Tom's salary plus Mary's?"
- *Creating new data records*. For example, "Add a new programmer to R&D whose name is "John Smith"."
- *Updating multiple data records*. For example, "Increase the programmers' salaries by 10 percent."

continued

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To conserve space, we didn't try to provide natural-language support for word-processing operations such as "Make this paragraph bold," "Set the left margin to 2 inches," or "Send this memo to every manager in the eastern region." Also, certain Report options remained inaccessible from the IA, primarily because the English for the operations would be awkward. These options included specifying nonstandard column headings, widths, page headers, and so forth.

Habitability

Having adequate habitability means that if an operation is accessible, you can request it through natural-language sentences that come readily and comfortably to mind. For example, using a personnel database, Q&A's Report module can produce a report that lists the salaries of all female employees. This functionality is accessible with English even if there is only one way to ask for it, such as through a rather formal construction: "Print the name and the salary from the records where the sex is female." But it is quite improbable that you would express this thought in exactly these words.

You can make a natural-language system habitable in three ways. First, you can train its users to enter only those few English sentences that the system accepts. However, this approach sacrifices the key purpose of a natural-language system—naturalness. A highly restricted subset of English is merely another formal language to learn. The sentences may be easy to understand because they're in English, but they're not easy to construct because many English sentences that come naturally to mind aren't in the formal language.

Second, you can actively guide the user in creating requests. You might display a limited number of input choices and ask the user to select from a list of sentences or sentence parts.

Third, you can have the system recognize many alternative expressions of the same idea in the hope that one of them will be the one actually used. The IA uses this strategy. For example, the IA will accept hundreds of variations on the female-salary query given above. Table 1 contains a partial list of the variations that the IA will accept.

Providing access to a breadth of functionality through a wide variety of linguistic constructions requires that you approach natural-language analysis with considerable sophistication. An approach based on keywords might suffice to interpret several of the requests in table 1 by picking out the words *female* and *salary*. However, such an approach would fail miserably on the query "Is John older than Sue?," where meaning depends critically on word order.

To achieve the accessibility and habitability necessary for the IA, we decided to use a context-free grammar expressed as a collection of augmented phrase-structure rules. Such rules are fairly easy to adapt and maintain as the grammar evolves, and you can compile them into a very efficient run-time system. The semantic augmentations to the syntax rules are expressed as procedures in LISP; these procedures translate inputs into an internal representation language related to first-order logic. Schemes based on augmented transition networks (ATNs) or unification grammars might work equally well.

Verifiability

In a system that accepts only a narrow sliver of English or that forces you to construct requests under the guidance of the system, the meaning of inputs may always be clear. However, because the IA has been designed to accept a wide variety of inputs, and because English is often ambiguous and the system's knowledge of the language is limited, the IA will sometimes miss your intended meaning. How can you verify whether its interpretation of a request is consistent with yours?

The IA shows you its plan for dealing with each request and asks your permission before taking further action. This is not unlike the dialogues between air-traffic controllers and pilots, in which the pilot parrots back the controller's instructions. (Some systems attempt to deal with miscommunication by providing an Undo function, but Undo is inappropriate in non-RAM situations where the cost of mistakes is high.)

The IA presents its plan of action in English, but in a highly stylized manner, using indentation to clarify the meaning, as shown in figure 1. Sometimes users make requests that the underlying database can't perform or that contain language the IA doesn't understand. In such cases, the IA doesn't paraphrase the request, but presents its best efforts at understanding it.

Resilience

We designed the IA to be resilient to many types of errors in English inputs. We could have designed its grammar analyzer to flag errors in grammar. This would be appropriate in a parser for correcting the grammar and style of business letters, or for grading themes in an English course, but it's not appropriate for database users who want results, not corrections. Therefore, the IA has a forgiving response to poor English. Consider the request, "I wants you please shows me what salary's of females be?" The IA asks whether you want the full name and salary of females. (Interestingly, many foreign users have commented that the IA can understand their English when most Americans cannot.)

The question of resilience greatly influenced the IA's entire approach to language analysis. An analysis that demands strict adherence to English grammar is too brittle. An analysis that ignores syntax and relies simply on keywords is resilient but usually misses critical aspects of sentence meaning. To gain resilience without sacrificing syntactic acumen, we developed the notion of a layered relaxation grammar. The layered grammar first tries to find large, syntactically well-formed constructions, including whole sentences. If this attempt fails, the constraints on syntax are progressively

continued

Table 1: *A partial list of the variations on the female-salary query that the IA will accept.*

Female salaries.
Show the female salaries.
Salaries for females.
Salaries of the women.
What do we pay the women?
What are the salaries of the female employees?
What are the women paid?
Please find the earnings of our women employees and present them for me.
How much pay do women get?
Get the salaries of the employees who are women.
Get the salary data on all females.
What salaries do the female employees have?
I want to see the salaries of the females.
Let us see the salaries of the female employees.
Can I have the salaries from the records for females?
Please make a report that shows the values from the salary field from all forms where the value in the sex field is female.
For female employees, make a list of the salaries.
If an employee is female, I want to see her salary.

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relaxed, and analysis continues using progressively less demanding grammar rules.

Sometimes, however, you simply can't understand a request. For example, if you enter the request "Show the New York employees," the IA will ask for clarification: Do you mean New York City or New York state? The sequence in figures 2a, 2b, and 2c shows how the IA deals with an unknown word. Although the word *man* is unknown, you can choose to define it on the fly in terms of *male*, which is already known as a value in the *sex* field. For hopelessly flawed syntax such as "Whose salaries are between $10,000 and print them," the IA will highlight the confusing part, "between $10,000," and ask if you want to continue. If you do, it will discard the highlighted portion of the request and cope with the remainder as best it can.

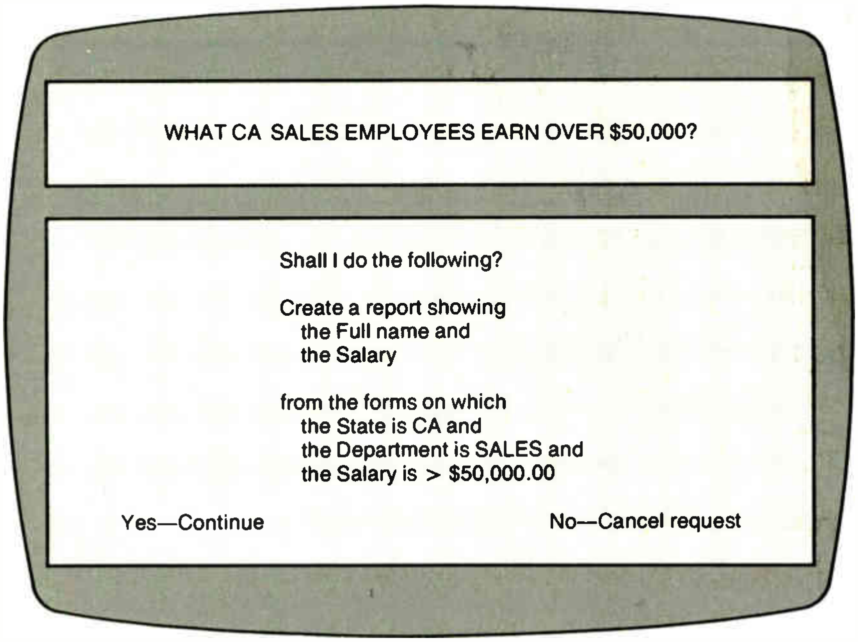

Figure 1: *The IA presents its plan of action in highly stylized English, clarifying its meaning with indentation.*

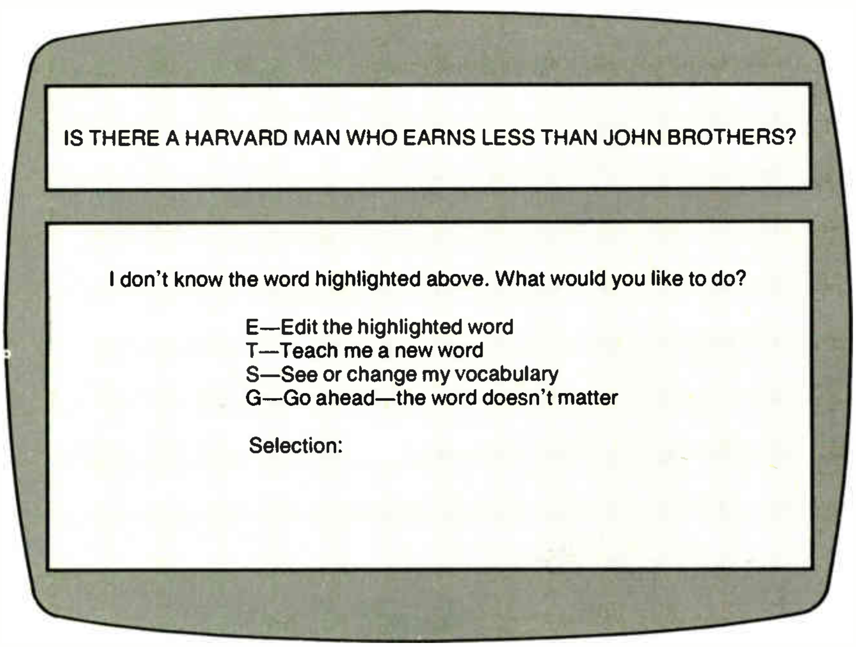

Figure 2a: *The options that the IA presents to you to define an unknown word on the fly.*

Performance

The greatest engineering challenge in creating a natural-language system for Q&A was squeezing it into the IBM PC environment, which imposes two severe constraints: a relatively slow CPU and very limited addressable memory. Other natural-language systems run on $100,000 dedicated LISP machines in 10 megabytes of RAM. We needed to be able to run from a single 360K-byte floppy disk in 512K bytes of RAM. To cope with these constraints, we used several tactics.

To begin with, we recognized that we couldn't provide linguistic coverage as extensive as current theory would permit. Thus, we fashioned grammar rules that covered frequently used constructions, knowingly omitting rules for less important patterns. What *not* to do became more important than what *to* do.

Both the syntax rules and the associated semantic interpretation functions begin life in LISP: the syntax rules as data structures, and the semantic functions as LISP code. For the final product, both are compiled into custom p-codes. (A p-code, or pseudocode, is a machine-language instruction, but for a virtual machine rather than the physical hardware. The p-codes are executed by an interpreter that runs on the physical hardware and emulates hardware of a different design.)

To minimize parse times, we wrote the parsing algorithm in C, with parts in assembly language. It interprets p-code instructions such as the one in figure 3, which means "if the current word in the request belongs to the lexical category called *field-name*, then bind the lexical entry of the current word to the atom *field-name* and jump forward 137 bytes to the parsing state encoded there."

The p-codes for semantic functions have a separate interpreter, also written in C and assembly language. An example p-code is the 1-byte instruction for replacing the top of the stack with its `caddr` (i.e., a LISP function that, when given a list, returns the list's third item). In writing the semantic functions, we were careful to use only about 100 LISP primitives, minimizing the size of the run-time library. Our data suggests that the p-code approach saved us a great deal of space; machine code would have been five times as costly.

Adaptability

Adapting a general-purpose natural-language interface to a new application may be the most unappreciated problem in NLP design. It's very difficult for nonlinguists to provide linguistic information about a new domain. For a new database, for example, you must prime the system with hundreds, or even thousands, of new database-specific words before it becomes very useful. You must also provide structural information about the new database. If not handled properly, this priming process can create a human-factors hurdle that we call the NLP wall (see figure 4).

The essence of the problem is this: You buy a natural-language interface because it's easier to ask questions in ordinary English than to worry about syntax or the underlying database-management system. But to adapt the interface to your database, you may well have to become an expert in the DBMS and in lexicography.

We thought it was essential to shield our business-oriented users from anything requiring programming, linguistic, or database-administration knowledge. Therefore, we included a predefined base vocabulary, automatic acquisition of most data-specific terms, and a Teach system for acquiring special classes of lexical items and structural data.

The IA's base vocabulary includes over 400 words for manipulating data. This covers a broader spectrum than the number indicates, because these are the high-frequency words of data applications. For comparison, half the words that Shakespeare wrote come from a set of 100 high-frequency words; the King James Bible contains only 8000 words, many of them used just once. The IA automatically adds words and phrases used in labeling fields on Q&A forms to the lexicon, as well as values entered in text fields. These words represent the vast majority of the vocabulary used by an application.

Since we can't control the kinds of words and phrases you may enter as data, and since we certainly can't ask you to lexically classify every field entry and label, we used grammar rules that refer to lexical categories such as *field-name* and *text-value* instead of making full use of more convenient categories such as *noun* and *verb*.

After adding the field labels and text-field entries to the base vocabulary, the IA lets you fully access the major underlying DBMS functions. But you can greatly enhance the habitability of the system if you provide it with additional information through a Teach module.

The Teach main menu features eight lessons you can teach your IA (see figure 5). The lessons are presented roughly in the order in which they enhance the usability of the system, so if you become impatient, the most important information will generally have been acquired first.

Lesson 1 gives you the opportunity to introduce new terms for the database. For example, a personnel database might have labels for *salary* and *sex*, and data fields with the values *male* and *vice president*. so the system learns these terms automatically. But nowhere does the database actually include the words *employee* and *worker*, and they are what the database is really all about. Lessons 5 through 8 also acquire vocabulary terms.

Acquiring structural information is a similar process. For example, Lesson 4 asks you to mark the fields that hold the names of people. This is important because personal names require special treatment in English. Lessons 2 and 3 also acquire structural information.

Synchronization

To analyze inputs, a natural-language system needs information about the

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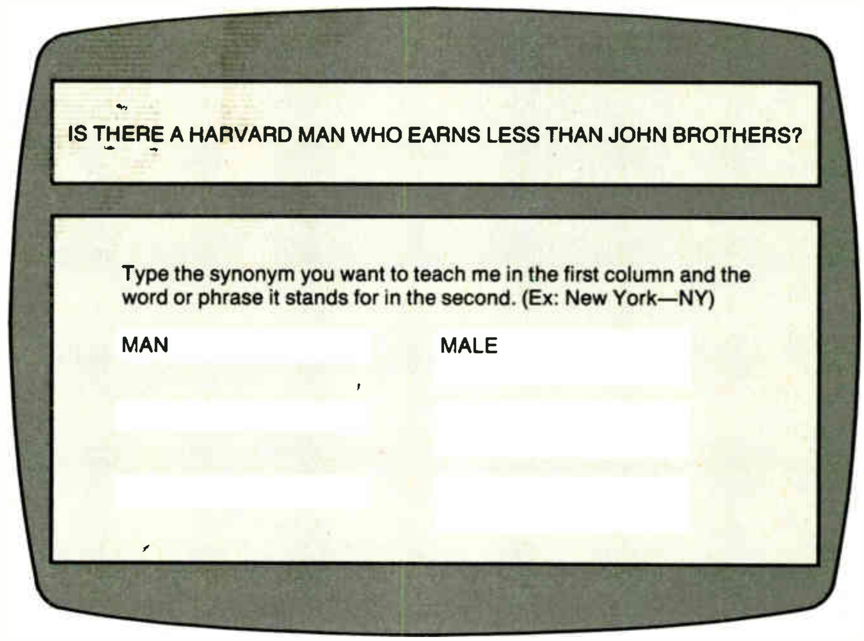

Figure 2b: *If you select the T option in figure 2a, you can define the unknown word "man" in terms of the known word "male."*

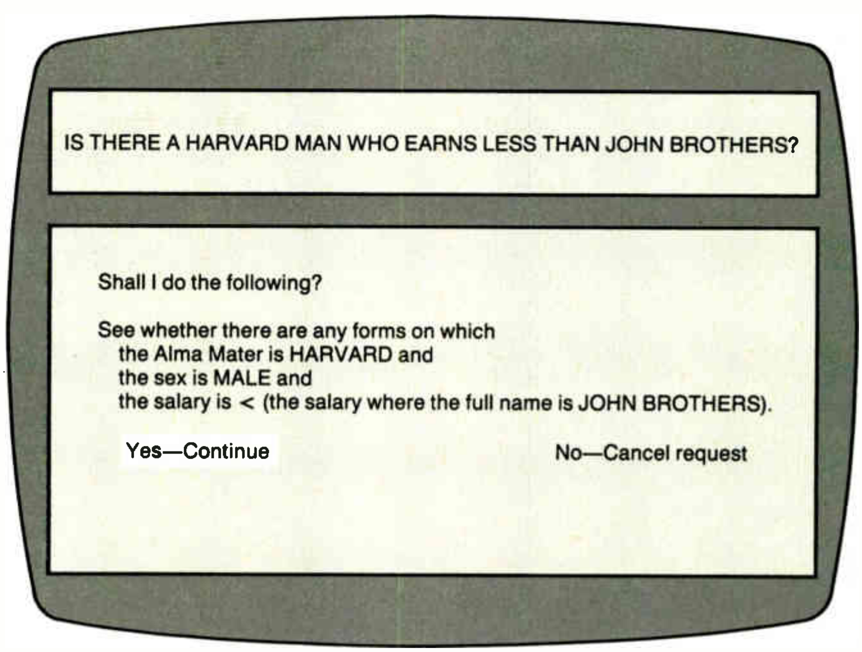

Figure 2c: *This screen lets you approve or disapprove the IA's new understanding of the question.*

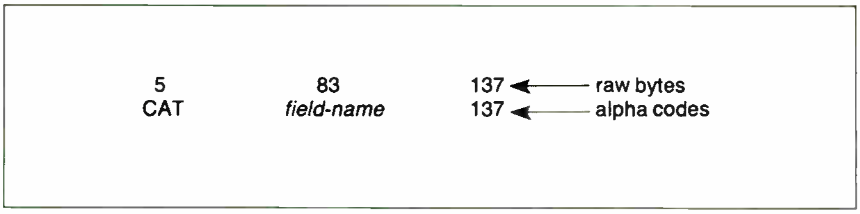

Figure 3: *A p-code instruction that means "if the current word in the request belongs to the lexical category called* field-name, *then bind the lexical entry of the current word to the atom* field-name *and jump forward 137 bytes to the parsing state encoded there."*

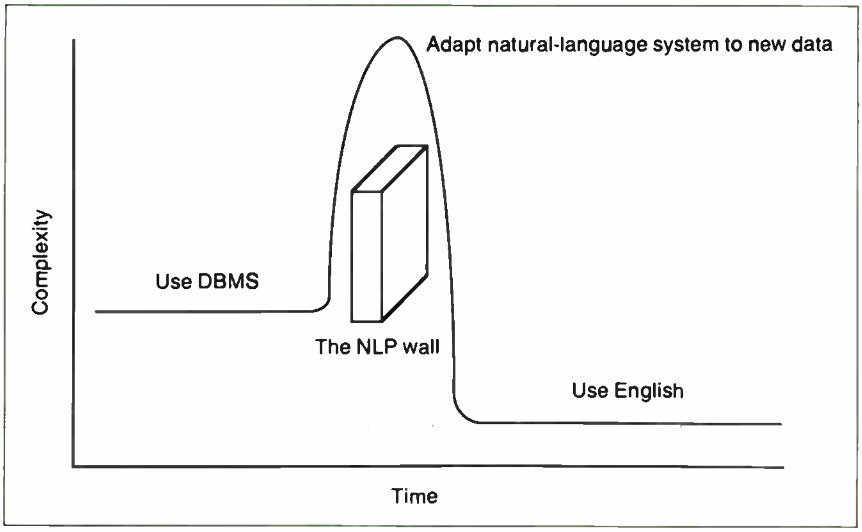

Figure 4: *The NLP wall, a human-factors hurdle that can occur when you try to implement a new application on your natural-language interface. The interface is meant to make interaction with the computer more natural, but in order to set up your computer to use it, you need to use a great deal of "unnatural" language.*

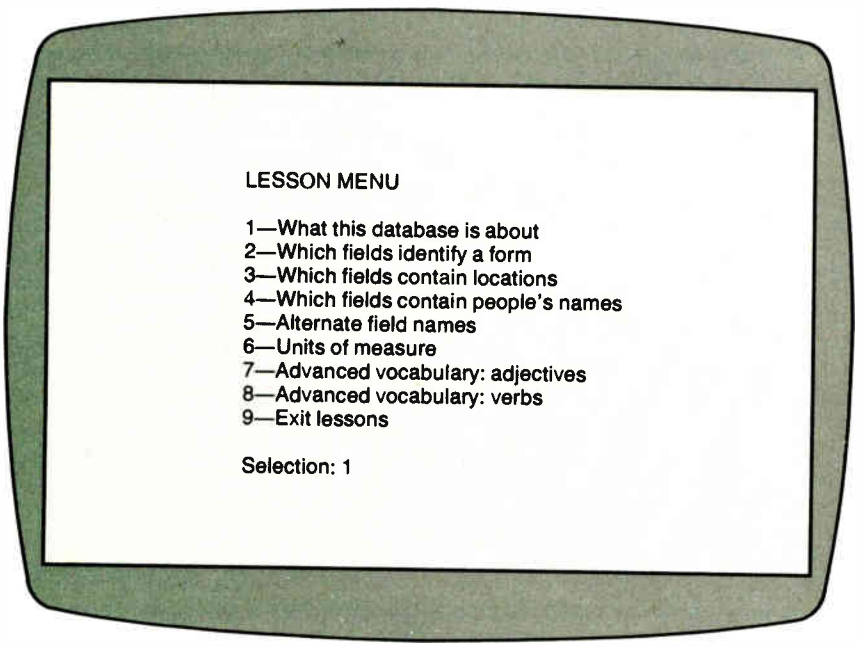

Figure 5: *The eight lessons (plus an exit) on the Teach main menu. These lessons enhance the usability of the system in roughly the order presented.*

words that can appear in legal sentences. This information is maintained in the system's lexicon. It is important to keep the lexicon synchronized with the database. If you don't, for example, someone could add a record for a new employee named Thelma and subsequently be told that "Thelma" is an unknown word when asking about her in English.

Full synchronization requires close cooperation between the DBMS and NLP system, and it is therefore difficult to achieve when you add NLP to an existing DBMS as an afterthought. For this reason, most natural-language systems freeze their lexicons, ignoring the problem altogether. Others scan the database hoping to find "Thelma" as a value in some field in some record, but this is highly inefficient on all but very small databases.

Because we designed Q&A as an integrated system, the requirements of the natural-language component influenced the design of the database itself. In particular, the lexicon of the IA is maintained as a database index that, like the indexes used to speed up searches on frequently queried fields, is automatically revised by all data updates. Thus, when you use "Thelma" as a data item, the database itself automatically ensures its entry in the lexicon. Q&A's DBMS also updates the lexicon when you change the database structure, such as when you add or delete fields.

Like the other indexes in Q&A, the lexicon is stored as a disk-based B-tree and can grow arbitrarily large. Using Q&A's standard routines for searching B-trees, you can retrieve lexical items far more quickly than if you had to scan the primary data records. Thus, Q&A's IA and DBMS cooperate to let you edit live data and keep the lexicon current and fast.

Great Expectations

User expectations also greatly affect the usability of NLP. In fact, unrealistic expectations pose the greatest human-factors problem in the design of a natural-language interface. Novices have few preconceived notions about an ordinary computer program, and they even blame themselves if they have difficulty learning or using it.

But people *do* have preconceived notions about using English. They use it every day with no apparent effort. It seems perfectly natural that they should be able to talk to a computer in English; they've seen it on TV for years. Thus, even a system that claims only limited understanding of English can evoke inordinately high expectations.

continued

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Think of the IA as a new office worker from another country who is still learning English.

This problem greatly concerned us, and we devoted considerable design and engineering effort to addressing it. After making the IA as fluent as we could within the hardware limitations, we looked for ways to recalibrate user expectations to more realistic levels.

We tried to present our natural-language functionality as a concrete yet vulnerable process, with human-like imperfections. The manual, Help screens, menus, and various other parts of the system all invite you to think of the IA as a new office worker from another country who is still learning English. Like that worker, the IA tries to be helpful but sometimes makes linguistic or cultural errors.

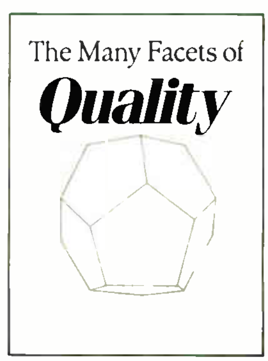
We established `Get Acquainted` as the first of the three options on the IA's main menu (along with `Teach` and `Ask`). `Get Acquainted` introduces you to the basic capabilities of the IA and the most successful strategy for coming to "speaking terms" with it.

In each session, the first time the IA displays its query request box, it shows two example requests in a syntax it understands. In white-room tests, this dramatically improved the likelihood of success. The IA normally states its plans of action in terms that *it* can understand. After a while, a user will gradually adopt its way of "speaking" as a model for communication with it. In addition, Q&A includes an IA fast-start card that briefly states how to ask questions successfully.

We also found that foreign users wanted to use the IA in their native tongues. To accommodate them, we have adapted the IA for German, Swedish, French, Dutch, Italian, and Finnish.

Meeting the Challenge

Looking back, the major challenge in designing a natural-language interface was not in understanding how to process English, but in identifying the collective needs of those who want English as an interface, and meeting them with available technology. As the microcomputer industry breaks through the 640K-byte RAM barrier and migrates to faster CPUs, linguistic coverage will rise quickly to the levels supported by current linguistic theory. Other aspects of usability will remain limited only by the creative capabilities of NLP designers. ■



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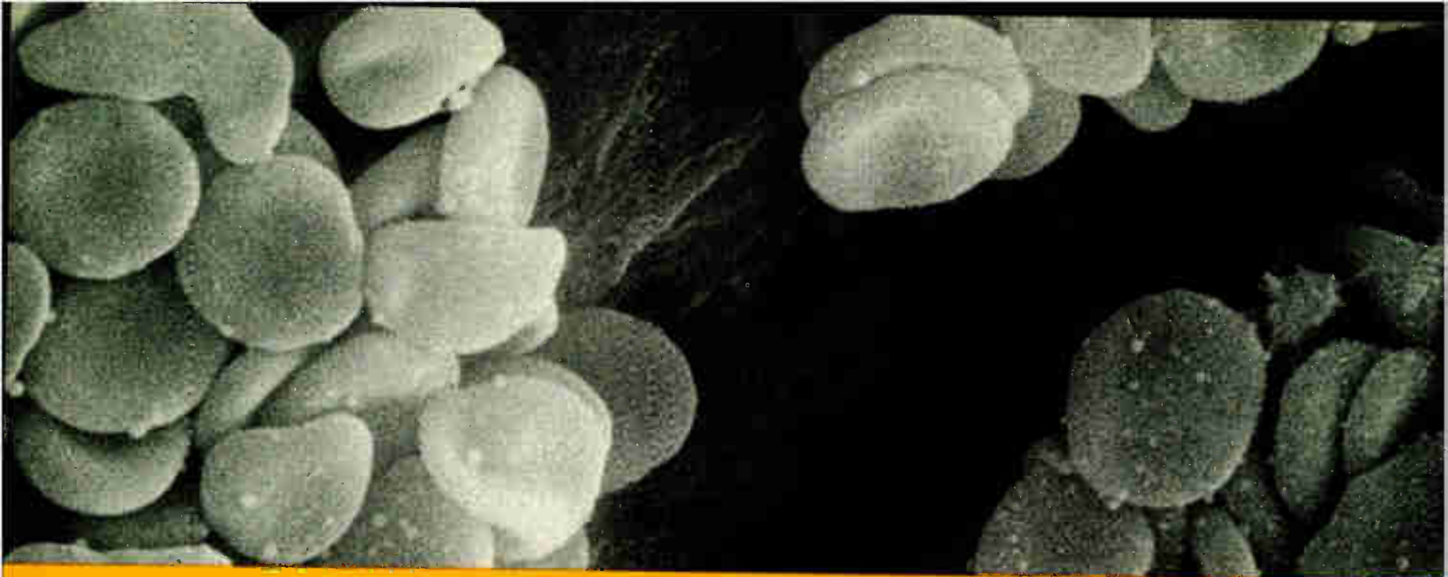

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DOS in English

A Turbo Prolog program can get your message across to the operating system in your own words

Alex Lane

AS COMMAND LANGUAGES go, DOS is fairly simple. Nevertheless, it poses problems for novice users, and potential problems for those who, like me, spend a lot of time using other command languages. After changing default directories several dozen times on a DEC VAX with the `set def` command, I invariably type in the same command to change directories on my IBM PC. Then, I throw a mental "Read my mind!" at the machine and edit the command to `cd` (short for `chdir`).

In frustration, I decided to write a simple program that would allow me to use DCL (Digital Command Language) commands on my IBM PC. When I mentioned this to a colleague over lunch, he responded enthusiastically and immediately suggested an improvement: Why not a program that translates English-like commands into DOS commands? Why not, indeed!

I'd already decided to use Prolog for this project, mostly because of its usefulness in parsing and symbol manipulation. Then I settled on Borland's Turbo Prolog for two reasons: its slick window-based programming environment and its ability to compile and link executable files with a minimum of fuss. Although purists may scoff at using Turbo, it did the job. In retrospect, however, I might have had an easier time with a "standard" implementation, but I have no regrets about my choice.

Setting Some Limits

What the program does falls into the category of natural-language processing. That is, it accepts an English-like statement such as "show me the files on drive b:" and outputs the DOS command `dir b:*.*`. You would get the same result from "show all files on b:" or "catalog b:." Despite this input flexibility, however, I had to impose some rules to keep the program manageable. As impressive as it might be to have a program that translates "show all files starting with the letter *S* that are on my hard disk" into `dir c:s*.*`, the memory required for such a program would be huge.

These are the rules (punctuation rules, I call them): You must identify disk drives with a trailing colon (e.g., b:); you must use periods only in filenames or fragments of filenames (e.g., foo.bar or .txt); subdirectory specifications must have either a leading, embedded, or trailing backslash character; and dates must be one "word," with either hyphens or slashes between month, day, and year.

The source code for this program is contained in seven files: NLDOS.PRO, NLDOS.DOM, NLUTILS.PRO, NLTOKENS.PRO, NLDATE.PRO, NLDOS.SYN, and NLRULES.PRO.

[Editor's note: *These Turbo Prolog files, as well as NLSIMPLE.PRO, NLSIMPLE.DOC, NLDOS.DOC, and NLREAD.ME, 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.*]

NLDOS.PRO, the main Turbo Prolog file, has two goal sections. One is for experimenting within the Turbo Prolog environment; the other applies when the program is compiled and linked into executable form. The program doesn't actually perform any of the commands resulting from the experimental goal section, so it's safe to enter some wild command lines and see what the program does with them.

However, if you're running the executable version, beware. The program will try to make something of what you say, and then it will execute what it "thinks" you mean. Don't experiment. Don't use obtuse wording. Keep it simple, or you may end up doing something catastrophic. I speak from experience. While playing with an early version of the program, I inadvertently wiped out all the files on my b: drive. I'd gotten so used to entering test commands that I gave no thought at all to the consequences of "zap all files on b:" in compiled mode.

NLDOS.PRO also contains the database predicate declarations and predicates that do some intermediate and final processing of the input command line. (In Turbo Prolog, a database predicate is one that consists only of facts [no rules] and

continued

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First, we have to break the command statement into a series of tokens. Then we need to sift out the noise words and standardize the remaining tokens.

can be added [asserted] or deleted [retracted] as the program runs.)

The file NLDOS.DOM contains the domain declarations. The Turbo Prolog implementation requires these declarations; all predicate parameters must belong to one of the half-dozen standard Turbo domains or to one of the domains defined in this file. The domain `worktok` consists of a number of functors with a string argument. These functors will be used to classify the tokens found in the command line.

The NLUTILS.PRO file contains the predicates for some Prolog workhorses like `member/2`, `append/3`, `repeat/1`, and `remove/3`. With correct predicate declarations, this file can be useful in a variety of Turbo Prolog programs.

NLTOKENS.PRO supplies a tokenizer that improves on the standard Turbo Prolog `fronttoken/3` predicate. The file NLDATE.PRO gives the program the capability of reading dates in a variety of formats, while NLDOS.SYN is a database of synonyms for DOS commands and switches. Finally, the file NLRULES.PRO is a collection of rules for "massaging" the input command line into something the program can work with. When compiled and linked, the program occupies almost 70K bytes of memory.

Collecting Tokens

The first task that we need to accomplish is to break the command statement into a series of tokens; the tokenizer does this. For our purposes, a token is a word such as "files" in the expression "Show all files on b:." The other tokens in the expression are "show," "all," "on," and "b:."

I initially wanted to use the Turbo Prolog `fronttoken/3` predicate as a tokenizer, but it mercilessly singles out nonalphabetic characters like "*" and "\" as single tokens. Thus, the file specification "c:*.*" is tokenized into the series `token("c"),token(":"),token("*"),token("."),token("*")`, instead of the much easier to manage `token("c:*.*")`. After several attempts at working around this obstacle, I abandoned `fronttoken/3` and adopted a more traditional approach.

The tokenizer in NLTOKENS.PRO uses a common Prolog strategy for extracting tokens from an input character stream. (You may recognize it as an enhanced version of the tokenizer in my article "Simulating a Microprocessor" in the August BYTE.)

Once the tokenizer has found an acceptable character in the input, it collects characters until it finds some delimiting character, like a space. It then transforms the collected characters into a string, sets them aside, and starts over again with the rest of the input stream. When the input stream is empty, the tokens are returned in a list of functors of the domain type `worktok`.

Using my punctuation rules, the tokenizer can also classify the token it's working on as it collects characters. For example, if the tokenizer encounters a colon, it knows it's dealing with a drive name. If it encounters a space after the colon, it stores the token as a drive—that is, `drive("c:")`.

If, however, the tokenizer finds another letter after the colon, it assumes it's dealing with a file specification and stores the token as a filespec—`filespec("c:notes")`—unless the input contains a backslash character. In this case, the tokenizer decides it's reading a directory and stores it as such—for example, `directory("c:notes\\")`.

Note that in Turbo Prolog, a single backslash character is an escape character within a string; thus, a "real" backslash is represented by two consecutive backslashes within the string.

Sifting Out the Chaff

The first thing we need to do with the new list of tokens is to sift out the noise words like "me," "you," "a," and "the." A complete listing of the noise words is found in the predicate `chaff/1`, and the predicate `cull_chaff/2` performs the actual sifting.

Now that we have thinned the ranks of the tokens a bit, we need to standardize the remaining ones. For example, "all," "every," "everything," "entire," and "completely" become the token "all"; "ch," "cha," "chan," and "chang" become "change." When editing these or any other synonym lists, you need to be careful not to introduce synonyms that clash with the synonyms for other commands. If you're not careful, you can get some strange and undesirable results.

Next, the program looks for a command or a command synonym. The DOS command `del`, for example, comes from "delete," "kill," "erase," "zap," "chop," or "remove." The program scans the tokens from left to right until it finds a command.

Then you need to massage the token list using a collection of `if...then` rules that try to identify common usage and redundancy, as well as specifications of source files and target directories. (These are not generic Prolog rules, which are statements of the form ***A :- B.***, where ***A*** is the head and ***B*** is the body of the rule.)

Listing 1 contains a typical rule from NLRULES.PRO, which is interpreted in the following way: If the input token list contains a `filespec/1` functor, instantiate its filename argument to the variable *A*, then replace the sequence `token("to"), filespec(A)` with `targetfile(A)` in the output token list. Technically, the first subgoal, `member(filespec(A),Input)`, is not necessary, but since it suppresses a warning message about using a variable twice with an output flow pattern in the second subgoal, I left it in.

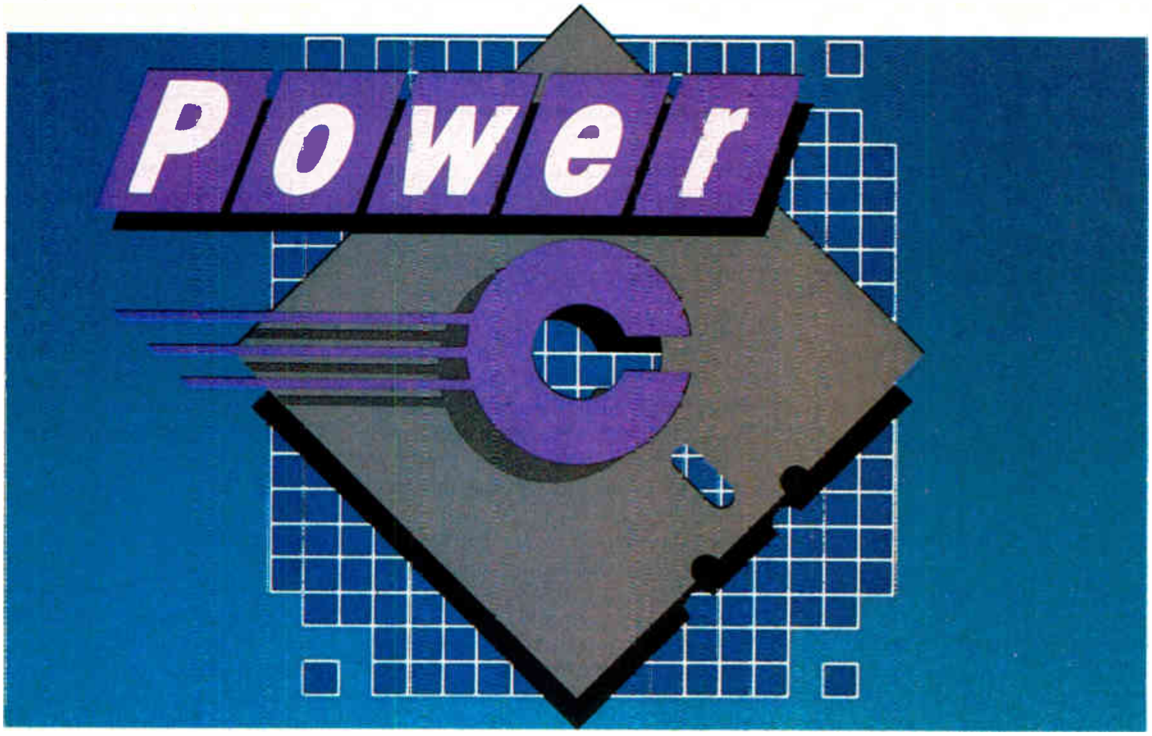
Under certain circumstances, the rules can also correct a misinterpreted command. Given the input "change directory to \alpha," for example, the `find_command/2` predicate returns the list `[token("change"),command("dir "),token("to"),directory("\\alpha")]`, which is not what the input intended. The rule `dos_directory_commands` changes this list so that it correctly reads `[command("chdir "), token("to"), directory("\\alpha")]`.

