BYTE

THE SMALL SYSTEMS JOURNAL®

MAY 1988 VOL. 13, NO. 5

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PC/Mac File Transfers
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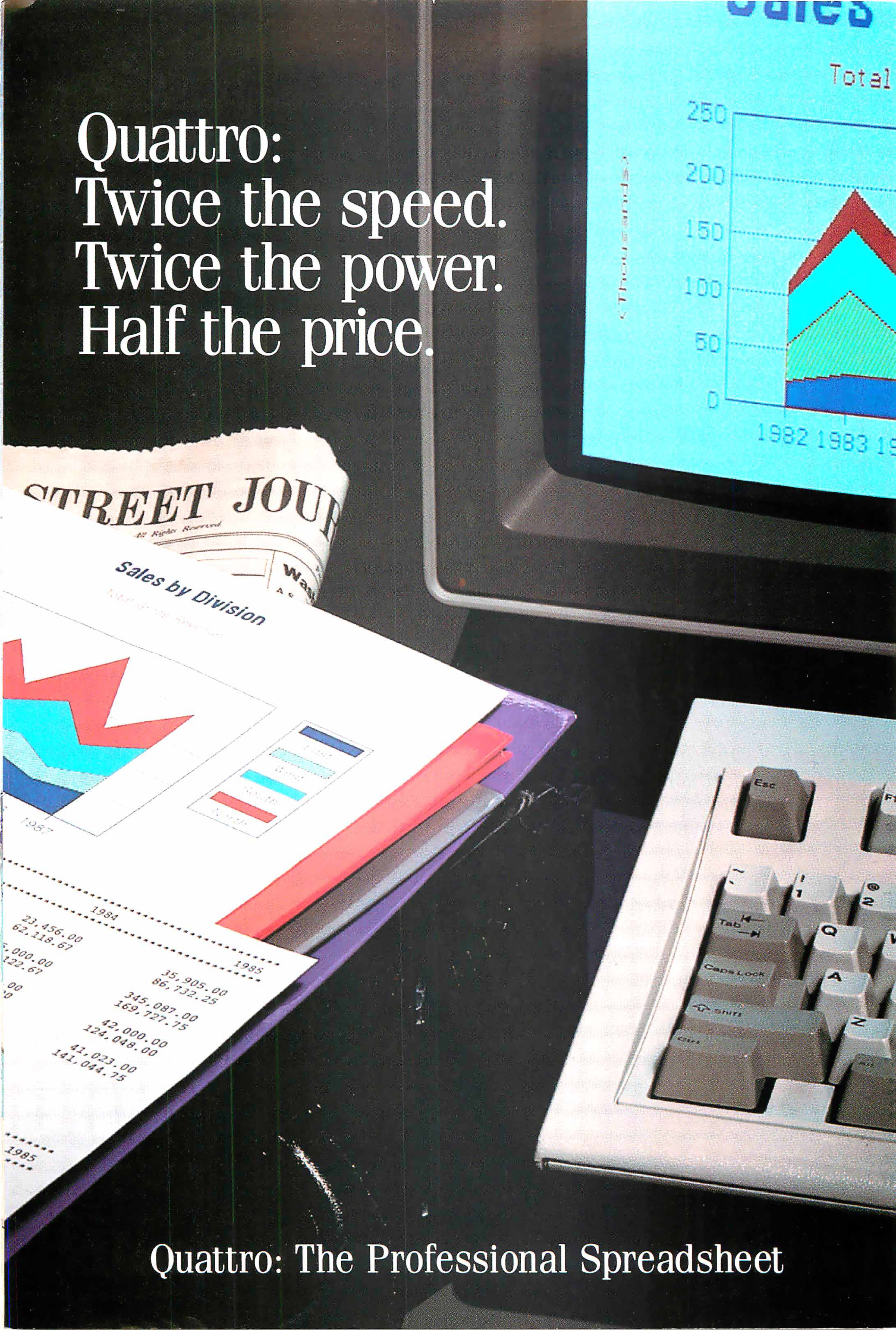
Past and Future

CPU Architectures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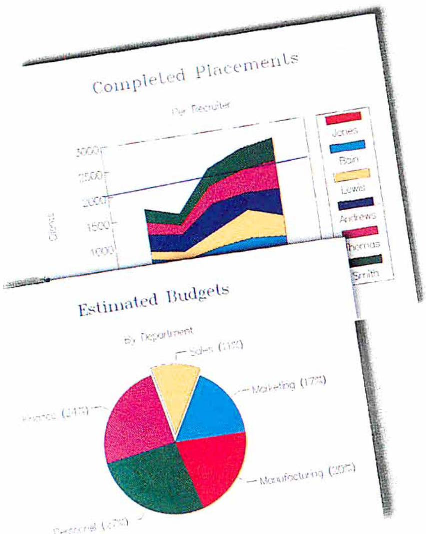

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> **“** Quattro has features that 1-2-3 users will want—better graphics, easier macros, no copy protection—plus compatibility with the files and keystrokes they already use.
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> *Michael J. Miller, Infoworld* **”**

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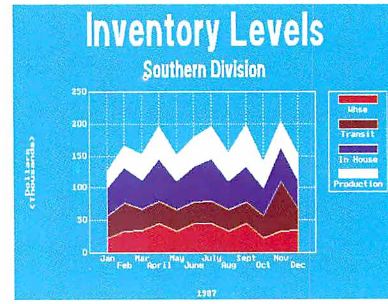
For the IBM PS/2™ and the IBM® and Compaq® families of personal computers and all 100% compatibles

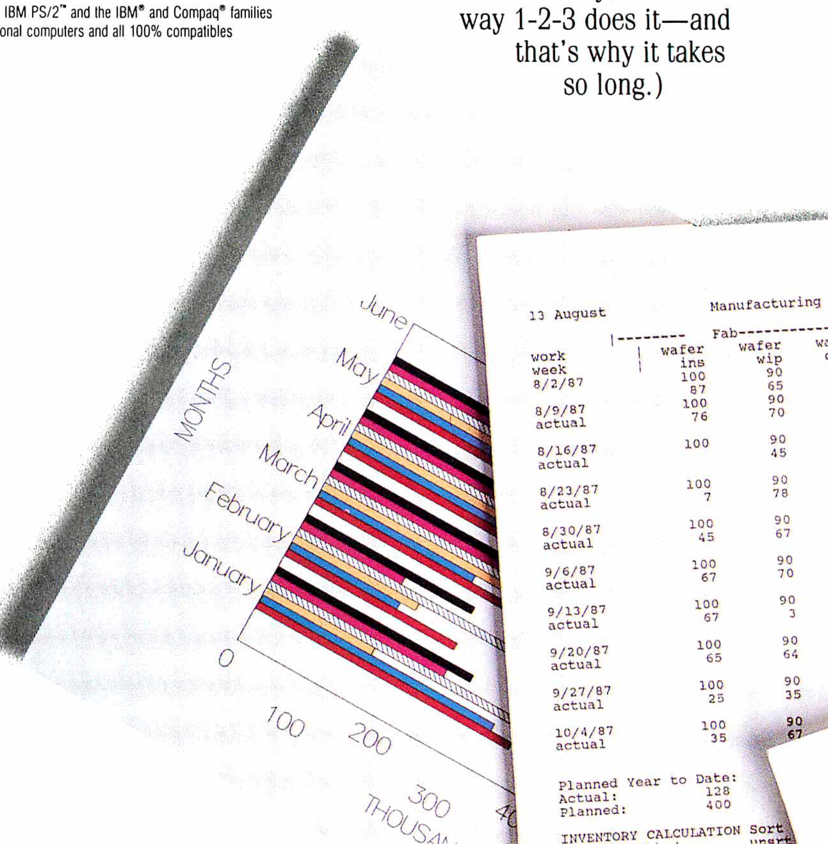


"What we show you"

Quattro recalculates a lot faster than you-know-who

The smartest and fastest way to recalculate a spreadsheet is to do what Quattro does, something called "intelligent recalc," which in English means you only re-count the numbers that count.

In a spreadsheet, not all numbers are born equal, and changing one number doesn't always change *everything*. Quattro recalculates just the formulas that matter, not all the formulas it knows. (You wouldn't reshoot a whole movie just because you changed one scene, but unfortunately, that's the way 1-2-3 does it—and that's why it takes so long.)



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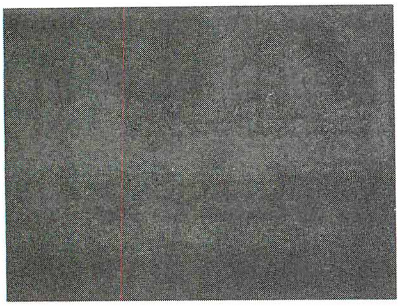

"What they show you"

Quattro demystifies macros and makes your work go faster

Using macros—electronic shortcuts—is easy with Quattro. Quattro offers a complete macro debugging environment and puts you in control as you "single-step" or fast-forward through your macros. Quattro's "Macro Learn Mode" lets you record macros as you work—which is something 1-2-3 users have been waiting for—and the wait is over.

You can't lose with Quattro

If you forget to close and save your spreadsheet—or a power outage shuts down your computer—all is not lost. Quattro automatically keeps track of every change you've made to the spreadsheet during the session, so if disaster strikes, it misses.

Quattro lets you build your own menus

Quattro includes a Menu Builder that lets you customize menus. Coupled with macros, this application development feature allows you to create dedicated applications quickly and easily.

Quattro includes SQZ!® Plus data compression

A special implementation of SQZ! Plus, the spreadsheet file compression utility, is built into Quattro and comes to you absolutely free. SQZ! Plus for Quattro automatically compacts and expands Quattro spreadsheets by up to 95% during file saving and retrieving.

You know how to use Quattro

You can tell Quattro to respond to 1-2-3 commands. You don't have to learn a whole new program. Quattro works directly with all 1-2-3 file formats. No importing/exporting or macro translation is required.

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Faster than 1-2-3? Yes.
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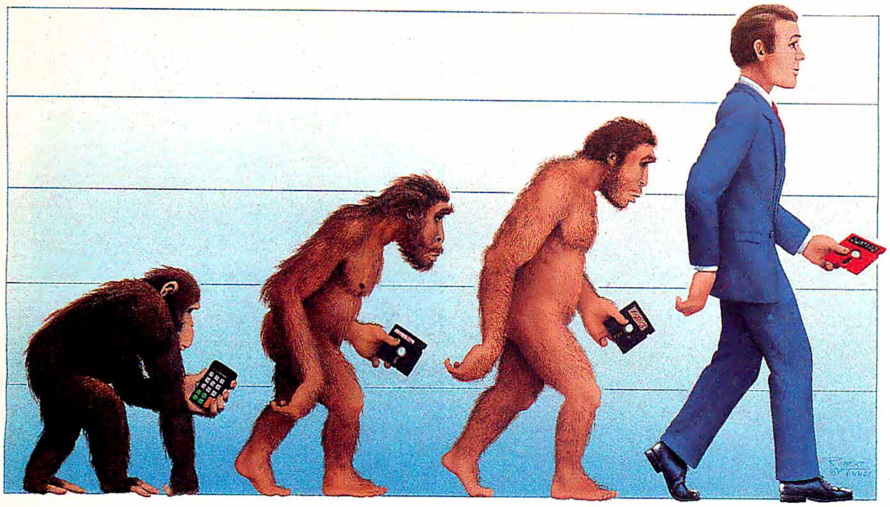

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GRAPHICS	Presentation-quality Graphics	YES	NO
	Graph Types	10	6
	Integrated Graph Printing	YES	NO
	Full Graph Customization	YES	NO
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	PostScript Support	YES	NO
VERSATILITY	User-modifiable Menus	YES	NO
	Menu Shortcuts	YES	NO
	Pull-down menus	YES	NO
	Point and Press Editing	YES	NO
	Automatic Installation	YES	NO
POWER	Macro Learn Mode	YES	NO
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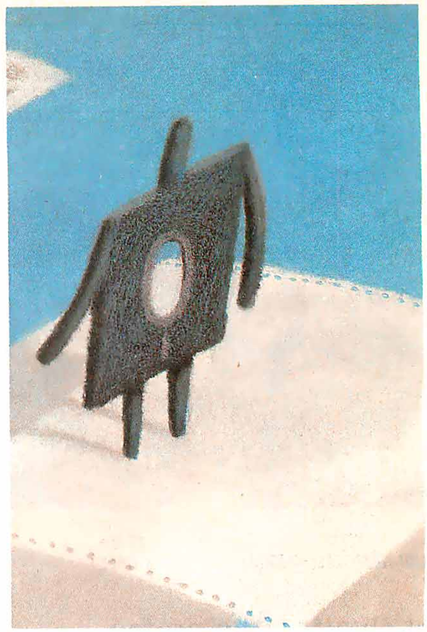

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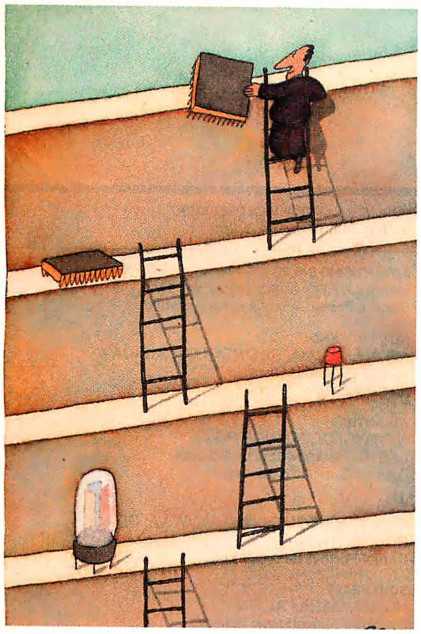

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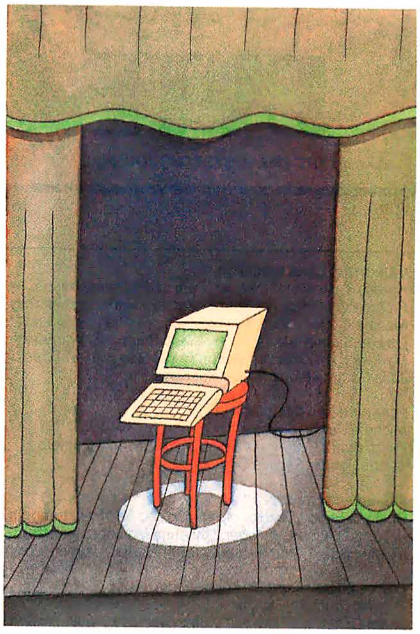

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BYTE

MAY 1988
VOLUME 13
NUMBER 5

BYTE (ISSN 0360-5280) is published monthly with an additional issue in October by McGraw-Hill Inc. Founder: James H. McGraw (1860–1948). Executive, editorial, circulation, and advertising offices: One Phoenix Mill Lane, Peterborough, NH 03458, phone (603) 924-9281. Office hours: Monday through Thursday 8:30 AM–4:30 PM, Friday 8:30 AM–1:00 PM, Eastern Time. Address subscriptions to BYTE Subscriptions, P.O. Box 7643, Teaneck, NJ 07666-9866. Postmaster: Send address changes, USPS Form 3579, undeliverable copies, and fulfillment questions to BYTE Subscriptions, P.O. Box 7643, Teaneck, NJ 07666-9866. Second-class postage paid at Peterborough, NH 03458 and additional mailing offices. Postage paid at Winnipeg, Manitoba. Registration number 9321. Subscriptions are $22 for one year, $40 for two years, and $58 for three years in the U.S. and its possessions. In Canada and Mexico, $25 for one year, $45 for two years, $65 for three years. $69 for one-year air delivery to Europe. 31,000 yen for one-year air delivery to Japan, 15,600 yen for one-year surface delivery to Japan, $37 surface delivery elsewhere. Air delivery to selected areas at additional rates upon request. Single copy price is $3.50 in the U.S. and its possessions, $4.25 in Canada and Mexico, $4.50 in Europe, and $5 elsewhere. Foreign subscriptions and sales should be remitted in U.S. funds drawn on a U.S. bank. Please allow six to eight weeks for delivery of first issue. Printed in the United States of America.

Address editorial correspondence to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Unacceptable manuscripts will be returned if accompanied by sufficient postage. Not responsible for lost manuscripts or photos. Opinions expressed by the authors are not necessarily those of BYTE.

Subscription questions or problems should be addressed to: BYTE Subscriber Service, P.O. Box 7643, Teaneck, NJ 07666-9866.

Section art by Richard Goldberg © 1988

BYTE

THE SMALL SYSTEMS JOURNAL

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New York Branch Editorial Office: 1221 Avenue of the Americas, New York, NY 10020, (212) 512-3175.
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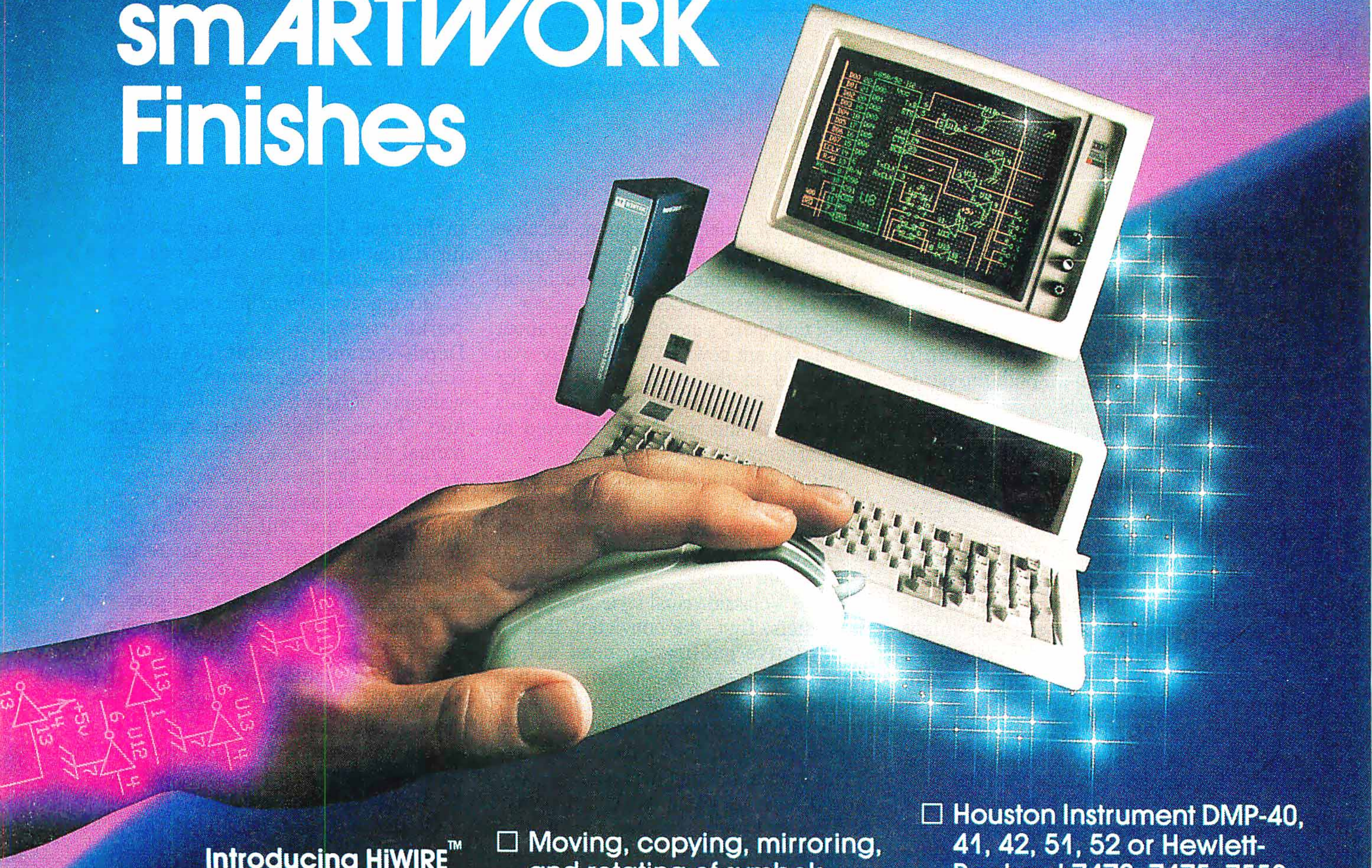

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EDITORIAL

Graphics, DTP, and Price Wars

As I write this, I'm on my way to the National Computer Graphics Association show in Anaheim, California. It promises to be a good show since the field of computer graphics is undergoing rapid growth and maturation on both the hardware and software fronts.

For example, in anticipation of the show, we've been working behind the scenes with a major hardware manufacturer to obtain early coverage of a new, highly sophisticated graphics coprocessor that will let your IBM PC compatible handle graphics primitives and operations (e.g., area fills, arc and line draws, and rotations) with a speed you might normally associate with workstations. We'll get the specifics and present them to you in an upcoming issue.

Other major players exhibiting at NCGA include AST Research (showing new VGA cards), Jasmine Technologies (with its latest Rembrandt board/monitor combos for the Macintosh), Texas Instruments, Mitsubishi, Seiko Instruments, Chips and Technologies, Adra Systems, Autodesk, and many more.

Less familiar companies will be there in abundance, too. One I am looking forward to seeing is Nth Graphics, which will be showing its parallel-processing transputer-based IBM PC-compatible graphics cards that can write 40,000 three-dimensional vectors per second or draw 10,000 constant-shaded polygons (with 500 pixels each) per second. This is the first transputer-based graphics card I've heard of.

Control Systems will be showing its new VGA-compatible graphics controller for the PS/2; it offers 1024- by 768-pixel noninterlaced output, plus a zoom feature that gives you a virtual resolution of 16,000 by 12,000.

On the software side, Circuit Studio has introduced Velocity. This is a three-dimensional motion control and video animation package that lets you specify complex on-screen motions for manipulating solid, shaded objects in real time. Circuit Studio's background is in TV graphics, and it shows: Velocity supports ultrahigh resolution of up to 8000 lines for truly professional-looking, broadcast-quality results.

There's lots more, and it's all inspiring, even for noncomputer graphics applications: a timely inspiration, because we're engaged in a graphics redesign of BYTE—a freshening up and sprucing up of BYTE's classic appearance.

Not that there's anything shabby about the way we are now: BYTE recently won 11 awards in the regional Society for Technical Communication's graphics competition, and we're now entered in the international competition.

Also, our June 1987 cover recently was judged the "Best Newsstand Cover for 1987" among all computer magazines in *Magazine & Bookseller*'s national competition.

BYTE's classic visual style arose from two beliefs: first, the conviction that an authoritative publication need not be drab; and second, the equally certain knowledge that screaming colors, half-empty pages, and jumbled headline types were no substitute for solid content.

But even a winning design can be improved. Just as we're working to make BYTE's text more readable and inviting without compromising our traditional editorial excellence, we also are looking to make every page as visually appealing as possible without losing the classic aesthetic we've defined over the years. You'll see the results in a few months; we think you'll like our new look.

Who Needs DTP?

There's publishing and then there's publishing: At the desktop end, the pace is fast and furious—some estimates show desktop publishing (DTP) growing at the almost unbelievable annual compound growth rate of 47 percent.

A full 36 percent of BYTE subscribers plan to fuel that fire by picking up DTP software sometime this year, edging out the 35 percent who plan to buy conventional word-processing software. But a new class of word-processing software may change that balance, and it's the subject of this month's Product Focus: high-end word-processing packages that have some of the features found in DTP packages.

For people who need a modest amount of page-layout ability coupled with world-class word-processing features, these hybrid packages could save money and time. They're worth a look. As is true with most BYTE articles, this one goes beyond the mere recitation of facts. In this case, Lamont Wood provides useful definitions of just what does—and does not—constitute true DTP.

Moving away from the nitty-gritty of workhorse software, this month's In Depth section (superbly illustrated by cover artist Robert Tinney) offers some welcome perspective on CPU architecture. These articles detail how fundamental design decisions made years ago in 4- and 8-bit chips still affect the performance and capabilities of today's 32-bit architectures and will affect tomorrow's designs, like 80486, 68030, and reduced-instruction-set-computer chips.

Speaking of tomorrow's designs, you no longer have to wait for Apple's long-rumored portable Mac: The third-party Dynamac portable already exists. It is pricey (like all Mac things, unfortunately), but it's loaded and comes with a screen that offers even higher resolution than that of standard Macs. Nice stuff. It's reviewed in this issue.

On the Intel side, with more competition, the 80386 price wars are creating a consumer's paradise. Recently, I decided to take the upgrade plunge when even religious use of data-compression utilities wouldn't let me shoehorn another byte into my home computer's hard disk drive. (It wasn't an easy decision to make: Although working at BYTE lets me try all manner of very nice, no-holds-barred hardware, I still shop carefully for my home-use equipment, which I pay for myself.)

After checking out our reviews and spelunking in BYTE's ad pages, I discovered a fantastic buy on a mail-order 80386-based machine, checked on the company with the Better Business Bureau, and phoned in my order.

I now have a very fast, very inexpensive 80386-based machine with a large monitor, ample memory, and a fat, fast hard disk drive. It's wonderful. I can't believe I waited this long to get an 80386 for home use. The difference in real productivity is amazing—I honestly get more done in less time, which makes after-hours work a lot easier to take. If you haven't looked at prices recently, you owe it to yourself to do so: 80386 upgrades are probably a lot less expensive than you think.

—Fred Langa
Editor in Chief


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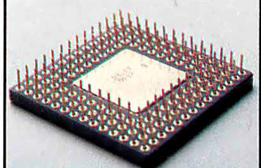


FlexCache 386 series: The performance of 80386 technology with the power of advanced FlexCache architecture.

Compatible
Novell, DOS 3.X, SCO Xenix 386, OS/2
Software

"Even Compaq's DeskPro 386/220 eats the dust made by the ALR FlexCache 20386..."
-*PC Magazine, March 15, 1988*

The philosophy of getting more for your money has become an unbroken tradition with ALR. A tradition that has been recognized by all the major trade journals with excellent reviews.

ALR 386/220, PC magazine's choice as "The Best of 1987"

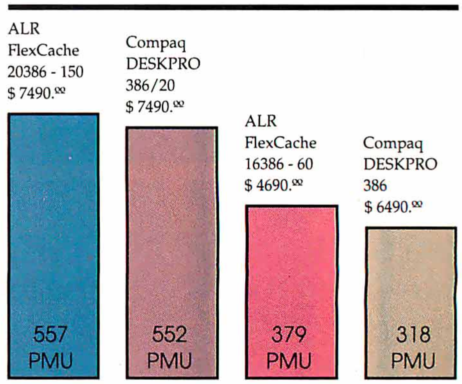
THE BEST OF 1987

Based on the ALR 386/220, PC magazine's choice as "The Best of 1987", ALR extends its product line and introduces the FlexCache 386 series. Now the fastest PCs available, the FlexCache 386 series approach minicomputer proportions and offer two new ways to get the most for your money:

FlexCache 16386 -
a 16MHz, 0-wait-state,
80386/82385 based system.

FlexCache 20386 -
a 20MHz, 0-wait-state,
80386/82385 based system.

Both systems have ALR's advanced FlexCache architecture. The flexible dual bus design provides a wide open, high-speed data channel for up to 60% faster CPU/memory through-put than the IBM PS/2 model 80-071 with the much touted microchannel architecture.



Power Meter Performance Index

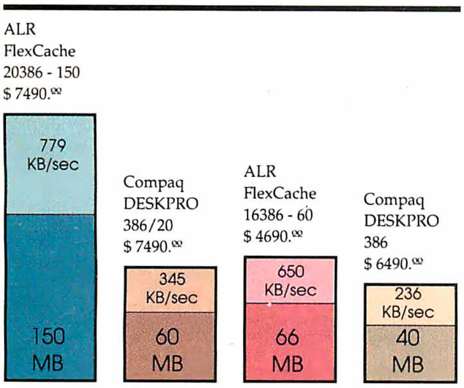
FlexCache 386 series edge out Compaq's DESKPRO 386/20 & DESKPRO 386 in CPU/memory aggregate performance test.

The cache memory controller can eliminate wait-states 95% of the time by keeping frequently used data close at hand, eliminating the need for the CPU to address main memory. This powerful blend of enhancements allows a FlexCache 16MHz CPU to move data along as fast as many 20MHz CPUs and a FlexCache 20MHz CPU to move data even faster than a Compaq DESKPRO 386/20™.

The FlexCache 386 series comes equipped with the most fixed disk capacity for your money. The FlexCache 16386 has a 66 or 100 megabyte fixed disk.

The FlexCache 20386 will give you an extra 45,000 pages of document disk storage for free.

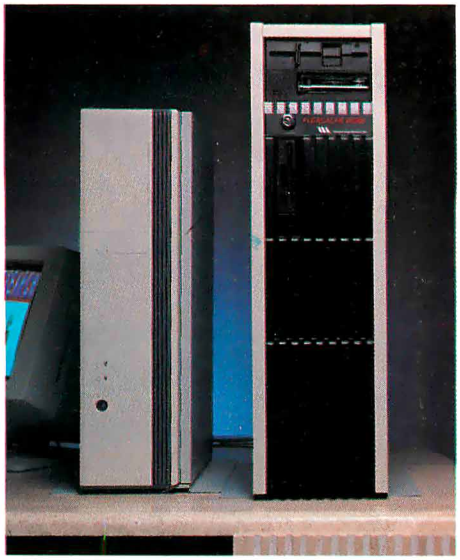
The FlexCache 20386 comes with either a 100, 150, or 300 megabyte fixed disk. The FlexCache 20386 will give you an extra 45,000 pages of document disk storage for free when you compare it to the performance and price of Compaq's DESKPRO 386/20 model 60.



Disk Capacities & Transfer Rates

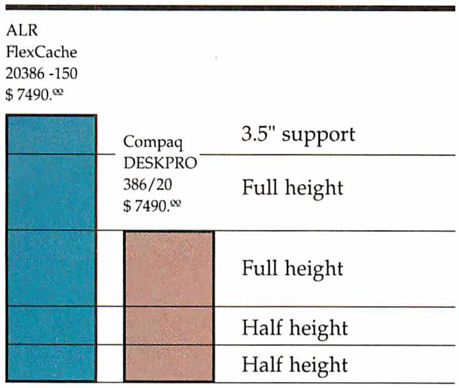
FlexCache 386 fixed disks store more pages of documents and achieve transfer rates of up to twice that of the competition.

FlexCache hard disk controllers transfer a full track of data in one disk revolution (1:1 interleave) instead of several disk revolutions as with (2:1 interleave) most current systems. Full track data transfering plus ESDI (Enhanced Small Device Interface) look-ahead buffering, turns what used to be a data traffic bottleneck into a super high-speed corridor.



So, FlexCache 386 systems achieve transfer rates twice that of Compaq's DESKPRO 386 and 386/20 model 60.

Advanced Logic Research offers the FlexCache 386 series as a powerful solution for today's business growth and performance needs. The FlexCache series offers power and expansion possibilities not easily exhausted. The minicomputer-style chassis of FlexCache 20386 offers space for five internal peripheral devices, allowing more data storage devices than any other PC available. With the money you save on a FlexCache system you can afford additional data storage options.



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With the future in mind, the FlexCache 20386 is built to accomodate growth.

To make some serious feature and cost comparisons give ALR a call at (800) 366-2574 for the name of the dealer nearest you.

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- FlexCache 386 series specifications
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- 80387 support with 16MHz clock
- 66Mbyte <30ms hard disk

FlexCache 16386 Model 100...$5690⁰⁰

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- 80386 CPU with 16MHz system clock
- 80387 support with 16MHz clock
- 100Mbyte <30ms hard disk

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- 80387 support with 20MHz clock
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- 80387 support with 20MHz clock
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Staff-written highlights of developments in technology and the microcomputer industry

Getting Small: Engineers Put Print Head on a Chip

If a prototype "thermal print head on a chip" is any indication of things to come, thermal printers will continue to get smaller and less expensive. The CMOS chip, developed by Sony engineers in Japan, provides a density of 180 dots per inch with a dot pitch of 140 micrometers for character printing, and 8 dots per millimeter and a dot pitch of 125 μm for graphics printing. Current versions of the chip measure less than ½ by ⅒ inch. Finer lithography will lead to resolutions as high as 32 dots per mm, according to Yuji Hayashi, one of the engineers on the project.

The silicon chip holds heating elements, power transistors, enable gates, latches, and shift registers. For graphics printing, it uses 11,448 thin-film transistors; for character printing, it uses only 1272 transistors.

Although engineers have for some time tried to develop thermal print heads on a chip, they have been stymied by their inability to integrate heating elements and drivers on a single chip because silicon has a high thermal conductivity, making it impossible for the silicon substrate to hold the necessary heat.

With the Sony chip, which has a quartz substrate, the highest temperature point on the chip—about 50° C—is at the center of the heating element. This ensures that the heating elements do not adversely affect the driving circuits, Sony engineers said. The variation between conventional heating elements and power transistors is about 15 percent; with the Sony chip, the variation is only 1 percent to 2 percent.

Designers have also been unable to reduce the size of power transistors, so they had to resort to using inefficient wire bonds between heating elements and drivers. Sony got around this obstacle by using superthin-film transistors that resulted in relatively small drivers.

Sony officials would not comment on when the chip might be used in an actual thermal printer.

Apple's Sculley to Lone Users: "Hang in There"

As the Apple/DEC Computing Center drew crowds at the Dexpo show in New York recently, some longtime users of Apple computers tried to gauge the effects of the "repositioning" of the personal computer company. Connectivity between groups of users is certainly more readily available, but what about the single user, who has traditionally been Apple's installed base? What are Apple's plans for the people who don't need to tie into a VAX or who don't want to work with a "workgroup"?

"Single users should hang in there," Apple CEO John Sculley told Microbytes Daily. "We introduced two new processors last year to meet the needs of our users. This year we are focusing on the extension of those machines into the multivendor workplace, which is important.

"As has already been said, we are not going to introduce any new CPUs this year," Sculley said, "but that doesn't mean Apple has forgotten about the single user. Far from it. I think that '89 will bring new products that address the single user's needs with the kind of technology that people have come to expect from Apple."

Intel Designs C Compiler for Embedded Applications

In the midst of the excitement about the 80386 and protected-mode applications, it's easy to forget the huge market for embedded applications, in which microprocessors are used with code in ROM to control data or processes. Unlike reprogrammable software applications

continued

Nanobytes

• That Dylan guy was right when he said the times are a-changin'. And if you need supporting evidence, look at what **IBM** executives have been doing: They've been commenting on unannounced products. **William Lowe**, president of the Entry Systems Division, has been telling just about everyone that the company will gradually move its entire PS/2 line up to the 80386, will come out with an 80286-based system in the vague range of $1300 to $2300, will release PC-DOS 3.4 sometime this year, and will deliver a 32-bit version of OS/2 next year. A Big Blue vice president said the company will roll out as many new systems this year as it did last year. Bigger hard disks in smaller packages were also promised.

• So what's the deal with this new verbosity at IBM? Several industry watchers say that IBM wants to keep its current customers, and potential customers, from looking at equipment from **other vendors** who might deliver similar goods first. "We're going to come out with some new products sometime, so don't go buying them elsewhere," is how one observer interpreted IBM's pre-announcement announcements.

• Personal computers at **DEC sites** aren't news anymore, but the rate of infiltration could be surprising. According to a survey taken at a recent DEC exhibition, 84 percent of the attendees said they use an IBM PC or compatible at work; 54 percent said they use a Macintosh. With all the recent announcements of Macs-to-VAX connections, people at DEC sites will be able to use their Macintoshes for more than graphics and presentations.

• **Ashton-Tate** chairman Ed Esber said a future version of

continued

dBASE for the Mac will be able to read dBASE programs from IBM-compatible systems. Esber conceded that it was maybe a mistake not to have implemented that power in the initial version.

• **Tandy** and **Apple** computers each represent 23 percent of the models sold through computer stores (including Tandy computer stores) last year, according to figures from the research firm **InfoCorp** (Cupertino, CA). The numbers are based on monthly sales. The statistics as quoted say that IBM computers made up 17 percent of sales, and Compaqs made up 6 percent, followed by Epson and Leading Edge with 4 percent each, AT&T with 2 percent, and the popular "Other" at 20 percent.

• **Addison-Wesley** (Reading, MA) will publish a new volume in its series on Adobe **PostScript**. The new tome, *PostScript Language Program Design*, is aimed at software developers who need more information on the mechanics of the page-description language. It will sell for $22.95.

• **Sharp Electronics** (Mahwah, NJ) knocked $300 off the price of its PC-4501 laptop computer. The little unit now sells for $995; it comes with a supertwist LCD screen, a 3½-inch floppy disk drive, a parallel port, and 256K bytes of memory.

• **Votan** (Fremont, CA) has given voice-recognition capability to its IBM PC-based TeleCenter voice-mail system. A new software module lets an authorized caller step through the mail menu by talking, rather than pushing phone buttons. Unlike other voice-mail systems, TeleCenter with the Voice Entry module lets you check in from a rotary phone rather than requiring a push-button model.

• **Applied Reasoning** (Cambridge, MA) lowered the price of its PC-Elevator 386 accelerator for the IBM PC, XT, and AT to $1795 and added a few things, most notably the ability to use more forms of memory, including as much as 13 megabytes on the board (it comes with 1 megabyte), motherboard RAM of the host machine, extended memory, and expanded memory.

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that you run on a microcomputer, embedded applications must reside in absolute addresses in ROM. Microcontrollers are being used in everything from laser printers to lawn sprinklers to refrigerators.

To facilitate writing the program code that controls these embedded microprocessors, Intel's Development Tools Operation (Hillsboro, OR) is bringing out a new C compiler, the iC-86 R4.0, which generates predefined machine functions and "ROMable" code, which would normally require assembly language routines using a standard compiler. The iC-86 compiler functions include the ability to set register flags and enable or disable interrupts directly, thus avoiding the debugging and maintenance complications inherent in assembly language.

The use of predefined machine functions reduces the overhead associated with assembly language and improves performance, according to Intel spokespersons. The iC-86 compiler has a "locator" that lets you specify absolute memory addresses for storing the code in ROM.

The iC-86 is designed to work with Intel's line of in-circuit emulators (ICEs) to allow full symbolic debugging of the program to be downloaded into the microprocessor. An ICE from Intel costs about $7000 for the 8086/80286 and about $15,000 for the 80386. Although you can use iC-86 with 80286 or 80386, it is designed for use only in the processor's real mode.

The new compiler is priced at $750 and is currently available with preproduction libraries. Updated libraries will be shipped at no additional cost in July, Intel said.

Scoff If You Must, But Ada Is "Doomed to Success"

Calling Ada "everybody's six favorite programming languages," Hewlett-Packard's Larry Rosler told a group of developers in San Francisco recently that the language is "doomed to success." Rosler, manager of HP's Computer Languages Laboratory, said that Ada "is exactly in the same situation as COBOL was 25 years ago. Everybody scoffed at it, but today 85 percent of all code is COBOL." Rosler doesn't necessarily claim that Ada is the best programming language available to developers, but he did say it will be a "commercial success."

The rise of Ada will be largely due to Department of Defense and other government agency requirements. As Rosler pointed out, the DoD requires that Ada be used in all embedded systems and, more recently, has extended the Ada mandate to all programming-related projects, embedded or not. Other parts of the government are following suit. Rosler added that, even though Unix is being pushed as an operating system standard in government environments, "if you want Unix to be a success, it is inevitable that it will be Unix with Ada." Recent reports indicate that the government currently spends more than $20 billion a year on programming projects, a figure that does not include hardware or software purchases.

One thing that will help make Ada a commercial success, said Rosler, is the vast number of Ada-trained programmers who will filter down from government projects to develop commercial applications. "They [Ada programmers] will do indirectly what students did to C," said Rosler. "For Ada, this will mean a thrust from above [the government] and from underneath [programmers]."

Even though Ada critics say the language is bulky, it has standard tools and was created with portability in mind, Rosler said. Ada also offers some of the object-oriented features that C++ provides. "With Ada, everything is in there," he said, "that is, if you know how to look."

C++ developer Bjarne Stroustrup agreed with Rosler, saying that "Ada will succeed because it is the only language people are willing to throw tens of billions of dollars at."

ISDN Demo Works, But Is Demand for It Here Yet?

Predicting an "ISDN explosion" within the next couple of years, AT&T, Pacific Bell, and Lockheed demonstrated in California recently some of the powerful capabilities of Integrated Services Digital Network (ISDN) technology. (ISDN divides a standard two-wire telephone line into three digital channels [B,D, and H] capable of simultaneously transmitting voice, data, and video over a single wire.) "ISDN

continued

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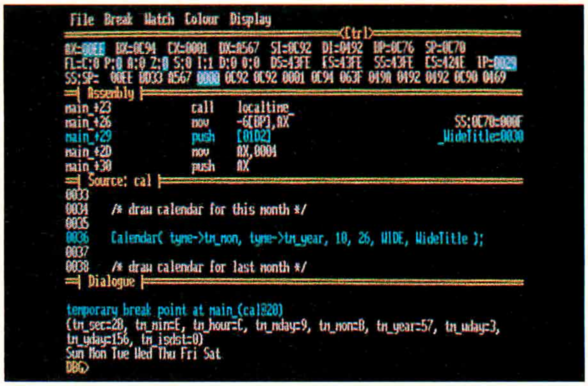

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Dhrystone	992 / 89.0	1246 / 98.0	1144 / 121.0

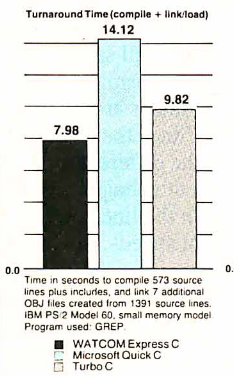
*IBM PC XT

bytes / seconds

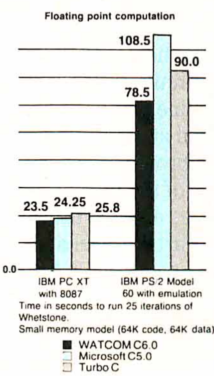
The fastest, tightest code
(medium memory model*)

	WATCOM C6.0	Microsoft C5.0	Turbo C
25 Iterations Sieve	150 / 2.7	184 / 3.0	159 / 3.4
Dhrystone	1001 / 18.0	1232 / 19.0	1156 / 24.0

*IBM PS 2 Model 60



Time in seconds to compile 573 source lines plus includes, and link 7 additional OBJ files created from 1391 source lines. IBM PS/2 Model 60, small memory model. Program used: GREP.



Time in seconds to run 25 iterations of Whetstone. Small memory model (64K code, 64K data)

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• **Extended Systems** (Boise, ID) has a new device that lets four computers share an HP LaserJet II printer. The ShareSpool board slips into the printer's extra I/O slot and talks directly to the printer backplane. The company says the $495 device provides "true simultaneous inputs," has a 256K-byte memory buffer, and is totally transparent to the users.
• **Sony Microsystems** (Palo Alto, CA), the new arm of the electronics giant, is seeking developers to work with its NEWS workstations, a line of Unix-based 32-bit computers. Sony is aiming the systems, which range in price from $3995 to $19,900, at CAD and publishing markets.
• **Tiara Computer Systems** (Mountain View, CA) has a new adapter card that links 386-based personal computers to Ethernet networks. The $395 LanCard E-386 fits in a short slot and operates at 16 MHz with no wait states.

capability is here today," said AT&T spokesperson Jerry Herman, while Pacific Bell's Pat Bergmann added that "ISDN is where we are migrating our customers."

The beauty of ISDN, its proponents say, is that it will enable personal computer users who now have two or more phone lines running into their offices—one for voice phone and one for a modem—to have a single phone line that can be used simultaneously for both voice and data transmission. Instead of a standard phone and modem, you would need a phone with a built-in terminal adapter. Your computer would be connected to the phone, which would, in turn, be connected to the wall jack. No other modifications would be needed. However, your central telephone office would have to have an ISDN telephone service switch installed.

Herman emphasized that ISDN will not be adapted by users or local phone companies until it is at least as cheap as today's methods. "For ISDN to make any sense, it will have to be less expensive than existing telephone lines," he said. Estimates are that ISDN costs are from 1.5 to 1.6 times that of current technology. When ISDN benefits reach a low enough cost, Herman said, we will see companies aggressively attacking the potentially multibillion-dollar ISDN market.

Herman told us that "there are a ton of companies, including Apple, working on ISDN products" and that we should begin to see those products within the next year.

As part of its demonstration, the companies connected three MS-DOS-based AT&T PC 6300s and accompanying voice/data phones via standard phone lines. After establishing voice communication with users at the other PCs, Herman sent and received files (created with Microsoft Word) while talking on the same phone line. In this instance, packet-switched data was traveling over one channel while voice communication went over another.

The PCs were using unmodified EZLAN communications software. Herman added that they had previously used unmodified versions of Crosstalk to accomplish the same operations. In a separate demo, files were transferred from a Macintosh SE to a Mac II, both running unmodified MacTerminal software. In another demonstration, video was transmitted at 64K bits per second over standard phone lines using CLI's Rembrandt hardware; remote video cameras were connected to telephone lines and simply dialed up.

GaAs Chip Beats the Clock; Designers Claim at Least 100 GHz

A gallium-arsenide-based IC, built by researchers at Stanford University's Ultrafast Electronics Laboratory, is performing at such high levels that its designers say they're having trouble measuring its speed. So far, they say, they've determined that the chip is running at least at 100 gigahertz (GHz), or 100 billion cycles per second, which is about 10,000 times faster than standard 16-MHz microprocessors.

What's particularly unique about the chip, said Mark Rodwell, one of its developers, is that it's based on "very simple ideas that were conceived in the early 1960s but that no one ever built." Rodwell said that "the real conceptual breakthrough for the chip is that we took old ideas and made the sort of device that can be developed only with today's technologies."

The new circuit is basically a nonlinear transmission line that may eventually replace the step-recovery diodes used in today's high-performance electronic measuring devices. Rodwell said the circuit itself consists of a transmission line that has Shockley diodes attached at regular intervals. Since the diodes provide reverse bias, the different parts of the line have different voltages, and, as a signal travels down the line, its "parts" travel at different speeds, each successively faster.

The chip will be used initially to generate pulses for driving high-speed measuring devices that will have a time resolution comparable to that of a laser-based system. Such a device would also be much smaller, less complex, and less expensive than current measurement systems. Among those devices might be a diode-sampling oscilloscope. (Some of today's measurement devices can also get up to 100 GHz; however, they do so by generating 10-GHz signals that are then mixed to generate detect signals of much higher frequency. The new chip will generate the higher-frequency signals directly.) These higher-performance measurement devices, said Rodwell, will make possible the development of ultrahigh-speed computers.

Scoreboarding Boosts Speed of Forthcoming Intel Processors

Intel (Hillsboro, OR) has resurrected a relatively old approach to circuit design in order to boost performance on its emerging generation of microprocessors. The on-chip circuitry, called "register scoreboarding," essentially separates memory reads from the operation that uses the memory. (Or, in more technical terms, scoreboarding decouples the external memory access latency from the microprocessor's instruction execution.) The net result is that the average access time of the memory subsystem is lowered, since the microprocessor does not have to spend so much time waiting for memory access to be completed. Because high-performance microprocessors are executing more instructions in fewer cycles, the memory system gets slowed even more.

According to Intel engineer Glen Hinton, scoreboarding has provided average performance increases of from

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10 percent to 50 percent. In large C programs, for instance, Hinton said performance gains have been about 10 percent; in assembly language programs, gains have been about 40 percent. Hinton wouldn't say on which chips Intel has implemented scoreboarding, but he did say it wasn't the 80386. "It can help performance only with processors that have wait states," he explained. "It [scoreboarding] lets the internal operation proceed where wait states occur."

Scoreboarding is simply one technique that designers can use to offset the bogging down of the system due to microprocessors operating at a higher frequency than the external bus pins. A more common, but more costly, alternative is the use of an external memory cache. The basic approach was developed in the late 1960s as a method of enabling concurrency on mainframe computers.

With scoreboarding, the read access is sent to the external bus controller and the destination register is marked as busy whenever a memory read is executed. Execution then immediately continues with the next instruction. The source and destination registers of the new instruction are checked; if they are busy, the instruction is canceled and is then tried again later. If the registers are not busy, however, the instruction is completed.

Hinton said scoreboarding is helpful only when the system uses independent instructions that execute concurrently with the external bus access of the previous read access. With dependent instructions, execution is delayed until memory reads are complete.

Lotus's Manzi Warns CD-ROM Developers: Don't Promise Too Much

Sometimes stating the obvious is a good place to start. Jim Manzi, president of Lotus Development (Cambridge, MA), did just that when he told an audience at Microsoft's CD-ROM conference in Seattle that "customers won't buy what they can't use."

Manzi said the personal computer industry has a history of "overpromising and underdelivering," and he urged developers not to make this mistake with CD-ROM. Manzi warned against what he termed the technological arrogance that afflicted the mainframe and minicomputer industry 5 to 10 years ago. He suggested that sometimes the best research and technological advancements come from an unexpected source: listening to customers.

Packing large amounts of raw data on a disk is not the ultimate objective of CD-ROM, he said. "There's more to it than loading data and producing a generic lookup engine." People are looking for ways to transform raw data into useful information; according to Manzi, this is the promise of CD-ROM.

"Customers don't care about the underlying technology. They just want useful information" and want to spend less time in front of their computers, he said. "Our industry will be truly successful when it frees customers from their computers to spend more time thinking creatively."

One of the potential benefits of CD-ROM, according to Manzi, is "freeing customers from information middle-

continued

men and the charges of on-line services." CD-ROM products will someday be updated frequently enough that users will be able to spend less time using on-line services, he said.

Manzi predicted big times ahead for the CD-ROM industry, saying that in 5 years the medium will be indispensable in government, business, and education. After the medium becomes essential to those markets, CD-ROM-related sales will account for 10 percent of revenues at software companies (up from 1 percent now), he predicted. We trust he wasn't overpredicting.

Toshiba Designs Graphics Processor for Fast 3-D Drawing

Companies that have been considered the leaders in the graphics processing market—like Intel and Texas Instruments, with their respective powerful graphics engines on chips—could be seriously challenged by Toshiba with its new high-performance graphics processor.

Toshiba claims that its chip can draw and render three-dimensional images at up to 10 million pixels per second. The processor could find its way into CAD workstations and graphics boards for personal computers, if Toshiba can convince designers to use it.

The CMOS device contains more than 130,000 transistors and provides graphics functions such as Gouraud and constant shading, line drawing, depth cuing, image data transfer, and hidden-surface removal.

Although as many as four processors can be linked in parallel in a multichip architecture (with resulting performance of up to 40 million pixels shaded per second, Toshiba says), the chip itself consists of four parts: a 32-bit command processor, a 32-bit pixel processor, a memory interface, and a window block for multiwindow support. The command processor, which includes firmware, executes preprocessing operations and sends instructions to the pixel processor. The pixel processor is the main engine for shading, drawing, and bit-map operations. The memory interface generates the memory timing signals. A special multiprocessor mode makes parallel processing possible. Special algorithms for smooth shading are in the firmware.

For constant shading, Toshiba claims the chip can execute at the rate of 160 million pixels per second and draw 1 million lines per second.

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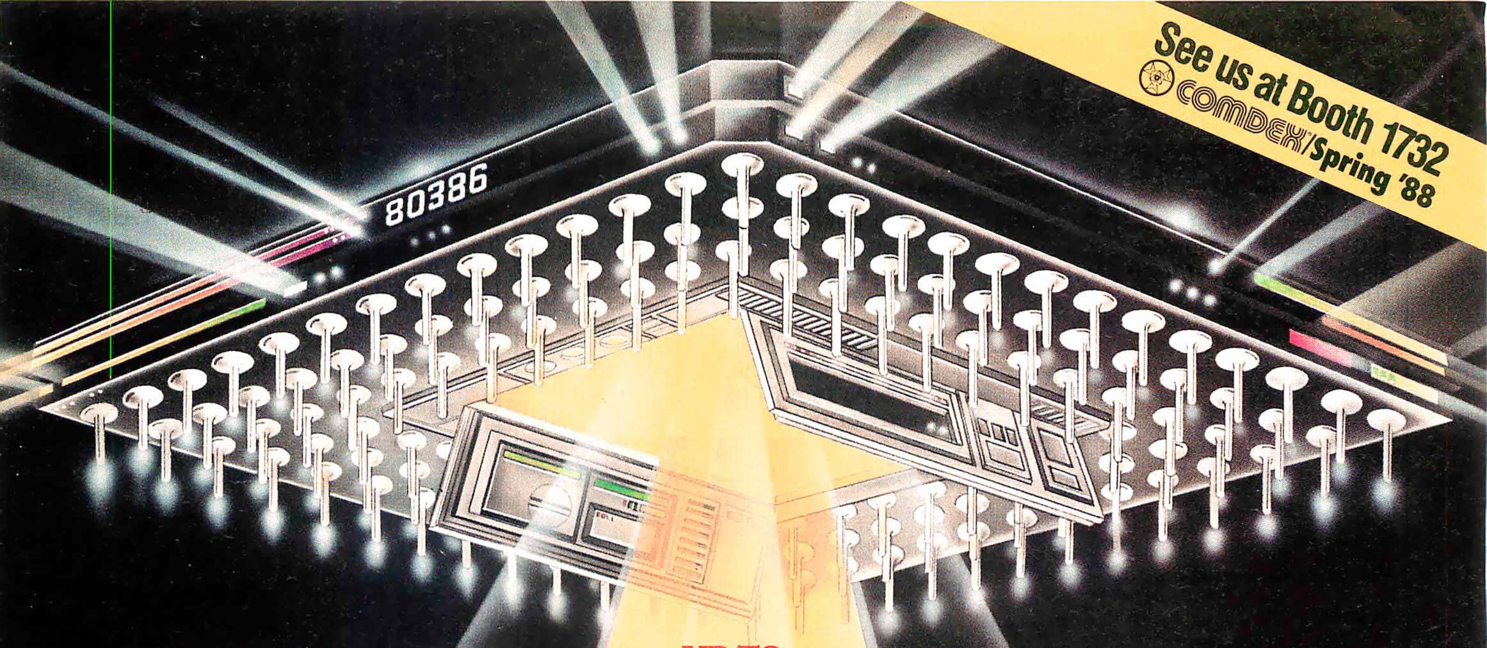

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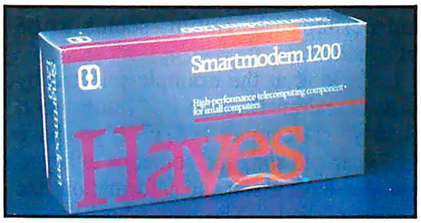

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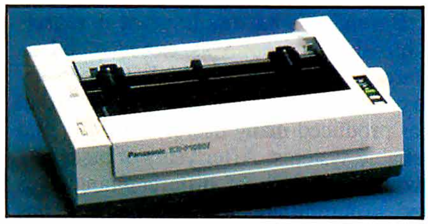

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LETTERS

Top-Down Gets Thumbs Up

Although I enjoyed your In Depth section on Lisp (February), I found it unfortunate that "Lisp: A Language for Stratified Design" by Harold Abelson and Gerald Jay Sussman included an attack on top-down structured design. The authors claim that top-down methodology is "flawed" and that it cannot be used to create systems that are "robust" because it does not let designers "stratify complex designs."

This assertion is simply not correct. Top-down design and the stepwise refinement that is inherent in the approach provide a methodology in which stratification is the norm. You can't use any of the CASE tools based on structured design techniques without becoming immediately aware of the conscious development of different levels of abstraction, with hidden details at each level.

Beyond this narrow issue, it is regrettable that someone as experienced as Harold Abelson would think it necessary to mount an attack on a methodology that has produced many useful, flexible, and reliable systems. After years of bickering about the merits of different languages and programming environments, it has become obvious to most of us that there is no universal "best method" to be applied to any or all of the work we ask computers to do for us. The Lisp environment may offer advantages in some situations, but a Modula-2 or SQL environment might be preferable in others.

A good case can be made for understanding Lisp and the manner in which it can aid analysis, but we should be conscious of the warning given by Edsger Dijkstra in his book *Selected Writings on Computing: A Personal Perspective* (Springer-Verlag, 1982): "The tools we use have a profound (and devious!) influence on our thinking habits, and, therefore, on our thinking abilities." The task facing system designers is not to master one language or methodology, but to develop the knowledge and flexibility that allow selection of the most appropriate tools for the job to be done.

John Boddie
Newark, DE

Conveying Information

Mathematical theory is so many years ahead of its practical use that mathematicians are eager to find a field in which to apply their knowledge, lest some would say they are useless.

Dr. Claude E. Shannon seems to be trying to apply the mathematics of probability to something somewhere. His aim, and perhaps his victim, seems to be information.

Let's look at the example selected by Ramachandran Bharath in "Information Theory" (December 1987): "If you have a 10-year-old son, and someone tells you that you have a son, no information has been conveyed." The man who believes that no information has been conveyed will become poor indeed. If messages in daily life were scanned only for the simplest content, there would be no communication at all—and maybe no human culture.

In the example used, the parent of the 10-year-old son now knows that the person speaking to him also knows that the son exists and that this person thought he was the first to tell the parent. That is part of a certain content. And in combination with the context, the content—probable, hypothetical, and so on—would be much larger.

You could write a book about all these contents of the sentence. But I am not a mathematician, and maybe for a mathematician there is only noise in my message.

M.-C. Stricker
Strasbourg, France

Speech Software from Dataflo

I bought my Heath HV-2000 speech card after reading about it in What's New (January, page 86). I wanted to write a spelling tutorial for my second-grader, and I thought the task would be relatively easy.

Programming the card was a snap, but developing a fully integrated program that was tailored to the needs of a 7-year-old was something else.

When I called Heath to find out what programs were available for the card, I was disappointed to learn that there was nothing on the market. Ever optimistic, I called my local bookstore and discovered that a nearby software company publishes an entire line of educational programs for the card.

The company is Dataflo Computer Services (HC 32, P.O. Box 1, Enfield, NH 03748, (603) 448-2223). I purchased Dataflo's Spell And Tell program, and it has proved to be the perfect program for my child. The company has several programs, and some of them even come in foreign languages.

I'm sure other users of this card will be happy to know that there is software for it.

Dennis Draper
West Lebanon, NH

While attending the Northeast Computer Faire in Boston last year, I was intrigued by the educational speech software offerings of a small New Hampshire firm, Dataflo Computer Services, which were exhibited on both IBM and Apple II machines. To date, this is the only ready-to-run speech software I've been able to find.

My only hesitation arose over the prices of the two supported speech synthesis boards for the IBM, one from Votrax and the other from Artic Technologies. Both cost over $200. For some users who would like to give their children talking educational software, this might seem a steep investment.

But, lo! Good ol' Heath now advertises a speech board in kit form for only $89.95. A call to Dataflo confirmed that its entire educational speech software line (including several spelling and math programs) is now available in a version for the Heath board. I also learned that, for those who already own the Votrax or Artic synthesizers and are inclined toward writing their own speech programs, Dataflo offers SONCOM, the only utility the company knows of that allows access to those boards from compiled BASIC.

As always, Apple users are in a different boat. Apple IIs must use Applied En-

continued

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gineering's more sophisticated Phasor board, which costs about $179.

All the same, it appears that after being little more than an experimenter's curiosity for some time, speech synthesis is beginning to carve a practical place for itself in the personal computer market. Shades of HAL!

Michael Dawidziak
Central Islip, NY

MathCAD and Bessel Functions

George A. Stewart's review of MathCAD 2.0 (February) was thorough and informative. The comparison with TK Solver Plus and Eureka was especially helpful. However, Mr. Stewart is incorrect when he states that TK Solver Plus lacks built-in Bessel functions. TK Solver Plus does have Bessel functions, but they're not mentioned in the reference manual. The manual, Application Notes, covers the Bessel function feature on page 4-2. TK Solver Plus also includes the gamma function as well as the Gaussian error function.

Programs like TK Solver Plus, MathCAD 2.0, and Eureka add a new dimension to computing. Engineering and scientific problems of significant difficulty that could previously be solved only through custom programming can now be solved much more easily. Setting up problems with these programs is much easier to learn than programming, and you can set up most problems much more quickly than you can write a conventional program. I have found TK Solver Plus very valuable in teaching various engineering courses.

Edwin G. Wiggins
East Northport, NY

Answers on AI

I am writing in response to Marin David Condic's letter (January, page 30). This letter raises two questions, the simpler of which I shall answer first.

Should artificial intelligence (AI) research be supported if it is unable to achieve its stated goals? Yes. Research has given us many practical applications, such as expert systems, and promises more, such as natural language processing. Research of any type always pays off if you are persistent. As long as it produces results, whether they are practical or theoretical, it should be supported. This can be answered only by comparing its merits with the relative merits of other endeavors.

Can AI achieve its goals, or are there inherent limits to it? We do not, as yet, know the extent of AI and what is possible. It is difficult to say if there is an insurmountable barrier somewhere in this

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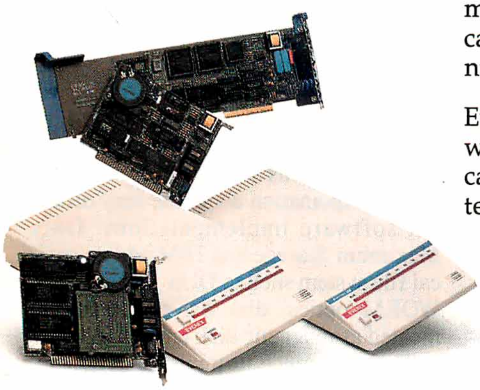

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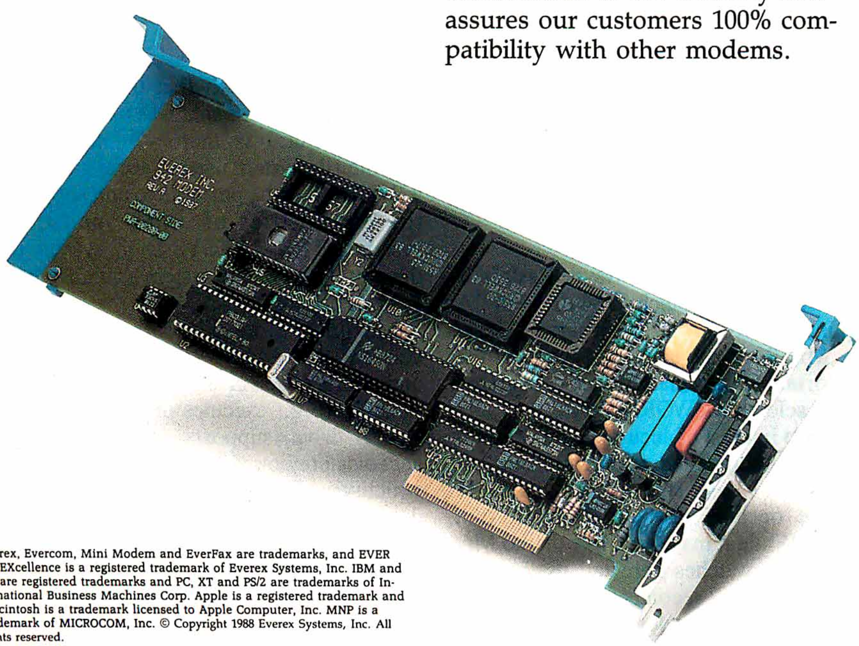

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field. Until it's reached, this question will remain unanswered.

What Mr. Condic seems to be saying—he does not explicitly state it—is that humans have a special piece of magic that no other animal has and that cannot be duplicated in machines. The question becomes, "How does the next generation acquire this special piece of magic?"

Children grow up to be as smart as, and, in some cases (e.g., Einstein), much smarter than their parents. Their development is based on two factors: the genes they inherit and the environment in which they grow up. Is this special magic transferred by the environment? Do we teach children how to be intelligent? And if we teach children, why can't we use the same methods to teach machines? The answer often given is that children have intelligence built in; we are only expanding on what is already there. If so, this leaves genetics as the means of transferring this magic. All we need to do is to map out the human chromosomes and decipher the coding. Since function is independent of the hardware, it is possible to have intelligent machines.

No? Well, what's left? Nothing. Or, rather, no known mechanism. Let's assume there is an unknown mechanism involved. One of its properties is that this unknown, unpredictable, and uncontrollable but reliable mechanism is supposed to transfer this special magic from adults to their children. Yet, if we make a conscious effort to use it, it will always fail.

To answer Mr. Condic's last question—why do AI researchers seem unaware of other work on intelligence?—they are not. Many of these authors make the assumption that humans have a special something that they cannot possibly duplicate. (The above discussion shows it must be duplicated for our children to be intelligent.) Since the researchers disagree with this, they ignore these studies because they do not pertain to their work.

Shawn Corey
Winchester, Ontario, Canada

A Can of Worms

We were gratified to see Wayne Rash Jr.'s review of the Optotech 5984 drive in "A Quintet of WORMs" (February). Clearly, Mr. Rash has identified many of the important factors that must be considered when selecting a WORM drive.

In the interest of accuracy, we at Optotech feel compelled to correct one remark. Mr. Rash stated that it takes "a minute or two" for our drive to spin down. While it may seem like that to Mr. Rash, our watches here tell us that it's more like 6 or 7 seconds.

In February we released a single-board controller that improves our product's performance by a factor of 2 and eliminates the bulky double-board controller that Mr. Rash was working with. In addition, the software that accompanies our new release has been downsized considerably by exploiting any EMS memory the user may have. This allows large programs like Ventura and AutoCAD to be executed while our driver is loaded.

Edward Beshore
Manager, Applications Engineering
Optotech
Colorado Springs, CO

I would like to thank Wayne Rash Jr. for his review of WORM optical disk drives. However, I would like to point out one serious error and several significant omissions.

Mr. Rash incorrectly states that the Maximum Storage drive is made by ISI. The APX-3200 Optical Storage Subsystem is designed and manufactured by Maximum Storage.

The omissions were due largely to the lack of explanation about the very different software implementations. Only Maximum Storage and IBM add an optical file system shell to DOS. All the other WORM optical disk drives are implemented as magnetic disk emulators.

This difference in implementation approach shows up in disk overhead, file system functionality, and data portability. The magnetic disk emulators typically consume large amounts of overhead because they are emulating a system that was not designed to conserve disk space. Other features unique to WORM storage applications that are not supported by emulator software include multiple-volume partitions and full file audit (who, what, when, and so on, for each file entry).

The most important aspect of WORM data storage suggests that the data may outlive the machine that was used to generate the data. It is, therefore, imperative that the file system used to access data on a WORM disk be portable to and support the capabilities of other operating systems. The MAXSYS-DOS system is the only WORM file system available that has this capability.

Maximum Storage recently announced version 2.0 of MAXSYS-DOS; it is faster and more efficient and has more functionality (e.g., executes programs on the optical drive, supports multiple drives, accesses previous file versions) than 1.1, which was used to derive the benchmark data for this article.

David R. Wooten
Vice President, Product Development
Maximum Storage Inc.
Colorado Springs, CO

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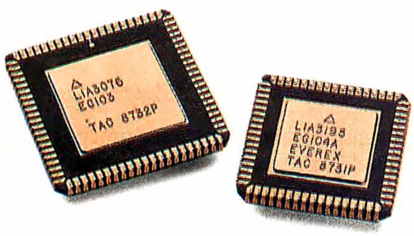

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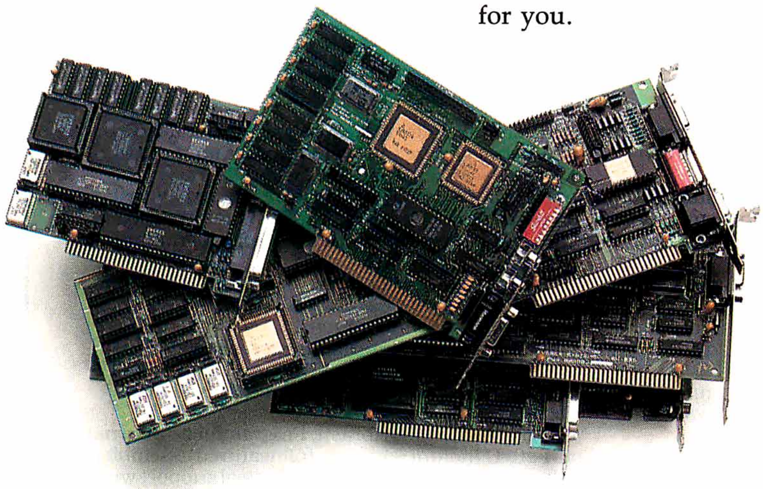

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68000 Relative Addressing

I was interested in Mike Wilson's comments about position-independent code (PIC) and the 68000 relative to the size of a code segment in his review "MPW C for the Mac" (February). Here are a few comments:

For anyone who is curious, 32-bit personal computer relative addressing can be accomplished at the assembly level on the 68000, though not as readily as on the 68020.