In addition, the `if...then` rules in the program can find commands where the predicate `find_command/2` can't. For example, they correctly interpret the input "show *.*" as `dir *.*`. They also take care of finding switch specifications. For example, finding `token("wide")` in a list with `command("dir ")` transforms the former into `parameter("/w")`; similarly, finding `token("after")` in a list

continued

Listing 1: *An example of a typical rule from NLRULES.PRO.*

```
rule(establish_targetfile, Input, Output) :-
 member(filespec(A),Input),
  repl([token(''to''),filespec(A)],targetfile(A),Input,Output).
```



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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

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with command("backup") initiates a routine to look for a date in the token list.

Looking for a Date

The impetus for building a date finder into the program stems exclusively from my desire to implement the backup command. When I use this command, I usually end up lugging out the DOS manual to recall the correct command syntax, especially if I want to include subdirectories in the backup. Now, using the program, I can simply type "back up all files in all subdir modified after 23-jun-87 to a:" and have the program tell DOS backup *.* a: /s/d:06-23-87.

The date finder in NLDATE.PRO examines the tokens in the token list and tries to further tokenize them, this time using the Turbo Prolog fronttoken/3 predicate. If no part of the original token resembles a year—that is, if it doesn't contain an integer larger than 80—the program assumes that the year is 1987. If the month is alphabetical in the original token, the month/2 predicate returns its number, leaving only a day to be found. If the month is numerical, the first number (if between 1 and 12) is used as the month, and the next as the day.

NLDATE.PRO uses Prolog's backtracking mechanism to try all variations until it finds a valid date; if it doesn't, it returns "bad date." Thus, "6/23/87," "23/Jun/87," "1987-6-23," and "Jun-23-1987" all reduce to "06-23-87."

The Firing Line

Every time a rule "fires," the program returns a modified list of tokens to the massage/2 predicate, outputs the name of the fired rule to the console for diagnostic purposes, and passes the new token list to the rules as input again. Once no more changes occur, it passes the token list (now highly refined) on for final processing. The program then searches the token list for a command. When one is identified, the associated command_params/3 rule extracts all necessary command-line parameters (including switches) and concatenates them into a single final string. This string can be passed to the standard Turbo Prolog system/1 predicate for execution by DOS.

In Your Own Words

The current version of the program doesn't understand all of DOS. It won't use sort, find, format, and some other commands. It won't let you set the time or date; however, you can view them. The c_syn/1 database predicate in NLDOS.SYN contains the definitive list of commands covered by the program. Feel free to experiment with the words you would like to use.

This program has great potential for experimentation. The commands issued in a command language form a small, yet interesting, domain that is amenable to natural-language processing on an IBM PC or compatible. In particular, you can expand standard DOS commands to offer some of the features of the "higher-priced" command languages.

For example, you could add more date-related commands, like "delete all .BAK files dated prior to 12 Dec" and "copy all files created today from c:\alpha\ to a:." You could also endow the program with the "intelligence" to issue warning messages like "do you really want to delete your only copy of NLDOS.SYN? You've been working on it for hours."

Natural-language processing may well be the most important field of study in artificial intelligence. Getting your message across to the computer in your own words will allow you more time to solve problems *on* your computer, time that you're now spending figuring out how to explain problems *to* your computer. ■

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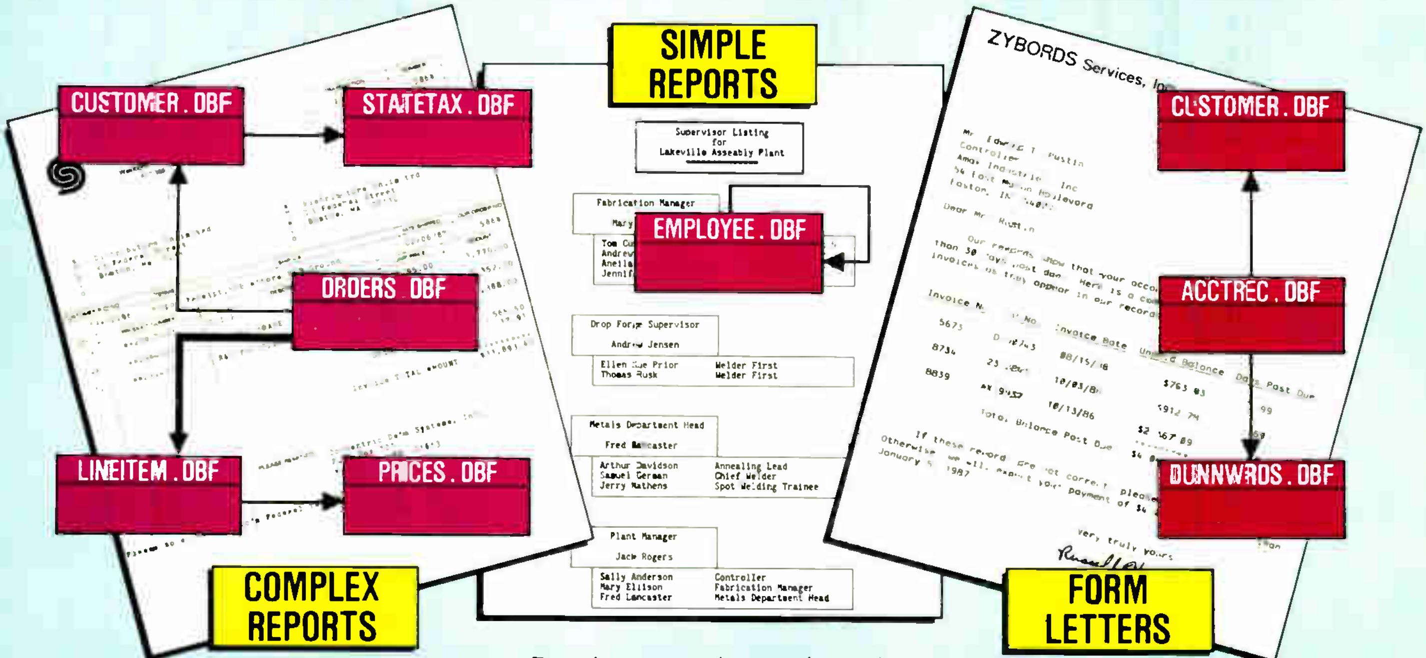

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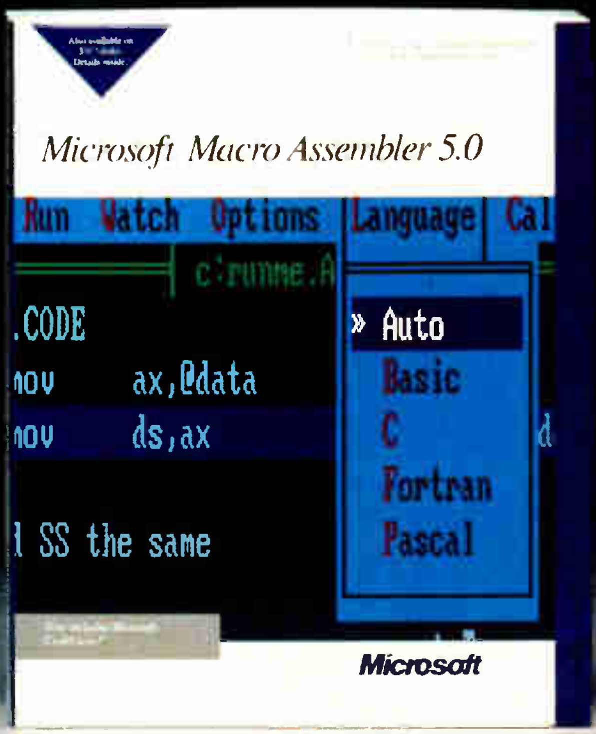

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Natural-Language Processing in C

A simple context-free recursive-descent parser that opens the door for computer comprehension of human language

Herbert Schildt

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NATURAL-LANGUAGE PROCESSING (NLP) may be the most important task that artificial intelligence can solve because, once accomplished, NLP would open the door for direct human-computer dialogues, bypassing normal programming and operating-system protocol. NLP is a "doable" task, but the sheer size and complexity of human language has kept it from being fully accomplished. This article develops a simple natural-language parser that can serve as the starting point for your own NLP program.

What Is NLP?

NLP tries to make the computer capable of understanding commands written in standard human languages. (This article assumes that English is the human language being processed, but you can apply all the concepts that are presented to any other language.) A somewhat less important part of NLP is making the computer construct natural-language-like responses. After the computer understands natural language, it is a small step to generating responses.

In my opinion, speech synthesis and recognition are not actually part of NLP. A natural-language processor doesn't care how a sentence is input into the computer; its job is to extract information from that sentence.

While NLP has no direct use of its own, except for research, it can provide a front end for other computer programs—especially database managers and generalized problem solvers. Many programmers are interested in NLP-driven operating systems, which would virtually eliminate the time it takes to learn to use the computer. Context-sensitive foreign-language translators need NLP in order to produce accurate translations; and NLP is essential to autonomous robots, which must effectively interact with a human world.

Approaches and Constraints

There are two opposite approaches to NLP. One approach attempts to use all the information in a sentence, just as a human would. Its goal is to make the computer capable of carrying on a conversation. However, this is quite difficult to accomplish. The other approach tries to let the computer accept natural-language commands, but only to extract information essential to that command—a much easier task to program. The parser presented in this article has a slim chance of reaching the first goal; it has a much more probable chance of accomplishing the second.

One of the most difficult aspects of constructing an NLP-driven system is the complexity and flexibility of human language. When you implement a natural-language processor, it is tempting to try to restrict the type of sentences that the processor will understand to a subset of the natural language. If you restrict the grammar, your task becomes much easier, and, if done correctly, the restriction is barely noticeable. Therefore, let's assume that all sentences are declarative, not interrogative, and that they generally follow the standard form: subject, verb, object.

Let's also assume that all adjectives precede the nouns they modify, all adverbs follow the verbs they modify, and all sentences end with a period. With these constraints, the following sentences are valid: "The child runs to the house." and "The large child runs quickly to the window." However, a sentence such as "The child quickly runs to the house." is invalid because the adverb "quickly" precedes the verb "runs." Let's call our restrictive set of rules the G1 grammar.

In addition to rules, you need a vocabulary. For our purposes, let's keep the number of words to a minimum, but you are free to add to the list if you like. Our parser will recognize only the words shown in table 1.

The State-Machine Parser

The core of any NLP system is the *parser*, the section of code that reads each sentence, word by word, to decide what is what. One approach to parsing, the state-machine parser, uses the current state of the sentence to predict what type of word can legally come next. A state-machine

continued

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parser is a directed graph that shows the valid transitions from one state to another. For example, a noun can legally be followed only by a verb or a preposition (see figure 1).

The worst problem with the state-machine parser is its complexity; even for the simplest grammar, you need several separate conditional statements to determine whether a state transition is legal. Imagine how many states you would need to define the entire English grammar! Another problem is that the state-machine parser doesn't know how it got to any particular state. In other words, you can't call on a state-machine parser to supply any information other than its current state.

On the plus side, state-machine parsers are ideal for certain specific needs, such as job-control languages and some database applications. In these environments, you need only ensure that the user enters the commands in a valid format and that the computer knows each word. State-machine parsers can work in these situations because they have few valid types of sentences and, thus, few states.

Table 1: *The words that our parser will understand.*

Word	Type
door	noun
window	noun
house	noun
child	noun
has	verb
runs	verb
plays	verb
large	adjective
quickly	adverb
the	determiner
a	determiner
to	preposition

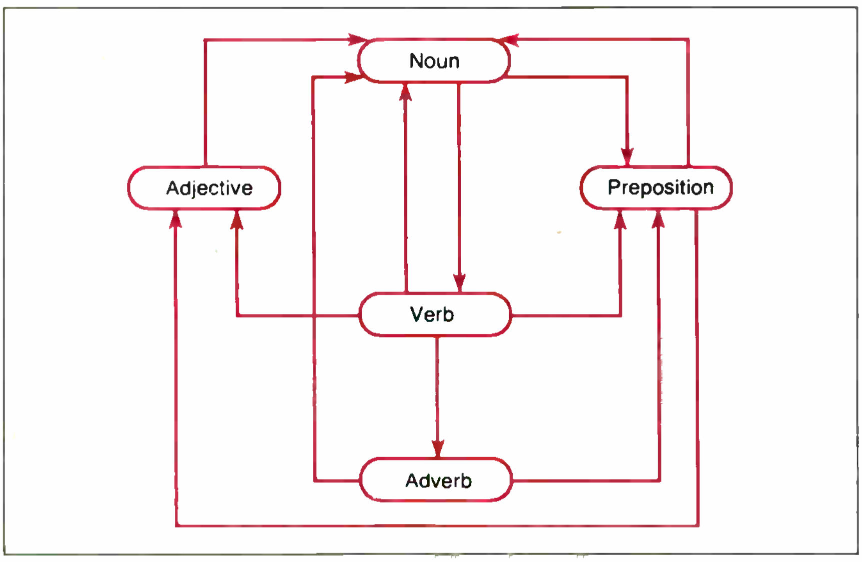

Figure 1: *The state-machine parser for the restricted G1 grammar.*

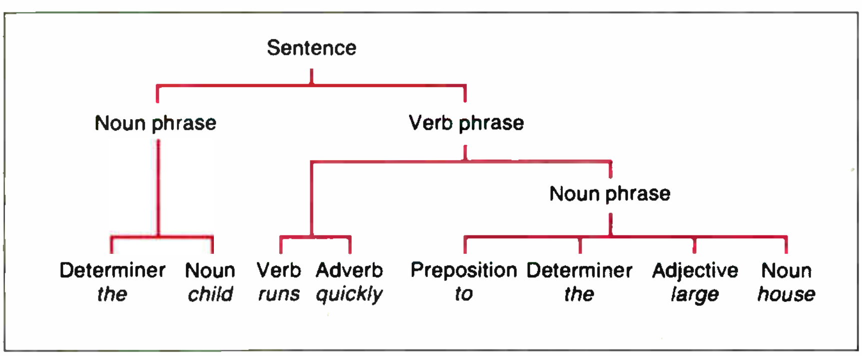

Figure 2: *A tree structure that parses the sentence "The child runs quickly to the large house."*

The Context-Free Parser

To understand context-free parsers, you must look at sentence construction completely differently than you do for the state-machine model. You must think of the sentence as being composed of various items, each of which is composed of other items, and so on, until you break the sentence down into its atomic elements (e.g., noun, verb, and adjective). The rules that govern how each item can be constructed are called the production rules of the grammar. A context-free parser uses these production rules to analyze a sentence.

The production rules for the G1 grammar are as follows:

SENTENCE → NP + VP
NP → determiner + noun
NP → determiner + adjective + noun
NP → preposition + NP

VP → verb + NP
VP → verb + adverb + NP
VP → verb + adverb
VP → verb

where the right arrow stands for "produces," NP for "noun phrase," and VP for "verb phrase." The noun phrase is a recursive definition for a prepositional phrase; the verb phrase is indirectly recursive, because it evokes a noun phrase as part of its definition.

Figure 2 shows how to apply these rules to a sentence. The production rules form a sort of tree, often called a parse tree, which represents how the parser sees the sentence. A parser that generates this type of parse tree is called context-free, because the tree is not based upon the context of each element: The rules will work for any sentence that conforms to the G1 grammar, without regard to the context of each phrase.

NLP programs are not the only ones to use context-free parsing; virtually all computer languages use it. For example, you can parse Pascal, BASIC, C, Modula-2, and others with a context-free parser. However, the fact that you can represent even a subset of English with

continued

Listing 1: *The database for the G1 grammar defined as an array of structures.*

```
/* structure of the word database */
struct word {
  char word[20];
  char type;
};
struct word wdb[MAX];  /* array of db structures */
```

Listing 2: *The function* `get_token()`*, which reads the input sentence one character at a time until it encounters a space.*

```
/* return one token from the input stream */
get_token()
{
  char *p;
  p=token;
  /* skip spaces */
  while(*t_pos==' ') t_pos++;
  if(*t_pos=='.') {
    *p++='.';
    *p='\0';
    return;
  }
  /* read word until a space or period */
  while(*t_pos!=' ' && *t_pos!='.')  {
    *p=*t_pos++;
      p++;
  }
  *p='\0';
}
```

Listing 3: *The* `parse()` *function for a context-free recursive-descent parser. This function is found in NLP.C.*

```
/* Context-free recursive descent NLP parser */
parse()
{
  if(!nounphrase()) return 0;
  if(!verbphrase()) return 0;
  if(!terminator()) return 0;
  return 1;
}
/* read a noun phrase from the input stream */
nounphrase()
{
  char type;
  get_token();
  type=find_type(token);
  switch(type) {
    case DET:
      get_token();
      type=find_type(token);
      if(type==NOUN) return 1;
      else if(type==ADJ) {
        get_token();
        type=find_type(token);
        if(type==NOUN) return 1;
      }
      break;
    case PREP:
      return nounphrase();
  }
  return 0;
```

continued

production rules that a context-free parser can parse has enormous implications.

First, it asserts that, in some ways, English conforms to a strict set of rules—that is, English is not just a jumble of disconnected arbitrary restrictions. Second, it lets you apply some well-understood parsing techniques that were developed for computer languages to natural language—you don't have to reinvent the wheel. Finally, because context-free production rules are organized from phrases down to the words that actually compose them, you can easily extract not only individual words, but also whole phrases. Thus, you can parse individual words as well as phrases—and know where each phrase came from; this gives you the basis from which you can gather semantic information. All these points make a context-free parser a big step forward from the state-machine parser.

Recursive Descent

There are many ways to implement a context-free parser that uses the G1 production rules. The easiest, especially in C, is to create a recursive-descent parser that uses a collection of mutually recursive routines that descend through the production rules until they completely parse the sentence.

Before you can implement a context-free parser, you must define a database to hold the vocabulary and the types of words that the parser can recognize. Listing 1 defines this database as an array of structures. The parser also needs a routine to break a sentence into its components. The function `get_token()` in listing 2 accomplishes this: `get_token()` reads the input sentence one character at a time until it encounters a space. The characters that are read form the next word in the sentence. Then, `get_token()` places this word into the global string `token`. A global variable `t_pos` holds a pointer to the input sentence and is incremented as each word is read.

Using `get_token()`, you can write the context-free recursive-descent parser in listing 3. At the topmost level, a sentence comprises a noun phrase, a verb phrase, and, in this case, a period as a terminator. Therefore, the function `parse()` calls the routines `nounphrase()` and `verbphrase()`. If you assume that these succeed, implying that the sentence meets the G1 grammar rules, then the parser calls `terminator()` to confirm that the sentence ends in a period. The functions `nounphrase()` and `verbphrase()` use their various support functions to implement the context-free rules as described above. If a sentence doesn't conform to

continued

```
}
/* read a verb phrase */
verbphrase()
{
  char type,*pos;
  get_token();
  type=find_type(token);
  if(type!=VERB) return 0;  /* must start with a verb */
  pos=t_pos; /* save current position for backtracking */
  /* verb + adverb + NP */
  if(verb_adv_np()) return 1;
  /* verb +NP */
  t_pos=pos;  /* back up */
  if(verb_np()) return 1;
  /* verb+adverb -- no NP */
  t_pos=pos;
  if(verb_adv()) return 1;
  /* just verb */
  return 1;
}
verb_np()
{
  /* verb + NP */
  return nounphrase();
}
verb_adv_np()
{
  char type;
  get_token();
  type=find_type(token);
  if(type==ADV && nounphrase()) return 1;
  return 0;
}
verb_adv()
{
  char type;
  get_token();
  type=find_type(token);
  return (type==ADV);
}
terminator()
{
  get_token();
  return(find_type(token)==TERM);
}
```

these rules, then either nounphrase( ) or verbphrase( ) will fail, causing the parser to reject the sentence.

For example, let's see how the parser parses the sentence "The child runs quickly to the large house." First, parse( ) calls nounphrase( ), which succeeds, because it finds both the determiner "the" and the noun "child." Then parse( ) calls verbphrase( ), which calls verb_adv_np( ) to see if the verb phrase consists of a verb followed by an adverb, which in turn is followed by a noun phrase. In this case, the verb phrase does contain these: The verb "runs" is followed by the adverb "quickly," which is followed by the prepositional noun phrase "to the large house."

Next, this prepositional noun phrase causes nounphrase( ) to call itself recursively. After the parser reads the final phrase, all the recursive calls unravel, and verbphrase( ) succeeds, returning to parse( ). The parser confirms that a period ends the sentence by using terminator( ). Finally, parse( ) succeeds, implying that the sentence satisfies the rules of the G1 grammar.

The context-free recursive-descent parser is expanded to an entire program in NLP.C. To better understand its operation, try it with several different sentences. [Editor's note: *NLP.C and NLPRPT.C are available in Microsoft C 4.0 source code for the IBM PC AT 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.*]

By slightly modifying parse( ), nounphrase( ), verbphrase( ), and their

continued

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Listing 4: *The* nounphrase( ) *function for a context-free recursive-descent parser that displays phrases. This function is found in NLPRPT.C.*

```
/* read a noun phrase from the input stream */
nounphrase(s)
char *s;
{
  char type;
  get_token();
  type=find_type(token);
  switch(type) {
    case DET:
      strcat(s,token);
      strcat(s," ");
      get_token();
      type=find_type(token);
      strcat(s,token);
      strcat(s," ");
      if(type==NOUN) return 1;
      else if(type==ADJ) {
        get_token();
        strcat(s,token);
        strcat(s," ");
        type=find_type(token);
        if(type==NOUN) return 1;
      }
      break;
    case PREP:
      strcat(s,token);
      strcat(s," ");
      return nounphrase(s);
  }
  return 0;
}
```

support functions, these routines can break sentences into their component phrases. Unlike the state-machine parser that could deal only with words, the context-free recursive-descent parser can extract phrases. This is an important capability, because it opens the door to the computer actually comprehending, rather than simply verifying, a sentence; thus, it lets the computer work with related groups of words.

Listing 4 contains the noun-phrase parser revised for phrase extraction. The program using the phrase-extraction version of the complete parser, including revised versions of parse( ), nounphrase( ), and verbphrase( ), is called NLPRPT.C. It returns both the noun phrase and the verb phrase of a sentence. If you run NLPRPT.C with the input sentence "The child runs quickly to the house.", your output will be

noun phrase: the child
verb phrase: runs quickly to the house

Pros, Cons, and Possibilities

The context-free parser has many advantages. First, it is easy to implement in C. Second, you can use it to deal with a sentence on both the word level and the phrase level. Third, it knows where it is in the sentence at all times. This differs from the state-machine parser, which has no idea where it actually is in a sentence.

The main disadvantage of context-free parsers is that they can't handle the many valid ways in which an English sentence can be constructed. It's easy to define a set of production rules that fully describe the simple G1 grammar, but for real-world English (or any other language), the production rules would be very complex, which could lead to a combinatorial explosion, perhaps making this method impossible to use.

The context-free parser in listing 3—and in NLP.C and NLPRPT.C—is just a starting point intended to excite your imagination. I encourage you to enhance and evolve it to suit your needs. One thing you will probably want to do is include additional production rules in the parser so it can recognize a wider variety of English grammar. You will probably want to add better error checking, too. Also, although fully adequate for demonstration, the database that holds the words in table 1 is simply an array of structures in which the words are stored in no special way. You will probably want a sorted, tree-based database that will allow fast lookups for several hundred—or several thousand—words. ■

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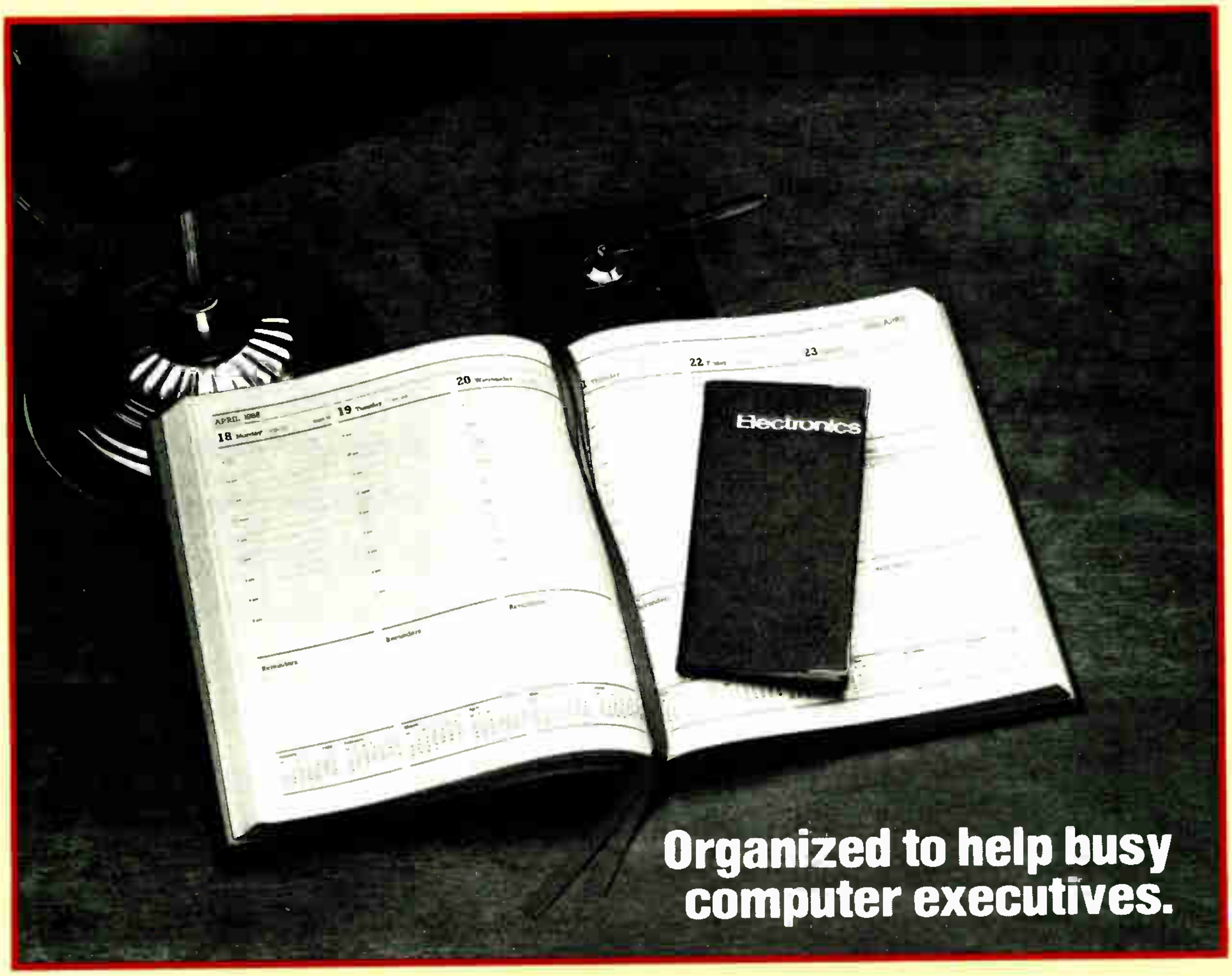

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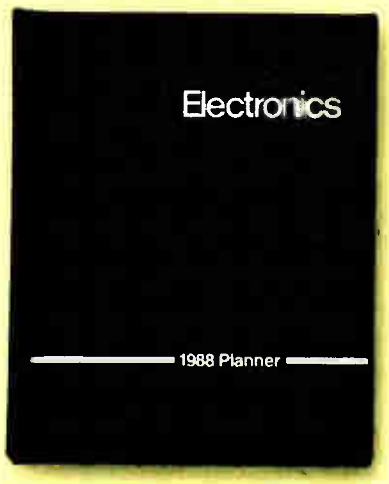

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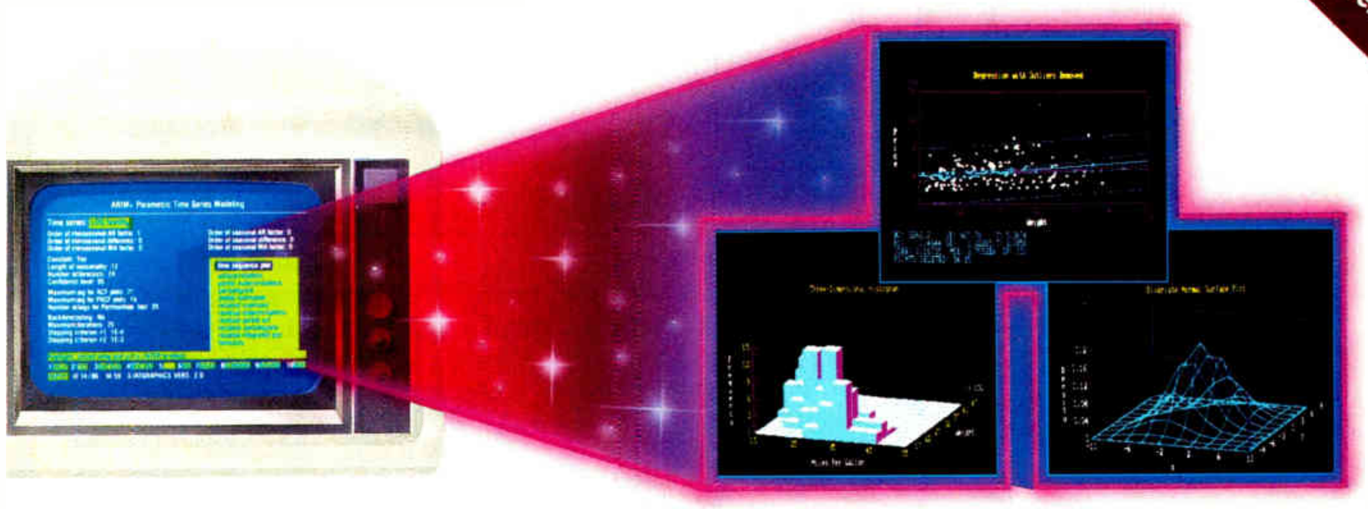

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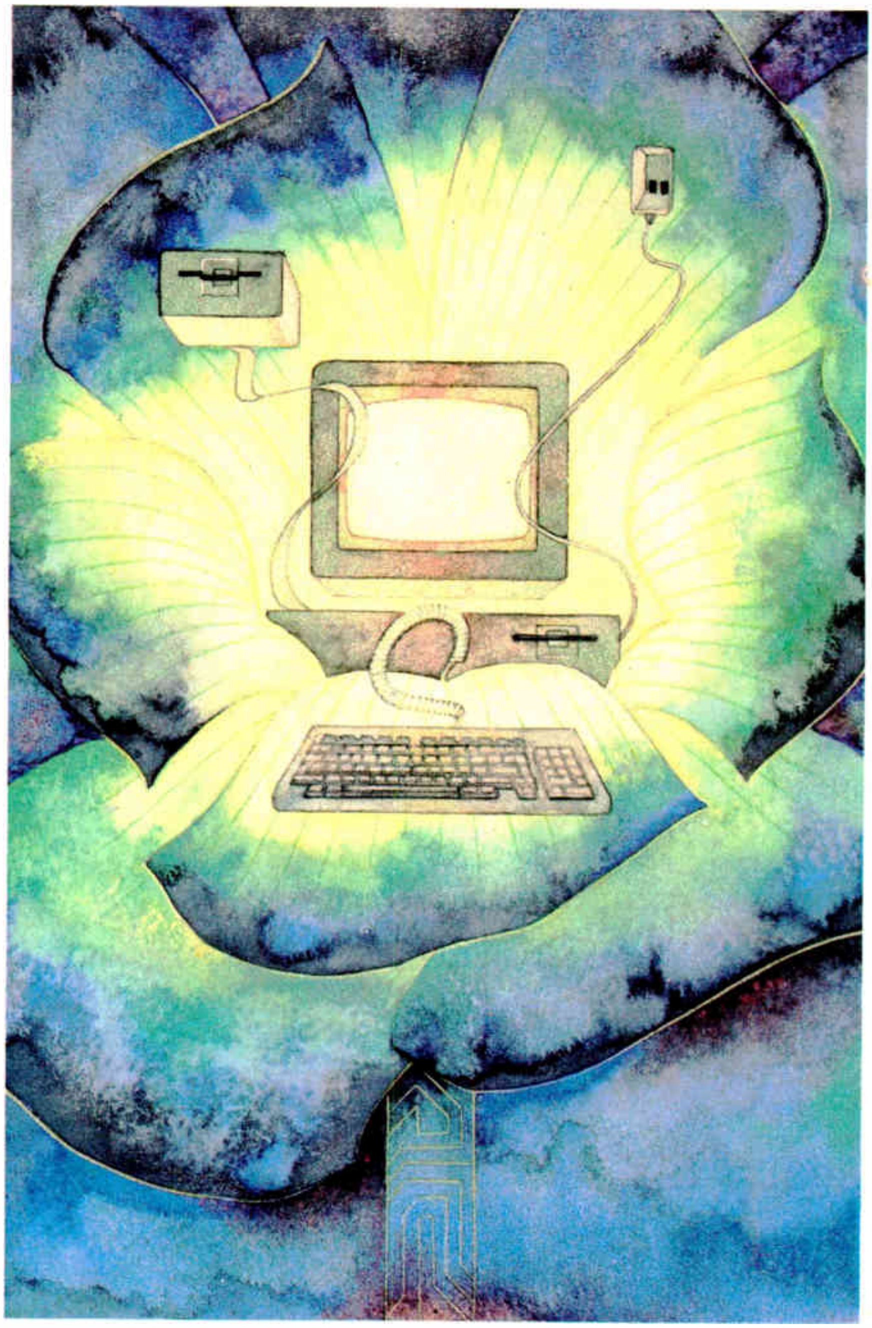

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Part 2: Software and Operation

Steve Ciarcia

Build the Circuit Cellar IC Tester

Steve guides us on a tour of the software that makes his inexpensive IC tester possible

Last month, I talked about the design of my IC tester. This month, I'll talk about its software and operation.

Three in One

To refresh your memory, the IC tester supports three modes of operation: PC-host mode, terminal mode, and stand-alone LCD mode.

PC-host mode requires that you connect the tester to a serial port on an IBM PC or compatible. In this mode, the PC handles all test-vector transfers and comparisons and provides the highest level of flexibility and power.

To operate the tester in terminal mode, you connect it to a dumb terminal or any microcomputer that emulates a terminal (see photo 1). The options are essentially the same as those offered in PC-host mode, although you can use only a fixed, ROM-resident device library.

The stand-alone mode of operation lets you operate the tester with only two push-button switches and a 2-line by 20-character LCD. As in terminal mode, this mode operates only with a fixed, ROM-resident device library. It lacks some features of the other two modes, but it permits device identification (using the Identify push button) and specified-device testing (using the Retest push button). The latter lets you determine specific pin failures on a bad IC and display this information on the LCD.

Much of the flexibility of the IC tester comes from its modifiable and expandable device library. While an IBM PC (or clone) is essential for PC-host mode operation, it is required if you're going to make any system software changes, like adding new chips to the library.

With the exception of a single assembly language serial-port driver, all the software was written in Turbo Pascal on an IBM PC. (While the programs do take advantage of some PC-specific features of Turbo Pascal, you shouldn't have much trouble converting them to other Pascal compilers.)

The Definition of a Test Vector

In order to define test vectors, it is important to develop a straightforward means of describing the vector information. What information do we need to define a device and its test vectors?

The device definition consists of the device name (e.g., 7400), the specific package size (e.g., 14 pins), the locations of the power and ground pins (e.g., 14 and 7), and which pins are inputs, outputs, or tri-state.

A test vector merely specifies the high (1) and low (0) logic levels to be written to the pins of the device under test (DUT). A test vector written to the DUT pins is referred to as an output vector.

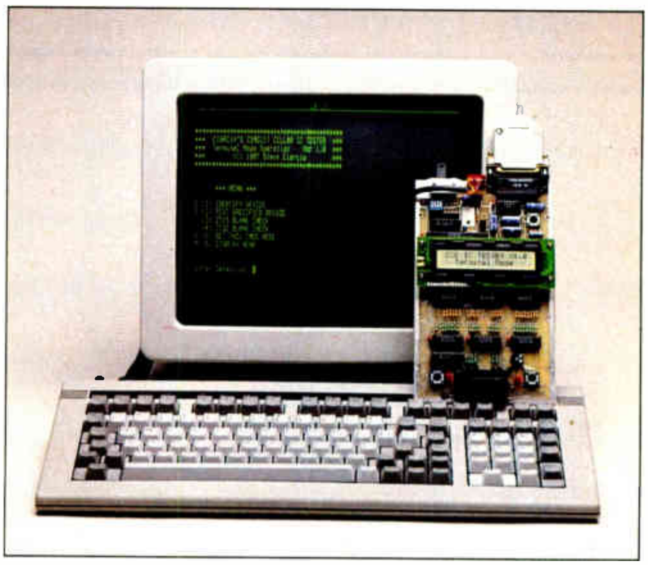
To determine if the DUT responded properly to the output vector (i.e., to make sure outputs switched as expected and to verify that no inputs are shorted), the tester must read a corresponding read-back vector from the DUT and compare this to an expected read-back vector. Each complete test vector consists of an output vector and an expected read-back vector.

The format for specifying the vector-definition modules is shown in table 1. The order of the different line types is important, though you may freely intersperse comment lines. (Like many assemblers, all characters on a line following an asterisk are ignored by the test-vector compiler.)

The best way to understand the vector-definition module format is by example. Table 2 shows the vector-definition module for a 7400 quad two-input NAND gate. As its name implies, this device contains four two-input NAND gates (the pin-out is shown in figure 1).

continued

Photo 1: *The Circuit Cellar IC tester shown here is operating in terminal mode, connected to a Tandy DT-100 terminal via the RS-232C port on the top of the tester.*



Steve Ciarcia (pronounced "see-ARE-see-ah") is an electronics engineer and computer consultant with experience in process control, digital design, nuclear instrumentation, and product development. The author of several books on electronics, he can be reached at P.O. Box 582, Glastonbury, CT 06033, or on BIX as "sciarcia."

In table 2, the first line is the device name. The name can appear anywhere on the line after the pound sign (preceding and following spaces are ignored). As a general rule, you should keep device names as generic as possible. Instead of using the name "74LS00" use "7400," and so on. Since the tester will logically identify both a 74LS00 and 74HC00 as the same chip, it is better to display "7400," or perhaps "74xx00." There are, of course, cases where you can make exceptions.

The second noncomment line of the vector-definition module is the setup line, which has an *S* in the first column. Three numbers with delimiting spaces must follow the *S*; the first number indicates the number of pins the device has, the second indicates the ground pin number, and the third indicates the power pin number. These numbers tell the compiler (and the tester) what the chip's device type is. As I described last month, the tester supports six device types (see table 3).

Following the next comment line is the pin-function line, which has an *F* in the first column. This line specifies a pin-function identifier for each pin, with the identifiers being separated by one or more spaces. Valid identifiers are *I* for input pins, *O* for output pins, and *T* for tri-state pins.

The pin-function line also determines the columnization for the remainder of the device vector definition. All 1s and 0s in the test vectors must be aligned under these columns, and the pin numbers in the pin-number line (the next line in the definition) must also be aligned under these columns.

The next line in the vector-definition module is the pin-number line. It has the letter *P* in the first column. This line specifies the device pin numbers used in testing. The numbers must correspond to the pin-function identifiers specified in the pin-function line and must fall in the columns defined by the function identifiers. If the pin number for a column has two digits (e.g., pin 14), either of the two digits can fall in the column.

The next several lines in the vector-definition module are the actual test vectors. The lines beginning with *I* are initial vectors (output vectors), and the lines beginning with *R* are the expected read-back vectors.

For *I* vectors, the acceptable identifiers are 1 and 0, corresponding to high and low digital values, respectively. For *R* vectors, acceptable identifiers are 1, 0, and *X*, with *X* indicating "don't care." (*X* indicates that the tester should ignore the specified pin when comparing the actual read-back vector to the expected read-back vector. If the 1 or 0 bit value of a column does not change from one line to the next, leaving the column blank in the subsequent line[s] implies that the value should be the same as the last value explicitly stated for that column.)

The last line in the vector-definition module is the end line,

Table 1: *Device test-vector definition-module format.*

```
# DeviceName                 * Device-name record
* Comment lines may be interspersed
* for documentation and clarification purposes.
S #Pins Gpin Ppin            * Device-setup record
F  I   O  . . . T   I   I    * Pin-function record
P  p#  p# . . . p#  p#  p#   * Pin-number record
I  0   1  . . . 1   1   0    * Initial (output) vector record
R  1   0  . . . 1   X   0    * Expected read-back vector record
I . . .
R . . .
.
.
E                            * End-of-definition record
```

Notes: DeviceName = name of device
* = start of comment area
#Pins = number of pins on the IC
Gpin = ground pin number
Ppin = power pin number
p# = pin number

Table 2: *Device test-vector definition module for the 7400.*

```
# 7400          * Quad two-input NAND
S 14 7 14
*  NAND 1     NAND 2     NAND 3     NAND 4
F  I  I  O    I  I  O    I  I  O    I  I  O
P  1  2  3    4  5  6    9  10 8    12 13 11
I  0  0  0    0  1  0    1  0  0    1  1  1
R        1          1          1          0
I  0  1  0    1  0  0    1  1  1    0  0  0
R        1          1          0          1
I  1  0  0    1  1  1    0  0  0    0  1  0
R        1          0          1          1
I  1  1  1    0  0  0    0  1  0    1  0  0
R        0          1          1          1
E  * end of 7400
```

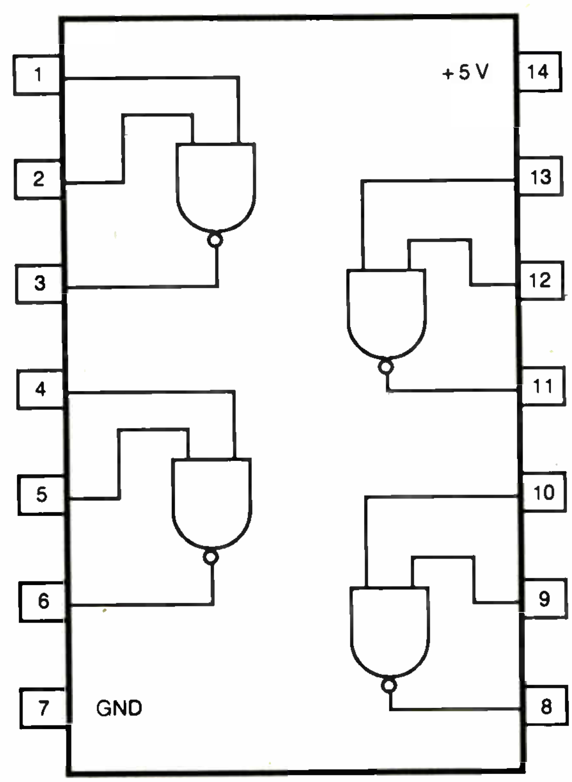


Figure 1: *Pin-out for a 7400 quad two-input NAND gate.*

which begins with an *E*. This is the only letter required to specify the end of the vector-definition module.

Finally, there is the issue of logically identical devices that have different part numbers (like 74LS04 and 74LS14). Differences typically lie in some of the special operational parameters, like Schmitt-trigger inputs or improved current drive capability, which cannot be detected by this IC tester.

Functionally identical devices (i.e., the same test vectors would pass on both devices) are declared to be clones of a specific device. An example of this is shown in table 4. The device-name and end lines are the same as the standard vector-definition module, but only the *C* line is found between them, indicating which device it is supposed to be cloned from.

Compiling Test Vectors for Use

The test-vector compaction compiler, VECCPT.PAS, is a Turbo Pascal program that accepts files conforming to the device test-vector definition format described above. It converts the device and vector information into a single compact module that the computer and tester use to test the devices.

VECCPT.PAS uses seven primary arrays to store the compacted vector information. The primary array, `VectorTable`, holds the actual test-vector information, including the device pin-function information (i.e., which pins are inputs, which are outputs, and which are tri-state), the output vector bytes, the input vector bytes, and the "don't care" mask bytes.

Because the ZIF (zero insertion force) socket has 24 pins, tester software uses 3 bytes for pin and vector information for every device, regardless of size. Consequently, the pin-function and test-vector information is stored as if a 24-pin device were being tested.

The "don't care" mask generated by VECCPT.PAS automatically masks the read-back vector pins not associated with the device being tested. For example, if a 20-pin device is being tested, the bits of the 3-byte read-back vector associated with ZIF-socket pins 1, 2, 23, and 24 will be masked by the "don't care" mask (power and ground pins are automatically masked).

Each of the six device types supported by the IC tester has its own associated array for storing device names and pointers into the `VectorTable` array. These arrays are called `DeviceType` arrays.

While the `VectorTable` array uses variable-length records, with each record being the information to support one device, the `DeviceType` arrays use fixed-length records, with each record containing a 9-byte field for the device name (8 bytes for the name and 1 byte for the string size) and an integer (2-byte) field for the `VectorTable` pointer.

Figure 2 illustrates the information stored in the various arrays and how the arrays interact. As shown, device names are stored in the appropriate `DeviceType` array, and the device pin-function and test-vector information is stored in the `VectorTable` array. A pointer in the `DeviceType` array indicates the start of the corresponding vector-information record in `VectorTable`.

The `VectorTable` device record begins with a 2-byte field indicating the number of bytes in the record. The next 3 bytes specify which pins are inputs and which are outputs (set bits are inputs, and cleared bits are outputs).

The following 3 bytes indicate which pins are tri-state (set bits are tri-state). If a pin is indicated as being tri-state, the I/O value in the corresponding bit position of the previous I/O definition bytes is irrelevant. By default, VECCPT.PAS specifies unused ZIF (zero insertion force)-socket pins as being tri-state.

Following the 2 record-size bytes and 6 device pin-function definition bytes, the actual test-vector information begins. Each complete test vector consists of 9 bytes in the record. The first 3 specify the output vector, the next 3 specify the expected read-back vector, and the last 3 specify the "don't care" mask.

As VECCPT.PAS executes, it stores device-name, pin-function, and test-vector information into the appropriate arrays. Notice that the program does not need to store device-type information, since a device's type is determined by which `DeviceType` array it is placed in.

Device clones are handled somewhat differently. When a device is specified as a clone of another device (the "original" device), the name of the clone is placed into the next available record of the appropriate `DeviceType` array. The record number of the original device (in the same array) is then determined, and the value 32,767 is subtracted from the record number; this value (always negative) is then stored in the pointer field of the clone record.

Thus, when the operating software finds a negative integer value in the pointer field of a device record, it will know the device is a clone of another device. It then adds 32,767 to the pointer value to get the record number of the original device.

I should point out that when VECCPT.PAS processes a clone, it looks through its arrays to find the named original device. If the specified original device is not found in any of the six `DeviceType` arrays, the software generates an error, and the clone device will not be stored in any array (the compiler would not even know which array should get the clone record). Thus, it is essential that you specify clone devices only after the corresponding original device.

When compaction of the test-vector files is complete, the compacted information is stored in a binary file. (The format of the data stored in the compacted file is shown in figure 3.)

Operating Software

Once the device test vectors have been developed and compiled into a compacted file, we are ready to use the tester for testing and identifying devices. This involves the cooperation of several programs.

First, there's a ROM-resident program on the IC tester. This program is written in 8031 assembly language and handles the three operating modes from the tester's vantage point. Then there's a Turbo Pascal program that executes on the IBM PC (or XT or AT) for operating the tester in PC-host mode.

Finally, another Turbo Pascal program converts the information in the output file produced by VECCPT.PAS into Intel hexadecimal ASCII format. This permits you to download to an EPROM burner. This lets you put new device vector information into the IC tester's ROM for operation in the terminal and stand-alone LCD modes.

continued

Table 3: *The six device types supported by the tester.*

Device type	Number of pins	Gnd pin	+5-V pin
1	14	7	14
2	14	11	4
3	16	8	16
4	16	12	5
5	20	10	20
6	24	12	24

Table 4: *Definition module for the 7437, a "clone" of the 7400.*

```
#7437     * Quad two-input NAND buffers
C 7400    * Clone of 7400 (Dev. type=1)
E         * End of 7437 definition
```

Explaining all the software for the IC tester would involve considerably more space than I have available here (see the Circuit Cellar Ink applications publication for additional support materials). While my description here is tailored to the application and use of the IC tester, the user's manual and distribution software contain much source code and go into significant detail describing the process for creating a new device library and testing custom devices.

PC-Host Mode

The PC-host mode of operation is the most powerful of the three modes. I'll start with its description, because the basic testing technique is the same for all three modes.

The PC-host mode provides flexibility in letting you download and use different device libraries and offers test-vector debugging features not available in the other two modes. Functions like `Identify` and `Test Specified Device` differ only in the information displayed and are the same in all modes.

Once you give the PC-host mode operating program the name of the compacted test-vector file and the serial-port number (1 or 2), the software attempts to establish a communication link with the IC tester. If the tester does not respond, the PC will perform two retries (three tries total) before printing an error message and sounding a beep.

Once communication is established, the PC reads the specified compacted test-vector file, downloads it to the IC tester, and displays the version number and a formatted operation menu on the screen. The typical menu offers four device-testing options and two mode-selection options.

The display also shows three status/information lines. The first line, `Device:`, indicates the name of the current or most recent device being tested, or the name of an identified device. The second line, `Message:`, displays messages like `Device Passed` and `Device Not Found`. The third line, `Pin Failures:`,

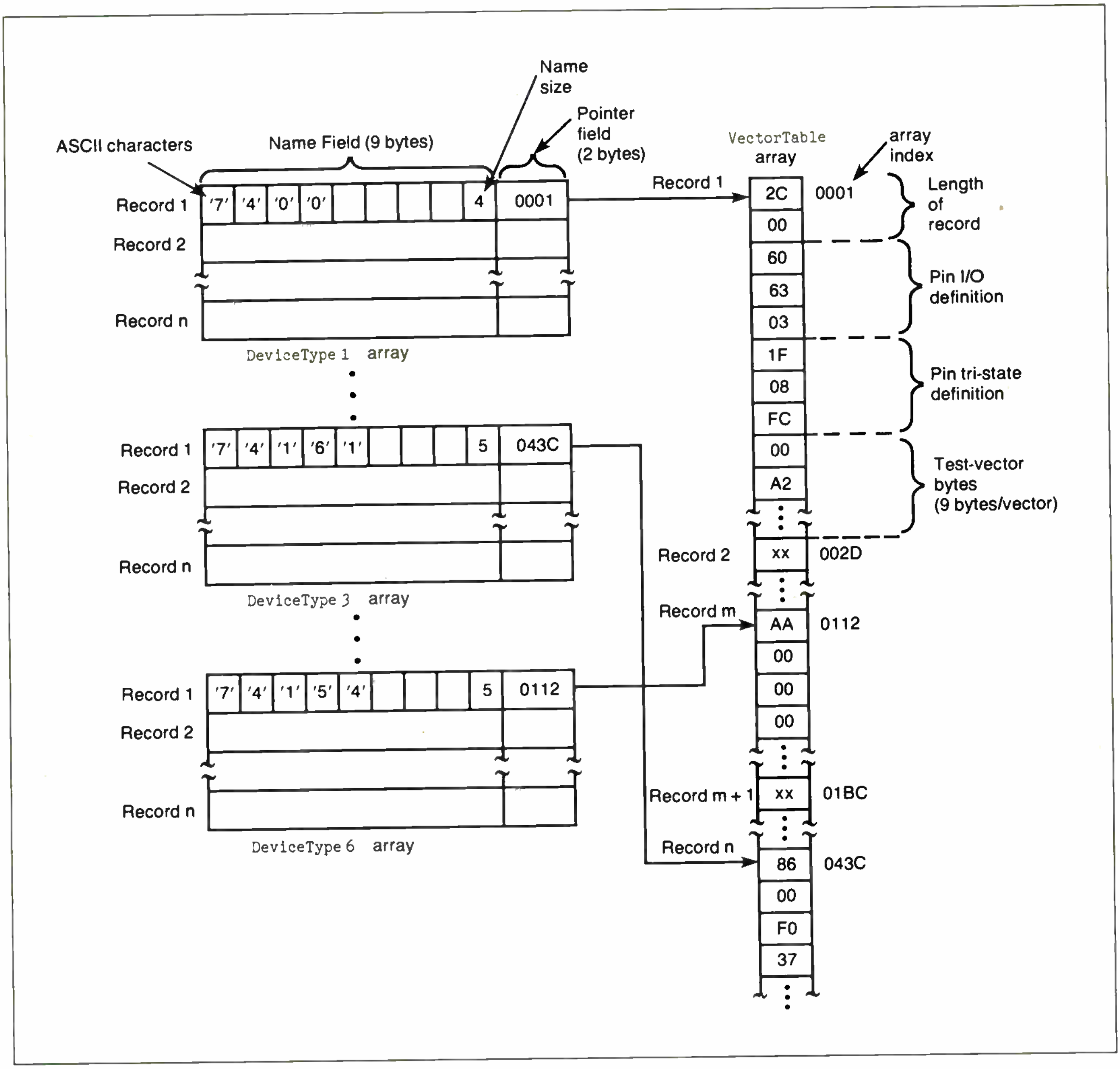


Figure 2: *Illustration of the information storage in VECCPT.PAS's primary arrays.*

displays pin numbers that failed vector tests when testing a specified device or an EPROM.

The first menu item, `Identify Device`, tells the tester to attempt to identify the device in the ZIF socket (the device-identification algorithm supports only devices having the corner power and ground pins). To identify a device, the system powers the ZIF socket for a 24-pin device and then applies the first 24-pin device test vector (if any) in the device library to the DUT.

If the read-back vector compares favorably to the expected read-back vector (along with the "don't care" mask), the next vector for the same device is applied, and so on. This continues until the DUT passes all the test vectors—indicating proper device identity—or until a vector failure occurs. If a vector failure occurs, a check is made to see which bits in the read-back vector, if any, are different from those sent out in the output vector. These bits represent pins that must be either output or tri-state pins, and the pin values are noted in an accuracy array.

If the DUT passes all the test vectors, the tester has identified the device; its name is displayed, and control returns to the menu. If the DUT fails a vector, the next device in the 24-pin library is checked.

Testing continues until the DUT is identified or no more 24-pin devices are left to test. If the program runs out of 24-pin devices, it clears the accuracy test array and repeats the same procedure with the 20-pin, then 16-pin, and finally 14-pin devices. Inability to finally identify the part is only the result of the device not being in the library, or because it is defective.

The second menu item, `Test Specified Device`, moves the cursor to the `Device` line. If any devices have already been tested or identified, the name of the last device tested is automatically displayed on the line. If you desire to retest the same part type, press Return (or Enter). If you wish to choose a different device, enter the new device name and press Return to test the DUT.

By telling the IC tester what type of chip is in the ZIF socket, all the test vectors for that device will be applied to the device and checked, regardless of whether they pass or fail. If vector failures do occur, you'll see the pin numbers on the `Pin Failures:` line.

The first two menu items represent the operations you will probably want to do 99 percent of the time and can be done in all three operating modes. Sometimes, however, you may have 2716 or 2732 EPROMs that you would like to verify are blank. Menu items 3 and 4 provide this capability.

In addition to performing a blank check on the EPROM, the EPROM tests also check for shorts on the EPROM input pins. If shorted pins are detected, an error message is displayed and the failed pins are displayed on the `Pin Failures:` line. Since the ZIF socket is only 24 pins, the tester cannot accommodate larger EPROMs.

The third menu selection deals with CMOS logic devices only. As I discussed last month, all the standard 74xx00-series logic families except the 74C00 series (and some specific devices within other families) are capable of sourcing and sinking enough current on their outputs for proper operation of the tester.

The 74C00-series devices (and the similar 4000-series CMOS devices) have a problem sinking enough current to switch logic states when an output is pulled up to +5 volts. Most of the tests for the 74xx00-series families attempt to load the device outputs in the direction opposite the expected state (if an output is expected to go low, it is loaded with a pull-up resistor), causing particular problems when testing the 74C00-series family devices when reading outputs that are expected low, but are being pulled up.

The remedy for the 4000-series devices is simple: Write all test vectors for these devices always using a pull-down load on all outputs. In order to keep the 74xx00-series tests the same for all families, however, I had to use a different approach. Menu item 5 lets you `Set 74Cx Mode`.

In this mode, regardless of the original output vector-bit levels, all output vector bits that correspond to device output (non-tri-state) pins are changed to low (pull-down). This allows the 74C00-series devices to pass the generic 74xx00-series tests. You can also select this mode for identifying 74C00-series devices.

The final menu option is `Set Diagnostic Mode`. This option is available only when operating the tester in PC-host mode. It adds an extra line to the bottom of the display, `Vector Failures:`, to indicate which test vectors failed when testing a device.

When testing a specified device (not when identifying a device) in diagnostic mode, the `Device:` line indicates the number of pins the device has, as well as the ground pin number and the power pin number. If the device is a clone of another device, this is also indicated, along with the device name of the original device.

If the device being tested fails, the `Message:` line indicates how many vectors failed (along with the normal failure message), and the `Vector Failures:` line indicates the vector numbers of the first 10 failed vectors (or all failed vector numbers, if fewer than 10 failed). The extra information can prove helpful when debugging new test vectors.

ROM-Resident Control Program

The IC tester's 8031 assembly language control program provides local support for all three modes. A software-readable, four-position DIP switch selects mode and data transfer rate, while a status LED indicates the tester's current operating disposition (a second LED acts as a power-on indicator).

continued

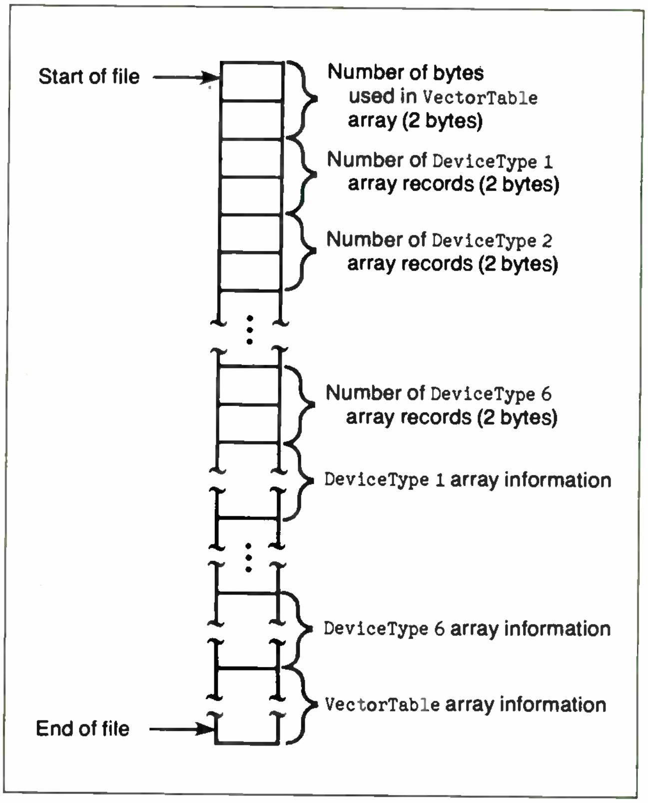


Figure 3: *Format of the vector-compaction file output by VECCPT.PAS.*

Upon power-up or reset (using the on-board reset button), the program initializes the 8031's on-chip ports to turn off all power and ground transistors to the ZIF socket and to place the LCD interface lines in their appropriate default states.

It then generates a brief delay (nominally, 1 second) to provide time for power to stabilize for all devices on the board. Software then checks two of the DIP switches to determine the desired data transfer rate and configures the 8031's on-chip UART to handle serial communications at the specified data transfer rate.

Once initialization is completed, the program checks another DIP switch to see if the user has selected PC-host mode or terminal mode. For terminal mode, the system turns on the status LED (to indicate that a serial operating mode, as opposed to stand-alone mode, is currently enabled) and sends a sign-on message and menu out the serial port to the attached terminal. For PC-host mode, no sign-on message is sent.

In either case, the tester also displays a sign-on message on the optional LCD, if present. In order to select the stand-alone mode, you merely press the "Identify" push button—which is constantly polled during both serial operating modes—and the system will turn off the status LED to indicate stand-alone mode operation. The only way to return to serial mode operation is by pressing Reset.

When operating in PC-host mode, the IC tester's ROM program merely responds to commands from the host. Various commands allow "reset" (power and ground transistors turned off), software version request, power and ground switch setup, and DUT output vector application and read-back vector reading. Terminal mode operation is similar to PC-host mode operation, with the exception that you are restricted to the device library stored in ROM, and the diagnostic mode described earlier is unavailable.

Stand-alone operation requires no connection to the serial port, but it does require that you have the LCD installed (see photo 2). All interaction is via the on-board "Identify" and "Retest" push-button switches and the LCD. A DIP switch enables or disables "74Cx" mode.

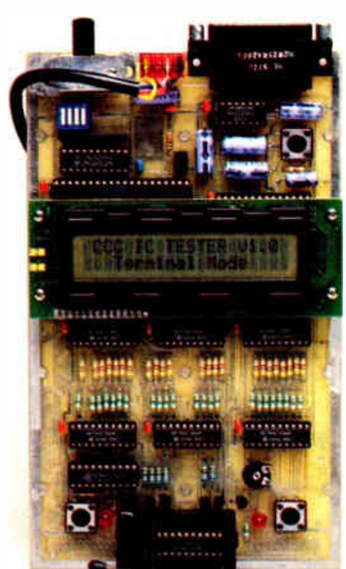


Photo 2: *You can use the IC tester in stand-alone mode, provided you have attached the tester's optional LCD. The push-button switches in the upper right, lower left, and lower right control the tester's operation.*

Pressing the "Identify" push button causes the tester to attempt to identify the device in the ZIF socket. If the identification is successful, the device name is displayed on the LCD; otherwise, an identification failure message is displayed.

Once a device has been identified, you can test other devices of the same type using the "Retest" push button. The test vectors for the identified device are then applied to the DUT, and detected pin failures, if any, are displayed on the LCD.

Flexibility

While the Circuit Cellar IC tester represents hundreds of hours of hardware and software development, the end result is something that was designed to be simple to operate. It clearly offers a great deal of flexibility for testing common devices, but it is also useful for developing tests for custom or proprietary devices like programmable array logic.

In order to test a PAL, you must develop a series of test vectors that apply bit patterns to the device inputs and watch for expected output values just like those from any standard 74xx logic device. The PAL test vectors are based on the logic-transfer functions (the logic equations) of the device.

You compile and name the test vectors and then add them to the device library. To test PALs, you run the IC tester in the normal way: Just insert the PAL to be tested in the ZIF socket (bottom-justified) and specify either the `Identify Device` option (the easier choice) or the `Test Specified Device` option, giving the device's name, "PAL1," for example.

In Conclusion

The powerful, yet easy-to-use, Circuit Cellar IC tester can provide testing and identification for innumerable standard and custom IC devices, in packages ranging from 14 to 24 pins. It's a tool that can save you time and money by catching potential problems during production, helping debug problem boards, and by identifying and/or verifying unknown devices or devices with uncertain operation. The flexibility and capability offered by this tester were previously available only to those willing to spend thousands of dollars.

In all honesty, I have to admit that the hardware for this project was trivial compared to the enormous software task involved in creating the operating system and device library. The initial Revision 1.0 ROM-resident library contains more than 200 generic entries. Considering that a generic entry of "7400" can cover 10 clone entries, the library physically covers about 800 chips. I owe a special debt of gratitude to those who helped put this project together and saved me from having to deal with all this software.

Experimenters

While you can order printed circuit boards and kits for the Circuit Cellar IC tester, I encourage you to build your own. If you don't mind doing a little work, I will again support your efforts. A hexadecimal file of the executable code for the IC tester's 8031 EPROM (a 27256) is available free for downloading from my bulletin board at (203) 871-1988. It contains the complete Revision 1.0 ROM-resident device library and software for complete stand-alone and terminal mode operation.

Alternatively, you can send me a preformatted IBM PC 5¼-inch disk (2.0 or higher) with return postage, and I'll put the file on it for you. Please add $5 for a printed copy of the user's manual. Of course, as always, this free software is limited to non-commercial personal use.

Next Month

Build the BCC180 multitasking microcontroller board. ■

I would like to personally thank Roger Alford and Bill Potter for their collaborative efforts on this project. Bill Potter's tireless dedication creating the test-vector library and Roger Alford's clever programming expertise served to make the Circuit Cellar IC tester a true performer.

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 Company, P.O. Box 400, Hightstown, NJ 08250.

Ciarcia's Circuit Cellar, Volume I covers articles in BYTE from September 1977 through November 1978. *Volume II* covers December 1978 through June 1980. *Volume III* covers July 1980 through December 1981. *Volume IV* covers January 1982 through June 1983. *Volume V* covers July 1983 through December 1984.

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.

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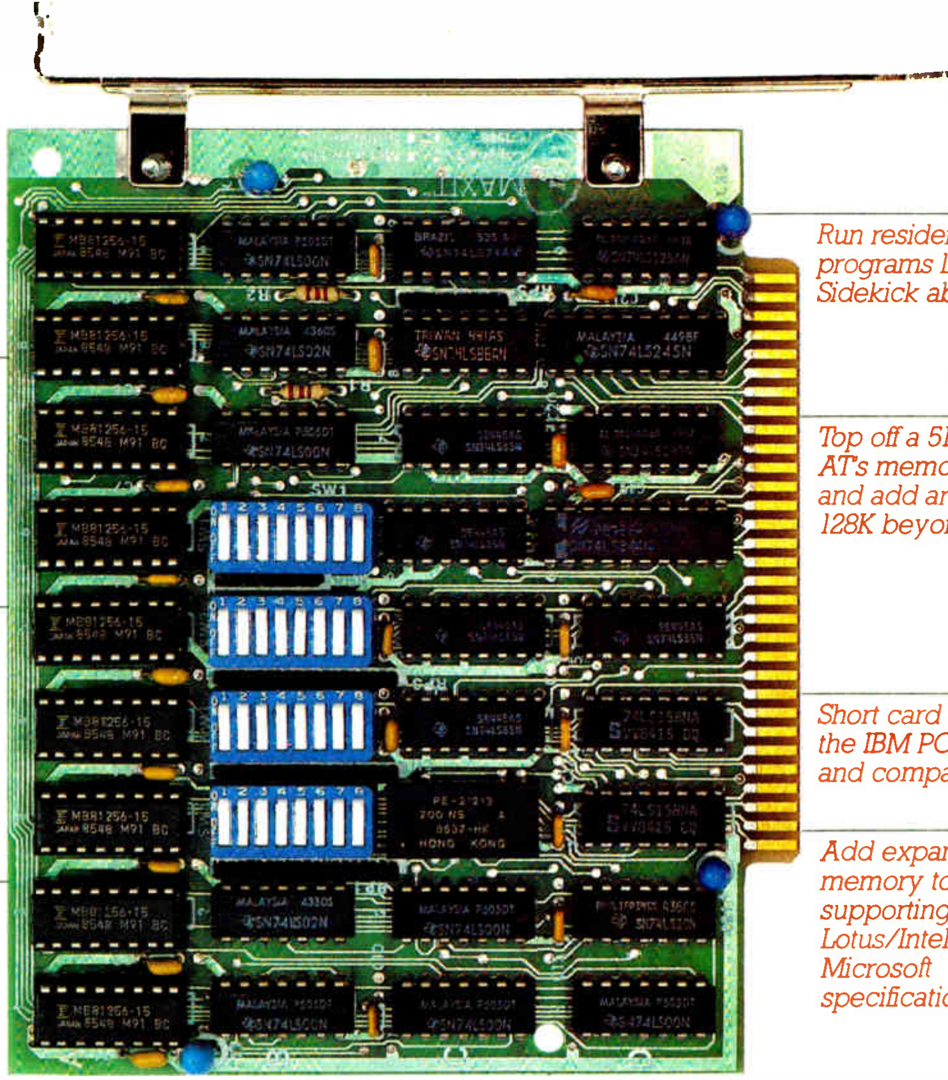

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Ramachandran Bharath

Information Theory

How much information a message contains depends on the extent to which it resolves uncertainty

Some things are easy to recognize but difficult to define or measure. Beauty is one of these. Information is another. We all intuitively recognize information, but in concrete terms, exactly what *is* it? How do you measure how much information a message contains? Information theory, or communication theory, tries to answer these questions. It is substantially the creation of one scientist, Dr. Claude E. Shannon of Bell Research Laboratories. The book *The Mathematical Theory of Communication* by Shannon and Warren Weaver (see reference 1) is one of the classics of twentieth-century science.

What Is Communication?

The key problem that Shannon was trying to solve concerned transmitting messages through various channels: telephone, television, radio, and so on. All transmission channels have one drawback: They tend to partly change or corrupt the message being transmitted due to accidental errors or random signals that get mixed up with the intentional signals. This corrupting factor is generically called *noise*, whether it is actual noise on a radio or telephone, garbled telegraphic signals, or flicker on a TV. Shannon's specific concern was: What, if anything, can you do to counteract the effect of noise and transmit messages as faithfully as possible?

This leads to the question of how you measure information. You must be able to measure the information being sent and the information being received, so that you can compare them and see how much has been lost due to noise interference.

The basic structure of communication, as defined in Shannon and Weaver's book, breaks down into what happens at the transmitting end (see figure 1a) and what happens at the receiving end (see figure 1b). All information to be communicated is represented in some suitable code and sent over a transmission channel. At the receiving end, the information is received and decoded. During transmission, noise becomes mixed up with the actual signals being sent from the information source.

This concept of communication is broad enough to cover the process of storing information for later use, whether on paper, on disk, or in computer memory. The only difference between this process and more immediate communication is the delay, the indefinite amount of time between when the information is coded and placed in the "channel" and when it is received and decoded.

In principle, however, storing information for later use fits into the same schematic diagram (figures 1a and 1b); thus, Shannon's concept of information is significant far beyond the specific problems he considered.

Measuring Bits of Information

Information theory is based on certain key assumptions, or postulates, that are inherently plausible and reasonable. However, the ultimate justification is that logical conclusions drawn from these postulates have led to useful and effective solutions to real-life problems.

One assumption of information theory is that a message is not significant by itself; it is significant in the context of all the other possible messages that could have been sent. When a message tells you something that you already know, it's reasonable to say that the message conveys no information; there was no other possible message. For example, if you have a 10-year-old son, and someone tells you that you have a son, no information has been conveyed. On the other hand, under different circumstances (when more than one message is possible), the same message *could* convey some information. For example, if you are in the hospital delivery room, and someone tells you that you have a son, some information has been conveyed.

"The significant aspect is that the actual message is one *selected from a set of possible messages*" (Shannon and Weaver). The greater the number of possible messages, the greater the amount of information conveyed. In other words, how much information a message contains depends on the extent to which it resolves uncertainty.

You could also say that the more probable a message is, the less information it conveys. For instance, a message selected from a set of only one possible message has a probability of 100 percent, or 1, and conveys no information. A message selected from a set of two equally probable messages, each with a probability of ½, conveys some information, while a message from a set of three (probability of ⅓) conveys even more, and so on.

The amount of information increases as the probability of the message decreases; they are inversely related, but in exactly what proportions? You could say that the information content of a message with a probability of $p1$ is $1/p1$, but this doesn't give zero information content for a message with a probability of 1.

Shannon suggested a more definite form for relating information content and message probability. He argued that you can measure information so that the total amount conveyed by two messages is equal to the sum of the information conveyed by each of them; in other words, the information conveyed by a series of messages is *additive*.

If you have two messages, one with a probability of $p1$ and the

continued

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other with a probability of $p2$, you could say that the quantity of information these messages convey is related to $1/p1$ and $1/p2$, respectively. However, if you think of the two as a compound message, the probability becomes $p1 \times p2$. For example, if $p1$ is $\frac{1}{3}$ and $p2$ is $\frac{1}{5}$, there is a one-in-three chance of the first message being selected. If it is chosen, there is only a one-in-five chance that the second message will also be chosen. Thus, the chances of the compound message being sent are $\frac{1}{3} \times \frac{1}{5}$, or $\frac{1}{15}$. Thus, the information content of this compound message should be related to $1/(p1 \times p2)$.

The concept of additivity requires that the information content associated with a $1/(p1 \times p2)$ probability be the sum of the information content associated with $1/p1$ and that associated with $1/p2$. Therefore,

$$I(1/(p1 \times p2)) = I(1/p1) + I(1/p2) \ ,$$

where I denotes quantity of information. According to Shannon, the only mathematical relationship that satisfies this requirement is: The quantity of information associated with a probability of $p1$ is

$$I(1/p1) = \log(1/p1).$$

This, then, is Shannon's fundamental equation for measuring quantity of information.

Briefly, the logarithm of any number to a particular base is defined as the power to which you must raise the base to get that number. For example, the log of 1000 to the base 10 is 3, since $10 \times 10 \times 10$, or 10^3, is 1000. So what base should Shannon's equation use? Base 2 seems a natural choice because, in the simplest case where one of two equally probable messages is selected, each with a probability of $\frac{1}{2}$, the quantity of information is $\log(1/\frac{1}{2})$, or log2. The log of 2 to the base 2 is 1. Thus, the amount of information contained in each of these two messages equals one unit. The average amount of information also equals one unit.

Shannon chose the name ***bit*** for this unit for measuring the amount of information. Let's call it an ***infobit***, since it isn't quite the same as a bit in computer storage, which represents information (let's call that a ***repbit***). Thus, if a message with a probability of $\frac{1}{4}$ is chosen out of four equally likely messages, the amount of information would be $\log_2(1/\frac{1}{4})$, or $\log_2 4$, or 2 infobits.

To see the difference, as well as the connection between repbits and infobits, suppose you are expecting one of two messages, *yes* or *no*, in regard to some decision, and the two are equally probable. The message could be sent as *yes* or *no*, using 8 repbits for each character, 24 for *yes* or 16 for *no*, with an average of 20 repbits. However, in terms of information theory, for two equally probable messages, each with a probability of $\frac{1}{2}$, each has an information content of $\log_2(1/\frac{1}{2})$, or $\log_2 2$, or 1 infobit; and the average is also 1 infobit.

Thus, the number of repbits is not necessarily equal to the number of infobits, but there is a connection. You could say that the number of infobits is the *smallest* number of repbits required. If there are only two possible messages and you use a code of 0 for *no* and 1 for *yes*, then a message of 1 repbit is enough. Similarly, if there are four possible messages, each with a probability of $\frac{1}{4}$, the number of infobits needed is 2; the minimum number of repbits required is also 2.

What if you have three messages, each with a probability of $\frac{1}{3}$? According to Shannon's equation, the number of infobits is $\log_2 3 = 1.58$ infobits, and the average information content is also 1.58 infobits. But repbits can only be whole numbers, so how does this work?

You need at least 2 repbits to distinguish between the three alternatives. But with 2 repbits, you could actually handle four alternatives, so you're wasting some of the capacity of the 2 repbits for sending messages. You could reduce this waste if you code blocks of such messages, rather than sending each one individually.

If you code blocks of 10 such messages, the whole block could contain 3^{10}, or 59,049, alternative forms. If you use a string of 16 binary signals, you can have 2^{16}, or 65,536, alternative forms. Since a string of 16 binary signals is more than enough to handle 10 of these three-alternative messages, on the average you need only $\frac{16}{10}$, or 1.6, repbits to represent the average three-alternative message.

An alternative name that Shannon gave to the average amount of information is *entropy*, a term from thermodynamics. One interpretation of the amount of entropy in a physical system concerns the degree of uncertainty about which of many possible states of the system is actually realized at different stages. Shannon chose this name because of the analogy between realizing one of many possible states and choosing one of many possible messages, and also because the mathematical equations for calculating thermodynamic entropy and average quantity of information were similar.

Thus, the fractional entropy represents the *average* amount of repbits required if you code the messages in sufficiently long blocks instead of one at a time. The longer the block of messages, the closer the calculation of 1.6 repbits moves to the 1.58 average that the entropy calculation gives.

In reality, messages aren't usually a series of signals indicating which of different messages is being sent; they are a series of characters selected from a character set or alphabet. If you consider each choice of a character as a "minimessage," a selection from the set of all possible characters, the method still applies. You can think of an overall message as a long series of such minimessages.