The following code sequence will cause a position-independent call or jump anywhere in the address space, without using registers:

```
RPSH  PEA    RDISP-2(PC)  return
                          address
      PEA    2(PC)        current
                          address
JPAD  ADD.L #JDISP,(A7)   make
*     target on stack
      RTS                 jump
RDISP SET    *-RPSH       displace-
*     ment to return to code
*     continues here and, after the
*     procedure is declared,
JDISP SET    PROC-JPAD    displace-
*     ment to procedure
```

The symbol * in an expression is the current location counter. At run time, the processor pushes the return address, pushes the address of the ADD instruction, adds the constant difference between the last address pushed and the procedure entry address, then pops the procedure address into the computer. For a simple jump, the programmer will not push the return address.

You can generate a faster, and more understandable, call or jump using a register:

```
      MOVE.L #JDISP, A0  procedure
                         offset
JPAD  JSR   -2(PC,A0.L)  PC = PC +
                         offset
*     and after the procedure
      declaration
JDISP SET   PROC-JPAD
```

At run time, the offset to the procedure is loaded in a register; then the return address is pushed and the offset is added into the computer, adjusted by the space consumed by the instruction extension word. On a personal computer, relative data addressing for jump tables and such beyond the 32K-byte limit can be generated with the latter method.

Most assemblers should be able to handle the order of declaration given above. It is faster and cleaner, of course, to use the 32-bit branches allowed by the 68020.

Now, as to whether it should be done or not, part of the PIC methodology is the idea that large programs should be divided into smaller, independent, communicating pieces. When the 68000 was designed, it was hoped that the PIC methodology would eliminate the need to jump directly to code more than 32K bytes away. System calls and interprocess communication were thought to provide the necessary flow of control. Whether these are really sufficient is still not known. In the meantime, the 68020 is proof that PIC-oriented architecture can function well with the traditional methodologies.

Joel Matthew Rees
Salt Lake City, UT

Sequel to SQL

SQL/QIT is another database package that would hold its own with those discussed in the January BYTE. In fact, from some of the local benchmarks against Oracle and Ingres, it could be considered superior. However, later revisions of Oracle, at least, have since been released. SQL/QIT is a homegrown Aus-

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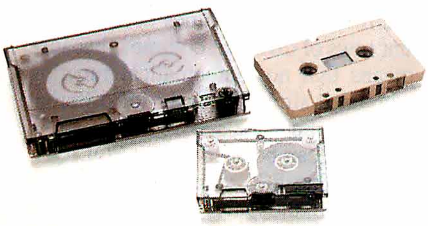

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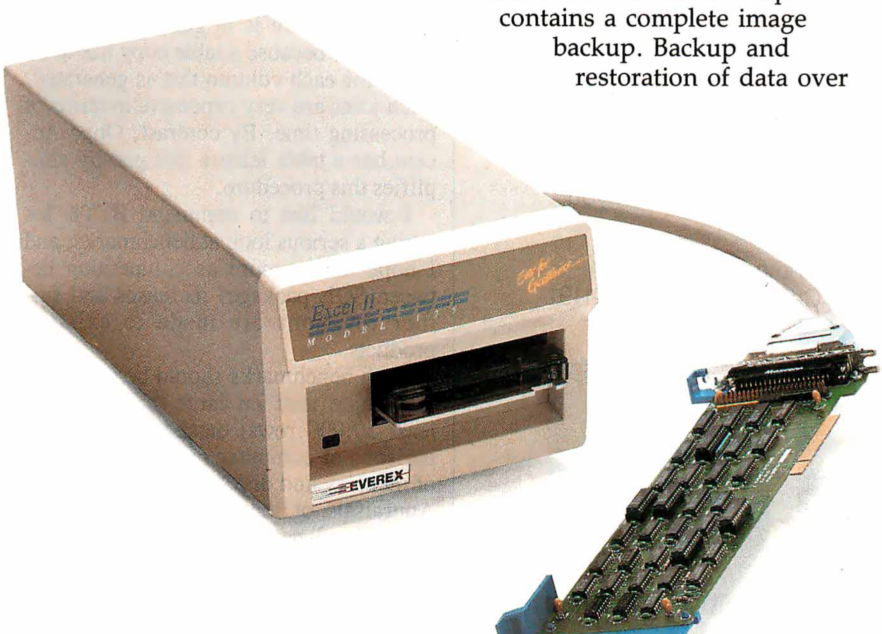

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tralian product that was developed by Queensland Information Technology.

SQL/QIT has an additional forms package that provides the user with a powerful tool to design screen forms or hard-copy reports without having to use ancillary programming languages and compilers. Its features, on paper, appear similar to Oracle constructs, in that each field can have "triggers" attached to it, such as ON_ENTRY, ON_EXIT, and ON_CHAR. Other features of the forms package include subforms that allow multiple rows of the same type to be displayed and scrolled both forward and backward.

Another powerful feature that is not mentioned in the article is the product's ability to nest a SELECT statement within the SELECT command to generate a column. For example,

```
SELECT NAME, (SELECT GROSS FROM
                    PAY_DETAILS
   WHERE PAY_DETAILS.SALARY_CODE =
      EMPLOYEE.SALARY_CODE)
FROM EMPLOYEE
WHERE EMPLOYEE.DEPT = 'SALES'
```

This facility can provide a more efficient query compared to a table copy, because of the additional overhead involved in table joins and because the number of rows considered is reduced by the WHERE clause. This means that there will be fewer rows to determine the value of gross pay.

Being able to use nulls is an important feature for any user confronted with missing data values. The use of an arbitary value like −1 or −999 to show a missing value means that these rows need to be filtered out before any mathematical functions can be employed on that column. This becomes even more of a nuisance if the missing values occur in different rows of different columns, because it means that no mathematical function can be used simultaneously for different columns in the same query.

Routines can be used within SQL/QIT by embedding SQL commands within a routine table, thus saving retyping similar queries because placeholders allow for variables to be substituted within a command.

As a user of the Open Access database module, I found that some queries were faster than SQL/QIT. It remains to be seen whether this would still hold true for large-scale databases. However, Open Access employs only a subset of SQL commands, so many direct SQL queries would require a print mask to implement them in Open Access, if indeed they could be done at all (e.g., correlated subqueries).

One area where relational databases really fall down is in generating a two-way table, because a table copy has to be made for each column that is generated. Such joins are very expensive in terms of processing time. By contrast, Open Access has a table feature that greatly simplifies this procedure.

I would like to commend BYTE for taking a serious look at benchmarks, and I hope to see more as competition between SQL packages increases and further revisions are made to existing products.

Such benchmarks should be expanded to include tests on large-scale (i.e., at least 50,000 rows) databases and comparisons of computer resources in terms of memory and disk space requirements. Appraisals of the interface with third-generation languages like C are also necessary, because there are times when you need to choose whether to use forms or a third-generation language. In applications involving mathematical functions, a third-generation language is indeed the only alternative.

Cec Chardon
Taringa, Queensland, Australia ■

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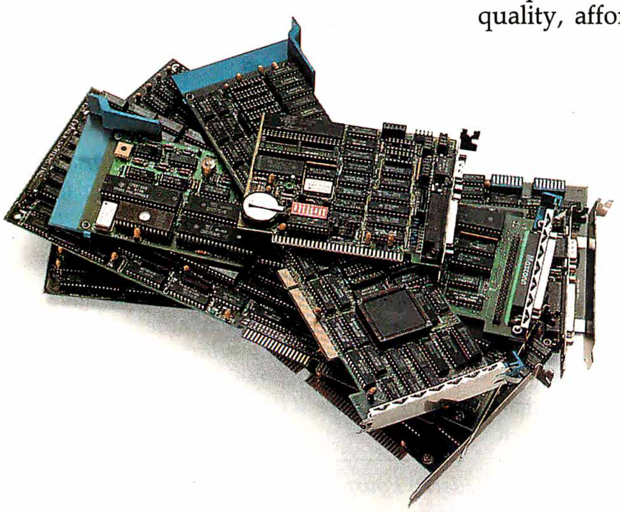

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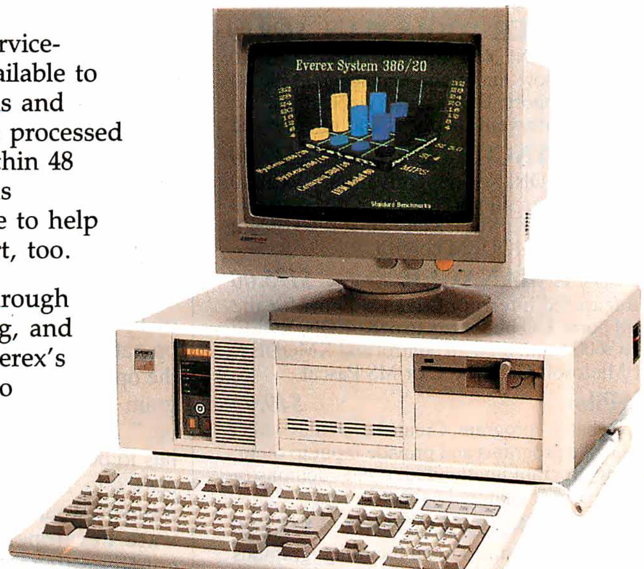

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CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

Multitasking Defense

Dear Jerry,

In recent months, you have spoken out strongly against the use of multitasking operating systems such as OS/2 for personal computers. While I agree completely with your philosophy of one person, one CPU, I disagree that the CPU should be limited to a single task. I believe that the IBM PC and its 5-MHz clones are incapable of supporting a multitasking environment due to their less than overwhelming performance. I also believe, however, that the 8-MHz 80286-based machines and 16- or 20-MHz 80386- and 68020-based machines are very capable of providing a useful multitasking environment.

One of your major concerns seems to be, "What can a multitasking system bring to a personal computer?" I believe that the biggest advantage of multitasking is that it will clean up the interface that all software has with the underlying hardware. You often mention problems you experience in trying to load terminate-and-stay-resident programs under DOS in the correct order to make them all function properly. Under a multitasking operating system, this is no longer a problem because those programs become one of the many processes managed by the operating system. They are activated by the operating system instead of each program using its own method of "waking up." In addition, the process no longer has to be aware of the state of other processes to function properly. This environment would greatly simplify the software developer's job as well as the configuration issues for the eventual users. Given your partiality toward these utilities, I suspect that you would find an environment like OS/2 much more desirable than MS-DOS.

Your concern that performing more than one task simultaneously on a single CPU would create performance degradation is only partly true. In any computing system, the CPU can easily be faster than many of the other devices with which it must interface. Machines based on the faster 80286 CPU and all the 80386 and 68020 CPUs will have more time available because of slow disk drives, printers, tape drives, and people. This time can be used to service additional processes running on the machine. It is true, however, that when the mix of processes shifts toward exclusive compute-intensive tasks, performance degradation occurs.

I currently use a Sun-3/75 every day running Sun's version of Unix. If I want to do serious text processing, I don't try to do compiles or other compute-intensive tasks simultaneously. I do, however, edit text files, read my mail, look at spreadsheet files, and check my appointment calendar while I am compiling. I typically have a Mandelbrot set generating in a background window while I do a lot of those tasks. When the machine becomes too slow, I stop some processes and run them later. I particularly enjoy being given the choice of running more than one program, as opposed to the designers of the operating system telling me that I am capable of doing only one thing at a time.

Finally, many types of things that you like to do are implemented through some hack or patch to MS-DOS; these really require a multitasking operating system to be done correctly. I'm referring to items like electronic mail, networking, print spooling, and all those wonderful pop-up tools that you truly enjoy.

I believe much of your opposition to OS/2 comes from a lack of understanding of the potential that it holds. I assure you that the engineers who have to use a PC-based product on a daily basis are truly excited and welcome a multitasking operating system—especially one with virtual memory.

Dan Mutchler
San Jose, CA

Well, I've recently been to a Microsoft conference on OS/2 and talked with its systems architect, and I agree, if the company can pull it off, it will be wonderful.

I don't even question that Microsoft can make it work for the 386. I do have some worries about whether the company has made everything reliable for all the various steps and revisions of the 286, and on that we'll just have to see.

continued

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

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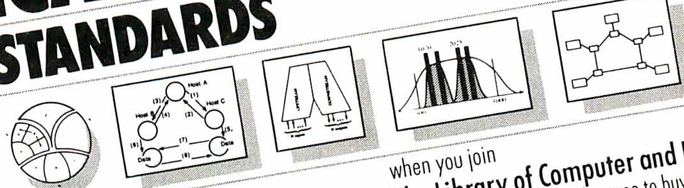

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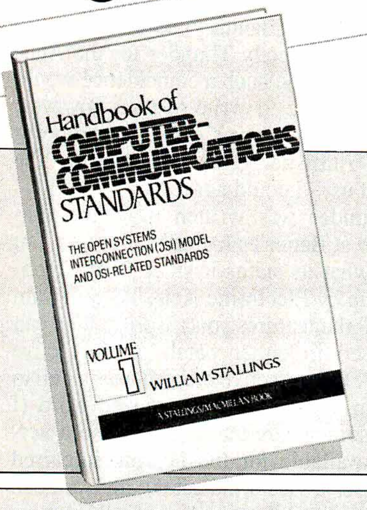

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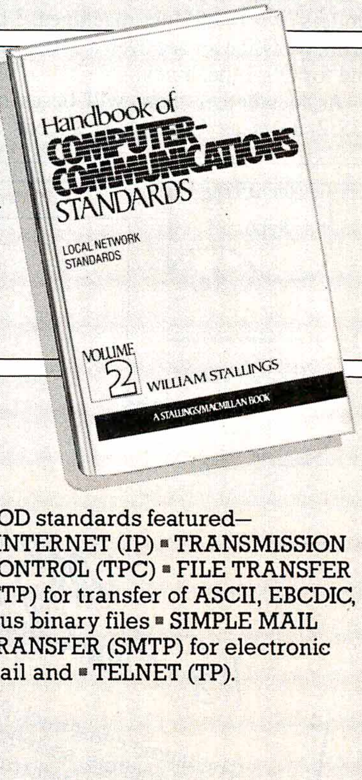

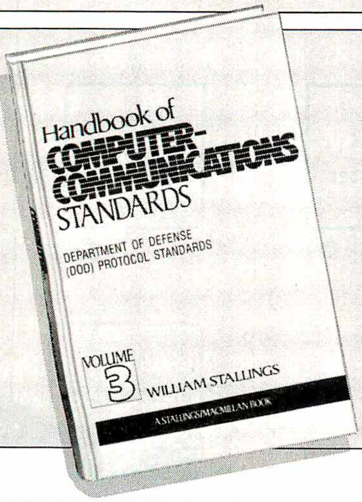

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I have no objection to multitasking if it works as you describe your life. I've just yet to see that happen on a micro.—Jerry

Why Not Unix?

Dear Jerry,

Have you seen the button that reads, "OS/2 = half an operating system"?

The person wearing it is probably a Unix person, which leads me to the topic I wish to comment on. In the "Hackers 3.0" section of your January column, you said, "I think of little that OS/2 promises that you can't do with Unix." Me, too. I can also think of a lot of things it doesn't promise that you can do with Unix, such as allowing multiple users.

You mentioned that Unix isn't going anywhere without a major backer, and that the obvious major backer is AT&T. Oh, no! Please, not AT&T. If it weren't for the University of California at Berkeley, AT&T would have destroyed Unix. How about a major backer being a customer? Like the Department of Defense, which just put out a bid for 4 or 5 billion dollars' worth of Unix machines. I don't think we will ever see even a $100 million bid for OS/2 machines.

As to whether there will be as many OS/2 users as Unix users a year after OS/2 comes out: I don't think so. OS/2 is out as of this writing. There is no software for it, and you need an 80286/80386 chip to run it. Granted, the software will come, but those 8088 boxes will not all be upgraded to 286/386 boxes.

Finally, you said that the main objection to Unix was that it's too big and too slow. I thought the main objection to Unix was that it is cryptic and difficult to learn. If it is too slow, then buy faster hardware. That is the solution Microsoft is offering for Windows.

Note also that I am (and I assume you were) talking only about microprocessor-based computers. If you were to include all computers, many of my above answers would be subject to change.

Michael Tighe
Freehold, NJ

I suspect that Microsoft/IBM will be more than happy to leave the 8086/8088 market to Unix. Unix on a vanilla PC is like a dog playing chess: You don't expect it to be done well; the miracle is that it can be done at all.

Without a major backer, Unix is not going to go far in the micro community. The obvious candidate for major backer is AT&T; as my friend Paul Chisholm says, the people at AT&T know how to write good compilers—they invented Unix.

I'm doing a major essay on Unix and OS/2 for the column; watch for it.—Jerry

Thunder and Writing

Dear Jerry,

Your comments about what you want in a spelling checker (Computing at Chaos Manor, January) seemed to me to describe perfectly Thunder for the Atari ST. Normally, such a coincidence would not move me to write to you; however, coupled with your closing comment about Atari being the "machine for the rest of us," I could not resist.

Thunder was written by Mark Skapinker at Batteries Included, but I am not sure what its status is since BI was gobbled up by Electronic Arts. The program has all the features you described and can be used in either batch or interactive mode. In interactive mode it uses a bell to inform you of an unrecognized word (I read somewhere that there is also a version available for the hearing impaired that uses a visual indicator), and you can either correct it yourself or use the mouse to call up a list of possible corrections and

continued on page 324

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ASK BYTE

Circuit Cellar's Steve Ciarcia answers your questions on microcomputing

A Bigger Buffer
Dear Steve,

I own an IBM Proprinter XL, and I'd like to expand its buffer. There is an empty 28-pin IC socket on the Proprinter's board, but I can't figure out which IC to use. I've called IBM and its service centers numerous times, but to no avail. I was told that I would have to bring the printer to a dealer to have the needed IC installed. This is more of a problem (and expense) than it's worth. Can you help?

Anthony Camp
Peekskill, NY

Aha! An easy one! Despite all the mumbo jumbo you've heard, all you need to do is buy a simple static RAM (SRAM) chip, drop it in the socket, and you're on the air. There are no switches to set and no software to install. . . . How's that for simple? The RAM is an 8K-byte SRAM. The part number depends on the manufacturer, but the generic number for it is 6264 (Hitachi calls it an HM6264, Toshiba calls it a T5565, and so on). The 150-nanosecond version (usually indicated by a "-15" suffix) will work just fine.

You can get these things from nearly any mail-order outlet. Microprocessors Unlimited (24000 South Peoria Ave., Beggs, OK 74421, (918) 267-4961) is selling 6264L P-15 ICs for $3.30 each with no minimum order.

Line the IC up with the notched end toward the rear of the Proprinter, just like the EPROM in the adjacent socket. Make sure that the power is off, touch a metallic part of the printer before you tuck the IC in the socket, and take care not to bend any pins underneath. Happy buffering!
—Steve

Call Forwarding
Dear Steve,

I'm writing to you in hopes that you know where I can get information concerning a specific type of telephone (or computer board) that will automatically perform the call forwarding function. We have more than two telephone lines in this office, so it would be no problem to route an incoming call back out over the second line. Our lines are all high-speed. The push-button telephone lines here in Europe—when you can get them—are faster than their counterparts in the U.S. The European PTT made the decision about 10 years ago to upgrade all its lines to handle both voice and high-speed data.

I have heard that a couple of companies in the U.S. sell telephones that will automatically perform call forwarding for you if you have two lines available. Do you know the names of any companies with such equipment? Alternatively, if there is some computer peripheral board that could handle call forwarding, I would be interested in contacting the board's manufacturer.

Please note that compatibility is not a problem. American equipment that has passed the FCC requirements or that can handle the V22.bis protocols works fine; you just plug it in. The European PTT tries desperately to deny this fact. For instance, in this office we use an off-the-shelf Hayes internal 2400-bit-per-second (bps) modem. It works great and costs about one-fourth the price of the junk the PTT tries to peddle.

Dr. J. F. Kenney
Rotterdam, Holland

I found a device that does just what you're looking for. It's called the Remote Access Call Diverter, and it's available from Fordham Radio (260 Motor Pkwy., Hauppauge, NY 11788, (800) 645-9518 or (516) 435-8080). Its catalog number is DAC-200, and it is available for just over $100.

You should be able to perform a similar function on data with different hardware. There are at least two multiplexed serial interface boards for IBM-type computers. These boards can, with appropriate software, operate several modems simultaneously. Intended primarily for use with multiline/multiuser bulletin board systems (BBSes), these devices are advertised as being capable of "conference call" operation. That is, they can link several remote computers together for data exchange and provide automatic, unattended transfer/forwarding of data and messages. You may have to do some software work to get what you require. Two sources for these boards are as follows:

ONLINE Store
1996 Eastman Ave.
Ventura, CA 93003
(805) 656-3741

G-TEK
Drawer 1346
399 Highway 90
Bay St. Louis, MS 39520
(601) 461-8048

—Steve

Turbo Turbo Pascal
Dear Steve,

When I first tried to write a large program in Turbo Pascal on the IBM PC XT, I came to the conclusion that Turbo Pascal's compilation process could be slightly changed to achieve a significant decrease in the effective compilation time.

As an example, consider a 5000-line program, 80 percent of which consists of tested graphics procedures and in which only a few lines at the very end contain errors. In this case, even if the compiler detects an error some 10 lines from the last end statement, you're forced to wait another few minutes until Turbo Pascal completes the compilation process. If you're debugging, these minutes can be-

continued

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come hours. Also, consider the fact that—after the compiler finds the above error—Turbo Pascal's text editor lets you make the necessary change to correct the problem. The compilation that follows should begin only in the vicinity of the change, since the preceding code compiled properly the first time. This change in the compiler should result in a radically reduced compilation time. What do you think of this idea?

Wojciech Skaba
Torun, Poland

The newer versions of Turbo Pascal support compilation of the Pascal program in sections. If you have a graphics library, you can compile it separately and link the library to the main program, thus avoiding recompiling code that you've already tested. This is one of the features of Turbopower Software's Optimizer. It requires Turbo Pascal 3.0 or higher. Contact Turbopower Software at 3109 Scotts Valley Dr., Suite 122, Scotts Valley, CA 95066.—Steve

Breaking the 64K Boundary

Dear Steve,

I need to transfer some in-house finite-element programs (for engineering analysis) coded in FORTRAN from an "ancient" DEC minicomputer to a family of nine IBM PCs, XTs, and ATs. Individual floating-point arrays in the programs contain 20,000 to 25,000 elements each. If I reduce the array size or use commercially available finite-element software packages that are still confined to the 64K-byte barrier, I'll be limiting the size of the problems the program can analyze or jeopardizing the accuracy of the output. I'd like to continue using MS-DOS software (we currently have Microsoft's FORTRAN compiler version 3.30 for MS-DOS), since we have a great deal of data saved on MS-DOS disks.

I've been looking into the TeleVideo and ALR 386 machines, Intel's Inboard 386 AT, and The Software Link's PC-MOS. I have not been able to inquire about Compaq's Deskpro 386 or IBM's PS/2 Model 80. However, I would like to find out about Microsoft FORTRAN version 4.0, Xenix, and a rumored 386 DOS from Microsoft. I hope you can shed some light on the matter and perhaps give hardware and software suggestions.

Muhd. A. AbdulRahman
Coral Gables, FL

There are several FORTRAN compilers that are no longer bound to the 64K-byte limit. Certainly, the 80386 is a match for the PDP-11 (or were you talking about the DEC-10/20 or VAX machines?).

Since you already have an installed base of MS-DOS software, you may not need to change your operating system to Xenix or some other operating system. You probably don't need multitasking to run analyses, and you will do better to get more computers than more users on one computer. Xenix is not likely to make your programs complete any faster.

Microsoft FORTRAN 4.0 is advertised on pages 216 and 217 of the May 1987 BYTE, and Microsoft indicates that it supports the large memory model and math coprocessors. Microsoft specifically states that common blocks and arrays can be larger than 64K bytes. Actually, three memory models are supported. There is also a source-level debugger, which should be a big help.—Steve

CCAT in the Mac

Dear Steve,

Would it be possible to make the CCAT fit the Macintosh II? It looks like the CCAT would be a cheaper and more efficient design than AST Research's Mac286.

Ellis Lai
Higginsville, MO

Unfortunately, though the CCAT includes the entire CPU and memory section of an IBM PC, it is not at all suitable for use in the Macintosh II. The most obvious problem is that the ZYMOS chips are designed to work with the AT bus. Retrofitting this design onto the Mac II NuBus would definitely be a nontrivial task. However, the real problem would be getting the Mac screen to emulate an IBM display standard such as MDA, CGA, or EGA. This is the real breakthrough of the AST design, and it probably requires a lot of tricky hardware and software. Without this, the system couldn't run existing PC software.

Actually, I find the general idea of an IBM PC "coprocessor" for the Mac humorous. In my experience, Mac users have little interest in (and, in fact, are quite opposed to) the PC. For those who need to run PC applications, it is almost as inexpensive to buy a low-cost PC clone as it is to install a PC coprocessor. I don't think many of the coprocessors will be sold.—Steve

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tion broadcasting on channel 8 is carried on cable channel 11). This would reset the TV selector to the way that the TV stations are listed in the *TV Guide*, rather than the way the signals are received from cable.

I have been hunting for this feature for several months now, and it appears that all the TVs that are now made use frequency-synthesized tuning that automatically locks into all the available channels. This is great for the Neanderthals who want to plug the cable into the TV and be up and running a minute after the TV is unpacked.

Unfortunately for people like myself, who are capable and willing to play around with toys, there is no way to adjust these settings (short of fine-tuning). The manufacturers expect me to keep remembering that 8 means 11, 6 means 9, 12 means 26, and so on. I always thought that increasing the logic of the TVs would make this feature easier to implement, especially since I remember being able to do this with an old mechanical tuner several years ago. What I really can't understand is why this feature is available on VCRs but is too old-fashioned for TVs.

In my conversations with salespeople, when they find out that I have a VCR (which I have readjusted already), they are quick to suggest that I use the VCR's tuner for the channel selections and leave the TV on channel 3. Great idea—until I want to record one station and watch another. Now I have to remember that station CFAN is 8 on the VCR, but 11 on the TV; CAPC is 6 on the VCR, but 9 on the TV. This is progress?

One salesperson suggested that I should have the TV and VCR set to the actual cable signals. I assume that this person hasn't ever been in the situation where, rushing around in the morning getting ready for work, he remembers there is something he wanted to record while he's at the office and quickly programs the VCR. Unfortunately, he forgets that 8 means 11 (6 means 9, 12 means 26, and so on) in the *TV Guide* and winds up getting several hours of the wrong programs from the wrong channels.

It is absolutely impossible to find a TV that does this. My last resort is to go cheapie-tech and tape cheat sheets to the VCR, TV, and remote control to remind me that 8 is 11, 6 is 9, 12 is 26. . .

There has to be a better way.

James S. Bertram
Vancouver, BC, Canada

I have shared in your frustrations of trying to correlate the cable channel assignments with the actual broadcast channel assignments. Some cable systems go to the effort of using the proper channel number to transmit the signals on the cable; alas, I've never been so fortunate as to have a system like that connected to my home.

Some manufacturers address this problem. Some Fisher and Toshiba VCRs and TVs/monitors (and some high-end Magnavox units) sold in the U.S. let you program the frequency and the displayed number separately (some manufacturers change models slightly for Canadian sale, so I don't know if these are available there).

Technological progress is actually adding to the problem. Newer tuner designs, and the ICs that control them, simplify the tuner design dramatically and lower the cost. Unfortunately, the idea of a "tuner control on a chip" virtually eliminates the ability to modify the circuit in the way you describe, since the same IC that generates the control signals in the tuner also generates the numbers. Rarely are there any programmable devices in this area, since the channel assignments are fixed by international treaty, so we are in somewhat of a corner.

Another thought: Converters available through some of the high-end video stores let you set your TV or VCR to a single channel and do all your tuning from the converters. There are also similar tuner-only devices made for inclusion in stereo systems that do the same job. Perhaps one of these could fit your needs.
—Steve

Hercules vs. IBM Graphics

Dear Steve,

I have a Hercules-compatible monochrome graphics card that didn't come with any information. When I try to change the mode from text to graphics, nothing happens. But when I run certain programs, such as Microsoft Windows, I get graphics. Please tell me where Hercules graphics memory starts and how I can access it.

Eugene Verba
Monmouth Beach, NJ

That's the trouble with the clones—they assume that you know everything there is to know and skimp on the documentation. Here's a fast education in display adapters.

It turns out that DOS supports only the "IBM standard" display hardware: the Monochrome display, the Color Graphics display, the Enhanced Graphics display, and lately the Video Graphics display, each more commonly known by its acronym—MDA, CGA, EGA, and VGA. That's reasonable, given the close

continued

relationship between IBM and Microsoft, but it's a nuisance for the rest of us.

Conspicuously absent from that list is Hercules graphics. Although Hercules cards are a standard, they're not an IBM standard, so DOS simply ignores them. PC-DOS BASIC graphics commands don't work on Hercules displays, and the MODE *command won't switch them into graphics.*

But programs that generate graphics handle Hercules cards by writing directly to the hardware, completely bypassing DOS and the BIOS in the process. That's why Windows (from Microsoft, no less) runs just fine.

As far as writing your own graphics code for the Hercules card, I'm not sure that it's worthwhile. A more practical course would be to get a language like Turbo C, which supports the Hercules card through the normal graphics library; you simply write C code calling the library functions, and your program can draw on any graphics display.

—Steve

S-100 Sources

Dear Steve,

Some years back, I bought an S-100 system from Morrow, which subsequently went out of business. I'd like to know sources of parts and kits, as well as books, because I would like to be able to at least get some kind of S-100 system running. Could you give me a starting point for my research?

My only other choice is to spend the money on jazzing up my Apple IIe and learning to be content.

Luther Atkinson
Richmond, VA

The S-100 standard machines, while not as widely available as they were a few years ago, are still alive and well. As you note in your letter, Morrow is no longer in business. There are, however, several companies that can help with your S-100 needs, among them the following:

Vision Computers
2235 Melvin Rd.
Oakland, CA 94602

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P.O. Box 906
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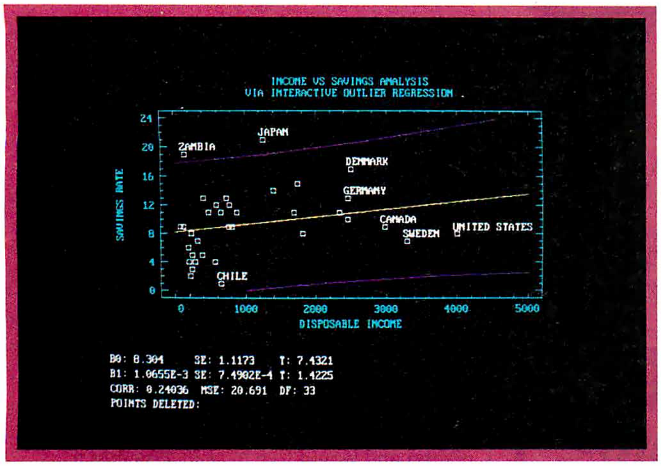

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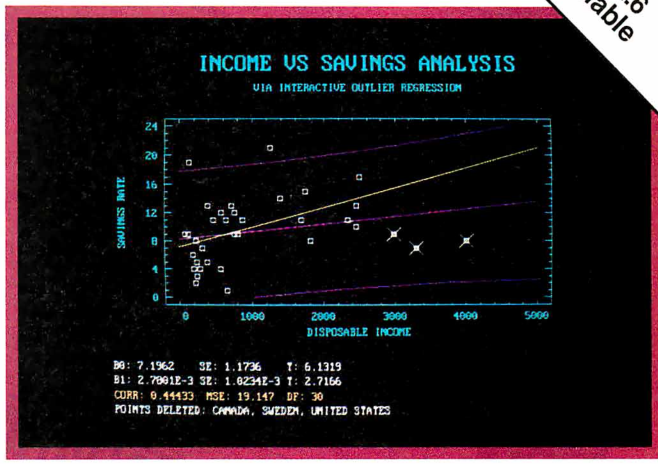

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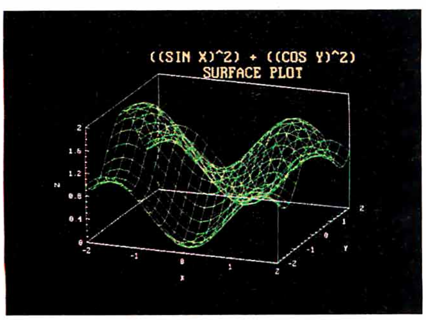

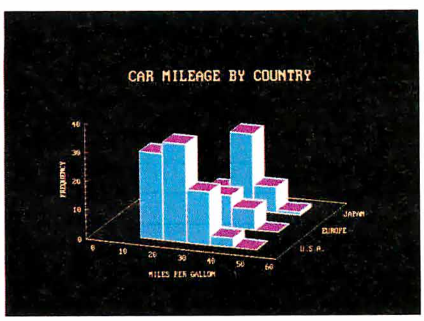

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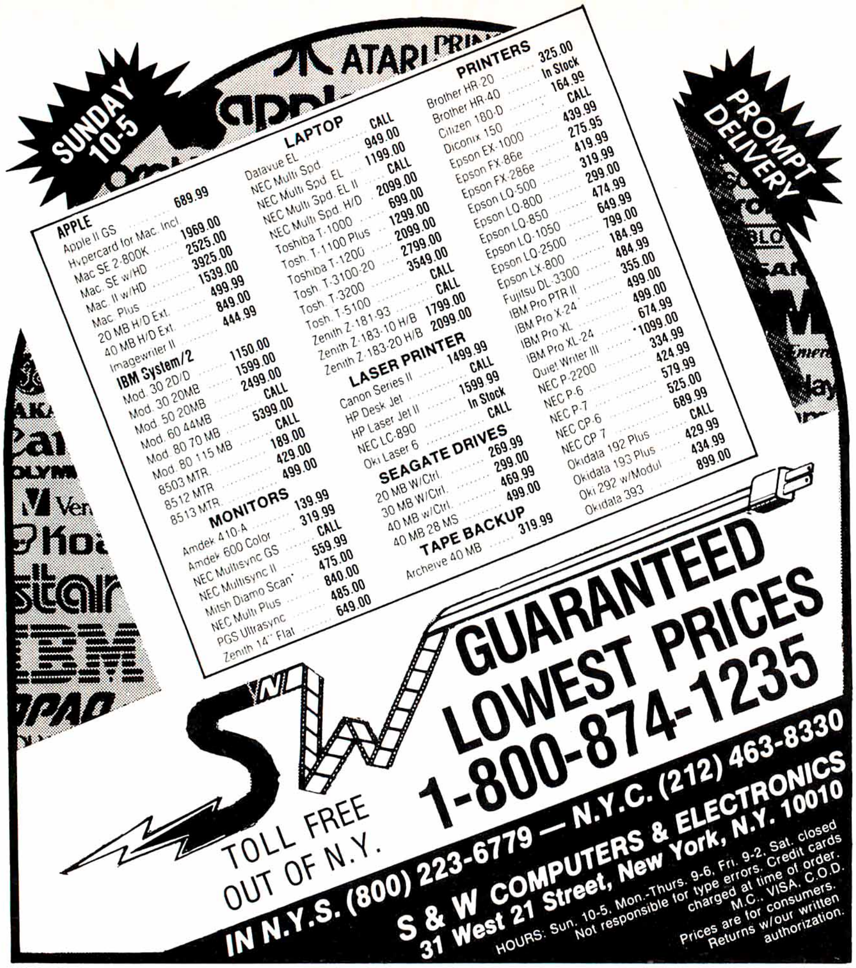

You might also want to get an issue of SUPERMICRO *magazine (also known as* S-100 Journal*) for further information on boards and peripherals available for your machine.*—Steve

Using the Fax Machine as a Digitizer

Dear Steve,

I have an idea that seems reasonable, but it may not be quite as simple as it sounds to me.

Because I'm involved in desktop publishing, I have used many types of scanners and digitizers to send images to the screen, including a Ricoh FAX20. Is it possible to use this facsimile machine as a digitizer for my computer? I am working with a monochrome 520ST (640 by 400 pixels) and would like to send a picture to DEGAS Elite.

Pete Reitano
Santa Cruz, CA

There's no limit to the number of ideas that "sound reasonable" but turn out to be such a pain that you'd rather take up knitting for a living . . .

You're exactly right about fax machines. They scan an image (at 200 dots per inch, no less), convert it into a run-length encoded bit stream, and mail it off over a 9600-bps modem. The wonder of it is that any two fax machines anywhere can talk to each other, because they exchange credentials to decide how fast to send data and what encoding to use. Pretty slick.

Obviously, if you had a suitable modem, you could tap into the fax machine's output and bash the beeps and boops back into bits (sorry). That's exactly what the fax boards for your PC do. The big expense is the 9600-bps modem, which must be designed to work with fax machines, because there are several different 9600-bps transmission "standards" around.

PC Magazine *had a write-up on fax boards in the January 26 issue. Basically, if you've already got a fax machine, you'll just need the board to act as a receiver; prices seem to range from $400 to $1000 for the boards (remember, the boards contain a very tricky modem) and some software.*

The only trick might be that the boards expect to answer a ringing phone line; you'd have to make sure that the software could handle a direct connection. But, after that, the code will grab the data and create a file in any one of several different graphic "standard" formats—which you can then convert into a paint program file, import into a desktop publisher, or whatever you want. And you don't have to build a thing or write a line of code!—Steve ■

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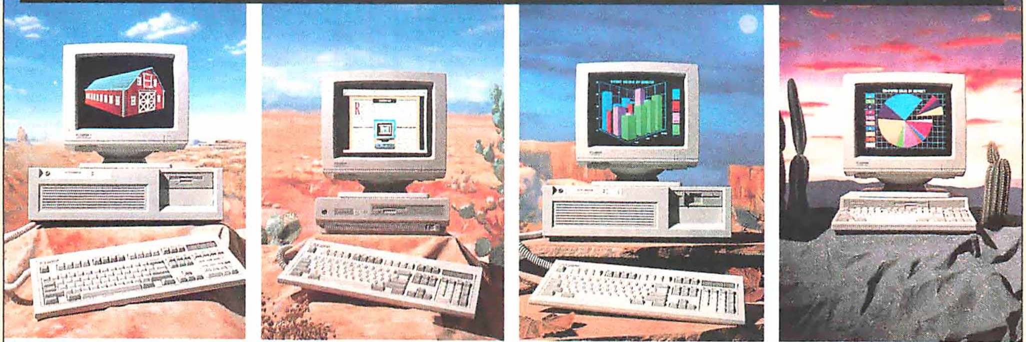

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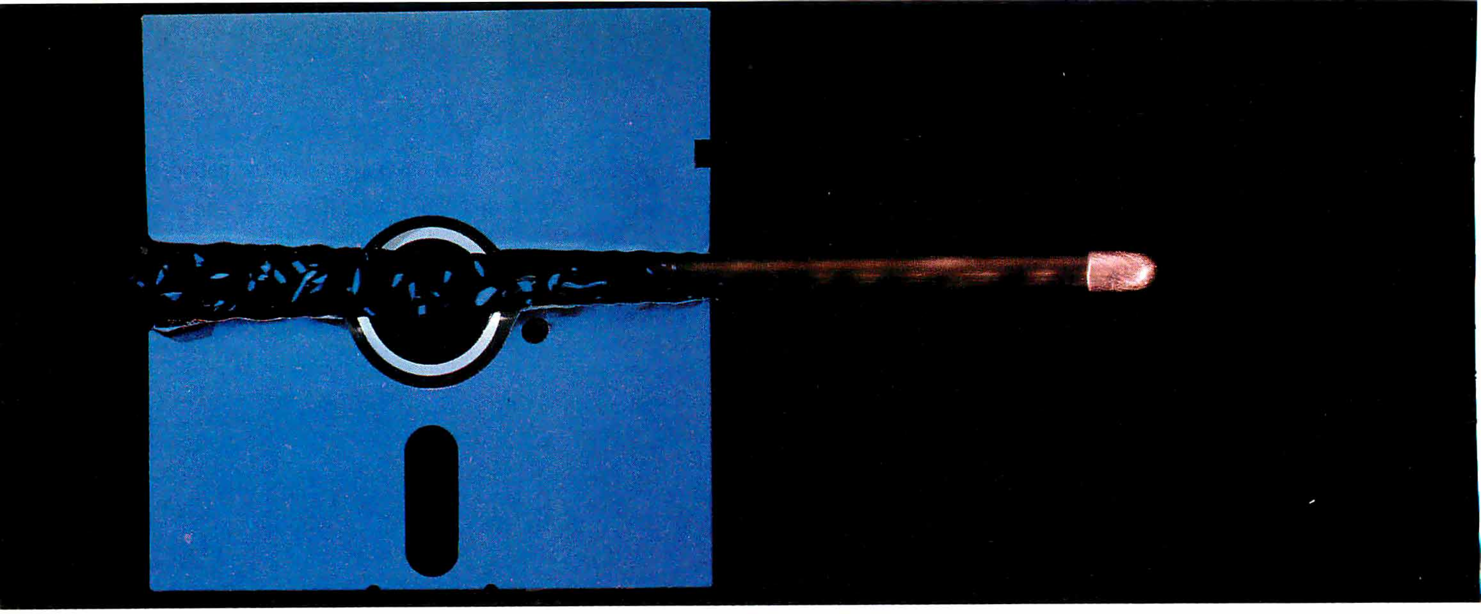

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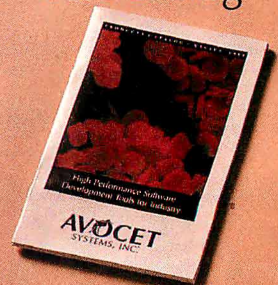

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Computing a Butterfly's Effect on the Weather

Hugh Kenner

CHAOS: MAKING A NEW SCIENCE
James Gleick

Viking, New York, NY: 1987, 352 pages, $19.95

The physical sciences for perhaps four centuries have cherished the dream of seeing their work finished—all but the grunt work, for which we have machines. With the last exponent in place in the last equation, the ultimate program purged of its final bug, the dishes feasting on data from myriad satellites, might we not be close to calling every shot? For if every state of a system causes the next—well, given ample data (and processing power), shouldn't we expect to know in mid-December if Topeka next August 9 at 3 p.m. will be having picnic weather on its southwest side?

But at present we're lucky if a local five-day forecast is not utterly misleading. Fluid systems (air and water) are rife with instabilities. The equations that describe them, though as definite as the ones that define planetary motions, have unstable points likewise, where the fourth decimal place of an input—0.5061 instead of 0.5060—can spell the difference between calm and hurricane. Small changes make catastrophes. This is stuffily called "sensitive dependence on initial conditions"; more picturesquely, the Butterfly Effect. "A butterfly stirring the air today in Peking can transform storm systems next month in New York": James Gleick's tour through chaos theory begins with that butterfly.

Gleick is a science writer for *The New York Times*, and his journalistic skills are evident in the narrative's lively pace and thorough documentation. Rather than fill space with opinions about *Chaos*—a tour de force of popular exposition, and almost rigorous enough to please a specialist—I'll offer a walk through some of the material. While drawing on details from other books, I'll stay within Gleick's outline.

Once discovered (in 1961, by a meteorologist named Edward Lorenz), the Butterfly Effect seemed to end all hope of long-range projections, not just of weather but of most unruly phenomena. Still, a Newtonian might argue, the Great Picture is unaltered. Let our input data include all butterflies; if that's unlikely in practice, doesn't it preserve the principle? Isn't what we lack just better information? Moreover, despite butterflies, doesn't the weather system display a large-scale stability? Summers always follow winters. Miami stays balmier than Nome. Likewise, a marble in the bottom of a bowl, however often perturbed, seeks equilibrium. So "practically all dynamic systems" ought to settle, most of the time, "into behavior that was not too strange." Right?

Wrong. Most of them don't. (Partly, we've been misled by preoccupation with the few nonlinear equations we know how to solve. The rest were "monsters.")

For the weather is an atypical example, "locally unpredictable, globally stable." It's more typical, "in a background sea of chaos," for some self-organizing system to assert itself. Thus the Great Red Spot on Jupiter is local but stable, "a hurricane-like system of swirling flow," host to endless variation that doesn't destroy

continued

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Illustration by James Endicott © 1988

its form. Though our weather hurricanes die out in days, the Red Spot has been a fluid presence for 400 years that we know of. On Jupiter, chaos has modes of stubborn order.

On Earth, too, as we've just begun to notice. After T. R. Malthus stated, in 1798, that population (say, in a fish pond) will always increase until food shortage stifles it, population biologists needed an equation that models the *drop* in population when competition for a fixed food supply increases. A good one (Verhulst's Law of 1845) is essentially

$$x_{\text{next}} = r\,x\,(1 - x),$$

where x is the population (0 = extinction, 1 = maximum) and r is the rate of growth. That's an easy loop to program. Start it with $r = 2.7$, and from the range $0 < x < 1$ pick any initial x you like. Iterate through successive generations, and watch how x (the population) shoots up until things get too crowded, then declines and levels off. It soon settles down to 0.6296; at a 2.7 growth rate, our fish pond stabilizes at just under ⅔ capacity. That's what we used to think dynamic systems generally did: They stabilized.

Run it again with $r = 2.9$ (slightly more rapid growth); again x stabilizes, at 0.6552. For $r = 2.96$, x stabilizes at 0.6622. But try $r = 3.4$, and x is no longer stable but is leaping to and fro between *two* populations, 0.4520 and 0.8422. (That's still predictable; for 0.4520 one year, expect 0.8422 the next.) By $r = 3.5$, it's cycling through four different values; by $r = 3.55$, through eight. Disconcerting, yes, but those regular cycles do keep us in touch with order. Now, push r up to 3.57, and behold, patternless chaos!—seemingly random results generation after generation, and no way at all to guess what the next population will be. And these changes of behavior—from stability, to ever-larger cycles, to chaos—happen at quite sudden thresholds.

Nor is chaos absolute. Inch up further to $r = 3.58212$, and, whoops, we're back with cycling values, 12 of them. But by $r = 3.58283$, chaos shows signs of returning, and by $r = 3.584$ it definitely has. On and on, order and chaos alternating, until just past $r = 4.0$, the equation blows up.

Pondering those zones where numbers seem drawn to one or another value, you get a first feeling for what Lorenz dubbed "attractors." That's been familiar (though unconnected with chaos) ever since Newton published his iterative method for finding an equation's roots. You start with a guess, and when several roots are possible, the one you find is the one your guess "attracted." Strange attractors have since received the accolade of deep theory. They underlie both bathtub turbulence and the dynamics of galactic clusters.

There are three more things to notice about the Verhulst equation. First, there seems no way to predict how long the discontinuities will last; you just run the iterations and watch. In 1976, though, their duration turned out to be governed by Feigenbaum's Constant, 4.6692016..., a number so ubiquitous in chaos theory that it seems structured into the universe like π. That asserts a commonality for all manner of local disorders: rolling streams, perturbed pendulums, or columns of smoke.

Second, it seems that what we've often shrugged off as inscrutable "randomness" (in genetics, economics, and fluid dynamics) is really a periodic chaos that's built into simple deterministic models. Thus, epidemics come in cycles, but a sudden kick to the system—say, a program of inoculation—can send the incidence of a disease into near-chaotic oscillations. That happened in Britain when they started wiping out rubella.

Third, a definite pattern recurs throughout chaos theory: *Any detail is apt to resemble the big picture*. That's easiest to see when the Verhulst equation is put on-screen as a graph; A. K. Dewdney outlined a program to do that in the July 1987 *Scien-*

continued

tific American. As you increase the resolution of an interesting area, you see utterly familiar shapes: amid zones of chaos, still those "doubling" cycles, powerless as always to fend off chaos again.

And here we're circling close to Benoit Mandelbrot, with his fractals and his talk of "self similarity." Every BYTE reader has surely seen fractal images by now and has heard how under increasing magnification they yield variations on an overall theme. A tree resembles a branch; a branch, a twig. From big aorta to tiny capillaries, the circulatory system is self-similar. A moon rock has the jagged texture of the moon. Yet "chaos" inheres in the sense that, however deterministic the equation, you can never *exactly* predict the next level of detail. To see it, you must run through the iterations.

Like the Verhulst equation, the equations fractal buffs use are iterative; each output becomes a new input. Again, nonlinearity confers a superficial look of chaos. Again, at Feigenbaum-governed levels of scaling, chaos yields recurrent self-similar orders that turn out to map all manner of phenomena we experience daily, such as cloud forms and fluctuations in cotton prices. Mandelbrot even speaks of "the fractal geometry of nature," and George Lucas's special-effects team has used fractal generators to invent convincing landscapes.

For Gleick's exposition, Mandelbrot can be a problem: a strange attractor toward whom more things are drawn than you'd think to allow him. Gleick rightly calls Mandelbrot's book "maddening," and to argue with Mr. Fractal you'd need to rival his grasp of math and arcane mathematical history. Mandelbrot does ask for argument, seeming to claim that everything chaotic is (a) an aspect of fractals and (b) essentially his discovery. He's right about one thing, clearly: After about 1875, divers mathematicians kept finding functions that seemed to have no use: ones that embarrassed the system, or generated "monsters." They were onto something they lacked terms to cope with. Again and again, Mandelbrot has retrieved some dusty paper and fitted it to fractality, a unifying concept that is surely his.

One clear thing, finally: Chaos theory and computerdom go together. Iterative equations seemed stagnant until we had machines to iterate them. Lorenz in 1961 found the Verhulst irregularities while running some simulations on a primitive Royal McBee. Feigenbaum's Constant emerged from a glorious old handheld workhorse, the HP-65. And it was IBM, in appointing Benoit Mandelbrot a Fellow at the Thomas J. Watson Research Center (programming collaborators, visual-display hardware) that chanced to midwife the fractal geometry of nature. The field stays open, and some BYTE reader may well donate the next input. ■

BRIEFLY NOTED

PROGRAMMING SECRETS FOR THE MACINTOSH *by Scott Knaster, Addison-Wesley, Reading, MA: 1988, 368 pages, $24.95.* If you're a serious Mac programmer, this book, written by a writer/engineer at Apple, will answer a lot of your questions and head off a lot of problems. Knaster's explanation of certain Mac II information, such as Color QuickDraw, is better than what you'll find in Apple's documentation. The book gives tips on using QuickDraw, such as drawing into an off-screen buffer and using `CopyBits` to put it on the Mac screen. Knaster also provides hints on managing multiple windows with some example code.

But the real gold mine of this book is its information on the Print Manager: how to find the current printer, how to display a document's name in the LaserWriter status alert box, and how to embed PostScript commands within QuickDraw comments

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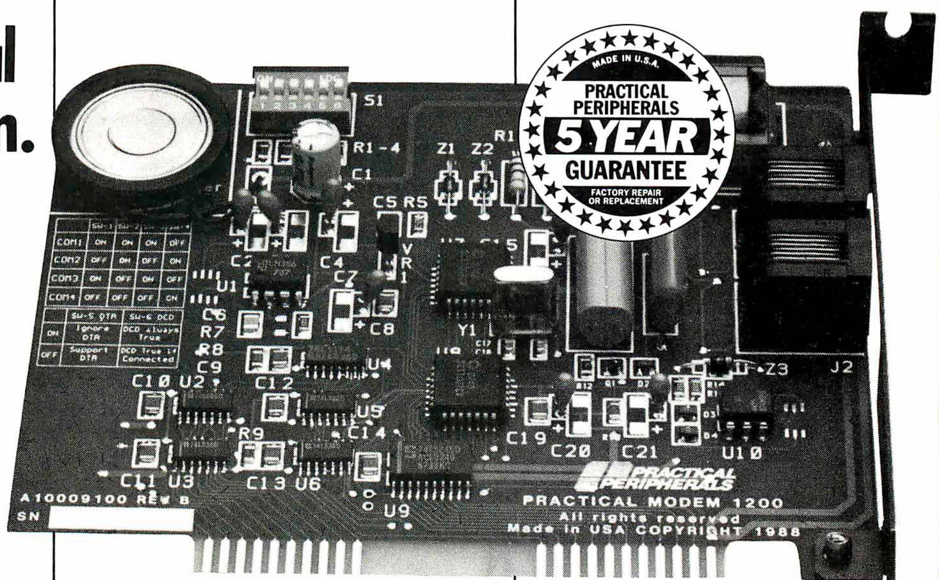

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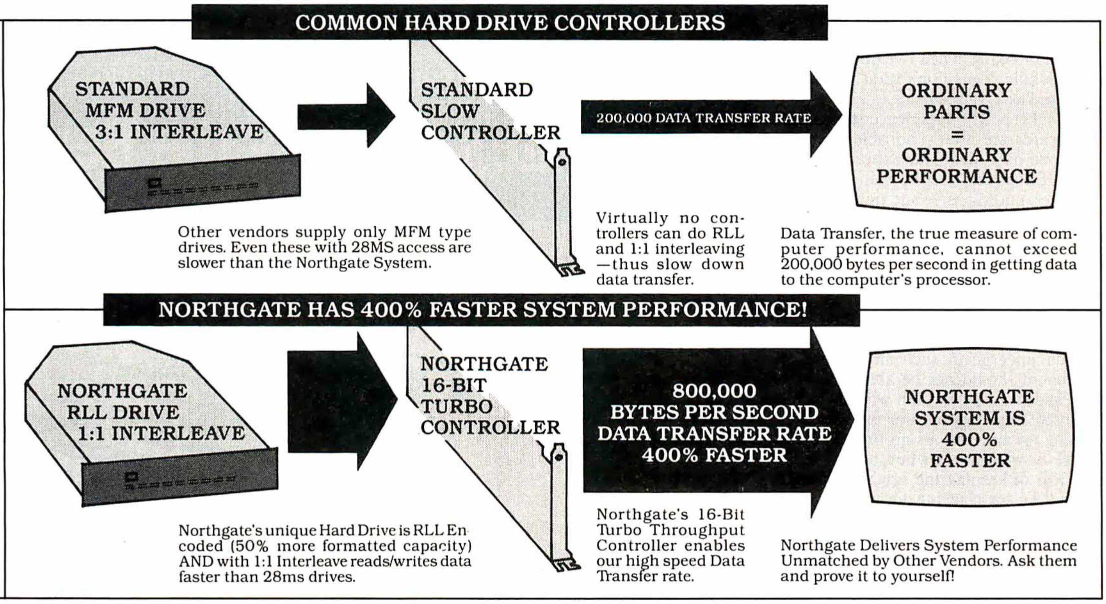

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Tech Talk

By Steve Gibson

FEBRUARY 8, 1988

Finding the Ideal Keyboard: One That Won't Throw Spitwads With Its Recoil

You might think that the best keyboard would be the last thing I'd worry about as I was assembling my "dream machine," but it was almost my first concern.

Have you ever stopped to really think about the "feel" of your keyboard? I've long believed that the feel of a computer's keyboard might almost be the single most important aspect of the machine. After all, except for occasional mouse and modem usage, the keyboard is the sole entry point for all of a machine's data. I care tremendously about the feel of the keyboard I'm typing with. I want it to feel just right under my fingers. I want to know from mechanical feedback, without looking, when I've pressed a key successfully. Yet I don't want my biceps enlarged as a consequence.

It's been my experience that most keyboards are utterly horrible, seeming to come only at the far extremes of the scale. Either they just lie there like dead sponges, unresponsive and unreacting, or they fight back tooth and nail, daring you to press the next key. To either extreme I say, "No thanks."

The original IBM keyboard must have been tough to engineer. I can't imagine the mechanical contrivance that was used to induce such a ridiculous snap action underneath such small keys. A keyboard should not be able to launch spitwads across the room with its recoil. Bruised fingertips are not my idea of a typing reward, and it's no fun having to close the windows on a hot summer night for fear of keeping the neighbors awake with the clack-clacking din.

At the other end of the scale we have the ubiquitous sponge-press keyboard. This keyboard dares you to determine whether the computer has sensed your data entry — which is not easy when you sure couldn't sense it yourself. I'm always worried that the keys are just lying there still depressed after I've removed my fingers.

So imagine my joy about a year ago when I stumbled upon a keyboard that knocked me flat (and not from its key recoil). Feeling a bit like Goldilocks, I ran my fingers over its keys. Here was a masterpiece that was neither too stiff nor too mushy — it was just right. It had a marvelous snap action.

Since the company selling this goody was one of those "here today, gone tomorrow" generic Taiwan clone outfits, I purchased seven keyboards on the spot! I was determined never to be caught without one of these beauties underneath me again.

As I proudly carried my collection home, I reasoned that I'd be adding machines over the years, and I needed them all to be outfitted not only with the best feeling keyboard I'd ever had the joy of touching but also with identical keyboards. There's nothing worse than moving to another machine after really getting used to one keyboard only to find that the Esc key has jumped to the other side of the room. Better to have plenty of spares in the garage.

Shortly afterward, the Taiwan-based company from which I'd purchased my keyboards stopped carrying the one I loved, and then it stopped carrying anything.

Well about two months ago I received a call out of the blue from a crazy-sounding guy identifying himself as the president of Northgate Computer Systems. Art asked if I was aware of his ads in the back of *InfoWorld*, and he was a bit peeved when I said, "No, not really." So he made me turn to the back of *InfoWorld* to take a look.

"Oh yeah, that's the ad with the tactile snap action diagram," I said. Art said this was the most incredible keyboard on earth and that he was going to send me one because he could tell from reading my column that I was a "touchy feely" kind of guy.

I warned him about me and keyboards. I told him about my inventory of spare keyboards in the garage, and I said that *nothing* would move me away from these beauties since there was no way to improve upon what I already had. Art was not swayed. He told me about celebrities who were using his keyboard and said he had lots of congratulatory letters, and it was simply the best keyboard anywhere. "Boy, this guy is a pain," I thought. I shrugged and told him to send it out but that I couldn't promise anything.

When it arrived, my curiosity took over. Imagine my surprise and delight when I found myself facing my dream keyboard, exactly like the four I still had in my garage! If you want the best keyboard I've ever had my hands on, check out Northgate's snap action keyboard.

Steve Gibson is the developer and publisher of Flicker Free and president of Gibson Research Corp. of Irvine, California. The views expressed are his own.

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for special effects or drawing high-resolution objects, such as hairlines for page layout. Despite the slight saccharine aftertaste left by Knaster's overdone humor, I recommend the book.

—Tom Thompson

PROGRAMMING THE INTEL 80386 *by Bud E. Smith and Mark T. Johnson, Scott, Foresman & Co., Glenview, IL: 1987, 346 pages, $22.95.* The authors present the 80386 as the next logical plateau in microcomputer development after the 8088/8086 machines, with the 80286 as a relatively minor intermediate step. The bulk of this work is made up of descriptions of the microprocessor instructions ordered and laid out for easy reference. In addition to the information you would expect, the authors include pseudocode descriptions of what the instruction does, and fragments of assembly language, showing usage.

The real strength of the book is in its description of the chip's features and its differences from predecessors in the 80x86 family. Smith and Johnson clearly explain why the 80386 is so much faster than earlier chips and describe how you can write programs that take advantage of this capability. They also give good descriptions of 80386 features, such as multitasking, paging, virtual memory, and operation in virtual 8086 mode.

On the other hand, the book does not contain sufficient source code to fully justify its title as a programming guide; missing are complete, working programs that demonstrate techniques and features unique to the 80386. But it's a useful, if not complete, reference for your 80386 library. *—John Unger*

COMPUTERS IN BATTLE: WILL THEY WORK? *edited by David Bellin and Gary Chapman, Harcourt Brace Jovanovich, New York, NY: 1987, 362 pages, $14.95.* Almost half the contributors to this collection of essays belong to an organization called Computer Professionals for Social Responsibility. Do the authors think computers will work in battle? Of course not. Most of the book is essentially an anti-SDI screed.

One-sided advocacy books like this have a generic problem: They offer little more than preaching to the already converted. The military use of computers is an extremely complicated subject, and to load the dice for either side doesn't do much for the cause of truth. Anybody working with computers knows that they are (a) fallible and (b) no substitute for human judgment, but many of the book's authors keep reinventing these creaky wheels in their analyses.

The most thoughtful essay in the book is Clark Thomborson's "The Role of Military Funding in Academic Computer Science," which makes the case that "If the DoD is allowed to maintain control of our R&D establishment, it will continue to sap our nation's commercial and political vitality." For example, the Defense Department's mania for stamping everything Top Secret (especially everything involving SDI) hasn't done private space commercialization much good.

The book scores some points, but it's too bad the editors weren't secure enough to include some contributors from the other side. By providing balance, they would have made what's there more convincing. *—Jack D. Kirwan*

PROGRAMMER'S GUIDE TO PC & PS/2 VIDEO SYSTEMS *by Richard Wilton, Microsoft Press, Redmond, WA: 1987, 532 pages, $24.95.* Richard Wilton does a marvelous job of exposing the strata of PC and PS/2 graphics systems. You'll find all you need here: from assembly language code for communicating with the video BIOS, to C source code of efficient line- and ellipse-drawing algorithms. The author even presents Pascal, BASIC, and FORTRAN programs and shows how to interface them to his assembly language graphics primitives routines.

continued

Few books can claim the distinction of being complete; this one comes as close as any I've seen. The author provides code for CGA, EGA, VGA, MCGA, and Hercules monochrome adapters. In addition to interfacing details, Wilton provides top-notch C code for drawing lines, ellipses, fills, bit-block operations, and even animation. For the fill operation alone, he presents three different algorithms.

My only complaint with this work is not its content, but its delivery: All the listings are printed in light green. If my vision fails, it's because of all the time I've spent squinting at the listings in this invaluable reference. *—Richard Grehan*

A COURSE IN NUMBER THEORY AND CRYPTOGRAPHY *by Neal Koblitz, Springer-Verlag, New York, NY: 1987, 204 pages, $34.* G. H. Hardy boasts in his autobiography that number theory is one of the few fields where the pure mathematician's work is safe from exploitation by practical applications. Neal Koblitz opens his excellent survey with that quote, but he means it ironically. For, today, number theory is at the heart of a very practical and worldly field: cryptography. The traditional lock and sealed envelope mean nothing in the realm of networks and electronic mail; instead, formerly arcane theorems about factoring numbers and finding primes are the essential tools in the quest to keep—or steal—secret information.

The first chapters review selected topics in number theory in an attempt to make the book accessible to lay readers as well as students and specialists. The presentations are clear, concise, and lightly spiced with humor. Later chapters attack more advanced concepts, like quadratic residuosity and public key systems. The final chapter discusses recent work on using elliptic curves to encrypt messages and factor large numbers. The importance of the computer in cryptography is reflected throughout the book by numerous exercises and examples involving computer algorithms for encoding data. *—Peter Wayner*

DESKTOP PUBLISHING TYPE & GRAPHICS *by Deke McClelland and Craig Danuloff, Harcourt Brace Jovanovich, New York, NY: 1987, 312 pages, $29.95.* This illustrated "shop reference" to PostScript typefaces is highly instructive and accessible. Apple screen faces, PostScript and Apple laser typefaces, and typefaces available from other sources are all thoroughly detailed: One page in each section is devoted to stylistic variations available within a given typeface—type weights, reverse type, condensed and expanded type, and so on.

A graphics chapter offers illustrations and usage advice for lines and shapes, screens and patterns, and clip art. The appendixes give background information on every typeface used in the book, listing available screen and printer fonts, font ID numbers, size in bytes of the available Macintosh screen fonts, total memory required for all sizes of a font, exact PostScript names, amount of memory the font requires, and the vendor.

If you're interested in using page layout software and find yourself frustrated by questions like, "How will 24-point Palatino headlines look next to 10-point Optima text in a 20-pica column?" get this book. It will seldom be left unopened while you design with the Mac or IBM PC. *—George R. Beinhorn*

CONTRIBUTORS

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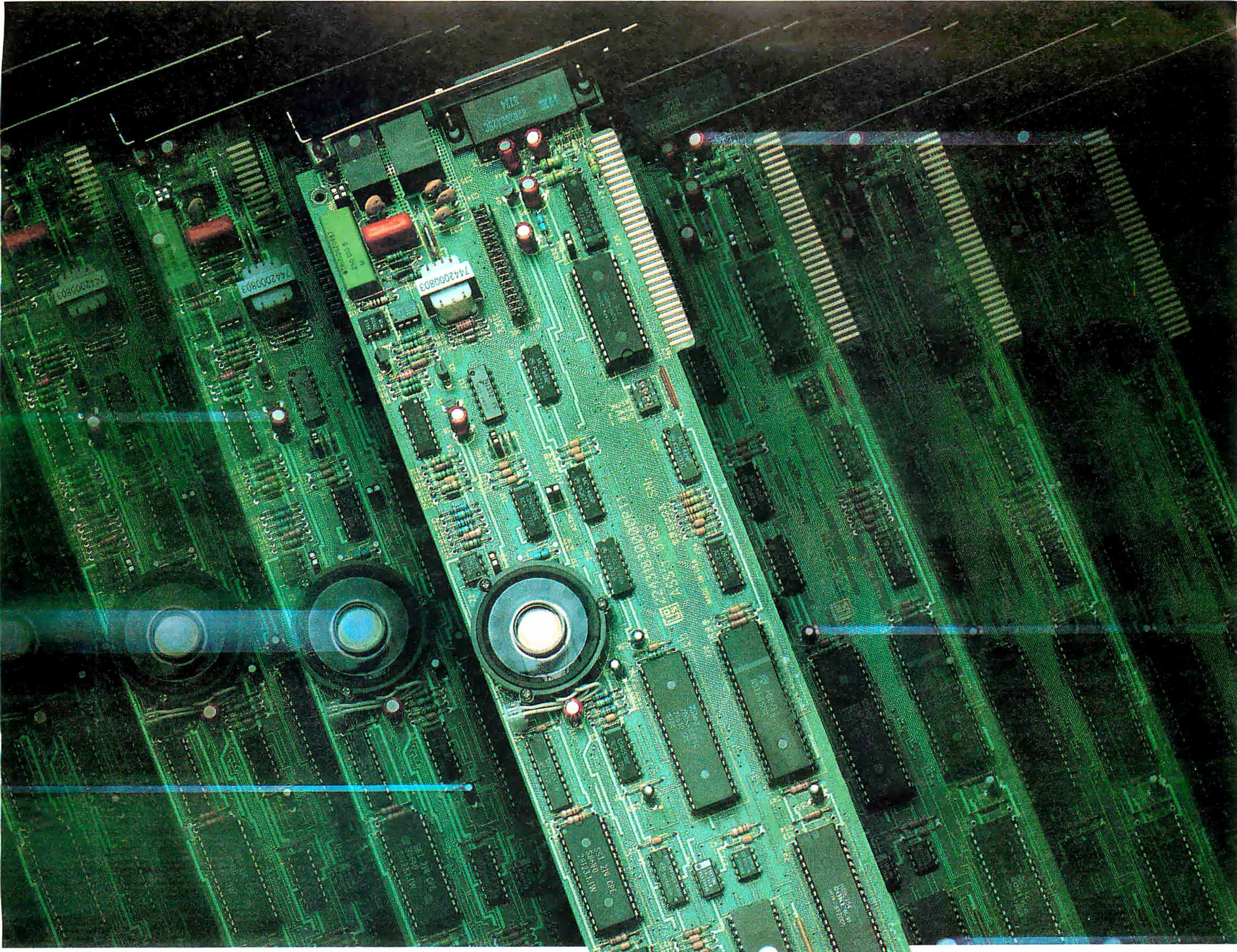

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The device provides full-duplex operation over either two-wire private or dial-up circuits; 2780/3780/3270 BSC and 3270/3770/5251 SNA software is available. The unit is compatible with most asynchronous communication packages, including *Mirror II.*

For additional specifications, quantity prices, and information on other Sync-Up products, contact Universal Data Systems, 5000 Bradford Drive, Huntsville, AL 35805.