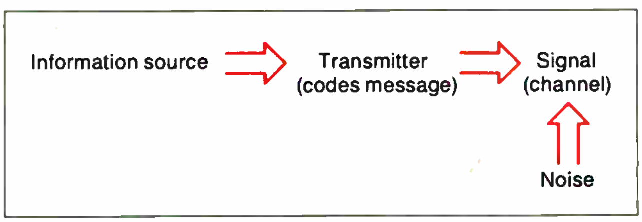


Figure 1a: *The process that occurs at the transmission end of communicating a message.*

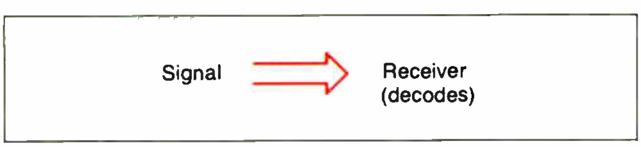


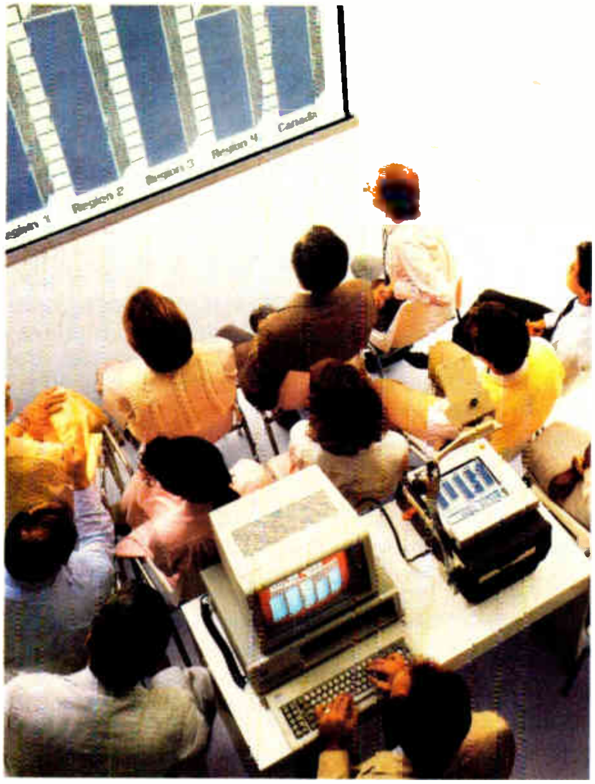
Figure 1b: *The corresponding process that occurs at the receiving end.*

Probable and Improbable Characters

What happens if the relative frequencies or probabilities of the various characters you use are not equal? Let's consider an alphabet with only two characters, A and B (see reference 2). If A and B have equal probabilities, the information content of each is $\log_2(1/\frac{1}{2})$, or $\log_2 2$, or 1 infobit. The average information content of this alphabet is also 1 infobit.

However, if A and B are not equally probable, and A occurs twice as often as B, their probabilities are $\frac{2}{3}$ and $\frac{1}{3}$, and their information contents, $\log_2(1/\frac{2}{3})$ and $\log_2(1/\frac{1}{3})$, respectively.

continued



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Even with noise, you can transmit error-free messages if you are willing to transmit somewhat longer messages.

So, what's the average information content of this alphabet? Since A occurs ⅔ of the time, it should have more weight, and B should have less. Thus, the average information content is $(\frac{2}{3} \times \log_2 (1/\frac{2}{3})) + (\frac{1}{3} \times \log_2(1/\frac{1}{3}))$, or 0.918 infobits.

Wait a minute. If you have two characters, how can you possibly use less than 1 repbit to distinguish between them, even if you code them as blocks? For example, if you use blocks of two characters, you have four possible strings, AA, AB, BA, and BB; how can you code them in less than 2 repbits and get an average per character of less than 1 repbit?

This is where probability enters in. The probability of an AA is $\frac{2}{3} \times \frac{2}{3}$, or $\frac{4}{9}$; a BB is only $\frac{1}{3} \times \frac{1}{3}$, or $\frac{1}{9}$; and an AB or a BA is $\frac{2}{3} \times \frac{1}{3}$, or $\frac{2}{9}$. If you use variable lengths of code, short ones for the more frequent, or probable, strings and longer ones for the rarer strings, then you can code the blocks, as in table 1.

By using unequal code lengths, the weighted average of the number of repbits used for a string of two symbols becomes $(\frac{4}{9} \times 1) + (\frac{2}{9} \times 2) + (\frac{2}{9} \times 3) + (\frac{1}{9} \times 3)$, or $\frac{17}{9}$. Thus, the average number of repbits per symbol is $\frac{17}{9}/2$, or $\frac{17}{18}$, or 0.9444, which is less than 1. Hamming shows, similarly, that by using strings of three, four, or more symbols, you can move closer to the theoretical average of 0.918 repbits per symbol.

Incidentally, this highlights a very important point: Calculations of information content or entropy don't indicate *how* you should code to achieve the minimum number of repbits required; they only show that a possibility of more efficient coding exists. The "how" question is dealt with by *coding theory*, the practical realization of the theoretical possibilities established by information theory.

You can extend the idea of *weighted average* to character sets of any size. For instance, let's consider the set of 26 letters that is the English alphabet, plus a space, and ignore for the moment punctuation, signs, and so on. If the 27 characters are equally likely, then the probability for each is $\frac{1}{27}$, and the information content for each is $\log_2(1/\frac{1}{27})$, or $\log_2 27$, or 4.75 infobits. The average amount of information for this character set is also 4.75 infobits per character. This process actually attaches a weight of $\frac{1}{27}$ to each character, so that the average is $(\frac{1}{27} \times \log_2 27) + (\frac{1}{27} \times \log_2 27)$ . . . repeated 27 times with a sum of $\log_2 27$.

However, the characters are *not* equally likely—for instance, E's are common, and Q's are rare. Estimates are that the probability of a space is 0.18, an E, 0.11, a C, 0.02, and so on for all the characters. Shannon and Weaver used such figures to calculate the weighted average amount of information:

$$(0.18 \times \log_2(1/0.18)) + (0.11 \times \log_2 \times 1/0.11) + \ldots$$

They estimated that this gives an average information content of 4.1 bits per character. The fact that the average is now lower makes sense because uncertainty is largest when the characters are equally likely. The reverse is also true.

Shannon used the word *redundancy* to capture the concept that a character set may have less entropy than the maximum it is capable of. In our 27-character English alphabet, the redundancy is expressed as (4.7 - 4.1)/4.7, or almost 13 percent. Actually, the redundancy in the English language is even higher. Not only are the characters not equally likely, but their probabilities depend on what characters precede them. (Consider the probabilities of the different characters when the previous one is a Q!) Taking these factors into account, the redundancy in English text is estimated to be higher than 13 percent.

Table 1: *Using probabilities to lower the average number of repbits required to encode blocks of characters.*

AA with probability of 4/9 is coded as	1
AB with probability of 2/9 is coded as	01
BA with probability of 2/9 is coded as	000
BB with probability of 1/9 is coded as	001

Noisy Channels

Redundancy is not necessarily a bad thing; it is actually a protection against noise. Shannon's theorem for noisy channels establishes that even with noise, you can transmit error-free messages if you are willing to transmit somewhat longer messages. In other words, by introducing redundancy and using longer messages, you can effectively defeat noise.

This theorem appears counterintuitive: How can you possibly transmit error-free messages despite the occurrence of random errors and message corruption? Consider a case where the two characters, 0 and 1, in the commonly used binary alphabet are transmitted with equal probabilities. If you had a noiseless channel, the entropy of this character set would be 1 infobit, and you could transmit these characters using 1 repbit per character.

But suppose the channel is not entirely reliable. When a 0 is transmitted, 90 percent of the time (a probability of 0.9) the channel transmits it as a 0, but 10 percent of the time (a probability of 0.1) the channel corrupts the 0 into a 1. Similarly, when a 1 is transmitted, 90 percent of the time it goes through as a 1, but 10 percent of the time it is corrupted into a 0.

With a noiseless channel, when you receive a 0 or a 1, you have no uncertainty as to what was sent. But with a noisy channel, when you receive a 0, you know that it could really be a 0, which happens $\frac{1}{2} \times 0.9$, or 0.45, of the time, or it could be a 1 that was corrupted into a 0, which happens $\frac{1}{2} \times 0.1$, or 0.05, of the time. So, in the 50 percent of cases when you receive a 0, there is a 0.45/0.50, or 0.9, probability that it is a 0 and a 0.05/0.50, or 0.1, probability that it is a 1. Applying the concept of weighted average, you can say that when a 0 is received, you have an average uncertainty of $(0.9 \times \log_2(1/0.9)) + (0.1 \times \log_2(1/0.1))$, or 0.469. (The same is true for a 1.)

In other words, with a noiseless channel, the transmitted message with an entropy of 1 infobit is received with 1 − 1, or 0, uncertainty. However, with a noisy channel, the uncertainty is not reduced totally; rather, it is reduced by 1 − 0.469, or 0.531. The amount by which the uncertainty is reduced (in this case, 0.531) is called the *capacity* of the channel.

You can draw an important conclusion from this: If the source has one unit of entropy and a message 1 repbit long, you can receive the message with no uncertainty. But because of the noise, since each transmitted message of 1 repbit can reduce the uncertainty by only 0.531, the source must send a message of 1/0.531, or 1.88, repbits to completely eliminate the uncertainty. For an example of entropy calculations, see listing 1. [Editor's note: *Listing 1 is available in BASIC source code for the IBM PC and compatibles as* ENTROPY.BAS *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 in 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.*]

Now, other questions begin to arise. What happens if the two

continued

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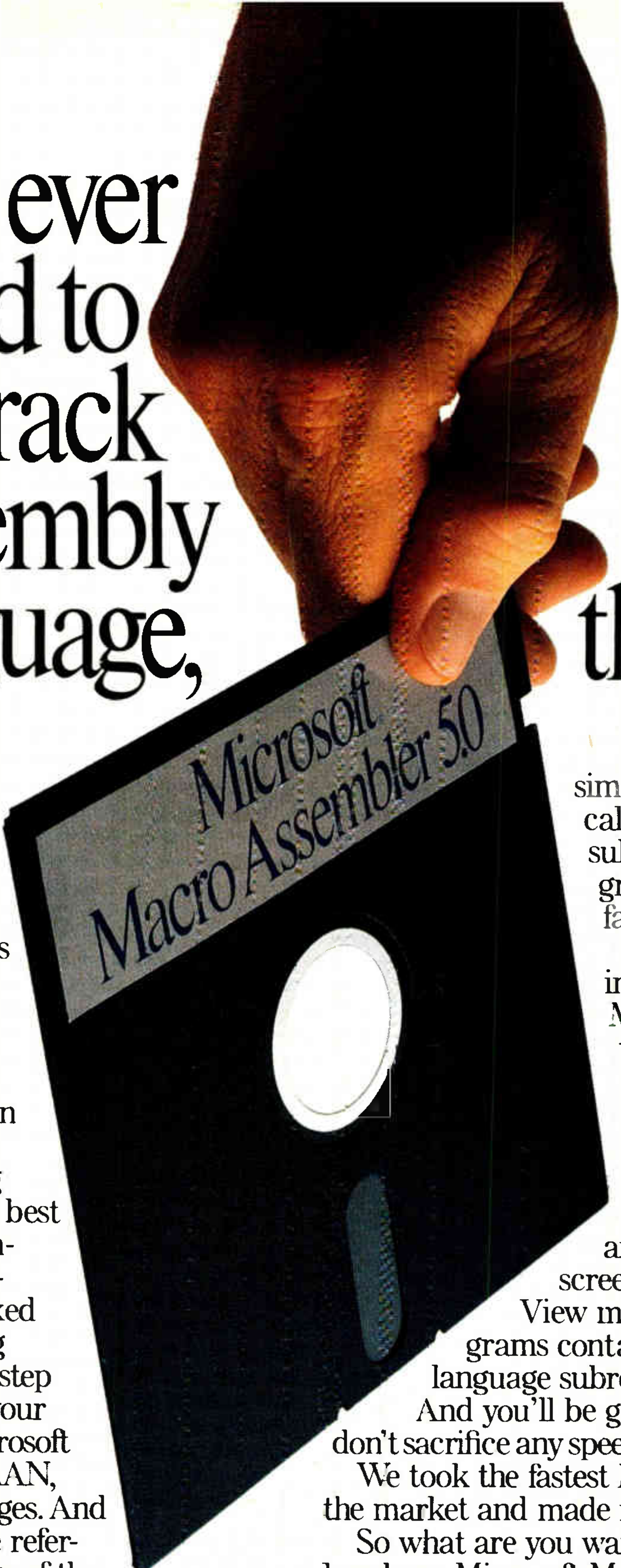

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characters are not equally probable? What is the capacity of the channel, or its ability to reduce uncertainty when you have more than two characters? What is the capacity of an asymmetric binary channel; that is, if the probabilities of corruption of the two characters aren't the same? (The previous example is called a *symmetric* channel, because you have taken equal probabilities of distortion, 0.10, for the two characters.) And, finally, how do you actually find a code that lets you move toward this theoretical average length of 1.88 repbits?

Despite these qualifications, Shannon's second theorem explains that you can counter the distorting effects of noise. A recent article by Dr. Mark Cartwright in *New Scientist* highlights this point (see reference 3). He observes that an alternative way of combating noise might be to repeat the message to make sure it is received correctly. But, he says, "Compare this length of time (i.e., a message 1.88 times longer than the actual message) with that needed for simple repetition, where the higher the accuracy required, the greater the number of times you must repeat the message, and you have some indication of the power of Shannon's theorem."

Listing 1: *A short BASIC program that calculates entropy.*

```
10 REM THIS PROGRAM WAS DEBUGGED AND
     STREAMLINED BY PROF JUNE PARSONS OF NMU
20 CLS
30 DIM S$(40),PROB(40)
40 LET ENTROPY = 0
50 INPUT "How many different symbols are
     there in your alphabet ? ",NUMBER
60 PRINT
70 FOR INDEX = 1 TO NUMBER
80 PRINT "Type in symbol #   "; INDEX ; " and
     relative frequency.  Separate"
90 PRINT " the two using a comma. (REMEMBER
     RELATIVE FREQUENCIES "
100 PRINT "MUST ADD UP TO 1.00) "
110 INPUT S$(INDEX),PROB(INDEX)
120 ENTROPY = ENTROPY +
     PROB(INDEX)*LOG(1/PROB(INDEX) )
130 NEXT INDEX
140 REM ENTROPY CALCULATIONS USE LOGS TO THE
     BASE 2
150 LET ENTROPY = ENTROPY/LOG(2)
160 PRINT
170  PRINT  "Entropy is  ", ENTROPY
180 PRINT : PRINT
190 PRINT "Symbol","Probability"
200 FOR INDEX = 1 TO NUMBER
210 PRINT S$(INDEX),PROB(INDEX)
220 NEXT INDEX
230 END
```

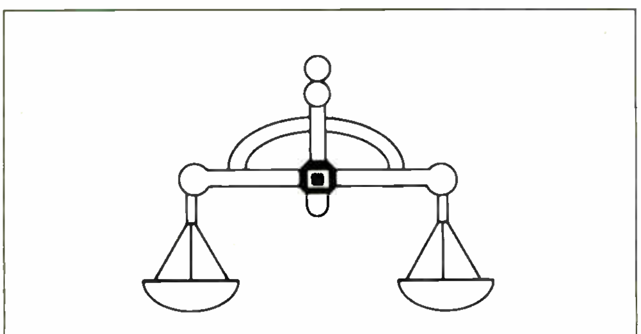

Figure 2: *A balance scale of the type used in the heavy-coin problem.*

As another illustration, let's consider one well-known type of puzzle. If you have 12 coins, and you know that one of them is heavier than the rest, what is the minimum number of weighings needed to identify the heavy coin? The device you have for weighing is a pair of scales with pans, so that if you put equal weights on the pans, it hangs horizontally; otherwise, it tilts (see figure 2). From an information-theory point of view, you can say that initially since any one of the 12 coins could be the heavier one, the amount of uncertainty or entropy is $(\frac{1}{12} \times \log_2 12) + (\frac{1}{12} \times \log_2 12) \ldots$ 12 times, or $\log_2 12$. Thus, the uncertainty is $\log_2 12$ infobits.

You need to gather enough information to be able to identify the heavy coin. Suppose you divide the coins into three sets of four, one set on the left pan, one on the right pan, and one left out. If the pans balance, you know the heavy coin is in the set left out; if they don't, you know which pan contains the heavy coin. In any case, you know which set of four includes the heavy coin. Now, you have only four possibilities, so the uncertainty becomes $\log_2 4$. With one weighing, you have gained information equal to $\log_2 12 - \log_2 4$. In other words, you had three possibilities with three sets of four, and you have eliminated the uncertainty, so you have gained information equal to $\log_2 3$. Due to the nature of logarithms, $\log_2(a) - \log_2(b)$ is the same as $\log_2(a/b)$; thus, $\log_2 12 - \log_2 4 = \log_2 3$.

How many weighings do you need? While the first weighing reduced the uncertainty to $\log_2 4$, each weighing can reduce the uncertainty *at most* by $\log_2 3$ (less if the probabilities of the three alternatives are not equal). Thus, a second weighing won't always be enough to identify the heavy coin, but a third weighing should be. Information theory states that you should expect to use three weighings, but as with coding, it doesn't provide the procedure.

After identifying the set of four coins, A, B, C, and D, that contains the heavy coin, you would like to divide the set into three equal groups to generate another $\log_2 3$ bits of information. But you can't divide four coins into three equal groups, so you use four groups of one coin each. First, you put A and B on the pans, one on each, and leave out C and D. This may be enough to identify the heavy coin; if A and B don't balance, obviously you have found it. However, if they do balance, you need a third. You can balance C against A and either identify C as the heavy coin, or conclude that it must be D. This example can be extended to cases where you know only that one of the coins is a different weight, either heavier or lighter; you don't know which. This generates 24 possibilities instead of 12.

Rather than pursuing this puzzle further, however, let's look at its practical relevance to data processing. Suppose you want to search a file to locate a particular item, for instance, a specific person's employee record. Files are usually arranged in order according to some key. For example, each employee may have an identification number, and the employee file may be arranged in order of increasing ID numbers. One popular technique is the binary search, in which you compare the ID number of the person you are looking for with the ID number in the middle of the file. Since the file is ordered, you can tell whether to look further in the first half or the second half, depending on whether the ID you want is less than or greater than the ID in the middle. Then you repeat the operation with the appropriate half to continue the search, and so on.

This process is similar to the heavy-coin problem. In this case, you are generating $\log_2 2$ bits of information, by identifying which half you should search next, while in the heavy-coin problem, you generated $\log_2 3$ bits of information with each weighing, by identifying which subset contained the heavy coin.

continued

Thus, if the employee file contains records for 90 people, you should allow about $\log_2 90/\log_2 2$, or $\log_2 90$, comparisons to locate the record you want. Sometimes you might be lucky and find it in fewer comparisons. This kind of calculation can be of practical importance in deciding which of several different search techniques would require less time.

Another practical application of information theory in data processing would be sorting. You can analyze sorting in terms of the uncertainty, or entropy, in an unsorted file compared with a sorted file as well.

Quantity vs. Quality

Extensive applications arising from the theory of information have been made in the obvious areas, such as television channels, telephone lines, and computer networks. However, information theory's applications in such frontier areas as speech processing, speech synthesis and recognition, optical-character recognition, music synthesis, and so on, are of even greater interest. *Information Theory for Technologists* by M. J. Usher (see reference 4) contains a summary of these applications.

One shortcoming of information theory is its restriction to the efficient transmission of messages without any regard for their meaning. For instance, a choice between two equally probable messages has an information content of 1 infobit, but the *significance* of the messages may be vastly different from a human point of view. For example, there is a vast difference in significance between the two messages "rain tomorrow" and "no rain tomorrow," and the two messages "earthquake tomorrow" and "no earthquake tomorrow."

Saying that information theory deals only with the quantity of information and not its *quality* may be a valid criticism. However, Shannon carefully pointed out that the theory was concerned only with the efficient transmission of messages and not with their semantics. Originally, the theory of probability dealt only with the chances of alternative events. In due course, it was extended to handle the relative values of the different events by incorporating the ideas of profits and losses associated with the outcomes. Similar extensions may arise as information theory is applied more and more to the frontier areas.

The qualitative implications of information theory, the implications of redundancy, and how these ideas have found application in areas much wider than the transmission of information are discussed in a fascinating book by Jeremy Campbell, *Grammatical Man* (see reference 5). ■

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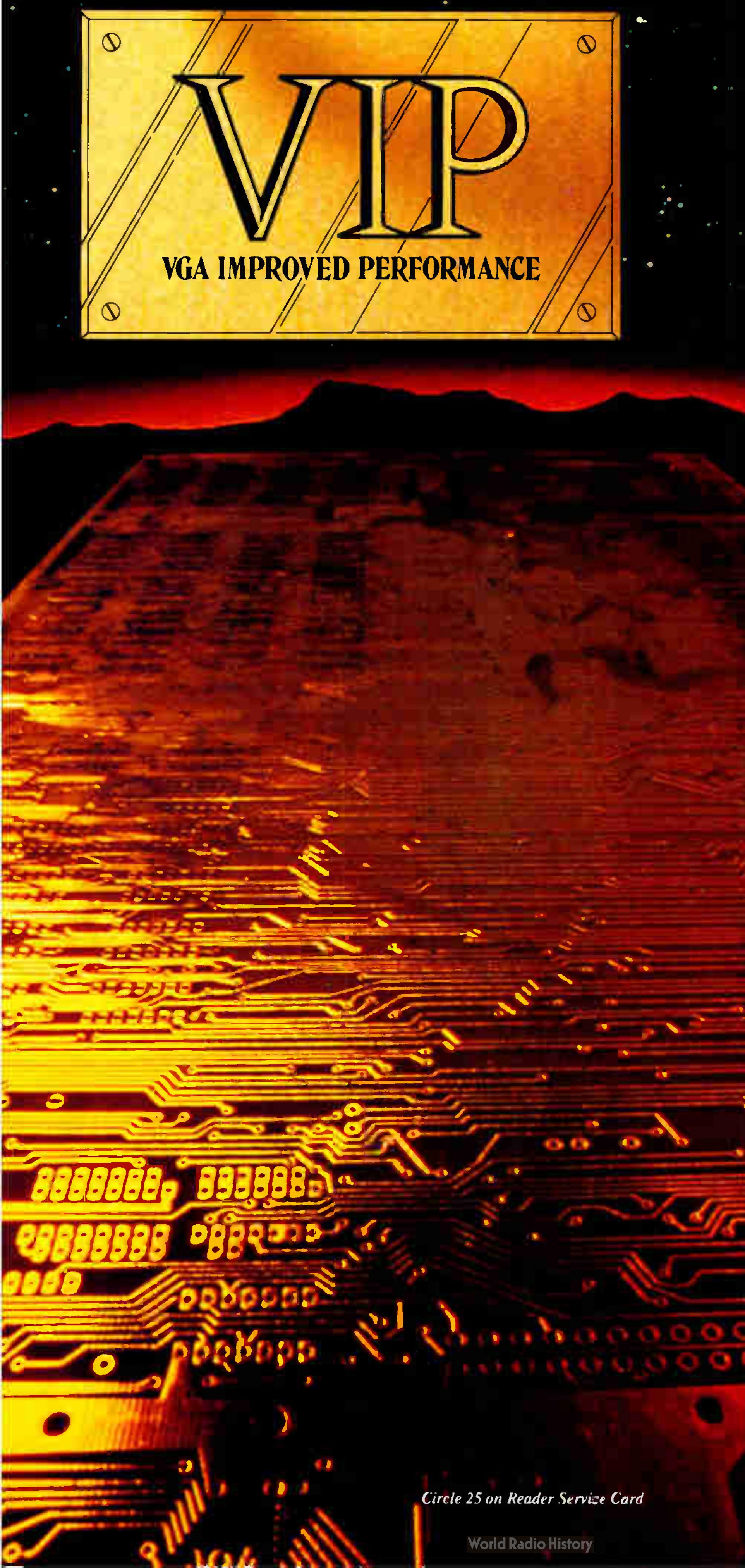

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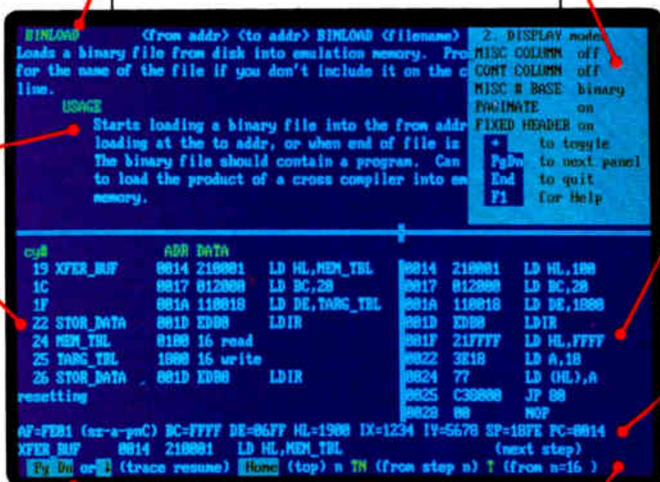

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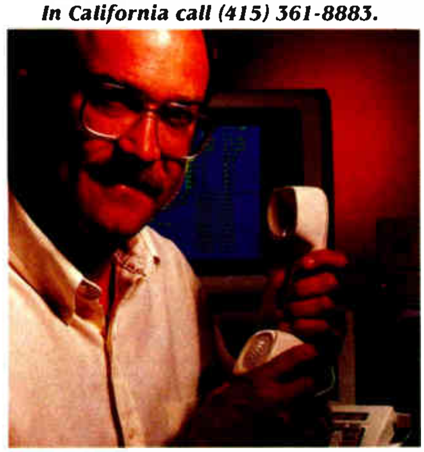

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The State of Chinese Computing

Chinese microcomputers, which are compatible with world standards, might soon be competing alongside IBM and Apple

The People's Republic of China has had its own supercomputer (the 100-million-instructions-per-second Galaxy) since 1984 and its own vector-array processor (the 100-MIPS 757) since the early 1980s. It has its own microcomputers, too: China's total annual production is now estimated at 70,000 microcomputers, of which about 25,000 are IBM PC XT–compatible "Great Wall" machines, manufactured by the China Computer Development Corp. (CCDC) in the suburbs of Beijing.

Alternately, though in lesser demand, CCDC factories also make a Motorola 68000 multiuser Unix-based system called the BCMS 68000. This machine capitalizes on the growing popularity of Unix, which is a strong contender for the computing environment of choice in China. The Chinese Academy of Sciences began publishing translated Unix materials 3 years ago. During the same time, over 2000 medium and large Western computer systems were installed in Chinese universities and elsewhere, filling a void caused by the earlier antitechnology chaos of the Cultural Revolution (1966-76). A large number of those newly installed machines run Unix.

Chinese Silicon Valley

While China's microcomputer volume doesn't yet match the million or more microcomputers that will sell in the U.S. this year, China's microcomputer growth is still exponential when you consider that there were none a few years ago. It's been only about 10 years since the first microcomputer was garage-built in California's Silicon Valley. Now, an ocean away, Shanghai and Beijing are claiming their own Silicon Valleys, even translating the term literally into Chinese as *guigou*.

China's competence in domestic computer production is growing. While we probably won't see flashy technology yet, by the early 1990s we can expect China to enter world competitiveness in the global low-end microcomputer sales. I believe "Made in China" microcomputers, compatible with world standards, will become accepted and prevalent consumer commodities in the Third World, as well as the U.S. and Europe.

Several recent events signal this development. China's top leadership has specifically targeted microcomputers as a home growth industry (while willingly importing machines for most medium-range requirements). Unlike a few years ago, the Chinese are no longer interested in importing microprocessors, but they *are* interested in importing manufacturing processes. Thus, in recent years, various joint ventures have been signed with IBM, Hewlett-Packard, Sperry, Wang, Gould, Burroughs, ComputerLand, Solar (French), and others. As one Chinese strategist put it, "Instead of the first, second, and third machines being imported, for microcomputers the formula will now become: The first machine is imported, the second machine is made in China, and the third machine is exported."

A recent congressional study, *Technology Transfer to China*, has opened up discussion of terminating completely the multinational (COCOM, Japan, and most of NATO) export controls on China, by which everything in computer technology sold to China requires a license. This would effectively make China an equal trading partner with the free world, a status previously denied China. At the same time, the still relatively embargoed Soviet Union, for example, has yet to produce a microcomputer that can be widely used and serviced domestically.

Meeting China's Needs with Its Own Resources

In June, I attended the Beijing Second International Conference on Computers and Applications, sponsored by the U.S. IEEE Computer Society and the Chinese Computer Federation, and hosted by the Chinese Academy of Sciences. Most impressive at the five-day conference was the diversity of attendance from other countries and the breadth of Chinese participation. Seventeen countries (most of Europe, the U.S., Canada, Australia, and some of Asia) were represented by over 300 computer scientists presenting about 160 papers. Of the 100 or so Chinese computer scientists, more than 60 presented papers on topics ranging from local-area networks to elegant microcomputer-based multilingual word-processing systems (a single word-processing package developed by a professor from distant Xinjiang runs on a PC XT under a Chinese variant of DOS and handles four diverse Chinese dialects).

A State Council official from the Office for the Vitalization of the Electronics Industry Leading Group, Li Xianglin, opened the conference with a speech in which he said China had over "170,000 computer professionals and [is] expected to need a million by the year 2000." Xianglin also said that China would need to produce a million microcomputers by 1990, up from the 300,000 in mid-1987 (about half of them imported). To meet such a goal, China's microcomputer production will have to increase by 500 percent over the next 3 years.

The Chinese Computer Federation (equivalent to the IEEE-CS) is very well organized. Formed in 1985, it now has over 25,000 national members and local societies and chapters in every province in China. The CCF has active committees (see

continued

John H. Maier is organizing a wide-area computer network (BITNET) in and with the People's Republic of China. You can reach him at 8830 Sandcastle Court, Fort Worth, TX 76179.

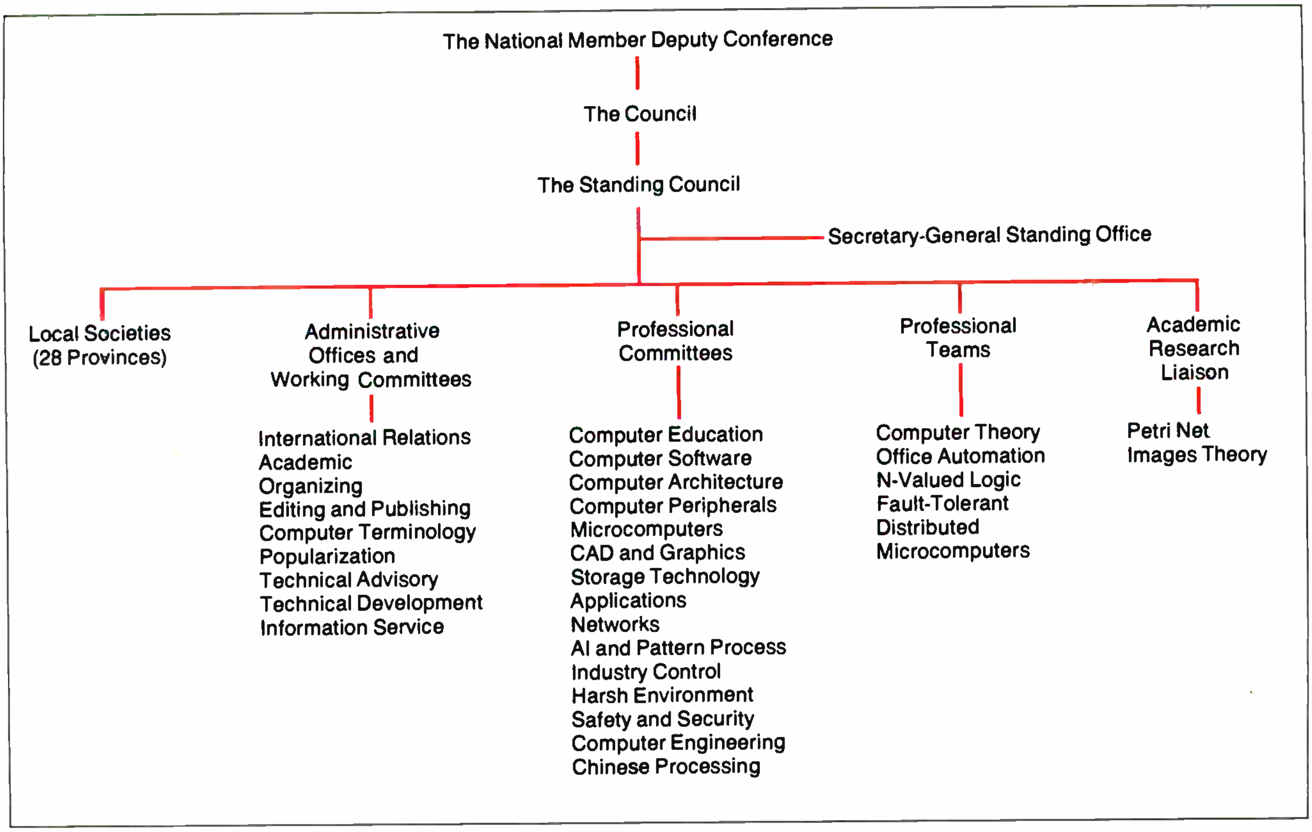

Figure 1: *The Chinese Computer Federation's impressive organizational backing has triggered the exponential growth of personal computers and the development of* "guigou" *("silicon valleys") in the People's Republic of China.*

figure 1) and a schedule that includes several international computer conferences a year, plus over 50 domestic ones. Its constitution follows the guidelines: "Let a hundred flowers blossom and a hundred schools of thought contend; fully develop academic democracy and encourage free academic discussion."

The CCF publishes eight professional journals, which have a total annual distribution of 700,000 copies. The CCF has also produced an authoritative English-Chinese computer science dictionary with 220,000 copies printed.

Building an Industry from Scratch

The CCF's Computer Education and Popularization Committees, tasked to spread computer science to China's 1.1 billion citizens, is now busy preparing 50 different computer-related self-study courses, completing other books for popularizing computer science, and editing a teenagers' computer-knowledge competition series. The CCF also prepares newspaper columns for five of the largest dailies in China. Finally, the CCF acts as an adviser in policy matters to China's government and participates in international activities. In short, the CCF is doing an effective job in a country that is clearly in the process of rapidly joining the global information-technology revolution.

China's computer industry infrastructure, it seems, is beginning to percolate and is gaining momentum. China's leaders at the highest levels recognize what they are now calling "the global new-technology revolution." They understand the important inherent links between computers and information technology. They see microcomputers as fueling widespread accessibility of the technology, taking it out of the custody of the scientists and putting it into the hands of the people. Walking along one of the lanes near Beijing University now, every other shop is a "computer disco" where any Western hacker would feel comfortable.

Further, China wants to make the transition from export of handicrafts to export of technology-intensive products, which will enable China to earn more foreign exchange and import Western high-end technology (e.g., DEC VAXes and IBM 30xxs) necessary for its own larger modernization program, with goals for both the year 2000 and the year 2050.

In fact, there may be other opportunities for China. Denis Simon of MIT has noted that China might develop software markets abroad. "Given the potential to build a 'clean' software industry (unencumbered by previous generations [of] installed code), it is likely that China will close the prevailing software gap at a faster pace than hardware. This may result in a significant Chinese presence in global software markets," says Simon.

As a variation, for example, one California firm, the Shanghai Software Consortium, has been farming programming piecework to a university in Shanghai, sending specifications and getting back debugged code at 60 percent of the going cost in the Bay Area. The Chinese programmers are highly overqualified scientists eager to earn foreign exchange with which they might then buy a Macintosh or MicroVAX.

Unencumbered by billions of lines of existing code, China might leapfrog into the software market, starting clean from the 4.5 (or wherever it is we are now) generation. Expert-system technology, for example, is now well known in China; a MYCIN-like Chinese traditional medical-diagnostics system appeared in China several years ago.