Universal Data Systems

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Circle 300 on Reader Service Card

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0 to 60 in 5 seconds

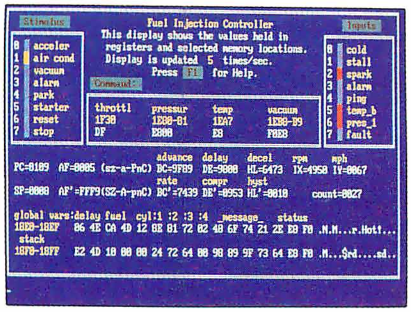
with new UniLab 8620 analyzer-emulator.

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

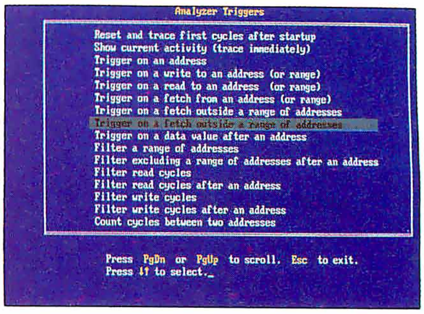
▪ The secret is a new, high-speed parallel interface: the Orion bus. Which zips data between your PC/AT and the 8620 analyzer-emulator, breaking the RS-232 bottleneck.

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

▪ A generous 2730 trace-cycle buffer with selective filtering lets you cut through the clutter and display just the traces you wish. And you get 1μsec resolution in program time measurement. Plus continuous InSight monitoring of your program's key functions as they are performed.



InSight Display. InSight blends analyzer-emulator techniques to give you continuous, real time monitoring of key processor functions. And still services user interrupts. It displays changing register contents, I/O lines, ports, user-defined memory windows. With your own labels.



Analyzer Triggers. Commonly used triggers can be selected quickly from a list of standard and user-defined triggers.

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

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

▪ UniLab 8620. Fast-lane debugging that gets you to market quicker.

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Circle 212 on Reader Service Card

Products in Perspective

SYSTEMS

PC Power in Your Palm

Datacomputer 3.0 is a 35-ounce, hand-held, 16-bit computer designed for "those who work while in motion," according to National Datacomputer. Measuring 10 by 5 by 1½ inches, it's based on a low-power 80C88 microprocessor and includes an 8-line by 26-character backlit supertwist LCD display. Since users of this type of system primarily work with numbers, it has a full-size numeric keypad. But there's also a downsized QWERTY keyboard for entering alphabetic data.

The Datacomputer 3.0 comes with an 8-pin DIN serial printer connector, an RJ-11 phone jack for an optional modem, a bar code wand port, an external power supply port, and RS-232C serial ports. It can also get its power from standard AA alkaline batteries, and it has power connectors for peripherals such as the bar code wand or laser scanner.

Interactive Data Manager, a memory-resident program, is shipped with the system. It lets you program the computer for data collection and transmit data in Lotus 1-2-3- and dBASE-compatible files. And since most MS-DOS applications won't run directly on the Datacomputer, it comes with software tools for customizing and developing applications.

Datacomputer 3.0 comes with either 128K or 384K bytes of memory on the main board.

Price: 128K-byte version, $1995; 384K-byte version, $2245; Hayes-compatible modem, $199.

Contact: National Datacomputer, The Middlesex Technology Center, 900 Middlesex Turnpike, Building 5, Billerica, MA 01821, (617) 663-7677.

Inquiry 751.

ALR Speeds Up Its 386-Based Systems

Using Compaq's Flex Bus Architecture, the Intel 82385 cache memory controller with 32K bytes of RAM, and high-speed hard disk drives, Advanced Logic Research claims its two new 80386-based systems zip along up to 50 percent faster than comparable IBM PS/2 Micro Channel systems.

The FlexCache 16386 runs at 16 MHz, and the FlexCache 20386 runs at 20 MHz, both with zero wait states. Each comes with 1 megabyte of 32-bit RAM (expandable to 2 megabytes on the motherboard). Also included are two 32-bit, four 16-bit, and two 8-bit expansion slots and a 1.2-megabyte 5¼-inch floppy disk drive.

The FlexCache 16386 comes with either a 66- or a 100-megabyte hard disk drive with an average access time of 30 milliseconds. To further speed things up, the RLL (run-length-limited) controller uses a 1-to-1 interleave for a data transfer rate of 650K bytes per second, according to the company.

ALR is now using Compaq's Flex Bus Architecture.

The 20386 comes in three configurations, with a 100-, 150-, or 300-megabyte hard disk drive. Its controller also uses a 1-to-1 interleave for a data transfer rate of 779K bytes per second.

The FlexCache 16386 measures 5½ by 15½ by 21 inches and weighs about 75 pounds. The 20386 measures 7½ by 17 by 26 inches and tips the scales at about 100 pounds.

Price: 16386 with 66-megabyte drive, $4690; 16386 with 100-megabyte drive, $5690; 20386 with 100-megabyte drive, $6490; 20386 with 150-megabyte drive, $7490; 20386 with 300-megabyte drive, $9990.

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

Inquiry 752.

SEND US YOUR NEW PRODUCT RELEASE

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

A 286 from the Golden Arche

Arche Technologies' corporate logo is a large single yellow arch, and it's prominently displayed on the front panel of its Rival 286, an AT-compatible system that runs at both 8 MHz and 12 MHz with one wait state. Standard configurations include either 640K bytes or 1 megabyte of 100-nanosecond (ns) RAM on the motherboard (expandable to 16 megabytes), six 16-bit and two 8-bit expansion slots, and the expected parallel and serial ports.

The Rival 286 also comes with single or dual 1.2-megabyte 5¼-inch floppy disk drives, a 101-key keyboard, and an out-front control panel with both reset and turbo switches. You can further customize your Arche with a variety of hard disk drives ranging from 20 to 80 megabytes.

Price: $1795 to $4195.

Contact: Arche Technologies Inc., 745 High St., Westwood, MA 02090, (800) 422-4674; in Massachusetts, (617) 461-1111.

Inquiry 753.

continued

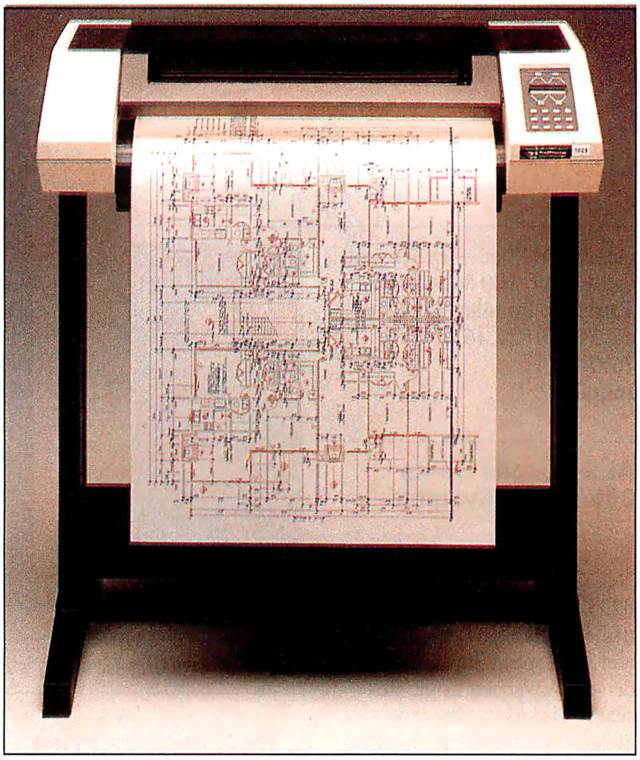
PERIPHERALS

Eight-Pen Plotter Plots from A to D

Signaling what could be a trend in high-performance pen plotters, CalComp's new model 1023, priced at $4895, has eight pens and two 68000 microprocessors. It can produce A- to D-size drawings and works with the IBM PC and compatibles to PS/2s to Macs to DEC MicroVAXes.

According to a company spokesperson, the 1023 incorporates new approaches to plotter engineering that have produced performance specifications of 30 inches per second on an axis and 42 ips on the diagonal. Along with separate 68000s to control paper and pen motors and data communications, a proprietary plotting algorithm searches the plot data to find the vector endpoint nearest to the present pen position.

Some additional features of the 1023 include addressable resolution of 0.0005 inch; repeatability of 0.005 inch; accuracy of 0.1 percent of the move or 0.01 inch, whichever is greater; and a mean time before failure of 3000 hours.
Price: $4895; buffer memory boards, $985 (1 megabyte) and $1450 (2 megabytes).
Contact: CalComp, 2411 West La Palma Ave., Anaheim, CA 92801, (714) 821-2142.
Inquiry 754.



The CalComp 1023 plots it all.

Add a 1.44-megabyte Floppy Disk Drive to Your System

Toshiba's newest Universal Installation Kit now includes the ND356T, its 2-megabyte (1.44-megabyte formatted) 3½-inch floppy disk drive. The kit adapts the 3½-inch drive to fit into the mounting space of any 5¼-inch floppy disk drive.

The ND356T lets you transfer software and data between 3½-inch and 5¼-inch floppy disks and gives you compatibility between IBM XT and AT desktops, portables, and PS/2 computers.

The drive operates with most standard floppy disk controllers; however, to use the 1.44-megabyte mode on an IBM PC-type computer, you need a controller that supports a 500K-byte data transfer rate.

If you don't have DOS 3.2 or 3.3, which directly support 3½-inch floppy disk drives, you can get an optional software device driver that lets you use the ND356T with MS-DOS or PC-DOS 2.0 to 3.1.

The kit contains the 3½-inch floppy disk drive, space plates, and jumper cables.
Price: $219; $14.95 for the software driver.
Contact: Toshiba America Inc., Information Systems Division, 9740 Irvine Blvd., Irvine, CA 92718, (714) 380-3000.
Inquiry 755.

NEW MOUSE USES LESS SPACE

Logitech says its new HiRez Mouse is just the thing for you if your desk space is cramped: The company claims the mouse needs 62 percent less desktop real estate than your garden-variety type of electronic rodent.

The HiRez Mouse has three buttons and a resolution of 320 dots per inch, as opposed to the 200-dpi resolution of most of its competitors. As a result, you don't need to move it as far to move the cursor on the screen. The company says the mouse is especially effective with large screens or high-resolution displays such as an EGA or VGA.

HiRez Mouse comes with driver and custom application software, but no cheese.
Price: $149.
Contact: Logitech, 6505 Kaiser Dr., Fremont, CA 94555, (415) 795-8500.
Inquiry 757.

The Little Drive That Can—Move Around

For you PC users who like your data to go, Western Dynex has a hard disk drive that holds 32 megabytes, weighs about 2 pounds, and is said to be as easy to snap in or out of a PC as an expansion card. You can pop the Dynamodule out of one machine and put it into another without losing any data, the company says, or you can take it out of the machine and store it elsewhere for security reasons.

The Dynamodule has a track-to-track seek time of 3 milliseconds. Head settling time is 15 ms, and data rate is 5 megabits per second. When used in a computer with another hard disk drive, either the Datamodule or the other hard disk can be used as the primary storage unit. You can snap in more Datamodules to provide more storage space.
Price: $1095.
Contact: Western Dynex, 3536 West Osborn Rd., Phoenix, AZ 85019, (602) 269-6401.
Inquiry 756.

DEC Modems Offer Security and Error Correction

If you have a computer system that lets folks dial in for data and you're concerned with security, Digital Equipment Corp.'s DF212 and DF242 stand-alone modems may be just the ticket to peace of mind. And they provide error correction to boot. The DF212 works at 300/1200 bps, the DF242 at 300/2400 bps.

Both modems give you four levels of security against unauthorized access. You can set the level of security from simple passwords to complete password and telephone number verification and callback.

The modems can store up to 30 telephone numbers, each up to 36 characters long, and can call predefined numbers

continued

PERIPHERALS

and make connections over WATS lines.

Both modems feature Microcom Networking Protocol (MNP) and X.PC protocol, and they can operate with the Digital Modem Command Language (DMCL) and the Hayes AT command language.
Price: $645 for the DF212; $795 for the DF242.
Contact: Digital Equipment Corp., Computer Special Systems Group, Nashua, NH 03062, (603) 884-5111.
Inquiry 758.

Put It on Tape

Irwin Magnetics has two new external tape systems for backing up data from a Macintosh; one holds 40 megabytes, and the other holds 64 megabytes.

The backup drives use DC 2000 minicartridge tapes and connect to a Mac's SCSI port. They do file-by-file image backups and streaming file-by-file backups. The company says the drives generally take about a minute to back up or restore 2 megabytes.

The control software, called EzTape/Mac, uses icons to take you through the process of putting your data on tape; the icons indicate which folders you've chosen to back up. EzTape/Mac also lets the drives read tapes from the IBM PC and compatibles and PS/2s. It supports MacFinder

EzTape/Mac.

ColorVueSE adds color capabilities to your Mac.

and Apple's A/UX.

The drives use embedded servo technology for accurate head tracking, Irwin says, and they employ FM (modified frequency modulation) encoding. In streaming mode, the data transfer rate is 500,000 bps. Tape speed is 50 inches per second for the 40-megabyte unit, and 38 ips for the 64-megabyte model.
Price: 40-megabyte model, $1395; 64-megabyte model, $1595.
Contact: Irwin Magnetics, 2101 Commonwealth Blvd., Ann Arbor, MI 48105, (313) 996-3300.
Inquiry 759.

Interface Brings Color to Your Mac SE

Orchid Technology's ColorVueSE is a color video interface card for the Mac SE that lets you see color displays of your applications programs. To use the interface, you need an additional color monitor, such as an Apple Color RGB monitor or an IBM or compatible VGA monitor.

You can display images on both the color monitor and the SE's standard screen at the same time, with an optional FatBits version on the SE's normal screen, and you can use up to 16 colors from a palette of 4096 at a resolution of 640 by 480 pixels. You can adjust the hue, brightness, and saturation of the colors; highlight areas; and color your pictures. Horizontal panning and an automatic screensaver are also featured.

You can print images in color on the Imagewriter II, the Imagewriter LQ, or the Hewlett-Packard PaintJet. The PaintJet can produce color overhead transparencies.

ColorVueSE is compatible with most Mac software, including SuperPaint, MacDraw, Cricket Draw, VideoWorks, QuarkXpress, and Cricket Presents.
Price: $695.
Contact: Orchid Technology, 45365 Northport Loop W, Fremont, CA 94538, (415) 683-0300.
Inquiry 760.

A Pair of Analog Monitors for Your PS/2

Princeton Graphics Systems' PSC-28 is a 12-inch high-resolution analog color monitor with a maximum resolution of 770 by 570 pixels and an infinite color palette. Other features include a color button for green, amber, or cyan text; 0.28-millimeter dot pitch for text and graphics; and a black matrix tube with a nonglare etched screen and dark tinted glass.

Then there's the PSM-03, a 12-inch high-resolution analog monochrome monitor with a resolution of 800 by 630 pixels and infinite shades of gray in analog mode. It has dynamic focusing circuitry and a white phosphor display.

Both monitors are compatible with IBM PS/2s and VGA and MDGA.
Price: $695 for the PSC-28; $250 for the PSM-03.
Contact: Princeton Graphics Systems, 601 Ewing St., Building A, Princeton, NJ, 80540, (609) 683-1660.
Inquiry 761.

continued

MAC SOUND RECORDER

If you'd like to hear more out of your Macintosh than an occasional *beep beep,* you have to put more into it. Farallon Computing, maker of the PhoneNet networking system for the Mac, has a hardware/software combination that lets you use a microphone to record sounds directly into the computer.

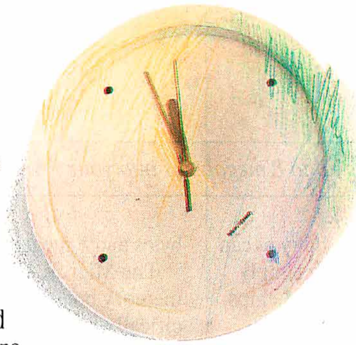
The MacRecorder Sound System consists of a sound digitizer and editing software. A bundled application called HyperSound lets you record material and paste it into a HyperCard stack.

The digitizer comes in a box (about twice the size of a mouse) that hooks to the Mac's serial port. It has a built-in microphone, a line for another microphone, and an input line for taking sound from an external source, such as a stereo. If you have a Mac II, you can get true stereo by plugging in two MacRecorders.

The editing software, called SoundEdit, lets you record, edit, and play back sounds in several formats, including StudioSession, VideoWorks, Beep INITs, and HyperCard. The software can control sampling rates, compress sounds, create loops, set pitch and echo, and mix sounds. Sampling rates are 22, 11, 7.5, and 5 kHz.
Price: $199.
Contact: Farallon Computing, 2150 Kittredge St., Berkeley, CA 94704, (415) 849-2331.
Inquiry 762.

"Within a few days, SideKick *Plus* became even more indispensable than SideKick"

Dick Pountain, Personal Computer World



Here's what Personal Computer World had to say about SideKick® Plus:

"When the news of SideKick Plus arrived, I made up a shopping list of the improvements I would like to see . . . Borland has provided all these things and much, much more."

Intelligence and elegance of design

"I discovered that the same intelligence and elegance of design that initially attracted me are still there, and certain new features like the customizable menu system represent a real breakthrough in user interface design."

Sophisticated memory management

"Memory management in SideKick Plus is so sophisticated that it almost amounts to an alternative operating system . . . The amount of memory tied up is tiny (less in fact than old SideKick!) . . . "

The Phonebook: Fully-featured communications

"The Phonebook has come a long way . . . For one thing, it has acquired a fully featured communications package which can work in the background; you can upload and download files while continuing to work on your PC . . . The Script language is one of the best I have seen."

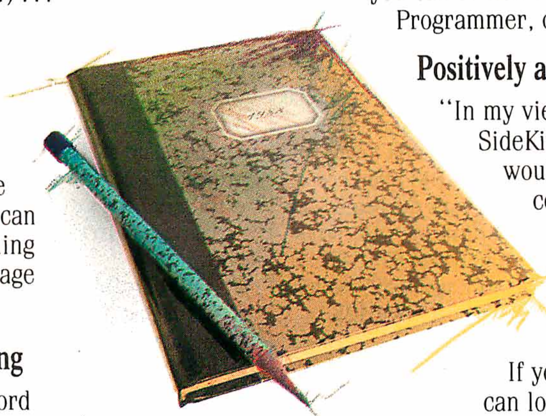
The Notepad: Power for serious writing

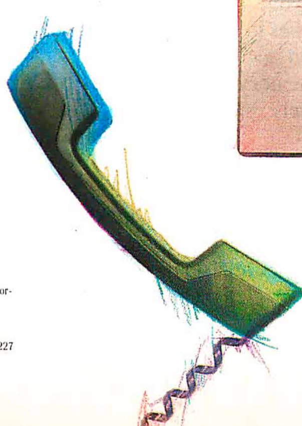
"The Notepad is as powerful as many word processors . . . I would happily use it for serious writing." "Up to nine notepads can be opened simultaneously with SideKick Plus."

Outlook: The best outline processor

"Outlook is . . . the best outline processor I've tried, comfortably beating ThinkTank, PC-Outline, and Ready! in elegance and ease of use."

3½" and 5¼" disks included.
Hard disk required.





The File Manager: Competing with the standalones

"The File Manager . . . performs a similar function to standalone utilities like Xtree, Quick DOS, or the Norton Commander, and shares features with all of them."

The Time Planner: Hugely enhanced

"The Time Planner has advanced even further than the Phonebook . . . it has been designed with networking in mind."

Plus a lot more

"The enhanced cut-and-paste functions are perhaps the most attractive feature of SideKick Plus . . . [it] has a powerful, consistent ability to cut-and-paste from any application to any other."

"The calculator is no longer one, but four calculators; you can switch the type to Business, Scientific, Programmer, or Formula."

Positively addicting!

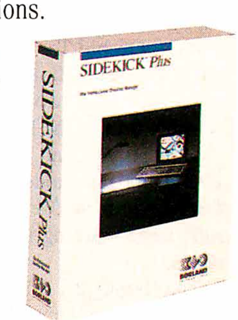
"In my view, the individual applications in SideKick Plus are of such a standard that I would be hard put to better them with a collection of standalone applications . . . I remain an addict."

Excerpts from Dick Pountain's review of SideKick Plus in Personal Computer World, March 1988.

If you have the Intel® Above™Board you can load the SideKick Plus desk accessories into expanded or extended memory and leave most of your conventional memory to run your other applications.

Ask your dealer about Borland's special offer for SideKick owners.

*60-Day Money-Back Guarantee**



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Circle 46 on Reader Service Card (DEALERS: 47)

ADD-INS

Ex Post Facto PostScript

If you have an HP LaserJet Series II printer but want or need PostScript compatibility, QMS offers a solution. The company's JetScript controller board lets the HP laser printer function as a full-fledged PostScript printer.

The product consists of three parts: a printer controller card that fits into an expansion slot of an IBM XT, AT, or compatible; an adapter card that fits into the LaserJet printer; and the PostScript software, which you install on your hard disk. The printer controller card features a 16-MHz 68000 microprocessor and 3 megabytes of memory, with 2 megabytes for data and 1 megabyte for the PostScript code. Since the PostScript code resides on your hard disk rather than in ROM, you can easily upgrade it as the software matures.

QMS claims that combining JetScript with the HP LaserJet Series II results in the fastest PostScript printer available.

Price: $2495.

Contact: QMS Inc., One Magnum Pass, Mobile, AL 36618, (205) 633-4300.

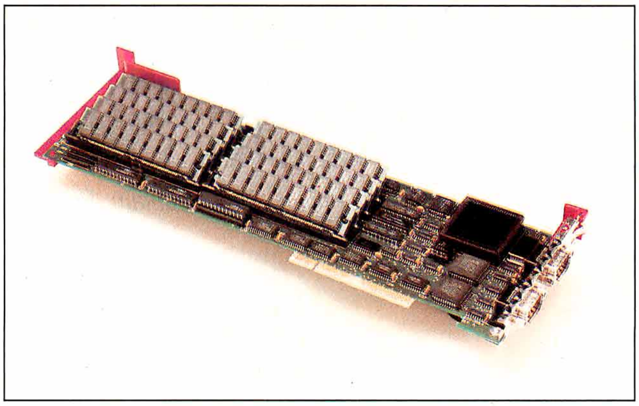
Inquiry 763.

PS/2 Boards Pack PS/2 Memory

The memory needs of new applications and the OS/2 operating system are creating a hunger for more and more memory—a hunger that add-on board makers are more than happy to feed.

First, Orchid Technology has expanded its line of memory boards with two new boards for the IBM PS/2 Models 50, 60, and 80. There's a basic model, and there's one for those with truly large working-memory needs.

The RamQuest II board is your basic add-some-memory board. It has 1 megabyte of on-board memory, but you can double its capacity by simply adding 256K-byte RAM chips.



RamQuest packs up to 8 megabytes into your PS/2.

But for truly "mondo" memory needs, the RamQuest Extra board has space for up to 8 megabytes of RAM, using either 256K-byte RAM chips or 1-megabyte SIMMs (single in-line memory modules) in any combination. The board also has two RS-232C serial ports.

Both boards come with autoconfiguration software to make installation a breeze. Orchid says the boards support DOS, EMS 4.0, and OS/2. The RamQuest Extra board has its own Micro Channel ID number, so you don't need to modify your IBM reference disk if you pack the board with more than 2 megabytes.

Price: RamQuest II, $649; RamQuest Extra, $599 (with 0K bytes) and $749 (512K bytes).

Contact: Orchid Technology, 45365 Northport Loop W, Fremont, CA 94538, (415) 683-0300.

Inquiry 764.

Meanwhile, Tecmar, one of the first companies to provide boards for the old IBM PC, has two new memory boards for the PS/2 Models 50, 60, and 80. Like the Orchid boards, the two new Tecmar boards feature maximum capacities of 2 megabytes and 8 megabytes.

The MicroRAM 50/60 memory board is designed specifically for the PS/2 Models 50 and 60. It gives you up to 2 megabytes of RAM compatible with EMS 4.0 and OS/2. You can use the board with either its own ID number or—for software compatibility purposes—the ID number of IBM's memory board.

Tecmar's second board, the MicroRAM AD (Advanced Design), can hold up to 8 megabytes of RAM. According to the company, all 8 megabytes are OS/2-addressable, as well as compatible with EMS 4.0. Two optional I/O modules for the board ($200 each) provide PS/2 users with two extra serial ports or an extra serial port and a single parallel port.

Price: MicroRAM 50/60, $350 (0K bytes) and $995 (2 megabytes); MicroRAM AD, $445 (0K bytes), $1145 (2 megabytes), and $4945 (8 megabytes).

Contact: Tecmar Inc., 6225 Cochran Rd., Solon, OH 44139, (216) 349-0600.

Inquiry 765.

Networking Card

If you want a quick way to add a four-user network to your IBM PC AT or compatible, QuickLink-IV may be your answer. The latest QuickLink product from InterContinental Microsystems, QuickLink-IV is a full-length add-in card with four NEC V40 processors, each with 768K bytes of zero-wait-state RAM. All you need to do is connect four terminals to the board and install the network software, and you're set to network.

According to the company, QuickLink-IV is unique because you can hook up any PC-based terminal, as well as most ASCII and ANSI terminals, including the new Hercules graphics terminals. You can simplify your installation by using your building's existing telephone wiring. Terminals can be up to 4000 feet from the file server.

Want to add more users to the network? Just plug in additional QuickLink-IV cards or the company's QuickLink single-user cards. The system is compatible with NetWare 286 software.

Price: $2295.

Contact: InterContinental Microsystems, 4020 Leaverton Court, Anaheim, CA 92807, (714) 630-3714.

Inquiry 766.

Ethernet Connects the Mac II

3Com Corp. has expanded its line of Ethernet local area network adapters by introducing one for the Mac II. Like other Ethernet adapters, the new EtherLink/NB (which stands for NuBus) supports a network data transmission rate of 10 megabits per second.

For higher throughput, the EtherLink/NB has a 16K-byte packet buffer and can do 32-bit transfers using the NuBus. The company says the new board is compatible with Apple's AppleShare network operating system, as well as with its own 3+ network operating system.

Price: $595.

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

Inquiry 767.

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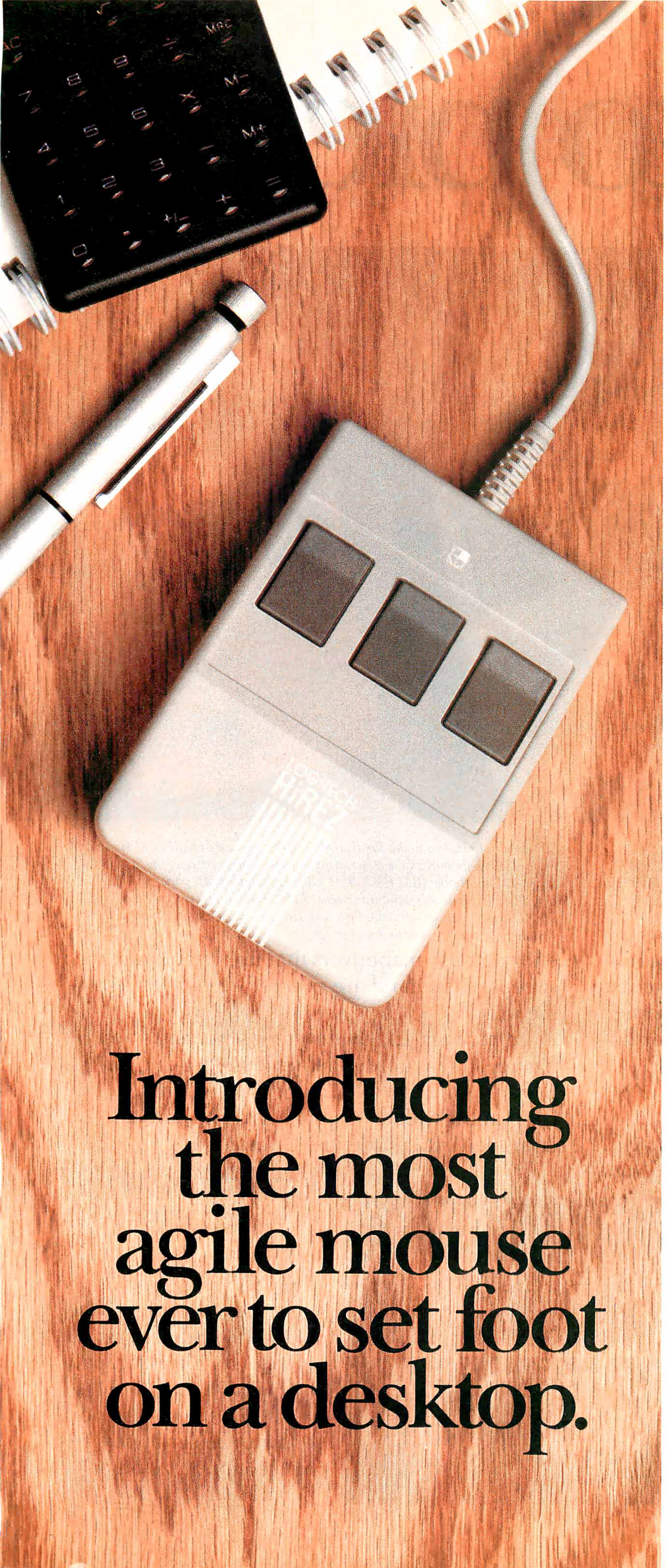
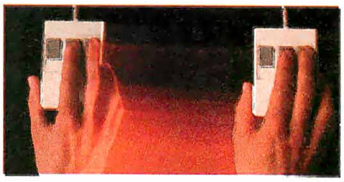


The LOGITECH HiREZ Mouse—the only mouse expressly designed for high-resolution screens.

With a resolution of 320 dots-per-inch (as compared with 200 dpi or less for ordinary mice), it covers the same area on your high-res screen, but needs less of your desk to do it. More than 50% less. Saving you valuable desk space, and effort: mouse maneuvers that used to require a sweep of the hand are now reduced to a flick of the wrist.



The LOGITECH HiREZ mouse needs 50% less desk space to cover the same amount of screen area as a 200 dpi mouse.

Which makes this new mouse a hand's best friend. And a more reliable, long-lasting companion—fully compatible with all popular software, and equipped with a Lifetime Guarantee.

Equipped, too, with other advantages exclusive to all Logitech mice: A unique lightweight ergonomic design. Low-angled buttons for maximum comfort and minimum fatigue. An exclusive technology that guarantees a much greater life span. An exceptionally smooth-moving, dirt-resistant roller ball. And natural compatibility with all PCs, look-a-likes, and virtually any software.

So if you've got your eyes on a high-res screen, get your hands on the one mouse that's agile enough to keep up with it.

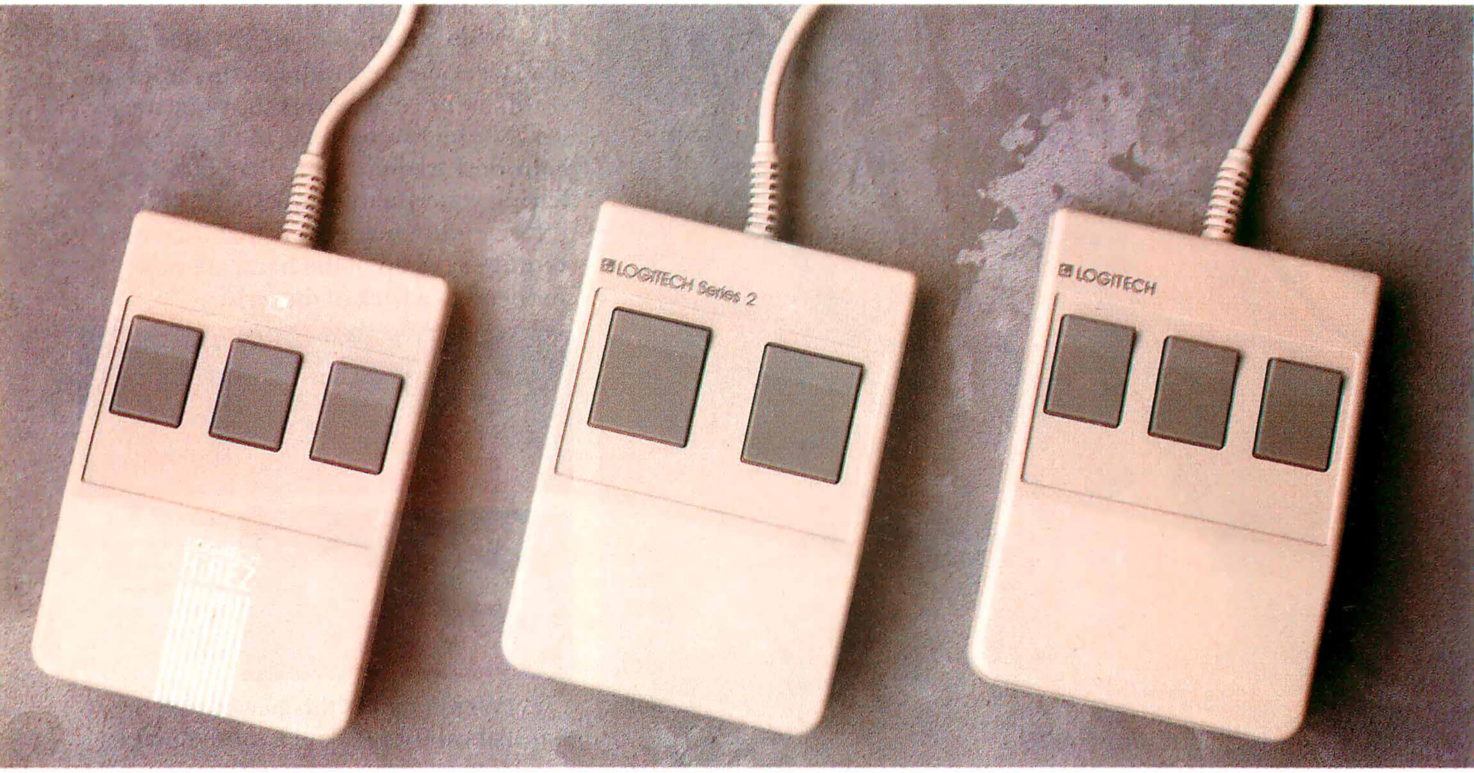
The LOGITECH HiREZ Mouse.

For the dealer nearest you, call **800-231-7717** (**800-552-8885** in California), or write Logitech, Inc., 6505 Kaiser Drive, Fremont, CA 94555. In Europe, call or write: Logitech Switzerland, European Headquarters, CH-1111 Romanel/Morges, Switzerland (++41-21-869-9656).

LOGITECH

Circle 167 on Reader Service Card (DEALERS: 168)

How to pick th



Good instincts run in this family (left to right): the new LOGITECH HiREZ Mouse ($179), the only mouse designed expressly for high-res screens; the LOGITECH Series 2 Mouse for the IBM PS/2 ($99, plugs right into mouse port); and the LOGITECH Mouse for standard screens ($119, in bus and serial versions).

All come with Logitech's own Plus Software, which assures ease of use with virtually any software, mouse-based or not.

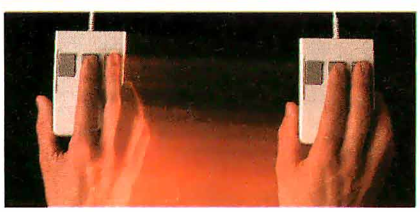
Though most mice out there look pretty much alike, they're not all equal in performance. It pays to be just a little choosy to make sure you end up with the right mouse for your needs.

Starting with software. If you want full compatibility with all of your software, all you have to do is look for a mouse with the Logitech name. There are four in all, each one designed for different hardware needs.

THE HiREZ MOUSE

If you've got your eyes on a high-resolution screen, the mouse to get your hand on is the new LOGITECH HiREZ Mouse.

With a resolution of 320 dots-per-inch (as compared with 200 dpi or less for ordinary mice), it covers the same area on your high-res screen but needs less of your desk to do it. More than 50% less. Saving you valuable desk space, and effort: mouse maneuvers that used to require sweeps of the hand are now reduced to a flick of the wrist.



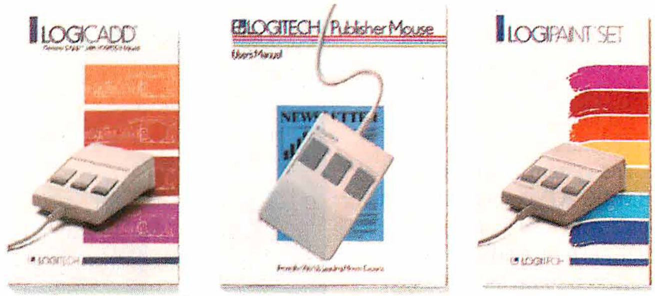
The LOGITECH HiREZ Mouse needs 50% less desk space to cover the same amount of screen area as a 200 dpi mouse.

Which makes this new mouse a hand's best friend. And a more reliable, long-lasting companion. And, like all Logitech mice, it's fully compatible with all popular software, and equipped with a Lifetime Guarantee.

THE SERIES 2 MOUSE

For those who've chosen the Personal System/2,™ the most logical choice is the LOGITECH Series 2 Mouse. It's 100% compatible with PS/2, and plugs right into the mouse port, leaving the serial port free to accommodate other peripherals.

e right mouse.



A Logitech mouse plus Logitech application software equals a complete solution (all prices include mouse, Plus Software, and application):

LOGICADD...$189. Turns your PC into a full-featured CADD workstation. Everything you need for dimensioned line drawing and CADD.

PUBLISHER PACKAGE ...$179. PUBLISHER software lets beginners and experts alike produce professional, high-impact documents. Design templates make page layout easy.

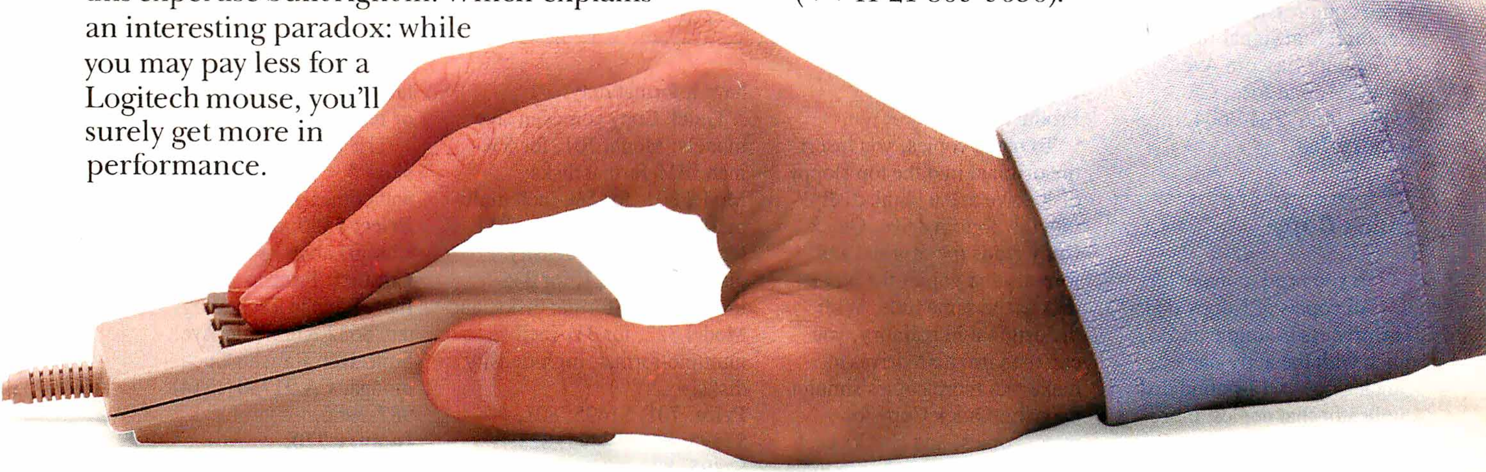
LOGIPAINT SET... $149. Eleven type fonts and a 16-color palette. Creates files that move easily into both LOGICADD and PUBLISHER documents.

THE ALL-PURPOSE MOUSE: SERIAL OR BUS

Most people find our standard mouse is still the best choice for their systems. It's available in both bus and serial versions, one of which is sure to fit perfectly with your hardware. And with all your favorite software—whether mouse-based or not.

It's hardly an accident that only Logitech offers you such a complete selection—we're the only mouse company to design and manufacture our own products. We make more mice, in fact, than anyone else. Including custom-designed models for OEMs like AT&T, DEC, and Hewlett-Packard.

The three mice pictured to the left come with all this expertise built right in. Which explains an interesting paradox: while you may pay less for a Logitech mouse, you'll surely get more in performance.



And in comfort. With a unique lightweight ergonomic design. Low-angled buttons for maximum comfort and minimum fatigue. An exclusive technology that guarantees a much greater life span. An exceptionally smooth-moving, dirt-resistant roller ball. And natural compatibility with all PCs, look-a-likes, and virtually any software.

All of which leads to an inescapable conclusion: if you want to end up with the right mouse, start with the right mouse company.

Logitech. We've got a mouse for whatever the task at hand.

For the dealer nearest you, call **800-231-7717** **(800-552-8885** in California). Or fill out and mail the coupon below to: Logitech, Inc., 6505 Kaiser Drive, Fremont, CA 94555. In Europe, call or write: Logitech Switzerland, European Headquarters, CH-1111 Romanel/Morges, Switzerland (++41-21-869-9656).

Logitech, Inc., 6505 Kaiser Drive, Fremont, CA 94555.
Logitech Switzerland, European Headquarters,
CH-1111 Romanel/Morges, Switzerland.

Yes! Please send me the name of the nearest Logitech dealer.

Name ______________________

Company/Title ______________________

Address ______________________

Phone ______________________

LOGITECH

Personal System/2 is a trademark of International Business Machines, Corporation.

Circle 169 on Reader Service Card (DEALERS: 170)

HARDWARE • OTHER

Get the Picture?

With the Image Phone system, StarSignal says you can store, retrieve, and send full-bandwidth color video pictures over conventional phone lines in 5 to 15 seconds.

The system includes an IBM PC AT–compatible computer with a keyboard, a dual-purpose RGB/NTSC (data/video) monitor, a video compression and frame capture board, a 40-megabyte hard disk drive, a color camera, software, a 9600-bps modem, and a mouse. You can store up to 2000 TV-resolution color stills on the 40-megabyte hard disk drive. You can also upgrade the system to NTSC (National Television System Committee) standards, making it usable for broadcast, cable, and other standard video applications.
Price: $12,995 for the complete system; $1995 for Starlite video compression board.
Contact: StarSignal Inc., 1210 South Bascom Ave., Suite 221, San Jose, CA 95128, (408) 294-9604.
Inquiry 768.

Image Phone sends full-bandwidth color over phone lines.

Quick Copy

Do you need to make lots of copies of floppy disks? The process is simple and quick with the aptly named Quick Copy, a 12-pound disk duplicator that copies unprotected 5¼-inch or 3½-inch disks 3 to 5 times faster than a PC, according to ALF Products.

To make copies, you insert the original into the top floppy disk drive and a blank disk into the bottom drive. Quick Copy reads the original and formats and copies the blank disk at the same time. With the original in memory, you can then use both drives to make two more copies simultaneously. Quick Copy formats, copies, and checks each disk; you can also choose to have it format only.

Quick Copy comes in five models: Model 701, for 5¼-inch IBM-format disks; Model 801, for 5¼-inch multiple-format disks; Model 811, for 5¼-inch high-density disks; Model 821, for 3½-inch multiple-format disks; and Model 822, for 3½-inch multiple-format, high-density disks.
Price: 701, $1495; 801, $1995; 811, $2495; 821, $2495; 822, $3495.
Contact: ALF Products Inc., 1315F Nelson St., Denver, CO 80215, (800) 321-4668; in Colorado, (303) 234-0871.
Inquiry 769.

Tracking the Elusive SCSI

To know what's happening in your small-computer-system-interface (SCSI) channels, use the RT101 SCSI Byte Grabber. It connects between your SCSI port and any SCSI controller or embedded SCSI drive. The face of the instrument has 10 hexadecimal LEDs that display all control-bus signals, including data parity status. A latched display indicates the data bus status and has a switch that lets you choose free-running or single-step modes.

The Byte Grabber operates from a single 5-volt DC power source, and a UL-approved power pack lets you operate from a standard AC line. Using the Byte Grabber's own reset switch, you can reset the target device without resetting or rebooting the system.

The Byte Grabber measures 5¼ by 4 by 1½ inches and comes with connectors.
Price: $380; optional 3-foot ribbon cables, $15 each.
Contact: Rancho Technology Inc., Rancho Technology Center, 8632 Archibald Ave., Suite 109, Rancho Cucamonga, CA 91730, (714) 987-3966.
Inquiry 770.

continued

PLAY THE NUMBERS GAME

The Touchstone 3 numeric keypad was designed for laptops, but it works with larger portables and standard PCs as well.

The 22-key layout includes math, cursor-control, Backspace, Escape, Enter, and function keys, as well as 10 numeric keys.

The keyboard uses standard ASCII character codes and attaches to any RS-232C serial port. It comes with a 4-foot cable and requires no batteries or external power. Touchstone says the keyboard draws only 6 milliamperes of current from the serial port.

The RAM-resident software that is included lets you use the numeric and main keyboards at the same time. Touchstone 3 measures a svelte 5 by 7½ inches and weighs just under a pound.
Price: $129.95.
Contact: Touchstone Technology Inc., 955 Buffalo Rd., P.O. Box 24954, Rochester, NY 14624, (716) 235-8358.
Inquiry 771.

SOFTWARE • PROGRAMMING

BRICKLIN DOES IT AGAIN

Demo II helps you to produce full-fledged mock applications, demos, and tutorials. The new version has 75 added features. It lets you create 80- by 25-character text slides, capture text or bit-mapped graphics images from other programs, and construct text screen images from other slides. It also now comes shrink-wrapped with standard documentation.

The bit-mapped graphics screen images can include normal text or bit-mapped images in CGA, EGA, or Hercules modes. In the new version, you can set and test string and numeric variables to turn overlays on and off or change their positions.

Other new actions that you can perform while it's running include arithmetic operations, `If`, `While`, `Select/Case`, file, and printer I/O. Slide Switch settings in Demo II let you create special effects, controlling how the screen changes from one slide to another.

Other minor changes in the new version include copy/paste, text-block word wrapping, type-ahead buffer flushing, and an upgraded `Capture` program.

The manual has grown from 29 to 200 pages, and the program comes with an on-line tutorial and function-key templates. Demo II lets you produce an unlimited number of copies of the run-time module—a change from the old version's run-time license for just 50 copies.

Demo II runs on the IBM PC, AT, PS/2s, and compatibles with DOS 2.0 or higher and 512K bytes of RAM. It supports monochrome, CGA, EGA, VGA, Hercules adapters, or their equivalents. (The run-time version requires 256K bytes of RAM.)

Price: $195.

Contact: Software Garden Inc., P.O. Box 373, Newton Highlands, MA 02161, (617) 332-2240.

Inquiry 775.

Talking to DOS

DOSTALK is a DOS shell that lets you submit your DOS requests in plain English. It then translates the request into its MS-DOS equivalent, and, using artificial intelligence and parsing techniques, enhances the translation with other information needed, according to SAK Technologies. The company reports that most sentences are parsed, understood, and transformed into a DOS command in less than 2 seconds on a conventional IBM PC.

The package includes DOS utilities such as `search` and `locate`, `undo`, `find`, `erase`, and `copy`, as well as an input history buffer. All DOS external commands are listed in a menu with their respective options.

The program is written in MuLisp, with a small portion in Turbo Pascal. The major DOSTALK module does not remain resident, although you can invoke it by pressing the F2 key at the DOS prompt. It comes in two parts: an 18K-byte section and a 190K-byte section. When you invoke an external program, the 190K-byte part is removed from RAM, and just the 18K-byte part stays resident. Once the external program is terminated, the 18K-byte part reinvokes the main body.

To run DOSTALK, you need an IBM PC or compatible with at least 256K bytes of RAM and DOS 2.1 or higher. It is not copy-protected.

Price: $89.95.

Contact: SAK Technologies Inc., 1600 North Oak St., Suite 931 W, Arlington, VA 22209, (703) 522-6425.

Inquiry 772.

Program in Prolog, with C and Pascal on the Side

Arity/Prolog version 5.0 includes an embedded C compiler that lets you use C and Pascal with Prolog. The Arity/Prolog compiler and interpreter are written in Arity/Prolog and assembly language and are a superset of Edinburgh Prolog. The program includes a development and run-time environment for writing, debugging, and running Prolog and assembly language programs. You can purchase the compiler and interpreter separately.

Arity/Prolog contains a C compiler that handles C declarations, preprocessor directives, and C expressions embedded within Prolog source code. Arity reports that it is 2 to 10 times faster than other microcomputer implementations of Prolog and that it outperforms many minicomputer implementations. It supports expanded LIM (Lotus/Intel/Microsoft) memory and generates standard MS-DOS `.OBJ` files that you can link to create stand-alone programs. It also includes object-oriented routines that let you create windows, pull-down menus, and edit and dialog boxes. Arity's programming shell lets you use its built-in editor or a text editor of your choice.

Arity/Prolog also includes a virtual database. Arity reports that you can manage databases of up to 2 gigabytes. Sequential, hashed, and binary-tree access methods are included, and you can also define custom-access methods.

Arity/Prolog supports IEEE floating-point arithmetic, including transcendentals. It also supports the 8087, 80287, and 80387 coprocessors.

Other Arity programs, such as Arity/Expert, Arity/SQL, or Arity/Advanced Toolkit, can be added onto the basic Arity/Prolog programming environment.

Arity/Prolog runs on the IBM PC, XT, AT, and compatibles with at least 640K bytes of RAM and a hard disk drive.

Price: Arity/Prolog compiler and interpreter, $650; interpreter alone, $295; Arity Combination Pak (includes all add-ons), $1095.

Contact: Arity Corp., 30 Domino Dr., Concord, MA 01742, (617) 371-1243.

Inquiry 773.

Disassemble and Patch Your Code

Soft-X-Plore is a disassembler and patcher that uses four algorithms to separate code from your data. RJ Swantek reports that the package does this at a rate of 10,000 lines per minute on a hard disk drive.

The disassembler is compatible with the 80386 and 80387 instruction sets. It disassembles what's in the files or in RAM memory and patches files using the same addresses given in the disassembled listing. It creates a MASM-ready output and generates labels for `Jump`, `Branch`, `Call`, `Data`, and `Stack`.

The program can generate comments for MS-DOS and BIOS services. And it will keep patches in separate files for documentation. To speed up creation of future listings, it saves the results of its first program pass.

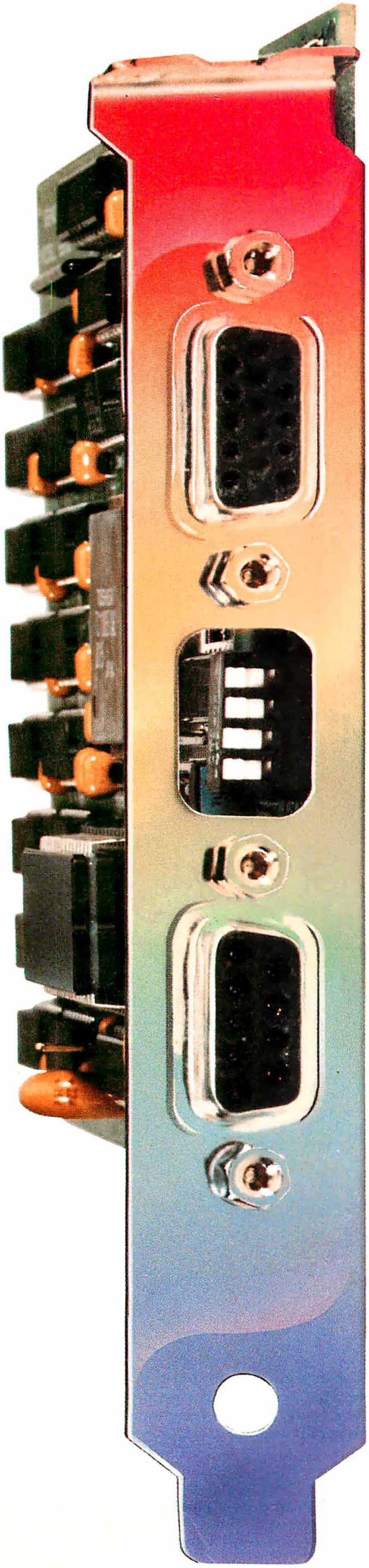
Soft-X-Plore runs on the IBM PC, XT, AT, and compatibles with at least 256K bytes of RAM and DOS 2.0 or higher.

Price: $99.95.

Contact: RJ Swantek, P.O. Box 1032, Hartford, CT 06111, (203) 560-0236.

Inquiry 774.

continued



Introducing the new JPI Modula-2

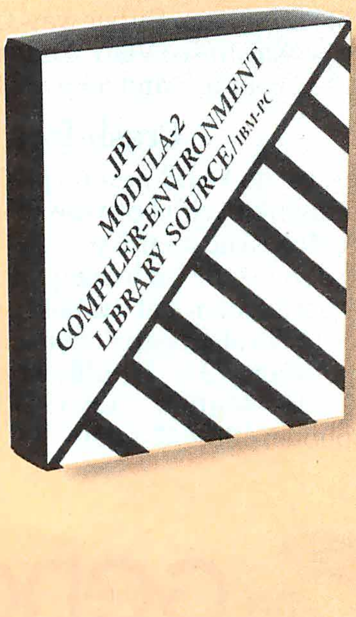
Faster than C

Smoother than Pascal

Sieve benchmark: 3.2 seconds

$59.95*

Yes, you can really get it today!**



What these distinguished users have to say:

"JPI Modula-2 is the Modula-2 compiler we've all been waiting for. Its speed and ease of use are an unbeatable combination. It is a delight to use."

—K. N. King, Dep't of Mathematics & Computer Science, Georgia State U.

"The JPI compiler is the best on the market; fantastic code; lovely environment."

—Paul Curtis

"JPI Modula-2 is a landmark product. I found JPI Modula-2 to be not just a good product, but an exceptional product. The compiler is superb, the programming environment is better than anything on offer from Borland or Microsoft . . ."

—Huw Collingbourne, Computer Shopper.

"I've now got my copy of JPI Modula-2, and can see what people are raving about. Super compiler, very good development environment (powerful and unfussy)."

—Martin Rand, PCIL

"I like JPI Modula-2 a lot better than any other M2 I've tried."

—Owen Linderholm, Personal Computer World.

* Introductory price until July 4, 1988. Then $99.95.

** Has been shipping in Europe since December.

JPI Modula-2 brings you the full power of Modula-2, the language of the future.

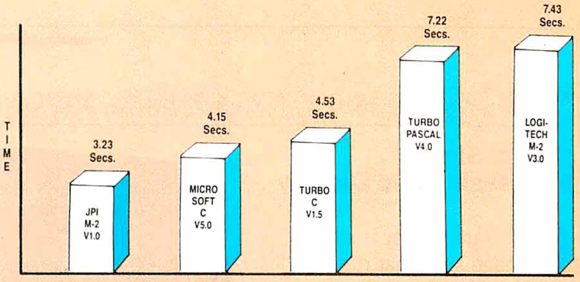
Modula-2 was designed by Niklaus Wirth as the successor to Pascal. But Modula-2 is not merely an updated Pascal. It is also ideally suited for serious systems programming, just like C.

In fact, anything you can do in C you can do in Modula-2. This includes all kinds of bit-twiddling and type-casting, and the use of procedure variables. In addition you get multi-tasking in the form of co-routines and all the other advantages a modern programming language offers.

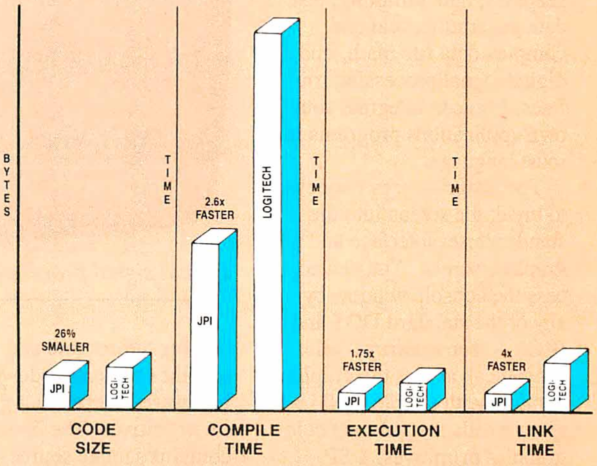
Moreover, the JPI programming environment takes the state of the art a step further. You get a completely window-based environment which lets you edit several files simultaneously in separate windows. It compiles, links and runs your programs at a single keystroke.

But the bottom line is code quality. The code should be compact and fast. Independent benchmarks carried out by the British Standards Institute confirm that JPI Modula-2 excels (see table on Sieve benchmark).

Beyond all this, if you already know Pascal, you already know enough Modula-2 to get you started. All it takes is half an hour getting familiar with the new powerful features in Modula-2.

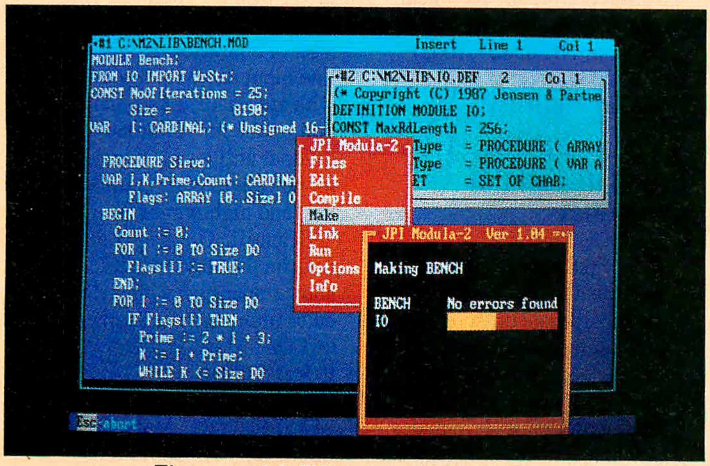


Sieve benchmark execution time; 25 iterations measured by British Standards Institute.



JPI-LOGITECH COMPARISON

Here's a comparison of JPI-Modula-2 with Logitech Modula-2 using the real-life program "Repertoire" produced by PMI of Portland. As shown, JPI-Modula-2 compiled the huge 39-module program 2.6X faster than Logitech, linked the program 4X faster, reduced the resulting code size for "screen compile" by 26%, and achieved a speed increase of 75%.
(Benchmarks run on Compaq 286 8MHz)



The powerful JPI environment in action.

$59.95*	**$49.95**
JPI-MODULA-2 COMPILER KIT (IBM PC)	**JPI-MODULA-2 TECHNICAL KIT** (IBM PC)
Includes free language tutorial, compiler, environment, ed'r, linker.	Includes communications, TSR modules; start-up assembler source code, PROM locator and much more.

OTHER DATA

Runs on all IBM PCs and compatibles. Requires 384K available RAM, two floppy drives (hard disk preferred).

COMPILER HIGHLIGHTS:

• Full edition 3 implementation as defined by Niklaus Wirth • Long data types (LONGINT, LONGCARD, LONGREAL) • Structured constants • Compiles 4-6000 lines/minute (PC AT 8 Mhz) • Up to 1M bytes code and data • Long and short pointers, short pointers in any segment • Total segment control (memory models) • Supports multi-tasking • Uses standard .OBJ file format • Separate compilation of modules • Automatic "librarian", smart linking • Automatic "make" facility • Supports hardware 80x87 and software emulation • Direct DOS/BIOS calls • Supports TSR programming (no assembler needed) • High-performance window management • Multiple overlapping windows • Write to partially obscured windows • Full cursor and attribute control • Move, re-size, re-color, re-stack windows freely.

ENVIRONMENT HIGHLIGHTS:

• Multi-window/multi-file editing • Compile, link and run with a single keystroke • Pin-points multiple compile-time errors in source • Pin-points run-time errors in source without delay • Interactive or batch operation • High-speed linker • All environment and editor commands and menus are re-configurable • Windows may be re-sized, re-colored, and moved around any time • Hot restart.

LIBRARY HIGHLIGHTS:

• Direct keyboard and screen input/output • File input/output and directory management • String handling • Storage management • Logarithmic and trigonometric functions • Time-sliced process scheduling • High-speed graphics for CGA, EGA, VGA • Procedure tracing and variable trapping • Sorting, random number generation, DOS/BIOS calls, long jumps, sound generation, error-handling • Full Modula-2 source supplied!

TECHNICAL KIT:

• High-performance JPI assembler • Assembler source for run-time library and start-up code • Binary locator for PROM use • Interrupt-driven communications driver • General JPI Modula-2 Terminate-and-Stay-Resident module.

ORDER NOW

30-day no-questions-asked money-back guarantee.

Only $59.95 until July 4, 1988. Regularly $99.95 CALL 1-800-443-0100 Ext. 255 free of charge, 24 hours. Or use coupon. COD, credit cards, checks accepted. Shipping charges in U.S. included in sales price. Calif. residents add 6% sales tax plus county tax.

JPI • 1101 San Antonio Road, Mountain View, CA 94043

Please ship: ☐ **One JPI-Modula-2 Compiler @ $59.95*.**
☐ **5¼"** ☐ **3½"** *99.95 after July 4.
☐ **One Technical Kit @ $49.95.**
☐ **5¼"** ☐ **3½"**

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In Europe, send coupon to: **Jensen & Partners, U.K. Ltd.,** 63 Clerkenwell Rd., London EC1M 5NP, Phone: (01) 253-4333, Free phone: 0800-444-143, 24 hours. COD, credit cards and checks accepted. London Prices: Compiler £59.95; Technical Kit £29.95.

JPI Jensen & Partners International, Inc.

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Mountain View, CA 94043
(415) 967-3200

Circle 151 on Reader Service Card

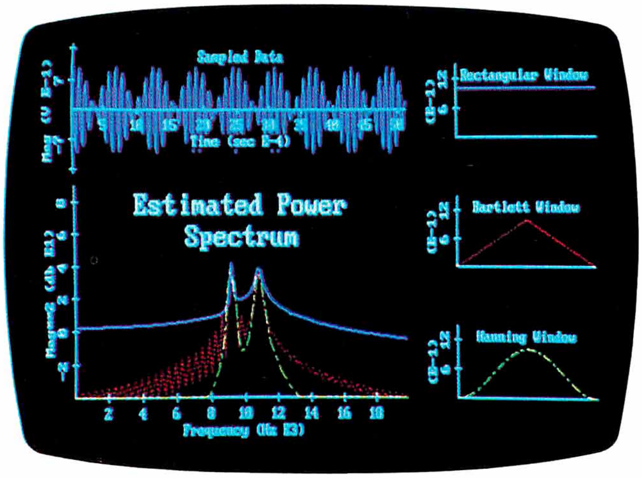
SOFTWARE • SCIENTIFIC AND ENGINEERING

Digital Signal Processing and Display

PC Data Master is a command shell that runs on top of DOS 2.0 or higher. The program comes with applications routines including graphics, data sampling, test data generation, real and complex data file math, and digital signal processing routines. You can integrate your own applications programs in most languages.

The program uses windows to break the screen into the standard user interface and a graphics screen. You can access the console window by any of the standard DOS and BIOS screen interrupt calls. Or you can access the graphics window with simple shell interrupt calls that provide color graphics primitives. DSP utility modules provided include forward and inverse fast-Fourier-transform (FFT) routines, convolution, correlation, window generation, and test data generation. Many data-file math operations are also included.

The basic program contains the shell, the signal processing utilities, and all the information you need to integrate your own data analysis routines with the supplied modules. An optional Application Development Toolkit offers information on the shell's enhanced BIOS calls for controlling the console and graphics screen windows and hardware-independent graphics primitives. The Toolkit also contains sample source code in C and FORTRAN.



Digital signal processing with graphics functions.

The program provides separate shells for systems with CGA, Hercules, EGA, or VGA graphics.

Written in assembly language and C, PC Data Master runs on the IBM PC, XT, AT, and compatibles with 256K bytes of RAM and DOS 2.0 or higher. A math coprocessor is recommended, as is additional RAM for data pipes. The program also runs on the PS/2s. It is not copy-protected.

Price: $115 for the basic package; $45 for the Application Development Toolkit; $95 for an academic site license.

Contact: Durham Technical Images, P.O. Box 72, Durham, NH 03824, (603) 868-7203.

Inquiry 776.

Graphics for the Scientist

CobraSystems' precompiled set of C routines lets you incorporate on-screen windowed data plotting, graphics, and text into your acquisition, analysis, and signal-processing programs. It includes 24 window formats, or you can specify your own screen format in a particular program, with up to 10 simultaneous windows. Scientific Graphics Library maintains up to five nested pop-up windows of any size, located anywhere on the screen.

The program supports linear, log, and similar Cartesian plotting, with up to three independent *y* axes, polar plotting, and three-dimensional perspective plotting. Data plot formats include multiple point and line style, envelopes, filled and unfilled bar charts, and vertical lines.

The library also includes graphics primitives such as point, line, and polyline drawing; filled and unfilled rectangles, circles, and arcs; and polygon drawing.

Text input and output is done with all positions defined in *x,y* window character coordinates. The package includes a set of character, string, and line input and output routines, with automatic cursor generation on the input routines. Additional utilities are provided for selective erasure, underlining, and highlighting.

Scientific Graphics Library runs on the IBM PC, XT, AT, and compatibles with a Hercules monochrome adapter or EGA.

Price: $180.

Contact: CobraSystems, 14700 Main St., Suite 3, Bellevue, WA 98007, (206) 641-2759.

Inquiry 777.

continued

CAD DREAMS TO DEBUT IN SUMMER

Dreams is a modular CAD program from Innovative Data Design (IDD), the makers of MacDraft. The program will be available in a base version, or with separate symbol libraries, plotter drivers, an integrated database, and palettes, depending on your needs. The program is not going to replace MacDraft; it will support drawings created with MacDraft by means of a resident conversion utility.

The Dreams base product includes a Drafting Palette consisting of a set of tools for creating text, lines, or shapes. An Accessory Palette offers tools for zooming, rotating objects around various axes, extending lines to their intersections, and creating fillets. A Dimension Palette supports point-to-point and object-dependent dimensioning in a variety of ways.

With a Mac II, you can have up to 255 colors per drawing, and pattern libraries of up to 255 patterns. Bézier and spline curves are included, along with a library of drawing tools. The program imports encapsulated PostScript files and bit-mapped images. Layers are limited only by memory, and keyboard entry is supported. You can zoom up to 32 times. Other features include floating palettes, hierarchical menus, and pop-out menus.

IDD plans to offer symbol libraries for both residential and commercial construction, electrical and mechanical engineering, and interior design. The program will also support user-defined symbol libraries.

Dreams is scheduled to ship in July.

Price: $500 for base package; add-on prices not yet announced.

Contact: Innovative Data Design, 2280 Bates Ave., Suite A, Concord, CA 94520, (415) 680-6818.

Inquiry 778.

SOFTWARE • BUSINESS

An Oracle with a Sequel

Oracle's database add-in for Lotus 1-2-3 lets you store SQL (Structured Query Language) commands as 1-2-3 functions. You retrieve Oracle data from menus that are transparently converted to SQL statements, or you can choose to type the SQL statements yourself.

Oracle for 1-2-3 also has a feature that updates the database when you change worksheet cells. You can interface with other versions of Oracle on microcomputers, minicomputers, or mainframes. In addition, the database offers data security, protected mode and support for 80286 and 80386 technology, distributed database functionality, and transaction management and recovery.

The program runs on 80286- and 80386-based systems and requires Lotus 1-2-3 version 2.01, DOS 3.0 or higher, 640K bytes of RAM, 896K bytes of extended memory, 5 megabytes of hard disk space, and a floppy disk drive.
Price: $199.
Contact: Oracle Corp., 20 Davis Dr., Belmont, CA 94002, (415) 598-8000.
Inquiry 779.

Button Pops Out New Programs

ButtonWare is adding features and new command options to PC-Calc. The new version, PC-Calc+, includes graphing, split screens, access to DOS, 8087 and 80287 support, formatting features, and sideways printing capabilities. It also includes business and financial, date and time, and additional trigonometric capabilities.

PC-Calc+ runs on IBM PCs with at least 280K bytes of RAM and DOS 2.0 or higher. It supports EGA and VGA graphics, along with monochrome and color.

ButtonWare has also upgraded its database program, PC-File+. Version 2.0 supports summary graphics with horizontal and vertical bar charts, and line, scatter, and pie graphs. A hot key has been added to the calculator to let you perform calculations at any time.

The program uses the Microsoft 5.0 compiler, which speeds up operation, according to ButtonWare. It supports the 8087 and 80287 floating-point coprocessors. And additional passwords, stored in an encrypted file, enhance security features.

Field size has been increased from 65 to 200 characters; record size has increased from 1665 to 3000 characters; and macros have increased from 12 to 22.

An enhanced report writer lets you keep field data in headers, footers, and subtotals. The program now supports date arithmetic as well.

PC-File+ 2.0 runs on IBM PCs with at least 384K bytes of RAM and DOS 2.0 or higher.
Price: PC-Calc+, $69.95; PC-File+ 2.0, $69.95.
Contact: ButtonWare Inc., P.O. Box 5786, Bellevue, WA 98006, (206) 454-0479.
Inquiry 780.

Check Those Changes

If you've ever had to compare document revisions against each other, you know it can be a time-consuming and error-prone task. The program DocuComp will compare two versions of a document, even if they were created on different word processors, according to Advanced Software. The program highlights revisions in the following ways: on a split-screen display, showing the original and revised documents simultaneously; in printed form, showing inserted, deleted, replaced, and moved text; in a comparison file on disk; and in summary report form.

The summary report gives a condensed view of every revision, showing the text that was changed, along with the page and line number of the change.

Version 1.0 of DocuComp is currently available, with version 1.1 following closely behind. The update will add a virtual memory scheme and will support a few more word-processing programs. DocuComp runs on the IBM PC and compatibles with 512K bytes of RAM and DOS 2.0 or higher.
Price: $149.95.
Contact: Advanced Software, 1095 East Duane Ave., Suite 212, Sunnyvale, CA 94086, (800) 346-5392; in California, (408) 733-0745.
Inquiry 781.

continued

A NEW LEGEND IN DESKTOP PUBLISHING

NBI has a desktop-publishing program for the IBM PC AT. The company says that the new product, Legend, combines the features of a standard desktop-publishing package with those of a full word processor and graphics package.

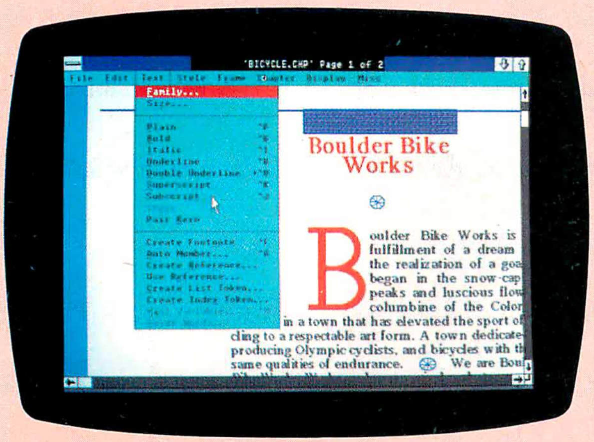
Legend runs under Windows 2.0 and uses that environment's user interface.

The desktop-publishing features of the program include automatic kerning and hyphenation, and automatic text flow into linked frames. The program handles up to 750 pages, page sizes up to 22 inches long or wide, and up to 32 columns per page.

The program's word-processing capabilities include an 80,000-word spelling checker and mail-merge capabilities.

The graphics features are similar to those of Windows Draw, from Micrographx. This object-oriented graphics package is compatible with files created by a number of other different graphics packages.

Legend runs on 80286- and 80386-based IBM PC ATs or compatibles with at least 640K bytes of RAM and a 20-megabyte hard disk drive, an EGA, a Hercules graphics card, or other Windows 2.0-compatible display devices. You also need a two- or three-button Windows 2.0-compatible serial or bus mouse, DOS 3.2, and Microsoft Windows 2.0. The program does not support CGA.
Price: $695.
Contact: NBI Inc., 3450 Mitchell Lane, P.O. Box 9001, Boulder, CO 80301, (303) 938-2584.
Inquiry 782.



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SOFTWARE • BUSINESS

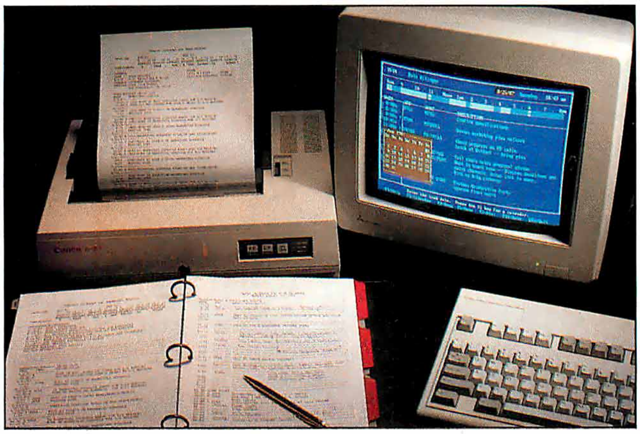
Who/What/When

The time and information management program Who/What/When from Chronos Software presents a view of people, projects, and time. You can look at lists of people, resources, and deadlines from a project-oriented view; view lists by projects, tasks, and schedules from a people-oriented view; or scroll through its daily calendar for a time-oriented view.

The program handles an unlimited number of people, resource projects, subprojects, and tasks. You can attach memos, notes, and expense and budget reports to people, resources, and projects. You can also create a to-do list ranked by priority.

Gantt charts are included in the project time lines, along with week-in-review and project-in-review overviews. Other features include a mailing list manager, address and phone book, card file, calculator, auto-dialer, and a notebook with preprinted forms that you can use in meetings.

Who/What/When runs on the IBM PC, AT, XT, and compatibles with at least 512K bytes of RAM and DOS 2.1 or higher. It also runs on PS/2s, and it is not copy-protected.
Price: $189.
Contact: Chronos Software, 1500 16th St., San Francisco, CA 94103, (415) 626-4244.
Inquiry 783.



Managing people, projects, and time with Who/What/When.

Two for 1-2-3

Flash-In lets you view any Lotus 1-2-3 worksheet without leaving your work. It adds search, replace, and locate features to Lotus 1-2-3. A zoom-out function is compatible with any graphics adapter that works with 1-2-3. A label search and replace function accesses labels, numbers, or formulas.

A second add-in is Graph-Mania, which adds rows, columns, and a graph in a window. You can compress or expand the worksheet for access to a larger or smaller block of data, and a variable-size window displays a graph that is updated in real time as you work on your spreadsheet.

Both add-ins run on IBM PCs with at least 320K bytes of RAM, DOS 3.0 or higher, and Lotus 1-2-3 version 2.0 or 2.01.
Price: Flash-In, $99.95; Graph-Mania, $79.95.
Contact: PC Publishing Inc., 1801 Avenue of the Stars, Suite 800, Los Angeles, CA 90067, (213) 556-3630.
Inquiry 784.

Paradox Picks Up Speed

Paradox 386 sorts, queries, and produces reports 5 times faster than previous versions. The 386 version has a Phar Lap 386|DOS-Extender embedded within the program, letting you access Paradox in the same manner as with earlier releases.

The program is available on 3½-inch and 5¼-inch floppy disks. Borland reports that it supports the Intel Inboard and runs under DESQview 386 from Quarterdeck.
Price: $895.
Contact: Borland International, 4585 Scotts Valley Dr., Scotts Valley, CA 95066, (408) 438-8400.
Inquiry 785.

A dBASE III Workalike for $39

One on One Computer Solutions' dBASE III workalike, 1 on 1 = 3, is compatible with dBASE III commands and functions in the dot prompt and programming mode. Its databases, memo, memory, report control, and label control files are compatible with dBASE II files. Index files are not. It can also read dBASE II files and report the information, but it cannot write them.

The company reports that 1 on 1 = 3 places no limit on the total number of lines of code. You can customize the menu structure and add functions to the assist mode. The program lets you enter a read-only mode.

1 on 1 = 3 is written with the FoxBASE Plus compiler. It runs on IBM PCs with at least 512K bytes of RAM.
Price: $39.
Contact: One on One Computer Solutions Inc., 26 Finchwood Dr., Trumbull, CT 06611, (203) 375-0914.
Inquiry 786.

continued

ASHTON-TATE GETS MACSERIOUS

Ashton-Tate has three new Macintosh applications: a new dBASE Mac, a new word processor, and a spreadsheet.

The new version of dBASE Mac is an execute-only program that cuts the cost of distributing applications you've developed with dBASE Mac. RunTime includes a full version of dBASE Mac, the relational database system that accesses IBM-compatible dBASE data files.

Ashton-Tate's new word processor, FullWrite Professional, was previously announced as an upcoming product by Ann Arbor Softworks. With this WYSIWYG (what you see is what you get) word processor, you can create and manipulate text and graphics. It has an outlining capability that updates an outline as you create the document. The program also features page layout capabilities with a built-in draw environment that lets you create graphics as you write.

The last of the trio is Full Impact, a spreadsheet that includes a mini word processor, import and export capabilities, global and C-like macros, and formatting control. The program lets you have up to eight spreadsheets open at one time, with up to eight views in each. Ashton-Tate reports that the new spreadsheet will ship on July 31.
Price: dBASE Mac RunTime, $795; FullWrite Professional, $395; Full Impact, $395.
Contact: Ashton-Tate Inc., 20101 Hamilton Ave., Torrance, CA 90502, (213) 329-8000.
Inquiry 787.

Perfect matches to DEC user needs. Hip. Hip. And Hooray.

One-size-fits-all is an attribute best reserved for inexpensive socks. In the realm of PC-based emulation and communications software for DEC mainframe users, it's important to match specific user needs with specific product attributes. We have.

SmarTerm® 240 features exact four-color emulation of a DEC® VT241 terminal. Along with delivering full-screen ReGIS® and Tektronix® 4010/4014 graphics, SmarTerm 240 offers precise VT220, VT102, VT100, and VT52 text emulation.

For non-graphics applications, SmarTerm® 220 duplicates virtually every SmarTerm 240 text, communication, and ease-of-use feature. Three error-free file transfer protocols, including Kermit and Xmodem, are provided. Downloading minimizes on-line time requirements to boost overall system efficiency. And an optional network package allows direct LAN access to shared modems, printers, as well as host mainframes.

As SmarTerm 240 and 220 focus on graphics and text, new SmartMOVE® makes PC-to-the-rest-of-the-World communications sharper than ever. Speed connect, auto redial, and background file transfer features make this VT100 emulator a loud and clear choice for advanced communications requirements.

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SOFTWARE • OTHER

Extend Your Imagination on a Mac

The simulation program Extend uses block diagrams and an internal language that lets you predict the outcome of large and complex natural or man-made events.

To begin, you build a block diagram, enter data into the blocks, and connect the blocks to form a model. You can double-click on a block to view its dialog box and enter any necessary data. You then have an opportunity to change the data or the model, and to click on the run menu to execute the simulation.

The ModL scripting language has built-in plotting routines that create independent, multipanel plotting and tabular data windows. It includes over 60 built-in functions for plotting, math, file I/O, data formatting, and diagnostics. The language generates 68000 machine code and supports real, integer, and string data types.

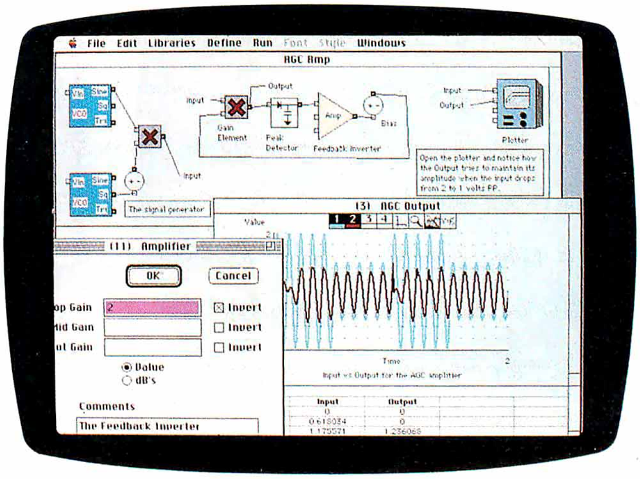
Extend blocks are actually programs written with the ModL language. You can access needed blocks by opening up to 20 libraries, each containing up to 64 different types of blocks. You can also create new libraries.

The program will run on AppleTalk networks and is compatible with the Mac Plus, SE, and II.

Price: $495.

Contact: Imagine That!, 7109 Via Carmela, San Jose, CA 95139, (408) 365-0305.

Inquiry 788.



Forming a model from Extend's block diagram.

Draw Applause

Ashton-Tate's presentation graphics program, Draw Applause, has charting abilities, a drawing board, and word charting, and it accepts a variety of input and display methods.

The program is compatible with dBASE III Plus, Master Graphics Series, and Presentation Pack. You can also import `WK1` and `DIF` files, and you can import and export Computer Graphic Metafiles (CGM). Input device options include a variety of mice and the Summagraphics SummaSketch tablet.

The program's charting features let you create line, bar, pie, area, mixed, and numeric table charts. You can customize data with multiple axes, three-dimensional effects, stacking, horizontal or vertical bars, exploded pie slices, and legend and chart frame options.

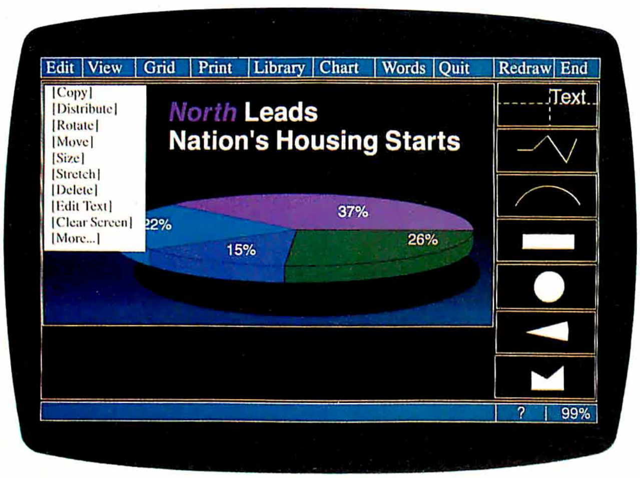
Drawing features let you customize solid or hollow fills, outline color and width, line type and thickness, and pointed or rounded corners. You can also zoom in on images; align shapes with custom and snap grids; and select colors, shapes and backgrounds for gradated effects. You can choose up to 256 colors to be displayed at one time from a choice of 16.7 million.

Draw Applause comes in 5¼-inch and 3½-inch floppy disk versions. It runs on the IBM PC, XT, AT, and compatibles, with DOS 2.0 or higher for the 5¼-inch disk version or DOS 3.3 for the 3½-inch disk version. It also runs on the PS/2s.

Price: $495.

Contact: Ashton-Tate Inc., 20101 Hamilton Ave., Torrance, CA 90502, (213) 329-8000.

Inquiry 789.



Designing applications in Draw Applause's picture window.

Got Disk Problems?

Disk Technician is a utility designed to prevent hard disk failure. You can set up the program to run automatically on a daily, weekly, or monthly basis.

According to Prime Solutions, the program reads and writes to every bit on the hard disk, whether it is occupied or not. It uses testing and repair algorithms that predict and correct failures before they occur.

The program also includes SafePark. This memory-resident program creates a safe area on the hard disk where it can place the disk heads in the event of a brown-out or power failure, thus preventing data loss.

Disk Technician runs on the IBM PC, XT, AT, and compatibles with 256K bytes of RAM and DOS 2.1 or higher. It works on hard disk drives with up to 32 megabytes. With more than 32 megabytes, it works on the first DOS partition only.

Price: $99.95.

Contact: Prime Solutions Inc., 1940 Garnet Ave., San Diego, CA 92109, (619) 274-5000.

Inquiry 790.

Upgraded Thesaurus for the Mac

WordFinder now runs with Apple's HyperCard and MultiFinder. It lets you look up synonyms while operating within any of the information stacks you create with HyperCard or while running any MultiFinder application.

The 220,000-synonym thesaurus uses less than 50K bytes of RAM.

Price: $59.95.

Contact: Microlytics Inc., Techniplex, 300 Main St., East Rochester, NY 14445, (716) 248-9150.

Inquiry 791.

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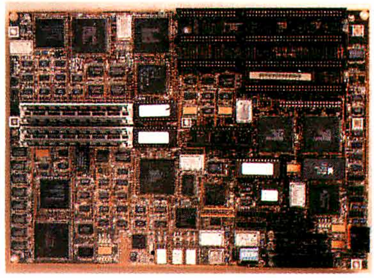

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REGIONAL SECTION

METRO NEW YORK • NEW ENGLAND

NEC's New 286

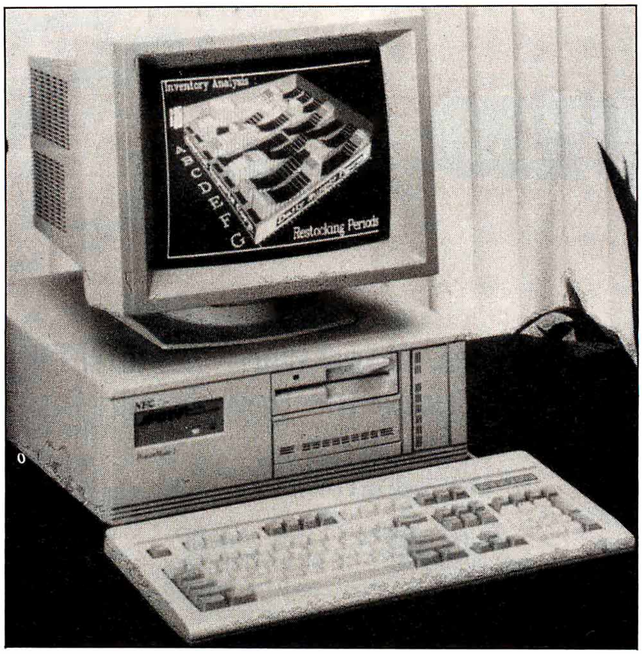
Based on an 80286 microprocessor running at 8 or 10 MHz, the APC IV PowerMate 1 from NEC provides 640K bytes of RAM, a 1.2-megabyte or 360K-byte 5¼-inch floppy disk drive, and a hard disk drive controller.

The APC IV PowerMate 1 comes with five full-size 16-bit expansion slots, one half-size 16-bit slot, and one 8-bit slot. An RS-232C serial port, parallel port, and clock/calendar are also included. MS-DOS 3.2 and GWBASIC 3.2 are standard. Options include additional disk drives.

Price: $1845.

Contact: NEC Information Systems Inc., 1414 Massachusetts Ave., Boxborough, MA 01719, (617) 264-8000.

Inquiry 820.



NEC's PowerMate 1 includes seven expansion slots.

E-Mail, Communications Program for LANs

InBox/PC is a communications and electronic mail program for IBM PCs connected to a local-area network (LAN). The memory-resident program enables you to create, send, and receive memos and phone messages. You can choose to be alerted audibly or visually when new messages arrive. The program runs in the background.

InBox/PC supports multiple message centers and provides file-transfer and password-protection capabilities. It also includes an address book, routing lists, public mailboxes, forward and reply capabilities, and RSVP notices.

The program runs on the

continued

METRO NEW YORK • NEW ENGLAND

IBM PC and compatibles with DOS 3.1 or higher, 256K bytes of RAM (640K bytes is recommended), and at least 95K bytes of free disk space. It runs on any LAN that supports DOS 3.1 or higher.
Price: $99 (supports 3 users); $599 (supports 100 users).
Contact: Symantec, Think Technologies Division, 135 South Rd., Bedford, MA 01730, (617) 275-4800.
Inquiry 824.

Books in Print Plus: Mac Version on CD-ROM

With over 770,000 citations in 17 categories, Books in Print Plus is a CD-ROM database for the Macintosh that enables you to perform searches by author, title, subject, keyword, publisher, language, price, publication date, edition, and audience. You can then save, print, or edit the information and place orders electronically.

Books in Print with Book Reviews Plus is another CD-ROM database that includes the *Books in Print* citations and about 38,000 book reviews from *ALA Booklist*, *Choice*, *Library Journal*, *School Library Journal*, and *Publisher's Weekly*.

Both databases are available in 1- and 3-year subscriptions that are updated on a quarterly basis. They run on Macintoshes with at least 1 megabyte of RAM and will be available in July, according to Bowker Electronic Publishing.
Price: 1-year subscription, Books in Print Plus, $995; 1-year subscription, Books in Print with Book Reviews Plus, $1395.
Contact: Bowker Electronic Publishing, 245 West 17th St., New York, NY 10011, (212) 337-6989.
Inquiry 825.

BASIC Software for the Mac Supports Math Coprocessor

True BASIC 2.0 for the Macintosh supports the 68881 math coprocessor. It writes to and reads directly from the coprocessor. Support has also been added for color graphics on the Macintosh II; you can select colors either by name or by number.

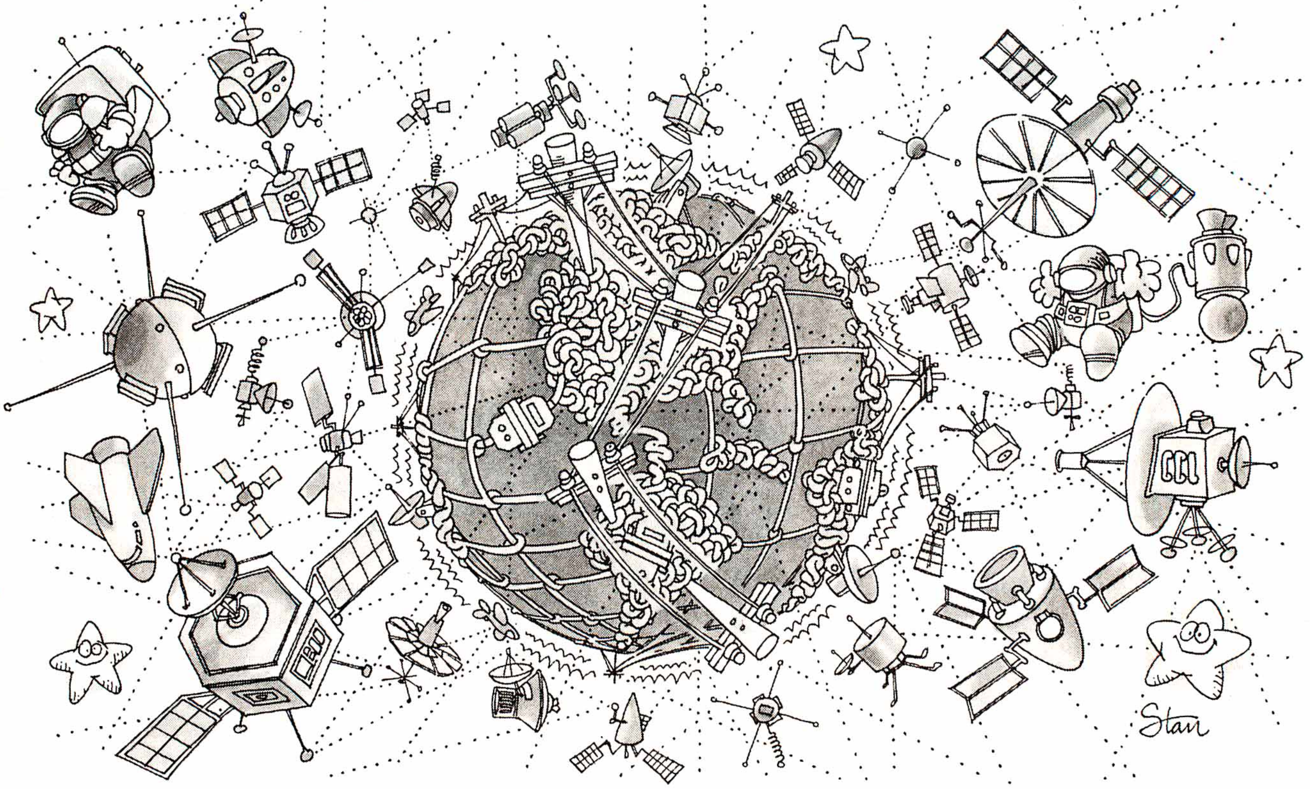
Other additions to True BASIC 2.0 include support for full-page displays and the Imagewriter and LaserWriter. You can organize collections of subroutines, functions, and data as modules; you can then share routines and data within a module while keeping them hidden from the main program. The modules support public, shared, and private variables, and have their own initialization sections. You can also add your own functions and subroutines to the language.

Additions to the editor include a `SCRIPT` command that lets you add a sequence of editor commands and program responses into a file. When you execute a `SCRIPT` command, the sequence passes to the editor, compiler, or program.

Among True BASIC 2.0's new debugging tools is one that allows you to trace through a program and view changing variables. It also has the `XREF` cross-reference utility.

True BASIC 2.0 runs on any Macintosh with at least 512K bytes of RAM. It supports MultiFinder.
Price: $99.95.
Contact: True BASIC Inc., 39 South Main St., Hanover, NH 03755, (603) 643-3882.
Inquiry 821.

IN A NOISY WORLD...



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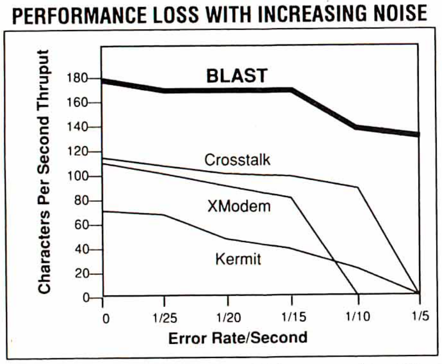

Noise simulation tests run with a 30K binary spreadsheet file at 1200 baud between IBM-PC's, using BLAST II, rev. 8.1. Comparable or better results on VAX and other environments.

Most communications software performs well under ideal conditions. But in the *real* world of noisy communications circuits and satellite-routed phone calls, there's only one consistent performance leader—BLAST.

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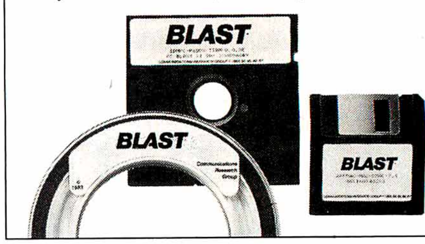
UNIX/XENIX	AT&T; Altos; NCR; Sun; Tandem; HP; VAX & mVAX; SCO Xenix; etc.

Many others available; please inquire.



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Hyundai's Super-286C gives you pro-quality performance at an affordable price.

The Power Hitter.

Hyundai's new Super-286C packs the punch of a PC AT, without socking it to your wallet. The Super-286C handles today's biggest applications: database management, desktop publishing, computer-aided design. And it packs this power into a remarkably compact unit—ideally suited for even the tightest quarters.

Like the rest of Hyundai's new PC line, the Super-286C comes with an 18-month warranty, plus service and support from a hand-picked nationwide dealer network. And they're backed by one of the world's largest manufacturing organizations: $14 billion Hyundai corporation.

- 80286 microprocessor switchable to 8 or 10MHz—for the right combination of speed and compatibility.
- High-capacity 1.2MB, 5.25″ floppy disk drives.
- Built-in 512KB RAM is expandable to 1MB, to support larger application programs.
- 6 expansion slots allow you to enhance the system for graphics or extended memory.
- Add your choice of hard disk drives: 30MB, 40MB and 70MB.
- Two serial ports and one parallel port for modems, printers, and other input/output devices.
- Full 101-key keyboard gives you complete control and ease of data entry.

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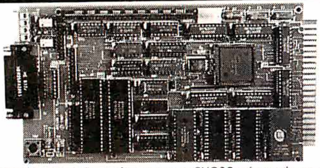
MICROMINT'S Gold Standard in Single Board Computers & Controllers

Announcing

BCC180 – $395.00
MULTITASKING CONTROLLER



The **BCC180**, only 4.5" x 8.5" uses the same 64180 CMOS Z-80 instruction compatible processor as Micromint's SB180 and SB180FX single board computers. Configured primarily for process control w/384K of memory, 6 parallel I/O ports, console serial port, RS-232/422/485 selectable auxiliary serial port, and an interrupt driven ROM-resident multitasking BASIC-180 compiler, the **BCC180** uses the same 44-pin I/O expansion bus as Micromint's BCC52 controller board.

PROCESSOR
- CMOS HD64180, 9.216MHz 8-bit CPU, 68-pin PLCC package

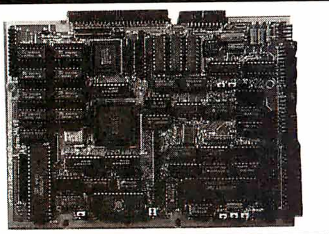
MEMORY
- Up to 384K bytes total memory on-board
- 128K of either static RAM (62256) or EPROM (27256)
- 256K dynamic RAM SIMM
- Full-function 8K ROM monitor included

INPUT/OUTPUT
- Console RS-232 serial port with auto baud rate select to 19,200 baud
- Peripheral serial port, 150-19, 200 baud, selectable RS-232, RS-422 or RS-485
- 48 bits bi-directional parallel I/O
- 64K I/O available through the BCC bus edge connector

DIMENSIONS and CONNECTIONS
- Dual 22-pin (0.156") edge connector
- Compatible with all Micromint BCC-series I/O expansion boards
- Two 26-pin headers for six bi-directional parallel ports
- 25 pin DB-25S for RS-232 console I/O
- 20 pin header for RS-232 auxiliary serial port
- 4 screw terminals for RS-422/485 connection

BCC180-1-20	9MHz assembled and fully socketed BCC180 Computer/ Controller with 32K bytes of static RAM, ROM Monitor, BASIC-180 development software and user's manual	**$395.00**
	For additional 256K DRAM add **$100.00**	
BCC180-1	**100 Quantity w/32K RAM, w/o Monitor ROM**	**$209.00**

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

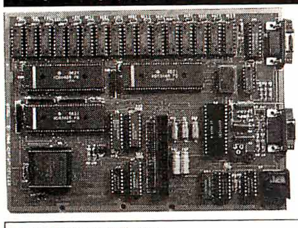
INPUT/OUTPUT
- Console RS-232 serial port with auto-baud rate select to 38,400 baud
- Peripheral RS-232 serial port, full hand-shaking, 150-38,400 baud
- Line printer parallel I/O port
- 24 bits bi-directional parallel I/O
- 19-bit address decoding, I/O port decoding, and dual bus interface brought out 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 five 5¼" SB180 format DSDD disks.	**$499.00**

GT180 — $395.00
Graphics Display System

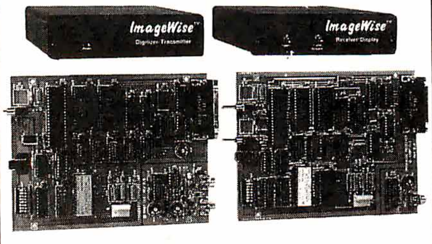


The **GT180** has both TTL RGB (red-green-blue intensity) and analog RGB outputs, is totally compatible with virtually all standard and multiscan CRT monitors, and has a connector for an IBM PC keyboard.

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**

ImageWise™
Serial Digital Imaging System

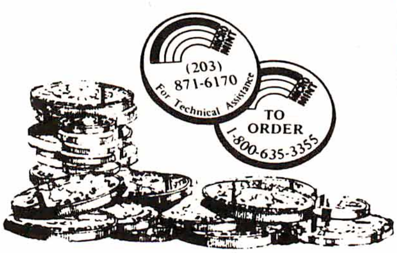


MICROMINT INTRODUCES A STAND-ALONE SERIAL DIGITAL IMAGING SYSTEM. The MICROMINT **ImageWise™ Serial Digital Imaging System** is the most cost effective and versatile high performance grayscale video digitizing system on the market today. The ImageWise system has been designed to function as a standalone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

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

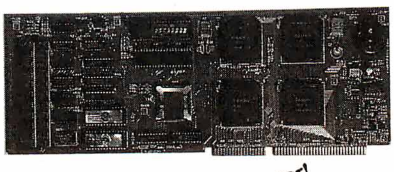
Optional PC Utilities Disk converts ImageWise™ files for use with popular Desktop and Paint Programs.

DT01	ImageWise Digitizer / Transmitter	**$349.00**
DR01	ImageWise Receiver / Display	**$349.00**



NEW LOW PRICE

OEM-286 — $620.00
complete PC/AT-CPU



Low Power! Expansion Card Form Factor! 100% AT Compatible!

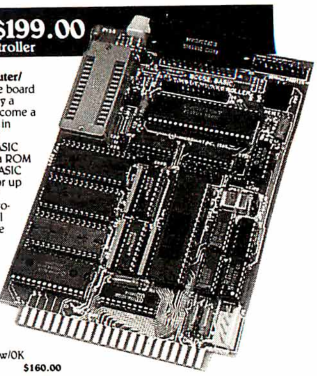
MICROMINT's **OEM-286** is a complete PC/AT-CPU and more. The **OEM-286** is the first low power, 100% AT compatible which has been specifically designed for OEM use within the industrial and business sectors. The **OEM-286** features the Zymos CMOS POACH set and 100% compatible Award BIOS. The development 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-286/10	10MHz AT/CPU	**$620.00**
OEM-285/BP	8 SLOT PASSIVE BACKPLANE	**$115.00**
OEM-286/10	**100 QUANTITY PRICE**	**$562.00**

BCC52 — $199.00
BASIC 52 Computer/Controller



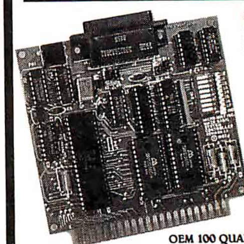
The MICROMINT **BCC52 Computer/ Controller** is a stand-alone single board microcomputer which needs only a power supply and terminal to become a complete system programmable in BASIC or machine language. The **BCC52** uses the Intel 8052AH-BASIC microprocessor which contains a ROM resident 8K byte floating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

OEM 100 QUANTITY PRICE **$89.00**

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

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**

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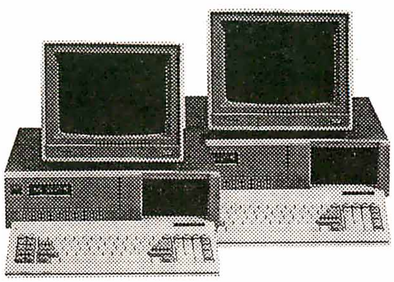
40 MB Turbo aT **$1595**
6/10 MHz • 512K RAM • Eight Slots • 1.2M DS/DD Half-Height Floppy • 40MB Half-Height Hard Disk • Hi-Res Amber Monitor w/Tilt-Swivel Base • Mono Text/Graphics Card • Parallel Port • AT-style Keyboard • 200W Power Supply • LEDs for Power/Turbo/Fixed Disk • Keyboard Lock



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Circle 478 on Reader Service Card

Circle 477 on Reader Service Card

BYTE editors offer hands-on views of new products

An LCD as Crisp as a CRT

Zenith's **TurbosPort 386 Model 40** incorporates some of the most advanced technology I've ever seen in a battery-powered portable computer, including a one-of-a-kind display and "intelligent power management." To conserve battery power, Zenith elected to run the 386 with zero wait states at a nonstandard 12 MHz. The slower speed is offset by fewer idle cycles, yielding excellent throughput: A preproduction TurbosPort (with no coprocessor) ran a sampling of our benchmarks from 86 percent to 99 percent as fast as a coprocessor-equipped IBM PS/2 Model 80.

Besides the clock speed, numerous other design features let the TurbosPort make the most of its battery power. One such feature, the intelligent power management (IPS) system, lets you use a pop-up menu to selectively power down I/O circuitry you might not need for a given task. You also can switch to a 6-MHz speed for maximum battery life during applications that are not computationally intensive.

The IPS is also supposed to dramatically reduce recharge time and prevent the power-robbing "memory effect" that sometimes limits the usefulness of nickel-cadmium batteries. However, a spectacular failure in our prototype's IPS (one that caused a low-battery condition to lock the machine to the point where even plugging it into AC power and cycling the on/off switch would not force a reboot) left me unable to verify this. I eventually disconnected the batteries to reboot. You have to expect glitches in a hand-assembled prototype.

Zenith's technological prowess is most clearly evident in the TurbosPort's screen, which is the centerpiece of the machine: The display is a fluorescently backlit supertwist liquid crystal display (LCD) that produces black-on-white images with a contrast ratio close to that of a conventional monitor and—to my eyes—better for extended viewing than a plasma screen. With its 10½-inch (diagonal) image area, 8- by 16-character matrix, 400-line resolution, and gray-scale CGA compatibility, this screen could be used full-time—not just when on the road. In fact, after 2 days of use with the TurbosPort side by side with a 12-inch monochrome graphics monitor, I preferred the LCD.

The display consists of two separate panels: active and passive LCD screens, separated by an air space and backed by fluorescent tubes in a reflector/diffuser assembly. The passive LCD corrects the chromatic aberration caused by the active, character-forming LCD much the same way that optical crown and flint glass combine to produce achromatic lenses. The net result is a screen that's very bright, with contrast ranging from near white to near black.

The screen assembly and the motherboard are mounted in the TurbosPort's clamshell lid, which lifts to reveal a detachable lightweight keyboard with 79 full-size keys. The back of the unit contains the power supply, battery, hard and floppy disk drives, and I/O connectors. The complete machine weighs about 18 pounds.

Placing the motherboard in the lid allows the TurbosPort to be convectively cooled. Although the hard disk drive and the power circuitry combined to produce a noticeable high-

The Facts:
TurbosPort 386 Model 40
$7599

Zenith Data Systems
1000 Milwaukee Ave.
Glenview, IL 60025
(800) 842-9000
Inquiry 851.

Options:
1200-bps internal modem, $299; 2400-bps internal modem, $549; 2400-bps autosync modem, $699; external 5¼-inch 360K-byte floppy disk drive, $399; 8-MHz 8087, $285; 16-MHz 80387, $1199.

pitched whine in the preproduction TurbosPort, overall, the fanless machine is quieter than most desktop machines—the Macintosh excepted.

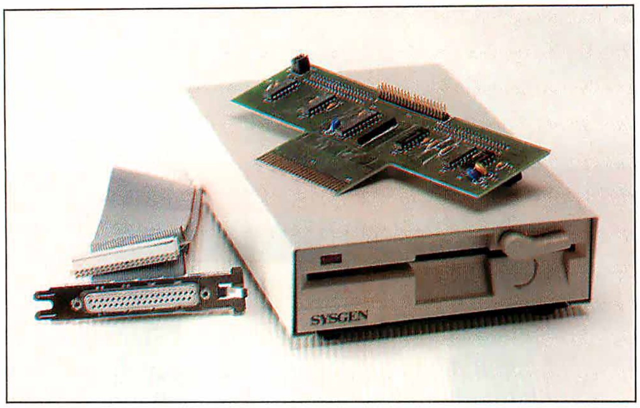
The basic TurbosPort system includes an 80386 CPU with 2 megabytes of RAM (expandable to 3 megabytes); a real-time clock/calendar; one 40-megabyte, 28-millisecond internal hard disk drive; one 1.4-megabyte/720K-byte 3½-inch floppy disk drive; a 25-line by 80-character "page white" backlit LCD; the 79-key detachable keyboard with a connector for an optional keypad; one serial port (D-9); one parallel port (D-25); RGB video out (D-15); two internal proprietary expansion slots (one for a modem, one for memory); a proprietary expansion bus connector; battery and charger/power supply; MS-DOS 3.2; and Windows/386.

We'll examine some of the technology incorporated in the TurbosPort in an upcoming First Impression. We'll also be reporting in the near future on the other new portables just announced by Zenith: the SupersPort and the SupersPort 286 (based on 80C88 and 80C286 CPUs, respectively).

—Fred Langa

continued

Safety Net for the PS/2 User



The Facts:
Bridge-File
$325

Sysgen Inc.
556 Gibraltar
Milpitas, CA 95035
(408) 263-4411
Inquiry 857.

Requirements:
IBM PS/2 Model 30, 50, or 60; or an IBM PC, XT, or AT (or compatible).

Sysgen's **Bridge-File** comes in two configurations. The first can add 1.2-megabyte/360K-byte 5¼-inch capability to IBM PS/2 Models 30, 50, and 60. A second version gives the IBM PC, XT, and AT the ability to read, write, and format both 720K-byte and 1.44-megabyte 3½-inch disks. A PS/2 Model 80 version is now said to be available, but it was not part of the package I reviewed.

My primary concern was to somehow get the ability to attach a high-density 5¼-inch floppy disk drive to a PS/2 Model 50. IBM's external 360K-byte 5¼-inch drive could get me only halfway home, and IBM's Data Transfer Facility requires two computers and a lot of time. The Bridge-File, on the other hand, lets you use just about any MS-DOS-formatted medium and is a simple, obvious solution to a vexing problem.

Installing Bridge-File is simple and requires no tools. You boot the system using the IBM Reference Disk to reconfigure the PS/2, reboot to establish the new configuration, run an installation program provided by Sysgen, and reboot one more time. That's it. The whole operation takes about 20 minutes. Sysgen's documentation was a big help, incidentally, and could serve as an industry model for clarity, brevity, and organization.

You can read and write with any 5¼-inch disk and run programs on the PS/2 from the newly designated drive D. You can format high-density disks on the external drive for 1.2-megabyte capacity, and, while I had no trouble formatting 360K-byte disks, Sysgen warns against it because such disks may prove unreliable in other 360K-byte drives.

My overall assessment of the Bridge-File is that it could make people a lot happier about owning a PS/2. I know I greeted both the concept and Sysgen's execution with a sigh of relief.

—Glenn Hartwig

Finite Element Analysis

In the past, most finite-element-analysis programs were written in FORTRAN by engineers who had neither the time nor the training to implement slick user interfaces. Thus, last summer's announcement of **ELM** interested me. Fujitsu introduced this finite-element program for the IBM PC, which is written in C and features icons and a menu-driven mouse interface. Fujitsu's demonstration of the program was impressive, with the user easily pointing and clicking through a complete analysis.

Unfortunately, the finished product, which did not ship until January, bears little resemblance to the polished demonstration I saw last summer. The version I reviewed (ELM2 version 2.07) had many menu options on the screen in faded blue, which, according to the manual, means "not implemented in ELM2." Among these nonimplementations were all element types except for beam elements; not even a truss or a spring element is included in this version. It seems that if the options can't be implemented, they shouldn't be in the menu bars.

To make matters worse, the system—I used an IBM PC XT with an Orchid TurboEGA board—would hang up periodically when I attempted various operations. For example, I tried the mirror option for creating a mirror image of a beam model and ended up having to reboot. I tried to print the screen to my printer and got gibberish. There was virtually no information in the two manuals about how to print your model. Both manuals lack an index.

Another major problem is the mouse interface. You can perform some operations with the mouse, but sometimes you're forced to use the keyboard to enter a yes/no response. You should be able to use the mouse for all one-click responses. Having to switch back and forth is confusing at best.

The mouse interface is supposed to help you create geometries quickly and easily. However, with ELM2, it is easy to overlap lines and node coordinates inadvertently. I also hung the system trying to erase part of a model and redrawing it.

Fujitsu's concept of a menu-driven mouse interface for finite elements is extremely attractive. However, the current version is simply not solid enough to be a commercial product.

—Nick Baran

The Facts:
ELM2 version 2.07
$3995

Fujitsu America
3055 Orchard Dr.
San Jose, CA 95134
(408) 432-1300
Inquiry 853.

Requirements:
IBM PC, XT, AT, or compatible with an EGA card, 640K bytes of RAM, a hard disk drive, a numeric coprocessor, a Microsoft Mouse (or compatible), and DOS 2.0 or higher.

continued

Hewlett-Packard's New Calculators

The Facts:

HP-19B Business Calculator
$175

HP-28S Scientific Calculator
$235

Hewlett-Packard
1000 Northeast Circle Blvd.
Corvallis, OR 97330
(800) 752-0900
Inquiry 856.

Although Hewlett-Packard has struggled in the personal computer marketplace, the company is still the leader when it comes to hand calculators. HP's new **28S Scientific Calculator** ($235) and **19B Business Calculator** ($175) are marvels of modern electronics and computer science.

The 28S, a calculator for scientists and engineers, is designed to perform sophisticated numerical analyses, including matrix algebra, differential equations, and complex numbers. In addition to a large function library, the 28S includes a comprehensive set of programming commands, including conditional and looping functions.

The 19B is a calculator for business and financial professionals performing calculations involving economics, accounting, and time management. The 19B includes a wide array of built-in financial and statistical functions.

Both calculators fold out to 7½ by 6⅓ inches. On the right side, you'll find a standard numeric keypad and a variety of functions that you can access with a Shift key. The left side has alphanumeric keys for entering text values for program commands, variable names, or data lists. You can fold the left side behind the right side if all you need is the numeric keypad.

The calculators have 4-line LCDs allowing 23 characters per line and a resolution of 32 by 137 pixels. I found the display hard to read, however, even after adjusting the contrast.

Both calculators have an infrared printer interface, letting you print results on HP's 82240A infrared printer. The 28S has 32K bytes of user-available RAM for storing programs and data; the 19B has 6.5K bytes. An impressive feature on the 28S is the ability to design menus and submenus of calculation options, which appear in the bottom row of the display and are selected by pressing the corresponding key below each option. The 28S also has a hierarchical directory system for storing variables for different programs.

Both calculators support graph plotting. The 19B allows plotting of statistical functions as well as curve fits and net

continued

Actual unretouched screen display - Sony CPD-1302

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18552 MacArthur Bl. ★ Suite 375 ★ Irvine, Calif. 92715

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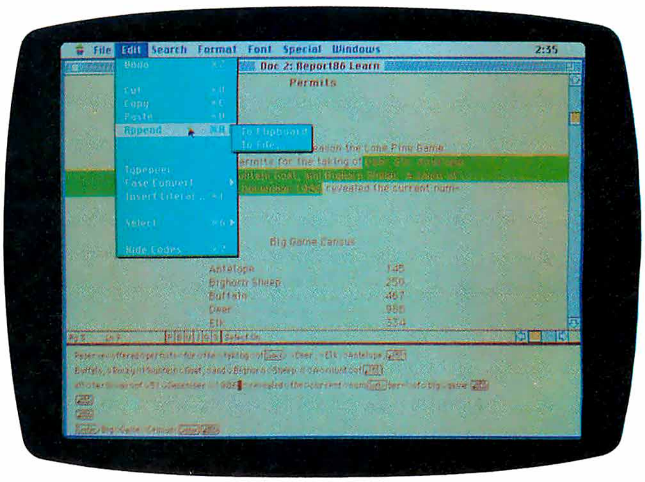
present value versus cost of capital. The 28S has more flexible graphing capabilities, including Cartesian or polar coordinates and scaling. You can store graphs in memory for later recall, and you can digitize any point on the graph to retrieve specific coordinates or data points.

The 28S uses postfix notation (also known as reverse Polish notation or stack logic) with a stack of four levels. The basic principle of postfix notation is that you enter values (arguments) on the stack before executing the arithmetic function. However, you can enter algebraic expressions in parentheses before storing the values on the stack. The 19B uses standard algebraic notation, which is more familiar to businesspeople. Being an old HP calculator user, I was disappointed in HP's decision to abandon postfix notation for its business calculator, but this is what the market demands.

While you can quickly perform basic calculations, these calculators are extremely powerful if you're willing to take the time to learn how to use them.

—Nick Baran

Word Processing with the Macintosh



The Facts:

WordPerfect for the Macintosh
$395

WordPerfect Corp.
288 West Center St.
Orem, UT 84057
(801) 225-5000
Inquiry 855.

Requirements:
Macintosh 512KE, Plus, SE, or II with System 4.1 or higher and two floppy disk drives or a hard disk drive.

WordPerfect for the Macintosh is a powerful program that expands the Macintosh interface in several ways. For example, a full-screen option lets you hide the menu bar until you need it, making about two additional lines visible. The program also uses hierarchical menus.

WordPerfect has dozens of major features, including outlining capabilities, a 115,000-word spelling checker, a thesaurus, footnotes and end notes, automatic creation of indexes and tables of contents, nested and chained macros, and redlining and strikeout options.

One feature that makes the program stand out is automatic timed backup of files, which I used to save my text every minute, since the beta copy I was using crashed often. An

continued

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append function lets you copy to an unopened document; a retrieve function enables you to do the opposite, add the contents of an unopened document to the current file.

WordPerfect lets you view formatting codes in a separate window at the bottom of the screen, a useful feature in laying out complex documents.

You can perform many file-management chores from within the program, eliminating the need to return to the Finder when you want to delete, copy, retrieve, or rename files and folders. You can also view unopened files and perform text searches on words or phrases.

—*Jeff Merron*

An Assembler that's Better and Faster than MASM?

The Facts:

Optasm
$195

SLR Systems
1622 North Main St.
Butler, PA 16001
(412) 282-0864
Inquiry 852.

Requirements:
IBM PC, XT, AT, or compatible, DOS 2.0 or higher, and 128K bytes of memory.

Optasm has one goal in life: to be better than Microsoft's Macro Assembler (MASM), the definitive IBM PC assembler. Now, when I say better, I don't mean just faster. Optasm seeks to make your job easier.

Say you've written a patch of 8088 code that ends with a comparison and a conditional jump to another patch of code you've eyeballed as being just inside the magical 127-byte limit. But you run it through the assembler and find that the jump's destination is 132 bytes away, so you've got to go back and recode the conditional jump into its opposite (i.e., turn a `JNZ` into a `JZ`) followed by an unconditional jump. This scenario will never happen with Optasm: It automatically generates a conditional/unconditional jump pair for conditional branches whose distance you've underestimated.

There's lots more goodies. Optasm won't sneak in `NOP` instructions for forward references, it will replace some instructions with shorter and faster equivalents where it deems appropriate (`LEA` with a `MOV` instruction, for example), and it lets you define local labels within procedures, so you don't have to contrive a unique name for the destination of something like a trivial loop.

There's a price to pay for all this wonderfulness: Optasm does not support the 80386, will not generate pass 1 listings, does not generate CodeView local symbols, and costs $195. The pass 1 listings issue isn't much of one, since you're usually generating a pass 1 listing to find phase errors, which Optasm does not permit.

To verify Optasm's claims of superior speed and output code efficiency, I ran an informal test. I assembled a source-code file of about 16K bytes on a 10-MHz IBM PC AT clone using both Optasm and MASM 5.0. Optasm completed it in a little over a second; MASM required over 5 seconds. Also, Optasm generated code that was about 30 bytes smaller than MASM's output. I couldn't measure any difference in the execution time—though it was nice to see that Optasm did in fact generate object code that was compatible with the linker and executed without a hitch.

—*Rick Grehan*

continued

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Targets:
- 6502 family
- 8080-8085-Z80-Z180-64180
- 8088-8086-80186-80286/8087-80287
- 68000-68010-68020/68881

Components:
- C compiler for host and target
- Assembler for host and target
- linker and librarian
- Unix utilities make, diff, grep
- Unix vi editor
- debugger
- download support

Features:
- Complete development system
- Fast development times
- Prototype and debug non-specific code under MS-DOS
- Compilers produce modifiable assembler output, support inline assembly, and will link with assembly modules
- Support for INTEL hex, S record, and other formats
- source for UNIX run time library
- processor dependent features
- source for startup

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Aztec C86 .... MS-DOS
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Aztec C65 .... Apple II & II GS

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- Macro Assembler
- overlay linker with librarian
- debugger
- UNIX and other libraries
- utilities

Developer System $299
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- UNIX utilities make, diff, grep
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Organizing the Desktop with a Free-Form Database

I have one of BYTE's most cluttered and chaotic offices, which I take some pride in. But as the stacks of paper slide into mounds of paper, and I find it harder to keep track of just what's in each mound, I know it's time to get organized.

Think'n Time, a Macintosh desk accessory, is a program that might help me cut the clutter. It's based on the metaphor of a desktop with room for many stacks of paper. Blocks of information, represented by little sheets of paper on the screen, can contain just about anything you want to put in there. Click on a sheet, and you'll find the information you've connected to it, be it a daily schedule, notes on a particular subject, or a grocery list.

But this program, which could be described as a free-form database, does a lot more than just visually organize information or concepts on an electronic desktop. It also lets you link all that information in both graphic and intelligent ways. Every time you set up a stack of paper, you can then propagate related stacks. You end up with a tree structure, with tagged stacks of paper linked by lines making your organization clear visually.

These stacks of paper can stand for anything you want them to, depending on what you're using the program for. Each stack essentially has its own text editor, which works like your standard Macintosh editor. When you click appropriately, you jump into a text window, where you can enter the information (text or numbers) you want to link to that stack or sheet. You just have to be able to say it in about 32,000 characters. After you've entered the information, you pop back to the tree structure. The paper icon now looks as if it has writing on it, which tells you that there's text in that stack or sheet of paper.

OK, so this is great for getting organized, for setting up tree charts and linking boxes, and for putting information into those boxes. But the thing I really like about this program is its search capability. Give it a keyword, and it will look at every stack tag and every sheet of text in the file.

Think'n Time has other features, like the ability to generate calendars, calculate numbers, import ASCII files, and save trees in MORE format. Nothing radical, but it is very handy having all this in a program that occupies just 50K bytes.

It, however, is not a program you just sit down and use. I worked through the tutorial and read the manual (130 pages of big type) several times before I felt like I knew most of what the program could do. The calendar part I found particularly confounding.

But Think'n Time looks like a good way to turn the clutter on my desk into neat little stacks of paper on my electronic desktop. The only problem now is getting those mounds of information into the Macintosh. ■

—D. Barker

The Facts:

Think'n Time
$99.95

Mainstay
5311-B Derry Ave.
Agoura Hills, CA 91301
(818) 991-6540
Inquiry 854.

Requirements:
Macintosh 512KE, Plus, SE, or II; it comes on an 800K-byte floppy disk but will access 400K-byte disks or any Hierarchical File System hard disk drive; occupies 50K bytes.

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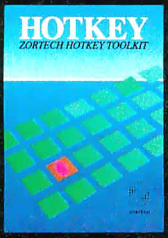

A complete set of Terminate Stay Resident (TSR) functions that help you to write reliable 'pop-up' programs.

Now you can make your programs 'Sidekickable'. Two example programs are included, a 'pop-up Calculator' and a pop-up 'Critical Error Handler'.

The Hotkey toolkit handles all floating point functions in resident mode.

The 32 page manual includes an interesting discussion of the origin and history of undocumented MS-DOS function calls, together with a full explanation of the theory and practical use of TSR's.

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Do you need to incorporate serial communications into your applications? Yes! Then get this inexpensive but highly professional COMMS toolkit from Zortech Inc.

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Two demonstration programs are included, MINICOM and MAXICOM (like Procomm) together with the 120 page manual and full source code FREE!

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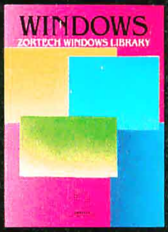

Have you ever wondered how to write a chess program? Now we reveal the secret algorithms and techniques of the masters with this dynamic Games toolkit.

The package comes complete with the full source code to three ready to play games of strategy – Chess, Backgammon and Wari (an ancient African game).

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This is not simply an 'Editor' toolkit, but a full-blown, 'WordStar' compatible wordprocessor with the full source code.

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Professional applications programmers will find this versatile utility and it's associated functions invaluable.

Comes complete with a substantial 78 page manual and demo programs.

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Add super-fast text screen handling to your applications with the WINDOWS library from Zortech Inc.

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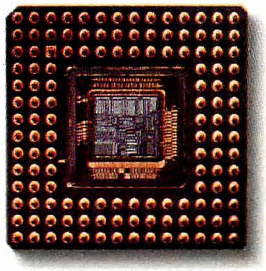

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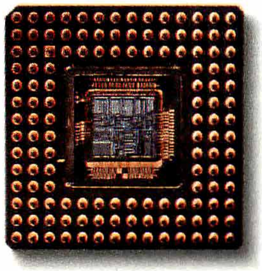

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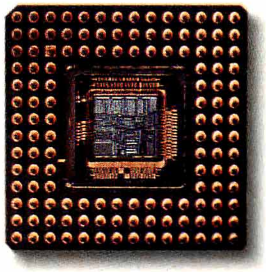

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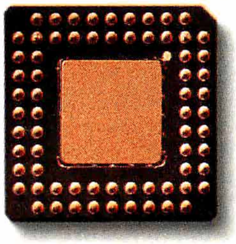

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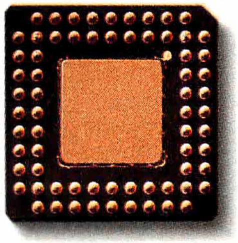

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These give you the highest-performance personal computers.

speed fixed disk drive tape backup systems.

Another graphic example of Compaq total system performance comes from the COMPAQ Video Graphics System. This system supplies VGA graphics with high-resolution COMPAQ Color and Monochrome Monitors along with speed enhancements from the COMPAQ Video Graphics Controller Board. When the board is used in a 16-bit slot, it makes screen updating 50% faster than the IBM® PS/2™ Video Graphics Array and other comparably equipped systems.

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Word Processors for Desktop Publishing

Lamont Wood

Advanced packages can do some desktop-publishing functions, but a gap still exists

Can any top-of-the-line MS-DOS word processor do desktop publishing? Theoretically, yes. Ever since word processors came into being, their manufacturers have been upgrading them with successive versions—not redesigning them, but piling new features on top of what they originally fashioned. Many present-day packages can do a lot, but in a few cases, this "add-on" philosophy has created monsters. Some of them now require over 20 disks to run, and users must try to wade through a huge set of manuals.

Despite efforts that have been made, though, there's still a big gap between desktop publishing (DTP) and word processing. At least, that's what I've gleaned from a review of 10 leading MS-DOS word-processing packages, selected for their claims to have DTP-like features. The manufacturers state that these packages can, at the very least, support multiple fonts within a document. That fact was borne out in my evaluations.

The Gap

DTP was developed to enable people and companies, not necessarily professional printers, to produce material similar to that appearing in books and magazines. DTP gives nonprofessionals the ability to visually combine text and graphics on the same page and see the result *before* it is printed.

To fulfill this mission, DTP packages, such as Xerox's Ventura Publisher and Aldus's PageMaker, must be able to furnish the same typographical characteristics that a print shop can supply. Such features (see the text box "True Desktop Publishing" on page 108) include:

- font selection
- proportional text
- WYSIWYG (what you see is what you get) display
- ruling lines
- graphics integration
- column formatting

In the least-case scenario, you should be able to see these features on the screen as you use them so that, as you create your document, you will know what your printed page will look like. This kind of representation is called WYSIWYG—pronounced "whizzy-whig." Without the benefit of WYSIWYG, you can't do layouts—you'll have to settle for implementing your needs by programming. Graphics design is tricky enough without interposing a user-indifferent computer between the designer and the product.

Generally, DTP software now available offers WYSIWYG graphics, either pictures or drawings in selected formats. You compose these with a graphics program or digitize them with a document scanner and add them to the page. DTP programs also should be powerful enough to make the text format wrap around a picture. The picture is shown on the screen as just another part of the document, faithful within the limits of the available resolution.

These features let you prevent fatal errors or problems creeping in by default. It's heady stuff. On the other hand, DTP software usually lacks all but the most rudimentary text-generation tools.

Currently, about all you can do with DTP software is to move the cursor around and change a few things. DTP software assumes you've generated the raw text with a full-featured word processor; that is, you've used a word processor that has functions like a spelling checker, thesaurus, mail-merge facility, outliner, word counter, redliner (i.e., a feature that lets you overstrike text and have it invisible on the printout), search/replace, onscreen math, footnotes, end notes, table-of-authorities generator (e.g., lawyers' footnotes), and a document comparer (to track ongoing changes).

The software packages reviewed were tested as word processors and examined for their DTP potential. Table 1 shows each program's features; table 2 gives the results of the benchmark tests.

DisplayWrite 4 Version 1.0

DisplayWrite 4 is a $495 package from IBM, requiring at least one floppy disk drive or one floppy disk drive and one hard disk drive and DOS 2.1 or higher. It needs 310K bytes of RAM for use with a hard disk drive and 384K bytes for use with floppy disk drives.

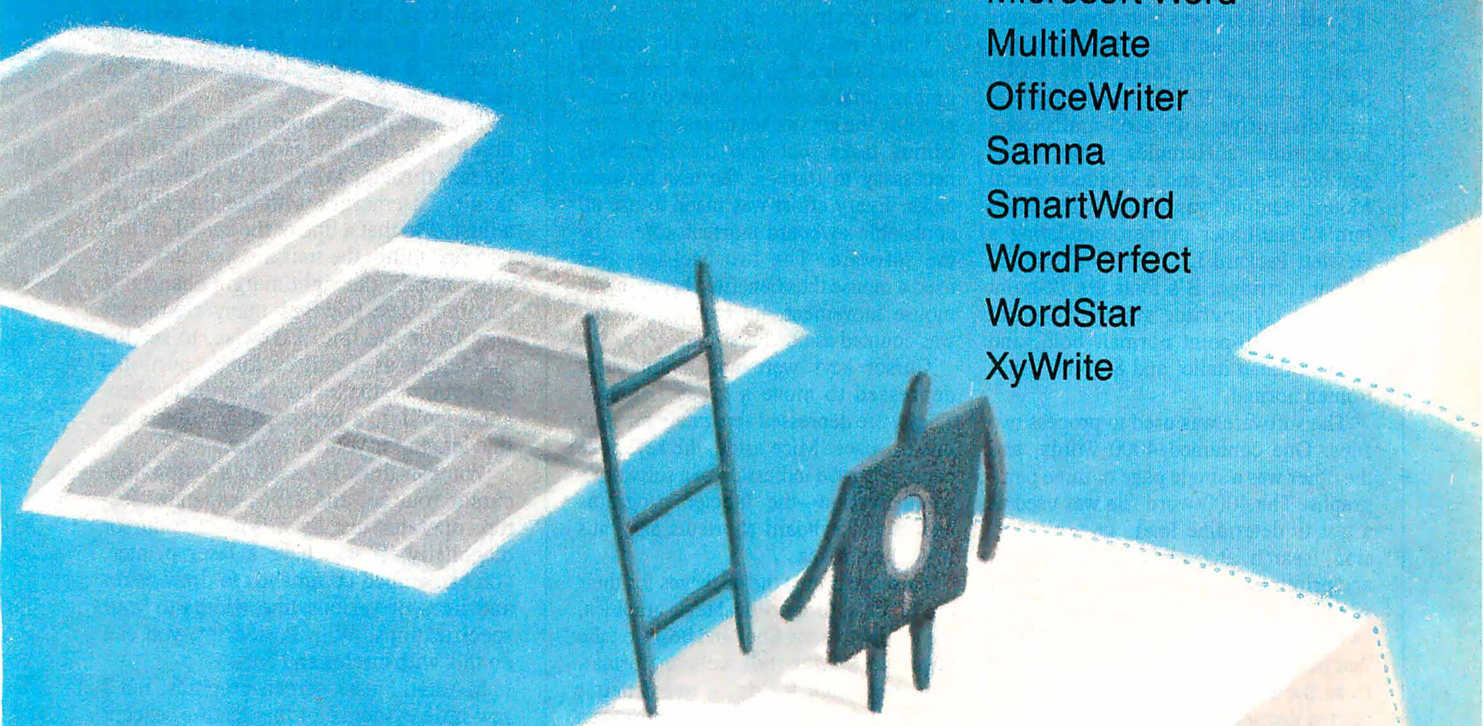
Of course, no one should ever need to use anything except IBM products. At least, that's the idea you better buy into before using DisplayWrite, since the first thing you'll discover about it is that it supports only IBM printers.

DisplayWrite gives the impression it's intended as a replacement for the typewriter. The list of available fonts is limited, and they are described in terms of pitch (typewriter terminology for characters per inch) rather than point size (printer terminology for character height in units of 1/72 inch). The pitches—which are 8.55, 10, 12, proportional, 15, and 17.1—are broken down into "typestyles," each with an ID number.

The ID numbers actually refer to daisy wheels or printer cartridges for various IBM printers. You can't, incidentally, change pitch inside a line—a severe limitation for anyone interested in "real" DTP, but typical if you're geared to typewriters.

What DisplayWrite puts on your screen only suggests what you should get on the page. Centered text is not centered on the screen, although it is printed that way. Changes in pitch, designed to change the number of characters that can fit on a line, are shown by adjusting the right margin. First, though, you have to either make a correction within that paragraph or use the reformat command to trigger

DisplayWrite 4
MASS-11
Microsoft Word
MultiMate
OfficeWriter
Samna
SmartWord
WordPerfect
WordStar
XyWrite



reformatting for the specific paragraph. The `View` command only lets you read a document without being able to change it (so you can refer to old material).

On the plus side, for those who like this mode of operation, DisplayWrite 4 does use a mouse. But because the screen does not utilize the graphics mode, the mouse jumps from character cell to character cell. The use of a mouse does expedite cursor movement and gave good results on the keystroke benchmark test.

Other test results are competitive, except for the global search and replace test, which operated at about half the speed of the average nongraphics system.

The software has a spelling checker with 125,000 words. It also contains a math routine, which is rather clumsy to operate since you have to keep referring to a menu while you are using it.

This version of DisplayWrite 4 does not let you integrate graphics. It has a line-drawing routine, but newspaper-style columns are not possible. When the documentation refers to columns, it actually means tabular lists. However, an OS/2 version, DisplayWrite 4/2, with a DTP multicolumn-text enhancement has been announced but was not available at press time.

Most of DisplayWrite 4's special features are indicated with extended ASCII characters—superscript is an up arrow, for instance. In normal mode, these characters appear only when the cursor is on them, an eerie feeling because at no other time are you able to see them.

You may call it a gimmick, but this product has at least one unique feature—integration with the IBM voice communications operating subsystem. With the proper audio hardware interfaced to your computer, a spoken message can be recorded and placed inside the document, where its presence is shown by a musical note. When you place the cursor at that point, it triggers the recording.

Although DisplayWrite 4 is a solid word processor, it is comparably overpriced and underfeatured. Its main attrac-

continued

Illustration by Rob Colvin © 1988

The Testing Procedure

Each package was tested on the same computer: an Eagle PC/XL with a plain vanilla 4.77-MHz 8088 CPU, 640K bytes of RAM, a 20-megabyte hard disk drive with a 65-millisecond access time, a Hercules monochrome graphics display, and a Logitech Serial Mouse. Output was tested with Quadram's QuadLaser printer, emulating a Hewlett-Packard LaserJet Plus with the B-font cartridge. B's fonts are 12-point Courier (typewriter style); 14-point Helvetica; 10-point normal, bold, and Times Roman italic; and 8-point Times Roman normal.

The software was used to process two files: One contained 4000 words, and the other was a single page of three paragraphs. The 4000-word file was used as a test to determine load, save, conversion, search and replace, formatting, and printing speeds. The results indicate whether the system is cumbersome or swift. Also instructive is the cursor test that measures the time it takes to scroll from the top to the bottom of a reformatted document. This operation is designed to tell you whether the system feels fairly responsive or as if molasses has been poured into it.

While making a series of editing changes to the single page of three paragraphs, total keystrokes were counted—not only the keystrokes necessary for the editing tasks, but also the keystrokes necessary to traverse the text between tasks. Every effort was made to use all applicable keyboard shortcuts offered by the software. The two packages that used a mouse thus benefited because one mouse movement, no matter how far, was counted as one keystroke.

Cursor keys were not continuously depressed to move a great distance. They were depressed separately for each line or space. Mice aside, the keystroke count is a good indication of a software's sophistication—the fancier programs had more keyboard shortcuts and thus fewer keystrokes.

I also examined the packages for their use of fonts, proportional text, graphics, the ability to draw lines and boxes on the page, newspaper-style column formatting (important for doing newsletters), degree of WYSIWYG, and other aspects related to DTP. The packages are discussed in alphabetical order.

tion is those three blue initials on the cover.

MASS-11 Version 7B

This strangely named $395 package requires a hard disk drive and 384K bytes of RAM. While the manual says that DOS 3.1 or higher is required, it loaded and ran fine under DOS 2.11. MASS-11 is the microcomputer equivalent of software that its maker sells for the DEC VAX minicomputer, a fact that explains the hard disk drive requirement.