Thus, China may metamorphose in a fashion similar to Japan, economically and technologically. China has one of the 10 largest economies in the world, growing at a healthy 5 percent to 7 percent annually. Its GNP is expected to top $1.5 trillion by the year 2000. Many economists now say, in fact, that the twenty-first century will be the century of the Pacific Basin. ■

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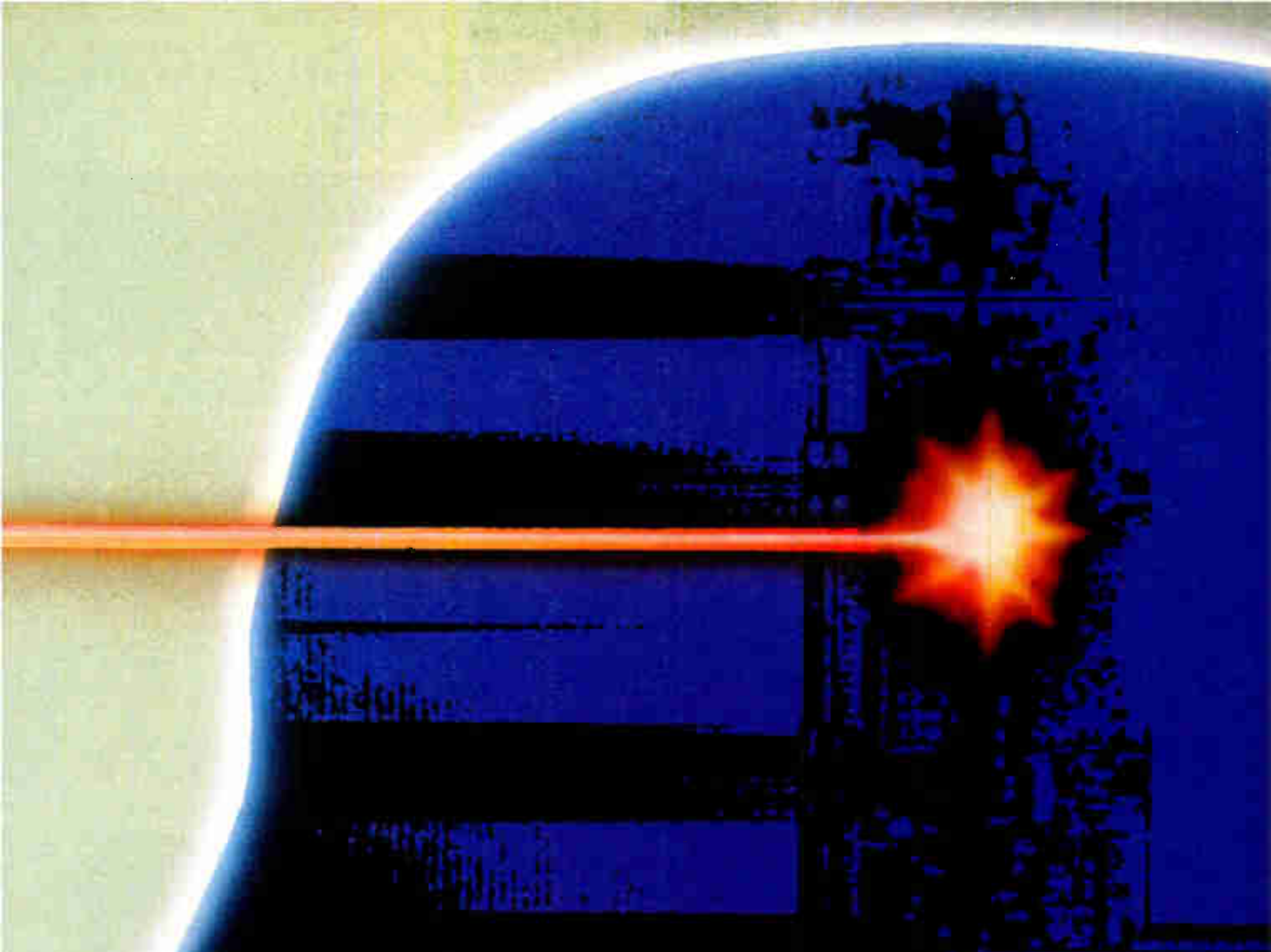

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Tyrone Daulton

Three-Dimensional Perspective Plotting

With perspective, you can realistically depict a three-dimensional object on a two-dimensional screen

Most three-dimensional computer-plotting routines don't draw in perspective. This is unfortunate, because perspective is an important aspect of any three-dimensional image. Without it, the object looks somewhat artificial, especially if you view it from an extreme angle (e.g., at a small angle relative to the horizontal x, y plane). In such cases, perspective gives the eye valuable information concerning the distance of various structures from the observer. Perspective gives a true three-dimensional appearance to a two-dimensional screen image (see figure 1).

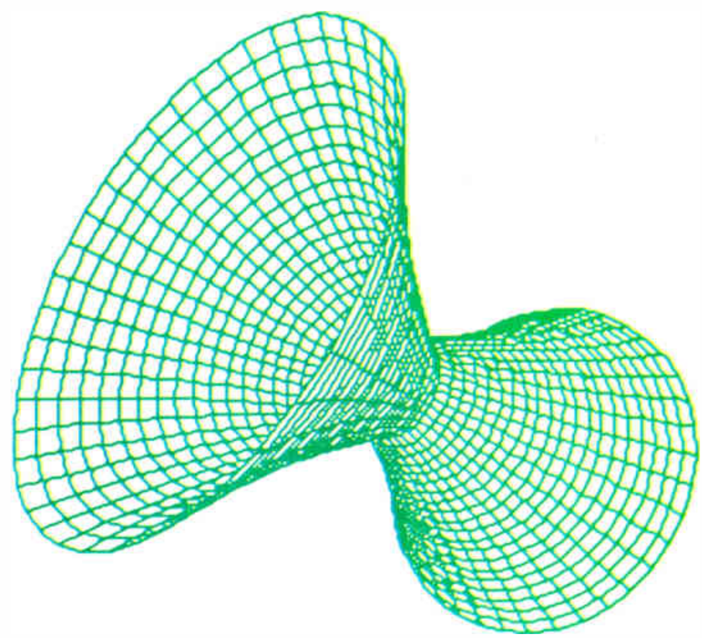


Figure 1: *A three-dimensional "goblet" drawn in perspective. Without perspective, you would have more trouble determining which half is closer to you.*

The Mathematics of Perspective

Perspective is easily explained: Objects far away from an observer appear relatively small because they subtend a smaller solid angle. If the object is brought closer, the solid angle it subtends will increase. The object appears larger because it occupies a larger region of the field of view.

Since perspective is not an effect of binocular vision but of solid angles, you can model it mathematically for a computer screen. To examine perspective from the standpoint of constructing a computer-plotting routine, think of the computer's screen as a window. This window has an object placed at some distance behind it and also has an observer situated at a fixed distance in front of the screen. Your task is to project the three-dimensional object onto the two-dimensional surface of the window. This amounts to a coordinate transformation T from 3-space to 2-space (notated as $T:\mathbb{R}^3 \rightarrow \mathbb{R}^2$). We say that a transformation like this shows a *dimensionality decrease*.

The image formed from a dimensionality-decreasing transformation is usually referred to as a *shadow*, and the transformation is referred to as a *shadow projection*. The most common shadow projection is the expanded type, which we can illustrate by imagining a backlighted object: Selected rays from the light source hit the object and create an outline image on a wall. Mathematically, this shadow is the expanded projection of the object with a dimensionality decrease.

In our case, the projection we want is similar to the one described above, but with one modification: The shadow formed is contracted rather than expanded (see figure 2). We will consider the origin (0,0) to be in the upper left corner (as it is with most video displays) and call the two axes *sx* and *sy* (where the *s* in each name reminds us that we are using screen coordinates).

The angle θ is the angle the object subtends in the *sx* direction. If the object is moved closer to the window, the angle θ will increase, and, consequently, the projected image of the object will be larger. The object's image will vary with two factors: the object's size and its distance from the observer.

Before we can derive the necessary transformations, we first need to define several fundamental constants that uniquely specify the characteristics of the window.

These parameters are declared as constants in the computer program. The first constant is β, defined as the angle in the screen's x-direction that the window subtends as seen by the observer a distance r_s from the window or screen. The screen's width in the x-direction (this is determined by the number of horizontal pixels on your computer screen) is defined to be $2sx_s$. Figure 3 shows the geometry that couples these three values together.

Tyrone Daulton is a graduate student working toward a Ph.D. in physics at Washington University-St. Louis. You can reach him at the Department of Physics, Washington University-St. Louis, St. Louis, MO 63130.

continued

The three parameters are linked together by a simple trigonometric relation:

$$\tan\beta \equiv \frac{sx_s}{r_s} .$$

Since the resolution of the computer screen sets the value of sx_s, you need only assign a value to either of the two remaining variables to uniquely fix the other.

The value of β is restricted to $\pi/2 \geq \beta \geq 0$; you can adjust it to your preference. It is a measurement of the window's field of view. A small value of β is like looking through a keyhole. A good starting value is $\beta = \pi/4$, or 45°.

Now consider an object placed at some arbitrary distance r_o from the observer, as shown in figure 4 (the subscript o will be used to denote variables related to the object). θ_x will denote the angle subtended by the object in the sx direction. Denote the object's length projected onto the window as $2sx_o$. A three-dimensional point located on the edge of the object with coordinates (x, y, z) will be projected down to the adjusted screen coordinates (sx_o, sy_o). (For convenience, the origin for these coordinates is the center of the window; we will later change them to proper screen coordinates with an origin translation.)

continued

Figure 2: *Mapping a three-dimensional object into two dimensions. Here, a three-dimensional object (a line segment) is projected onto a two-dimensional plane that is between the object and the observer.*

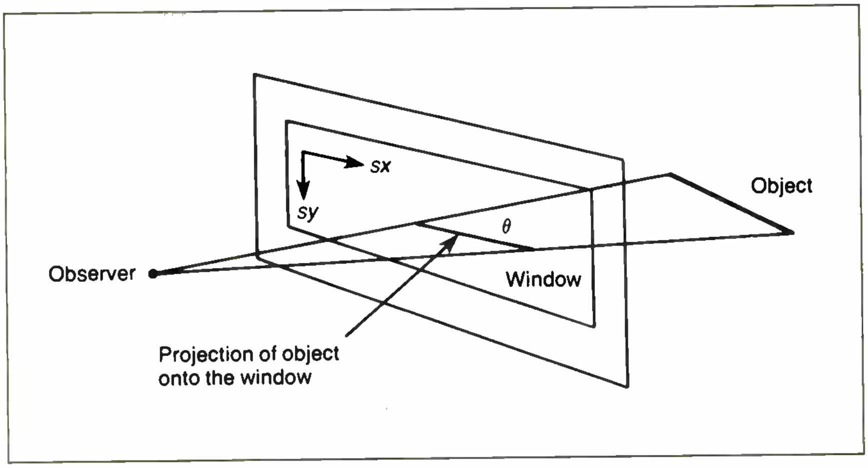


Figure 3: *The relationship between the angle of observation, β, the distance to the window,* r_s*, and the width of the window,* $2sx_s$*.*

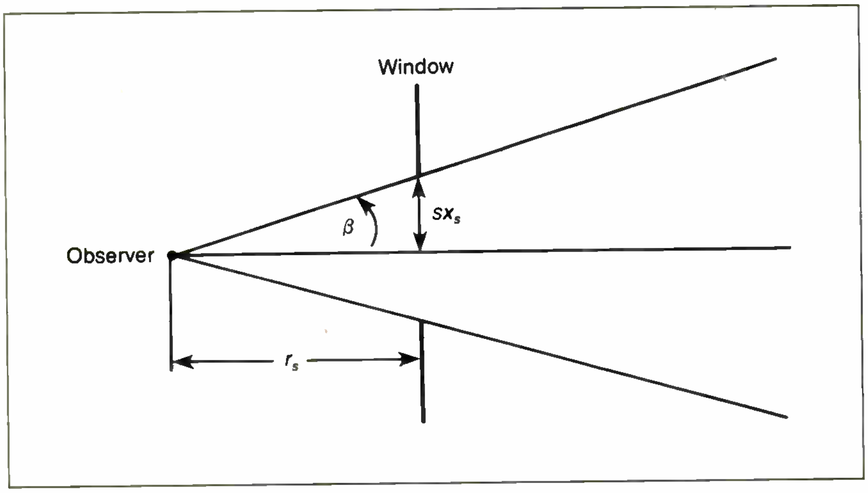
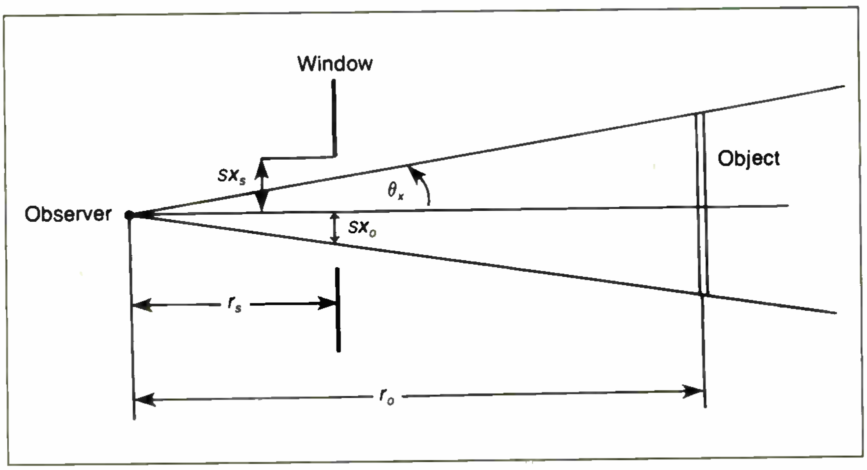
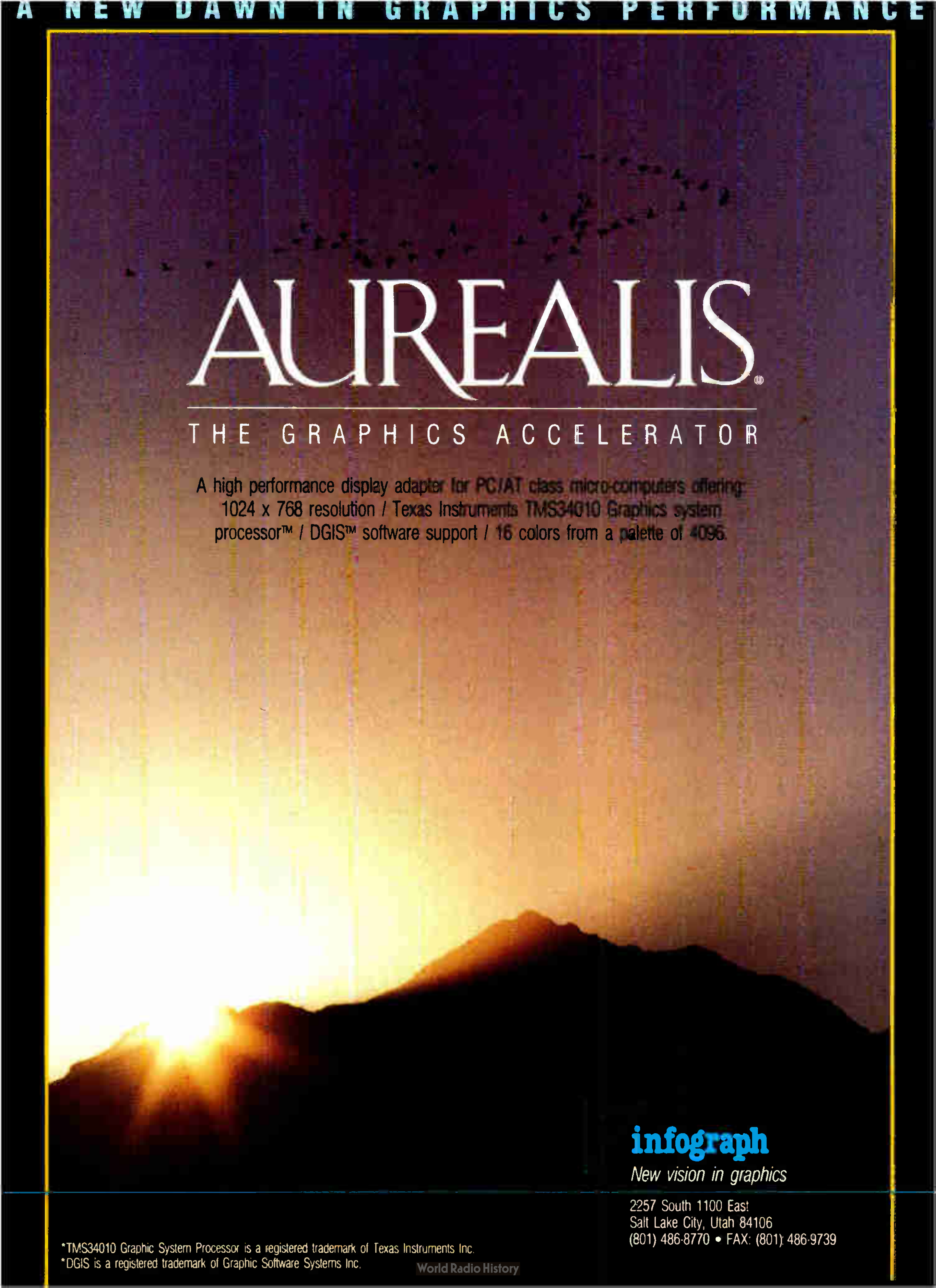


Figure 4: *Viewing an object through a window. Here, we are measuring the size of the object's image,* sx_o*, in relation to other angles and distances.*

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The variables sx_o (sy_o in the sy direction) are related to the window size by the equations

$$\tan\beta = \frac{sx_s}{r_s}, \quad \therefore r_s = \frac{sx_s}{\tan\beta}$$

and

$$\tan\theta_x = \frac{sx_o}{r_s}, \quad \therefore r_s = \frac{sx_o}{\tan\theta_x},$$

which combine to give us

$$\frac{sx_s}{\tan\beta} = \frac{sx_o}{\tan\theta_x}.$$

From this, we can calculate sx_o and sy_o:

$$sx_o = sx_s\frac{\tan\theta_x}{\tan\beta} \text{ and } sy_o = sx_s\frac{\tan\theta_y}{\tan\beta}.$$

The Proper Coordinate System

Before you can utilize these equations, you have to determine a relation between the unknown angles θ_x and θ_y and the known coordinates of a point (x, y, z) on the three-dimensional object.

Consider a point **a** on the object's three-dimensional surface. This point has coordinates (x, y, z) relative to the coordinate system shown in figure 5. It has been chosen such that the z-axis points out of the page and the x-axis points toward the window. We will call this the *proper coordinate system*.

It is clear from the geometry that the tangent of the angles θ_x and θ_y is given by

$$\tan\theta_x = \frac{y}{r_{\infty} - x},$$

where r_{∞} is the distance from the observer to the proper coordinate system origin. In the y-direction, we get

$$\tan\theta_y = \frac{z}{r_{\infty} - x}.$$

The value of r_{∞} depends on the observer's location relative to the coordinate origin; I'll say more about this later. Combining the above equations, we get

$$sx_o = \frac{sx_s}{\tan\beta\,(r_{\infty} - x)}\,y$$

and

$$sy_o = \frac{sx_s}{\tan\beta\,(r_{\infty} - x)}\,z,$$

continued

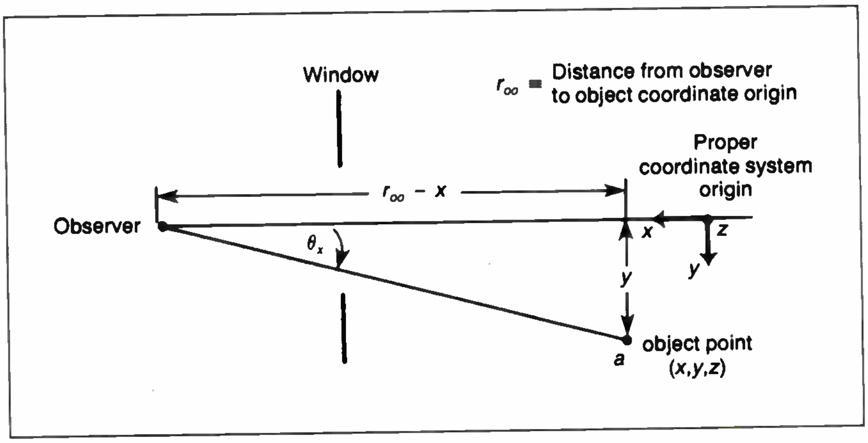


Figure 5: *The proper coordinate system. In this figure, the coordinates of points are given in terms of an origin shown here as just below the letter z. The z-axis points out of the page.*

$$\begin{vmatrix} sx_o \\ sy_o \end{vmatrix} = \begin{vmatrix} 0 & \frac{sx_s}{\tan\beta\,(r_{\infty} - x)} & 0 \\ 0 & 0 & \frac{sx_s}{\tan\beta\,(r_{\infty} - x)} \end{vmatrix} \begin{vmatrix} x \\ y \\ z \end{vmatrix}$$

Figure 6: *The projective transformation* **P**. *This equation projects a three-dimensional point (x, y, z) in the proper coordinate system to a two-dimensional point in the adjusted-screen coordinate system.*

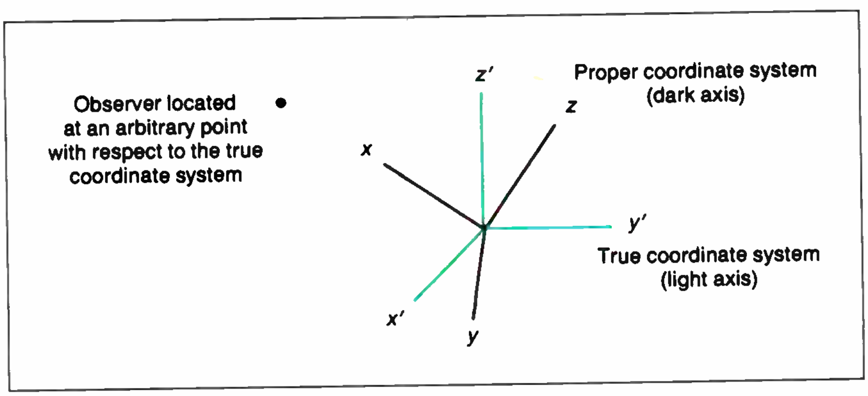
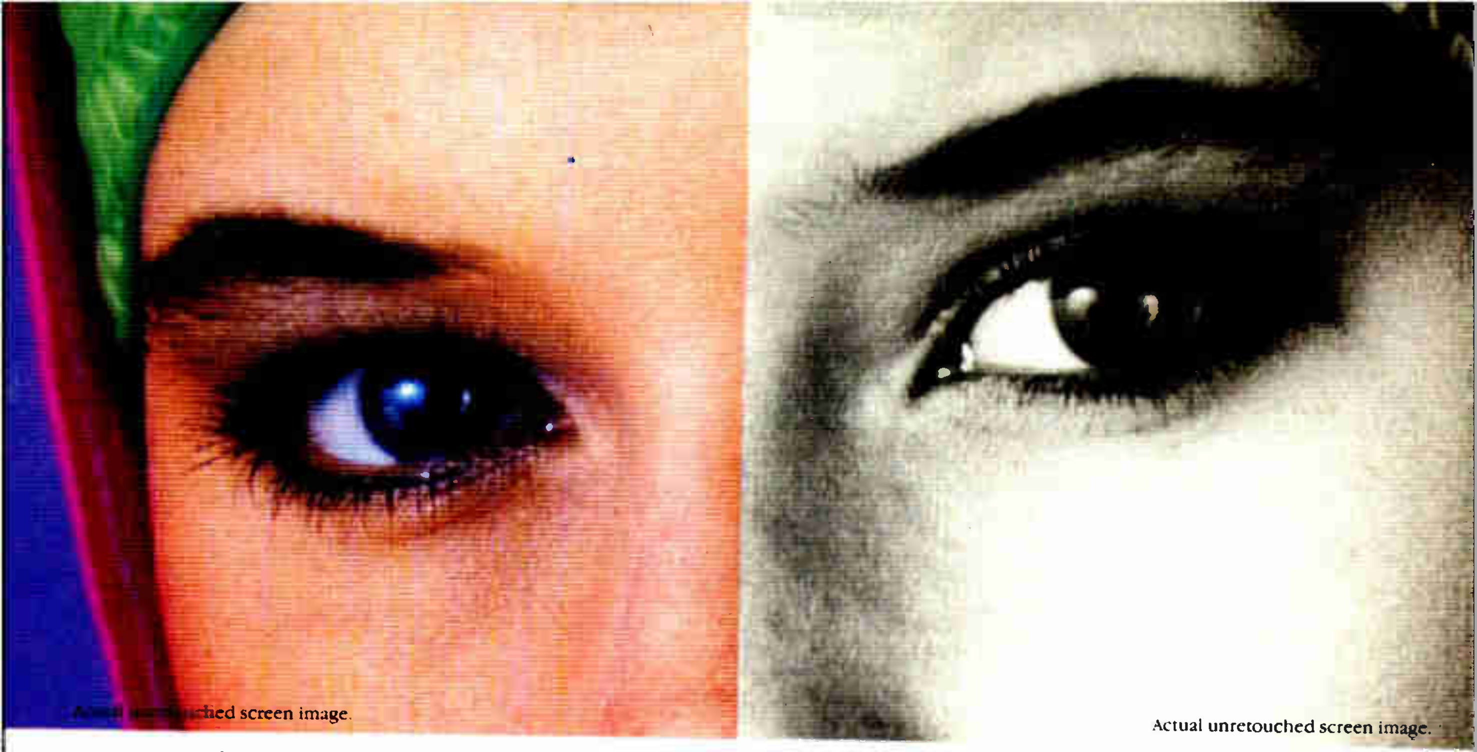


Figure 7: *Converting from the true coordinate system (colored axes) to the proper coordinate system (black axes). Note that the observer is directly on the x-axis, and the z-axis points up in the proper coordinate system. It is this property that allows us to project the rotated object in two dimensions.*



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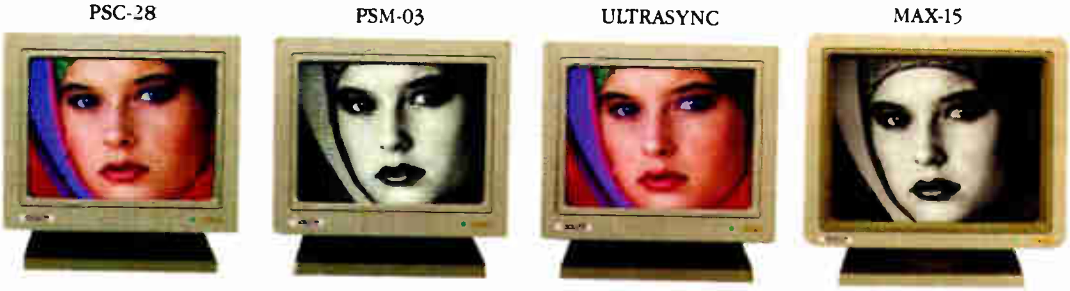

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Figure 8: *Rotations around the* x, y, *and* z *proper coordinate axes. For all three transformations, multiplying the appropriate* **R** *matrix by the coordinates of a point in the real coordinate system (given by the* x'-, y'-, *and* z'-*axes) gives the coordinates of that same point with respect to the proper coordinate system (given by the* x-, y-, *and* z-*axes).*

$$R_x = \begin{vmatrix} 1 & 0 & 0 \\ 0 & \cos\gamma & \sin\gamma \\ 0 & -\sin\gamma & \cos\gamma \end{vmatrix}$$

$$R_y = \begin{vmatrix} \cos\theta & 0 & \sin\theta \\ 0 & 1 & 0 \\ -\sin\theta & 0 & \cos\theta \end{vmatrix}$$

$$R_z = \begin{vmatrix} \cos\phi & \sin\phi & 0 \\ -\sin\phi & \cos\phi & 0 \\ 0 & 0 & 1 \end{vmatrix}$$

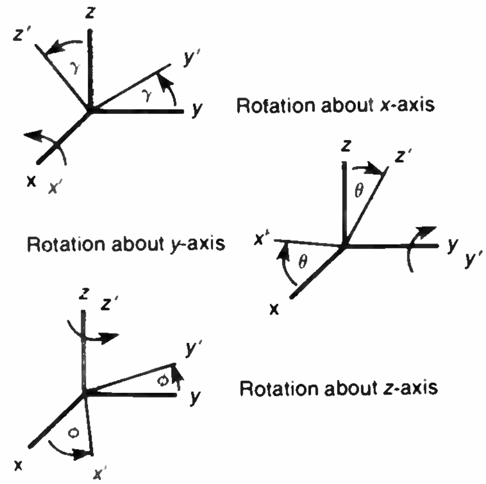


Figure 9: *Rotating the true coordinate system about axes of the proper coordinate system. A rotation around the* x-*axis tilts the resulting image in the window. A rotation around the* y-*axis changes the altitude from which the object is viewed. A rotation around the* z-*axis moves the object in a circle that is perpendicular to the window.*

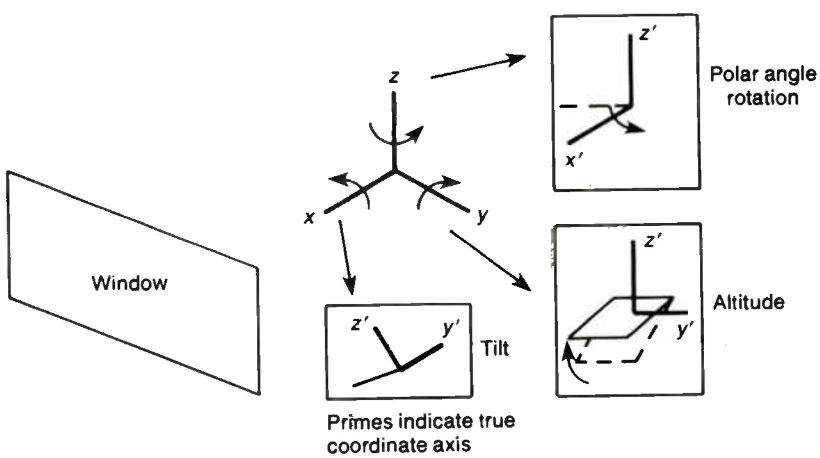
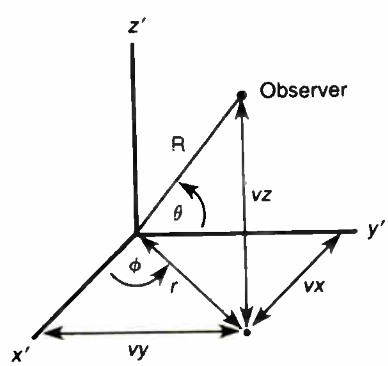


Figure 10: *Calculating the trigonometric functions of* ϕ *and* θ. *Since the* **R** *transformation matrices do not need to know the actual values for* ϕ *and* θ, *only their sine and cosine, we can calculate those four values directly from this figure and substitute them into the* **R** *matrices.*



which together describe the projection transformation ($P:\mathbb{R}^3 \rightarrow \mathbb{R}^2$).

We can write these equations in matrix form, as shown in figure 6, summarizing them in matrix notation as

$$\mathbf{SX}_o = \mathbf{P} \cdot \mathbf{X}$$

and in summation notation as

$$\mathbf{SX}_{o_i} = \sum_{k=1}^{3} \mathbf{P}_{ik} \mathbf{X}_k ,$$

where $\mathbf{SX}_o$ is the desired point transformed to two dimensions, **P** is the 2-by-3 perspective transformation matrix in figure 6, and **X** is the original point in three dimensions.

The matrix formalism used above is very useful for two reasons. First, it is a simple notation. Second, and more importantly, computers are well equipped to manipulate matrices rapidly.

Notice that the matrix of the perspective transformation is not a square matrix and, as a consequence, is not invertible. This means that the adjusted screen coordinates cannot be transformed back into the three-dimensional proper coordinate system. This is what you would expect, since more than one object point may map onto an image point.

At this stage, the matrix in figure 6 can transform the three-dimensional point on the object to its two-dimensional counterpart on the window (as shown in figure 5). Remember that the projected point has its coordinates in terms of adjusted screen coordinates (sx_o, sy_o), which have their origin at the *center* of the window.

The screen coordinates for most computers, however, have their origin at the top left corner of the screen. To convert a point in the adjusted screen coordinates (sx_o, sy_o) to normal screen coordinates (calling the corresponding point (sx, sy)), we need to perform only a simple translation of the origin. The equations for this are

$$sx = sx_o + sx_s$$

and

$$sy = sy_s - sy_o ,$$

where $2sy_s$ is defined to be the number of vertical pixels on the computer screen. We can now translate a point from three-dimensional space in a way that the result can be stored in the computer's memory and used to plot directly to the screen.

Vantage Points

It is useful for a set of three-dimensional plotting routines to be able to view the plot from a variety of vantage points. It allows you to step back and view the entire plotted surface or zoom in on an interesting feature.

Unfortunately, the equations developed thus far do not allow us to look at the object from any desired vantage point. Referring back to figure 5, note that the observer must be *somewhere* on the x-axis and that the z-axis must point up—this is the definition of the proper coordinate system. In effect, what we must do is, while keeping the origin the same, rotate the actual axes and the object we want to view until the x-axis points directly at the observer and the z-axis points straight up. We can then project the rotated object onto the screen using the perspective transformation

$$\mathbf{P}:\{x, y, z\} \rightarrow \{sx_o, xy_o\} ,$$

which is defined by the equations above and in figure 7.

Let us begin by defining the original axes as x', y', and z'; we will call this the *true coordinate system*. If the observer's position in this system is (vx, vy, vz), the distance from the observer to the origin, r_∞, is defined by the equation

$$r_\infty = \sqrt{vx^2 + vy^2 + vz^2} .$$

Note that, even when we rotate the axes, this value of r_∞ is still correct for the proper coordinate system because the observer and the origin have not changed with respect to each other.

Since the origins of the two coordinate systems are the same, the only difference between them is their orientation, which can be uniquely specified by the angles between each of the three axes. Through a series of rotations about each axis of the proper system, we reorient the true coordinate system in such a way that its axes coincide with those of the proper coordinate system. Let us define this transformation as

$$\mathbf{R}:\{x', y', z'\} \rightarrow \{x, y, z\} .$$

The rotation transformation comprises a series of ordered individual rotations about each of the independent axes. Figure 8 shows what each rotation does and adds the matrix that will bring out that transformation.

These rotation transformations in figure 8 are specific cases of a general-rotation matrix **R**. Each entry in these matrices is obtained by taking the scalar dot product of the unit vectors in the proper coordinate system with the unit vectors in the true coordinate system. The general form of the rotation matrix **R** is given by

$$\mathbf{R} = \begin{vmatrix} \hat{i}'\cdot\hat{i} & \hat{j}'\cdot\hat{i} & \hat{k}'\cdot\hat{i} \\ \hat{i}'\cdot\hat{j} & \hat{j}'\cdot\hat{j} & \hat{k}'\cdot\hat{j} \\ \hat{i}'\cdot\hat{k} & \hat{j}'\cdot\hat{k} & \hat{k}'\cdot\hat{k} \end{vmatrix} ,$$

where $\hat{i}'$, $\hat{j}'$, and $\hat{k}'$ are the unit vectors in the x-, y-, and z-directions in the (beginning) true coordinate system; $\hat{i}$, $\hat{j}$, and $\hat{k}$ are the corresponding unit vectors in the proper coordinate system; and the scalar dot product of two vectors **A** and **B** is given by

$$\mathbf{A} \cdot \mathbf{B} = ab \cos\theta$$

(a and b are the lengths of vectors **A** and **B**, respectively, and θ is the angle between them).

Now, it is important to point out that matrix multiplication is noncommutative. This means that the order of the rotations is very important. Even if you rotate the true system through the proper angles, if the order of rotations is incorrect, you will not be superimposed onto the proper system.

Using the Correct Rotations

To understand the effects of each of the individual rotations, we must view them in a different sense. Consider the proper and true coordinate systems to be superimposed onto one another such that their axes coincide. We want to rotate the true coordinate system (and, along with it, the point of the observer) so that the observer lies on the x-axis of the proper coordinate system. What series of rotations about the individual axes (and in what order must they be executed?) will achieve this required orientation? Before we can answer this question, we need to know what each rotation does to the true coordinate system.

With the two systems overlapped, we will examine each rotation separately. A rotation of the true system about the proper system's z-axis will result in rotating the true system through a polar angle about the z-axis. A rotation of the true system about the proper system's y-axis will result in achieving altitude and a

continued

vantage point above or below the surface of the true system. A rotation of the true system about the proper system's x-axis will result in a tilting of the true system (see figure 9).

When viewing the plot from a vantage point (vx, vy, vz), you would expect to view the plotted surface from any polar angle or altitude. You would not expect to view the surface at a tilt. Thus, we need to be concerned with only the z- and the y-axis rotations, respectively. If we wish to tilt the surface, we can later rotate the image of the surface in two dimensions without losing the correctness of the resulting image.

The two rotation-order possibilities are a z-axis rotation followed by a y-axis rotation, or the converse. These two possibilities are not interchangeable due to the noncommutative property of matrix multiplication. The series of rotations that we are interested in are, in matrix notation:

$$\mathbf{X} = \mathbf{R}_y \cdot \mathbf{R}_z \cdot \mathbf{X}',$$

or, in summation notation:

$$\mathbf{X}_i = \sum_{j=1}^{3} \mathbf{R}y_{ij} \sum_{k=1}^{3} \mathbf{R}z_{jk} \mathbf{X}'_k \,.$$

This is a rotation about the proper system's z-axis, then the proper system's y-axis. This will yield the correct orientation.

All that remains is for us to determine the angles, ϕ about the z-axis and θ about the y-axis, that rotate the observer to lie on the x-axis of the proper coordinate system. Figure 10 shows the angles through which the true coordinate system must be rotated.

The lengths of the vectors **R** and **r** are

$$R = \sqrt{vx^2 + vy^2 + vz^2}$$

and

$$r = \sqrt{vx^2 + vy^2} \;.$$

The geometry of the coordinate system yields the following trigonometric relations for the rotation angles:

$$\cos\phi = \frac{vx}{r}, \quad \cos\theta = \frac{r}{R},$$

$$\sin\phi = \frac{vy}{r}, \quad \text{and } \sin\theta = \frac{vz}{R},$$

giving the rotation matrices

$$\mathbf{R}_y = \begin{vmatrix} \frac{r}{R} & 0 & \frac{vz}{R} \\ 0 & 1 & 0 \\ -\frac{vz}{R} & 0 & \frac{r}{R} \end{vmatrix}$$

and

$$\mathbf{R}_z = \begin{vmatrix} \frac{vx}{r} & \frac{vy}{r} & 0 \\ -\frac{vy}{r} & \frac{vx}{r} & 0 \\ 0 & 0 & 1 \end{vmatrix} .$$

Hence, if you have a set of points that describe a three-dimensional object, you can transform the coordinates of each point from the true to the proper coordinate system with the **R** rotation transformations described above. Once you have done that, you can then transform the proper coordinates into adjusted-screen coordinates via the perspective transformation given in figure 6. Finally, you can obtain the true screen coordinates from the adjusted screen coordinates by the two equations given just above the section "Vantage Points" on page 313.

Constructing an Algorithm

Now that we have completed the mathematics of the three-dimensional perspective algorithm, we can summarize the overall algorithm. First, we should summarize the four different coordinate systems we will be dealing with:

- A point (x', y', z') in the true coordinate system will be denoted as the vector $\mathbf{X}'$.
- A point (x, y, z) in the proper coordinate system will be denoted as the vector $\mathbf{X}$.
- A point (sx_o, sy_o) in the adjusted-screen coordinate system will be denoted as the vector $\mathbf{SX}_o$.
- A point (sx, sy) in the screen coordinate system will be denoted as the vector **SX**.