A list of fonts—each with an ID number—is assigned to your printer during the installation procedure, and you can view the list through a separate, external printer facility. To change a font, you just type a command into the text. If you input <FO=2>, for instance, it means, with the LaserJet B cartridge, change to 14-point Helvetica.

The screen shows no immediate reaction to font changes. However, if you run the text through MASS-11's hyphenation facility, it emerges with the line lengths adjusted so that a line of the specified font text fits within the margins you chose. In other words, the right margin changes to accommodate however many characters now fit on the line. Likewise, to see the line length as it will be for proportional text, you run the text through the hyphenation facility, a process that adjusts the line length for your font size.

You can draw lines with a follow-the-cursor routine, and a box-expander feature operates just by moving the cursor diagonally. If you have a laser printer, you can embed commands to draw boxes and lines of various line widths to your specifications. With PostScript, you can do this with circles and arcs.

MASS-11 uses screen graphics, but I saw little evidence of this feature, except when using superscripts or subscripts and when drawing scientific equations, something MASS-11 emphasizes. In this situation, what you see is indeed what you get.

Graphics can be imported from a $495 companion product, called MASS-11 Draw; Lotus PIC; Hewlett-Packard Graphics Language; and encapsulated PostScript files. You insert the name of the graphics file, along with its dimen-

continued

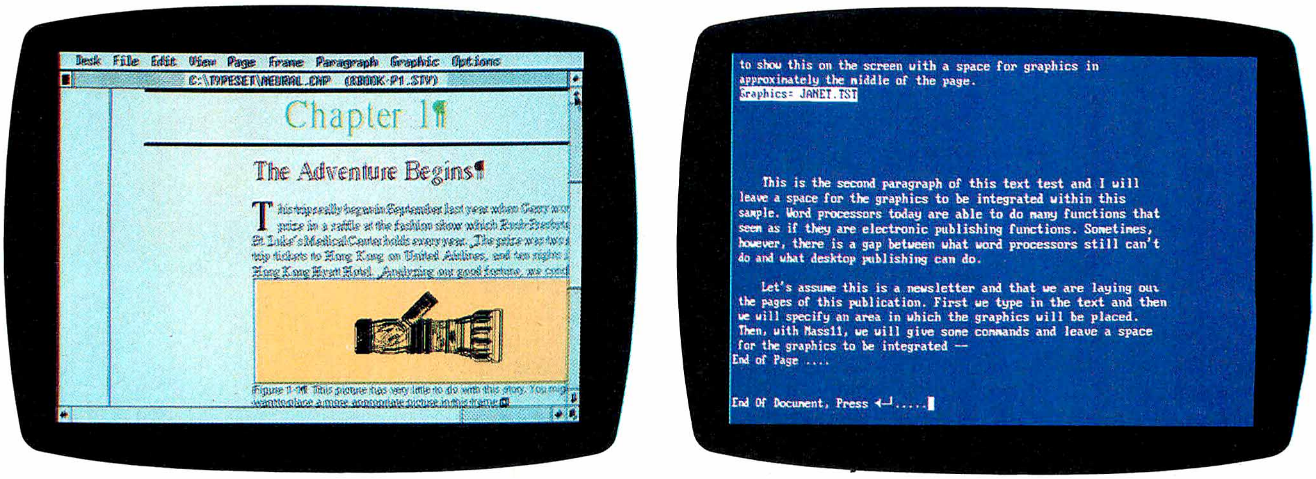


Photo 1: *While, for true WYSIWYG, desktop publishing emphasizes the on-screen inclusion of graphics images, word-processing software has not quite made the leap. Although some word-processing packages, like MASS-11 on the right, allow the sizing and cropping of picture files, graphics integration generally means that space is left by embedded commands in the document for the insertion of graphics at printing time. On the other hand, desktop-publishing software often integrates the graphics with the text on the screen, as in the Ventura Publisher screen on the left.*

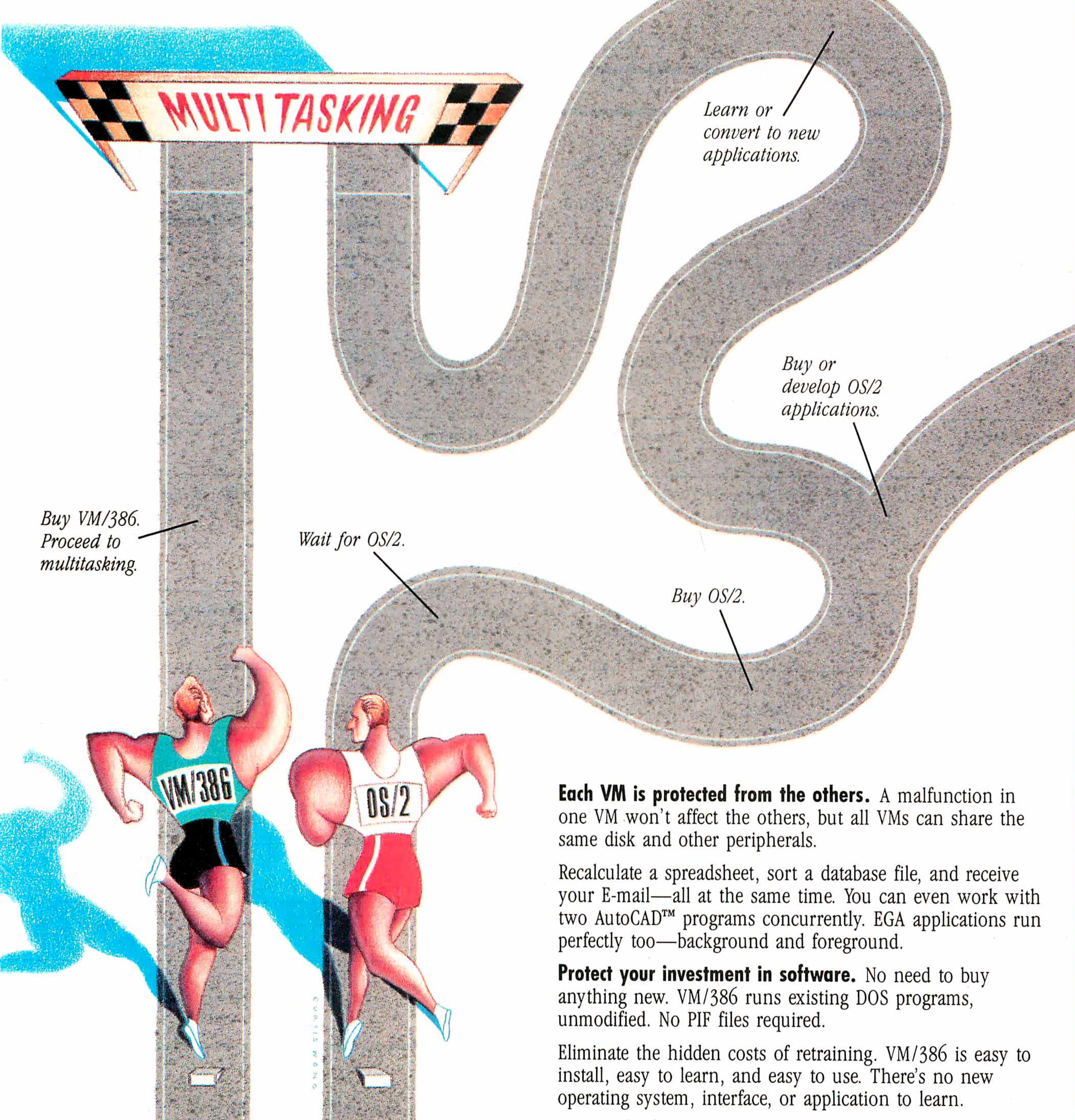


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Table 1: *All these word processors offer ways to dress up your documents. Besides general features, this table includes categories that show each program's desktop-publishing-like features.*

Name	Version	Price	Format	Documentation	Language	Operating system	Memory requirements
DisplayWrite 4	1.0	$495	5 5¼-inch disks	3 manuals/ 422 pages total	N/A	DOS 2.1 or higher	310K bytes of RAM for a hard disk drive; 384K bytes for floppy disk drives
MASS-11	7B	$395	10 5¼-inch disks	3 manuals/ 506 pages total	Pascal, assembly language, and FORTRAN	DOS 3.1 or higher	384K bytes of RAM
Microsoft Word	4.0	$450	5 3½-inch disks	5 manuals/ 884 pages total	C and assembly language	DOS 2.0 or higher	256K bytes of RAM
MultiMate Advantage II	1.0	$565	6 3½-inch and 11 5¼-inch disks	9 manuals/ 1025 pages total	N/A	DOS 2.0 for 5¼-inch disks; DOS 3.2 for 3½-inch disks	384K bytes of RAM
OfficeWriter	5.0	$495	7 5¼-inch disks	3 manuals/ 390 pages total	C and assembly language	DOS 2.0 or higher	256K bytes of RAM
Samna Word IV	1.1	$595	13 5¼-inch disks	2 manuals/ 530 pages total	C and assembly language	DOS 2.0 or higher	512K bytes of RAM
SmartWord	3.1	$395 ($895 for SmartWare)	11 5¼-inch disks	1 manual/ 180 pages; for SmartWare, 4 manuals/ 635 pages total	C	DOS 2.0 or higher	230K bytes of RAM; 294K bytes with spelling checker
WordPerfect	4.2	$495	6 5¼-inch disks	3 manuals/ 635 pages total	Assembly language	DOS 2.0 or higher	256K bytes of RAM
WordStar 2000 Plus	3.0	$495	21 5¼-inch disks	5 manuals/ 984 pages total	N/A	DOS 2.0 or higher	384K bytes of RAM; 512K for graphics
XyWrite III Plus	3.52	$445	5 5¼-inch disks	4 manuals/ 1020 pages total	Assembly language	DOS 2.0 or higher	384K bytes of RAM with speller; 256K bytes without

sion (see photo 1), and the software leaves enough room on the page for it (but the picture does not appear on the screen). MASS-11 does include a facility for trimming, scaling, and rotating the graphics. Again, the picture does not appear on the screen. The manual urges you to first print it out for reference purposes before you fiddle with it.

You can format text as newspaper columns, but the columns cannot be shown side by side on the screen. You can see them lined up, however, with a special preview command, where printer output is directed to the screen.

MASS-11 does not use a mouse. However, the Num Lock key toggles the numeric keypad between two states: standard cursor controls and a set of keyboard shorthand functions. In normal mode, the program operates with straight cursor functions. With the Num Lock key set, you can go forward or backward by word, sentence, line, tab, or paragraph. Also, in the toggled mode, certain keys assign underlining, boldfacing, and uppercasing and paste previously saved text. Cutting text has to be done separately.

Using the numeric keypad is fairly easy—as long as you keep your eyes on the keyboard template rather than on the keyboard. This information is buried deep in the manual, however, and I got startling results until I learned to pay constant attention to the state of the Num Lock key.

Included in this package are many other keyboard shorthand features that, all else remaining equal, would have resulted in the lowest keystroke count of the nonmouse packages. Unfortunately, it cannot impose superscripts or subscripts on existing text (a keystroke-test criterion). When you need a superscript or subscript, you have to retype text and delete the old text—efforts that add about 50 keystrokes to the count.

Among this package's other features are outlining, redlining, indexing, table-of-contents and table-of-authorities generation, and a spelling checker with 100,000 words. Also, it includes an interesting on-screen math function, where you can move the cursor from number to number and—using the math function keys—add to, subtract from, multiply by, or divide by the number the cursor is on.

The depth of this little-known system was a real surprise to me, although its unconventional use of the numeric-pad keyboard layout may make it more appealing to those who already use MASS-11 on the VAX. Version 8A is due out about May 1. According to the manufacturer, this update will have enhanced WYSIWYG capabilities, including a review mode and

● Yes
○ No

Megabytes on hard disk	System configuration	Mouse	PostScript	WYSIYWG preview	Import art	Line drawing	Newspaper columns
1.5	A minimum of 1 360K-byte (or 1.2-megabyte) floppy disk drive or 1 floppy disk drive and 1 hard disk drive	●	○	○	○	●	○
3.4	Hard disk drive	○	●	○	●	●	●
1.8	2 floppy disk drives or 1 floppy disk drive and 1 hard disk drive	●	●	○	●	●	●
3	2 floppy disk drives or 1 floppy disk drive and 1 hard disk drive	○	○	○	○	●	●
2.1	2 floppy disk drives or 1 floppy disk drive and 1 hard disk drive; a hard disk drive is recommended	○	○	○	○	●	●
1.4	2 floppy disk drives, 1 with 1.2 megabytes available	○	○	Greeked	●	●	●
2.2	2 floppy disk drives or 1 floppy disk drive and 1 hard disk drive	○	○	○	●	●	○
1.8	2 floppy disk drives or 1 floppy disk drive and 1 hard disk drive	○	●	○	○	●	●
4.4	2 floppy disk drives or 1 floppy disk drive and 1 hard disk drive	○	●	●	●	●	●
0.9	1 or 2 floppy disk drives; a hard disk drive is recommended	○	●	○	○	●	●

support of print graphics at printer typesetter resolution (up to 2500 dots per inch depending on your printer).

Microsoft Word 4.0

Microsoft Word 4.0 costs $450 and requires at least two floppy disk drives, 256K bytes of RAM, and DOS 2.0 or higher.

You can change fonts within a line, but the line widths do not change unless you elect to see the output in "printer display" mode. For the LaserJet, Word displays a list of fonts, all of which you are free to try to use. The software does not keep track of what's installed in your printer. You have to do that and limit yourself to the fonts that are actually in the printer.

LaserJet interface software works by transmitting a list of font attributes to the printer rather than a font ID number. If the font's description matches a font resident in the LaserJet—either in a cartridge or downloaded from the computer—it's used. Otherwise, the LaserJet invokes whatever font it has that's closest to the description. This is a big caveat with Word. "Know thy printer," or you may be surprised at the looks of the output.

Word's manual advises against using the space bar to align columns when you want proportional text. You should use tabs instead. If the space bar is used, what you see may not be what you get.

The extent of this program's line-drawing capability is a simple follow-the-cursor routine. However, Word does have a feature that lets you automatically enclose selected paragraphs in boxes or straddle the paragraphs with ruling lines.

Interestingly, Word has a dual personality: one based on a graphics screen and one based on a text screen. You can toggle between the two—and you'll want to. The scroll test took 10 times longer in graphics mode than in text mode. Formatting operations that are essentially instantaneous in text mode take about 4 seconds in graphics mode because the screen has to be repainted. According to Microsoft, though, with an IBM CGA monitor and a fast processor, graphics mode can actually be faster than text mode.

With the graphics screen, the mouse is easy to use. Unfortunately, though, with its use, everything else slows to a crawl. In text mode, the mouse cursor, while usable, shows up as a ghostly square that jerks between words.

Aside from making the mouse control more precise, Word uses the graphics mode only to show superscripting or subscripting with half-size characters, italics, double underlining, overstrikes, and

continued

True Desktop Publishing

What constitutes true DTP? For laying out and producing pages that combine text and graphics in the most aesthetic way possible, a software package needs to have several specific features.

To create titles and headlines, the DTP software must have a font-selection feature. A font is a combination of a particular typeface and size. Unless the text is going to look like typewriter output does, it also has to be proportional—so that the letters *W* and *i* take up radically different amounts of space on the line of type.

Another factor having to do with fonts is kerning, which is a method whereby spaces between letters are allowed to overlap in certain ways depending on the configuration of the adjacent letters.

Ruling lines (of various widths) are used to separate columns; boxed text is used to highlight the material, frame a page, and create other special effects. Graphics integration allows externally created graphics or digitized pictures to be included on the page—even at the preview stage.

Newspaper-style column formatting requires multiple columns to be placed on a page, with the text at the bottom of one column running to the text at the top of the next.

Special characters include copyright, trademark, and legal citation symbols, as well as other common symbols that would be found in a print shop but not on a microcomputer keyboard.

With these tools, people can create materials that range anywhere from fancy personal letters to newsletters to brochures to actual books and magazines.

The pervasiveness of DTP has already reached the point where an experienced user can pick up an industrial newsletter and deduce with which software it was produced.

Many print shops now are offering typesetting through the PostScript page-description language. This means you can use DTP to create your document utilizing 300-dot-per-inch laser-printer output as the "proof copy." Then you can transmit the PostScript file to the typesetter as "camera-ready copy."

---

other typewriter-like enhancements.

Through the usual method of assigning a filename and appropriate measurements to a blank area on the page, you can incorporate graphics into the document, but they show up only when a page is printed. You do not see any evidence of the graphics or commands on the screen.

Word can import any kind of graphics "print file," as long as that file doesn't reset the printer, send out linefeeds or formfeeds, or use about a dozen specifically prohibited PostScript commands. When I tried to incorporate graphics into some of my material, however, the graphics kept turning up on a separate page. To preclude this glitch, says the company, you must purchase a companion product called PageView, which sells for $49.95 and runs under Microsoft Windows.

When formatting in newspaper columns, only one column is shown on the screen, even in printer display mode. Word does, however, let you print in columns.

Disappointingly, the help messages are not contextual—you have to wade through the same menu each time—and the manual's index does not always give you the right page number. The instructions for converting a word-processing file into ASCII just didn't work. Microsoft called it a "reported error."

The program also includes a whole raft of top-of-the-line word-processing features: footnotes, form generation, boilerplate, indexes, math, sorting, a spelling checker with 130,000 words, hyphenation, spreadsheet insertion, tables of contents, and a thesaurus with 15,000 root words.

Word embodies the typewriter-emulation approach to a full-functioned, professional word-processing system. This also means it's a long way from DTP. If your needs are conventional, Word is a very good package.

MultiMate Advantage II 1.0

MultiMate costs $565 and requires 384K bytes of RAM, DOS 2.0 for 5¼-inch disks, and DOS 3.2 for 3½-inch disks. A hard disk drive is recommended.

MultiMate does not use a mouse, but you are able to do nearly everything in two ways: with pull-down menus or keystroke combinations. The keystroke combinations are faster. MultiMate suffered in the keystroke benchmark test because, after translation, the test file had a margin set to the length of the first line. The margin had to be moved to the right by 40 spaces, and there is no shortcut way to move the margin marker in this situation.

The manual actually consists of six booklets in a binder—separate installation booklets for 3½- and 5¼-inch disks, basic editing, a tutorial, and applications and printer guides—plus three reference manuals: a general manual, advanced topics, and one covering On-File, a companion database product. The indexes of some of these booklets cross-reference each other—and some do not—leaving you with no central reference point. As a sort of trade-off, though, MultiMate offers the largest keyboard template I've ever seen, and it is one of MultiMate's useful features.

To change fonts, you type `Alt-C`, which inserts a `Pt` symbol in the text. At this point, pressing the question-mark key gives you a list of available fonts. Then you type a letter identifying the font you want.

In MultiMate, the left margin is set in terms of character widths, so changing a font inside a paragraph (if it also changes the pitch) can result in a left margin as ragged as an unjustified right margin. This condition occurs because the character widths used to count the margin have suddenly changed size. Since the screen pitch never changes, though, you must remember to change the left margin when you change the font.

There is a line-drawing function, but no use of graphics and no way to print graphics files. Newspaper columns can be handled, but formatting and printing them took more than twice the normal amount of time—3½ minutes versus 1½ minutes for the faster programs.

MultiMate, however, can convert documents created with 12 different word-processing formats. Among its other useful features are a 110,000-word spelling checker, a thesaurus with 40,000 root words, a minidatabase, math for rows or columns of numbers, table-of-contents generation, and support for 400 printers. It does not have indexing capabilities.

Very fast and very slow speeds show up in the 4000-word-file benchmark tests run on MultiMate. Scrolling and file conversion are slow. Loading and saving happen immediately, and search and replace is very fast. A preview mode is available to check pagination, footers, and headers, but it takes more than a minute to repaginate after reformatting.

MultiMate is a fairly full-functioned word processor, but it still lacks the redline function. The program, though, is still firmly rooted in the typewriter-emulation world.

OfficeWriter 5.0

OfficeWriter costs $495 and requires 256K bytes of RAM, DOS 2.0 or higher, and two floppy disk drives (or a hard disk drive if you use the thesaurus).

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FONT SCALING	YES	NO	YES
DEGREES OF BOLD	2	2	14
PATTERNED FONTS	NO	NO	YES
300 x 300 DOT QUALITY	YES	YES	YES
TIME TO CREATE 30 POINT FONT	1:34	—	:16
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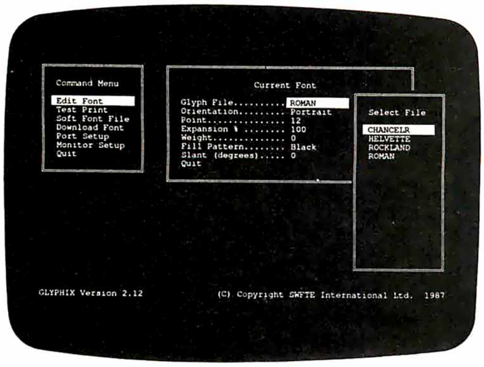

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Table 2: *No one package came out tops in all the benchmark tests, but several did well. WordPerfect, MASS-11, OfficeWriter, and XyWrite scored in the more-than-acceptable range. Due to their use of a mouse, Microsoft Word and DisplayWrite 4 won the keystroke contest hands down. (Times are in seconds.)*

Name	Keystroke count	Search/ replace	Reformat 4K file	Convert ASCII to WP	Convert WP to ASCII	Print in columns	Scroll test	Load WP file	Save WP file
DisplayWrite 4	183	114	32	23	39	120*	61	9	3
MASS-11	247	25	10	137	117	105	118	5	6
Microsoft Word									
Text	158	24	<1	1	5	160	35	3	6
Graphics	158	26	4	4	5	160	320	8	8
MultiMate	296	17	<1	160	160	293	63	3	<1
OfficeWriter	263	88	<1	12	25	70	46	4	4
Samna	273	231	58	90	27	177	74	4	1
SmartWord	400	102	4	7	13	75*	33	12	13
WordPerfect	246	8	<1	7	12	90	89	2	4
WordStar	234	38	3	199	129	230	33	5	7
XyWrite	270	18	<1	1	2	89	33	1	2

* Formatting in columns not available
<1 Less than a second

You can select fonts from a list of ID numbers assigned to your installed printer. Up to 60 fonts can be assigned to a printer. The only on-screen indication that you have changed fonts is a font-change symbol, f. You have no way to preview the effects of proportional spacing and font changes.

OfficeWriter, like MultiMate, shows its typewriter roots—margins are counted in character spaces—but the left margins of the printed page manage to stay anchored when you change fonts. On the other hand, OfficeWriter does not respond by resetting the right margin—the same number of characters remains on the line after you change font sizes. You have to remember to change the margin.

Since the manuals are well laid out and answers are easy to find, the learning process is smooth. An expanding-box function lets you "pull" the corners of a box around text, and the lines can pass over the text without obliterating it. To incorporate graphics into your document, the company suggests that you use OfficeGraphics, a companion product that costs $145.

OfficeWriter's test results are competitive, except that the keystroke count suffered because the available keyboard shortcuts (jump ahead and jump to line number) do not work during the move-text or the margin-setting procedures, when they are needed. The package does newspaper-style column formats.

Special features include a legal and medical spelling checker (as well as a standard spelling checker), an 80,000-word dictionary, a thesaurus with 40,000 root words, and a range of conversion utilities.

Generally, the package seemed to live up to its name—office word processing. But it also lives up to the typewriter-emulation limitations of conventional office word processing.

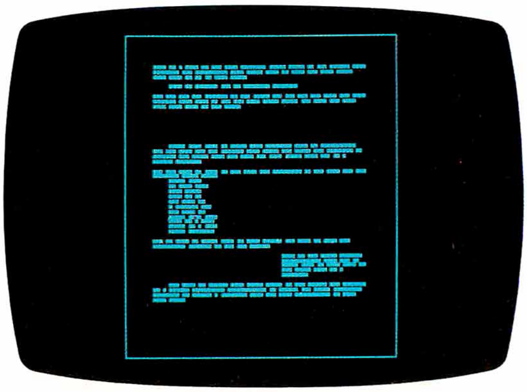


Photo 2: *"Greeking," the representation of text with shaded bars, is a common approach for representing full-page layouts in both desktop-publishing and advanced word-processing software. Shown here is a page layout with Samna greeked text.*

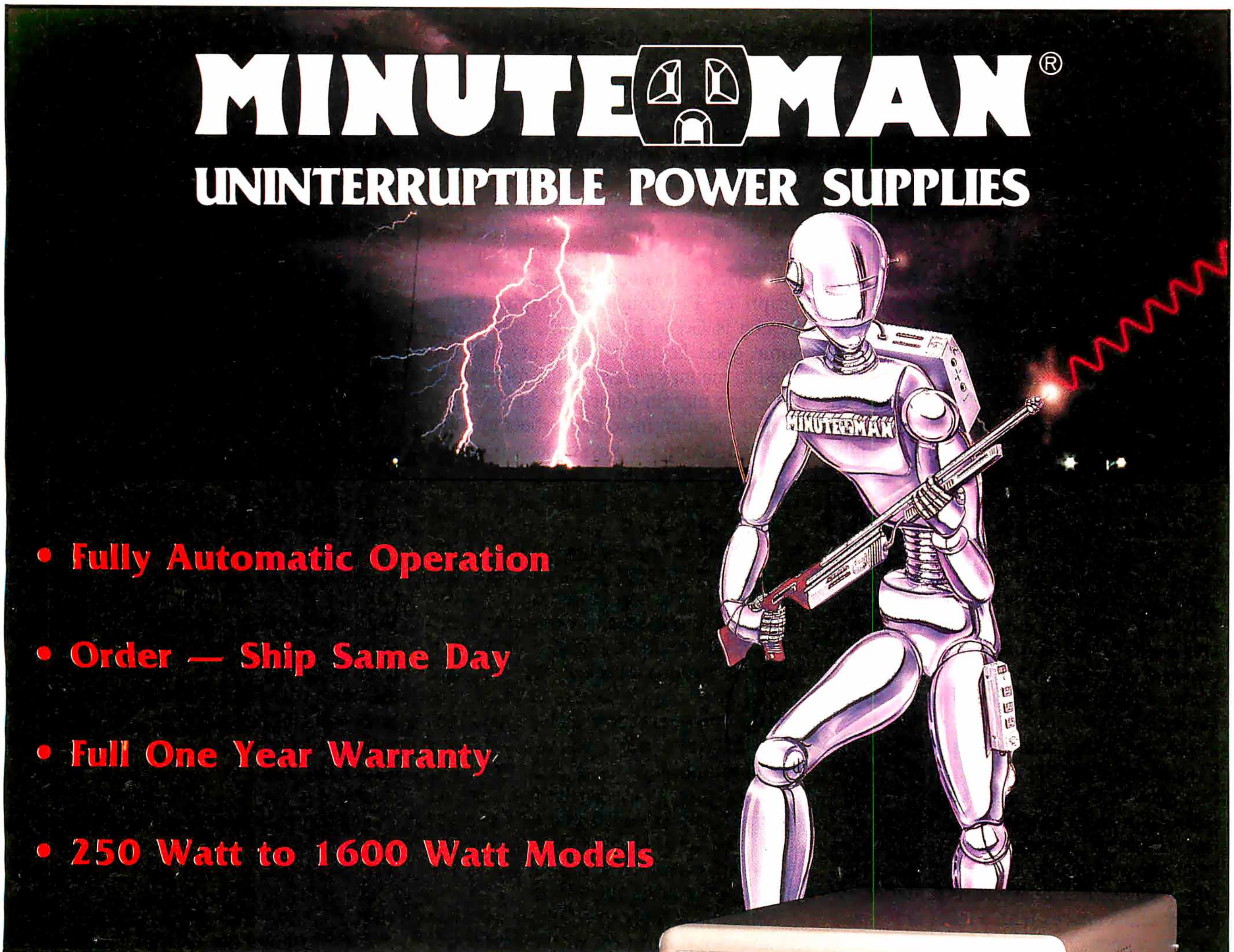
Samna Word IV 1.1

Samna requires DOS 2.0 or higher, 512K bytes of RAM, and two floppy disk drives. The package costs $595.

With Samna we arrive at a word processor with one foot truly in the DTP environment. WYSIWYG isn't among its list of features, but a zoom command shows a full view of the page with the text "greeked"; that is, you can see what the page looks like, but you can't read it because the text is represented by shaded bars (see photo 2).

Having designated your printer as a LaserJet, Samna gives you a list of LaserJet fonts to chose from: 358 of them in all. You can assign 30 fonts (called "print-wheel sequences" by Samna—the typewriter heritage again) to a printer. I picked only six fonts for the B-cartridge equivalent, but Samna then filled out the

continued



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*250 watt and 500 watt units offer 4 msec transfer time, PWM wave form.

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250 WATT	120 Volt	**$ 359.00**
300 WATT	120 Volt	**$ 549.00**
500 WATT	120 Volt	**$ 699.00**
600 WATT	120 Volt	**$ 899.00**
1200 WATT	120 Volt	**$1499.00**
1600 WATT	120 Volt	**$1999.00**

230 Watt Units Also Available

PARA SYSTEMS, INC.

1455 LeMay Drive
Carrollton, Texas 75007

Telephone:
(214) 446-7363

1-800-238-7272

FAX: (214) 446-9011
TELEX: 140275 OMEGA

rest with default values.

Changing fonts (by inserting a "printwheel change" marker) does not change the display or cause Samna to refigure the line lengths. Again, you must figure your own margins. Changing to a proportional pitch, however, causes changes in the zoom display—the lines are shorter. Line drawing is a simple follow-the-cursor routine.

Some oddities are involved in the editing process. Backspacing leaves blanks in the line rather than closing up text. Going into insert mode drops the text to the right of the cursor and down a line, and the text reformats when you're finished. There is no on-screen indication of superscripted or subscripted characters. During pagination, Samna asks for your approval of each page break. You can avoid this tedium by having it done automatically at printout time. Nothing on the editing screen—including the line counter—indicates double spacing. You have to zoom to see it.

Samna can include graphics—in the Tag Image File Format bit-mapped image standard or those produced by Samna Decision Graphics (available for $450)—in a document. It manages this via the usual method of embedding a command with the graphics filename and its dimensions. Only blank spaces with a label are shown on the screen.

Newspaper columns are possible, but they are handled rather crudely. You must format the text in narrow-enough columns so that two rows can fit on a page. In the printing procedure, you tell Samna to print the text as two columns. You can't put both columnar and noncolumnar text on the same page.

The keyboard layout takes some getting used to. Home is Next Word or Previous Word. PageUp is Next Sentence or Previous Sentence. End is Next Paragraph or Previous Paragraph. PrintScreen is Go to File. In all, you'll find some good keyboard shortcuts, but the need to manually traverse the format line to set the margin (shortcuts do not work during the margin-setting procedure) increased Samna's keystroke count by about 60. Otherwise, it would have done very well.

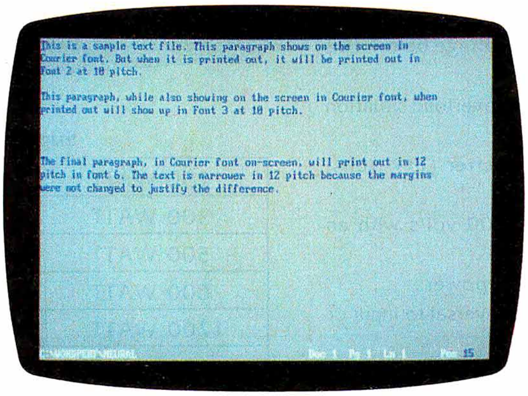
Other Samna test results are competitive, except for search and replace. Each `Find` is scrolled to, highlighted, and then replaced with a pop—more on the order of an arcade game than a word processor.

Special features include on-screen math, a spelling checker with 100,000 words, footnotes, indexes, table of contents, forms generation, and special functions to write math equations (using clever combinations of line drawing, superscripting and subscripting, half-line spacing, and extended graphics characters). The software also includes an 8½- by 14-inch clear plastic overlay with a 12-pitch grid for designing forms.

Samna is serious about office use. For its somewhat hefty price, though, you'd expect to get a thesaurus. And its stab at WYSIWYG—greeking—is of little real use, except perhaps for getting an ordinary memo nicely balanced on the page.

An upgrade, version 2.0, is slated to be available this spring. Samna people say it will include a 40,000-word thesaurus, on-screen graphics and font display, support for two additional file formats for graphics printing with Lotus PIC and PC Paintbrush, a table-of-authority function, and support for the Hercules RAMfont.

Photo 3: *When you embed the font command in WordPerfect text at the point where you want the change to occur, no visible character appears on the screen. When it is printed out, however, the printing has changed, along with the margins if you also changed the font pitch. Currently, few word processors show font changes on the screen.*



This is a sample text file. This paragraph shows on the screen in Courier font. But when it is printed out, it will be printed out in Font 2 at 10 pitch.

This paragraph, while also showing on the screen in Courier font, when printed out will show up in Font 3 at 10 pitch.

The final paragraph, in Courier font on-screen, will print out in 12 pitch in font 6. The text is narrower in 12 pitch because the margins were not changed to justify the difference.

SmartWord 3.1

SmartWord costs $395 by itself and $895 as part of SmartWare. It requires DOS 2.0 or higher; DOS 3.1, if used with a local-area network. It needs 230K bytes of RAM unless it is used with the spelling checker, which takes another 64K bytes. It will run on two floppy disk drives, but a hard disk drive is recommended.

SmartWord has a unique way of limiting your use of fonts, which just about, but not quite, results in WYSIWYG. With the LaserJet, SmartWord offers 10 optional (or "enhanced") fonts—not the fonts inside the LaserJet, but "soft" fonts that SmartWord itself downloads. All the fonts are 10-pitch monospaced, so what you see on the screen is indeed what you get on the page, at least in terms of line lengths.

The enhanced fonts available are italic, superscript, subscript, strikeout (for redlining), Greek, two sets of box-drawing characters, gothic, script, and small capitals.

Two custom fonts also are available so you can design with SmartWord's font-design function. You may want to do this, because SmartWord's fonts use "strokeweights" that are so light I thought the printer had run out of ink. Don't get any ideas about designing different-size fonts—you get only a standard-size character cell in which to design each letter.

The default or normal LaserJet font is Courier. Sticking to it will save you time, since it takes 3 minutes to download the SmartWord fonts. This company has solved the problems of proportional spacing, font sizes, and pitches simply by pretending they don't exist.

There is a line-drawing facility, but no way to format text into newspaper columns. Graphics, produced by the business graphics subsystem, can be incorporated but not shown on the editing screen—although you can see them in a separate window as part of the spreadsheet software. These SmartWord graphics do not have to take up the width of the page, and text can wrap around them. This mammoth system obviously is intended for people more seriously interested in the use of data, not just the pretty presentation of text.

If SmartWord has neglected a few details, forgiveness comes fairly easily when you realize that it is just one part of Innovative Software's SmartWare. The

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full system includes an integrated spreadsheet, a database manager, a communications package, business graphics, personal time-scheduling software, a programming language, and an on-screen calculator. The whole thing comes in an 11-pound package with 10 disks and four manuals—but, alas, no central index.

Trying to be all things to all people, however, exacts a toll. In this case, the user interface suffers. You can give commands with Control-key combinations, as you can with WordStar, or by escaping to a list of commands along the bottom, as Microsoft Word does. Either way, there are no meaningful keyboard shortcuts, giving SmartWord the worst keystroke count of the bunch.

SmartWord's approach to DTP is based on fancy typewriter emulation. But data-oriented audiences may find this fact easy to overlook. Although SmartWord is light on word-processing features, it offers a little bit of everything else. But if you are interested in these peripheral features, you probably aren't primarily concerned with word processing.

WordPerfect 4.2

This $495 package requires DOS 2.0 or higher, 256K bytes of RAM, and two floppy disk drives (or one floppy disk drive and a hard disk drive).

With WordPerfect, you can have eight fonts per printer, and the list is set when you pick your printer. You can have multiple printers, though, each with its own eight fonts. Changing fonts does not affect line width, although the system includes suggestions for setting margins for each font size. Fonts are referred to by number, and because it is impossible to remember eight, it is necessary to keep referring to the list.

Font changes and other format changes are made by embedding commands (see photo 3) that remain invisible until you switch to the Reveal Codes screen. But this screen is such a jumble of function codes and text that you cannot seriously edit in that mode.

There is a preview screen, but it's just to check the layout of headers, footers, end notes, page numbers, and similar things that the software places on the page. In other words, you'll find no real WYSIWYG here—except that, unlike most word processors, line spacing is actually shown on the screen. WordPerfect does have a line-drawing facility.

To do proportional spacing with WordPerfect, set the font number and pitch to proportional pitch and then use the `Preview` command, which will show the text formatted to the appropriate line length.

continued

One of WordPerfect's few voids is that it does not provide the capability of including a graphics file on the page. It has just about everything else you would expect from a leading word processor—a spelling checker with a 110,000-word dictionary, a thesaurus with 10,000 root words, file encryption, tables of contents and authorities, redlining, math, indexes, and an outliner.

The manual is well organized, and it makes good use of color and graphics. I found that all it took me to navigate through the documentation was the supplied keyboard function-key template and the help command.

Newspaper columns are one of WordPerfect's strong points. They are easy to format, and multiple columns are actually shown on the screen, though moving between them requires special commands. You can place columnar and noncolumnar text on the same page.

Except for the average keystroke count and moderate scrolling speed results, the test results from this package are excellent, with 400 replacements in the specified 4000-word document taking only 8 seconds.

With its numerous features, using WordPerfect is a satisfying experience—if you're interested in conventional word processing. Otherwise, it would be nice to have more WYSIWYG and graphics.

By the time you read this review, an upgrade should be available. According to the company, version 5.0 features more fonts in more sizes, the ability to show different font styles on screen, graphics integration, and support of text and graphics on the screen and printed out.

WordStar 2000 Plus 3.0

The WordStar 2000 Plus system ($495) requires DOS 2.0 or higher and 384K bytes of RAM (512K bytes if graphics are to be used). A hard disk drive is recommended.

When using this version of WordStar, you may or may not agree that this is a DTP-type package, but you will know you've accomplished something after getting involved with its 21 disks and 700-page user's manual. The software—even without all its optional features—consumes more than 4 million bytes on a hard disk drive. There are more than 230 files in half a dozen subdirectories—mostly devoted to help screens. A help screen is available for nearly every menu choice the software contains.

Actually, this version of WordStar is more a system of programs, many from vendors other than MicroPro. The copyright listing takes up a whole screen. Besides subsystems providing basic word processing, LaserJet fonts, file conversion, index and table-of-contents generation, and graphics (all of which I installed to comprise the equivalent of a DTP system), there are also the companion products. These include an outliner, a system that handles headline-size type for making placards, and a forms generator. There is also a legal edition, with companion products CompareRite and CiteRite.

Changing fonts is easy—you press Alt-F, pick what you want from the list that appears (tailored to your printer), and move on. The right margin changes by itself, if necessary. The font change command, with an abbreviation of the font's name, can be seen in the text with the `Display Tags` command, a feature that makes it easy to keep track of what you've done.

There's also a `View` (Ctrl-V) command, which toggles the screen to graphics mode and shows the entire page. Text is not greeked, but it is reduced to the point where only word length and occasional lone characters can be discerned—

sort of like using WYSIWYG from a distance of 5 feet. But superscripting and subscripting, underlining, and boldfacing stand out enough to be visible.

Newspaper columns are handled in a unique manner. The left-hand column appears on one page, and the right-hand column on the next. In reality, though, what looks like two pages is just one page—this arrangement just makes it easier to scroll between columns—and the `View` command gives the true picture.

A subsystem called Inset—a pop-up program that can be used by itself or with some other applications—lets you edit or create graphics images. These images can be imported into a WordStar document through the usual method of giving the filename and the dimensions. The graphics are shown as a blank box. If there is room, the text will wrap around it. Unlike all the other packages reviewed, you can then use a variation of the view mode to see the picture within the document.

Since so many of WordStar's functions reside in subsystems, overall performance can be lethargic and ponderous. Printing took 3½ minutes, compared to 1½ minutes in many cases, and file conversion took over 3 minutes, while many of the packages took less than 15 seconds.

Other features include a full-featured telecommunications subsystem that can convert WordStar documents directly to electronic mail format, a spelling checker with 87,000 words, a thesaurus with 50,000 root words, index and table-of-contents generation, extra LaserJet fonts, clip art for Inset, and more.

When using this full-featured version of WordStar, you feel as if you're standing under a waterfall—its massive nature is rather intimidating. You may think you are installing a program to operate a whole office, not just a word-processing package. In spite of the imposing nature of this package, though, the basic features are easy to use, the help screens ease the intimidation factor, and the program is my favorite of the bunch.

XyWrite III Plus 3.52

XyWrite (pronounced "zy-rite") costs $445 and requires DOS 2.0 or higher, 256K bytes of RAM (or 384K bytes if you plan to use the spelling checker), and one or two floppy disk drives. A one-disk installation is possible with help from XyQuest technical support.

If WordStar is aimed at DTP, XyWrite is aimed at commercial publishing—the kind with staffs, buildings, and a sales department. It's definitely tuned for the production of raw text, which would then be sent to a print shop.

Consistent with such an environment, XyWrite does not paginate as you go along. There is a `Types` (type screen) command to show the document on the screen the same way it will be printed. There you can see page breaks and all the rest of it.

If customizing for a commercial environment is needed, XyWrite uses printer-description files written in a sort of high-level programming language. You can reprogram by loading the printer-description file into XyWrite and editing it just as you would any other document. With the LaserJet, you can perform functions such as assigning an 8-point font to be the superscript or subscript version of a 10-point font.

Fonts are changed by inserting a `PT` command in the text. Every printer starts out with `PT1`, `PT2`, and `PT3` already configured. But you can go into the printer-description file to change these or add more. The only limit is the number of fonts supported by your printer. The printer-description file also lets you de-

continued

Company Information

DisplayWrite 4
IBM Corp.
P.O. Box 152560
Irving, TX 75015
(800) 447-4700
Inquiry 907.

MASS-11
Microsystems Engineering Corp.
2400 West Hassell Rd.
Suite 400
Hoffman Estates, IL 60195
(312) 882-0111
Inquiry 908.

Microsoft Word
Microsoft Corp.
16011 Northeast 36th Way
P.O. Box 97017
Redmond, WA 98073
(206) 882-8080
Inquiry 909.

MultiMate Advantage II
Ashton-Tate
20101 Hamilton Ave.
Torrance, CA 90502
(213) 329-8000
Inquiry 910.

OfficeWriter
Office Solutions Inc.
2802 Coho St.
Madison, WI 53713
(608) 274-5047
Inquiry 911.

Samna Word IV
Samna Corp.
5600 Glenridge Dr.
Suite 300
Atlanta, GA 30342
(800) 831-9679
Inquiry 912.

SmartWord
Innovative Software Inc.
P.O. Box 15998
Lenexa, KS 66215
(913) 492-3800
Inquiry 913.

WordPerfect
WordPerfect Corp.
1555 North Technology Way
Orem, UT 84057
(801) 225-5000
Inquiry 914.

WordStar 2000 Plus
MicroPro International Corp.
33 San Pablo Ave.
San Rafael, CA 94903
(415) 499-1200
Inquiry 915.

XyWrite III Plus
XyQuest Inc.
44 Manning Rd.
Billerica, MA 01821
(617) 671-0888
Inquiry 916.

fine how each font would be displayed on the screen. If you have a color screen, you can get pretty exotic by working with each font in a different color.

In the case of the LaserJet B cartridge, PT1 is Courier and PT2 is 10-point Times Roman. But PT3 is a strangely formatted Courier. Reading the printer-description file shows that the file wants to address something on cartridge F. I was immediately able to make PT3 invoke Times Roman italic. In another 2 minutes, I was able to cook up PT4 (by copying PT3 and changing some values) to invoke 14-point Helvetica.

As usual, the screen handles font size differences by unanchoring the right margin. There was no other pretense at WYSIWYG. Newspaper columns are shown in one column but printed as two columns.

XyWrite has a reputation for speed. And it is fast, although not the fastest in all categories. File conversion is not a problem because XyWrite documents are straight ASCII files with embedded commands.

There is also a spelling checker with 100,000 words, a thesaurus with 35,000 words, redlining, table-of-contents and index generation, and footnotes.

XyWrite is well suited for professional publishing environments with a staffed department to take care of graphics and other related matters. Otherwise, this program is no closer to achieving DTP functions than most other packages. And it's overkill for most basic tasks.

Program of Action

Overall, it looks as if we have another generation or two to go before we'll have DTP and word-processing features combined in one package. The first of those, NBI Legend, has been announced and will be reviewed in a subsequent issue.

Looking over the current crop of word processors, you can see that the ability to easily make large-scale font changes is limited. WYSIWYG of a sort is available only through special preview screens. Little use is made of graphics beyond showing superscript or subscript characters. On-screen text remains as monospaced typewriter emulation.

Proportional text—if the system even recognizes this concept exists—is represented by stretching the right margins. If graphics can be integrated at all, it's by assigning a graphics file to a blank area on the page—the picture is not shown on the screen.

Of these reviewed packages, the closest to producing DTP output is WordStar with its view screen. But even this feature is WYSIWYG on a macro scale. For serious work, you must get a close view of the material to fine-tune everything the reader will see. Samna, with its greeking ability, is at least in the ball game. The most disappointing of them is DisplayWrite 4, an underfeatured package with a full-featured price.

But it may be too much to ask for a true combination of DTP and word processing. To assure WYSIWYG, word processors will need graphics screens with "screen fonts" that mimic the printer fonts. For the sake of speed, however, perhaps the best way for this feature to be handled is to have the ability to toggle to a nongraphics screen while ordinary editing is underway—an approach already taken by Microsoft Word. To control the outcome on the page, the software should also have its own matching printer fonts that it can download, to free it from its dependence on the laser printer.

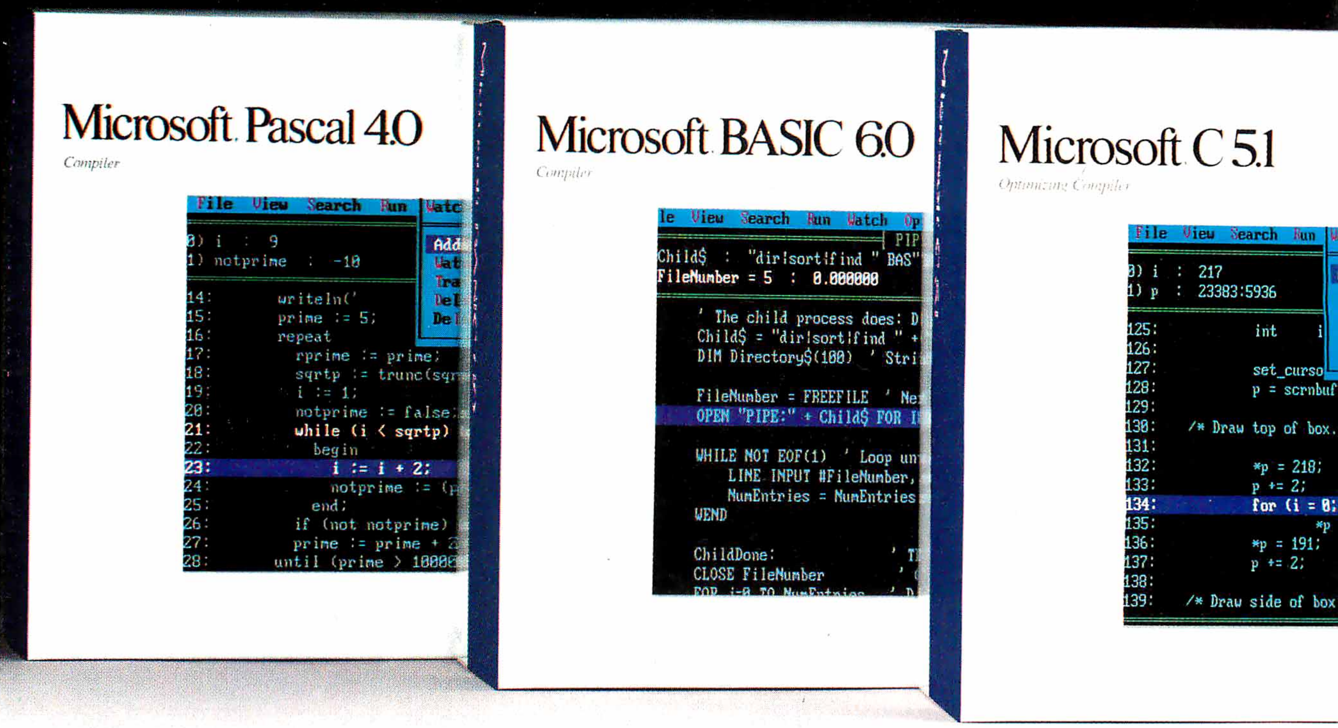
The DTP program Ventura Publisher takes up more than 3 megabytes on a hard disk. Some word processors consume just as much. Successfully combining DTP and word-processing approaches may result in gargantuan programs that require the most powerful hardware.

And last but not least, the user must also be considered. Today's state-of-the-art word-processing software is complex. Some packages use more than a dozen distribution disks and 10 pounds of documentation. This complexity factor could explain the general abandonment of copy protection, since with these mammoth packages, the copy-protection scheme becomes analogous to chaining the Great Pyramid to a lamppost.

Eventually, what could be known as "word-publishing" software, by definition, will be powerful. But it must also be approachable. It will happen. But for now, our reach still exceeds our grasp. ■

Lamont Wood is a freelance writer from San Antonio, Texas in the computer and electronics fields. He has been using word processors professionally for more than 10 years.

Introducing Mic for OS/2



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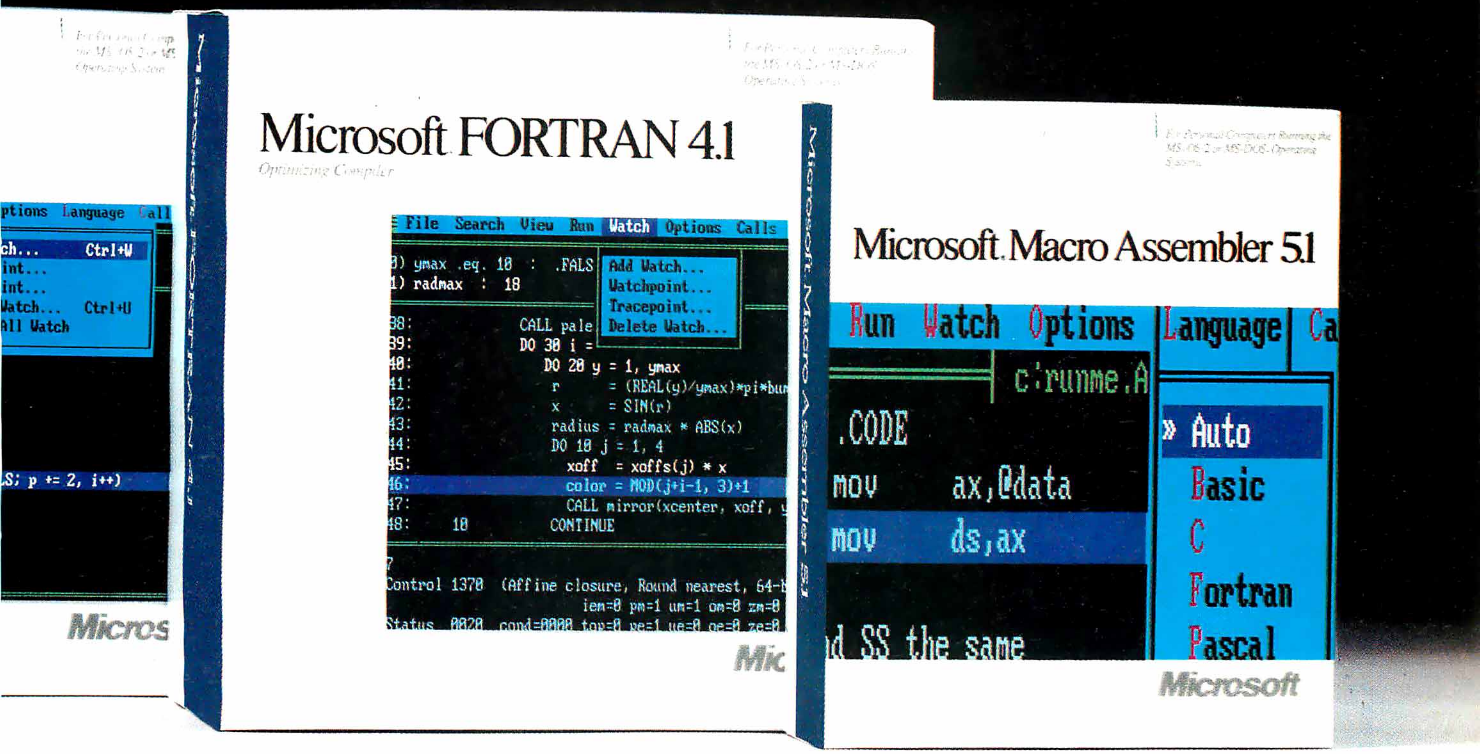

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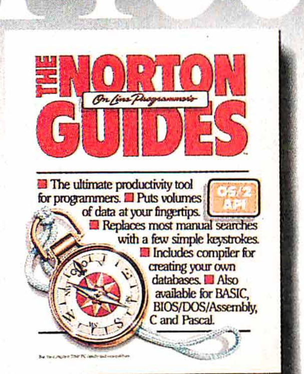

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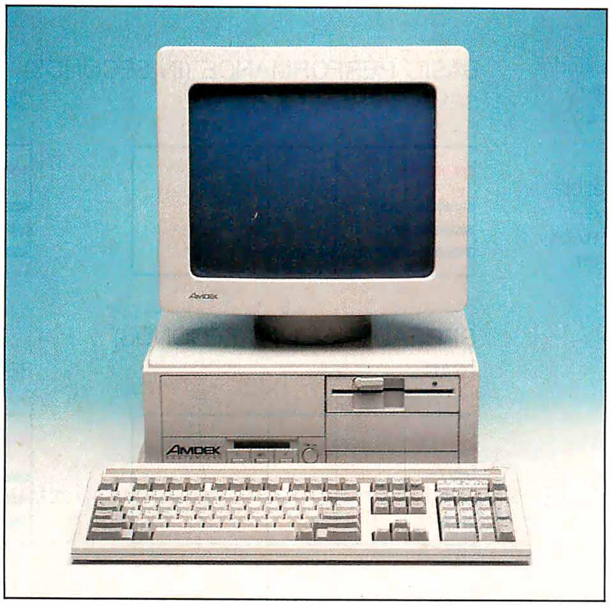


The Amdek System/386's small size and pleasing looks belie its serious side as an 80386-based microcomputer whose performance ranks among the best of the 16-MHz 80386 machines. Its CPU runs with zero wait states at 16 MHz (or with one wait state at 8 MHz) and is mounted on a card that plugs into the computer's backplane; there is no motherboard in the traditional sense of the word.

Amdek's entry into the high-speed 80386 microcomputer race has a clean and pleasing design. Its small-footprint chassis is only 15 inches wide, and the front panel has a small LCD that displays system messages. Three switches beneath the LCD let you monitor the date, time, and CPU activity, as well as display and switch the clock speed between 8 and 16 MHz.

The review unit came with 1 megabyte of 100-nanosecond (ns) RAM, a high-performance 40-megabyte hard disk drive, and a 1.2-megabyte 5¼-inch floppy disk drive. I also received Amdek's optional 1280 high-resolution display adapter and 15-inch paper-white monitor. This display combination gives a striking 1280- by 800-pixel monochrome resolution and is perfect for CAD/CAM and desktop-publishing chores. It does not have color, however. The System/386 with these components lists for $5949.

Amdek is a subsidiary of WYSE Technology, and WYSE makes most of the components in the machine. In fact, the System/386 and the WYSEpc 386 (April BYTE) share many components and perform similarly. They even use the same keyboard.

Just Plug It In

The System/386's overall hardware design is based on an uncomplicated backplane composed of eight expansion slots; all the components plug into these slots. This configuration is in contrast to the conventional design, where the CPU, I/O ports, memory, and other components are mounted on the motherboard.

The 80386 CPU comes on a plug-in expansion card, just like such components as the display adapter and disk controller. The CPU card is actually made up of three separate piggybacked cards and occupies the space of two 16-bit slots on the backplane. The 80386 and its related chips are mounted on a mother/daughter card combination; the system memory occupies the third card of the group. A separate 32-bit bus that extends across the top of the piggybacked cards connects the memory card to the CPU.

You can install up to 6 megabytes of 100-ns dynamic RAM (DRAM) in the System/386: 2 megabytes on the original card, and 4 more on a second memory card. The review system had three slots free for expansion: two 16-bit slots and one 8-bit slot.

Like the WYSEpc 386, the CPU card has one 9-pin serial connector on it. A second serial connector and a parallel connector are mounted on a half-length card connected to the CPU card by a ribbon cable. The serial port on the second card is designated as COM1, and the port on the CPU card is designated as COM2.

One difference between the WYSEpc 386 and the System/386 is that the Amdek computer uses a conventional disk controller card mounted in one of the 16-bit expansion slots, while the WYSE controller doesn't require any expansion slots (it lies at the bottom of its case and connects to the backplane via a special edge connector). The Amdek disk controller card supports up to two floppy disk drives and two hard disk drives.

The review unit had a Panasonic 1.2-megabyte 5¼-inch floppy disk drive and a Control Data Corp. 40-megabyte hard disk drive installed in two of the three available half-height storage-device bays. The Coretest utility shows that the hard disk drive has an average seek time of 25 milliseconds (ms) and a track-to-track seek time of 4.3 ms. It performed very well. However, initial access to the floppy disk drive seemed slow. For example, when I used the `A:DIR` command to access the floppy disk from the hard disk, it took a few seconds before anything appeared on the screen—a delay that seemed intolerable when compared to the high performance of the rest of the hardware. Once the drive is up and run-

continued

Amdek System/386

Company
Amdek Corp.
1901 Zanker Rd.
San Jose, CA 95112
(800) 722-6335
(408) 436-8570

Components
Processor: 16-MHz Intel 32-bit 80386 with no wait states, switchable to 8 MHz with one wait state; optional 80287 (from 6- to 10-MHz) or 80387 (16-MHz) math coprocessor
Memory: 1 megabyte of 100-ns, 32-bit, interleaved static-column RAM, expandable to 6 megabytes; 32K bytes of ROM
Mass storage: One 1.2-megabyte 5¼-inch floppy disk drive; one 40-megabyte hard disk drive
Display: Optional Amdek 1280 MDA and monochrome monitor with 1280- by 800-pixel resolution, compatible with IBM monochrome and CGA
Keyboard: 102 full-size keys with 12 function keys, separate editing keys, and numeric keypad (IBM-Enhanced style); LED indicators on Caps Lock, Num Lock, and Scroll Lock keys
I/O interfaces: Two RS-232C serial ports (DB-9); one Centronics-compatible parallel printer port (DB-25); eight expansion slots: six AT-compatible 8-/16-bit slots and two PC-compatible 8-bit slots

Size
17 by 15 by 6¼ inches; 38 pounds

Software
MS-DOS 3.21; GWBASIC 3.20

Options
High-resolution display system: $995
CGA: $130
MDA: $130
1-megabyte 32-bit memory upgrade: $549
2-megabyte 32-bit memory upgrade: $1395
360K-byte floppy disk drive: $190

Documentation
70-page Installation and Assembly Manual; 110-page Amdek Enhanced MS-DOS 3.2 User's Guide; 98-page Amdek 1280 User's Guide and Programmer's Manual; on-line Help facility

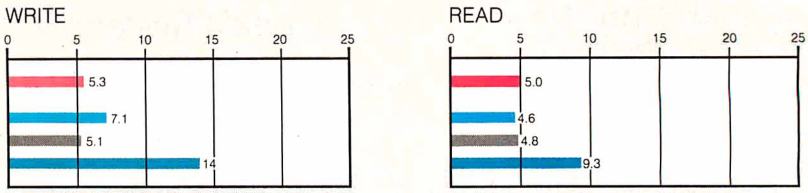
Price
System/386 with a 1.2-megabyte floppy disk drive (no monitor or display adapter): $3850
System/386 with a 1.2-megabyte floppy disk drive and a 40-megabyte hard disk drive (no monitor or display adapter): $4950
System as reviewed (without 80287 coprocessor): $5949

Inquiry 883.

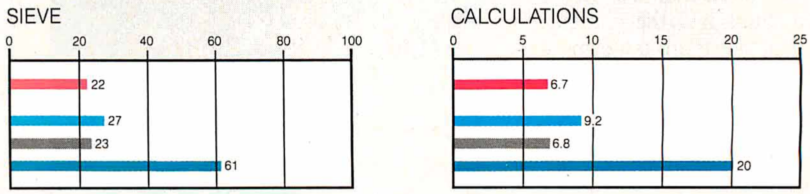
	Dhrystone*	Fibonacci	Float	Savage	Sieve	Sort
Amdek System/386 (80287-8)	3974	50.37	9.78	31.14	5.71	7.49
PS/2 Model 80 (80387-16)	3626	57.26	1.62	9.49	6.45	7.74
Compaq 386 (80387-16)	3748	53.11	1.43	8.95	5.98	5.58
Compaq 386 (80287-8)	3748	53.12	6.80	21.53	5.99	5.58
IBM PC AT (80287-8)	1590	126.22	10.98	37.30	24.60	43.17

*For the Dhrystone test only, higher figures denote faster performance.

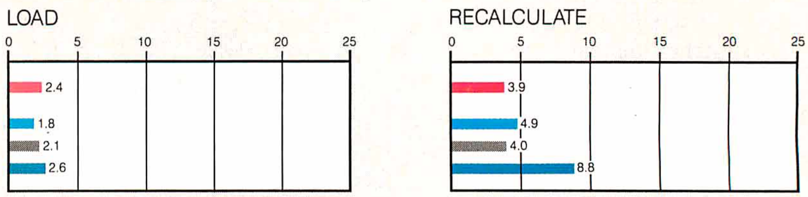
DISK ACCESS IN BASIC (IN SECONDS)



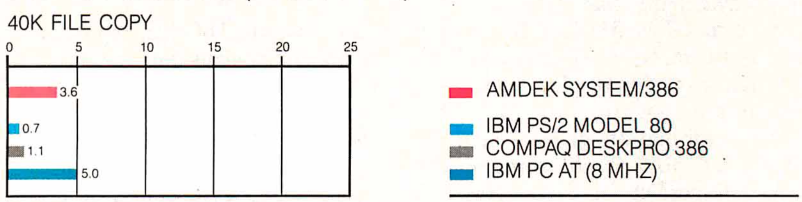
BASIC PERFORMANCE (IN SECONDS)



SPREADSHEET (IN SECONDS)



SYSTEM UTILITIES (IN SECONDS)



The table contains the results of the C language benchmarks (see "A Closer Look" by Richard Grehan in the September 1987 BYTE). All times are in seconds, except for the Dhrystone, which is in Dhrystones per second. 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 Spreadsheet tests load and recalculate a 100-row by 25-column Multiplan (1.06) spreadsheet. The 40K File Copy benchmark copies a 40K-byte file on the hard disk. The BASIC benchmark programs were run with MS-DOS 3.2 and GWBASIC 3.2 on the Amdek System/386 and IBM PC AT. The IBM PS/2 Model 80 used PC-DOS 3.3 and BASICA 3.3. The Compaq Deskpro 386 used MS-DOS 3.1 and BASIC 3.11.

ning, however, the actual data transfer rates are normal and acceptable.

Great Graphics

One component that separates the System/386 from the crowd is the optional Amdek 1280 high-resolution display adapter and monitor. This system can display graphics of up to 1280 by 800 pixels in true monochrome (black-and-white dots) in high-resolution mode. It also supports both the WYSE/Amdek high-resolution and IBM PC-compatible monochrome and CGA modes.

The principal advantage of the Amdek 1280 in standard 80- by 25-character mode is the large number of pixels it uses per character cell—16 by 32—resulting in smooth, well-formed characters that are easy on the eyes. I was, however, bothered by the look of the lowercase *m*: When my eyes scanned down a page of text, each *m* popped out from the other characters as if it were in a bold font. I prefer using the monitor with black characters on a paper-white background; it provides good contrast and is easy on the eyes. However, the *m* problem was even more noticeable in that mode.

The high-resolution modes aren't very useful unless you have software that can take advantage of them. In my collection of programs, only Brief 2.01, a programming editor, has a driver that lets you display the high-resolution text mode of 50 lines with 80 or 160 characters per line. I was able to integrate the graphics capabilities of the 1280 into some of my C language graphics programs by using Metagraphics' MetaWindows for C 3.2B; this is a library of graphics functions for C language compilers that has a driver for both the Amdek 1280 and the WYSE 700 display adapters. Graphics are impressive with all those pixels.

The 1280 display adapter comes with a utilities disk and a demonstration disk. The utilities disk includes a SCREEN program so you can change the display's text mode to any of the IBM-compatible or high-resolution modes. It's most impressive to be able to see an entire directory listing on the screen in 160 by 50 mode. However, the individual characters in this mode are tiny (8 by 16 pixels per character cell) and take real concentration to read. The 80 by 50 mode (16 by 16 pixels per cell) is much more legible, and you still have 50 lines of text on the screen.

The utilities disk also has drivers for Digital Research's GEM 2.2 and Microsoft Windows 1.x. I loaded the Windows driver onto my oldish version of this program (1.03) and had no problems getting the high-resolution window to appear on the 1280 monitor. However, when I tried to run either the Paint or Write programs, Windows told me I didn't have sufficient disk space—although I had over 30 megabytes left on the disk. I suspect the problem is an incompatibility between a very old version of Windows and a fast 80386 microprocessor. [Editor's note: *The company says that the driver now supports Windows/386 and 2.0.*]

The demonstration disk contains some impressive examples of the 1280's graphics capabilities. Two of the images look like they were created with CAD/CAM software, and a third is a picture of a GEM window.

The only problem I had in setting up the System/386 was related to the 1280 display adapter. When I first received my review unit, it booted fine from the floppy disk but wouldn't boot from the hard disk. After reinitializing and reformatting the hard disk, I still couldn't boot the system without loading a floppy disk into the A drive. Finally, I called Amdek's technical-support number (not toll-free).

After a couple of false starts, Amdek's technicians pinned the problem down to a conflict between the display adapter and the system bus. The display-adapter manual clearly states that if the 1280 is the only display card connected to your computer, you don't need to make any changes to the card before you install it. In reality, however, you have to set either the Color or Mono jumper settings on the card to "Off" before the System/386 will boot properly from its hard disk. The computer worked fine after that fix.

The only compatibility problems I encountered also centered around the optional Amdek 1280 display adapter. This card emulates the CGA colors as four shades of gray. In certain situations, the adapter's choice of how the colors from the CGA's palette correspond to the shades of gray can give rise to unreadable combinations of background and text. For example, if you have magenta characters on a blue background, you'll get dark gray on dark gray. You can solve this problem by changing the defaults when your software allows you to. In general, if your software doesn't specifically support the Amdek 1280 or the WYSE 700, you should set it up as a monochrome display to avoid any possible confusion with CGA emulation.

Fast, Fast, Fast

The enhanced versions of MS-DOS 3.21 and GWBASIC 3.20 included with the System/386 appear to be identical to those that come with the WYSEpc 386, right down to the utility programs and the Help system. The Amdek SCREEN command is used only for the 1280 display adapter and monitor. The disk-caching

continued

program improves the overall performance of hard disk I/O by between 15 percent and 25 percent, depending on the situation. For example, the File Read benchmark ran 20 percent faster with 256K bytes of cache installed. The speed improvement that the caching program provides is most evident when you use software with overlays or programs like compilers and some database managers that read and write temporary files to the disk while they are running.

The benchmark results show that the System/386 is among the fastest of the 16-MHz 80386 microcomputers. The review unit didn't come with an 80287 or an 80387 math coprocessor installed, so, for benchmarking purposes, BYTE added an 8-MHz 80287. Of course, a 10-MHz 80387 would have improved the Float and Savage benchmark results.

Getting Help

The installation manual is clear and well written. You should have no problem installing optional hardware or running the SETUP program. The MS-DOS user's guide contains good sections on getting started and on using a few of the more common operating-system commands, but it ignores most of the commands, as well as EDLIN and DEBUG; Amdek relies on the Help utility to provide the rest of the information.

To use the Help program, you simply type HELP and the name of the DOS command or utility you need to know more about. The program responds with details of the syntax and examples; it's similar to what you would normally find in an MS-DOS manual. This is fine for some users, but others feel more comfortable with some sort of manual to study and browse at their leisure. Ideally, both an on-line Help utility like the one Amdek provides and a detailed paper manual should be furnished.

The display-adapter user's guide has full information on installing and using the 1280 system and is invaluable if you want to write software that uses its high-resolution character and graphics modes.

The System/386 comes with a one-year warranty and has FCC Class B certification.

A Lot of Computer

The Amdek System/386 is a lot of computer in a small, attractive, desktop box. In performance, it ranks with the better microcomputers in the 16-MHz 80386 class. The fact that WYSE manufactures the hardware doesn't detract from its capabilities: WYSE has an excellent reputation for its hardware and has been making terminals for microcomputers since CP/M days.

The optional high-resolution 1280 display adapter and monitor are a pleasure to use, but I wish more software was available to take advantage of their capabilities. However, for $995, this ultra-high-resolution monochrome system is best suited for desktop publishing or CAD/CAM. Most users might opt instead to buy a good multiscan color monitor and an EGA or VGA board.

The System/386 itself is solidly put together, and its well-thought-out design will let you upgrade to a faster or better CPU just by plugging in a new CPU card. Its only possible limitation is the few free slots available in the system. (Amdek also sells a larger version of the System/386, called the System/386E, which has more expansion slots and additional space for disk drives.) However, if you need a good 80386 machine, I wouldn't hesitate to recommend this microcomputer. ■

John Unger is a geophysicist for the U.S. government and lives in Hamilton, Virginia. He writes graphics software and uses computers to study the structure of the earth's crust.

Dynamac's Portable Mac

Peter Wayner

Dynamac repackages the Mac Plus to prove that you can take it with you

The Holy Grail of the Macintosh world is a portable version of the computer—after all, what good is the power and convenience of the Mac if you have to leave it behind when you travel? Both the Mac Plus and the Mac SE, at 17 pounds and with built-in handles, might be considered portable, but their dimensions put them in a category best described as "luggable." Enter the Dynamac EL, the first truly portable Mac, from Dynamac Computer Products.

Dynamac Computer takes the internal components of a Mac Plus out of its boxy housing and places them in an easy-to-carry, sleek black case with a fold-up, flat-panel display and a built-in keyboard. The result is a machine with a soul made by Apple but the look of an executive briefcase.

A Dynamac EL with an internal hard disk drive weighs 1 pound more (18 pounds total) than a Mac Plus without a hard disk drive, and 8 pounds less than a Mac SE with an internal hard disk drive. The cost of this portability is high, however: A standard Dynamac EL with an 800K-byte 3½-inch floppy disk drive, 1 megabyte of memory, and a large electroluminescent display costs $4995. I reviewed a fully loaded Dynamac EL, priced at $8334 and equipped with 4 megabytes of RAM, a 40-megabyte internal hard disk drive, and a 300-/1200-bit-per-second (bps) internal modem.

The Soul of the New Machine

Dynamac Computer takes the basic circuits for the Dynamac straight from a Mac Plus. These circuits consist of a 68000 processor operating at 7.83 MHz, the latest version ("platinum") of the 128K-byte ROMs, 1 megabyte of RAM (expandable to 2.5 or 4 megabytes), and the 800K-byte 3½-inch floppy disk drive. The back panel holds the SCSI port, audio port, external floppy disk drive port, external keyboard connector, and two serial ports using DIN-8 connectors (see photo 1).

The internal similarity ends here, however, because Dynamac Computer provides its own circuitry to add a switchable external keyboard connector, an optional internal hard disk drive, and an optional internal modem. The Dynamac EL's 640- by 400-pixel electroluminescent display comes close to the 640- by 480-pixel screen size of a Mac II using the Apple video board. It also has connectors for composite video output and for E-Machines Inc.'s 1024- by 808-pixel Big Picture monitor.

These peripherals attach to the main Macintosh board in various ways. The large screen of the Dynamac EL receives its signals from a bus attached directly to the 68000 processor. This bus is powerful enough to drive E-Machines' monitor, but it is not designed to receive other cards. The port on the Dynamac EL that drives the Big Picture monitor can also drive any monitor or projector that accepts a 67-MHz video signal with 22-kHz horizontal sweep rates and a 60.15-Hz field.

On power-up, an `INIT` file supplied with the Dynamac EL checks for a Big Picture monitor attached to the back panel. If one is found, the video signal adapts to a 1024- by 808-pixel display; otherwise, the display is set to 640 by 400 pixels. One nice feature of this `INIT` file is that if you hold the Option key down while the machine boots, the display hardware reverts to the standard 512- by 342-pixel display. This lets you run any software that doesn't work properly on a large display.

The composite video output comes from the same port as the large monitor signals. At start-up, if you hold down the Option key and the Dynamac detects a composite monitor connected to the port, the system will generate a composite video signal. This display is limited to 512 by 342 pixels.

The optional internal hard disk drive is available in 20-megabyte and 40-megabyte versions and attaches to the SCSI bus within the computer. The circuitry of the SCSI is unaffected, and other SCSI peripherals can be attached to the external DB-25 SCSI connector as long they don't use address 4, which is the SCSI ID of the internal hard disk drive.

The Dynamac uses a fan-cooled switching power supply. This avoids some of the power supply problems that normally confront Mac Plus owners who want to add internal enhancements to

continued

Dynamac EL

Company
Dynamac Computer Products Inc.
1536 Cole Blvd., Suite 252
Golden, CO 80401
(303) 233-7626

Components
Processor: Motorola 68000 running at 7.83 MHz
Memory: 1 megabyte of RAM, expandable to 2.5 megabytes or 4 megabytes on the motherboard; 128K bytes of ROM
Mass storage: One internal 800K-byte 3½-inch floppy disk drive; optional 20- or 40-megabyte internal hard disk drive
I/O interfaces: Two DIN-8 serial connectors; SCSI port; external keyboard port; audio port; external floppy disk drive port; mouse port; video port, for connecting either an E-Machines Big Picture monitor or an external video monitor; models equipped with an internal modem have a telephone port
Display: Built-in 19- by 12-centimeter electroluminescent bit-mapped screen; 640 by 400 pixels
Keyboard: 61 keys with cursor keys
Other: Optomechanical one-button mouse

Size
15¾ by 13¾ by 3½ inches; 15½ to 18 pounds

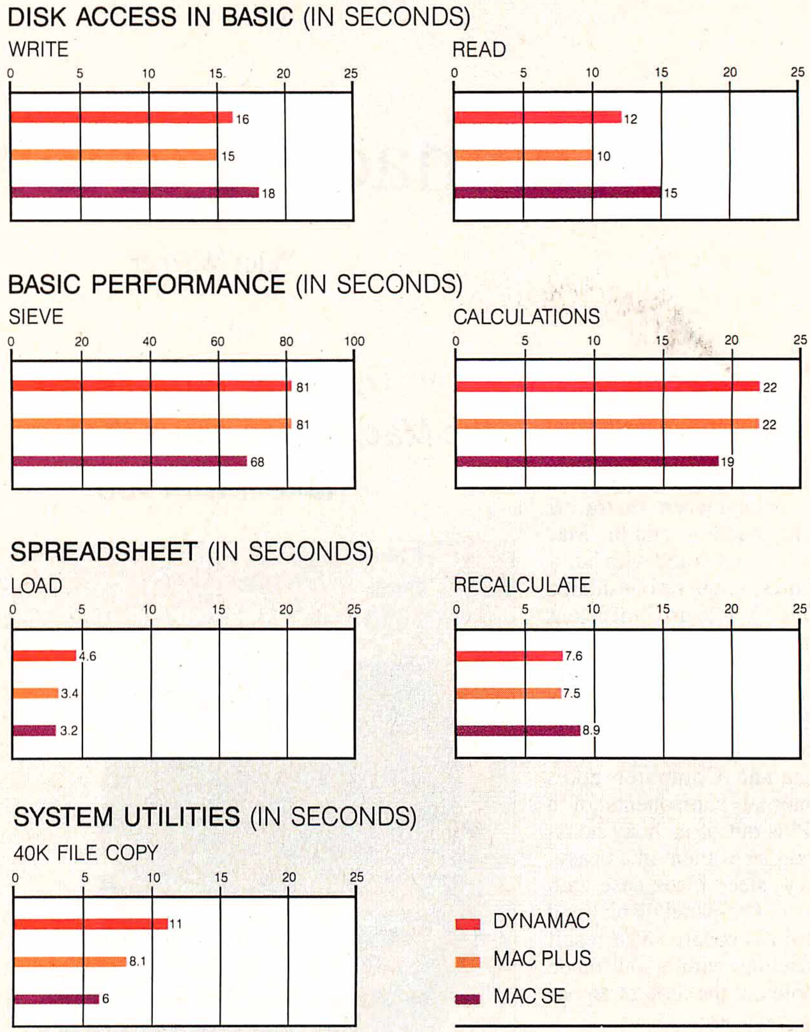
Software
Version 5.0 distribution disk with System 4.2/Finder 6.0; disk and desk accessory utilities; HyperCard

Options
2.5-megabyte memory expansion: $695
4-megabyte memory expansion: $1549
Internal 300-/1200-bps modem: $295
20-megabyte internal hard disk drive: $849
40-megabyte internal hard disk drive: $1495
Big Picture monitor: $1595
Standard carrying case: $99
Deluxe carrying case: $199

Documentation
100-page user's manual

Price
Base system: $4995
System as reviewed: $8334

Inquiry 884.



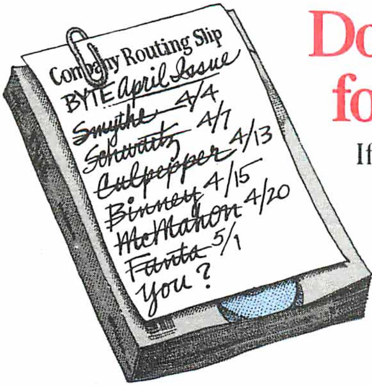
The Disk Access benchmarks write and then read a 64-byte sequential text file to a floppy disk. Sieve runs one iteration of the Sieve of Eratosthenes. Calculations performs 10,000 multiplication and division operations. The Spreadsheet tests load (from a hard disk) and recalculate a 25-row by 25-column Multiplan spreadsheet. The 40K File Copy benchmark copies a 40K-byte file on the floppy disk. The Mac Plus used System 3.0/Finder 5.0 and MS-BASIC 1.0. The Mac SE ran System 4.1/Finder 5.5 and MS-BASIC 2.1(b). The Dynamac ran System 4.2/Finder 6.0 and MS-BASIC 2.1(b). Multiplan version 1.02 was used for the Dynamac and Mac Plus tests, and Multiplan 1.1 was used for the tests on the Mac SE.

their computers. The power supply is switch-settable to accept either 110 volts or 220 volts, making it ideal for international travel. Unfortunately, there's no battery pack available that would let you operate the computer away from a power outlet.

The optional 300-/1200-bps modem is attached in line with the serial port. One switch on the back panel directs signals to either the internal modem or the serial port, and another switch sets the communication protocols of the modem to either U.S. standards (Bell 212) or CCITT European standards (V.21). This is another feature that begs for a trip to Europe.

The Body of the New Machine

The slim, easily portable package of the Dynamac EL is responsible for most of the machine's appeal. Dynamac Com-



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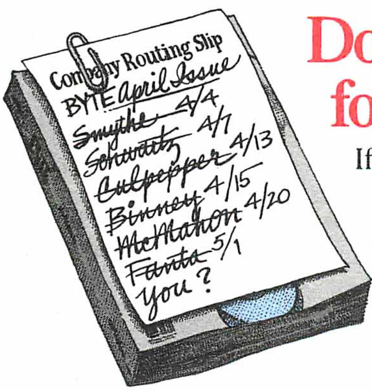

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puter replaced the round-edged boxy styling of the Macintosh with a compact style that appeals to corporate executives and *Star Wars* set designers. The bottom of the shell is fashioned from steel, and the top covering and folding display are of molded plastic. Everything is jet-black except the keyboard and the mouse, which are colored that sooty gray Apple calls "platinum."

The flat screen lies over the keyboard when stowed, and two sliding catches lock it in place. The screen folds up from a hinge that is located halfway along the top of the computer's body. When you unlock and open the screen panel, it unveils the keyboard and an internal 3½-inch floppy disk drive that's placed below and to the left of the screen for easy access.

The Dynamac EL uses an electroluminescent screen that displays the pixels in black, and the background appears as either a saffron yellow (in incandescent light) or a pale yellow-orange (under fluorescent lighting). The yellow-orange and black screen does not have as much contrast as the black-and-white screen of the Mac, but after a several-minute adjustment period, I didn't find this to be a problem. The screen's yellow color is quite pleasant to use because it seems to cut glare—much like the way yellow legal pads strain the eyes less than white ones.

This is just a coincidence of physics, however, and not an example of ergonomic design. The Dynamac EL's display uses a thin film of doped zinc sulfide deposited on glass that glows in this color when stimulated by the video circuits. The film is etched photographically, yielding an array of fine square pixels. The precision of the etching produces a crisp display with excellent clarity, perfect aspect ratio, and readability that is better than that of the original Macintosh display. It packs 46 percent more pixels (640 by 400 pixels versus 512 by 342 pixels) into only 22 percent more screen area (19 centimeters by 12 centimeters versus 17 centimeters by 11 centimeters). Given the choice of working with either a Mac SE or the Dynamac EL, I often chose the Dynamac EL with its large, comfortable screen.

The Dynamac EL's screen sits at a fixed angle to the keyboard. The hinge does not have a friction mount that would let you adjust this angle; a sliding handle built into the Dynamac lets you prop up the rear of the computer and gives you a second viewing angle, but that's it. Nor does the Dynamac EL have a knob for brightness or contrast, so you're stuck with what the display offers. These two fixed parts of the design would be a big problem for LCD screens, but this isn't the case for the electroluminescent technology because the display is readable from every angle. However, they are features that could be improved upon.

The mouse is the standard first-generation Apple mouse that came with the Mac Plus used to make the Dynamac; it plugs into a socket in the back panel. There isn't any place to store the mouse when the computer is folded up for traveling, nor is there a place to store the power cord. This is a bit of a disappointment, since I think a portable machine should be as self-contained as possible. The optional nylon and leather carrying case does have a pouch for both the mouse and the power cord, however.

This brings us to one of the big problems for designers of mouse-based portables: The mouse can't be used without a flat surface next to the machine, and that rules out many good working opportunities. One solution is to use the Easy Access INIT file provided by Apple. Easy Access was designed to aid handicapped people (who can have difficulty using a mouse) in using a Mac computer. This software also lets you operate the Dynamac without a mouse—but that doesn't mean that Easy Access is easy or desirable in this situation.

This is one problem that requires further examination by the engineers. For example, Grid Computer's first laptop had a touchpad above the keyboard that duplicated all the functions of the mouse. It is disappointing not to find a touchpad or a small built-in trackball to serve as a mouse on the Dynamac.

The keyboard is also cannibalized from the Mac Plus. The numeric keypad is missing, but a desk accessory (DA) called Keypad Overlay, provided with the computer, turns the *M, J, K, L, U, I, O,* 7, 8, and 9 keys into a numeric keypad. Once you've activated Keypad Overlay, these keys function as a keypad whenever you hold down the Option key. You use the same DA to remove this capability.

The Enter key from the numeric keypad is now directly above the Return key. This is a good feature, since many applications distinguish between the two keys. It shows that the Dynamac designers anticipated the many possible ways their modifications could inhibit compatibility. If the built-in keyboard is still not adequate for you, you can attach another keyboard to the extra keyboard port in the rear. This additional port is also suitable for people who want to use a separate keyboard in front of a large screen monitor.

Standard Software, Slim Documentation

Initially, the Dynamac EL came with System 4.1 and Finder 5.5. However, it's now being shipped with version 5.0 system software (System 4.2 and Finder 6.0) and copies of HyperCard.

With the generous 4 megabytes of RAM on the review machine, I could run MultiFinder, HyperCard, and several other applications without problems. I hooked the Dynamac up to a LocalTalk network to test its AppleTalk capabilities, and I printed several documents to a LaserWriter and a LaserWriter NT without problems. I also connected an Apple Hard Disk 20 to the external floppy disk drive port of the Dynamac EL. As is typical of the Mac Plus ROMs, at start-up the Dynamac checks the floppy disk drives and then the SCSI port for bootable volumes, so the Hard Disk 20 became the start-up volume rather than the Dynamac's internal SCSI hard disk. This behavior is normal, and the Dynamac op-

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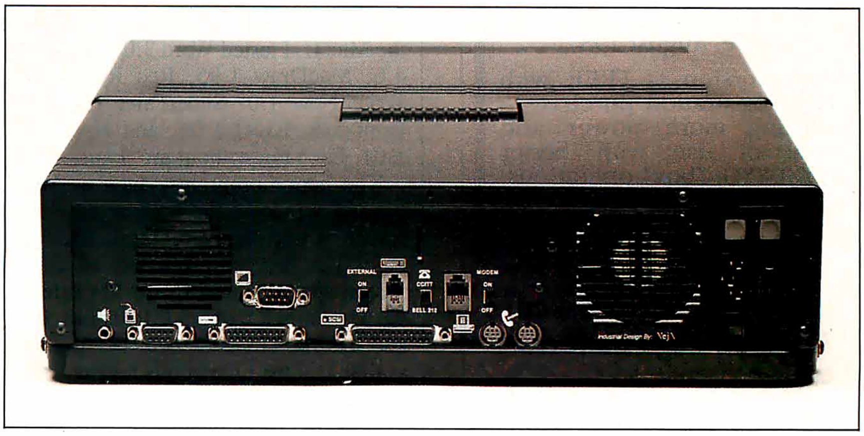


Photo 1: *The Dynamac's back panel holds (from left to right) the audio port, the mouse port, the external floppy disk drive port, the video port, the SCSI port, the external keyboard connector, the telephone port connector, and two serial ports using DIN-8 connectors.*

erated flawlessly with the external hard disk drive.

The Dynamac EL comes with one slim manual that describes the basic facts about the Macintosh desk software and the back panel of the computer. My copy of the manual was labeled "Preliminary Release—Summer 1987." A short section in the back gives hints for troubleshooting the computer. While the manual is small and pales in comparison to the extensive Apple documents, Dynamac didn't miss anything.

The manual has a few irregularities, however. For example, the communications entry in the index reads, "See MacTerminal; modems," despite the fact that there is no entry for MacTerminal in the manual and the program is not supplied with the computer. The manual doesn't hold a new user's hand, either, and you'll have to look elsewhere for descriptions of the more arcane utility programs on the System disk. For those who do experience problems, Dynamac Computer offers free telephone support and lists the number to call at the very beginning of the manual.

Performance and Portability

The benchmarks did not reveal anything particularly surprising about the Dynamac: It performs just like a Mac Plus. In both the Sieve and the Calculations tests, the Dynamac and the Mac Plus tied. The Disk Write and Read tests, which evaluate the floppy disk drive, were slightly slower for the Dynamac than for the Mac Plus. The hard disk drive also worked slightly slower than my SE's hard disk drive. These differences in performance were not significant.

It should come as no surprise that there were no problems with software compatibility. Most of the software packages have been modified by now so that they utilize the variable-size screens used on the Mac II. I tested Word 3.01, MacWrite 4.6, MacDraw 1.95, Red Ryder 10.3, Write Now 1.0, SuperPaint 1.0, MacPaint 1.5, Excel 1.04, and HyperCard 1.01. Each ran without problems.

The better programs, such as Word, opened windows the size of the larger screen, while older programs, like MacPaint 1.5, left you with lots of unused screen space. Claris Corp. has released the MacPaint 2.0 upgrade that does detect and use the larger screen, but it wasn't available at the time of this review.

VideoWorks 1.0 ran on the large display, but the screen animation was erratic. The solution is to use the Mac II–compatible VideoWorks II, which uses the larger screen and didn't exhibit any flicker during animation. One hidden cost of the Dynamac EL is that you'll have to upgrade your software to use the larger screen, or else run it on the 512- by 342-pixel display mode.

The machine's portability is one important facet that cannot be tested with ordinary benchmarks. With a hard disk drive, the Dynamac EL is slightly heavier than a Mac Plus, but it has the advantage in size and shape. The original Mac is small enough to be used as a portable computer when it is packed into the specially designed suitcases, but its rectangular shape can be ungainly when slung over your back. The Dynamac's briefcase shape makes it easy to carry at your side without bumping into other people. The bag comes with a shoulder strap because the computer is heavy enough to make long walks tiresome.

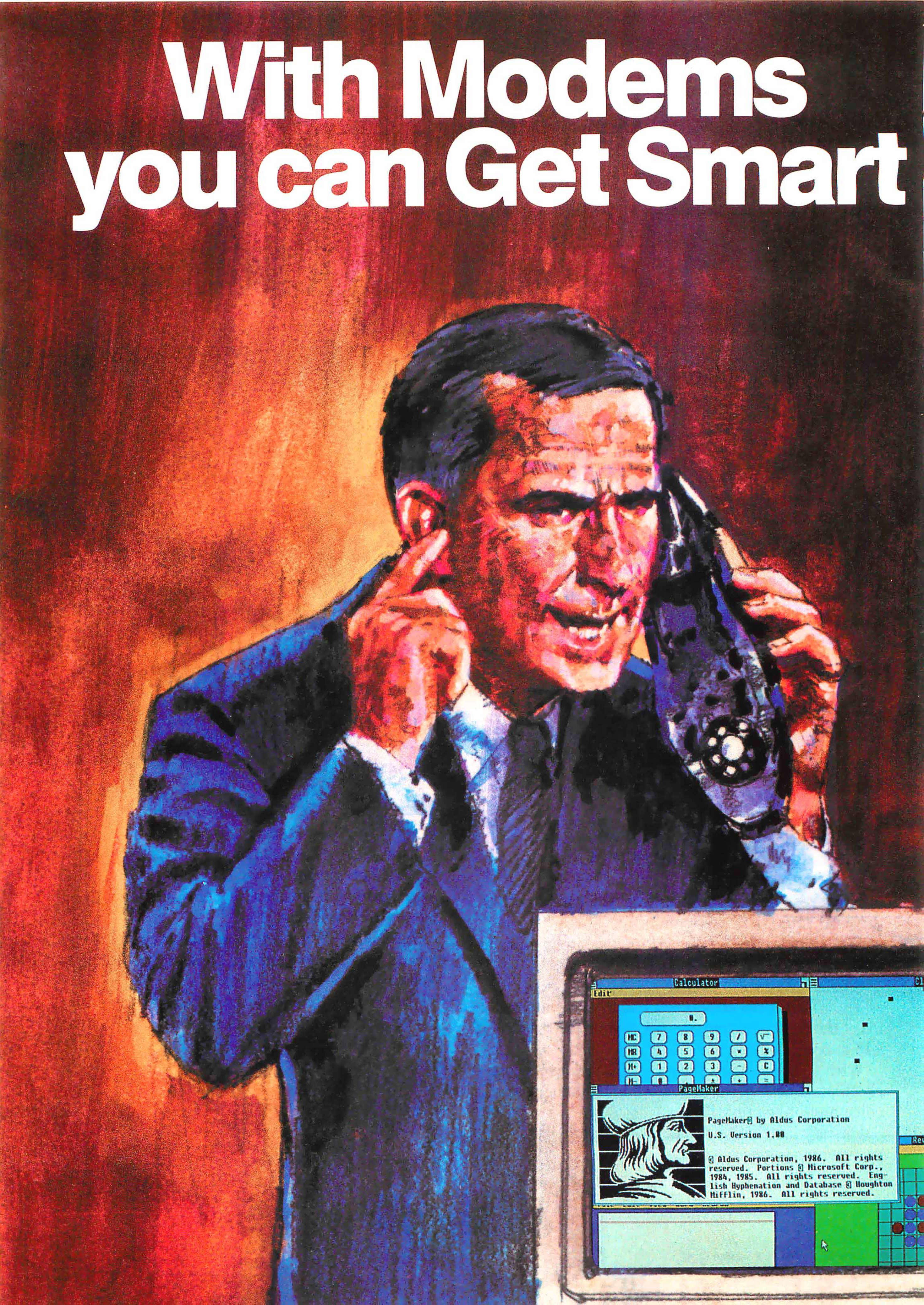
A Lightweight Computer with a Hefty Price Tag

The Dynamac EL is a Mac Plus computer in a slim case that sidesteps compatibility problems by using the actual circuits from a disassembled Macintosh. The Dynamac's screen is one of the best displays I've seen on a portable computer and is good enough to make the Dynamac the day-to-day machine of anyone who buys it. When I wrote this review, I had the choice of using a Mac SE, a Mac Plus, or this computer. The large, sharp screen of the Dynamac won.

The only drawback to this computer is its price. The top-of-the-line model with 4 megabytes of RAM, a 40-megabyte hard disk drive, and a built-in modem costs $8334. For just under the same price ($8089), you can buy a Mac II system with the following Apple components: 2 megabytes of memory, a 40-megabyte hard disk drive, an extended keyboard, a 13-inch color monitor, a video board with the 256-color upgrade, and an ImageWriter II printer. Of course, you're more likely to lug a Mac Plus or Mac SE around than to even think of moving a Mac II; but unless portability is an absolute priority, there are better ways of spending your hard-earned dollars in this price range.

However, if portability is indeed the issue, then the Dynamac fills the bill admirably. The Dynamac fits under any seat, and, with the carrying case, you can tote the computer just about anywhere. If you simply want to do a bit of word processing on the road, you can make do with a cheaper portable. If you must have everything that a Mac can offer, and you must have this capability wherever you go, then this machine's a must. ■

Peter Wayner is a graduate student in the department of computer science at Cornell University in Ithaca, New York.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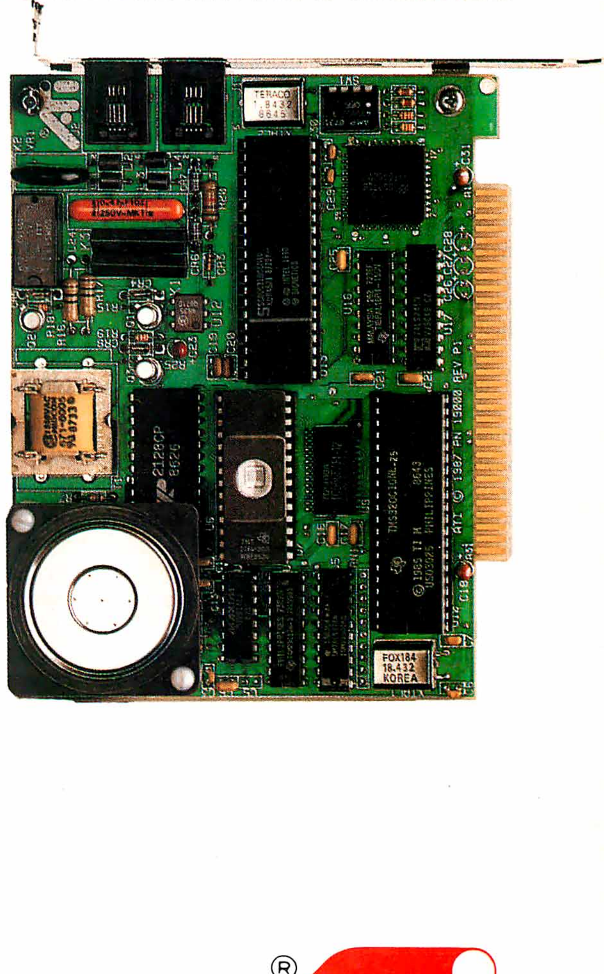

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Remaking a Classic

Curtis Franklin Jr.

A laser printer with three personalities: Apple's LaserWriter IISC, IINT, and IINTX

Changing a successful product is a sticky matter: Just ask Coca-Cola. But when you can take a classic, give it new power and speed, and wrap the whole package in a sleek new housing, as Apple has done with its new series of LaserWriter II printers, you just may have a big winner on your hands.

The LaserWriter IIs give Mac users who want laser-quality print three ways to pick and choose from low-cost QuickDraw printing to high-end PostScript, with a clear and easy upgrade path from the bottom to the top.

The LaserWriter II printers are designed around a 300-dot-per-inch (dpi) Canon second-generation LBP-SX printing engine placed within a shell holding a power supply and various controls (see photo 1). One of three "personality boards" fits into a slot on the bottom of this shell (see photos 2 and 3). This board determines the printer's characteristics. The printer's modular design allows Apple to reduce its development costs and, more important, lets you purchase a new board to improve the performance or capabilities of the printer when your needs demand it.

The LaserWriter IISC is, at $2799, the entry-level LaserWriter II. It does not support PostScript or AppleTalk. Next is the LaserWriter IINT, which costs more than the IISC ($4599) but adds PostScript and AppleTalk networking capabilities. The IINT is the most direct replacement for the discontinued LaserWriter Plus. At the top of the line, the LaserWriter IINTX gives you PostScript, AppleTalk networking, 2 megabytes of memory (expandable to 12 megabytes), hard disk drive expansion capability, and a Motorola 68020 processor. For this, you pay $6599.

A Single-User Printer

The LaserWriter IISC (the "SC" stands for SCSI) is a single-user printer that connects to a Macintosh through the computer's SCSI port. The IISC's personality board is built around a 7.5-MHz Motorola 68000 processor and has 1 megabyte of RAM. One of the nice features of the IISC (and the other two printers as well) is its dual paper path. Since different word-processing, page layout, and graphics programs print pages in different orders (first-to-last versus last-to-first), the LaserWriter II shell offers two different ways for the pages to be collected after they're printed. Normally, the paper is collected face-down on the top of the printer—perfect for first-to-last printing software. But by simply opening a door, you can have the paper collected face-up at the side of the printer.

Since the IISC uses the same print engine as the other LaserWriter IIs, the output's resolution is the same as the more expensive printers. In spite of this, the lack of PostScript makes "How's the quality?" the first question asked about the IISC. The answer is that, especially for text, the output is quite good. I found that on standard-size text (9 through 14 points), it is difficult to tell the output of the IISC from that of the IINT or the IINTX. In larger point sizes, and especially in large boldface fonts, the results were considerably more ragged (i.e., showing "stair-stepped" edges) than equivalent PostScript fonts.

The good results at normal point sizes come from a technique similar to that used by Imagewriter printers. For each font to be printed, two font sizes must be loaded into the System file. The first font size is the font used for the screen display. The second font is 4 times the size of the screen font and is used by the printer driver. Apple achieves high-quality print without the computational complexities of PostScript by scaling this large font down to 25 percent of its original size during the printing operation.

Graphics printed on the IISC are obviously different from those printed on PostScript-equipped printers. All IISC images are generated on the host computer by QuickDraw, Apple's proprietary graphics routines that are embedded in the ROM of every Macintosh. QuickDraw does not provide the automatic high quality of PostScript, but it does allow the meticulous user the opportunity to "hand-smooth" objects. Circles and diagonal lines showed some jaggedness, but the quality was miles ahead of Imagewriter resolution and was on a par with non-PostScript output (such as that from MacPaint) on the LaserWriter.

Installing the LaserWriter IISC was easy. The 126-page owner's guide provided clear instructions for installing the hardware and software for the printer. When I was ready to connect the printer to the Mac SE, I found that I did not have the SCSI terminator called for in the documentation. I plugged everything together anyway, and everything worked just fine. However, for permanent installations, I recommend that you follow the directions in the manual.

The LaserWriter IISC comes with four disks of software: one installation disk, one disk with the LaserWriter IISC driver version 1.0B12, and two font disks. The manual includes directions for installing this software, but since all the utilities follow Macintosh convention, most experienced Mac users will have no trouble. I did find that the fonts (Helvetica, Courier, Times Roman, and Symbol, in 9- through 96-point sizes) took up a lot of disk space, making me glad I had a hard disk drive on both the Mac SE and Mac II used to test the printer: For example, adding the complete Times, Helvetica, and Courier fonts to your System file balloons the size of this file by more than 1 megabyte. If you intend to connect a LaserWriter IISC to a floppy-disk-drive-only

Mac, you'll want to carefully choose those fonts that you install on your system disk.

I tried PageMaker 1.1 with the LaserWriter IISC and was surprised to find that pages printed with no translation or extra driver needed. The output from PageMaker was high-quality—not quite up to the standards of PostScript but very smooth and even. The only problem was that, between my early version (1.1) of PageMaker and the early version of the LaserWriter IISC printer driver, the computer consistently locked up about 45 seconds after printing. Apple says this problem is eliminated with the latest version (3.0) of PageMaker.

The LaserWriter IISC is the slowest printer in the LaserWriter family, taking more time than even the LaserWriter to print most of the benchmark documents (see figure 1). Only the 90K-byte MacDraw test file (described later) printed in significantly less time on the IISC than on the LaserWriter or the LaserWriter IINT. This is because the IISC's printing process eliminates a conversion step. Normally, the standard LaserWriter driver does a complicated conversion of QuickDraw graphics into PostScript commands for a print job. For the LaserWriter IISC, the Macintosh draws the page image in its memory using QuickDraw primitives, and this image is sent to the printer. This process has two important consequences: First, your Mac is tied

continued

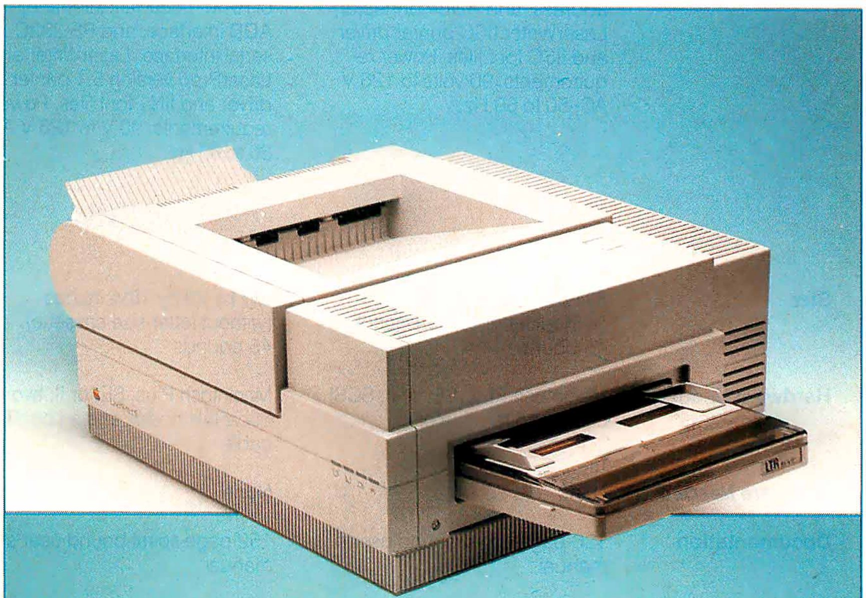

Photo 1: *The LaserWriter II shell, shown here with the paper tray attached, includes the print engine, controls, and power supply.*

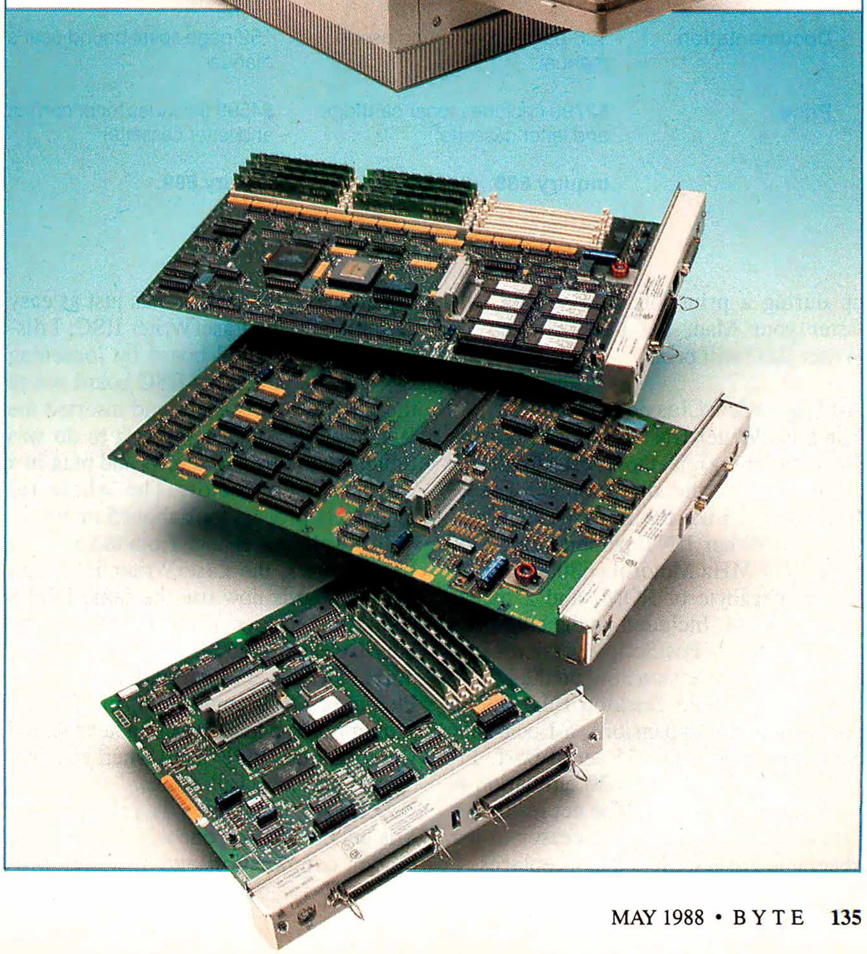

Photo 2: *The LaserWriter IINTX board (top) has space for an extra megabyte of RAM using 256K-byte-density SIMMs. The IINT board (middle) holds 2 megabytes of RAM, and the IISC board (bottom) comes standard with 1 megabyte.*

	LaserWriter IISC	LaserWriter IINT	LaserWriter IINTX
Type	QuickDraw-based laser printer	PostScript laser printer	PostScript laser printer
Company	Apple Computer Inc. 20525 Mariani Ave. Cupertino, CA 95014 (408) 996-1010	Apple Computer Inc. 20525 Mariani Ave. Cupertino, CA 95014 (408) 996-1010	Apple Computer Inc. 20525 Mariani Ave. Cupertino, CA 95014 (408) 996-1010
Features	Canon LBP-SX laser xerographic print engine, rated at 8 pages per minute; 300- by 300-dpi resolution; personality board with 7.5-MHz 68000 CPU, 16K bytes of ROM, 1 megabyte of RAM, SCSI with externally switchable address, and ADB connector; LaserWriter IISC printer driver and IISC font files. Power requirements: 90 volts to 126 V AC, 50 to 60 Hz.	Canon LBP-SX laser xerographic print engine, rated at 8 ppm; 300- by 300-dpi resolution; PostScript interpreter; Diablo 630 emulation; personality board with 11.5-MHz 68000 CPU, 1 megabyte of ROM, 2 megabytes of RAM, LocalTalk interface, ADB interface, and RS-232C serial interface; LaserWriter and LaserPrep version 5.1 printer driver and IINT font files. Power requirements: 90 V to 126 V AC, 50 to 60 Hz.	Canon LBP-SX laser xerographic print engine, rated at 8 ppm; 300- by 300-dpi resolution; PostScript interpreter with batch or interactive modes; Diablo 630 emulation; HP LaserJet Plus emulation; personality board with 16.7-MHz 68020 CPU, 1 megabyte of ROM, 2 megabytes of RAM expandable to 12 megabytes, LocalTalk interface, ADB interface, RS-232C serial interface, SCSI, and font expansion slot; LaserWriter and LaserPrep version 5.1 printer driver and IINT font files. Power requirements: 90 V to 126 V AC, 50 to 60 Hz.
Size	8½ by 20 by 18½ inches (without letter-size cassette); 45 pounds	8½ by 20 by 18½ inches (without letter-size cassette); 45 pounds	8½ by 20 by 18½ inches (without letter-size cassette); 45 pounds
Hardware Needed	Macintosh Plus, SE, or II; SCSI cable and terminator	Macintosh Plus, SE, or II; two LocalTalk nodes and a LocalTalk cable	Macintosh Plus, SE, or II; two LocalTalk nodes and a LocalTalk cable
Software Needed	None	None	None
Documentation	126-page spiral-bound user's manual	152-page spiral-bound user's manual	152-page spiral-bound user's manual
Price	$2799 (includes toner cartridge and letter cassette)	$4599 (includes toner cartridge and letter cassette)	$6599 (includes toner cartridge and letter cassette)
	Inquiry 888.	**Inquiry 889.**	**Inquiry 890.**

up during a print job, and second, the faster your Mac, the faster the LaserWriter IISC will print.

An Upgraded Classic

The LaserWriter IINT (the "NT" stands for networking) is the most direct replacement for the discontinued LaserWriter Plus. Like the LaserWriter Plus, the LaserWriter IINT personality board has a 11.5-MHz Motorola 68000 processor, 1 megabyte of ROM, and 2 megabytes of RAM. Included on the board is a faster version of PostScript (version 47.0, as compared to version 38.0 on the LaserWriter), an Apple Desktop Bus (ADB) port (for future expansion), a LocalTalk connector, and a DB-25 serial port. Finally, a special Diablo 630 emulation is built into the software. The net result is a printer that is a worthy successor to the venerable LaserWriters that it replaces.

Setting up the printer was just as easy as setting up the LaserWriter IISC: I disconnected the IISC board by loosening two screws, pulled the IISC board out of the LaserWriter II shell, and inserted the IINT board. All that was left to do was tighten the same two screws and plug in a LocalTalk connector. The whole replacement process took about 5 minutes.

In a welcome change from the original LaserWriters, the LaserWriter IINT and IINTX boards now use the same DIN-8 connectors for LocalTalk that are used by the Mac Plus, Mac SE, and Mac II serial ports. The LaserWriter and LaserWriter Plus used DB-9 connectors, making the printer hookup to a network a headache if you forgot this little detail when you purchased the LocalTalk nodes.

Software installation is just as easy. You get three disks: one with the System/Finder combination and Installer program, one with the new LaserWriter/LaserPrep version 5.1 drivers and a font utility, and the last with the LaserWriter IINT screen fonts to match the fonts in the board's ROM. You also get a 152-page owner's guide that does double duty as the manual for both the LaserWriter IINT and the LaserWriter IINTX. It is lavishly illustrated and even includes information for connecting an MS-DOS machine to the LaserWriter IINT's serial port.

The IINT has 11 resident fonts: ITC Bookman, Courier, New Century Schoolbook, Palatino, Times, ITC Zapf Chancery, ITC Avant Garde, Helvetica, Helvetica Narrow, Symbol, and ITC Zapf Dingbats. Like the LaserWriter it replaces, the LaserWriter IINT can use downloadable fonts from a number of commercial, shareware, or freeware sources. A utility application called

continued

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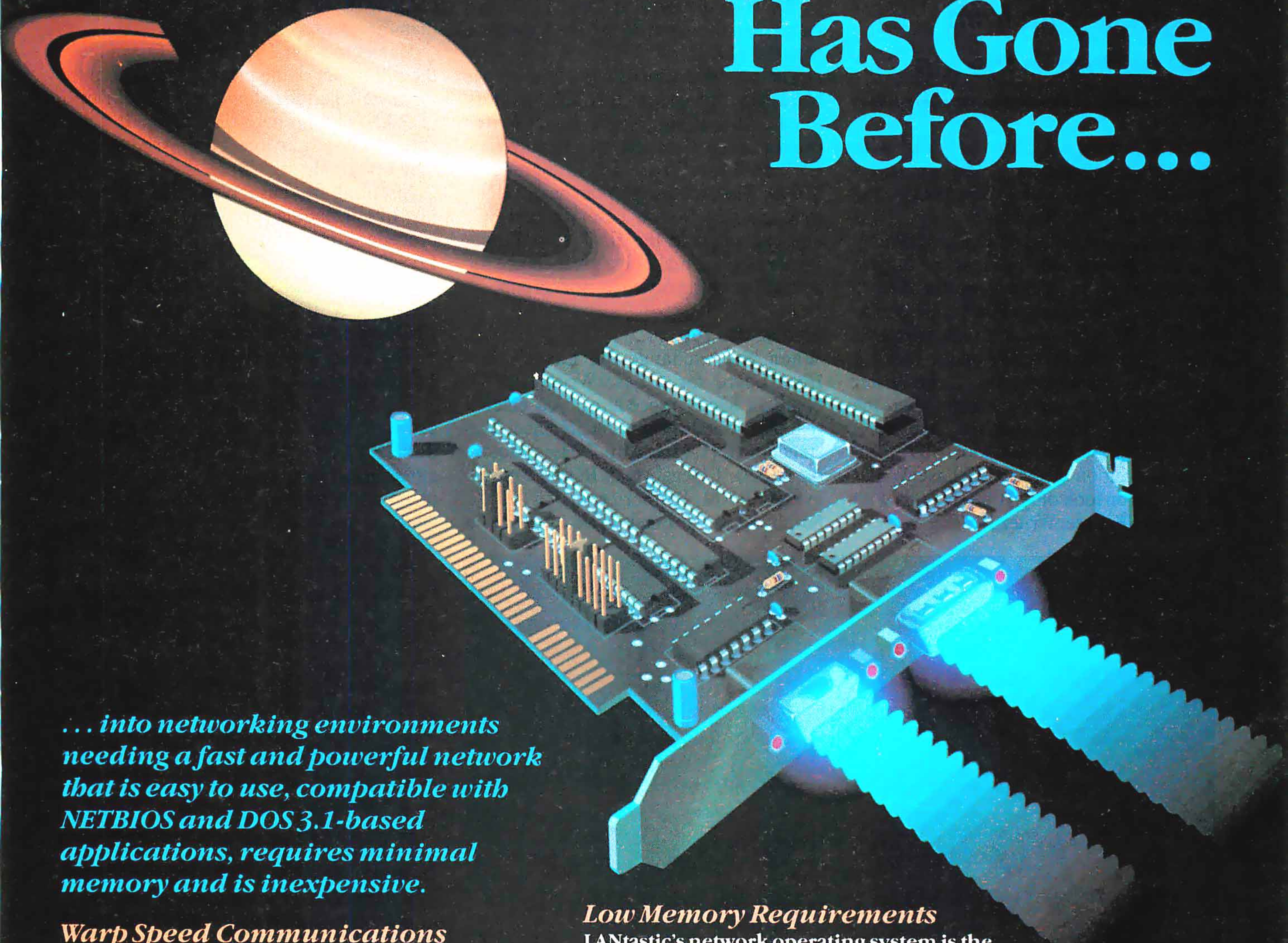

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The LaserWriter II gives Mac users three ways to pick and choose with a clear and easy upgrade path from the bottom to the top.

LaserWriter Font Utility, provided with the installation software, lets you select the font files you wish to download to the LaserWriter IINT's memory.

When I benchmarked the LaserWriter IINT, it became obvious that the biggest improvement in speed over the LaserWriter was in printing PostScript graphics files. In most of the text benchmarks (the 7-page MacWrite file on the Mac SE being the exception), the LaserWriter IINT was a few seconds faster than the LaserWriter. In comparison, the 90K-byte MacDraw file that took 1392 seconds to print on the Mac SE/LaserWriter combination took only 1088 seconds with the Mac SE/LaserWriter IINT.

The LaserWriter IINT was consistently faster than the LaserWriter IISC, with the exception of that 90K-byte MacDraw file. Since the LaserWriter IISC does not use the QuickDraw translation and PostScript processing, it was able to print the large MacDraw graphics file 2 minutes faster than the LaserWriter IINT paired with the Mac SE, and 7 minutes faster than the LaserWriter IINT coupled with the Mac II.

The LaserWriter IINT is a very capable PostScript printer that ably anchors the middle of the Apple LaserWriter printer family. The price of a LaserWriter IISC-to-LaserWriter IINT upgrade is $2099. The fact that you can have a IINT by upgrading from a LaserWriter IISC, and can upgrade the IINT to a LaserWriter IINTX, makes it a great choice for a small, growing office or workgroup.

And at the Top...

When you exchange the LaserWriter IINT board for a LaserWriter IINTX board (a $2499 procedure), you enter a realm of serious printer intelligence. The standard IINTX has a 16.7-MHz Motorola 68020, 1 megabyte of ROM, 2 megabytes of RAM, PostScript version 47.0, a 50-pin SCSI hard disk drive interface, a DB-25 serial port, and LocalTalk and ADB ports. Three SIMM (single in-line memory module) sockets hold the onboard RAM, and by populating these sockets with 1-megabyte-density SIMMs you can expand the board's total RAM capacity to 12 megabytes. It's amazing to realize that there are 32-user supermicrocomputers that have less raw horsepower than this printer.

Unfortunately, I didn't get to sample the full power of the printer; the unit sent for review had the standard 2 megabytes of RAM and no hard disk drive. It was still the fastest of the LaserWriters, be they new or old.

Installing the LaserWriter IINTX was just like installing the IINT, a 5-minute procedure involving two screws and a LocalTalk connection. The software installation was unnecessary because the LaserWriter IINT and the LaserWriter IINTX use the same fonts.

The LaserWriter IINTX has the same 11 resident fonts as the LaserWriter IINT, but where the LaserWriter IINT can have fonts downloaded to its RAM, the IINTX can store downloaded fonts either in its considerable RAM or on one of the chain of hard disk drives that can be attached to the SCSI port. If you do add hard disk drives, setting the SCSI address of the printer is a simple matter of pushing a button and watching addresses click past in a window on the LaserWriter IINTX board. The LaserWriter Font Utility lets you download fonts into the LaserWriter's memory or to the hard disk drive. One problem in chaining a new SCSI hard disk drive off an existing hard disk drive that's holding fonts is that you must reformat both disks and download all the fonts again to add the new drive. This can be a major job if you are chaining a hard disk drive off a 40-megabyte drive already packed with fonts.

If neither of these font options appeals to you, the LaserWriter IINTX also has an expansion slot where you can install font ROM boards. In addition to its PostScript graphics, the IINTX can emulate the HP LaserJet Plus and Diablo 630 printers. With the various ways of interfacing with the printer and the number of fonts and emulations it offers, this is one of the most flexible printers around.

The performance of the LaserWriter IINTX is, quite simply, wonderful. When I paired the IINTX with a Macintosh II, printing even large and complex files became a fast procedure. The most striking example was the 90K-byte MacDraw file. This file took over 20 minutes to print on the LaserWriter/Mac II combination. When I printed it using the IINTX with the Mac II, it took just 8 min-

continued

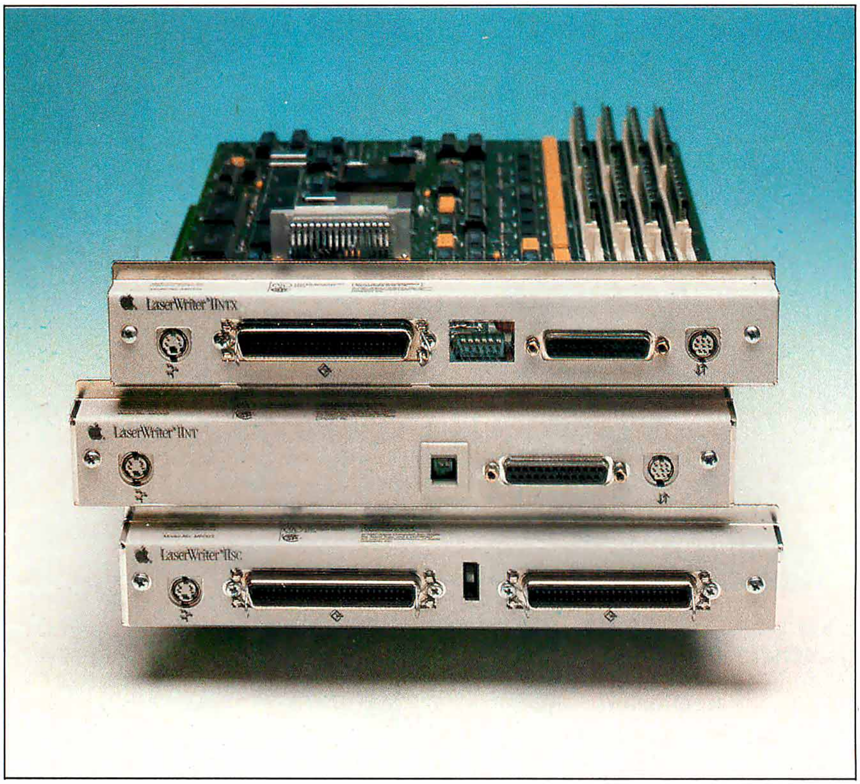


Photo 3: *The LaserWriter II boards offer a full range of connectors. The IINTX board (top, left to right): ADB port, SCSI port, configuration DIP switches, serial port, LocalTalk port. The IINT board (middle, left to right): ADB port, configuration switches, serial port, LocalTalk port. The IISC board (bottom, left to right): ADB port, SCSI port, board SCSI address selector, SCSI port.*

MAC SE

90K MACDRAW

Printer	Print time
Plus	24:38
IISC	16:10
IINT	19:55
IINTX	7:52

6K MACDRAW

Printer	Print time
Plus	1:05
IISC	1:43
IINT	0:55
IINTX	0:41

MIXED TEXT AND GRAPHICS

Printer	Print time
Plus	3:49
IISC	5:38
IINT	2:53
IINTX	1:34

30-PAGE TEXT

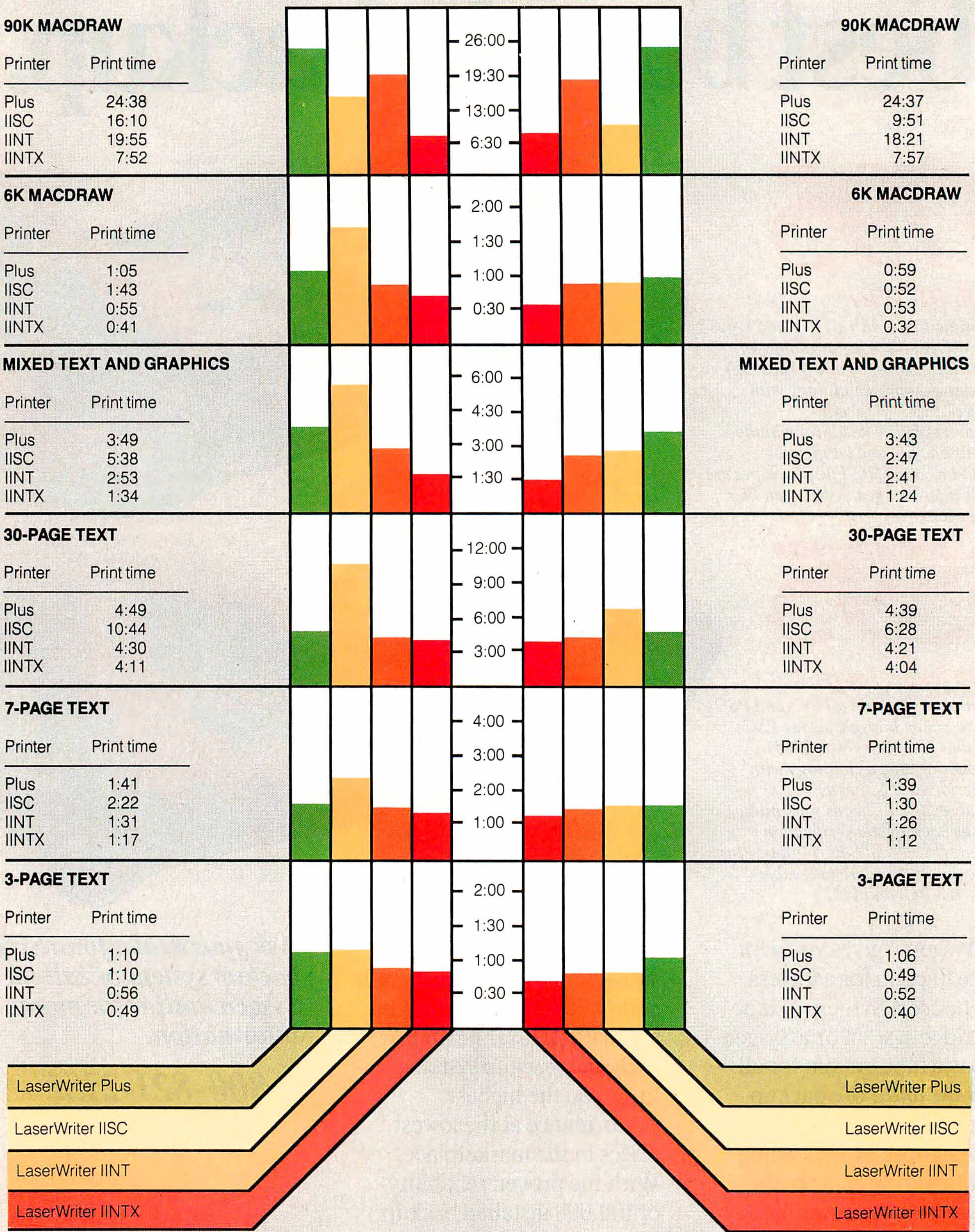
Printer	Print time
Plus	4:49
IISC	10:44
IINT	4:30
IINTX	4:11

7-PAGE TEXT

Printer	Print time
Plus	1:41
IISC	2:22
IINT	1:31
IINTX	1:17

3-PAGE TEXT

Printer	Print time
Plus	1:10
IISC	1:10
IINT	0:56
IINTX	0:49



MAC II

90K MACDRAW

Printer	Print time
Plus	24:37
IISC	9:51
IINT	18:21
IINTX	7:57

6K MACDRAW

Printer	Print time
Plus	0:59
IISC	0:52
IINT	0:53
IINTX	0:32

MIXED TEXT AND GRAPHICS

Printer	Print time
Plus	3:43
IISC	2:47
IINT	2:41
IINTX	1:24

30-PAGE TEXT

Printer	Print time
Plus	4:39
IISC	6:28
IINT	4:21
IINTX	4:04

7-PAGE TEXT

Printer	Print time
Plus	1:39
IISC	1:30
IINT	1:26
IINTX	1:12

3-PAGE TEXT

Printer	Print time
Plus	1:06
IISC	0:49
IINT	0:52
IINTX	0:40

Figure 1: *These tests compare an original LaserWriter against the LaserWriter IISC, IINT, and IINTX. The IINTX was fastest overall; the IISC was quicker than the IINT on complicated graphics or on very short text files.*

A Forest Gave Its All for Benchmarks

I went through ream upon ream of paper in testing the three printers against one another, the original LaserWriter, and a stopwatch. I used two Macintosh computers—a Mac SE with 4 megabytes of RAM and a 20-megabyte hard disk drive, and a Mac II with 5 megabytes of RAM and an 80-megabyte hard disk drive. With each combination of printer and computer, I used MacWrite 4.6, MacDraw 1.9.5, System 4.2, and Finder 6.0.

To get results that apply to real-world situations, I came up with six benchmark tests: a 3-page MacWrite document using Apple Macintosh Tech Note #154; a 7-page MacWrite document (Apple Macintosh Tech Note #12); a 30-page MacWrite document composed of 24 pages of BIX material and one of my old manuscripts spliced into the middle; a 6K-byte MacDraw File that prints on one page; a Mixed Text and Graphics document using the 3-page MacWrite document with the 6K-byte MacDraw file inserted into it, making that document 5 pages long; and a 90K-byte MacDraw File composed of a complex MacDraw diagram that printed on 16 pages.

All the tests were run with no INITs active on the host computer. For the LaserWriter IISC tests, I disabled AppleTalk. For the printers using AppleTalk, I removed the computer and printer from the larger network outside of the lab so that the printer would not have to spend cycles responding to other network traffic. After running the benchmarks and comparing the results, I reached a conclusion that should startle no one: The more you spend, the more power and speed you get.

utes. Speed like this can make a huge difference in a large office or workgroup, where waiting for the printer can have serious effects on productivity.

For most individuals, the IINTX will be overkill. But for graphic designers, engineers, or publishers who need complex graphics or pages output on letter-size sheets, and who need them in a hurry, the IINTX certainly fills the bill. In a larger networked environment, the IINTX has the power and expandability to provide most users with the services they need while not bogging down the net with queued-up print requests.

New and Improved

When a reviewer looks at any product that is supposed to be an improvement over and replacement of an established and successful product, the tendency is to look not only for improvements, but for those areas where the designers fumbled when they were adding features. I followed this tendency and looked for slip-ups, tragic deletions, or simple mistakes, and the only possible problem I saw was the IINTX's requirement that you reformat the SCSI hard disk when you chain a new one—something you might be able to live with. Apple redesigned the LaserWriter from the inside out, and I can't honestly say that the designers have done anything wrong.

The output from the new Canon print engine was consistently darker and more even than that from the first-generation Canon engine in my LaserWriter. When the output emerged from the printer, the options for stacking the pages saved a lot of time by putting the pages in the correct order for the type of software used.

One of the biggest problems with the original LaserWriter was the lack of an envelope feed. Apple engineers have solved that problem with the addition of a special feed tray for envelopes. This single improvement makes the LaserWriter II family much more feasible as general-purpose office printers, instead of just specialized report and graphics printers.

To top things off, Apple has taken a cue from the PC world and provided a clear upgrade path for users who want a low-cost, single-user QuickDraw printer now but who may need more from a printer down the road. By setting up the upgrade as a 5-minute procedure that can be done at any authorized service center, Apple has given LaserWriter IISC buyers great incentive to stay within the LaserWriter II family as their needs grow. From the entry-level LaserWriter IISC to the top-of-the-line LaserWriter IINTX, the new series of LaserWriter IIs should leave no one, except perhaps Apple's competitors, pining for the days of LaserWriter Classic. ■

Curtis Franklin Jr. is senior testing editor for the BYTE Testing Lab. He can be reached at One Phoenix Mill Lane, Peterborough, NH 03458.

PCs and Macs Working Together

Emil Flock

QuickShare, DaynaFile, and MatchMaker marry Macs and PCs

Until now, passing files between IBM PCs and Macintosh computers has too often been a stormy affair, involving serial cables, communications packages, and special programs to try and match file formats. Now, a number of companies are trying to marry Macs and PCs. I looked at three different approaches to bringing harmony to a two-computer desktop: QuickShare from Compatible Systems, DaynaFile from Dayna Communications, and MatchMaker from Micro Solutions.

QuickShare ($465) consists of a PC expansion card with a cable to the Mac's SCSI port, plus a bevy of programs. It offers high-speed (1.4 million bits per second on a Mac Plus or SE) data exchange and translation. As a bonus, QuickShare lets the Mac share the PC's hard disk drive. DaynaFile disk drives ($595 and $849) plug into the Mac's SCSI, allowing you to read and write PC files. Both QuickShare and DaynaFile are accessed normally from the Macintosh desktop. MatchMaker ($149) is a PC expansion card with a port and software that lets you read from and write to a Macintosh disk drive from your PC.

All three products do a reliable job of moving information from the PC's data format to the Mac's and vice versa. Unfortunately, that's less than half the job: File format translation is the real challenge. None of these products meets it entirely, but each saves considerable time and work. I tested these products on a Mylex 386 running at 16 MHz with a MiniScribe 23-millisecond (ms) hard disk drive, a 1.2-megabyte floppy disk drive, and a 400K-byte floppy (Mac) disk drive; and on a Mac Plus with one internal and one external 800K-byte floppy disk drive.

Fast Boots from a PC

Want to double or triple the speed of your floppy-disk-based Mac? QuickShare can let your Mac use part of your PC's hard disk drive—and even boot from it. Without QuickShare, it takes 39 seconds to boot my Mac Plus from a floppy disk drive. With QuickShare (and my Mylex 386's superfast 23-ms-access-time hard disk drive), I can boot in 15 seconds. For someone who is continually crashing the Mac, this is a godsend. Besides, when you do crash the Mac, you can turn your head about 10 degrees, shift keyboards, and use your PC while the Mac reboots. (Unhappily, most non-hard-disk-drive Macs are 512Ks that don't come with the SCSI port necessary to use QuickShare, but QuickShare is just about good enough to make you spring for the SCSI upgrade.) In addition to faster boots, QuickShare is up to 55 percent faster than the Mac's floppy disk drive when loading and exiting Omnis 3 Plus, Excel 1.04, Word 3.01, and MacWrite 4.6.

All this increased speed is really only a by-product of QuickShare's intended use. The real raison d'être of QuickShare is to share files between PCs and Macs. QuickShare helps widen the Mac/PC niche—it's one of those devices that leaves you wondering how you ever got along without it. You get to concentrate on your work instead of moving files around. File transfers through null-modem cables using telecommunications software at each end are not cost-effective when compared to spending less than $500 for QuickShare.

QuickShare comes bundled with software on two disks—one 3½-inch disk for the Mac and one 5¼-inch disk for the PC. PC Transfer is the sole inhabitant of the Mac disk, while the PC disk has four files: `QSINSTLL.EXE`, `QUICKSHR.EXE`, `QSPC.EXE`, and `MACDRIVR.BIN`. You need a Mac with a SCSI port and an IBM PC XT- or PC AT-compatible computer running under MS-DOS 3.1 or higher.

Creating a Virtual Disk

It takes 15 minutes to plug in the QuickShare expansion board and connect the cable to your Mac's SCSI port. The QuickShare installation package called `QSINST.EXE`, gives you a choice of two basic configurations: a minimum setup for file transfer only, or a larger setup where Macintosh files can be stored and accessed on the PC disk. In either case, it creates what the manual calls a "virtual disk" on your PC's hard disk. It makes a directory, called `\QUICKSHR`, and a file in that directory called `RFS01`, which becomes the virtual disk. In the minimum (6K-byte) setup, you have just enough room to run PC Transfer, but you cannot store Macintosh files on your PC's hard disk. You might choose this option if your Mac already has its own hard disk drive.

The real advantages of QuickShare accrue when you give it enough room for at least the Macintosh System and Finder. Then you can boot the Mac from the PC's hard disk drive. If you allocate enough memory to QuickShare, you can put any or all of your Macintosh applications programs on the PC's hard disk drive and run them from there.

`QUICKSHR.EXE` is the device driver that makes QuickShare go. It gets copied to your `\QUICKSHR` subdirectory during installation, and you're expected to run it in your `AUTOEXEC.BAT` file. It takes about 17K bytes of RAM to activate the QuickShare connection.

Living Together, Working Together

Since the Mac came out, my desk has been set up with the PC and the Mac cheek by jowl. When I got QuickShare, the two machines began to work productively together for the first time.

When they both try to access the PC's hard disk drive at the same time, each suffers a small degradation in performance. But it's still one man, two microprocessors when it comes to throughput and "dual-tasking." For instance, my Mac can copy files onto my PC's hard disk drive without SideKick's Notepad seeming to slow down a bit, and Paradox 386 can do a query on the PC without holding up my Mac spreadsheet. But running PC-Talk hangs up QuickShare entirely, crashing the Mac—although rebooting the PC and reloading `QUICKSHR.EXE` brings the Mac back to life.

The Mac can be locked out when you try to boot if your PC is too busy doing disk accesses. For example, if Paradox is grinding away on a modify/restructure and you try to boot your Mac from the virtual disk, you get Unhappy Face number 0F000A, and you must flick your power switch to reboot when the PC application is finished with the hard disk drive. This is because when the Mac's ROM boot sequence has to wait too long, it eventually produces a time-out.