Here, then, is the complete algorithm:

1) Define β, the angle of vision as described in figure 3.
2) Choose a vantage point (vx, vy, vz) in the true coordinate system and calculate the $\mathbf{R}_y$ and $\mathbf{R}_z$ rotation matrices.
3) Set up a double FOR loop that cycles through the desired range of points along the y'- and x'-axes.

a) Calculate a point on the object's surface using the equation $z = f(x', y')$ on the object.
b) The point (x', y', z') = $\mathbf{X}'$ becomes the point we want to transform.
c) Translate the point to proper screen coordinates using the equation

$$\mathbf{X} = \mathbf{R}_y \cdot \mathbf{R}_z \cdot \mathbf{X}' \,.$$

d) Calculate the perspective transformation **P**. Since this transformation depends upon the current object point, it must be recalculated for each iteration of the loop.
e) Project the three-dimensional object point onto a two-dimensional image plane (adjusted screen coordinates) with the perspective transformation

$$\mathbf{SX}_o = \mathbf{P} \cdot \mathbf{X} \,.$$

Translate the point to screen coordinates using the equations

$$sx = sx_o + sx_s$$

and

$$sy = sy_s - sy_o \,.$$

g) Plot the point (sx, sy).
h) End of double FOR loops.

This algorithm contains the mathematics needed to create a two-dimensional perspective rendition of a three-dimensional object or surface. I have created a Microsoft Macintosh BASIC 2.0 program, PROJ3D.BAS, that implements this algorithm along with menus, solid or wire-frame surfaces, and other enhancements.

You should insert the equation for the object you want to draft in the line `NZ = ...` in the first line after the BASIC label `FUNCTION:`. I hope you find it interesting and useful. ■

[Editor's note: *PROJ3D.BAS is available on disk, on BYTEnet, on BIX, 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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Clifford Harris

Ferret: An Image Processor

Clever techniques in astronomical image processing let you manipulate weak or "noisy" images

An astronomical telescope functions like a camera lens. It gathers light from an object and brings this light to a focus at the plane of the film. Since many objects of astronomical interest are quite dim, the primary reason for building large telescopes is to gather more light. The larger the telescope, the more light it can concentrate in the focal plane. However, if you place a detector in the focal plane that is more sensitive to light than photographic film, your small telescope could perform like a large one. Ferret, an image-processing system for astronomy, combines a sensitive imaging charge-coupled device (CCD) with the processing capabilities of a microcomputer.

Ferret's System Components

My CCD is made up of a rectangular array of 103,168 light-sensitive elements, or photosites (see figure 1). Photons of visible light carry enough energy to produce free electrons in the CCD's silicon, and these electrons are then stored at the nearest potential well that defines a photosite. As soon as an exposure is completed, the electrons from this photosite move to an amplifier that converts the electrical charge to a voltage. A 12-bit A/D converter (ADC) translates this voltage into a computer-readable number between 0 and 4095. Because the CCD is a linear device, this number is proportional to the intensity of light striking the CCD at this photosite. As the computer reads the 403 samples by 256 lines of photosite data, it stores a string of 103,168 twelve-bit numbers in memory. The regular spacing of the photosites lets the computer reconstruct the image from this string of numbers.

My image-processing computer is an IEEE 696-based system running a Motorola 68000 microprocessor. One megabyte of RAM lets the image-processing program and four images reside in main memory at the same time. My 40-megabyte hard disk drive is underutilized and currently contains only 36 images. Two lines of a parallel port control the CCD driver, which in turn drives the CCD.

A second parallel port sends image data to a graphics-display computer that displays 8-bit image data on a 672- by 480-pixel screen in 256 colors chosen from a palette of over 16 million. Because the graphics computer cannot display the full 12-bit ra[illegible] of pixel values, only the most significant 8 bits of each [illegible]ent for display. The program, called Ferret, runs on the [illegible]-processing computer and controls all the display computer's functions.

Ferret was written in 68000 assembly language under CP/M 68K, primarily for the speed with which that language allows in processing large volumes of image data. Ferret's menus provide access to image-processing functions in five major categories: image acquisition, restoration, enhancement, display, and analysis. [Editor's note: *FERRET.ASM is available in 68000 assembly language source code. Be aware, however, that the program was written for CompuPro's system Ee, and it will not necessarily run on other 68000-based machines. You might be able to adapt it to your system, but we make no promises as to its portability. The listing is 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.*]

Image Acquisition

To capture an image, you select an exposure time and press a key to begin the exposure. The computer then clears any accumulated charge from the CCD, times the exposure, and reads the image data into memory. To aid in removing the effects of electrical noise, the reading process is synchronized with the 60-hertz frequency.

Due to system limitations, such as thermal and electrical noise, pixel nonuniformity, and defective pixels, the raw image does not represent astronomical objects accurately (see photo 1a). Ferret's image-restoration functions minimize the effects of these limitations.

Image Restoration

The very properties that make the CCD a good imager also make it susceptible to unwanted noise. For example, thermal motion in a warm CCD can knock loose the lightly bound silicon electrons. Because of on-chip circuitry, an optical window, and slow readout times, the temperature and its effects are not constant across the CCD's surface. The thermal electrons mix with the photo electrons to produce a degraded signal and a noisy picture. Cooling the CCD can reduce the number of thermal electrons, but even temperatures as low as −40° C can't eliminate the effects of noise. Fortunately, the computer can remove the worst of the remaining thermal-noise effects.

Dark-field subtraction removes most of the thermal noise by taking the difference between an image containing the desired scene and a dark image made with the lens cap on. The temperature and exposure time are kept constant between the two expo-

continued

Clifford Harris (99 Mason Rd., Yerington, NV 89447) is an amateur astronomer who is pursuing his goal of developing an automated observatory.

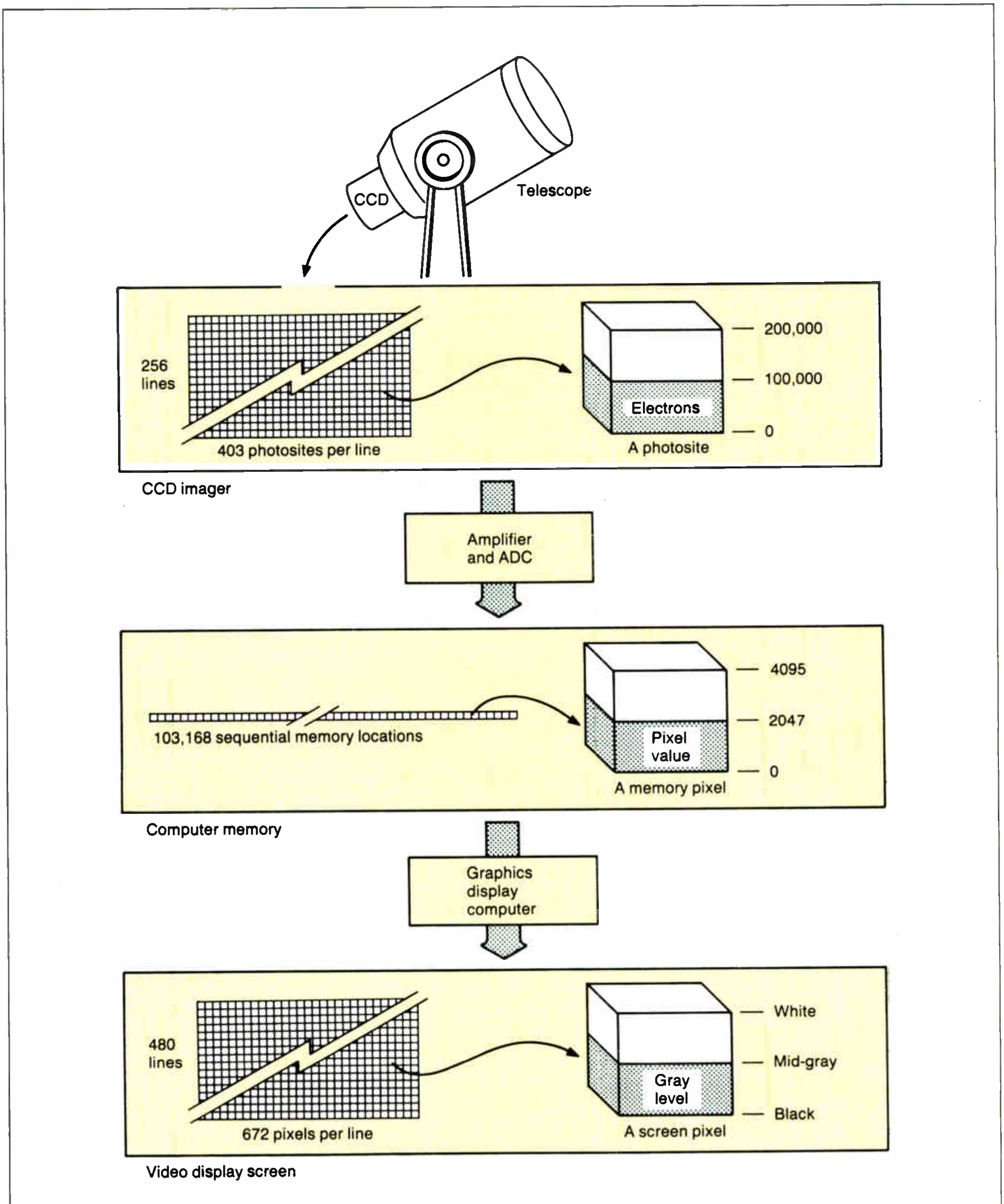

Figure 1: *The data path controlled by the Ferret image-processing program. Photons of light produce electrons that accumulate in the photosites making up the CCD's surface. The charge that the electrons carry from each photosite is converted first to a voltage and then to a computer-readable number by the amplifier and ADC. The entire image is stored in the computer's memory as a string of 103,168 twelve-bit numbers. The computer can greatly enhance image quality by manipulating image data within its memory. Finally, the image is transferred to a graphics computer for display. The right side of the figure tracks the transformation of a single pixel from the CCD to the display screen.*

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Photo 1a: *This raw image of M42, the Orion nebula, was taken with a 1-minute exposure and a warm (5°C) imager. The image has a substantial background of thermal noise and numerous hot spots or saturated pixels.*

Photo 1b: *This enhanced image is the result of subtracting the dark-field image from photo 1a. Reducing the background-noise level lets contrast enhancement bring out detail that was not apparent in the raw image. The black specks were caused by subtracting the equal pixel values of the hot spots.*

sures. Since the readouts of both of these images are synchronized with the 60-Hz line frequency, they contain the same level of electrical noise interference. The major difference between the two images is the light coming from the sky through the telescope. The subtraction results in a sky scene with much less noise interference (see photo 1b).

The following formula for dark-field subtraction takes into account the possibility that a defective photosite might yield a dark-pixel value that is greater than or equal to the corresponding pixel in the sky image:

$$V_{out} = 0 \text{ if } V_{in} <= V_{dark}$$
$$V_{out} = V_{in} - V_{dark} \text{ if } V_{in} > V_{dark} ,$$

where V_{in} is the value of a pixel in the raw image, V_{dark} is the corresponding pixel value in the dark image, and V_{out} is the pixel value for the resultant image. Dark-field subtraction is a very common operation used to improve every new image as it is received. Because it is used so often, one of the four image buffers in Ferret's main memory is dedicated to the dark-field image.

$$V_{OUT} = \text{median of} \left\{ \begin{array}{|c|c|c|} \hline V_{x-1,y+1} & V_{x,y+1} & V_{x+1,y+1} \\ \hline V_{x-1,y} & V_{x,y} & V_{x+1,y} \\ \hline V_{x-1,y-1} & V_{x,y-1} & V_{x+1,y-1} \\ \hline \end{array} \right.$$

Figure 2: *Ferret's method of removing image defects caused by hot spots and holes, where* x *and* y *represent the horizontal and vertical coordinates of a pixel in the source image, and the* V *refers to that pixel's value.*

$$V_{OUT} = \text{mean of} \left\{ \begin{array}{|c|c|c|} \hline V_{x-1,y+1} & V_{x,y+1} & V_{x+1,y+1} \\ \hline V_{x-1,y} & V_{x,y} & V_{x+1,y} \\ \hline V_{x-1,y-1} & V_{x,y-1} & V_{x+1,y-1} \\ \hline \end{array} \right.$$

Figure 3: *Ferret's method of pixel averaging involves using the mean value of pixels found in the neighborhood, where* x *and* y *are the horizontal and vertical coordinates of a pixel in the source image, and the* V *refers to that pixel's value.*

The photosites that make up the CCD's imaging portion vary in sensitivity in a manner similar to random noise. However, the sensitivity of an individual photosite is consistent, so you can readily correct this variance by making an image with the CCD exposed to a uniform level of illumination, such as an out-of-focus sheet of white paper or the day sky. After dark-field subtraction, this image contains variations that correspond to the actual variations of photosite sensitivity within the CCD. The arithmetic division, on a pixel-by-pixel basis, of a star image by this "flat field" removes these variations from the resulting image. The image is then scaled to approximately its original values by multiplying it by the average value of the flat-field image. The formula is:

$$V_{out} = 0 \text{ if } V_{flat} = 0$$
$$V_{out} = V_{avg} * (V_{in} / V_{flat}) \text{ if } V_{flat} > 0 ,$$

where V_{in} is the value of a pixel in the source image, V_{flat} is the corresponding pixel value in the flat-field image, and V_{avg} is the average value of the flat-field pixels. While the image improvement from this division is less than that from dark-field subtraction, the operation is done on nearly every new image. Therefore, another of the four image buffers is dedicated to the flat-field image.

Defects within the CCD cause some photosites to become saturated with electrons (hot spots), and others to be insensitive (holes). You can remove the resulting image defects by exchanging the defective pixel value with a value derived from surrounding pixels.

Ferret's method fills defective pixels with the median value of the 3- by 3-pixel array centered on the defective pixel (see figure 2). This means sorting these nine values into numerical order and taking the middle, or fifth, value as the output to the resulting image (see photo 1c).

If you know the precise positions of the defective pixels, you

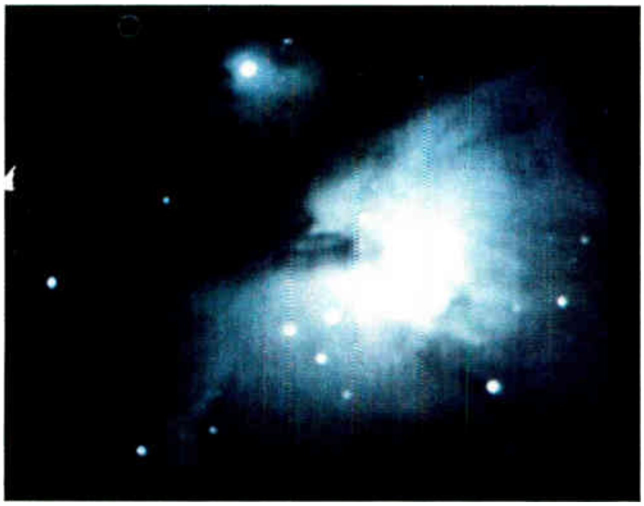

Photo 1c: *Application of the median-value filter has smoothed the image somewhat and removed the defective pixel values.*

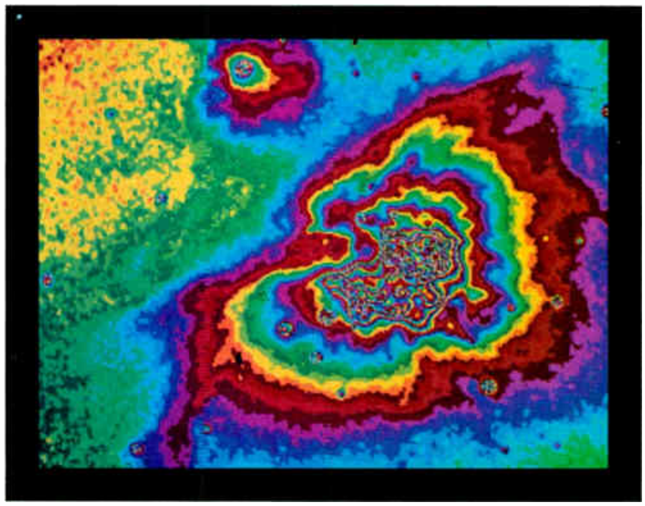

Photo 1d: *The rainbow-like colors of the* `Contour` *subroutine map areas of equal brightness. This photo of the Orion nebula was made after dark-field subtraction but without contrast enhancement.*

can perform this operation on only those pixels. If the number of defective pixels is large, or if there is substantial noise, you can produce subjectively improved images by applying this operation to every pixel in the image.

Image Enhancement

The program uses its image-enhancement functions interactively to produce subjectively improved images. They include functions for changing contrast, increasing magnification, and smoothing. They use Ferret's remaining two image buffers: One as the source and the other as the destination. By displaying the contents of these two buffers side by side, you can determine whether you have achieved the desired effect before you continue processing.

An image histogram—a graph showing the frequency distribution of pixel values within an image—is displayed on the graphics screen directly below each image. Ferret's histogram defines the limits for the contrast-enhancement function and provides information useful in correcting exposure times and determining noise levels.

To produce the histogram, the computer first zeros an array of 256 counters, one for each of the possible 256 display values. Then it steps through the image, one pixel at a time, using the high-order 8 bits of the pixel's value as a pointer into the array of counters. The corresponding counter in the array is incremented by 1, and the computer moves on to the next pixel. On completion, each counter in the array contains the number of pixels of a given value that are in the image. The graph generated from the contents of the counters is scaled to fit the available space under one of the two displayed image frames.

Contrast enhancement increases the apparent brightness difference between dim and bright objects. In a low-contrast image, it lets you expand the range of pixel values—by selecting a range of brightness values from the image histogram with two cursors—to match the range of display values. The system subtracts the lower value selected from each pixel in the image and forces negative results to 0. The highest possible pixel value is divided by the difference between the two selected values, giving a multiplier that will scale the chosen range to fit the available range. Pixels with values equal to or greater than the upper limit of the selected range are forced to the greatest value of the 12-bit range. For all pixels in the image, the formula for 12-bit pixel values is

$$V_{out} = 0 \text{ if } V_{in} <= lo$$
$$V_{out} = 4095 \text{ if } V_{in} >= hi$$
$$V_{out} = INT(4095*(V_{in} - lo)/(hi - lo)) \text{ if } lo < V_{in} > hi \text{ ,}$$

where hi and lo are the upper and lower limits selected by the histogram cursors, V_{in} is the value of a pixel in the source

continued

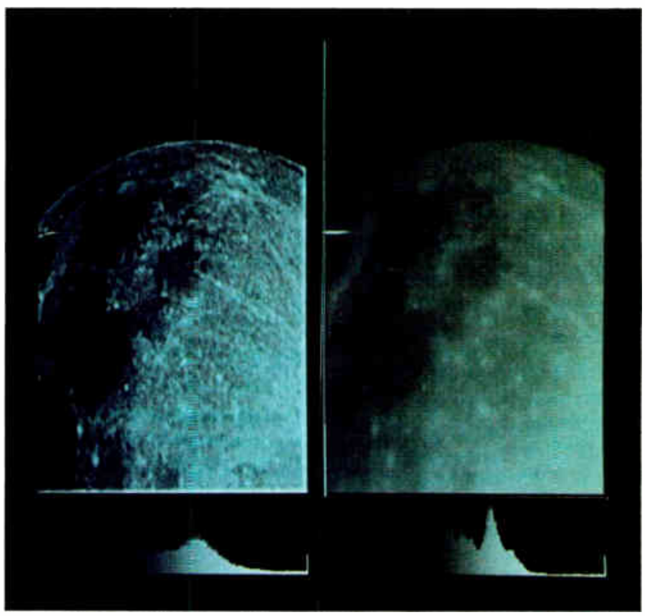

Photo 2: *A raw image of the moon appears on the right side. Dark-field subtraction, high-pass filtering, and a contrast enhancement produced the image on the left. In this image, reflected earthlight illuminates the dark side of the third-quarter moon. The sunlit crescent is just out of the field of view along the right side and bottom of the image.*

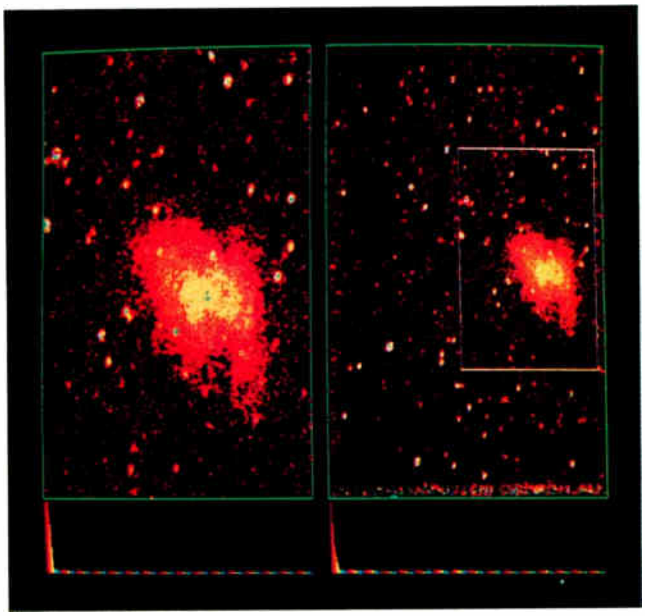

Photo 3: *The Crab nebula, a supernova remnant, is seen in this before-and-after example of the* `Magnify` *subroutine. The area inside the white frame in the image on the right is magnified by a factor of 2 to produce the image on the left.*

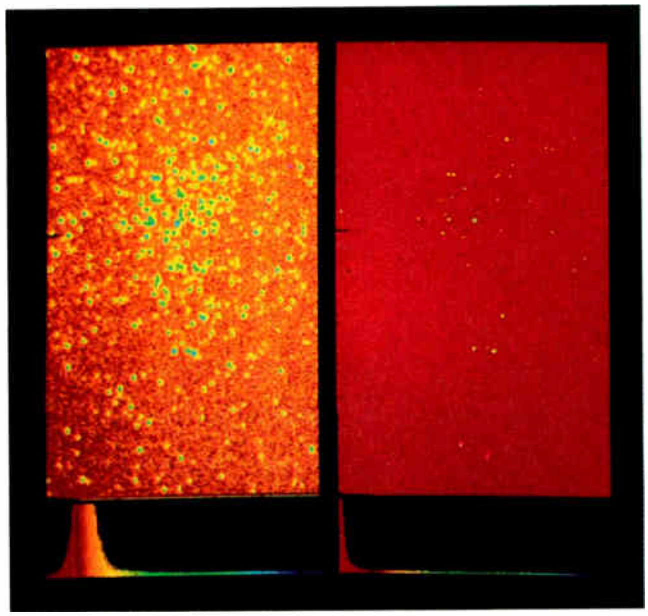

Photo 4: *The unenhanced image of the star cluster M37 appears on the right. On the left is the same image after the application of linear and logarithmic contrast enhancements.*

image, and V_{out} is the corresponding pixel in the enhanced image.

Images that contain a wide range of pixel values are common in astronomy. Converting pixel values to a logarithmic scale lets you view dim stars without forcing brighter objects to a saturated white. This function works much like the contrast-enhancement function, but it selectively increases contrast in the dimmer portions of the image while decreasing the contrast in the brighter portions.

Ferret implements the log-brightness scale with a lookup table of the logarithms of the 4095 possible nonzero pixel values. As the system encounters each pixel in the image, it looks up the log of the pixel's value, scales it appropriately, and places it in the resulting image. In the case of 12-bit pixels, the scale factor is 1133; thus, the formula for 12-bit pixel values is:

$$V_{out}=0 \text{ if } V_{in}=0$$
$$V_{out}=\text{INT}(1133*\log(V_{in})) \text{ if } V_{in}>0 .$$

As the enhancement functions are mostly concerned with the subjective appearance of an image rather than the exact value of a given pixel, the loss of accuracy involved in truncating to an integer is not serious.

Noise appears in an image as a slight random fluctuation in pixel values, even in places where the original sky scene contains no such fluctuations. You can make these variations less noticeable by "pixel averaging," a process that smoothes images by taking, as the output value for a given pixel, the mean value of pixels found in the "neighborhood." Ferret defines the neighborhood as a 3-by-3 array of pixels centered on the pixel in question (see figure 3).

Pixel averaging produces an image that looks slightly out of focus. Gradual changes in brightness within the image are retained, but fine detail is blurred and edges are softened. This is the digital equivalent of applying a low-pass filter. If you wish to sharpen detail and emphasize edges instead, you can apply the equivalent of a high-pass filter by subtracting the averaged image from the original, with a constant added to ensure that each pixel has a positive value. You then add this high-pass image back into the original to produce an image with the low-frequency characteristics of the original, but with increased sharpness of detail (see photo 2).

Ferret's `Magnify` subroutine enlarges a portion of an image by a factor of 2. A half-size frame, positioned by the cursor-control keys, selects the portion to be magnified. Each pixel within the frame is translated into a 2- by 2-pixel block in the resulting image (see photo 3). You can repeat this magnification as often as you wish, and you can enlarge a single pixel to fill the entire screen. Use of the `Magnify` subroutine is often followed by a smoothing function such as the pixel-averaging subroutine, which helps reduce the blocky appearance of the magnified pixels.

Image Display

The CCD imager I use is a black-and-white device; that is, it records the intensity of light but cannot distinguish between colors. The display format that most closely matches this is the gray-scale display that represents bright portions of the image as white, dark portions as black, and intermediate values as varying degrees of gray. The picture looks quite natural if you are used to viewing a black-and-white television.

The eye can often resolve faint detail better in the negative version of an image than in the positive. You can achieve this readily in a 12-bit system by subtracting each pixel value from 4095; the result is equivalent to a photographic negative. Alternatively, you can reverse the display representation so that large pixel values are displayed as dark areas and small ones as light areas.

A color display can represent intensity by a variety of color schemes even though the original image contains no color information. The added dimension of color helps you distinguish between subtle brightness changes that are difficult to see in shades of gray. Ferret's `Spectrum` subroutine assigns violets and blues to the brightest portions of the image, reds to the darkest, and greens, yellows, and oranges to the intermediate values.

continued

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This "false color" scheme is especially useful when determining the upper and lower limits for the contrast-enhancement function (see photo 4).

If the brightness variations within an image are very gradual, even Spectrum's colors are inadequate. The Contour subroutine represents the 16 darkest pixel values as 16 distinctive colors. This sequence of colors repeats for the next brightest pixel values, and so on. The result is rainbow-like bands of color that trace the isophotes, or regions of equal intensity (see photo 1d). When you use Contour's colors, brightness variations as small as one part in 256 become readily apparent.

Image Analysis

The two fundamental characteristics of any pixel in an image are position and intensity. Although knowing a screen position is useful if you are mapping bad pixels, it is also helpful to have the computer convert these values to others that bear a relationship to the object space that the image represents. Dimensional measurements of astronomical objects are often made in terms of the angular units of degrees, minutes, and seconds of arc. A degree is 1/360 full circle, a minute of arc equals 1/60 degree, and a second of arc is 1/60 minute. The image scale of the raw images obtained with my present optical system is about 1000 by 1250 arc seconds.

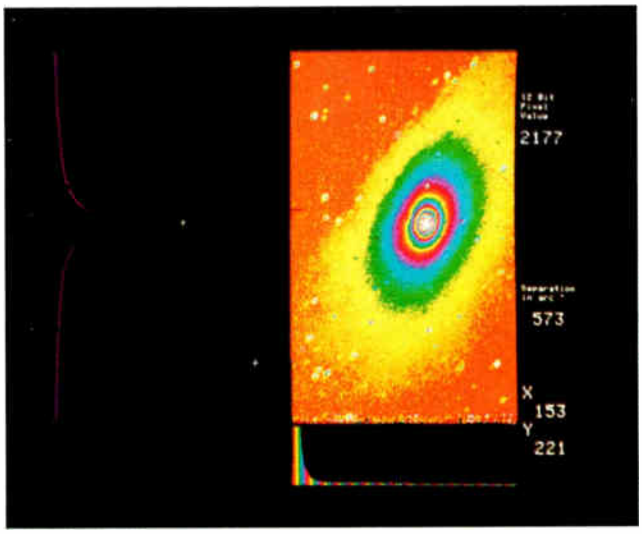

Photo 5: *The Andromeda galaxy is on the right. On the left is a graph of intensities for pixels lying on a vertical line through the center of the galaxy.*

A numeric display gives the *x, y* screen position, in pixels, of a cross-hair cursor that you can place at any position in an image. You can also make a second cursor active and place it anywhere in the image. The separation between the two cursors is displayed numerically in seconds of arc (see photo 5).

You measure pixel intensity by using an active cursor. The value of the pixel at the center of the cross hair is displayed in the decimal representation of the full 12-bit pixel value; my graphics screen displays only 8 bits of intensity. In addition, the Graph function displays a graph showing the pixel values versus vertical-image position for those pixels lying on the vertical line chosen by the cross-hair cursor. Actually, the system tilts the graph on its side, writes it into an image buffer, and displays it as if it were a sky image. You can then use the position cursors to read numeric values from any point on the graph.

A similar function draws many of these graphs but stacks them up on top of one another in the output image. This function color-codes the height of points on the graphs. In gray scale, the high points are drawn in white, the lows in black, and intermediate points are shades of gray. If you take care not to overwrite previously drawn points, the appearance of a three-dimensional surface builds up where stars appear as tall spikes, and diffuse objects resemble hills on a plain. (See the striking difference between an ordinary exposure of a nebula in photo 6a and a three-dimensional enhancement of the same image in photo 6b.)

The Groups subroutine is intended to run with Ferret in an automatic mode for the automated mapping of the night sky. Groups finds and characterizes groups of pixels corresponding to objects within an image (see photo 7).

If a pixel's value is above a limiting threshold value, the pixel is assigned a group number. If any adjacent pixel already has a group number, this pixel becomes part of the established group, and its position and value update the group position and intensity. If no adjacent pixels are members of a group, this pixel

continued

Photo 6a: *The planetary nebula M27 lies in the star-rich Milky Way. The dimmest stars in this 2-minute exposure are some 4000 times dimmer than the naked eye can detect.*

Photo 6b: *M27 in three dimensions appears to be surrounded by a forest of stars.*

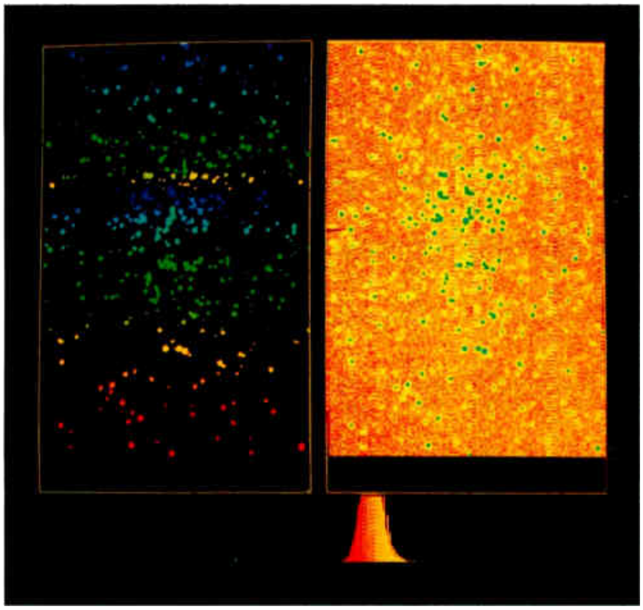

Photo 7: *The enhanced image of the star cluster M37 is on the right. The* Groups *subroutine assigns to an appropriate group each star in the cluster that has a pixel value exceeding a certain threshold value. Then the subroutine assigns each group a number for color coding as the groups are plotted on the left. The bottom of each image has been clipped because of high noise levels in this area.*

becomes the first member of a new group. The program interprets each group to be a single astronomical object, even though it might be made up of many actual objects that overlap in the sky. Data stored for each object reflects its position, area, and integrated brightness.

The Groups subroutine aids in finding diffuse objects by comparing them to a catalog of objects of known position, area, and brightness. Then it creates a report of significant discrepancies—representing such diverse objects as supernovas in galaxies other than our own, variations in the light output of clusters and nebulas in our own galaxy, or comets in the neighborhood of the sun.

A New Age for Astronomy

While objects such as supernovas and comets are often found by chance on photographs made by large observatories, many are still discovered by amateur astronomers who put in long, patient hours peering through telescopes and binoculars. However, the age of visual discovery in astronomy is drawing to a close as electronic light detectors and digital computers replace human observers.

Inexpensive computers with impressive graphics capabilities and large memories are now readily available. CCD imagers will become common as more manufacturers begin to include them in video and still cameras. The astronomical systems built from them will cover more sky and record dimmer objects with greater precision than a human observer. ■

FOR FURTHER READING

Castleman, Kenneth R. *Digital Image Processing*. Englewood Cliffs, NJ: Prentice-Hall, 1979.

Green, William B. *Digital Image Processing*. New York: Van Nostrand Reinhold, 1982.

Niblack, Wayne. *An Introduction to Digital Image Processing*. Englewood Cliffs, NJ: Prentice-Hall, 1986.

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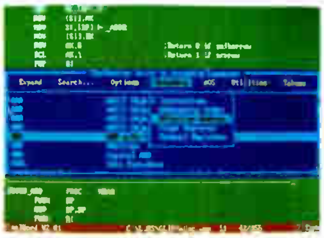

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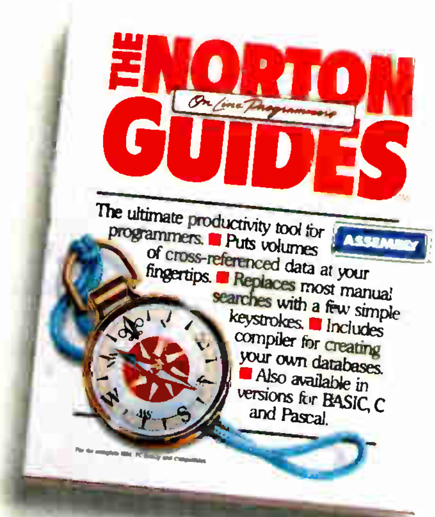

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Mapping the World in Pascal

A cartographic sampler: Five Pascal mapping routines that give you the power to change the face of the earth

Cartography is the science of making maps. It originated 2,000 years ago when the astronomers of ancient Greece and Egypt began charting the night sky. They invented the first map projections and established the rules for transferring the features on a sphere to a flat sheet. We, however, have a distinct advantage over these original cartographers, for computers can quickly solve the equations that govern map projections.

The five mapping routines we will discuss here represent a cartographic sampler. We've included two of the simplest projections (the Equidistant Cylindrical and the Sinusoidal), two of the most familiar (the Mercator and the Orthographic), and one commonly used in various scientific circles (the Hammer).

Picturing the Earth

Cartography has been described as "the effective compromise between all sorts of errors so that none is too objectionable." The Earth is round; maps are flat. This isn't a problem if you're interested in only a very small part of Earth's surface, but the larger the area you want to display, the more the sphere matters. A mundane example: It's easy to press a small section of orange peel flat. But when the piece is half the size of the orange, it tears and warps.

Different map projections tear and warp the Earth's "skin" in different ways. You can choose a projection that shows directions accurately, but it will alter sizes. Another might show areas correctly, but at the cost of distorted shapes. There is no all-around "best" map projection. Like any other tool, each has its special purpose.

Before discussing the projections themselves, let's briefly describe the way cartographers define locations. They identify points on our planet through a network of longitude and latitude lines (called a graticule) superimposed on Earth's surface.

Latitude lines, or parallels, are circles surrounding the globe on planes parallel to the equator. Longitude lines, or meridians, run from the equator and converge at both poles, crossing each parallel at right angles.

Unlike latitude lines, which use the equator and the poles as natural references, there's no obvious starting point for meridians. In 1884, the meridian running through the observatory in Greenwich, England, was arbitrarily chosen as the prime meridian (longitude line 0°). By convention, latitudes north of the equator are positive, while those south of the equator are negative. Longitudes east of the prime meridian are positive, but those west of that line are negative.

Mapmakers need one more bit of information—the shape of the Earth. Because our planet bulges at its equator and is somewhat flattened at its poles, the Earth is really an oblate spheroid, not a sphere. Its pole-to-pole diameter differs from that at its equator by less than one part in 300, but this is an important distinction for accurate maps. The difference is negligible on small-scale maps (such as those found in commercial atlases), and these procedures assume a spherical Earth.

The Groundwork

We implemented the five mapping routines along with their support functions in Turbo Pascal version 3.0 in a file named CARTOG.PAS. The code should be easily transportable to other Pascal implementations. Also, there's an awful lot of number crunching involved, and a math coprocessor chip speeds things up in a big way.

CARTOG.PAS generates coordinate grids as well as coastline data, but the entire program is too long to list here (about 12K bytes). We will discuss in detail only the procedures used to convert longitudes and latitudes stored in the WORLD.DAT data file into the *x,y* coordinates of your computer screen. The variables `Lambda` and `Phi` correspond to longitude and latitude, respectively. Then we will present the procedure that implements each mapping projection.

[Editor's note: CARTOG.PAS in its entirety, and CPLOT.PAS, *a program for sending the output to a Hewlett Packard 7475 plotter, 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. The data file WORLD.DAT is available only on disk, on BYTEnet, and on BIX, since it is not an ASCII file.*]

To use the mapping procedures, we first defined a few constants and functions that aren't available in Turbo Pascal. Most of the constants are obvious: `Sqrt2` is the square root of two, `HalfPi` is π divided by two, `TwoPi` is π times two, and we list π itself for completeness. `Radian` is used to convert angles measured in degrees to their equivalents in radian measure. `RadianDiv100` is equal to $\pi/180/100$ and is used to convert the coastline data in WORLD.DAT to radians. The constant `NotVisible` is a flag that is set when a point cannot be plotted on the map. `Xcenter` and `Ycenter` define the center of the graphics screen, `Aspect` represents the screen aspect ratio, and `R` is the radius of the scaled-down globe used to generate the map. To present full-screen maps on graphics boards other than the

continued

Robert Miller is a systems analyst for the state of Michigan, and Francis Reddy is a technical writer for the Milwaukee Public Museum. You can reach both authors through the museum's Education Dept., 800 West Wells, Milwaukee, WI 53233.