PC Drives for the Mac

DaynaFile consists of external PC disk drives for Macintosh computers. So

continued

	QuickShare	DaynaFile	MatchMaker
Type	PC expansion board for PC-to-Macintosh file transfer	Macintosh disk drive to read PC disk formats	PC expansion board to interface with Macintosh disk drive
Company	Compatible Systems Corp. P.O. Drawer 17220 Boulder, CO 80308 (800) 356-0283 (303) 444-9532	Dayna Communications Inc. 50 South Main St. Salt Lake City, UT 84144 (801) 531-0600	Micro Solutions 132 West Lincoln Highway DeKalb, IL 60115 (815) 756-3411
Size	5.25 by 3.88 inches	5 by 6.60 by 10 inches; Single drive: 9 pounds; Dual drive: 12 pounds	4.41 by 3.88 inches
Features	1.4-million-bit-per-second (mbps) file exchange between PC and Mac 512E (with SCSI) or Mac Plus; 1.75-mbps file exchange between PC and Mac SE; 4.2-mbps file exchange between PC and Mac II. Includes PC Transfer for Macintosh on 3½-inch disk; `QUICKSHR.EXE`, `QSINSTLL.EXE`, `MACDRIVR.BIN`, and `QSPC.EXE` for PC on 5¼-inch disk; 10-foot SCSI cable	Read/write of PC disks from Mac desktop; MacLink Plus Translator included	Copy, display, and delete files on Macintosh disks from PC; includes `MAC.COM` driver, `MAC2TEXT.EXE`, and adaptations of MS-DOS file commands
Hardware Needed	IBM XT, AT, or compatible and Mac Plus, SE, II, or other Macintosh with SCSI port	Mac Plus, SE, II, or other Mac with SCSI port	IBM XT, AT, or compatible with 192K bytes of RAM; external Macintosh disk drive with cable
Software Needed	MS-DOS 3.1 or higher	Macintosh System 3.2 and Finder 5.3 or higher	MS-DOS 2.0 or higher
Documentation	68-page Installation and Operations Manual, no index	91-page Guide, with index	56-page User's Guide, no index
Options		1.2-megabyte, 5¼-inch drive: $255 (add-in) 1.44-megabyte, 3½-inch drive: $355 (add-in) MacLink Plus OEM version: $95 SCSI cable: $40	
Price	$465	$595 (360K-byte 5¼-inch drive) $849 (360K-byte 5¼-inch drive and 720K-byte 3½-inch drive)	$149
	Inquiry 885.	**Inquiry 886.**	**Inquiry 887.**

equipped, a Mac can read directly from PC data disks—and write to them as well, right from the Finder. You need a SCSI port on your Mac.

DaynaFile works with the Mac II, SE, or Plus, or any Mac that has had a SCSI port added. My review unit had two floppy disk drives: a 360K-byte 5¼-inch drive and a 720K-byte 3½-inch drive. DaynaFile is also available with 1.2-megabyte 5¼-inch floppy disk drives and 1.44-megabyte 3½-inch floppy disk drives.

It takes less than half an hour to install DaynaFile—about 10 minutes to uncrate it, cable its 50-pin port to the Mac's 25-pin SCSI, insert the terminator plug, choose a SCSI ID number on a rotary switch, and power up the unit through its transformer with extra-long cables (which are a nice touch); and about 20 minutes to install the software. There is no power-on lamp on the unit, and it must be turned on before the Mac (this detail isn't mentioned until well into the manual).

It's impossible to shoehorn the DaynaFile driver (which requires 61K bytes of disk space) onto the same floppy disk with the System, the Finder, and the LaserWriter printer drivers and still have room for any major applications program. For example, since System 4.2 takes up 321K bytes, Finder 6.0 takes up 99K bytes, and the LaserWriter drivers require 75K bytes, that leaves only 244K bytes on a single 800K-byte disk. Without a hard disk drive, you are forced to mix data with your applications program in the second disk drive.

Good, but Not Perfect

Until I got my hands on QuickShare, I thought DaynaFile was the cat's pajamas. Two simple flicks of the wrist to remove a disk from my PC and insert it into my Mac—what could be simpler? Now that I'm spoiled by hard-wiring, it seems inconvenient to use mere floppy disks. DaynaFile can provide as much as 3 megabytes of storage between two 1.44-megabyte drives, but it doesn't let me forget floppy disks altogether, as QuickShare can.

DaynaFile deserves much of the praise it's garnered; there are some problems,

continued

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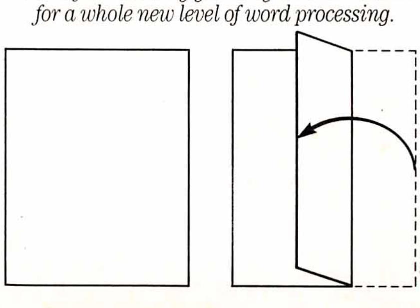

but they're mostly nits. If you open the disk drive door on the DaynaFile before ejecting the disk from the Mac desktop, you get a beep and a dialog box: `Please insert the disk: Untitled`. When you close the drive door again, the system crashes. This is one of those intermittent, nonreproducible, goes-away-when-the-doctor-comes annoyances. PC users need to train themselves to ask the operating system's permission to eject a disk.

Having a DaynaFile connected to a Mac Plus slows down the operating system somewhat. There's a lag when you return to the Finder and the screen icons are refreshed—and there are often two extra icons. Additionally, when you load a DaynaFile-produced `.WKS` file into Lotus 1-2-3, it takes considerably longer than loading the same file saved by Lotus 1-2-3 itself because it's necessary for a conversion routine to parse the file.

Mac Drives for the PC

MatchMaker forges a marriage of convenience between IBM and Macintosh data formats. MatchMaker is an inexpensive expansion board for a PC; you plug a Macintosh disk drive into it.

MatchMaker takes about 15 minutes to install and comes with a software device driver, `MAC.COM` (38K bytes for your `AUTOEXEC.BAT` file). You can plug any Macintosh floppy disk drive into MatchMaker—800K-byte or 400K-byte, Hierarchical File System (HFS) or Macintosh File System (MFS). MatchMaker requires an IBM PC XT, PC AT, or compatible with a minimum of 192K bytes of RAM.

Many types of files can make the leap between operating systems with MatchMaker's help. MatchMaker's device driver provides M-prefixed versions of familiar PC commands: `MType`, `MDir`, `MCopy`, and `MDel`, although what should be called `MFormat` ends up illogically as `MInit`. `MInit` lets you choose between three possible formats (`/H` for HFS, `/M` for MFS, or `/1` for 400K bytes in an 800K-byte disk drive). For HFS disks, the directory commands (e.g., `MCd`, `MMd`, `MRd`, and `MTree`) are active.

`MCopy` provides a good deal of flexibility with these optional parameters: `/B` for binary, `/Cxxxx` (where *xxxx* lets you specify a file creator), `/D` for data fork, `/R` for resource fork, `/Fxxxx` for file type, `/L` to lock a file, `/I` for DOS image files, and `/T` for text files. For example, `C>mcopy m:chap*.wor a:book.don` copies every chapter of a book from the M (MatchMaker) drive into a DOS file on the A drive. This can produce an entire book in one file, concatenating the chapters automatically. `MCopy` would assume the `/T` (text) option in this case.

Another advantage of `MCopy` is the ability to specify a file type. If you do so with the `/Fxxxx` option (where *xxxx* is the four-letter file type), you can double-click on the document and it will be loaded into its application. With QuickShare and DaynaFile transfers, there is no provision for specifying the file type.

Lots of Features, Lots of Switches

At first I could format only MFS disks with MatchMaker; it wouldn't handle the HFS and kept crashing my Mylex 386. Then, at the suggestion of Micro Solutions, I recopied the release software onto my hard disk drive. The MatchMaker hardware performed admirably thereafter, but time and date stamps were not retained.

Because there are so many commands and so many options, MatchMaker's M-prefixed commands aren't as easy to use as QuickShare's PC Transfer or DaynaFile's MacLink Plus transfer software. An unsophisticated filter program called `MAC2TEXT.EXE` comes with MatchMaker to bring MacWrite files into DOS. The skimpy `PRINT.ME` manual addendum gives seven lines about `MAC2TEXT`, explaining that you need the `/I` (image) option when you `Mcopy` a MacWrite document before running `MAC2TEXT` to convert to DOS format. Unfortunately, the resulting file does not retain print enhancements made under MacWrite.

`PRINT.ME` consigns all of 19 additional lines to two further rules of thumb: You can use `Save As` in MacWrite and choose `text only` if you don't want to bother with `MAC2TEXT` at all, and you might want to check out Document Content Architecture (DCA) if you mind losing all print-formatting information in transition.

The simple ASCII `PRINT.ME` file itself, for example, is easily `MCopyed` to and `MTyped` from MatchMaker's M drive. But if you don't use the `/T` (text) option with `MCopy` on a single-spaced file like `PRINT.ME`, it comes back double-spaced with `MType`.

MatchMaker does not address the broader problem of file translation between formats other than MacWrite and DOS text files. The MatchMaker documentation pretty much sidesteps the question of what to do with nontext files. For instance, there is no indication of how to take a PC Symphony worksheet into an Omnis 3 Plus database on the Mac. Nor is there any mention of what to do with Mac Word files to make them usable under DOS with WordStar.

For $149, MatchMaker can help ferry files back and forth between your machines—a bargain at 2 or 3 times the

continued

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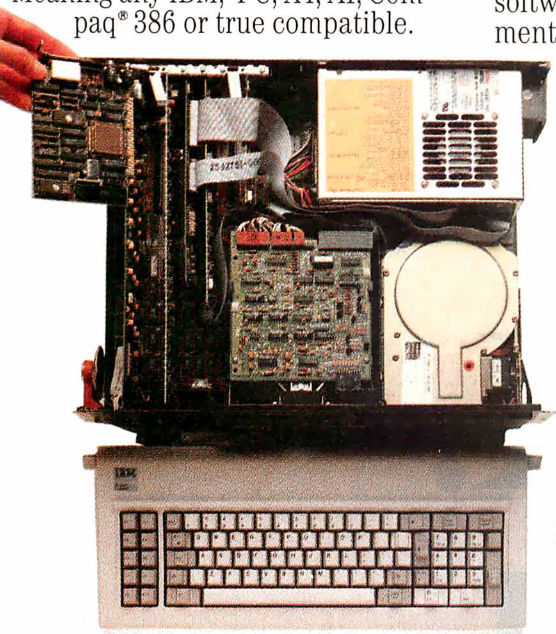

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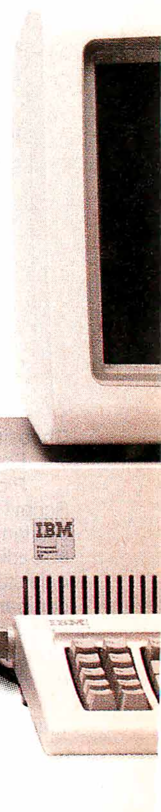

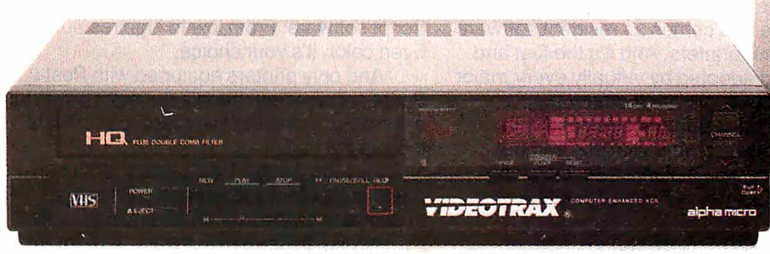

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price. But don't expect much translation help from this package.

Transferring Is Not Converting

All three vendors claim to have the file-format mountain climbed, but I'm here to tell you horror stories about translation. Just keeping track of the names, let alone the features, of all the translation software can give you a headache. QuickShare comes with PC Transfer and QSPC. DaynaFile has MacLink Plus Local Mode, and MatchMaker provides the `MCopy` command. I had grandiose plans to prepare benchmarks comparing translation times, but I got few files translated to my satisfaction. So I logged the glitches, goofs, inconveniences, and incongruities instead.

Aside from its `MCopy` command, MatchMaker opts out of the translation fray. The company has done a competent, inexpensive piece of work for transferring files, and its engineers say a good translator would have cost another year. Micro Solutions relies instead on third parties for translation software but makes no specific recommendations in the manual. Over the telephone, the company refers you to Apple File Exchange and RDOC/X.

QuickShare's PC Transfer software smoothly effects the change in data format from PC to Mac or vice versa. But if file format alterations are required, PC Transfer offers only partial solutions; the task is too difficult in some cases, absurd in others.

PC Transfer has built-in translation software that gives indifferent results in many cases, but it isn't because the company hasn't tried hard. You get a choice of five translation options. `Copy appropriately` is the default, which decides on a translation format—text or MacBinary—for itself as it moves through a file byte by byte. `Printer Capture` is the fifth choice.

"QSPC" stands for QuickShare Printer Capture. Compatible Systems has tried to provide a universal PC-to-Mac text and graphics converter. This is the scenario: You reconfigure your PC applications program to drive the IBM Graphics Printer. (It is assumed that your PC applications all have IBM Graphics Printer drivers.) `QSPC.EXE` is a memory-resident program (using 8K bytes of conventional RAM) that redirects printer output to a file, filtering it all the while. You produce this print image file and use PC Transfer to change it to the Mac data format. Then you should be able to load the transferred, translated file into the target application.

To take a specific Printer Capture example, suppose you have a 5K-byte document file in WordStar on the PC that has several centered lines, is right-justified, and has one sentence of underlining and one with boldface. You tell WordStar to print the file, but it never gets to the printer because QSPC jumps up and lets you redirect it to a disk capture file. When the capture is finished, QSPC waits 2 seconds and then beeps, indicating that the file has been closed (total time elapsed is about 4 minutes).

When you hand that capture file to PC Transfer, you get a MacWrite file that approximates its WordStar antecedent (another 4 minutes). Too bad that the lines that were centered aren't centered; they're not flush right, either. The right justification is lost in those paragraphs that contain underlining and boldfacing (but at least those print enhancements are intact). The original 2-page document becomes 3 pages in translation—the last page is blank. All in all, it takes about 15 minutes in MacWrite to fix it. That's a total of almost 25 minutes of shenanigans to transfer a file you could have typed in from scratch in about 10 minutes. Similarly, an Excel spreadsheet saved in .WKS format and translated/transferred by PC Transfer doesn't fare very well.

On the graphics side, I was able to get a Symphony .PIC file into MacPaint using QSPC and PC Transfer as the intermediaries. The transition between MacPaint's 72 dots per inch (dpi) and the 1/216-inch IBM Graphics Printer format QSPC captures is less than graceful. And you can forget about going from MacPaint into Symphony, although you can transfer and store MacPaint files in MacBinary format on the PC.

Too Many Formats

For an extra $95, DaynaFile offers MacLink Plus Local Mode to provide some help. Unfortunately, there are limitations to the help it provides. How is MacWrite supposed to respond to WordStar's use of its extended character set, for example? You can try running WordStar's PRINT.TST file through MacLink Plus (or QuickShare's QSPC or MatchMaker's MCopy) and taking a look in MacWrite. MacWrite finally gets so befuddled that the last two pages are all in underline/outline/shadow/superscript/subscript. Dot commands are ignored. Likewise, a MacWrite document gets short shrift in WordStar: Double-width stands in for shadow text, and outline becomes strikeout. And this is the easy stuff.

It gets worse when what you really wanted was a Macintosh Word document coming over from WordStar (MacLink Plus doesn't do this conversion—or windows, for that matter). You have at least two less-than-palatable choices. You can open the MacWrite file that MacLink Plus has created in Word, which gives you a dozen alert boxes stating `Error encountered-ignoring part of MacWrite file.` (That's right: It skips the material entirely.) Or you can try to load your original WordStar file into Word on the PC (if you have a copy) and feed the Word-formatted file to MacLink Plus to convert to the Mac format.

Suppose you want to get a Paradox table into Omnis 3 Plus on the Mac. It's straightforward enough (if unsavory) to export the table via dBASE format with Paradox's Tools/ExportImport. Then MacLink Plus will shovel it onto the Mac in Data Interchange Format (DIF), with running commentary as to exactly what cell is being converted: `0 Warnings, 0 Errors`. When you invoke Omnis 3 Plus and locate the Import data menu, you find you have to make a field list—it can't come up with its own field names or figure them out from your DIF file. Therefore, you have to type in the field names yourself before Omnis can finally import your Paradox table.

QuickShare Gets the Nod

All three products are impressive, but my preference is for QuickShare. It has the best transfer and translation capabilities, and it gets big brownie points for giving my Mac a hard disk drive.

DaynaFile, though expensive, provides utilitarian, high-test disk (not simply file) transfers. MatchMaker is quite a value. It's no mean feat to resurrect an old 400K-byte disk drive cum boat anchor (that cost $400 when new) to do important file movement between operating systems. ■

Emil Flock runs Computer Hand Holding (San Francisco, California), which specializes in third-party telephone technical support. He is coauthor of The Shareware Book: Using PC-Write, PC-File, and PC-Talk *(Osborne/McGraw-Hill, 1986) and* WordStar: The Second Phase *(Scott, Foresman & Company, forthcoming).*

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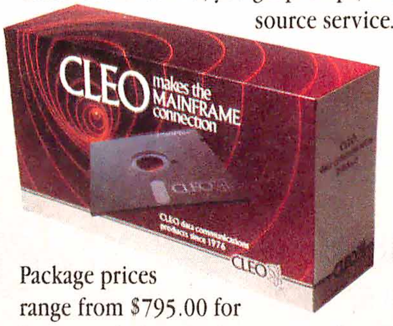

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Microsoft Windows 2.03 and Windows/386

Namir Clement Shammas

An updated version and a multitasking environment for 80386-based systems

We've all waited a long time for these: Microsoft Windows 2.03 for the 8088 and 80286 CPUs and Windows/386 for the 80386 CPU. The first version of Windows was slow; it did not support concurrency, nor did it directly use more than 640K bytes of memory. It also required more complex software development with limited choices of development language (mainly a Microsoft C toolbox).

Version 2.03 ($99) is faster than the original Windows product and makes the best of microcomputers without the 80386 chips. The 386 version ($195) offers true multitasking, thanks to the power of the 80386. Microsoft claims that both of these versions strongly resemble the Presentation Manager of OS/2. There are many aspects that are common between Windows 2.03 and Windows/386, and if you learn to use one, you can (to a good extent) utilize the other version.

The Windows 2.03 environment runs on the IBM PC, XT, AT, PS/2s, or compatibles. It runs under DOS 3.0 or higher and requires 512K bytes of memory, and you can use any additional memory (expanded or extended) with the SMARTDrive disk cache to enhance the system speed. You will need up to 2 megabytes of hard disk space to copy files from the seven 360K-byte distribution disks. You will also need a graphics adapter compatible with CGA, EGA, Hercules, or VGA.

The Windows/386 environment requires you to have an 80386 CPU, with 1 (preferably 2 or more) megabytes of memory, including extended or expanded memory. A high-density floppy disk drive is required to read the three distribution disks of this version, while 2 megabytes of hard disk space are needed to store Windows files. Windows/386 runs under DOS 3.1 or higher. You will also need a graphics adapter compatible with CGA, EGA, or VGA. For both versions, a mouse is optional. You might find that building reflexes for the combination keys works better.

Setup Considerations

The setup of Windows 2.03 is easy and straightforward. A `SETUP.EXE` utility guides you to select the various machine, printer, display, and mouse options. I was able to run Windows 2.03 without modifying my `CONFIG.SYS` or `AUTOEXEC.BAT` files. For this review, I installed Windows 2.03 in my second (card-type) hard disk and was able to run it successfully. I could not do the same with Windows/386, however. I had to install that version on my main hard disk, and I could not access the second hard disk. You can use the `AUTOEXEC.BAT` (or a specialized batch file), or you can issue a normal DOS command to invoke Windows 2.03.

The setup of Windows/386 is similar to that of Windows 2.03: You need to remove any RAM-resident pop-up utilities, such as SideKick and SuperKey. To use Windows/386, you have to create new `CONFIG.SYS` and `AUTOEXEC.BAT` files. If you plan to use Windows/386 consistently, you must make the changes to the files in the main hard disk directory. The other alternative, which I used for this review, is to prepare a separate boot disk, which should contain new versions of `CONFIG.SYS` and `AUTOEXEC.BAT`. The `CONFIG.SYS` files should not install the usual RAM-disk drive. Instead, you may install the Windows SMARTDrive disk cache. The `AUTOEXEC.BAT` should not install any RAM-resident pop-up utilities, since Windows/386 can easily and intelligently manage them. You can use the `AUTOEXEC.BAT` file to invoke Windows/386.

The Windows environment uses the text file `WIN.INI` to store various system parameters and special instructions. You can edit this file to fine-tune the parameters or alter the special instructions. The `WIN.INI` file represents a new variation of the combined `AUTOEXEC.BAT` and `CONFIG.SYS` files in DOS. Among the interesting options is the list of "load" and "run" programs. Whenever you load Windows, the applications shown in the load list automatically load and display as icons. Similarly, the run list names the applications that automatically execute when you load Windows. The programs list defines the program file-extension names. This list is set to `EXE`, `COM`, and `BAT`, and the MS-DOS Executive window uses it to select program files for the directory display. The `WIN.INI` file enables you to specify numerous parameters, such as spooling status, printer selection, font selection, I/O port selection, and beeping status. I look forward to seeing future DOS versions support a file similar to `WIN.INI`.

If you are afraid of corrupting the `WIN.INI` file with your text editor, Windows has another, more formal, route. You can alter many of these parameters by accessing the control panel, which is a window with menus that permits you to add or delete fonts and printers, alter window colors, change communication ports and data transfer rates, and so on.

The MS-DOS Executive

When you invoke either Windows version, the MS-DOS Executive windows appear. In general, there are three display levels for any windows application: full screen, window, or icon. Only Windows/386 is able to support these three levels of display for standard programs (i.e., those not designed as Windows-oriented applications). An application in either full-screen or window display uses the upper screen line to display the control-menu box, a title bar, and the maximize/minimize boxes. The latter boxes permit you to go between a full screen, a window, and an icon display.

continued

Table 1: *Comparing loop timings for the benchmark programs reveals that Windows 2.03 and DOS are able to run the benchmark programs at the same speed. The results also reflect the slowing down of the benchmark programs as Windows/386 allocates less resources for it. This is particularly interesting when you compare the timings for the exclusive, foreground, and background execution modes.*

Environment	Mode	Time (seconds)	DOS time
PC-DOS 3.1	N/A	15	100%
Windows 2.03	N/A	15	100%
Windows/386	Exclusive	19	79%
	Foreground	23	65%
	Background	26	58%

Windows applications use the second line to display their menu bars. You can use a mouse or key combinations to access the boxes in the top line or the menu options in the second line. The control box of any application enables you to manipulate the related window in the following ways: move, resize, manipulate the display status (e.g., maximize or minimize the window), close, or restore. At that point, the window displays any option that is not available to you by using blurred characters or faded colors. With Windows applications, you can use the close command to end the applications. With standard applications, you need to exit them using their own particular commands first, and then close their windows.

The MS-DOS Executive window is the launching point for many applications. It displays the names of the files and subdirectories of the current directory. Subdirectory names are displayed first in bold characters, and the list of sorted filenames is shown in normal characters. The Executive window also displays the current file or subdirectory selection in reverse video. Since you do not have access to a command-line processor, you must perform everything using pull-down menus. The MS-DOS Executive windows have three menu options: file, view, and special. The file menu offers you the ability to perform a number of internal DOS commands, such as rename, copy, and delete files, as well as load and run programs. These options work on the currently selected file.

Among the interesting features that I found in the MS-DOS Executive is that you can mark multiple files for collective copying or deletion. A `File` command lets you load an application and its related data file by simply loading the latter (this is similar to how the Apple Macintosh works). For example, if you load a text file created by the Window word processor `WRITE.EXE`, you create a special icon. When you click on the icon, you find yourself in a word-processing session with the text file being displayed.

The view menu enables you to view files in either a short format (just the filename) or a long format that includes file size and date/time stamps. You can also elect to display all or some of the files, or just programs. The MS-DOS Executive displays the filenames sorted by name, date, size, or time. The "special" menu offers more important commands that you would generally use less frequently. These options permit you to create a directory, change the current directory, format a disk, create a system disk, and set the volume name.

The two Windows versions come with the same set of applications, which vary in usefulness. Among the most versatile are Write, Paint, Terminal, Calc, PIF Editor, Notepad, Cardfile, and Clipboard. Other applications are the famous Clock program and the Reversi game. The Write program provides you with a scaled-down version of Microsoft's full-fledged word processor, Word. In addition, the two text files produced by either word processor are compatible. Write is also able to read pure ASCII text files. The manual dedicates about 100 pages to Write.

The Paint program is the other major Windows application, with about 70 pages dedicated to it in the product manual. You can regard Paint as a scaled-down version of the Macintosh popular MacPaint program. Paint supports drawing tools, such as the paint brush, pen, spray paint, color filling bucket, empty/full shapes (e.g., rectangles, triangles, circles, ovals, polygons, and freehand shapes), and the rubber band.

Both versions of Windows let you cut, paste, and copy text between different applications. For example, you can copy a drawing from Paint onto the Clipboard and then paste it into a Write text file.

Launching Applications

Under Windows, the proper way for launching standard applications requires the use of program information files (PIFs). These files give the Windows environment more information on the application, such as its directory location, memory requirements, and display mode, for example. In a sense, PIFs represent a new class of batch files (you can still use `.BAT` files). The PIF editor is an application supplied to create new PIFs and edit old ones.

Through PIFs, you can specify the filename to invoke an application, the program title to be displayed, the program parameters, the disk directory, and the memory for the application you are launching. PIFs also handle interaction with the display, communications ports, memory, and the keyboard. In addition, they store the status of program and screen swapping, and they optionally close a window when you exit an application. The Windows/386 environment also offers the option of setting the execution mode of the application.

PIFs make it easier for the environment to manage the applications that you launch. They also give you a section level of batch-like control. I hope that future text-based DOS versions support both batch and PIF programs, like Windows does.

PIFs can work with batch files in Windows/386 to invoke standard applications and their accompanying RAM-resident pop-up utilities. For example, I can write a batch file that works with a PIF to load SuperKey, a set of Pascal macros, and the Turbo Pascal environment. Once I am finished with Turbo Pascal, I exit its window, and the Windows/386 environment removes the copy of SuperKey and the macros I loaded. The above scheme offers an interesting autonomy for applications. Consider the case where you are working on two language development environments. You load each with its own copy of a keyboard macro utility and its own unique set of macros. You can switch from one to the other without reloading macros, source code files, or even language environments. This is an impressive aspect of Windows/386.

If you miss the DOS command-line processor, you can set up a PIF to create a `COMMAND.COM` window. You allocate the appropriate memory in the PIF for a copy of `COMMAND.COM`. Under Windows/386, I was also able to load Command Plus (from ESP Software Systems), a command-line processor that is compatible with `COMMAND.COM` 2.x and 3.x. Once I loaded Command Plus, I was able to successfully perform some simple `DIR` operations. This is an indication that Windows/386 tolerates highly compatible alternate command-line processors.

continued

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Windows 2.03	**Windows/386**
Type Graphics-based environment	**Type** Graphics-based environment
Company Microsoft Corp. 16011 Northeast 36th Way P.O. Box 97017 Redmond, WA 98073 (206) 882-8080	**Company** Microsoft Corp. 16011 Northeast 36th Way P.O. Box 97017 Redmond, WA 98073 (206) 882-8080
Format Seven double-sided, double-density 360K-byte 5¼-inch floppy disks	**Format** Three high-density 5¼-inch floppy disks and three 3½-inch floppy disks
Language Assembly and C	**Language** Assembly and C
Hardware Needed IBM PC, XT, AT, PS/2s, or compatibles with 512K bytes of RAM (640K bytes is recommended); two floppy disk drives or one floppy disk drive and one hard disk drive; a monochrome or color monitor attached to a graphics adapter; a mouse is optional	**Hardware Needed** MS-DOS-based computer with an Intel 80386 CPU; 1 megabyte of RAM (2 megabytes are recommended); one high-density floppy disk drive and a hard disk drive; a monochrome or color monitor attached to a graphics adapter; a mouse is optional
Software Needed DOS 3.0 or higher	**Software Needed** DOS 3.1 or higher
Documentation 500-page User's Guide	**Documentation** 500-page User's Guide; 33-page Using Microsoft Windows/386
Price $99	**Price** $195
Inquiry 904.	**Inquiry 905.**

Table 2: *With multiple copies of the secondary benchmark program, Windows/386 pays more attention to the first few secondary background programs. As the number of the secondary programs initially increases, the primary benchmark program slows down, reaching a minimum at 5 programs. Beyond that minimum, Windows/386 appears to allocate more resources to the primary program. The loop timing reached an asymptote when 8 programs ran concurrently.*

Total number of programs	Time (seconds)	DOS time
1	26	58%
2	34	44%
3	46	33%
4	40	38%
5	52	29%
6	47	32%
7	39	38%
8	38	39%
9	38	39%

The Windows/386 environment enables you to run multiple standard applications. When you invoke any such application, it begins to run in the usual manner, and it occupies the entire screen. You press Alt-space bar to display the control menu. This permits you to shift from full screen to the window display. When you move to a window display, you change the color of a nonmonochrome application very slightly (the visual effect is as if the display has fogged up a bit).

The control menu for an application running under Windows/386 offers several options, such as full-screen or window-display modes. It also lets you choose either exclusive, foreground, or background tasking. The exclusive tasking mode dedicates all the resources of the machine to execute an application, suspending any other applications. The foreground mode executes programs that require interaction with the user. You use the background mode for applications that can run unattended.

Other options in the control menu include suspended or resumed execution and the ability to terminate the execution of an application. You would use the latter when a program seems to no longer respond in a normal way. This option enables you to properly close other applications and avoid an across-the-board system crash.

I was able to load a copy of WordStar version 4 and WordStar 2000 version 3. Each word processor handled one text file. Switching from one application to another was interesting. Both applications ran in the foreground mode and consequently ran a bit slower. When I ran either in exclusive tasking mode, the speed increased, but it was still slightly slower than the same application running under standard DOS. I could not load more than these two large applications at one time. I experienced similar speed reductions with other applications.

Performance Results

To test the speed of the multitasking feature of Windows/386, I wrote two Turbo Pascal programs. Both programs looped continuously and used the `KeyPressed` command to trigger an exit. The primary benchmark program performed integer calculations in a `FOR` loop; then it beeped and displayed the time required to execute the `FOR-DO` loop (see table 1). The secondary benchmark program performed the same calculations and displayed the loop control variable. I used this as a visual indication of whether the copy of the program was actually running. The second purpose for displaying the numbers was to show how fast or slow a copy of the secondary benchmark was running.

I conducted the test on an IBM PC AT with an Intel Inboard/386, 1 megabyte of 16-bit memory, 1.6 megabytes of 8-bit memory, an 80387 chip, a 20-megabyte primary hard disk, and a 30-megabyte secondary hard disk. I used PC-DOS 3.1 to boot the system, and a Microsoft Mouse to manipulate the menus and windows.

From the MS-DOS Executive window, I started a PIF that executed a copy of the primary program. The PIF requests 64K bytes of memory to invoke the program. The program window reduced, and the MS-DOS Executive window moved into an icon. Then I read the time following the next beep. (I took several readings and averaged them.) During the multitasking benchmark test, I used only one copy of the primary program. The slowest timings are about 60 percent of the normal speed under PC-DOS, which is roughly the speed of a PC AT.

To load a copy of the secondary program, I activated the MS-DOS Executive icon and restored its window. I invoked another PIF to load a copy of this program in the same manner that I used for the primary program. The new window of the secondary program was repositioned, and the primary program window was reselected as the primary window. After carrying out these steps, I read the time following the next beep. (Again, I took several readings and averaged them.) I also performed the tests with several copies of the secondary program loaded.

During the benchmark testing, I did not interrupt the primary program. At the end of the test, I selected and pressed any key to close each copy of a secondary program window. This promptly halts the selected copy of the secondary program and closes its window (as specified in the PIF). You close the primary program window by selecting and pressing any key, and then you wait for the current loop to complete.

I found that when the total number of concurrent programs is low, each receives a bigger time slice (see table 2). When the number of concurrent programs increases, Windows/386 appears to reallocate more resources to the primary selected window. During the test, I observed the slowing down of the secondary program copies that I loaded earlier. The later copies ran much faster.

The Windows 2.03 package should appeal to the owners of IBM PC systems and compatibles running with 8086 and 80286 CPUs. Its promised similarity to the OS/2 Presentation Manager and enhanced speed are the major points of interest.

Windows/386 has a greater appeal for the users of 80386 machines, due to its ability to support multitasking and to break the 640K-byte memory barrier (making use of expanded or extended memory). Indeed, Windows/386 is a serious rival for OS/2. While OS/2 is seen as being weighed down by its compatibility with the 80286 chip, the Windows/386 system taps into the power of the 80386 tasking software productivity, taking it to a new level. ■

Namir Clement Shammas is a columnist for several computer magazines and a freelance writer living in Glen Allen, Virginia.

Improved Command Processor

Alex Lane

Get more versatility out of MS-DOS with Command Plus 2.01

Many people mistake COMMAND.COM for the operating system, because it is the only visible part of MS-DOS. But COMMAND.COM is really just a shell—a command processor that you can enhance. One alternative, Command Plus, lets you add several useful bells and whistles, as well as a more versatile script facility than DOS's batch files.

Among its enhancements, Command Plus lets you log all commands to a disk file, recall and edit previous commands, create command macros (called aliases, for often-used commands), create an environment up to 32K bytes in size, and display file directories in several formats. It sells for $79.95 and runs on the IBM PC, XT, or AT with at least 384K bytes of RAM and DOS 2.0 or higher.

The Command Plus 2.01 package consists of a 138-page user's manual, a quick reference card, and a single 5¼-inch floppy disk. The manual is well organized and has an adequate table of contents and index; explanations are clear, and they are illustrated with numerous examples. You will want to keep the reference card close at hand as you start to use the program, although you can enter any command with a /? flag to obtain help. Help is also displayed if the program detects incorrect flags.

The program files on the disk take up nearly 200K bytes of disk space. In addition, the disk contains a number of sample files that illustrate some of the features of Command Plus. Although you can run the program on a floppies-only system, the storage requirements for the shell and accompanying files make this impractical. With its default provision for 10 aliases and 10 history buffers, the Command Plus shell, COMPLUS.EXE, occupies about 50K bytes of memory. I tested the package on an IBM PC XT equipped with a hard disk drive and PC-DOS 3.1.

Command Plus requires no special installation procedure. After copying the software onto the hard disk, however, you must decide whether to use COMPLUS.EXE as a shell under COMMAND.COM (if you run DOS 3.0 or higher), or to load COMPLUS.EXE as the default shell, sidestepping COMMAND.COM altogether. If your version of DOS is earlier than 3.0, you are limited to the first option.

If you run the system under COMMAND.COM, you don't need to make any changes to the CONFIG.SYS file or to any batch files. Once you install the directory containing the Command Plus software in the path environment variable, COMPLUS.EXE runs like any other program in DOS. After printing a copyright message to the screen, the system prompt (typically C> in a hard disk system) is displayed, and although it seems as if nothing has happened, COMPLUS.EXE subsequently handles your commands. To leave COMPLUS.EXE, type exit at the system prompt, and you will return to DOS under COMMAND.COM.

To load COMPLUS.EXE during the boot process, the CONFIG.SYS system configuration file must have a SHELL= statement in it that tells DOS to load COMPLUS.EXE instead of COMMAND.COM as the boot shell. For those users who don't have an existing system configuration file, a sample file comes with the Command Plus software.

Bells and Whistles

With some minor exceptions, if you type tried-and-true DOS commands to COMPLUS.EXE, it gives you the same output as you would get from COMMAND.COM. I found the first notable exception (and annoyance) to be that any time you invoke a DIR, COPY, or DEL command, the system displays a two-line copyright message. Fortunately, you can suppress the message by invoking these commands with the /M switch, which you can set automatically using the aliasing feature of Command Plus.

I also found the output from the COPY command somewhat more verbose when I specified filenames using wild-card characters. For example, the command COPY *.* A: will output a descriptive line to the screen as every file is copied. You can suppress this output, too, using a

continued

Command Plus 2.01

Company
ESP Software Systems Inc.
11965 Venice Blvd., Suite 309
Los Angeles, CA 90066
(213) 390-7408

Format
One 5¼-inch floppy disk

Language
C and Assembly

Hardware Needed
IBM PC, XT, or AT with at least 384K bytes of RAM and DOS 2.0 or higher

Documentation
138-page Reference Manual; quick reference card

Price
$79.95

Inquiry 903.

switch on the command line.

Command Plus provides a Unix-like regular-expression syntax for filename specification. For example, `[*a-z]*.*` matches any file with a name not beginning with a letter, and `[*]+ABC*.*` matches any file with "ABC" anywhere in its name. Admittedly, you must overcome a learning curve to master this shorthand, but the added versatility is worth the trouble.

A variety of switch options in the `DIR` command gives you control over how you would like your directories listed. You can specify date ranges so that if, for example, you want to see only those files created today, you'd type `DIR/DO`. You can specify time ranges in a similar fashion. You control what types of file entries and file information to include or exclude from the listing. For example, in the command `DIR /F /E /ID /M`, the `/F` switch generates a filename-only listing, `/E` places extensions flush against the filename, `/ID` suppresses listing of directory files, and `/M` suppresses the directory copyright notice. If you direct the output from this command to a file, you can subsequently use that file as input to the `COPY` and `DEL` commands. The use of multiple character flags in Command Plus makes it advisable to use spaces between flags; otherwise, they may be misinterpreted by the program.

The `COPY` command provides many features often found in hard disk backup programs. For example, you can copy entire directory trees to the floppy disk, and `COMPLUS.EXE` will prompt you to change disks as they fill. You can choose to copy only those files whose "archive" bit is set, you can select files by date and by time, and you can exclude files from being copied. For example, `COPY *.BAK A: /E` will copy all files except those with the extension `.BAK` to the A drive. You can even do a "dry run" of a copy to see just what files would be copied as a result of a particular `COPY` command line, which is useful to prevent accidental overwriting of files. I particularly found the `/Q` switch, which prompts for a yes/no/quit response before each copy, to be valuable since you can issue the command `COPY *.* A: /Q` and selectively copy files that may otherwise be difficult to specify using wild cards.

Like `DIR` and `COPY`, options for the `DEL` command let you specify date and time ranges, exclude files, and do dry runs. You can also delete files in subdirectories and then remove the subdirectories. As with `COPY`, you can ask for a yes/no/

quit prompt to force verification before you delete the files. As a convenience, you can also specify multiple files on the command line in the form: DEL *filename filename. . . .*

Although the TYPE command is available through COMPLUS.EXE, the BROWSE facility is vastly more useful. It lets you page up and page down within a file, perform forward and backward searches for Unix-like regular expressions, and browse through a series of files. I found BROWSE to be useful, but the program does not respond well to files with embedded control characters. I was unable, for example, to use BROWSE to view a 7K-byte file that I generated by printing a Microsoft Word document to disk.

Getting Around Some Confusion

Although the enhancements offered by Command Plus are powerful, they are, nonetheless, confusing. Again, you have to spend some time with COMPLUS.EXE to master it, but here the aliasing feature can help ease the pain.

Aliases provide you with macro processing that lets you define up to 64 aliases, each of which consists of a name and a definition. For example, if you wanted to suppress the copyright notice every time you typed DIR, you could define the alias DIR to mean DIR /M. Afterward, if you type DIR, it will be expanded to the command DIR /M. You can turn alias expansion on and off from the command line; and you can clear aliases en masse, remove them individually, or disable them temporarily. A supplemental script file that comes with the package loads files of aliases on demand.

Command Plus's history feature allows up to 48 previous command lines for you to recall and edit for immediate use. You can recall commands either by number (the command HISTORY outputs a numerical list of previous commands), by string segment, or by repeated tapping of the up arrow key. You edit the commands using the left and right arrow keys along with Backspace, Delete, and Insert. This arrangement beats DOS's painfully primitive command-editing procedure using the function keys. In what I consider feature overkill, you can even edit the command line using a customized set of keystrokes or a set that conforms to the WordStar or BRIEF editors.

The log feature of Command Plus gives you the option of automatically keeping a time-stamped record of every command you enter into the computer. You can also make manual entries like Beginning work on Project X whether or not you enable the automatic log feature. You will find this log feature useful for keeping track of your time.

The problem with organizing your hard disk into subdirectories is that you have to type long directory paths in your CD commands. With Command Plus, however, you can store your paths as variables in the environment and then access them by preceding their names in a command with a $. For example, with the environment variable KERMIT set to C:\UTIL\COMM\KERMIT, you can type CD $KERMIT to change directories. The commands PUSHD and POPD, respectively, push and pop directories from a special stack. When you use a POPD, it has the same effect as changing to the directory on the top of the stack. You use the DIRS command to view the contents of the stack.

Albeit a minor feature, the ability to edit environment variables won my heart. To do this, you enter the variable name at the system prompt and type Control-E. COMPLUS.EXE then offers an editable SET command for that variable. I've found this feature invaluable in editing my PATH variable, which I continually modify.

continued

The ability to execute command files in DOS is limited to its batch facility. Command Plus executes its own brand of command files using scripts, all of which have an extension of .S, through a separate program called SCRIPT.EXE.

Learning to use SCRIPT.EXE is like learning a programming language. There are integers, long integers, and string variables; string-to-numeric conversions; assignment of variables; arithmetic and Boolean operators; and FOR, WHILE, and CASE control structures. There are also extensive file-operation routines that allow parsing of filenames and fetching of file-creation dates, times, and file sizes. This list of features is not complete, but you get the idea. A variety of sample SCRIPT files comes with the package to help you master the language.

Although DOS's batch files cannot execute directly under COMPLUS.EXE, you can get the job done by running a temporary version of COMMAND.COM, provided it is available on the disk. You must rewrite any .BAT file that changes or sets environment variables as an .S file, because if you execute the .BAT file under COMMAND.COM, the changes introduced are lost when COMMAND.COM exits to COMPLUS.EXE. The same thing goes for .BAT files that install terminate-and-stay-resident (TSR) programs. If a TSR loads above COMMAND.COM while the latter executes a .BAT file, a hole is left in memory after COMMAND.COM exits. The same caveat applies to Command Plus script files: Since COMPLUS.EXE loads SCRIPT.EXE to execute all script files, TSRs must load only from AUTOEXEC.S (which is a special file that executes by itself).

Left-Handed Criticism

Command Plus's features mimic those found on terminals attached to more powerful machines, like DEC's VAX. At $79.95, this package offers exceptional value for the money.

But in this era of ever-more-user-friendly software, Command Plus may stand out as something of an anomaly. To use it well requires an investment of time and effort that the casual user—one who, perhaps, knows only enough about DOS to run Lotus 1-2-3—may not be willing to make. For the experienced user who continually deals with DOS, however, the effort required to master Command Plus will be well spent. The only major criticism I can level at this software is somewhat left-handed: The more you use it, the harder it is to settle for mere COMMAND.COM. ■

Alex Lane is a knowledge engineer with Technology Applications Inc. in Jacksonville, Florida.

So Many Options—So Little Room

John McCormick and Jane Morrill Tazelaar

Wendin-DOS promises a lot for $99—is it too good to be true?

A multitasking, multiuser, windowing, MS-DOS–compatible operating system for $99? Impossible! Or is it?

Wendin-DOS 2.12 from Wendin Inc. runs MS-DOS and Wendin-DOS programs in a multitasking environment with multiple windows on standard IBM PCs, XTs, ATs, and true compatibles with a minimum of 512K bytes of RAM. It also runs on 80386 machines, and you can add up to 31 users to your system.

But let's not go crazy, folks. Reason prevails. The capability may exist in the operating system, but you can't run much in 512K bytes. Wendin-DOS itself takes up 300K bytes.

Time Slicing

True multitasking exists when the operating system controls the scheduling, prioritization, and execution of more than one task at a time without manual intervention. Time slicing often controls the maximum amount of time each task has to perform a particular function; that is, when the task receives control of the system, it has a limited amount of time to execute before control passes to another task. Some multitasking systems allow a task to maintain control of the system until that task's immediate function is complete; compute-bound programs can effectively tie up these systems.

Wendin-DOS uses time slicing to determine the maximum amount of time a task, called a *process* in Wendin-DOS, can maintain control of the system. Checking the schedule is event-driven, meaning that the operating system checks to see whether the currently active process has finished its time slice based on the occurrence of certain events. These events are a timer tick, which occurs approximately 18 times per second, and a key press (either local or remote), which initiates a rescheduling so that the process reading the keyboard input can interpret the character.

The system chooses which process should receive control based on priorities: The process with the highest priority receives control. If more than one process has the highest priority, then scheduling proceeds in a round-robin fashion. Priorities range from 0 to 31; the default is 5, but you can modify that with the PRIORITY=*n* command in Wendin-DOS's CONFIG.SYS file. The system reserves priorities between 16 and 31, inclusive, for real-time processes.

Setting Your Priorities

You can boost priorities based on certain events (e.g., a key press). Wendin-DOS automatically boosts the priority of the process reading the keyboard input so that it is likely to be scheduled when the input is complete. This helps to ensure a quick response for the user and, thus, a smoother overall system performance.

You can modify the priority assigned to a specific process by changing certain optional parameters in the CONFIG.SYS file, including SVCBOOST=*n*, which lets you raise by *n* the priority of processes requesting operating system services, and IOBOOST=*n*, which lets you raise the priority of processes requesting I/O services (this is one parameter to tweak when you're trying to hone your system's performance).

Swapping Processes

To handle multiple processes, Wendin-DOS uses an optional high-priority system process called the Swapper. When an executing process needs more memory, the Swapper transfers processes not in execution to a RAM disk or disk file to free the memory those processes occupy. If you wish to enable swapping, you must add the SWAPFILE=*filename* command to the CONFIG.SYS file. If you don't include this command, the operating system will not swap, and if you try to execute more than a few programs at one time, Wendin warns that you will run out of memory quickly. Using a RAM disk, if you have one, is faster than using a regular disk file.

You can control how often the Swapper takes control with the SWAPRATE=*n* command (also in CONFIG.SYS), where *n* is the number of timer ticks between Swapper "wakeups." This is another param-

continued

Wendin-DOS 2.12

Type
Multitasking, multiuser, windowing operating system

Company
Wendin Inc.
P.O. Box 3888
Spokane, WA 99220
(509) 624-8088

Format
Two 5¼-inch floppy disks

Language
C

Hardware Needed
IBM PC, XT, AT, or 100 percent compatible or 80386-based system with 512K bytes of RAM and two disk drives

Documentation
120-page Wendin-DOS User's Manual

Price
$99

Inquiry 917.

eter you'll need to tweak for good performance. If the number is too low, the Swapper will hog the system and the system performance will go down, because no other process will get any compute time. If the number is too high, the Swapper will hibernate too long and the response time will go down. The manual contains suggestions about numbers to start with; from there, it's trial and error, because each system makes unique demands based on the number of users and the exact program mix at any one time.

Multiuser Operations

To accommodate multiuser operations in addition to the default single-user system, Wendin-DOS differentiates between a console and a terminal. Wendin-DOS defines the console as the keyboard and monitor combination on the controlling computer, the one running Wendin-DOS. It defines a terminal as a device that operates in two-way serial communications with the controlling computer.

Remote terminals connected to the host computer via a serial-communications port have access to the system if the serial port is defined in the `CONFIG.SYS` file with a `TERMINAL` command. `TERMINAL=` *`ttyname`* `AT` *`portaddress`* `ON IRQ`*`n`* lets you assign a name of your choice, *`ttyname`*, to the device on the serial port at the hexadecimal *`portaddress`* and lets you specify which hardware interrupt request line, *n*, to use. Other terminals physically connected to the system but lacking the `TERMINAL` definition can access the system if they have communications software that completely takes over the serial port. You can use multiport add-in adapter boards with Wendin-DOS to increase the number of serial ports available, if the boards contain an industry-standard 8250 communications chip.

The file management system in Wendin-DOS provides security controlled by a permission mask that is located in the directory entry for each file control. This mask includes four classes of access rights: `SYSTEM` (for system management, such as systems and applications software maintenance programmers), `GROUP` (for all users of a particular type, such as a programming class; a group ID code, or GIC, determines group membership), `OWNER` (for the particular user or users who own a file; a user identification code, or UIC, establishes file ownership—you can authorize more than one user to have a particular UIC), and `WORLD` (for everyone). You can be a member of more than one class.

In addition, you can have up to four possible file-access permissions: `READ` (needed to execute a program that reads the file), `WRITE` (needed to share files like a spreadsheet with other users), `EXECUTE` (needed to run a program, although, with some overlay structures, you also need to have `READ` permission to execute), and `DELETE` (needed both to delete a file or to recreate it, since that process involves deleting the old version). You can alter file permissions with the `PROTECT` command.

You can set up all the file permissions and protections you want, but none of them will do any good if you don't set `VALIDATE=YES` in the `CONFIG.SYS` file. The system default is not to validate, which grants everyone access to everything. (`LOGIN=YES` requires that each user log into the system with the `LOGIN` command and thus pass a security check at that level as well.) Also, since MS-DOS doesn't check permissions, it can bypass Wendin-DOS's security setup. This could cause a problem with data security if MS-DOS is available on your system. The company suggests that you use a file-encryption system to encode such data.

As for keeping unauthorized users from getting into the system, the first line of defense is the `USER=`*`ttyname`*`:`*`baud,parity,databits,stopbits`* command in the `CONFIG.SYS` file. A `USER` statement must accompany and follow, although not necessarily directly, each `TERMINAL` statement in the configuration file if you want Wendin-DOS to start a shell process at that terminal. A shell process accepts commands and then interprets and executes them. The default is the Wendin-DOS shell; however, you can select an alternative program as a shell for all user tasks by adding the `SHELL=`*`filename`* command to the `CONFIG.SYS` file.

The various parameters in the `USER` command tie it to a particular `TERMINAL` command via the *`ttyname`* and initialize the communications port, specified in `TERMINAL`, to the stated data transfer rate, parity, data bits, and stop bits.

Another line of defense is the `LOGIN` process that requires you to enter your user name and password—both are case-sensitive—to gain access to the system. The `AUTHORIZE` command lets you add or delete users, assign or change privileges, and create or change passwords. Privileges involve the user's authorization to perform certain operations; for example, if you have `OPER` privilege, you can change the system date and time; if you have `PHYIO` privilege, you can perform physical I/O; and so on.

To create the password file, `PASSWD`, you first set up file-access permissions so that only you can write to its directory, `ETC`; Wendin-DOS encrypts the passwords so that you can let anyone read the file. `AUTHORIZE` stores the user name, password, home directory, UIC, GIC, and privilege mask in the password file. (The `UIC` command lets you change a user's UIC or GIC.) Users can also enter the `AUTHORIZE` command, but they can modify only their own passwords, and they must know the old password before they can change it. Entering the `AUTHORIZE` command followed by `HELP` provides a list of commands acceptable to the `AUTHORIZE` utility.

Multiple Windows, Multiple Tasks

The operating system lets you create multiple on-screen windows on the console. To activate windows, you must include the `WINDOWS=`*`n`* command (where *n* is the number of windows allowed, up to a maximum of 20) in the `CONFIG.SYS` file. Windows are memory-hungry, however; each one takes 21.5K bytes.

You can overlap windows, move them, resize them, or select them with various function-key combinations called "hot keys." For example, Alt-F1 changes the active window; Alt-F2 lets you resize the window with the arrow keys; Alt-F3 lets you move the window with the arrows; Alt-F4 rearranges the windows so that the active one is in front of any others; Alt-F5 puts the active window in the back; and

continued

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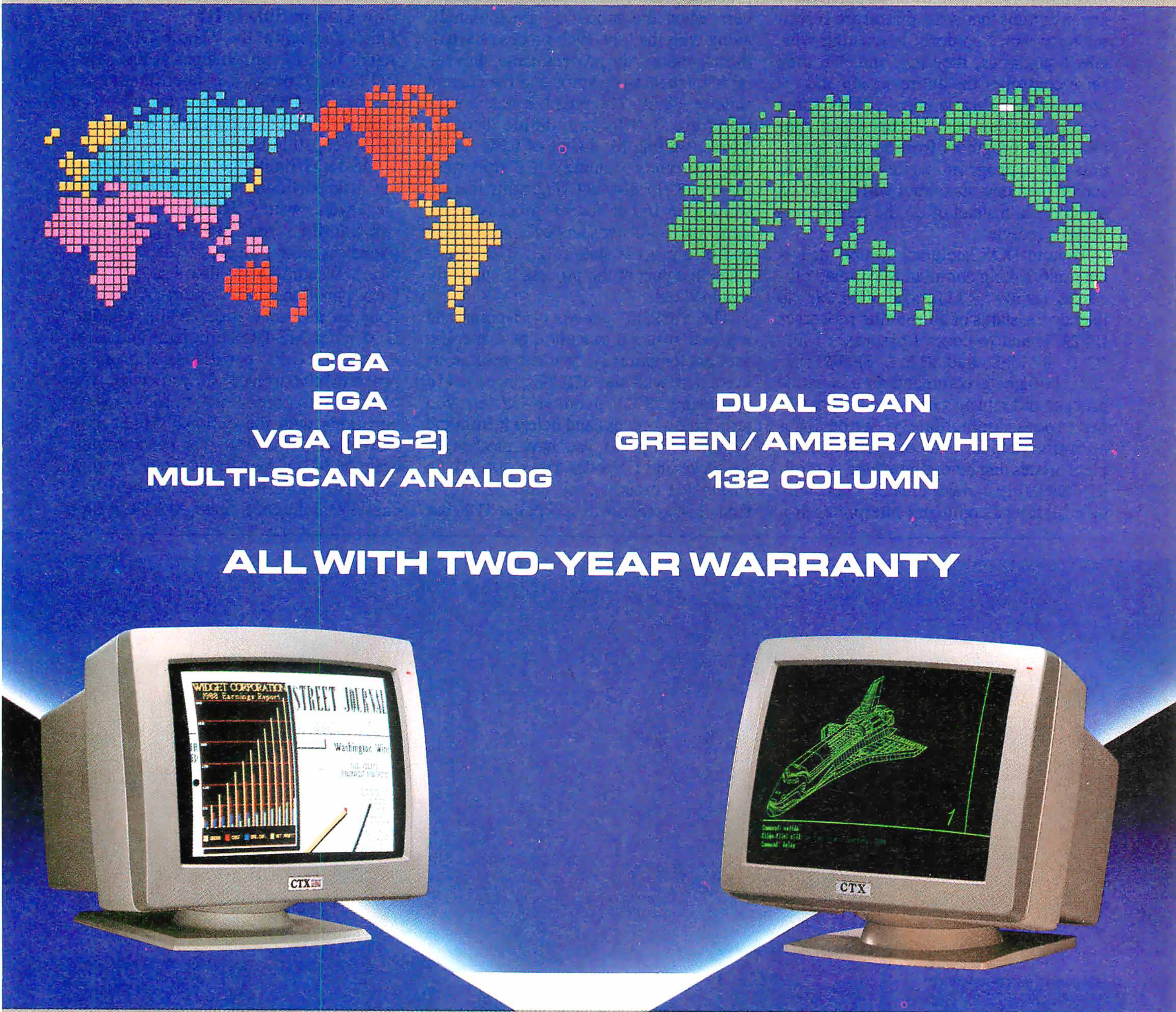

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Alt-F6 creates a new window with a shell process in it. The HOTKEY command lets you choose a different set of hot keys if the current ones interfere with your application's use of the function keys.

Some applications won't run properly in Wendin-DOS windows. In particular, any programs that write directly to screen memory won't conform to existing window boundaries; they may run, but they seize control of the entire screen and ignore any existing windows. This same kind of problem also occurs when running these programs from remote terminals. If a program writes directly to screen memory, its output will appear on the console instead of on the remote terminal's screen.

Wendin-DOS includes several different multitasking commands to create processes (SPAWN, CALL, and WINDOW); to display the status of all running processes (PSTAT); and to control processes (SUSPEND, RESUME, and KILL). SPAWN *command* initiates a command as a separate process and returns control to the spawning process immediately, while CALL *command* waits for that command to complete processing before returning control. WINDOW *window-name* creates a new window running a command-interpreter process. You can enter the WINDOW command only from the console. If you have enabled windows on your system, each new process you CALL or SPAWN at the console will appear in its own window.

PSTAT displays the ID numbers for all processes (the system assigns these numbers when the processes are initiated), along with the time each process started, the user name, the process name, the type of task (such as system), and the current state or status. The possible state conditions are COM (computable; in other words, waiting for a slice of CPU time), CUR (currently running), HIB (hibernating), LEF (local-event flag wait; that is, waiting for I/O or another process to finish), and SUSP (suspended). A 0 at the end of a process state (e.g., HIB0) indicates that part of the process is currently swapped out.

The SUSPEND *process-id* command lets you suspend execution of a specific process temporarily; you can resume its execution with the RESUME *process-id* command. KILL *process-id* lets you terminate a process and delete it from the system as long as you have the proper privilege and ID code. You can't KILL a suspended process; you must RESUME it first. The system will accept the KILL but will hold it until the process resumes. You also can't KILL your own process (you wouldn't be able to enter commands) or any of the system processes: System, Disk, Terminal, or Swapper (the system would crash).

How Compatible Is It?

Although many of the Wendin-DOS commands have the same names as their MS-DOS counterparts, it is important to use the Wendin-DOS versions, because they contain extensions that utilize Wendin-DOS's capabilities.

MS-DOS limits the maximum size of the disk partitions it can support to 32 megabytes, while Wendin-DOS says it can handle sizes into the gigabytes. (Needless to say, we couldn't test this feature.) Wendin-DOS also lets you mix Unix partitions and Wendin-DOS partitions on the same disk. While Wendin-DOS reads MS-DOS programs and files, it ignores Unix partitions, allowing a peaceful coexistence. If you wish, you can program access to Unix files in Unix partitions with the optional Application Developer's Kit ($99). You need not separate MS-DOS partitions from Wendin-DOS partitions unless you wish to, because Wendin-DOS reads MS-DOS files and programs without conversion.

If you are more comfortable with Unix or VAX/VMS file specification formats, you can enable them. The `SWITCH` command lets you notify Wendin-DOS that you wish to use forward slashes in pathnames, as Unix does, or square or angle brackets, as VAX/VMS does. Wendin-DOS also lets you use piping and redirection commands.

Up, Up, and Away

Wendin-DOS can boot from any floppy or hard disk drive except those that are RLL (run-length-limited) controlled. Wendin-DOS's `INSTALL` program creates a basic `CONFIG.SYS` file for you. You simply answer questions, which are accompanied by detailed, well-thought-out explanations, at each step. The `INSTALL` program doesn't generate `TERMINAL` and `USER` commands, however, or priority-elevation commands, among others; you still need to go through the options in the manual and figure out what you want. The installation procedure also doesn't tell you that you need to copy the `.EXE` files from the original system disk and the contents of the utility disk to your system disk.

Fine-tuning the system involves time, familiarity, and experience. It would be a good idea to take a couple of hours and read the manual, cover to cover, before you install Wendin-DOS. The manual gives you a good feel for the many options and variables you need to consider when you decide how to set up your system: how many windows to use, how much memory to allocate for different functions, how often to check the scheduler, and so on. For one thing, if you aren't familiar with multitasking systems, you need to become aware of the many different facets that you have to consider.

Checking It Out

We tested Wendin-DOS on a Zenith Z-386 with 1 megabyte of memory and an 80-megabyte hard disk drive, on a MicroServe Pro-Plus+ AT Turbo with 1 megabyte of memory and a 30-megabyte hard disk drive, and on an IBM PC with 512K bytes of memory and two floppy disk drives. We had a variety of problems.

Installation was smooth and easy on the Z-386 and on the AT Turbo. On the two-floppy-disk-drive IBM PC, however, it would not install. Although the instructions indicate that you can install it on a two-floppy-drive system and although the entire system takes 300K bytes, it ran out of room on a 360K-byte floppy disk at the very beginning of installation.

We had a few problems with some of the Wendin-DOS commands, such as `CHKDSK`, which gave us a garbage display of non-ASCII characters on the Z-386 (although it worked fine on the AT Turbo), and `FIND`, which died with no response before freezing up the keyboard on both machines, necessitating a reboot.

We tried to test a variety of applications, with mixed success.

- Reflex 1.11 was too large to fit into memory with Wendin-DOS. Wendin hasn't yet broken the 640K-byte barrier, and you can't use extended memory, except as a RAM disk or expanded memory. Considering that the system itself takes 300K bytes, you aren't left with much to play with.
- dBASE III Plus 3.51 ran fine.
- Lotus 1-2-3 version 2.01 ran fine, but with the 640K-byte memory restriction, you'd better keep your spreadsheet small.
- XyWrite III Plus 3.51 ran into problems: It appeared to be loaded and ready to run, but it wouldn't work.
- Peachtext 5000 version 2.02 worked fine as long as Wendin-DOS's windows

continued

weren't loaded. When they were, the screen showed a lot of confusion; Peachtext is one of those programs that seize control of the screen. If you avoid windows, the only apparent problem is that you can't exit from Peachtext. You must reboot after you're done with it.

• WordPerfect 4.1 worked without any apparent problems.

• PC-TALK III wouldn't run in Wendin-DOS's windows, but as long as windows were out of the picture it ran fine and allowed BIX communications.

• GWBASIC 3.2 loaded fine, but when we tried to `LOAD` a program using the F3 function key, the response was "illegal function call."

• Turbo Pascal 3.01A compiled and ran `CHESS.PAS`.

Wendin-DOS's privilege and permission protections for a couple of users worked easily, as did the authorization and logging functions.

Clearly, Wendin-DOS still has bugs, lots of them. Minicomputer and mainframe experience, however, tells us that the sheer number of setup parameters in a multitasking system creates a huge number of possible parameter combinations. With each new qualifier, the possibility of error increases factorially. The company is aware of many of the bugs, and as solutions are found, it issues updates. Wendin-DOS is being actively updated at this time. In fact, during the two months in which we wrote this review, the company issued two updates.

Complain, Complain

Wendin-DOS generates a series of system error messages that the manual covers in detail for such conditions as insufficient memory, bad file name, and so on. Wendin has "cute" names—a little too cute—for catastrophic system errors: Guru alerts or Guru meditations. We also found that the Guru alert messages gave a lot of information indicators—PSL (process status longword) number, event mask number, event flags number, and state number—without any source for what these numbers mean. In other words, we found the Guru alerts terse and not at all helpful. A few short paragraphs in the manual give you possible reasons for a few of them, but for the majority, you are supposed to call the company. That's not an acceptable way to handle errors.

Another complaint is that there isn't nearly enough documentation. The basics are there, but some of the details are missing. The manual has the same problem that many of us in the computer industry share: We think that we are speaking simply and comprehensibly, but some aspects of the computer world have become so ingrained in us that we don't even realize we are using buzzwords. The documentation has this problem in the area of multitasking systems. Certain functions and phrases are second nature to those experienced in the area, but microcomputer owners aren't necessarily familiar with multitasking systems. Other problems are that the manual lags behind the software updates and that it has no index.

Wendin-DOS doesn't have its own editor, but then, with its MS-DOS compatibility, perhaps it doesn't need one. You can transfer your favorite editor over and run it under Wendin-DOS. Don't, however, transfer your favorite TSRs (terminate-and-stay-resident programs) over, because they are unlikely to run. TSRs tend to take control of hardware interrupts that they can't receive while they're hibernating; thus, Wendin makes no claims about running TSRs. Similarly, programs and device drivers that are ill-behaved won't work under Wendin-DOS because they bypass normal operating system calls.

A Bit of a Mismatch

The list of features and capabilities in Wendin-DOS is long and impressive—but it's still on the drawing board. In concept, it may be a bit of a mismatch. When—and if—Wendin breaks the 640K-byte barrier, IBM PCs, XTs, ATs, and compatibles still won't be big enough to make full use of its tools. Can you imagine the response time of an 8-MHz AT with 1 megabyte of memory that has 16 terminals connected to it?

The 80386 machines show a lot more promise for an operating system like Wendin-DOS. It may be capable of far more than the systems it runs on, but for $99, you can use whatever capabilities you have room for and experiment with the others. Wendin-DOS definitely has a future—after it is debugged. ■

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Jane Morrill Tazelaar is a BYTE senior technical editor with eight years of experience in programming multitasking, multiuser, mainframe systems. She can be reached at BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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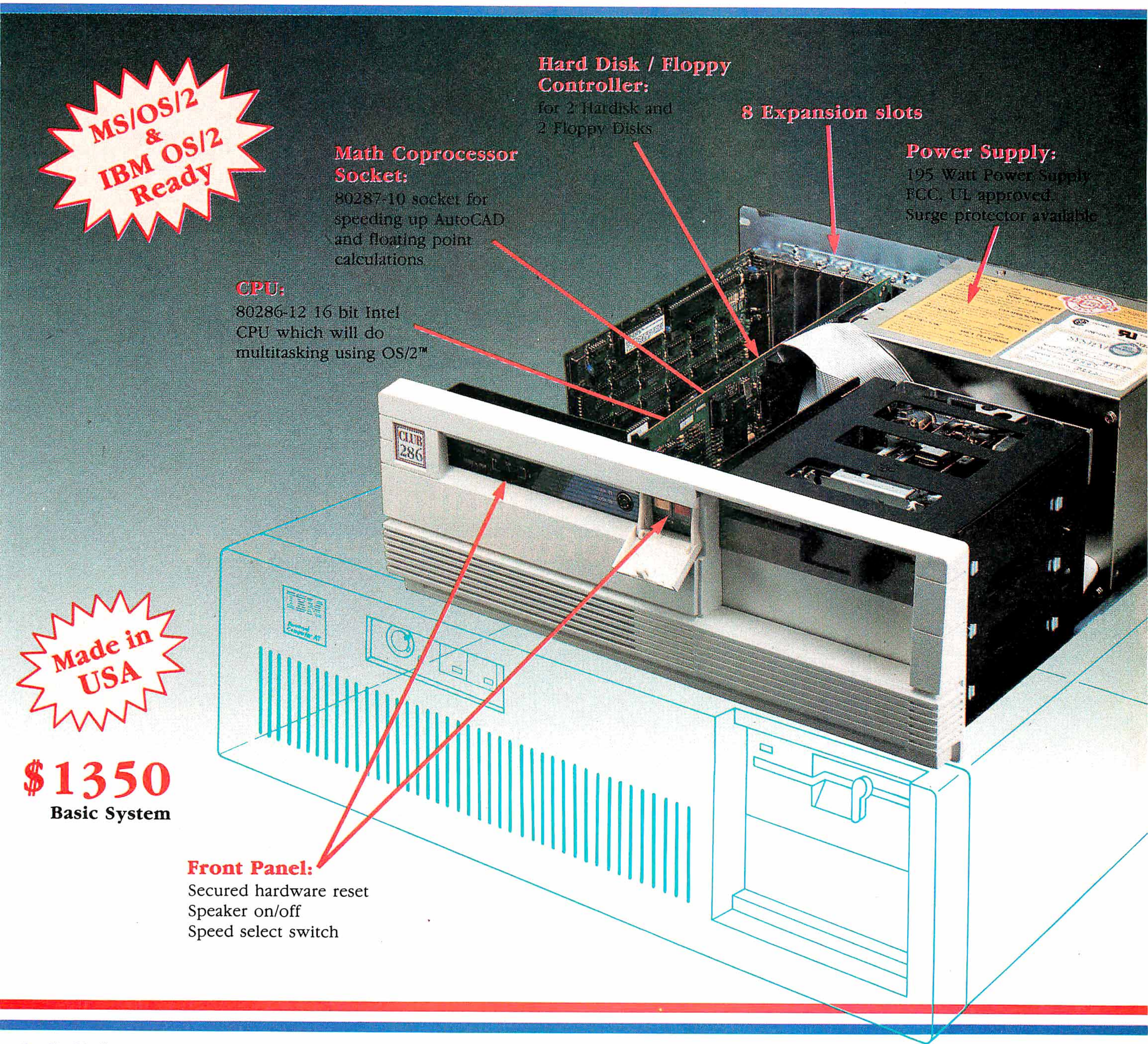

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Database Management via 1-2-3

Diana Gabaldon

Silverado and @BASE give you real database features from your spreadsheet

Lotus 1-2-3 wasn't really intended for database management—one of the common things people use it for. Sure, it can handle up to 800 or so data records, and it can sort and select records, but it has none of the more advanced capabilities of a true database manager. Also, as the number of records increases, the program's speed slows to a maddening crawl. Beyond 800 records, the program comes to a virtual standstill.

Now, however, there are alternatives. Two add-in products, Silverado and @BASE, add the capabilities of a reasonably good database manager to Lotus 1-2-3. Both products require that you have 1-2-3, as well as an MS-DOS system to run it.

But just what should a good database manager do? Minimally, it should allow you to add, delete, and edit records easily, to sort all or part of the database quickly, and to select records on the basis of any single key field or several key fields in a combination. In addition, a good database manager indexes the data in some manner so that you don't have to do each and every sort absolutely from scratch.