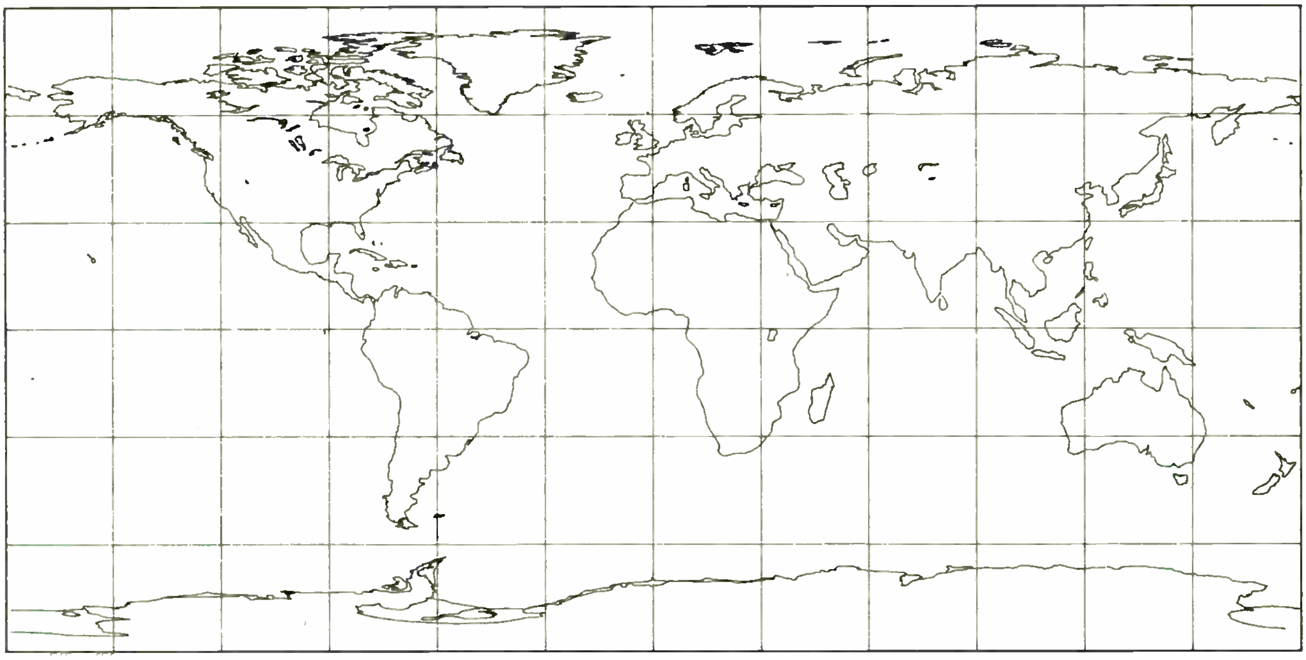

Figure 1: *Equidistant Cylindrical projection is easy to implement, but it distorts both the shape and the area of land masses.*

CGA, see the text box "Scaling to a Graphics Board."

Now for the functions. ArcSin and ArcCos are inverse sine and inverse cosine, respectively, and return the angle whose sine or cosine is passed into the function. (The inverse tangent, ArcTan, is supplied by Turbo Pascal.) ArcTanH is the inverse hyperbolic tangent and is used only by procedure Mercator. Function Meridian returns the difference between the current longitude passed to it (called Lambda) and the central longitude of the map (Lambda0). This difference (called DelLam) is adjusted if it falls beyond the range of $+180°$ and $-180°$ (π radians) by adding or subtracting $360°$ (TwoPi). Meridian is used by all projection procedures.

Finally, a word about the data file. We compiled the program WORLD.DAT from two government-produced world maps. For Antarctica, we used a polar view from the U.S. Geological Survey's 1-to-40,000,000 "World Outline Map"; all else was taken from the Defense Mapping Agency's "The World," which is also available through the USGS. The resulting binary file, which consists of about 6,000 latitude/longitude pairs, provides a nice low-resolution view of the world.

We chose a Pascal binary file format for WORLD.DAT. The first 2 bytes of each record are a two-letter ASCII code: LS means to draw line strings, beginning with the data point in this record, and connect all subsequent points with records containing an S code. Each record contains one data point consisting of a longitude/latitude pair.

The longitudes and latitudes are stored as a 16-bit integer representing hundredths of a degree. Coordinates south of the equator and those west of Greenwich are considered negative. This scheme produces a relatively compact data file giving an adequate resolution of data points (better than 1 mile on the ground) for this purpose.

We have subsequently obtained both medium- and high-resolution coastline databases from the Goddard Space Flight Center in Greenbelt, Maryland. The smaller file contains about 15,000 points, and the larger one holds about 95,000 points, including international boundaries. The data is in a format compatible with CARTOG.PAS and is available from the authors for a copying/handling charge of $15.

The Easy Maps

Perhaps the simplest map projection is the Equidistant Cylindrical (see figure 1). Imagine a globe tucked inside a cylinder so that only the equator touches the sides. That's the basic idea behind this and all other so-called "cylindrical" projections.

"Graph paper" may be the best way to describe the Equidistant Cylindrical. In this projection's simplest form, the equator is chosen to be the standard parallel, called Phi1. This means that the equator is the only latitude displayed true to scale and without distortion. If meridians and parallels are equally spaced, the result is a grid of tiny squares twice as long as it is wide.

Features of Equidistant Cylindrical include:

- It preserves neither shapes nor areas;
- Poles are shown as lines;
- Meridians and parallels are equidistant (straight lines intersecting at right angles);
- It is easy to compute.

```
PROCEDURE EquiCyl(Lambda, Lambda0, Phi, Phi1,
                  R : REAL; VAR X, Y : REAL);
{ For R=1: -Pi<=X<=Pi, -Pi/2<=Y<=Pi/2. }
BEGIN
  Lambda := Meridian(Lambda, Lambda0);
  X := R * Lambda * COS(Phi1);
  Y := R * Phi;
END;   { EquiCyl. }
```

Interesting things happen if you choose a standard parallel other than the equator (Phi1 <> 0). The whole map becomes compressed in the east-west direction. In this case, there are two standard parallels: Phi1 and -Phi1. Recall that one of the features of the Earth's graticule is that meridians converge north and south of the equator. Meridians don't converge on the Equidistant Cylindrical (or on the Mercator). So, if the equator represents the map's standard parallel, all the other parallels are longer than they should be. This is most obvious at the poles, which should be represented as points.

With `Phi1 = 0`, all parallels are forced to be the same length as the longest one on the globe—the equator. With a standard parallel other than the equator, `Phi1` and `–Phi1` become the latitudes displayed true to scale. All the parallels between `Phi1` and `–Phi1` are then smaller than they should be; those beyond them, larger. This reduces the map's east-west dimensions, and the scale is now closer to being true over a larger portion of the map. Features between the standard latitudes are slightly smaller than they should be, and features beyond the standard parallels are scaled slightly larger. Changing the standard parallel also helps control distortion in the north-south direction—it keeps the map's scale closer to being true over a larger area than if you just used the equator.

All in all, the Equidistant Cylindrical projection is not a very good choice for displaying geographic data. It preserves neither area nor shape and is best used when distortions are less important than just getting the data on-screen as quickly as possible.

The Sinusoidal projection (see figure 2) is more useful and only slightly more complex. Developed in the sixteenth century, the Sinusoidal is an equal-area projection; that is, it shows areas correctly and exhibits no distortion along the equator and central meridian. Distortion becomes pronounced at the outer meridians, extreme near the poles. Latitude lines are straight, parallel, and equally spaced. The central meridian is a straight line and crosses all parallels at right angles; other meridians form curves, their curvature increasing with greater distance from the map's center. You'll usually see the Sinusoidal used for world maps, often in an "interrupted" form. In this case, the world is broken into sections, each with its own central meridian. Some atlases also use the Sinusoidal for South America, Africa, and the central Pacific.

Features of Sinusoidal include:
- It shows area correctly but distorts shape, especially in polar regions;
- Central meridian is straight, all others are sinusoidal curves;
- Parallels are equally spaced straight lines;
- It is easy to compute.

```
PROCEDURE Sinusoidal(Lambda, Lambda0, Phi, R :
                     REAL; VAR X, Y : REAL);
{ For R=1:  -Pi<=X<=Pi  and  -Pi/2<=Y<=Pi/2. }
BEGIN
  Lambda := Meridian(Lambda, Lambda0);
  X := R * Cos(Phi) * Lambda ;
  Y := R * Phi;
END;  { Sinusoidal. }
```

Scaling to a Graphics Board

The program CARTOG.PAS scales the maps in this article for CGA graphics. But what if you have an EGA or some other graphics card? To determine how to alter the graphics constants for your specific system, you must first examine the comment accompanying each of the mapping procedures. In procedure Sinusoidal, for example, the following comment is the key for calculating the proper *R* to fill a given graphics screen:

```
For R = 1: -Pi <= X <= Pi and -Pi/2 <= Y <= Pi/2.
```

R represents the radius of the scaled-down globe from which the map is developed—it's the radius of the globe at the scale of the map. To scale the maps to a computer screen, you need to know the values returned by each map projection for a globe of unit radius. You also need to know the resolution of your screen and its aspect ratio—that is, the factor by which you need to divide the *x*-coordinate to compensate for non-square pixels.

Let's find R for displaying a full Sinusoidal map on the CGA. The map's total range is 2π in x, π in y. The map's x-axis must fit within 640 pixels; the y-axis must fit within 200 pixels. For the CGA, the aspect ratio is 2.4. So for x:

```
R = (640/2Pi)/2.4 = 42.4 .
```

And for y:

```
R = 200/Pi = 63.6 ,
```

because the smallest R controls; to fit a full Sinusoidal map on the CGA requires an R of 42.4, which we rounded to 40 in CARTOG.PAS. As it turned out, we could use this value for all the projections, so we defined it as a constant.

If you don't know the aspect ratio of your system, just plot the Orthographic grid and plug in values until it forms a circle. Depending on your system, you may also need a different aspect ratio to get proper screen dumps.

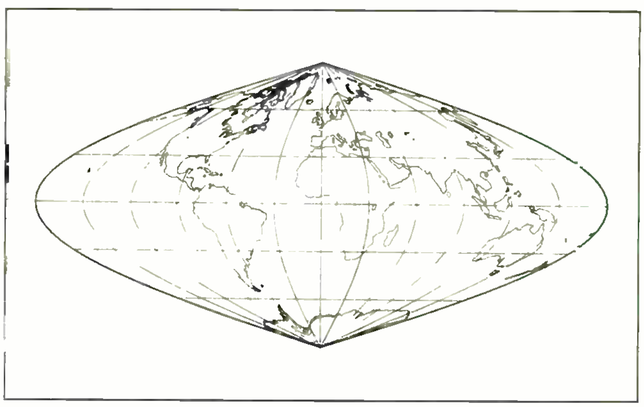

Figure 2: *Sinusoidal projection is easy to compute and preserves the relative area of land masses, but it distorts their shape.*

Best-Known Projections

The Mercator map projection (see figure 3) is unquestionably the most familiar. In fact, it may be the only projection many students see. This is unfortunate, since the Mercator greatly distorts areas of large north-south extent. Which is bigger: Greenland or South America? If you're not at all sure, part of the blame rests with the Mercator projection. Greenland is only one-eighth the size of South America.

The map's primary purpose is navigational. A ship or plane following the same compass course will travel a straight line when plotted on a Mercator map. Gerhardus Mercator developed this projection in 1569 specifically as an aid to navigation. Mercator's projection is classed as a cylindrical, and at first glance it looks much like the Equidistant Cylindrical. But look again. On a Mercator map, the poles cannot be shown because they lie at infinity, and the spacing between parallels increases with increasing distance from the equator. A region at the 60th parallel plots twice as large as the same area at the equator. Moved to 80°, that same area

continued

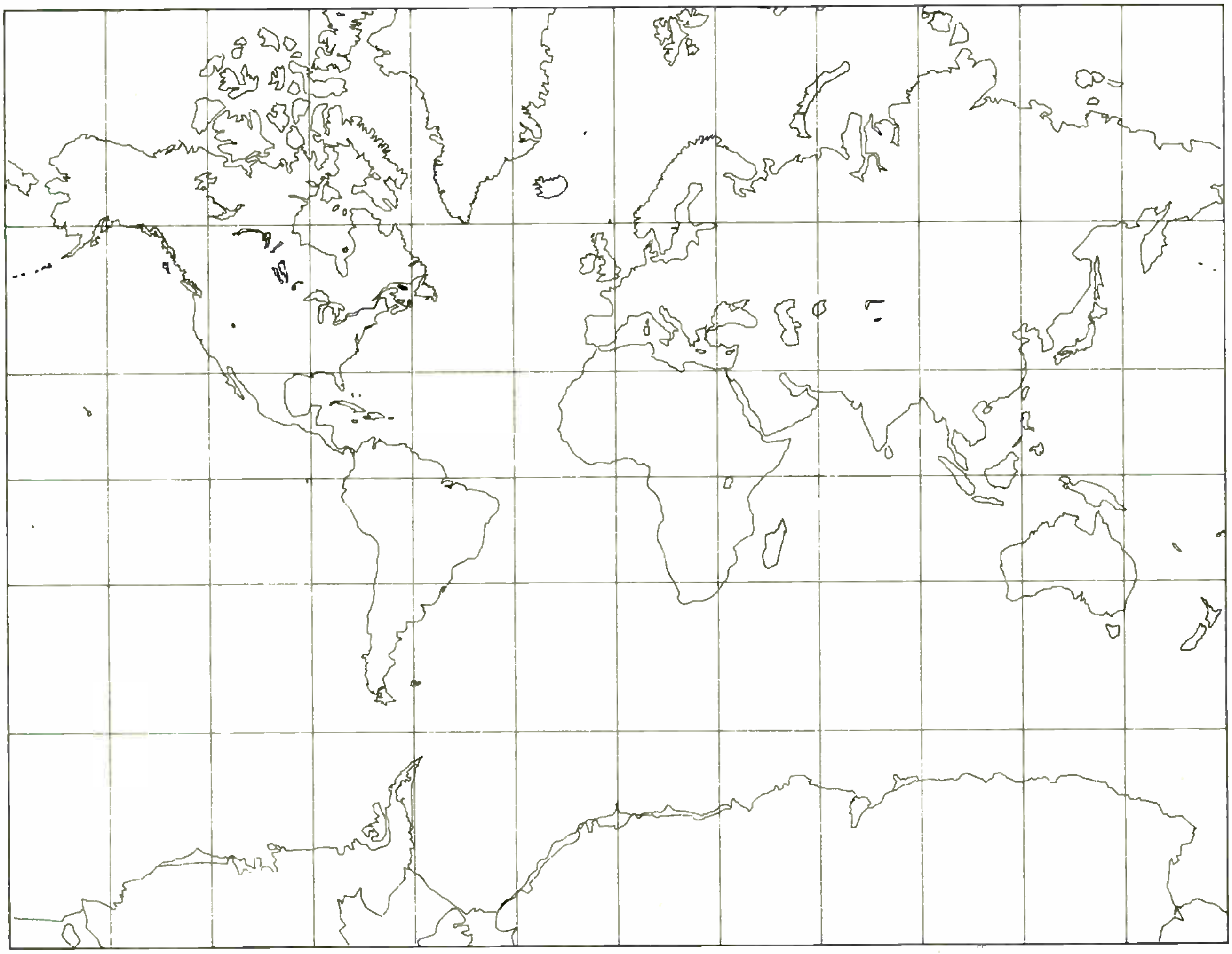

Figure 3: *The Mercator mapping projection is one of the most widely known and is responsible for the confusion as to whether Greenland is bigger than South America. While it preserves the shape of coastlines, it distorts the area.*

becomes 33 times larger than at the equator! The Mercator maintains the shapes of small areas at the cost of distorting sizes; the Equidistant Cylindrical preserves neither.

Features of Mercator include:

- It preserves shape but distorts area, especially in polar regions;
- Poles lie at infinity;
- Meridians are straight, equally spaced lines;
- Parallels are straight lines spaced unequally;
- Meridians and parallels intersect at right angles.

```
PROCEDURE Mercator(Lambda, Lambda0, Phi, R :
                    REAL; VAR X, Y : REAL);
{ For R=1: -Pi<=X<=Pi, -Pi/2<=Y<=Pi/2.   }
CONST MaxLat : REAL = 1.397;  { 80 degrees. }
             { REAL = 1.483;    85 degrees. }
BEGIN
  IF ABS(Phi) < MaxLat THEN
  BEGIN
    Lambda := Meridian(Lambda, Lambda0);
    X := R * Lambda;
    Y := R * ArcTanH(SIN(Phi));
  END
  ELSE X := NotVisible;
END;    { Mercator. }
```

As latitudes and longitudes are passed into the procedure, the values are tested to see if they fall within -`MaxLat` and +`MaxLat`. Placing a limit around 80° or 85° gets all major arctic landforms on the map; most of Antarctica passes the test as well. But since distortion is pretty severe at high latitudes, you may want to try a lower cutoff value.

Note that procedure Mercator is nestled within an `IF` statement. The loop that generates the graticule for these projections produces values for `Phi` ranging from −90° to 90°. When `Phi` reaches `MaxLat`, the *x*-coordinate is set to `NotVisible` (−32767).

This flag tells the "drawing pen" to lift off the screen. Since the Mercator projection cannot show extremely high latitudes, you must set the "pen up" flag when the latitude reaches `Maxlat`.

Figure 4 shows an Orthographic projection of the world. This map looks very much like a globe. It is the least useful map for making measurements because of the extreme distortion near its edges—in fact, the center of the map is the only point without distortion. Unlike the other projections mentioned here, the Orthographic plots only one hemisphere on a single map. It is generally reserved for pictorial views, such as for index maps in an atlas.

continued

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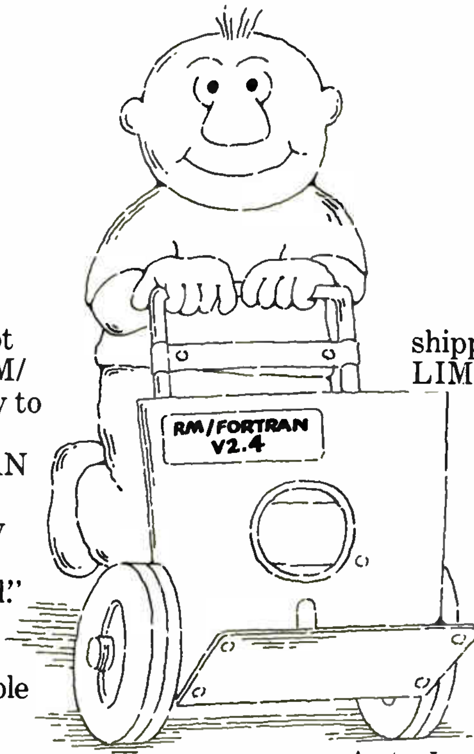

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Figure 4: *Orthographic projection displays only one hemisphere at a time. The center of the map is the only point without distortion.*

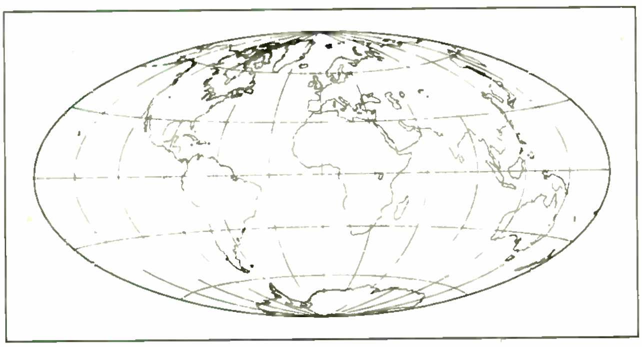

Figure 5: *The Hammer is another equal-area projection. It is more realistic than the Sinusoidal, but its curved parallels and meridians make it more difficult to construct.*

Features of Orthographic include:
- It shows perspective projection from infinite distance;
- It can show only one hemisphere at a time;
- Great distortion along the edge of the visible hemisphere;
- Azimuthal — directions from the map center to every other point on the map are shown correctly.

```
PROCEDURE Orthographic(Lambda, Lambda0, Phi,
          Phil, R: REAL; VAR X, Y : REAL);
{ For R = 1, -2 <= X, Y <= 2. }
VAR CosC, CosL, SinPhil, CosPhil, SinPhi,
                        CosPhi, R2 :  REAL;
BEGIN
  Lambda :=Meridian(Lambda, Lambda0);
  R2:=R+R;
  CosPhil:=COS(Phil); SinPhil:=SIN(Phil);
  CosPhi :=COS(Phi);  SinPhi:= SIN(Phi);
  CosL :=COS(Lambda)*CosPhi;
  CosC :=SinPhil * SinPhi + CosPhil * CosL;
  IF CosC >= 0 THEN BEGIN
    X:=R2 * CosPhi * SIN(Lambda);
    Y:=R2 * (CosPhil*SinPhi - SinPhil*CosL);
  END ELSE X:=NotVisible;
END;  { Orthographic. }
```

Procedure Orthographic contains a graphics flag similar to the one in Mercator. In this case, however, the problem is to determine whether or not each point is visible from the viewing location (central meridian and standard parallel) you choose. The Orthographic presents the Earth as seen from space. Each point coming into the procedure is first tested to see if it lies over the horizon. For each *Phi*, *Lambda* pair, the procedure first determines the value of CosC. Any point with an angular distance from the map center greater than 90° (CosC < 0) is over the horizon and cannot be plotted. If CosC is 0 or positive, the point lies within the hemisphere being plotted and passes the test. Otherwise, the point is discarded and *x* is set to NotVisible.

The Hammer Projection

Figure 5 shows a Hammer projection of the world. A German professor of surveying developed this equal-area projection in the late nineteenth century. It looks more realistic than the other equal-area projection discussed here, the Sinusoidal, but this realism comes at a price. Hammer's projection has curved parallels and curved meridians, a feature that makes it somewhat more difficult to construct. Of course, it's a good choice for displaying global distributions because it shows the whole world at a glance. Climatic data, the movement of continents, the distribution of astronomical objects—all have been plotted on this projection in recent science journals.

Features of Hammer include:
- Equal area;
- Equator and central meridian are straight lines;
- Curvature of meridians increase as the distance from the central meridian increases;
- Curvature of parallels increases with increasing distance from the Equator.

```
PROCEDURE Hammer(Lambda, Lambda0, Phi, R :
                     REAL; VAR X, Y : REAL);
{ For R = 1: -2*SQRT(2) <= X <=2*SQRT(2)
        and - SQRT(2) <= Y <= SQRT(2). }
VAR K, CosPhi, HalfLambda : REAL;
BEGIN
  HalfLambda :=
        0.5 * Meridian(Lambda, Lambda0);
  CosPhi:=COS(Phi);
  K := R * SQRT2 /
      SQRT(1 + CosPhi * COS(HalfLambda));
  X := 2 * K * CosPhi * (SIN(HalfLambda));
  Y := K * SIN(Phi);
END;  { Hammer. }
```

The World in Your Hands

The best way to discover the properties of map projections is to make maps. These routines give you a head start in combining cartography with your own applications. You might even want to modify the map procedures and create a weird custom projection. You now have the power to manipulate the earth's surface—surely one of cartography's most appealing aspects. ■

ACKNOWLEDGMENTS

The authors wish to thank Lloyd Treinish at the Goddard Space Flight Center and Larry Browning at Marquette University for their assistance in creating the databases for this program.

FOR FURTHER READING

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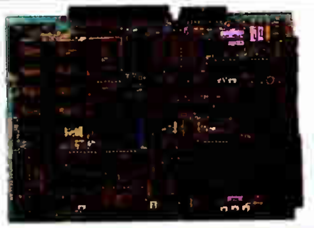

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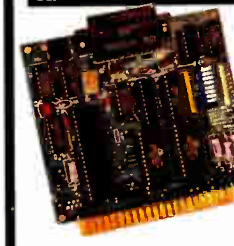

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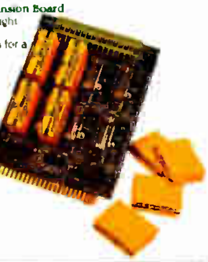

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Tom Jeffery

Mimicking Mountains

Modeling the curves and surfaces of coastlines, mountains, and wood grains requires fractal geometry

Man-made shapes may be smooth, rectilinear, and easy to model, but shapes in nature are more complex and richer in detail and texture. Nature's roughness appears to be chaotic and random, but there is a pattern to the randomness. A coastline, for example, is rough with bays, inlets, capes, and peninsulas. However, if you examine these features closely, you find that they are made up of smaller bays and peninsulas. While the smaller aspects are not identical to the larger ones, they have similar statistical properties, scaled down. Therefore, you could call coastlines statistically self-similar.

Modeling complex curves and surfaces, such as coastlines, mountains, and wood grains, requires a more complex geometry than the usual two- and three-dimensional variety. Fractal geometry, a term coined by Benoit Mandelbrot (see reference 1) describes figures with fractional dimensions; that is, figures whose effective dimensions exceed their topological dimensions. Fractals differ from ordinary geometrical shapes; they appear rough or fragmented, and this fragmentation exists at all scales. Thus, many fractals could also be called self-similar, although the precise definition of self-similarity is more restrictive; I will use the term to mean that they are similar—either exactly or statistically—at any magnification.

In fractals, the size of a particular feature at a given scale is proportional to that scale. In other words, for random fractal surfaces, the interval between two heights is a random Gaussian variable with a mean-square variance proportional to some fractional power of the distance between the two points. That is, the formula for random fractal surfaces is:

$$Av\{[Z(x1,y1) - Z(x2,y2)]^2\} = [(x1-x2)^2 + (y1-y2)^2]^H,$$

where Av stands for the average, Z is the surface defined by x and y, and H is a fractional number between 0 and 1.

H determines the surface's roughness. When H is close to 1, small-scale features make a small contribution, and the surface is relatively smooth. When H is between ½ and 1, the surface shows the mixture of regularity and disorder that characterizes nature. In fact, the value of H for actual mountains is around 0.8. When $H = ½$, disorder takes over. Any straight-line path over the surface is a Gaussian random walk with intervals that are related only to the size of the step, not to previous values. When H is less than ½, the intervals are inversely related to previous values, and the surface is too chaotic to seem natural.

Figure 1 shows three surfaces, constructed from the same random numbers, with different values of H—from 0.6, the roughest of the three, to 0.8, the smoothest. Changing H while using the same random numbers has been suggested as an animation technique (see reference 2); in this case, you might use animation to represent erosion of the mountains.

Constructing Random Fractal Surfaces

The formula for a random fractal surface suggests a simple method of construction. The midpoint-displacement algorithm consists of adding random detail at successively smaller scales. Relating the size of the detail to the scale size by the formula ensures that the final surface approximates a fractal.

You start by displacing the corners of a square cell a random distance up or down (see figure 2). Then you divide the cell into four smaller cells and perform the same corner displacement on each cell. The new cells are formed by connecting the midpoints of the edges of the old cell to the center point. The center point is the average of the four corners. Then you repeat the process recursively, finding the midpoints of the edges of the new cells and displacing them.

This midpoint-displacement algorithm is associated with Fournier, Fussell, and Carpenter (see reference 2), who have used it in many computer graphics applications, including animations. The algorithm has several attractions. The calculations involved are simple—only a few additions and multiplications. There are no transcendental functions, Fourier transforms, and so on. More important, you need to perform these calculations only once for each point, so the number of calculations is linearly related to the number of points (order = n). Once the height of a point is calculated, it is fixed.

Although the algorithm is defined recursively, the program Frakffc.pas uses a simpler, recursive version. [Editor's note: *The programs Frakffc.pas, Frakvoss.pas, Texture.pas, Map.pas, and 3-D.pas are available in Macintosh Pascal 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.*] In the recursive algorithm, the values for adjacent cells are calculated twice. This is not only wasteful, but it means that you must constrain the random numbers, or you will generate different values for the same point at different times.

The surface is a square array, `srf[0..size, 0..size]`. The variable *step* is the scale size. It starts out equal to *size*, the maximum index of the square array. The corners, (0, 0), (0, *size*),

continued

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(*size*, 0), and (*size*, *size*), are displaced by a Gaussian variable with 0 mean and unit variance times a step factor, which is $step^{2H}$ times 100, converted to an integer. You calculate the step factor logarithmically, since it includes a fractional exponent. The factor of 100 keeps small random numbers from being rounded off to 0, since Gaussian variables tend to cluster around 0.

Then, the program begins iterating. For each iteration, *step* is divided in half, and the program stops when *step* = 1. (Therefore, it only approximates a fractal. An actual fractal would require an infinite number of divisions.) Thus, *size* must be a power of 2 (I used a 64- by 64-pixel array). You calculate a step factor only once, proportional to the step size, and then add details at the new scale, or step size.

For each row, the program calculates the midpoint between old points [*row*, (*n* × *step*)] and [*row*, ((*n* + 2) × *step*)] for *n* = 0 to *size* − (2 × *step*), and displaces them by a random amount proportional to *step*. This will be the new point [*row*, ((*n* + 1) × *step*)]. Then the program determines the midpoints and displacements for the columns in the same way. Centers are calculated between the rows and columns (see figures 3 and 4).

After the surface has been calculated, the program stores it on disk. Since each of the surfaces generated by this algorithm contains 4225 points, they take a while to calculate. Save each one you generate.

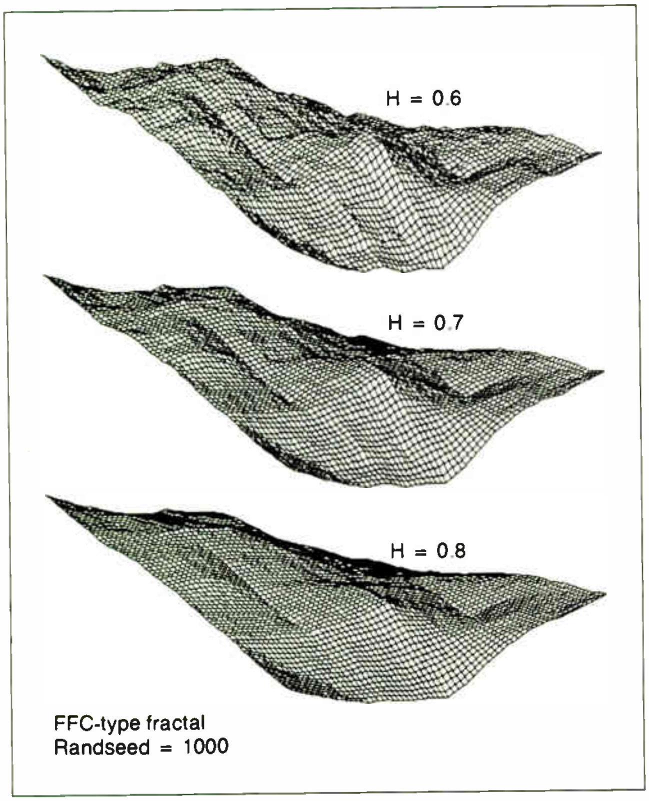

Figure 1: *The effect of varying H in the formula for random fractal surfaces.*

Ironing Out the Creases

As simple as midpoint displacement may be, it has a flaw. Figure 5 shows a wireframe representation of a fractal generated by this algorithm. Notice the creases. When a point is determined, it is fixed and can't be affected by future points. These become special points, with different statistics from the rest, leading to creases along grid lines. You can't solve this problem, a kind of discontinuity, by using more points or iterating further. It is inherent in the algorithm.

continued

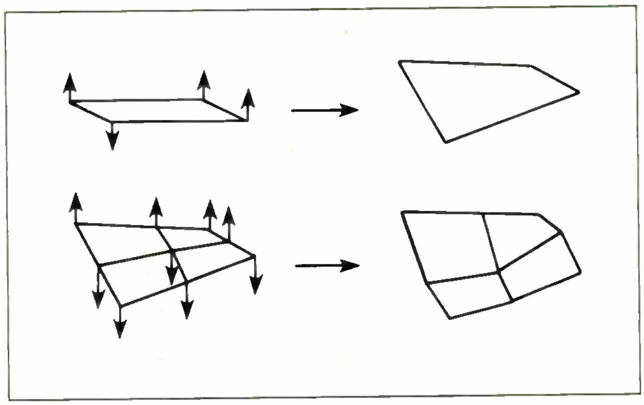

Figure 2: *Steps 1 and 2 of the midpoint-displacement algorithm.*

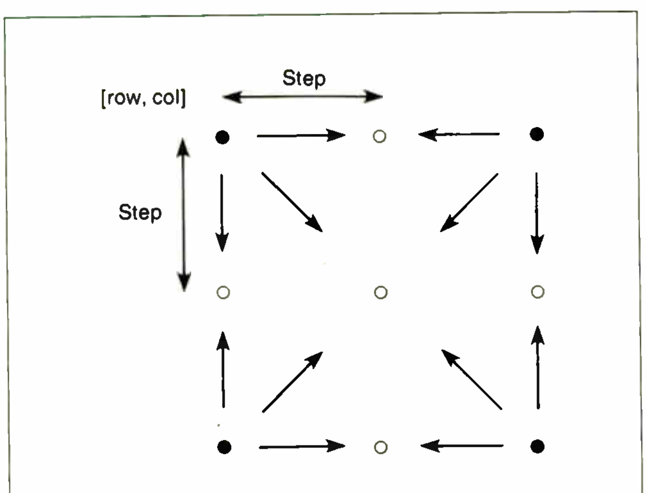

Figure 3: *Finding new points in the calculations of the midpoint displacement.*

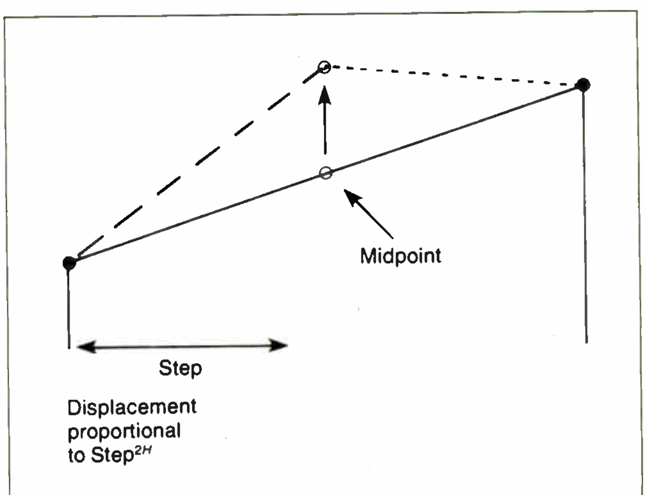

Figure 4: *Calculating the height of a new point by the midpoint-displacement method.*

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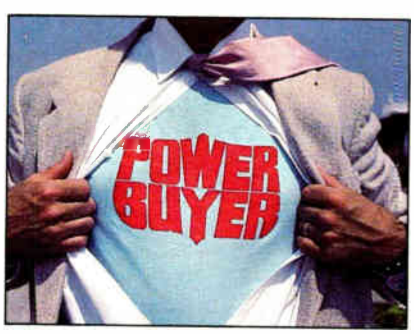

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Listing 1: *Pseudocode for the coastline routine.*

```
FOR Row = 0 TO Size, DO the following:
FOR Column = 0 TO Size, DO the following:
IF the Surface (Row, Column) > 0,
  THEN set the Pen Pattern to Black;
  ELSE set the Pen Pattern to White.
Paint the point at Row, Column with
  the Pen Pattern.
```

Listing 2: *Pseudocode for the stripe routine.*

```
FOR Row = 0 TO Size, DO the following:
FOR Column = 0 TO Size, DO the following:
Divide the Surface (Row, Column) by Interval.
IF the result is odd,
  THEN set the Pen Pattern to Black;
  ELSE set the Pen Pattern to White.
Paint the point at Row, Column with
  the Pen Pattern.
```

Listing 3: *Pseudocode for the topo (topological) routine.*

```
FOR Row = 0 TO (Size - 1), DO
FOR Column = 0 TO (Size - 1), DO
Divide the Surface (Row, Column) by Interval.
IF the Surface (Row, Column) is in the same
    zone as the Surface (Row, Column + 1)
  AND the Surface (Row, Column) is in the same
    zone as the Surface (Row + 1, Column),
  THEN set the Pen Pattern to White;
  ELSE set the Pen Pattern to Black.
Paint the point at Row, Column with
  the Pen Pattern.
```

Richard Voss (see reference 3) has improved the situation somewhat with a slightly different algorithm. In the successive random-additions method, instead of adding a displacement only to the midpoints, you add it to all points at that scale. Voss compares this to a Fourier series that uses sines and cosines, instead of just cosines. This algorithm also lets you decrease the step size by more or less than ½ at each recursion. When the factor drops below ½, Voss claims that the creases virtually vanish.

The program Frakvoss.pas is a slight modification of Frakffc.pas, using a reduction factor of ½. It finds midpoints in the same way but adds a random displacement, proportional to step size, to all the points that have been calculated. Frakvoss.pas takes a little longer than Frakffc.pas, since it must add displacements to the old points as well as the new ones. On average, each point requires less than two random additions. This is not a serious problem, since it's still linear with respect to the number of points. However, the improvement in the creases is somewhat marginal (see figure 6). The best way to avoid discontinuity problems seems to be to generate a number of surfaces, by either algorithm, and choose the ones that best suit your purpose. (Discontinuity is most severe with a large *H*.)

Creating Texture

The program Texture.pas displays the fractal surfaces the programs generate in various ways in a 64- by 64-pixel image. The

continued

Table 1: *The two vectors that define the patch at point [row,col], followed by the actual cross product, and thus the normal vector.*

	Vector *x*	Vector *y*
Row direction:	0	1
Column direction:	1	0
Height direction:	{srf(row, col) − srf(row, col+1)} * 100/range	{srf(row, col) − srf(row+1, col)} * 100/range

The cross product is:

Row direction: {srf(row, col+1) − srf(row, col)} * 100/range
Column direction: {srf(row+1, col) − srf(row, col)} * 100/range
Height direction: 1

Dividing this vector by its length gives the normal vector.

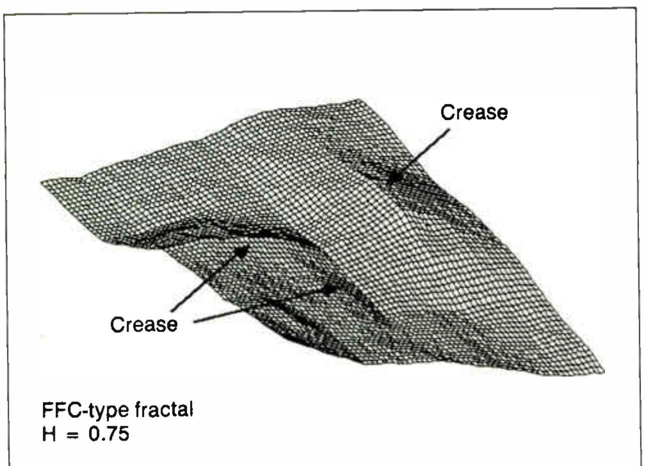

Figure 5: *Creases generated by the FFC fractal algorithm.*

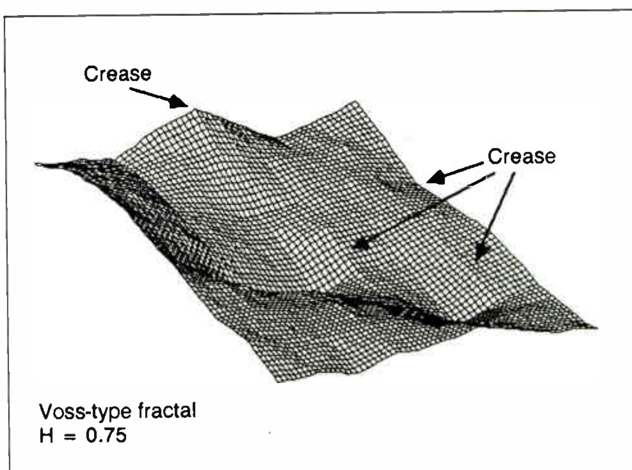

Figure 6: *Creases generated by the Voss fractal algorithm.*

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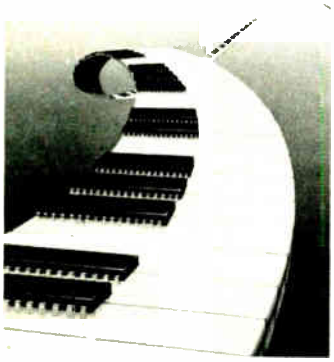

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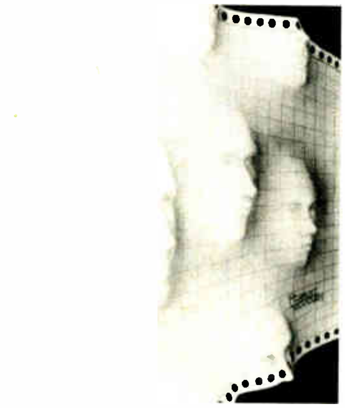

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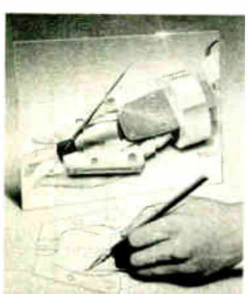

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procedure CoastDisp floods the surface with color. Any points lower than 0 elevation are colored black, and points higher than 0 are white. The procedure StripeDisp displays the surface as alternating black and white stripes, separated by a given height interval, and the TopoDisp procedure draws contour lines for a given interval. The GrainDisp procedure simulates wood grains. It is similar to the StripeDisp routine but divides the

continued

Listing 4: *Pseudocode for the grain routine.*

```
Divide Interval into four zones:
  Black zone: 2/7;
  Dark gray zone: 1/7;
  Gray zone: 1/7;
  Light gray zone: 1/7;
  White zone: 2/7.
FOR Row = 0 TO Size, DO the following:
FOR Column = 0 TO Size, DO the following:
IF the Surface (Row, Column) is in first 2/7
    of Interval,
  THEN set the Pen Pattern to Black;
  ELSE IF it's in the next 1/7,
  THEN set the Pen Pattern to Dark Gray;
  ELSE IF it's in the next 1/7,
  THEN set the Pen Pattern to Gray;
  ELSE IF it's in the next 1/7,
  THEN set the Pen Pattern to Light Gray;
  ELSE set the Pen Pattern to White.
Paint the point at Row, Column with
    the Pen Pattern.
```

Listing 5: *A section of code in Macintosh Pascal that implements the pseudocode in listing 4. This code comes from Texture.pas.*

```
procedure GrainDisp;
{Displays wood grain, grain spacing: int}
  var
    col,row,int,res,sp,drk,gr,lt : longint;
 begin
  write('Interval?');
  readln(int);
  if int > 0 then
   begin
    sp := int div 7;
    drk := sp * 2;
    gr := sp * 3;
    lt := sp * 4;
    for row := 0 to size do
     for col := 0 to size do
      begin
       res := srf[row, col] mod int;
       if res < sp
        then penpat(black)
       else if res < drk
        then penpat(dkgray)
       else if res < gr
        then penpat(gray)
       else if res < lt
        then penpat(ltgray)
       else penpat(white);
       paintpt(row, col);
      end;
   end;
 end;
```

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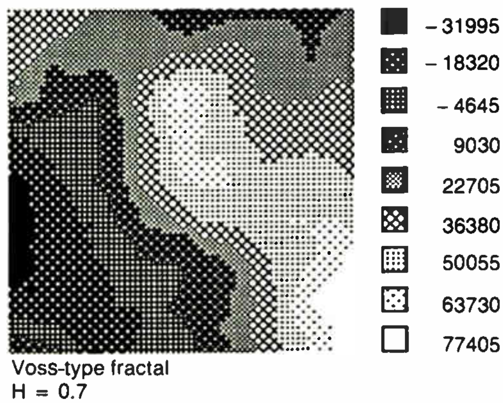

Figure 7: *Display of the surface generated by Map.pas denoting height with various shadings. The lighter the color, the higher the number; the darker the color, the lower the number.*

$$\begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix} \times \begin{bmatrix} y1 \\ y2 \\ y3 \end{bmatrix} = \begin{bmatrix} x2y3 - x3y2 \\ x1x3 - x3y1 \\ x2y1 - x1y2 \end{bmatrix}$$

Figure 8: *The formula for a cross product used to calculate a patch's normal vector.*

$$\begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix} \bullet \begin{bmatrix} y1 \\ y2 \\ y3 \end{bmatrix} = x1y1 + x2y2 + x3y3$$

Figure 9: *The formula for the dot product used to calculate the cosine of the angle between the illuminating vector and the normal vector.*

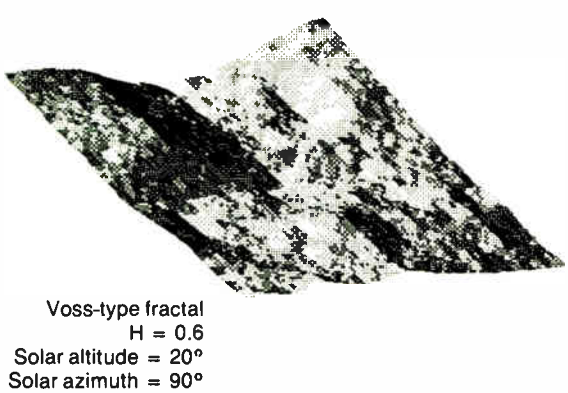

Figure 10: *A shaded three-dimensional projection of a fractal surface.*

stripes into shades of gray. Listings 1 through 4 show pseudocode for these routines. The patterns generated all represent the same surface. Listing 5 contains the actual code for the `GrainDisp` procedure.

The Map.pas program divides the surface into nine equal-height ranges and colors each range a different shade (see figure 7). You could use this sort of procedure to produce a battle map for a combat-simulation game.

Projecting Three Dimensions

The clearest way to see the surfaces I've described is in three-dimensional projection. If your system has any 3-D projection routines, I suggest you use them. If not, you should try 3-D.pas; it is a quick-and-dirty—well, maybe not so quick—3-D program.

The heart of 3-D.pas, the projection routine, computes the screen coordinates from a row, column, and height, using an orthographic projection. Points farther back appear higher and to the right of more forward points. There is no perspective, so parallels stay parallel. Array columns are horizontal on the screen, four pixels per unit. Rows are displayed "back into" the screen; that is, right by three pixels and up by two pixels per unit.

To adjust the vertical scale to the row/column scale, the height is divided by the range of the surface and multiplied by 100. The horizontal and vertical screen coordinates are: *horizontal* = (4 × *column*) + (3 × *row*); *vertical* = *height* × 100/*range* + (2 × *row*). Using only the projection routine, you can draw a wire-frame model of the surface.

A simple shading model would be to set the intensity of brightness of a plane patch equal to the cosine of the angle between the patch's illuminating vector and its *normal* vector (the unit vector perpendicular to the surface). You can find the normal vector by taking the *cross* product—in other words, the vector product between two sides that define the plane—which gives a vector pointing in the right direction, and dividing that vector by its own length. Figure 8 shows the formula for a cross product. Table 1 shows the two vectors that define the patch at point [*row*, *col*].

You input the vector for the illumination in degrees above the horizon (*alt*, or altitude), and degrees around the horizon (*az*, or azimuth). The program converts this to a three-component unit vector. The dot, or scalar, product gives the cosine of the angle between the illuminating vector and the normal vector.

Figure 9 shows the formula for the dot product. Figure 10 shows the result of this model, a shaded three-dimensional projection of a fractal surface.

Some Fractal Tools

Although there have been many articles published on fractals, most of the algorithms they include have been for nonrandom geometric fractals. The routines I have given here are not sophisticated, but they should provide a framework within which you can start to play with random fractal surfaces. Mandelbrot's book (see reference 1) can give you a lot more to think about, but if you just want to experiment, here are some tools. ■

REFERENCES

1. Mandelbrot, Benoit B. *Fractal Geometry of Nature*. New York: W. H. Freeman and Co., 1982.
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3. Voss, R. "Random Fractal Forgeries," course notes to *Fractals: Basic Concepts, Computation and Rendering*. Siggraph, 1985.

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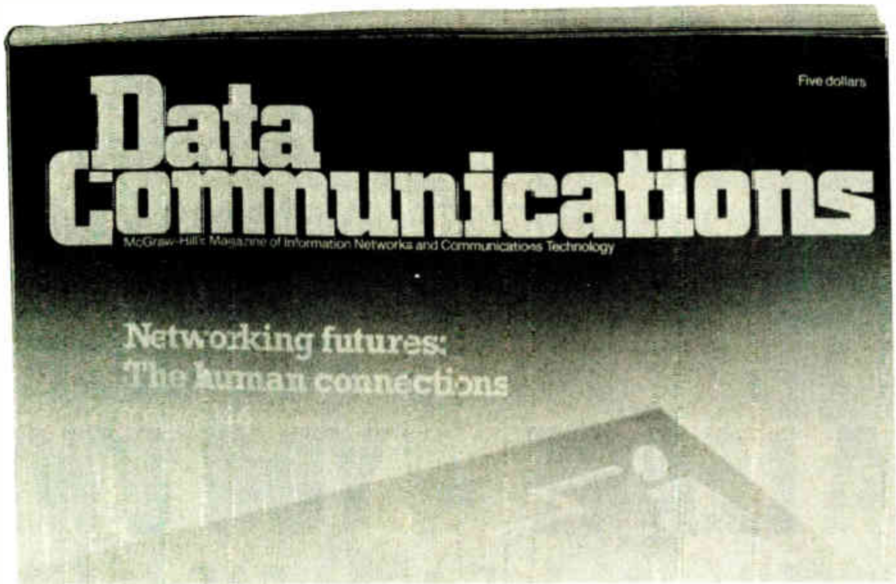

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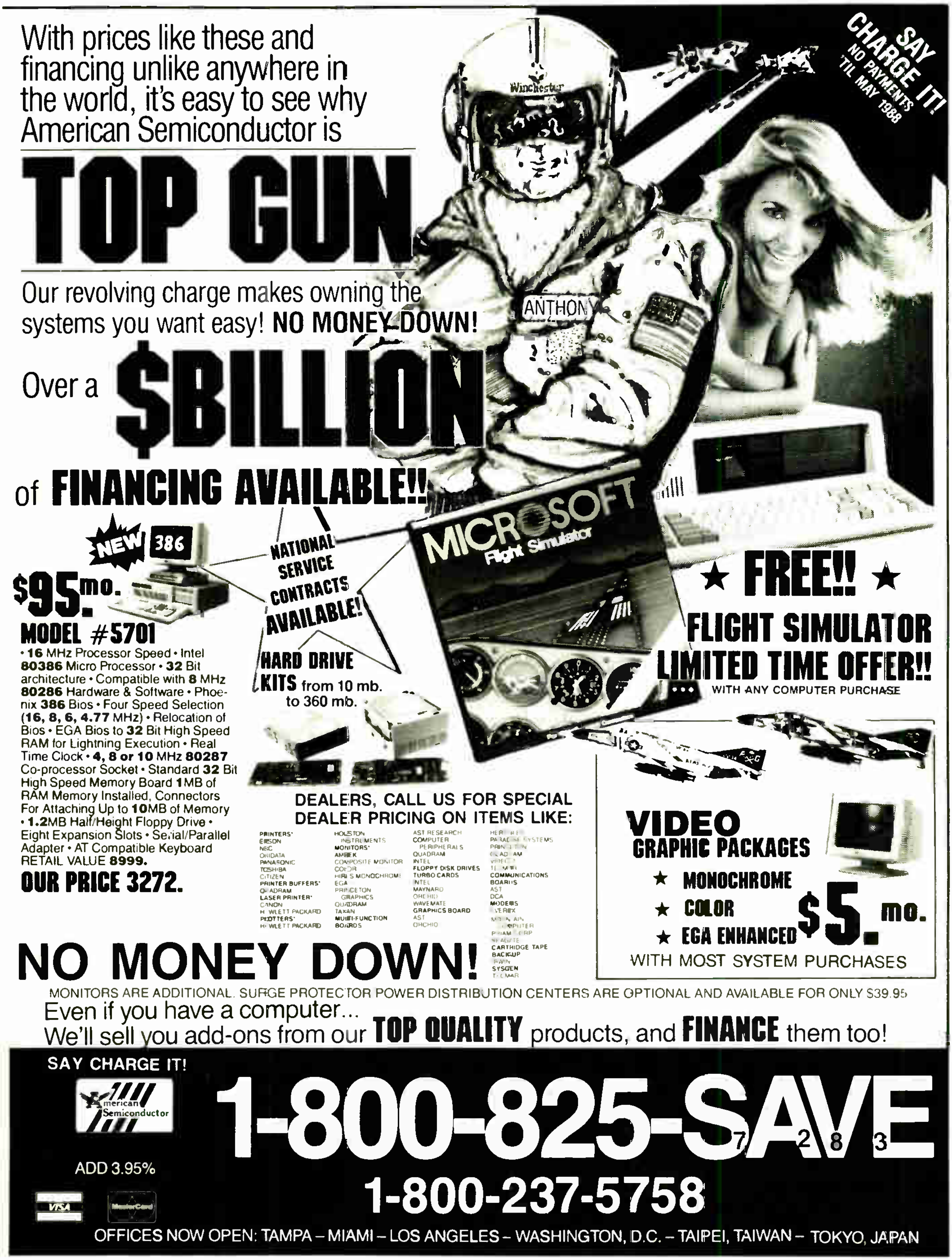

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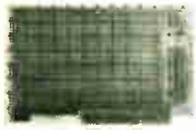

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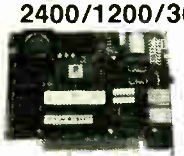

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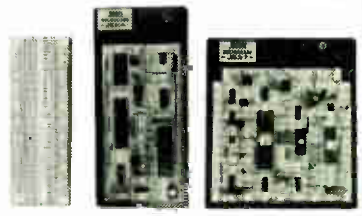

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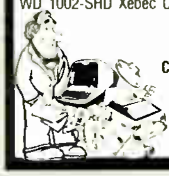

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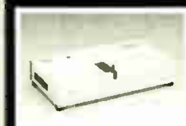

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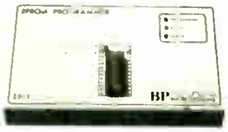

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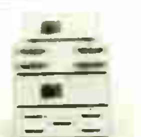

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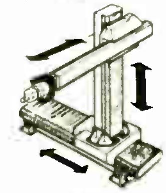

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See page 351 for details of the SC-149

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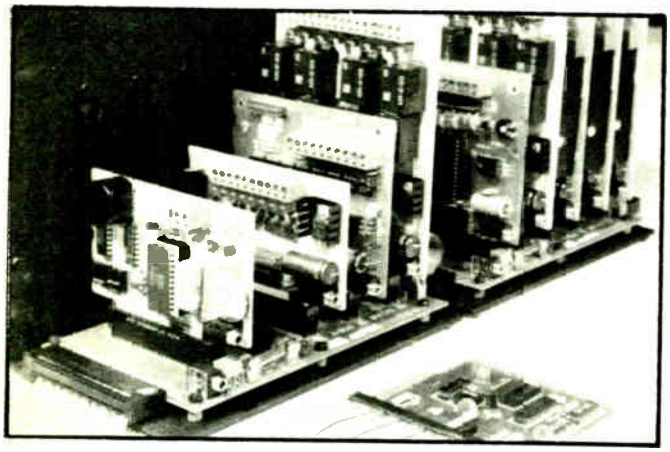

An A-BUS system with two Motherboards
A-BUS adapter (IBM) in foreground

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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
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Analog Input Card — AD-142: $129
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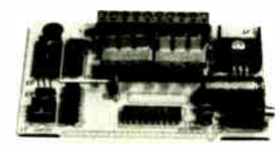
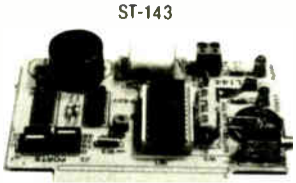


ST-143



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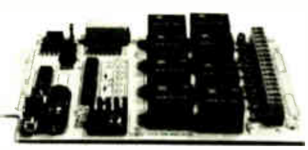

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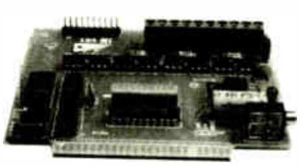
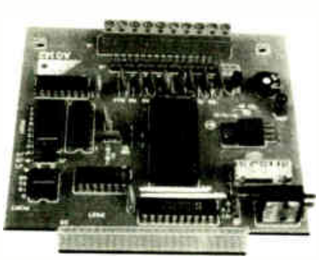


IN-141



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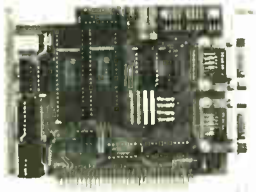

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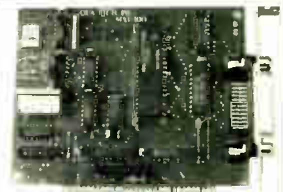

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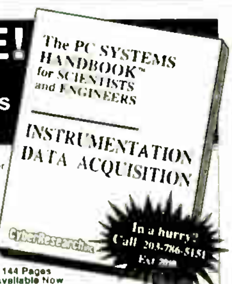

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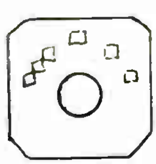

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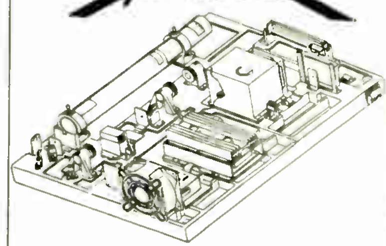

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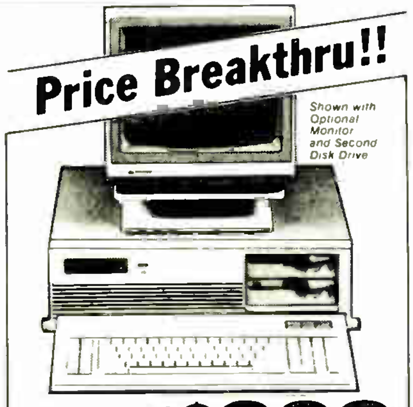

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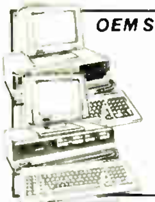

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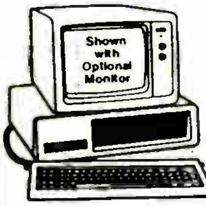

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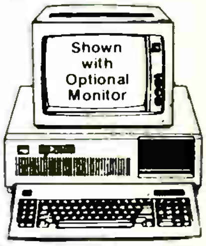

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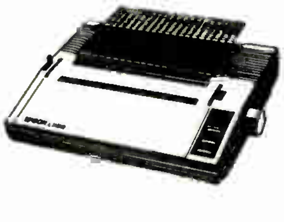

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20 MB ½ Ht Kit $268 — 30 MB ½ Ht. Kit $298

30 MB for AT.... $378 — 40 MB for AT.... $398

21 Megabyte Card

21 MB Card **$338** — 40 MB Card **$498**

Plus Hardcard 20 $568 — Hardcard 40 $828

360K DISK DRIVE

Built By Alpine Electronics to IBM Specifications, same as Qume 142

$65

- 360K
- 48 TPI
- Double-sided
- Double density
- Half Height

3½" DISK DRIVE

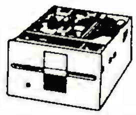
FOR YOUR PC/XT/AT

720K Disk Drive for Mass Storage or for Down Loading to your Lap-Top or New IBM PS/2. Requires DOS 3.20

$128 Includes Free Mounting Kit

360K DISK DRIVE

Tandon TM100-2 Full Ht. Replacement Drive for Your IBM PC or XT



$78

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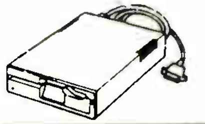

20 MB Hard Disk	$799
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IIe, II+ Disk Drive	$129
Grappler Printer Card	$89
II+ 16K RAM card	$39
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Circle 143 on Reader Service Card

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10 MEG HARD DISK SYSTEM

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SPECIAL ENDS 1/31/88

CAPACITORS

TANTALUM

1.0µf	15V	.12	1.0µf	35V	.45
6.8	15V	.42	2.2	35V	.19
10	15V	.45	4.7	35V	.39
22	15V	.99	10	35V	.69

DISC

10pf	50V	.05	.001µf	50V	.05
22	50V	.05	.005	50V	.05
33	50V	.05	.01	50V	.07
47	50V	.05	.05	50V	.07
100	50V	.05	.1	12V	.10
220	50V	.05	.1	50V	.12

MONOLITHIC

.01µf	50V	.14	.1µf	50V	.18
.047µf	50V	.15	.47µf	50V	.25

ELECTROLYTIC

RADIAL			AXIAL		
1µf	25V	.14	1µf	50V	.14
4.7	50V	.11	10	50V	.16
10	50V	.11	22	16V	.14
47	35V	.13	47	50V	.19
100	16V	.15	100	35V	.19
220	35V	.20	470	50V	.29
470	25V	.30	1000	16V	.29
2200	16V	.70	2200	16V	.70
4700	25V	1.45	4700	16V	1.25

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UL APPROVED

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- QUICK HEATING & RECOVERY
- RANGE: 200°–900°F

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EXT-80286 $39.95

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FR-4 EPOXY GLASS LAMINATE GOLD-PLATED EDGE CARD FINGERS

XT

BOTH CARDS HAVE SILK SCREENED LEGENDS & MOUNTING BRACKET

IBM-PR1 $27.95
WITH +5V AND GROUND PLANE
IBM-PR2 $29.95
AS ABOVE WITH DECODING LAYOUT

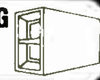
AT

IBM-PRAT $29.95
LARGE +5V & GROUND PLANES

BYPASS CAPACITORS

.01 µf	CERAMIC DISC	100	$5.00
.01 µf	MONOLITHIC	100	$10.00
.1 µf	CERAMIC DISC	100	$6.50
.1 µf	MONOLITHIC	100	$12.50

SHORTING BLOCKS 5/$1.00



SOLDERLESS BREADBOARDS

WBU-D	100 TIE POINTS	2.95
WBU-T	630 TIE POINTS	6.95
WBU-204-3	1360 TIE POINTS	17.95
WBU-204	1660 TIE POINTS	24.95
WBU-206	4390 TIE POINTS	29.95
WBU-208	3220 TIE POINTS	39.95

RESISTOR NETWORKS

SIP	10 PIN	9 RESISTOR	.69
SIP	8 PIN	7 RESISTOR	.59
DIP	16 PIN	8 RESISTOR	1.09
DIP	16 PIN	15 RESISTOR	1.09
DIP	14 PIN	7 RESISTOR	.99
DIP	14 PIN	13 RESISTOR	.99

VOLTAGE REGULATORS

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7808T	.49	7905K	1.69
7812T	.49	7912K	1.49
7815T	.49	78L05	.49
7905T	.59	78L12	.49
7908T	.59	79L05	.69
7912T	.59	79L12	1.49
7915T	.59	LM323K	4.79
7805K	1.59	LM338K	6.95

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- ★ FRIENDLY, KNOWLEDGEABLE STAFF
- ★ MONEY BACK GUARANTEE (ASK FOR DETAILS)
- ★ TOLL FREE TECHNICAL SUPPORT
- ★ EXCELLENT CUSTOMER SERVICE

VISA MasterCard

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PRECUT ASSORTMENT IN ASSORTED COLORS $27.50

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250ea: 2.5", 4.5", 5.0"
500ea: 3.0", 3.5", 4.0"

SPOOLS

100 feet $4.30 | 250 feet $7.25
500 feet $13.25 | 1000 feet $21.95

Please specify color: Blue, Black, Yellow or Red

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IDCEN36	RIBBON CABLE	3.95
CEN36	SOLDER CUP	1.85
IDCEN36/F	RIBBON CABLE	4.95
CEN36PC	Rt Angle PC Mount	1.85

DISCRETE

1N751	.15	4N28	.69
1N4148	25/$1.00	4N33	.89
1N4004	10/$1.00	4N37	1.19
1N5402	.25	MCT-2	.59
KBP02	.55	MCT-6	1.29
N2222	.25	TIL-111	.99
PN2222	.10	2N3906	.10
2N2907	.25	2N4401	.25
2N3055	.79	2N4402	.25
2N3904	.10	2N4403	.25
4N26	.69	2N6045	1.75
4N27	.69	TIP31	.49

...What was impressive, to me, was that Rick was able to talk a customer through a problem very quickly by phone. By knowing what he was talking about, he made short work of what could have been a very time consuming and frustrating project.

Sincerely,
Max Lent

EDGECARD CONNECTORS

100 Pin ST	S-100	.125	3.95
100 Pin WW	S-100	.125	4.95
62 Pin ST	IBM PC	.100	1.95
50 Pin ST	APPLE	.100	2.95
44 Pin ST	STD	.156	1.95
44 Pin WW	STD	.156	4.95

SOCKET-WRAP I.D.™

- SLIPS OVER WIRE WRAP PINS
- IDENTIFIES PIN NUMBERS ON WRAP SIDE OF BOARD
- CAN WRITE ON THE PLASTIC; SUCH AS AN IC #

PINS	PART #	PCK. OF	PRICE
8	IDWRAP 08	10	1.95
14	IDWRAP 14	10	1.95
16	IDWRAP 16	10	1.95
18	IDWRAP 18	5	1.95
20	IDWRAP 20	5	1.95
22	IDWRAP 22	5	1.95
24	IDWRAP 24	5	1.95
28	IDWRAP 28	5	1.95
40	IDWRAP 40	5	1.95

PLEASE ORDER BY NUMBER OF PACKAGES (PCK. OF)

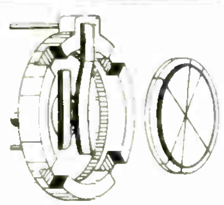
IDC CONNECTORS/RIBBON CABLE

DESCRIPTION	ORDER BY	CONTACTS 10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2 20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1 76	2 31	2.72	3.39
WIREWRAP HEADER	IDHxxW	1.86	2 98	3 84	4 50	5 28	6 63
RIGHT ANGLE WIREWRAP HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4 80	7.30
RIBBON HEADER SOCKET	IDSxx	.63	.89	95	1 29	1 49	1.69
RIBBON HEADER	IDMxx	---	5.50	6.25	7.00	7.50	8 50
RIBBON EDGE CARD	IDExx	.85	1.25	1.35	1 75	2 05	2 45
10' GREY RIBBON CABLE	RCxx	1.60	3.20	4 10	5.40	6.40	7.50

FOR ORDERING INSTRUCTIONS SEE D SUBMINIATURE CONNECTORS BELOW

3 VOLT LITHIUM BATTERY $1.95

BATTERY HOLDER $1.49



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¢

EPROM ERASERS

SPECTRONICS CORPORATION

Model	Timer	Chip Capacity	Intensity (uW Cm²)	Unit Cost
PE 140	NO	9	8,000	$89
PE 140T	YES	9	8,000	$139
PE-240T	YES	12	9,600	$189

DATARASE $34.95

- ERASES 2 EPROMS IN 10 MINUTES TIME
- VERY COMPACT—NO DRAWER
- THIN METAL SHUTTER PREVENTS UV LIGHT FROM ESCAPING

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CAN BE SNAPPED APART TO MAKE ANY SIZE HEADER, ALL WITH .1" CENTERS

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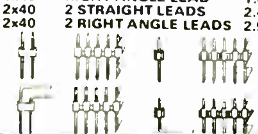
1x40	RIGHT ANGLE LEAD	1.49
2x40	2 STRAIGHT LEADS	2.49
2x40	2 RIGHT ANGLE LEADS	2.99



IC SOCKETS/DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 8	14	16	18	20	22	24	28	40
SOLDERTAIL SOCKETS	xxST	.11	.11	.12	.15	18	15	.20	.22	.30
WIREWRAP SOCKETS	xxWW	.59	.69	.69	.99	1.09	1.39	1 49	1 69	1.99
ZIF SOCKETS	ZIFxx	---	4.95	4.95	---	5.95	---	5.95	6 95	9.95
TOOLED SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1 69	2 49
TOOLED WW SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2 90	3.15	3.70	5 40
COMPONENT CARRIERS	ICCxx	.49	.59	.69	.99	.99	.99	.99	1 09	1.49
DIP PLUGS (IDC)	IDPxx	.95	.49	.59	1.29	1.49	---	.85	1.49	1.59

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE CONNECTORS ABOVE

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

25 PIN D-SUB GENDER CHANGERS $7.95

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MEETS FCC REQUIREMENTS 100% SHIELDED

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- ONE YEAR WARRANTY

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PS-135/150

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- BY POWER SYSTEMS
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PS-1558

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- IBM COMPATIBLE TTL INPUT
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- AUTO FREQUENCY ADJUSTMENT
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5¼" SEAGATE HARD DISK DRIVES

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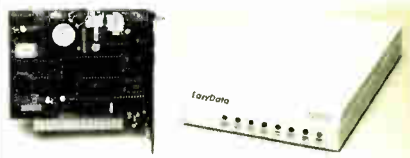

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12H	1200 BAUD ½ CARD	$69.95
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(NO SOFTWARE INCLUDED)

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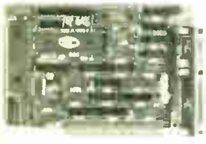
Circle 146 on Reader Service Card

ALL MCT PRODUCTS CARRY A 1 YEAR WARRANTY

INTERFACE CARDS

FROM MODULAR CIRCUIT TECHNOLOGY



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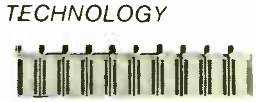

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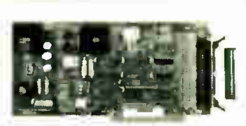

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Products in Perspective:

Our usual fixtures—What's New, Short Takes, and First Impressions—are followed by a Group Review of database software and an associated BIX Product Focus discussion.

System reviews look at the PC Designs 386, the Toshiba T1000 and T3100 Plus, and the Symmetric 375.

Hardware reviews include graphics boards using the Texas Instruments 34010 chip and an evaluation of the GCC Personal Laser Printer.

Languages due for review are Allegro Common LISP for the Apple Macintosh and Personal REXX.

Rounding out the reviews are applications software reviews: a comparison of two spreadsheet compilers (Baler and Liberty), Microsoft's Bookshelf CD-ROM, and Professional CAD.

Columnists Jerry Pournelle and Ezra Shapiro contribute their personal perspectives on products new and noteworthy.

In Depth:

You'll learn about managing megabytes in January. Individual articles will explore immense storage management, fractal image compression, query optimization, and achieving mainframe performance. We will also run a Resource Guide listing names and addresses of many sources of storage-management hardware and software.

Features:

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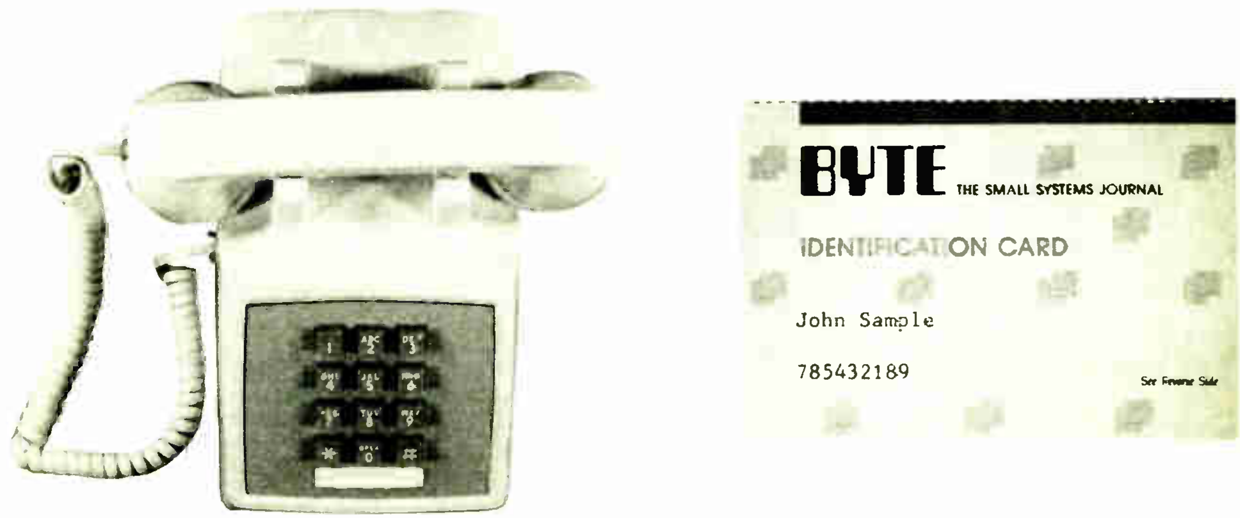

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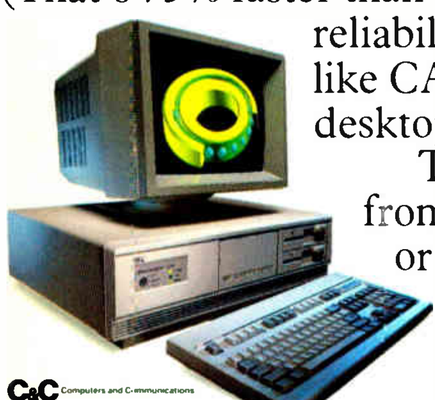

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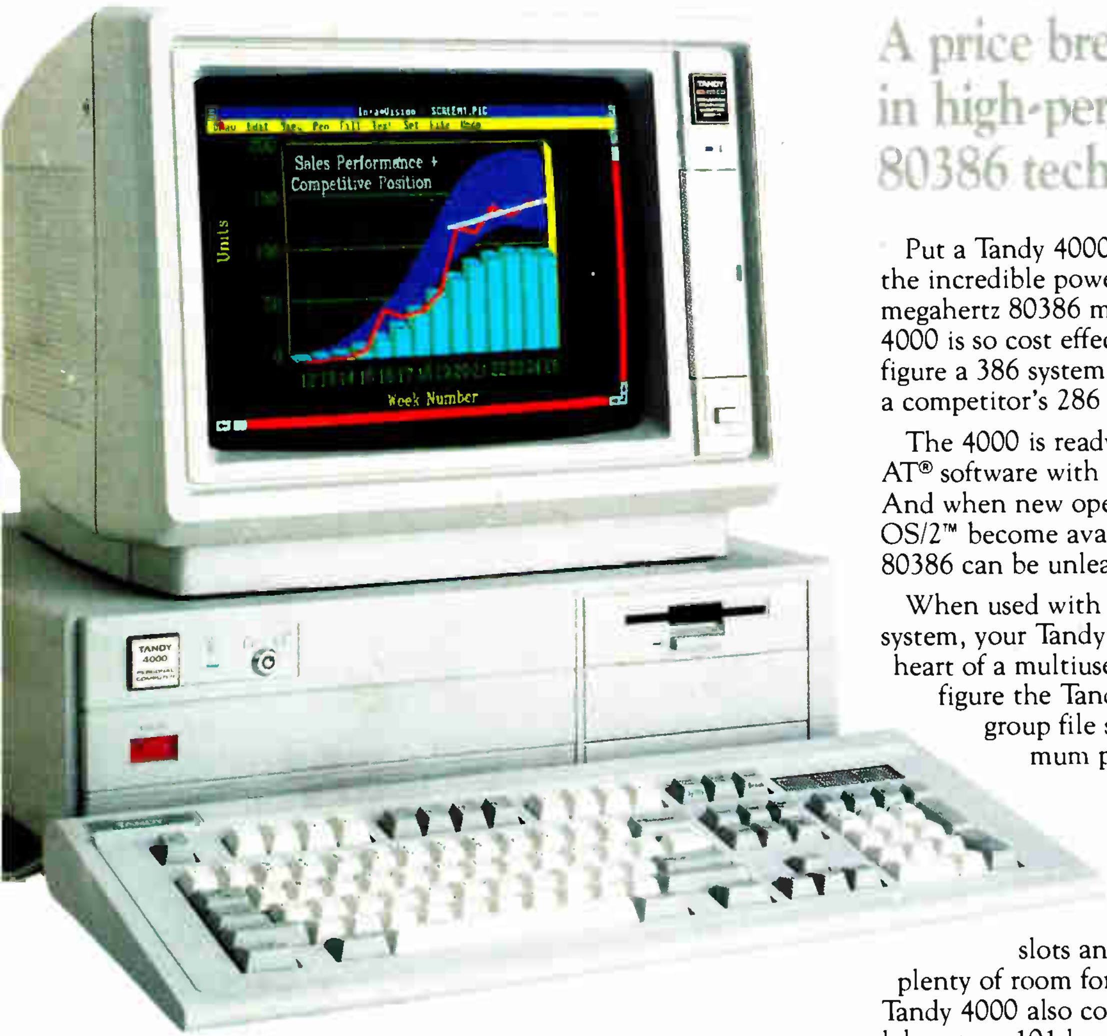

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