A relational database manager, compared to a file manager, also lets you access and use several databases and the relationships between data elements in the multiple databases. A simple flat-file manager, which is what 1-2-3 has, lets you use only one unindexed database at a time, providing only a rudimentary database system.

In 1-2-3's database, a record is just a row in a spreadsheet. Each cell's value is a field. You can specify a range of cells to extract records and blocks. You can then sort these extracted records by specifying which column to use as the key field. But that's it. There is no simple method for data entry or editing, and no indexing to speed up sorts.

Another important feature, though not specific to a database management function, is the ability to generate formatted reports from a database.

Silverado 1.0

Like many add-ins, you load Silverado 1.0 first and then Lotus 1-2-3. You can specify the key combination that activates Silverado from within 1-2-3. When Silverado is active, the forward slash calls the Silverado menu line rather than the 1-2-3 menu.

Silverado integrates well with Lotus 1-2-3. Menus are similar in appearance and operation to the 1-2-3 menus; only the mode indicator tells you whether you are in 1-2-3 or Silverado. Also, you can control Silverado using 1-2-3 macros, which is a major benefit.

The program does not actually operate on a 1-2-3 spreadsheet. In fact, it creates a small separate database, displayed in a window in the 1-2-3 worksheet screen. All database operations, calculations, and so forth are carried out in this separate database, not in the worksheet. However, you can copy data back and forth between the worksheet and the database.

Once in the Silverado mode, you can define a database range, which must not overlap existing spreadsheet columns. Unlike many other database or file managers, you need not specify the length or the type of information that you will store before you enter data. You can enter data directly into the database or copy it from a worksheet range.

A Silverado database looks superficially like a worksheet. You can enter values, functions, formulas, and the like into cells, with minor variations on the usual 1-2-3 formats for special cases, such as when you enter dates and numeric digits as label information. You edit with the F2 key, just as in worksheets.

Database columns are the data fields, just as they are when using 1-2-3's rudimentary data handler. You can add, rename, move, or hide fields, and you can specify field size as small or regular. This affects screen display and sorting speeds (where the screen displays records automatically) but does not affect other database operations; for example, the program adjusts reports automatically.

If you define a small "window" in the 1-2-3 spreadsheet, displays, and therefore sorts, are quick. If you ask to have a large database displayed, a sort operation can take upwards of 2 or 3 minutes to complete from initiation to final display of the sorted database. In addition, the first time you request a sort, Silverado automatically generates an index, and this speeds up subsequent manipulations.

For data storage, Silverado uses virtual memory. It stores data in memory or on a disk, and it updates the database constantly by moving data back and forth between RAM and disk, unlike 1-2-3, which uses a static database.

You can also adjust the amount of RAM available that Silverado uses. The default amount is 32K bytes, but you can allocate amounts from 25K bytes to 256K bytes. Naturally, the more RAM you allocate, the faster the program completes operations.

As a nice touch, Silverado accepts data that you enter into a blank column, and it automatically creates a new field and assigns a temporary default name to the field.

Silverado is more than just a convenient data-entry device and speedy sorter for worksheet data, though. There are considerable calculation capabilities built in, such as summary calculations, which are displayed as a special type of record called a "total record." Silverado automatically closes and saves your database to minimize the risk of losing records. It also has automatic database recalcula-

continued

Silverado 1.0	@BASE 1.0
Type Add-in database manager for Lotus 1-2-3	**Type** Add-in database manager for Lotus 1-2-3
Company Computer Associates 1240 McKay Dr. San Jose, CA 95131 (408) 432-1727	**Company** Personics Corp. 2352 Main St., Building 2 Concord, MA 01742 (617) 897-1575
Format Two 5¼-inch floppy disks	**Format** One 5¼-inch floppy disk
Language C	**Language** C
Hardware Needed IBM PC, XT, AT, PS/2, Convertible, or compatible with 512K bytes of RAM and two floppy disk drives or one floppy disk drive and a hard disk drive	**Hardware Needed** IBM PC, XT, AT, PS/2, or compatible with 512K bytes of RAM and two floppy disk drives
Software Needed Lotus 1-2-3 version 2.0 or 2.1; DOS 2.0 or higher	**Software Needed** Lotus 1-2-3 version 2.0 or 2.1; DOS 2.0 or higher
Documentation 250-page user's manual; keyboard templates; Quick Reference Guide	**Documentation** 202-page user's manual
Price $149	**Price** @BASE: $195 @BASE Options Pac: $89.95
Inquiry 902.	**Inquiry 906.**

tion, which you can turn off, just like 1-2-3's worksheet `Recalc`.

One of the most powerful functions of Silverado is the "crosstab" capability, which is a tool for analyzing relationships in your data. A crosstab shows the breakdown of information by category or range of value. This is especially useful in the analysis of two- or three-variable relationships among data. The program gives the user considerable control over the crosstab function. You can use "basic crosstab," in which Silverado does most of the work, or "advanced crosstab," in which you specify the complete design of the crosstab.

Silverado has a good report generator that lets you design reports interactively, including user-designated fields in standard or custom formats. A nice feature is that, once designed, you can print forms in the background while you do other work. However, you cannot print forms in the background simultaneously with macro control.

Inasmuch as Silverado is a relational database manager, you can link two or more database files using a common field and then view, edit, or extract information from the linked files. Also, Silverado will directly read dBASE files, though it does not use the `.NDX` (index) file from dBASE; instead, it creates an equivalent Silverado index when you sort the file.

@BASE 1.0

Unlike Silverado, @BASE 1.0 is somewhat difficult to load. You must use something called the Add-in Manager, invoked from within 1-2-3. When this menu appears, you must attach two separate files to use @BASE. Once attached, the program is available anytime by pressing Alt-F8, until you use the Add-in Manager to detach the files or the 1-2-3 session ends. You can, however, set up the program to load automatically every time you use 1-2-3.

In general, both Silverado and @BASE have equivalent database managing capabilities. There are significant differences in style and speed, however.

@BASE is a little cruder in operation and requires more decisions and input from the user. For example, while Silverado automates such things as filenames and new data fields by providing default values, @BASE requires that you supply a filename before opening and, rather strangely, before closing a file.

Unlike Silverado, @BASE uses disk-based storage only for database files; thus, it's not quite as fast as Silverado, although it's still much faster than 1-2-3. However, @BASE will sort and select records from a database file without displaying the file on-screen, which speeds up its operation considerably. It does not allow adjustments in display or RAM allocation.

As is, @BASE does not support indexing. However, Personics Corp. will soon offer an @BASE Options Pac that provides this feature at an additional cost of $89.95. It will also give @BASE the ability to link two or more data files using a common field (giving it "relational" capabilities) and the ability to generate computed fields—all of which should place @BASE more in line with Silverado.

These two packages are roughly comparable in the time each takes to execute a command, although, depending on the specific operation, one or the other may be slightly faster. For example, @BASE is somewhat faster than Silverado at searching for a record because it doesn't use a special data window for its operations. However, this is an obvious tradeoff; since @BASE uses the regular spreadsheet display, you can't view a spreadsheet and a separate database simultaneously, as you can with Silverado.

Although @BASE is not a relational database manager, it can read and write dBASE files directly. It can even convert a 1-2-3 worksheet into a dBASE III or III Plus database on disk. This means you can also use 1-2-3 as a "front end" for existing dBASE applications—a boon to those whose data is heavily spreadsheet-oriented. In fact, the ability to analyze or convert files from 1-2-3 to dBASE format on disk, without bringing them on screen, is a real advantage for @BASE.

@BASE has a report generator, though it is not nearly as comprehensive and flexible as Silverado's. You must define customized reports by retrieving a special worksheet file (provided on a distribution disk) and by redefining cell labels in it. This is much less flexible than the interactive Silverado report generator. @BASE does not allow background forms generation.

Like Silverado, @BASE integrates well with 1-2-3. Also like Silverado, @BASE can work in an "unlinked" mode; that is, you can manipulate data without necessarily transferring it into a worksheet. If you want to use any of the 1-2-3 functions or macros, you will need to transfer the data into a worksheet.

@BASE gives you somewhat more power in its unlinked mode, which provides you with a "browse" window. You can display and query a database in a window on-screen and use the @BASE analytical functions without importing the data into the worksheet. Since the data remains on disk, you do not use worksheet memory.

In addition, @BASE has a good data filter, so you can select records quickly and easily. You set the criteria for selection through a series of prompts. You can use the data filter in the browse window.

Getting up to Speed

The learning curve is quite short for Silverado, owing to the excellent design of the program, the completeness of the documentation, and its operational similarity to 1-2-3. You can have an operational database within minutes of installing Silverado, and you can construct simple reports within an hour. If you are familiar with 1-2-3 already, you will have no difficulty at all in using Silverado. If you are a new 1-2-3 user, it may take you a little longer to become used to the menu structure and cursor moves. If you get into trouble, the 1-2-3 help key (F1) brings help for Silverado.

Due to a poorly organized manual, it will take you somewhat longer to learn @BASE. The program is not designed to be particularly friendly to the inexperienced user. It depends more heavily on built-in functions than Silverado does, and the menu commands require more steps. However, learning @BASE is not difficult. You can create and query a database within several minutes, but you'll have to do it without an on-line help function to fall back on.

Both Silverado and @BASE have functions that they share with 1-2-3, such as `@DBSUM` and `@DBMAX`. Likewise, both have logical and database functions that you can use only within the database add-in. For example, Silverado lets you use database range functions, such as `@UPTO` and `@THRU`, and logical functions such as `@ISFORMAT` (for setting data format). @BASE includes similar (though not always identical) functions. It also contains more analytical database functions than Silverado, though you could use the Lotus macro capability to make Silverado perform these functions. Manuals for both programs include reasonable tutorials that introduce the user to the general program features.

For help in solving problems, Silverado comes with 6 months of free basic phone support for registered users, plus a free subscription to *CA News*, the Computer Associates newsletter. An extended SupportPlus maintenance plan is also available. Computer Associates does enforce its registration plan; you must give a valid registration number in order to get support. Personics gives unlimited phone support for @BASE to any user, without asking for a registration number.

One potential problem area with Silverado arises from its capacity for instant updates. Since data is in movement between RAM and disk, you must set the data directory or insert a blank disk before you create a new database; otherwise, an error may occur. Likewise, you cannot swap disks or change directories while performing database operations. Silverado automatically saves and closes database files, thus minimizing the risk of losing data. Both the documentation and the screen warn you of permanent field deletions.

@BASE lets you exit to DOS and access a file that @BASE currently uses. However, if you do this, the program doesn't monitor changes made to the file, so you run a considerable risk of losing data. The documentation notes this danger, but only on an insert sheet of "Late Additions."

I encountered very few errors in using

continued

Table 1: *The benchmark tests gave mixed results. Although Silverado was slow completing the sort test, it also created a new index in the process. The general lack of an index in @BASE resulted in a long wait when looking for a nonexistent record. Times are in minutes:seconds.*

	Sort	Search for last record	Search for record #1001	Save file	Load file	Index file
@BASE	0:38	0:03	0:20	0:03	0:03	N/A
Silverado: w/32K bytes of RAM	2:19	0:02	<0:01	0:36	1:22	0:16
w/256K bytes of RAM	1:55	0:02	<0:01	0:25	1:10	0:10

Note: Silverado displayed the entire database in its data window during these operations. Displaying a smaller window significantly speeds up completion of sort and retrieval operations.

either program. My own data-input errors prompted most error messages. Silverado has a facility for validating data during entry. @BASE uses the Lotus 1-2-3 data checker, which will beep at you if you enter an improperly formatted value into a cell.

I tested both products with a database of 1000 records. I used an IBM PC XT with a hard disk drive and 512K bytes of RAM. I timed how long each system took to save and retrieve the file, to sort the file in reverse order (from ascending order to descending order or vice versa), and to search for the last record (record #1000) and a nonexistent record (record #1001). I also timed how long Silverado needed to index the file; @BASE does not have an indexing capability.

The results were mixed (see table 1). When I ran the sort on Silverado with a standard display format, it took additional time to create an index and display each record; @BASE was nearly 4 times faster. With a smaller display and on subsequent sorts, however, the times were comparable. @BASE was many times faster than Silverado at saving or loading the database file. But, when it came to searching for a nonexistent record (a typical error usually caused by an erroneous entry), Silverado responded instantly, while @BASE took 20 seconds.

The whole question of speed is tricky to define when dealing with these two database managers. Should you consider the actual speed in completing an operation as separate from the information displayed on the screen? When you sort or select from an @BASE file, the results are not displayed automatically; you must go back to the menu and enter the data-browse mode to see anything. Silverado repaints the screen whenever you resort an open file, and while the sort itself is reasonably quick, the screen display is very slow if you have a large data window defined.

continued

The Smoothest Ride

You can program 1-2-3 to do almost anything, including database manipulations. But is it worth the effort? You can use the 1-2-3 macro language to force 1-2-3 to access multiple files and approximate a relational database manager, but doing so requires advanced programming skills and is very cumbersome. At $100 to $200, it's more economical and much more efficient to buy an add-in database management package like Silverado or @BASE.

Of course, neither package is quite the equivalent of a full-featured stand-alone database manager, such as dBASE III. For instance, neither has its own programming language. Both, however, can use the 1-2-3 macro language, which gives them considerable power and flexibility. In general, either package is capable of satisfactory database performance on the scale that a 1-2-3 user would likely need.

Someone whose chief concern is handling very large or complex databases should still opt for the speed and sophistication (hashing algorithms, programming languages, and so forth) available only in a large, stand-alone database manager. Silverado and @BASE are intended for the person who generally uses only Lotus 1-2-3 but definitely needs more speed and power in data handling and more flexibility in report generation.

Overall, the feel of @BASE is a lot more nuts-and-bolts than Silverado, which glides along, not bothering the user with trivia, such as file closing. In terms of power, performance is similar between the two programs. Silverado also has a significant advantage in that its indexing capability is built in, while @BASE requires the additional, and yet-to-be tested, Options Pac. The Options Pac promises to make a major difference in terms of relational database handling, and some difference in speed.

Silverado is a more refined and even better-designed program. Although @BASE offers some powerful features, such as analysis and built-in statistical functions, it is significantly less easy to use and slower than Silverado unless you spring for the additional $89.95 Options Pac.

It boils down to this: Silverado is a BMW with cruise control, while @BASE is a stick-shift Chevy. Both will get you there, but the ride is more pleasant with Silverado. ■

Diana Gabaldon is the editor of Science Software *and an assistant research professor at the Center for Environmental Studies at Arizona State University, Tempe, Arizona.*

Byline

Diana Gabaldon

Desktop publishing for the IBM PC without extensive hardware

Ashton-Tate's newest entry in the IBM PC-compatible side of desktop publishing differs from most other desktop-publishing packages. First, it does not require a mouse, nor much hardware. Second, it is relatively inexpensive.

Byline 1.0 is for people with fairly simple desktop-publishing applications in mind. While competent at the things it does, it doesn't have the power of established large packages like Ventura Publisher and PageMaker. On the other hand, it has features with considerable range and flexibility and is remarkably easy to use. It's ideal if you would like to produce stylish reports and general-purpose business documents, but don't want to set up as a professional typesetter.

To run Byline, you need an IBM PC or compatible with two 360K-byte 5¼-inch floppy disk drives (or a hard disk drive and one floppy disk drive), 384K bytes of RAM, a graphics adapter and display, and DOS 2.0 or higher. It supports a number of 9-pin and 24-pin dot-matrix printers, as well as several laser printers, including Apple's LaserWriter, LaserWriter Plus, and other PostScript devices. It sells for $295.

Easy Operation

Byline's greatest strength is its ease of use. While out-and-out typesetting packages like TEX take weeks of work to master, and the "big" desktop-publishing packages take days, you can have Byline producing respectable documents within an hour.

The package works with a vertically split screen. The right side displays a "minipage," a small image of the laid-out document in progress. The left side of the screen is for several things: layout specifications, the main menu, and editing of text files. Naturally, you wouldn't use the left side for all these things simultaneously; the left screen defaults to layout specifications. You can call the main menu anytime with F10 and load a text file for editing by pressing F8. When called, the main menu or a text file temporarily replace the layout specifications, which return automatically when you discard the menu or store the text file.

You can zoom either side of the screen to fill the entire screen by pressing F7. Most frequently, you'll want to view the minipage up close to check text. Zoom overdoes it a bit here. When you zoom a minipage, the top half of the page fills the screen; you have to use the down arrow to view the bottom half. Of course, this preserves the minipage's proportions, but it sometimes makes it hard to tell whether text ends where you want it.

The key definitions are logically designed; in general, arrow keys select functions, Return executes any selected function, and Escape gets you out of whatever you are doing. The keyboard template provided is largely unnecessary. Each function key has only one function, and most are displayed in the bottom-of-screen menu most of the time.

The package works from two types of menus: bottom-of-screen function-key menus and a main pop-up menu in two tiers. The menus are small and well designed. The main menu is especially nice—very compact and explicit. The second tier of choices for each highlighted main choice pops up as you move the cursor over the first-tier choices. Simultaneously, a very detailed help prompt pops up beneath the menu, telling you what that choice does. F1 produces a context-sensitive help screen at any point in the program, and most of these are, in fact, helpful.

Besides the menus and function keys, Byline has several useful speed keys, which execute functions directly without going through a menu. These include a Quick Save function and keys for executing an alternate view or preview of a page. With these functions, you can view two pages simultaneously or obtain an overview of your document, among other things.

Byline also has a keystroke-capture utility, which you can use to produce boilerplate text, automate frequently performed operations, or integrate Byline operations with DOS batch files. Byline has a speed key that you can use to open a DOS window.

There is a limit to the size of the publications that Byline can handle, but this is difficult to specify. Maximum size is determined not only by the number of pages, but by the number and type of elements you include in the publication. Generally, you should have no problem with 100 pages or even more.

You can adjust both leading and kerning in Byline. Adjusting leading (the space between lines of text) is simple; you just change the numbers in a spec sheet. Changing kerning (the space between letters) is more complicated; you must edit a kerning table for the specific typeface in use, and you must adjust kerning one letter pair at a time, which is simple, but very tedious.

Flexible Page Construction

Byline is quite flexible in its approach to document construction. Using the layout specification menus, you can develop "master pages" that are basically style sheets for the document. Master pages control margins, column placement, and general page formatting. In addition, you can completely customize a page by creating text elements or photo elements. An element is an empty shape that you place on the page, using the arrow keys to drag a square to the desired position.

Once you determine the initial position for an element, you can change the size and shape by typing measurements (given in inches) into the chart of layout specifications at the left side of the screen. Each element has its own spec sheet, which defines the left, right, top, and bottom bounds of the element, number of columns, typeface and type size for headings and body text, vertical rules between columns, and solid borders for the element, if you want them.

You can change an element's size, shape, or other attributes at any time. Making many changes can be complicated, however; you may cause elements to overlap. Overlapping elements don't have any boundaries in the area where they intersect, so the minipage may be confusing to look at.

Fortunately, you can discard a messed-up page or file. Loading a new file erases the one displayed. You can enter text under a specified filename after assigning the filename to a page or element, or you can assign a file with already existing text to a page or element. If you assign an existing text file to an element, the text is poured into the element displayed on the minipage. The photo editor works similarly, inserting material from a graphics file into an element displayed on the minipage.

When you pour text or a graphics file into an element, it likely won't fit exactly on the first try. If the text fills more or less space than the element has reserved, you might need to resize or reshape the element. You can do this easily by changing parameters in the spec layout menu on the left side of the screen. If the text overflows the element, the surplus text is simply not displayed, unless you have assigned the same text file to several elements. In this case, the text fills the elements in turn.

One minor difficulty is that sometimes an element will not be large enough to accommodate both text and borders. You must keep a certain minimum distance between the edge of a border and the nearest text. If you make a long, skinny element with fat borders, for example, there might not be enough room in the middle for text to display, because the necessary empty spaces on the insides of the borders overlap. The program does not warn you when this occurs. The element shape and borders will display on the minipage and will print correctly, but no text will appear inside the element, even though the text file is correctly assigned. This is easily curable by expanding the size of the element or by reducing the size of the borders, but a novice user might easily wonder what on earth happened to the text in that element.

Adequate Text Editor

You can zoom the left side of the page so that the text file you are editing can fill the whole screen. The text editor is fairly simple, but adequate. It has standard cursor moves, including PageUp, PageDown, and word-by-word moves. The text editor includes character styles such as underlining, bold, italic, superscript, and subscript. However, you can't turn these styles on as you type. You must enter text, then define the block of text that you want to underline, embolden, and so forth, and select the appropriate style.

The text editor includes a cut-and-paste facility, a go-to-page capability, and a Find function, all of which are assigned to function keys. The program adds your changes to the right-hand pasted-up minipage. The package can cut or copy a block of text, photo, or what have you to a clipboard, where it will remain until you overwrite it with another one.

One of the nicest features of Byline is the connection between a text or graphics file on the left and the minipage on the right. The minipage layout reflects any editing changes you make to the source file as soon as you save the source file. This is something many bigger packages don't have. Ventura Publisher, for example, forces you to exit the desktop publisher entirely and load a text file into an external text editor or word processor for major editing changes (you can make small replacements and deletions inside Ventura). After editing, you then reenter the desktop publisher and reload the text file. In Byline, you can move back and forth from editor to layout with one or two keystrokes. Byline automatically updates a publication file whenever you change its source files, text, or photos. However, if you want to save a copy of a publication with an earlier version of source files, the Archive utility lets you do so.

The text editor can also directly import text files produced by several popular word processors: XyWrite II, III, and III Plus; WordPerfect 4.1 and 4.2; WordStar 3.3 and 4.0; and MultiMate 3.3, MultiMate Advantage, and MultiMate Advantage II. Naturally, you can use plain ASCII text files.

Photo Imports

In addition to the text editor, Byline has a photo editor. Analogous to the text editor, the photo editor occupies the left side of the screen when you define a photo element. The photo editor uses the arrow

continued

Byline 1.0

Type
Low-end desktop-publishing program

Company
Ashton-Tate
20101 Hamilton Ave.
Torrance, CA 90502
(203) 522-2116

Format
Five 5¼-inch floppy disks;
not copy-protected

Language
Assembly

Hardware Needed
IBM PC or compatible with two 360K-byte 5¼-inch floppy disk drives (or one floppy disk drive and a hard disk drive), 384K bytes of RAM, DOS 2.0 or higher, and a graphics display and adapter (e.g., CGA, EGA, Hercules, or Hercules Plus)

Documentation
307-page user's manual;
Customer Support Guide;
keyboard template; printer's sizing guide

Price
$295

Inquiry 901.

keys to crop an image to the desired dimensions.

Byline directly imports quite a few different graphics file formats, and it is not at all picky about filenames and extensions. It can directly use worksheet files from Lotus 1-2-3 versions 1A and 2.0; Symphony 1.0, 1.1, and 1.2; graphs from Lotus and Symphony (.PIC files); PC Paintbrush and PC Paintbrush Plus images; Publisher's Paintbrush images; MacPaint images; Fontasy Art folders; Windows Paint files; and high-resolution graphics saved in the BASICA BSAVE format. The program also imports .DBF and .NDX files created from dBASE III Plus. I tried Byline with Lotus 1-2-3 worksheet and graph files in the photo editor with no problem.

In addition to the standard graphics file formats, Byline imports images scanned by any scanner that produces images in the ZSoft (PC Paintbrush) format. Also, Byline's own camera utility, which takes snapshots of screens (such as Framework II pie charts and graphs) and stores them in a format Byline can use, can capture screens from any IBM PC graphics program. The camera utility is a terminate-and-stay-resident program, and it takes about 8K bytes of overhead.

A Few Limitations

Desktop-publishing packages, by their nature, tend to be slow, especially on an IBM PC. The constant screen rewriting required by layout edits even slows down packages running on 80386 machines. However, running as it does on an IBM PC or clone, Byline is really slow. Screen painting of a new minipage takes 3 to 7 seconds.

While Byline isn't in the same league with big desktop-publishing packages, you can't help making comparisons. Byline's most significant limitation is that it cannot do landscape orientation. Also, you can do portrait-orientation documents only on pages that are 8½ by 11 inches or smaller. Otherwise, limitations fall mostly in the realm of special effects; there is no reverse printing, solid-block printing, or special symbols available. Byline borders are limited to solid lines, and only solid-line vertical rules are available. You can achieve some special effects by nesting elements with different border specifications or creating grids using Byline's column grid feature, but this is not as simple or as varied as the selections from a Ventura menu.

Byline uses rectangular elements only. Though you can have multiple columns within elements, you can't have irregularly shaped elements. This means that you can't flow text with irregular margins or with dropped initial letters, or at least not without an unconscionable amount of trouble.

Byline includes only five available typefaces: Times, Courier, Bookman, Swiss, and dBASE Elite. This is adequate for most business and general-purpose documents, but far less than the type selection usable with bigger desktop-publishing packages. Typefaces in large packages are virtually unlimited, as software like Ventura Publisher and PageMaker can use downloadable software fonts. Byline can't.

Desktop Publishing for the Masses

On the plus side, the user's manual is very good, especially for the first release of a new product. The manual includes a tutorial, reference guide, glossary, and index, with a small "Other Information" section for advanced users. This section has instructions for such things as editing the kerning tables, as well as details on importing various kinds of text and graphics files. There are chapters on mail-merge, database publishing, and the archive utility.

I found the error trapping to be satisfactory. The program detected and warned me about an unready printer and an open drive door, and after I corrected the condition, it resumed execution properly. Few other error messages occurred while I was using the program, but all of them were adequate.

Technical support is classic Ashton-Tate; a labyrinth of telephone operators, but very well organized. The package comes with 90 days of free technical support, provided that you send in your registration card. The first call is free, regardless, but your registration card must be in before you can call again. After 90 days, you have to purchase one of the company's paid support plans. Some companies have policies like this but don't enforce them. Ashton-Tate does.

Basically, Byline is desktop publishing for the masses. You need not have expensive hardware or spend a lot for the software, either. The package is very friendly—thoughtfully laid out and easy to use. It's also very egalitarian in the kinds of files it will work with. However, it's not meant for highly sophisticated jobs that require lots of fancy special effects. One thing to bear in mind when comparing a package like this to bigger packages, such as PageMaker and Ventura Publisher, is that the average desktop-publishing user is generally going to use only about 70 percent of the features that a big package offers. If you can do without landscape orientation and special printing effects, Byline is an excellent value. ■

continued

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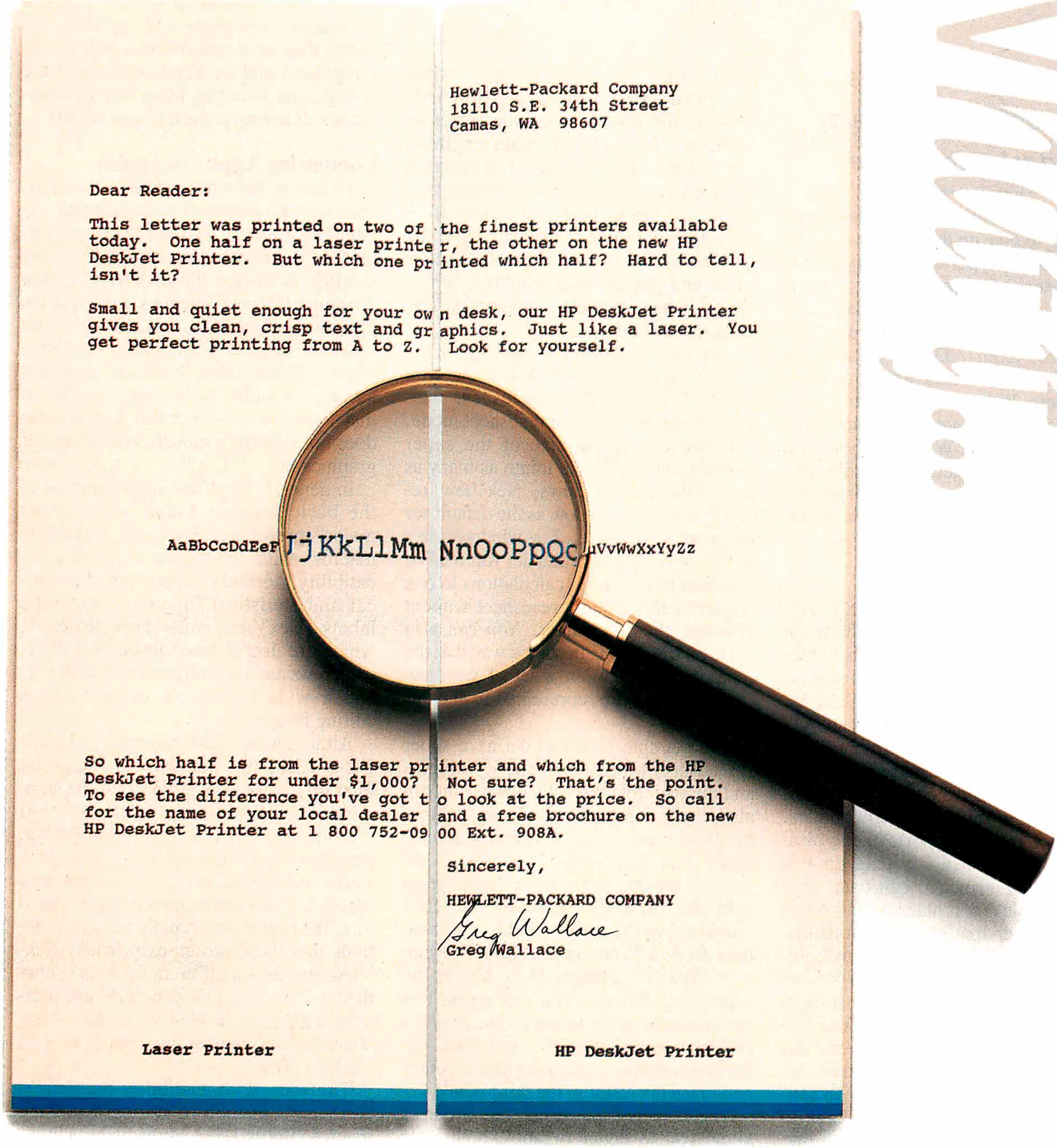
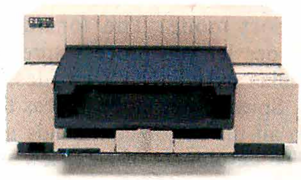


The New HP DeskJet Printer. Laser-Quality Output for Under $1000.



HEWLETT PACKARD

Circle 132 on Reader Service Card

A New-Wave Spreadsheet

Keith Weiskamp

NexView combines spreadsheet practicality and relational power

Just when it seemed that spreadsheets were going to give up the torch to the new technologies of hypertext or expert systems, the second wave hit. Now spreadsheets are smarter, faster, slicker, and easier to use. NexView, the relational spreadsheet from ADC & Associates ($595), is one of this new breed of spreadsheets. It supports relational attributes, a powerful concept inherited from database technology. With NexView, you can create spreadsheets and easily link them to each other using the product's built-in Distributed Spreadsheet Database System (DSDS).

The Essentials

NexView 1.1B runs on the IBM XT, AT, or compatibles with a hard disk drive, at least 512K bytes of RAM, and a monochrome or graphics display adapter. While I ran the program on an IBM PC XT, the company recommends an AT-class computer for best performance.

NexView is a mode-based program that includes spreadsheet, ready, auto, help, report, formula, and edit modes. Spreadsheet mode supports the typical Lotus 1-2-3-like menu system. In this mode, you can enter and edit data, read spreadsheet files, edit macros, and select any of the other modes and commands. Ready mode provides a powerful command-language interpreter that processes a variety of instructions, from customizing the screen to reading ASCII files into NexView's editor. Auto mode executes NexView commands stored in user-defined logic and macro files. You can activate a special help mode at any time to display pop-up help windows and on-line index cards. To generate custom reports on spreadsheet files, NexView provides a report mode. The formula and edit modes let you process spreadsheet formulas and edit NexView files.

Spreadsheet mode acts as the gateway to all the major commands and modes. The developers of NexView went out of their way to create an environment that looks like 1-2-3. Unfortunately, while the initial menu bars greatly resemble 1-2-3's, the results, after you select an item, are far different from anything Lotus does. You can select commands using a highlighted letter or function key. If you get stuck, help is available from anywhere within the program from the on-line manual or the on-line help index cards and pop-up help windows, which appear when you select commands that require data entry.

NexView introduces the concept of the "super spreadsheet," a device that you use to link multiple spreadsheet windows. Once inside the spreadsheet mode, you can define the size of the super spreadsheet and divide it into as many as nine different windows. NexView reserves the tenth window as the default for the super spreadsheet. The windows are a nice feature, because they let you read or edit data and perform calculations in one region of the super spreadsheet without affecting the other areas. You can also perform operations in such a way that the relationships between a set of windows (spreadsheets) are represented in another window.

For example, you can define a super spreadsheet with 20 rows and 60 columns and divide it into three windows. You can also dimension each window as 20 rows by 20 columns. Window 1 represents columns A to T, window 2 represents columns U to AN, and window 3 represents columns AM to BH. Now you can select window 2 as the active window and read data from a Lotus spreadsheet file into this window (columns U to AN in the super spreadsheet). You can repeat this operation using the second window and a different spreadsheet file and then add the two windows containing data together and place the result in the third window.

The concept is powerful. The windows allow you to better organize both your data and the types of calculations that you need to perform. Unfortunately, to really pull off these features, NexView needs an improved user interface. When working with the super spreadsheet, I found it difficult to keep track of which region was assigned to a given window. NexView lets you use a function key to toggle between a view of the window mapping of the super spreadsheet and the normal spreadsheet mode. I found that constantly flipping between views was a clumsy and confusing way to work.

Ready mode really expands the power and flexibility of NexView. It provides a command interpreter that allows you to perform operations such as reading ASCII files, executing a file of stored commands, searching and replacing selected data in a spreadsheet, setting the foreground and background color of the screen, and selecting other editing commands. It supports over 35 commands.

Comparing Apples to Apples

Let's face it, there are a lot of new spreadsheets on the market. The latest trend, established recently by the release of Borland's Quattro and Microsoft's Excel for the PC, is toward the modern interface sporting features such as high-quality presentation graphics, windows, context-sensitive help, and multiple fonts. NexView, on the other hand, is designed around an older technology similar to that found in 1-2-3 version 2. NexView does not support a mouse, PostScript, or graphics.

In general, NexView supports most of the basic features found in the other major spreadsheet packages, including macros, a limited degree of 1-2-3 compatibility, formula support, mathematical and statistical functions, symbolic labels (NexView calls these lexicons, which are user-defined labels that reference rows and columns in a spreadsheet), and a wide assortment of spreadsheet editing features.

Although NexView can read and write 1-2-3 files, it's not truly compatible. First off, it does not support all the standard mathematical functions that 1-2-3 provides. In fact, I discovered that NexView does not currently provide a square root function (`@SQRT`). If you're a real 1-2-3 or Quattro power user, you'll miss the useful set of mathematical functions that these programs provide. NexView also uses a different formula syntax than 1-2-3. In 1-2-3, functions are prefaced with `@`, as in `20 + @LOG(A2)`. NexView uses a syntax of the form `A,#1 = 20 + LOG(A,#2)`.

The second compatibility problem is NexView's method of storing and using macros. Lotus 1-2-3 stores macros in individual spreadsheet cells. NexView macros are actually stored in macro files. Because of this technique, you can use the same NexView macro on multiple spreadsheets. Unfortunately, it also means that you cannot use 1-2-3 macro files in NexView spreadsheets. You can use the macro-learn mode to create and

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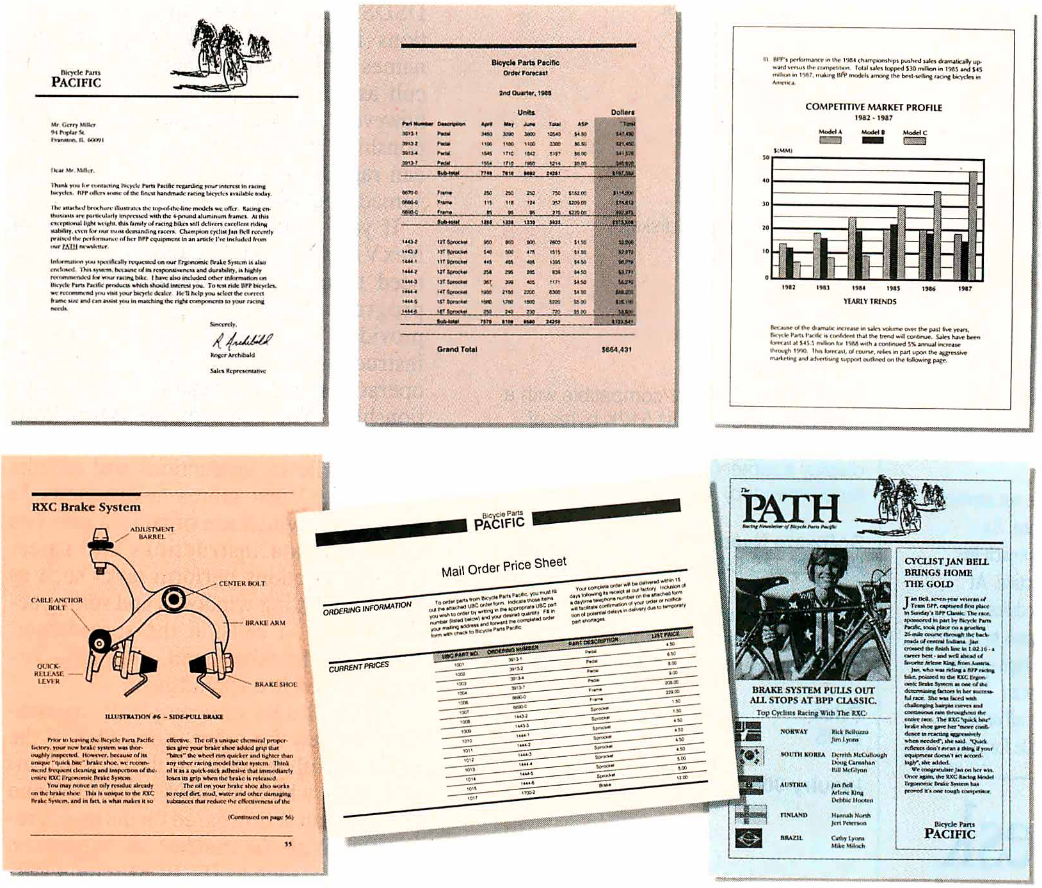

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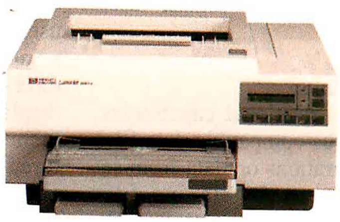

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NexView 1.1B

Type
Relational spreadsheet

Company
ADC & Associates Inc.
P.O. Box 273
Marlboro, NJ 07746
(201) 536-1524

Format
Four 5¼-inch floppy disks;
not copy-protected

Language
C

Hardware Needed
IBM PC XT, PC AT, or compatible with a hard disk drive, at least 512K bytes of RAM, and a monochrome or graphics display adapter (AT-class PC recommended)

Software Needed
PC-DOS/MS-DOS 2.0 or higher

Documentation
261-page Reference Manual; 100-page Beginners Guide

Price
$595

Inquiry 900.

test a set of macros for the current spreadsheet. You can also save these macros in a file of their own, independent of the spreadsheet you created them for. You can later use the macros with other spreadsheet files. Macros are easy to create and modify because of NexView's interactive macro-development environment.

Relational Features

With NexView's relational capabilities, you can link Lotus-compatible data files and perform operations on data from selected spreadsheets. By linking files using the DSDS, you can merge worksheet files, or you can piece together smaller spreadsheets to create a very large spreadsheet.

The DSDS provides its own menu, and you can access it from the spreadsheet mode, the formula command prompt, or a logic file. The DSDS maintains a master database file for each set of spreadsheets that you link. You can easily access this master file to obtain information about the linked spreadsheets, such as the number of linked spreadsheets, the range of the labels (lexicons) you used to link spreadsheets, and the ranges of the linked spreadsheet files. This feature helps you keep track of how spreadsheets are related to each other when you use the DSDS. Since you can specify all operations in the DSDS by using symbolic names, linking spreadsheets isn't as difficult as you might think. Keep in mind, however, that the complexity of the relationships stored in a super spreadsheet can rapidly increase as you start to link spreadsheet files.

If you want to take full advantage of NexView's linking capability, you'll need to master the BASIC-like custom programming language that NexView provides. The language contains over 40 instructions for performing mathematical operations and expressing logical relationships. You can type the instructions interactively in ready mode, or you can create a file of instructions and execute them. NexView stores instructions in logic files, which are organized into two sections: data instructions and rules. Data instructions perform tasks such as data I/O, setting windows, and setting access limits to cells in the spreadsheet. Rules, on the other hand, alter data currently stored in a spreadsheet.

Logic files let you completely customize NexView for other users. One of the more useful features is the `$INPUT` instruction, which displays a question and performs an action based on the user's response. With the conditional expression statements, such as IF, ELSE, and FOR, you also can easily test relationships between cells in a spreadsheet and execute additional instructions. Debugging help is important with a complex language such as this, and NexView lets you run a program in single-step mode where you can execute one instruction at a time and see the results of each operation.

NexView's report generator is another useful programmable feature. You can print reports that reflect the status of the data stored in a super spreadsheet, display reports on the screen, or save them in a disk file. To support this feature, NexView provides a set of instructions to specify the rules for generating reports. The program stores these instructions in line-oriented ASCII files, called report files, or in other files (e.g., logic files). Instructions define attributes for the report, such as the dimensions (width and number of lines per page), the titles for rows and columns, and the ranges to specify the number of columns and rows to include in a report.

Ease of Use

The basic spreadsheet data-entry and editing commands are relatively easy to

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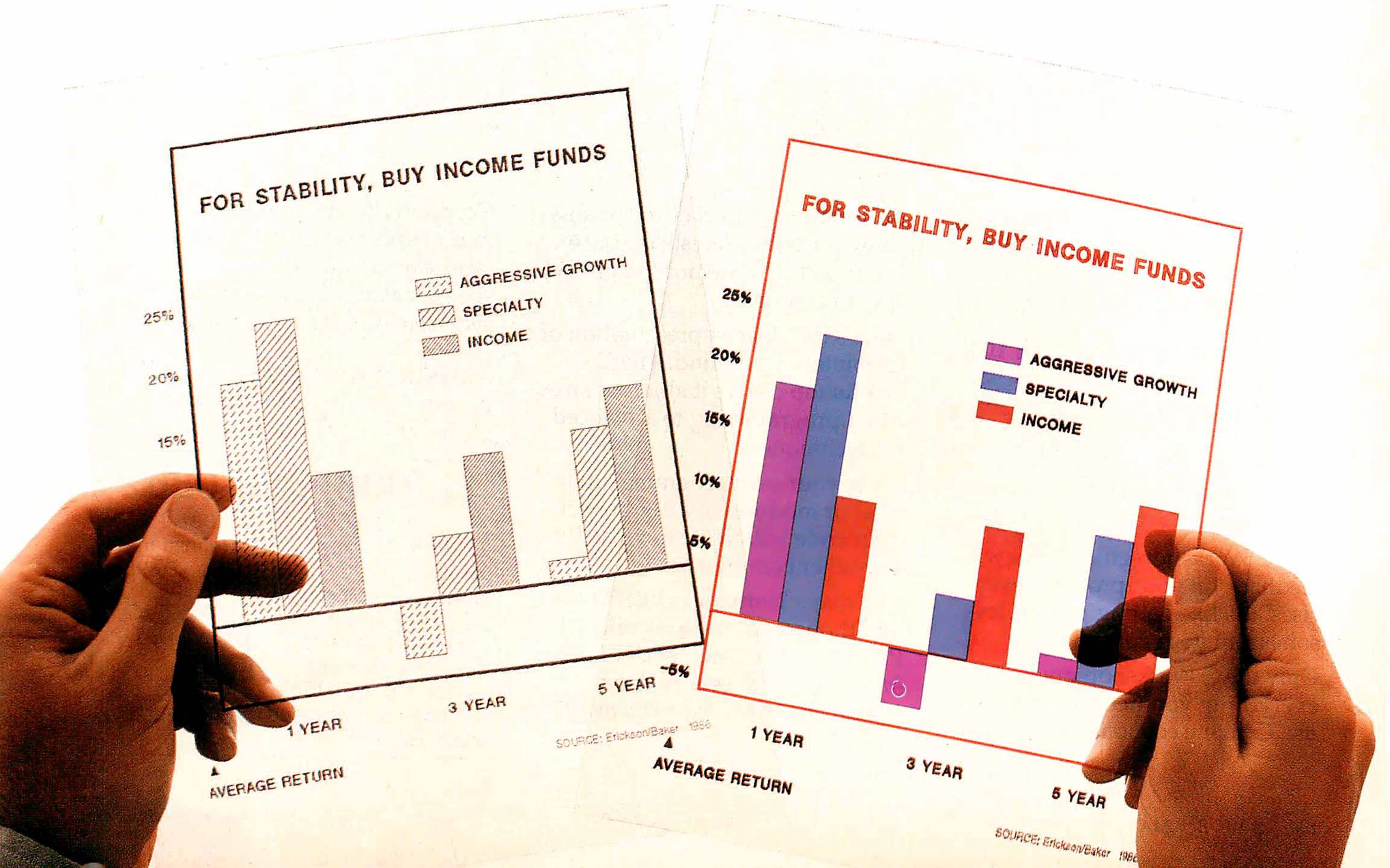

perform, especially if you're familiar with 1-2-3. Menus at the top or bottom of the screen list all the basic editing commands. NexView reserves the menu at the top of the screen for listing commands for calculating formulas, editing and running macros, altering the dimensions of the super spreadsheet, and loading and saving files. You can select any of these commands by entering a single letter. The bottom menu is reserved for the function key operations. NexView uses the function keys to perform tasks such as activating the command mode, setting the current window, and calling the on-line help system. In addition, NexView uses the function keys and control key combinations as command shortcuts.

You can easily customize NexView by setting help levels and selecting the foreground and background colors of the spreadsheet mode screen. When you first use the program, I recommend that you set the help level to the basic level, which causes pop-up help windows to be displayed whenever NexView expects a response. The information displayed in the help windows is useful and in most cases saves you from having to use the manual.

In general, the documentation is well written and easy to use. The product includes an eight-part Beginner's Guide and a Reference Manual, all packaged in a small three-ring binder. The Beginner's Guide starts with the basics on how to use the program and then covers most of the major topics of NexView, including loading 1-2-3 files, working with the super spreadsheet and windows, moving around menus, creating formulas, creating and editing macros, and using the basic spreadsheet entry and editing commands. Unfortunately, the tutorial text does not provide any useful information on some of the more interesting and powerful features of NexView, such as the DSDS, the reporting features, and the logic programming commands.

The Reference Manual suffers from the same problems of organization and indexing found in many reference manuals. I discovered that some of the basic mathematical functions, such as log, were not documented in the manual. Because of this, it is difficult to determine which functions the program supports. In fact, I had to call ADC's technical-support office to find out if NexView supports the standard functions found in 1-2-3. The coverage of macros is also very brief; the manual devotes only nine pages to this topic. Fortunately, the Beginner's Guide presents a fairly complete tutorial on how to create, edit, and use macros. NexView contains a wide assortment of powerful commands and features, but I found it difficult to extract the needed information out of the Reference Manual in order to use these features and commands.

NexView does provide an on-line manual with a search feature. You can select the manual by pressing the F8 key from the main menu in the spreadsheet mode. Once you activate the on-line manual, you can select a topic using the cursor keys, or you can use the built-in search feature to locate a topic. If you use the search feature, be patient because it responds agonizingly slowly. I searched for the topic "help" and it took NexView over 3 minutes to search the manual file. NexView provides a utility program that lets you customize the on-line help system. You can use a standard word processor to add, remove, or modify text in the on-line help file and then run the utility program to index the file for NexView.

Performance Trade-Offs

I reviewed NexView on an IBM PC XT with a 10-megabyte hard disk drive and no coprocessor. Since NexView does not

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provide arctangent or natural log (ln) functions, I was unable to run the Savage benchmark, which is based on the following formula:

```
tan(arctan(exp(ln(sqrt
 ((PREV_CELL)^2)))))+1
```

When I entered this formula in NexView's formula mode, the program locked up the computer. I was, however, able to run the Recalc benchmark for both 1-2-3 and NexView.

To run the Recalc test in 1-2-3, you copy a formula created with relative addressing to each spreadsheet cell. When you place a value in the first cell, the complete spreadsheet automatically recalculates. This process took 9½ seconds.

When I ran the benchmark on NexView, it was not as easy. To begin with, the program does not provide a mechanism for easily assigning formulas to spreadsheet cells. In order to run the benchmark, I had to use NexView's logic programming language. The second problem occurred because I had difficulty with one of the logic statements. NexView provides a REPEAT instruction for duplicating a task or set of tasks; however, this instruction did not always function consistently. The operation that failed was

```
B,#1 = (A,#1) * 1.001 REPEAT 99
```

This statement instructs the program to multiply the contents of cell (A,1) by 1.001, place the results in (B,1), and repeat the operation for each column in the first row. Each time the program repeats the instruction, the column index is automatically incremented. Unfortunately, this statement would not always repeat the specified number of times. A call to the technical-support group at ADC revealed that the REPEAT instruction has a serious bug. A spokesman for ADC said any users experiencing this bug should call the company for information on a free update.

I discovered an alternative approach for performing the benchmark by using an instruction called GROWTH, which increases a cell value by a specified percentage. In order to use this instruction to perform the Recalc operation for each row in the spreadsheet, I had to write a program that included 25 GROWTH instructions. Using this logic file, NexView required 35 seconds to perform the Recalc benchmark.

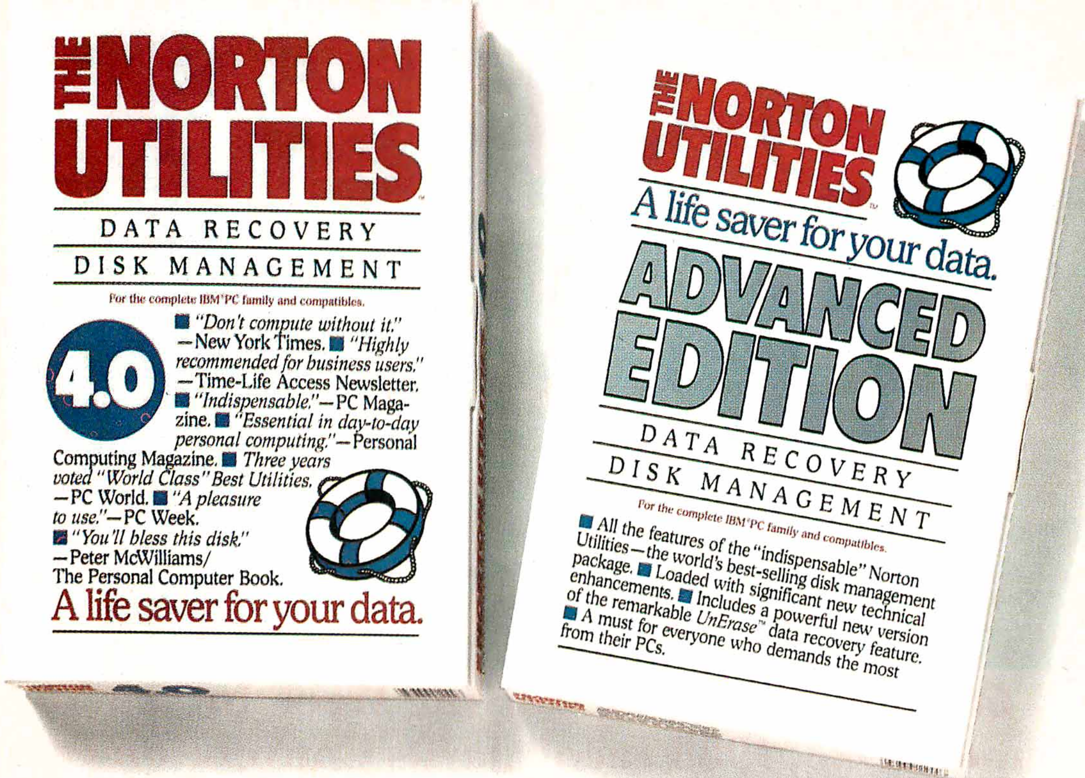
In the Scroll Right benchmark, where the display scrolls from the first column of the spreadsheet to the last, NexView beat 1-2-3, taking 1 minute and 12 seconds, compared to 1-2-3's 3 minutes and 10 seconds.

Not for Beginners

NexView is not a program designed for beginning spreadsheet users. The complexity of the program make it difficult to use at times. Although it contains a menu system similar to 1-2-3 and provides a complete on-line manual, many of the features and commands differ significantly from those of 1-2-3. If you're looking only for a program that has true 1-2-3 compatibility and supports graphics, NexView might not meet your needs.

However, if you're looking for an analysis tool that has the capability of linking spreadsheets and producing detailed reports, you'll appreciate NexView's advanced features. NexView offers many state-of-the-art spreadsheet processing capabilities, but you'll need to put on your programmer's hat in order to take advantage of its real power. ■

Keith Weiskamp is the editor of PC AI *magazine and a freelance writer living in Phoenix, Arizona.*



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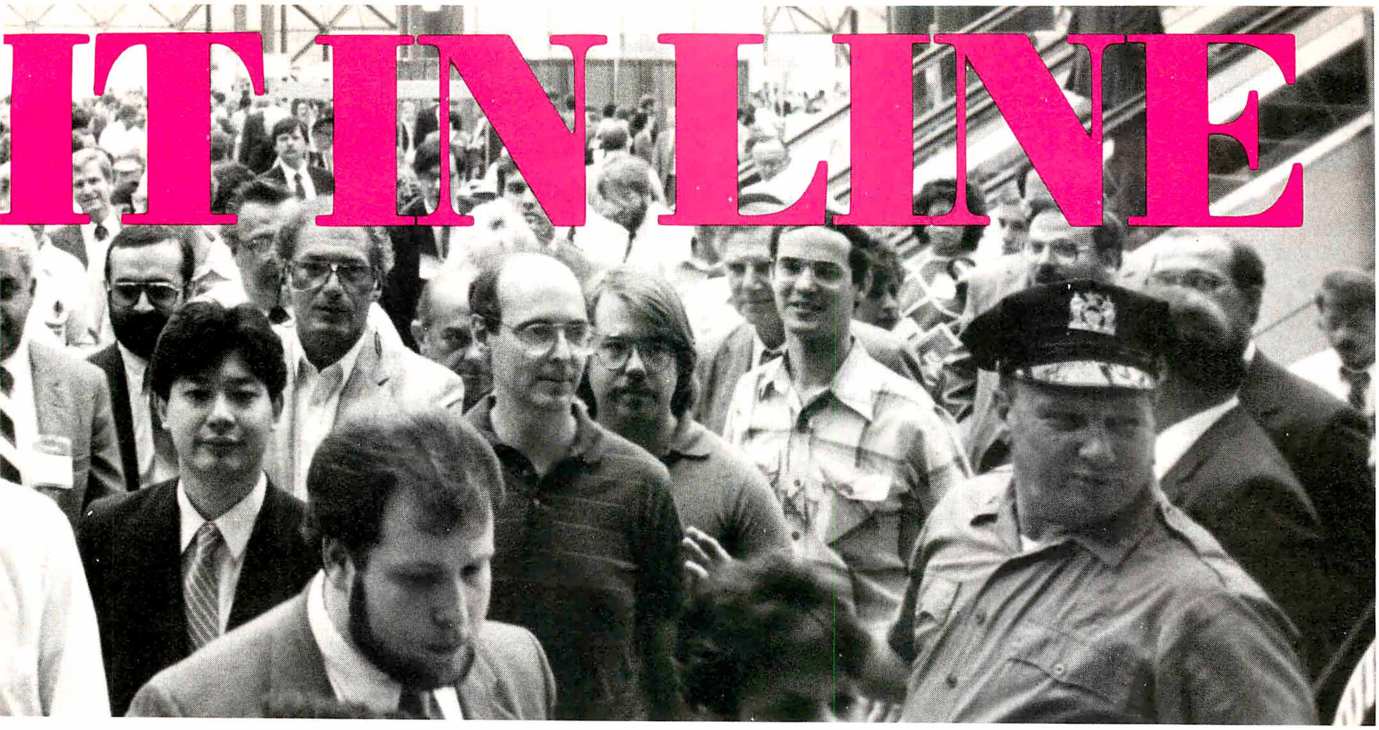

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80386 and Beyond
Distributed Database Management Systems*
Modern Clones and the Corporate Marketplace
Legal Issues in the Technology Field
Costs and Benefits of Microcomputers

Wednesday, June 22

Dealing with the Inevitable: Departmental Systems
The Macintosh in the Corporate Environment*
Artificial Intelligence/Expert Systems
Softline: Candid Comments from Industry Leaders
Network Management: Keeping Your Network Running*
Desktop Publishing — What Corporations are Doing
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Vendor Quotas: Their Impact on Resellers and End Users
The Backbone's Connected to the....TCP/IP and Other Protocols*
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LANs — User Views*
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Latest Developments in Spreadsheet Software

Thursday, June 23

How to Grow your Net*
Executive Information Systems
The Changing Concept of an Information Center
Workgroup Computing*
New Lives for Old — What to do with Out-dated Equipment
Micro-to-Mini Connections*
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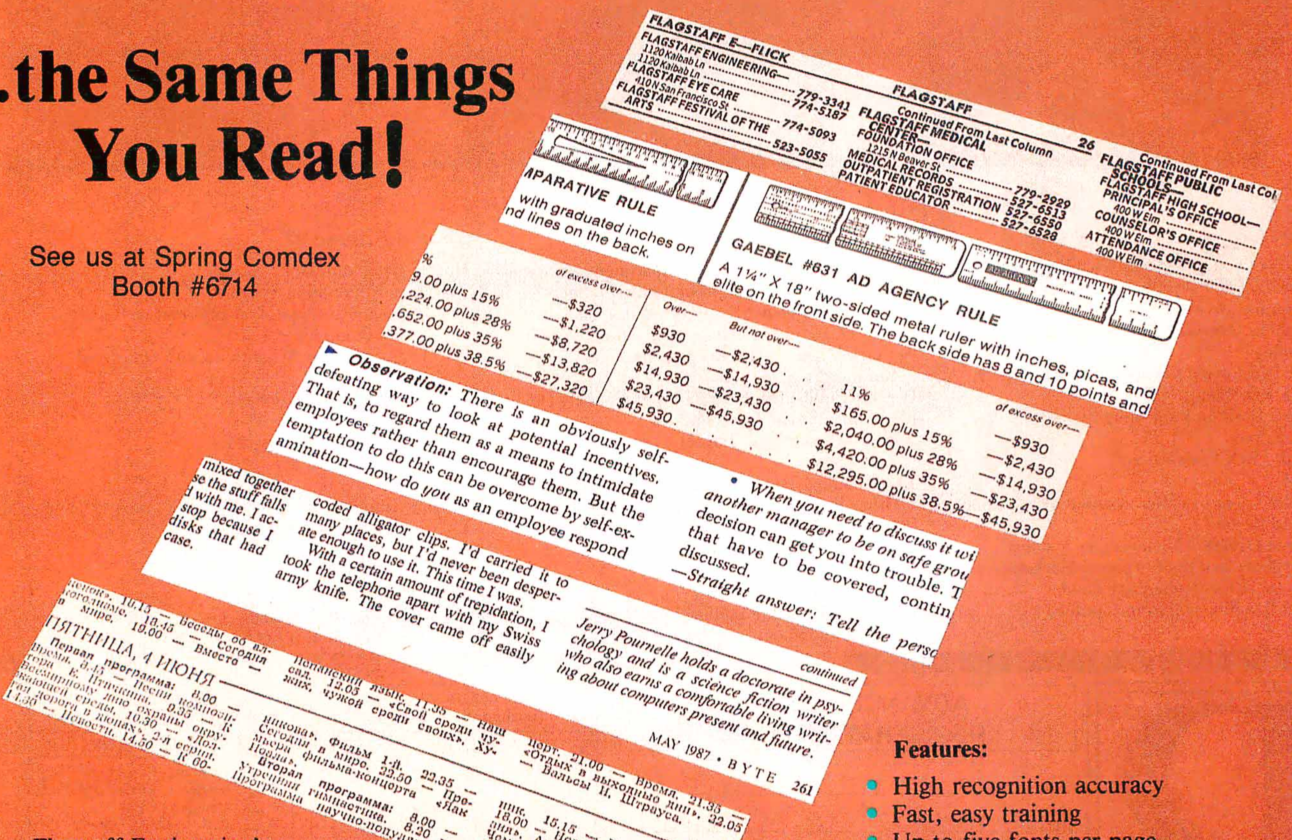

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Shifting into High Gear

Jerry Pournelle

Installing a USRobotics Courier HST modem lets Jerry move into the future

This is going to be one of those columns. It's Friday night, the absolute drop-dead deadline is Monday morning, and I don't have a lead item.

I'd intended to write about changing over from Fast Kat the Kaypro 386 to the new Zenith Z-386. Before you ask, no, there's nothing wrong with Fast Kat, and I have no hesitation in recommending Kaypro equipment. Fast Kat has served me well, what with his math chip (80287 and adapter), big (44-megabyte) Priam hard disk drive, and 2 megabytes of Kaypro 32-bit memory plus another 2 megabytes of Cheetah 16-bit memory. I've used him *hard* for nearly a year, with never a glitch.

However, Fast Kat isn't Kaypro's latest 640K-byte backplane 386; he's an early model you can't buy anymore, based on the Intel 540K-byte motherboard, and requires software kludges to bring him up to 640K bytes of memory.

That hasn't been a problem so far; DESQview and its companion—Quarterdeck's Expanded Memory Manager 386 (QEMM)—work wonderfully well with Fast Kat. However, I am about to do experiments with alternative operating systems, particularly Xenix and VM/386, and those are said to work a lot better in systems that have hard-wired 640K bytes. I want to compare them to DESQview.

Unfortunately, although I've had the Z-386 for some time, I don't have any extra memory for it. Zenith has been selling 4-megabyte 32-bit memory boards as fast as they can make them—Larry Niven had to wait 2 weeks to buy one for his Z-386—so they haven't had too many to ship to reviewers. However, when I called earlier this week, they said they'd have one to me by Thursday; when it didn't come yesterday, I put off the column, expecting the board to arrive today. Alas.

I could have stuffed the Zenith with Cheetah 16-bit memory boards, but that didn't seem quite fair to Xenix and VM/386. The boards would work, but 16-bit memory is slower than 32-bit memory, so I'd have it to do all over again when the new Zenith board comes; best to put the whole thing off until next week.

One plans for this sort of thing, and I thought I had another possible lead: I've had a write once, read many (WORM) drive from Information Storage sitting next to the Z-386's cabinet for over a week, and I figured that would do. Alas, when I uncrated the WORM drive, I discovered that they had neglected to send me the disk controller card for it. I'll call them Monday; but by then this column's got to be on the wire.

Of course, there's no shortage of stuff to write about, and, indeed, I have a whole bunch of items lying about.

Modem Problems

I have been using OmniTel internal modems in my IBM PCompatible machines for a couple of years now. They work quite well. We've used several of them, and the one time we had any trouble with one, Alex got it taken care of under the warranty without ever mentioning me or the column.

I always preferred internal modems because they are easy to install and don't take up any extra room on my desk or computer stand. You can address them (at least the OmniTel modems I've used) to any port from 1 to 4. I preferred to set mine at port 3; that way, there's no interference with the mouse and, more important, with Traveling Software's LapLink and DeskLink (more on them in a bit) communications programs, which want port 1.

Thus, when I began the changeover from CP/M-compatible to IBM PCompatible machines, I needed a communications program that could use a modem at port 3. Mycroft Labs' MITE—which I'd happily used on my CP/M systems—could address only ports 1 and 2. That's changed now; but before they came up with a version that could use port 3, I got used to Crosstalk and was always too busy to change back to MITE.

Then I added Borland's SideKick to my system. SideKick is wonderful—I still use it, and I can't imagine doing without it—but I found that the blankety-blank SideKick dialer recognizes only ports 1 and 2! I could just as well have stuck with MITE.

Anyway, for a long time that was my communications system: an OmniTel 300-/1200-baud modem, later OmniTel's 300-/1200-/2400-baud internal modem card, addressed to port 2; Crosstalk; and SideKick to keep track of phone numbers and dial the phone for me.

I had a number of annoying experiences with Crosstalk. Most of them were caused by inadequate documentation (or insufficient spelunking in the documents on my part). For example, when I loaded a Crosstalk file, the program insisted on dialing the number even when I didn't want it to, and then it wanted to redial periodically until I told it not to do that.

Thus, it could take quite a while just to call in a Crosstalk file and change something. I wrote about that problem several times, and although I always got some kind of response from Microstuf (now known as Crosstalk Communications), no one from there ever told me the secret of how to stop it.

Finally, a reader did: when you create a Crosstalk file using their setup program, the program saves the result in a file with the extension `.XTK` and automatically adds a command line that looks something like `GO /45`. That command tells Crosstalk to dial the number and then redial at 45-second intervals.

Since the `.XTK` file contains a *lot* of command lines, most of them needed and

continued

The real reason I've always preferred internal modems is that I don't understand the RS-232C connector system.

few explained, it's easy to miss that GO command. But if you eliminate that line (it helps to have a good programming editor, such as Brief or Logitech's Point), Crosstalk waits for you to tell it to dial.

Incidentally, another reader told me how to handle another problem I had. When I told Crosstalk to GO LOCAL, it still wouldn't connect, even though I could hear the carrier tone on the other end. If you do GO LOCO <enter>, the program is ready to send commands directly to the modem. If you have a Hayes-compatible modem, typing ATO <enter> will actually make the system listen to the modem; meaning that you can do GO LOCO, ATO, and manually dial the number. When the carrier comes on, you'll be connected.

With those two tricks, Crosstalk is considerably more docile than it used to be and is now fairly satisfactory. I'm told by people I respect that Procomm 2.4.2 is at least as good; but I'm used to Crosstalk, it uploads to BIX very well, and I've had no trouble using the capture facility for downloading. Better is the enemy of good enough. Right now, Crosstalk seems to be good enough.

Hang-Ups

Even so, I had problems. Sometimes I would try to connect to BIX, and my local Tymnet number would be busy. I'd issue the Crosstalk command BYE—and even QUIT—to exit the Crosstalk program and close its DESQview window, but the modem still wouldn't hang up. I could no longer hear the busy signal on the modem; but if I lifted the telephone receiver, it was still there.

I could then yank the phone connection so that the modem was no longer connected to the phone line; that would let the phone hang up. But if I reconnected the modem, it wasn't cleared; it still thought it was connected, and so did Crosstalk. The only way to fix the problem was to turn the modem off—and with an internal modem, that means turning the computer off.

For me, that's a big deal: I work in DESQview, and I generally have the Logitech Mouse with Plus Software and Microsoft Bookshelf in main memory. Also, I have SideKick, Ready!, Q&A Write with WordFinder, and probably something else each in separate windows, and I may have another job going as well. It takes *time* to reload all those programs and reconfigure the system. I don't *want* to turn off the machine.

So, thought I, the remedy is obvious: I'll put in an external modem. That way, if I have hang-up problems, I can reach back and turn off just the modem, not the whole computer.

It was about time, anyway. I've had a USRobotics Courier HST since December, and it has capability for 9600 baud. I also have a list of 9600-baud bulletin boards thoughtfully provided by US-Robotics. I'd intended to hook up the Courier HST with the Z-386 anyway; why not now?

An external modem has three problems you won't face with an internal modem. First, you have to find a place to put it. The Courier HST is 13 inches deep, 8 inches wide, and about an inch and a half tall. It has vents on top, meaning that you probably don't want to cover it with papers that block the airflow.

It will sit nicely on top of a computer, or you can Velcro it to the side of your monitor, or you can do what I did. I got a little low-height rolling stand (originally designed for a big TV, I think) and put that under the desk, consolidating the computer itself, modem, Amdek CD-ROM drive, telephone answering machine, and other auxiliary equipment into one place; but it's going to take up space no matter what you do.

The second problem is trivial. Unlike an internal modem, you have to supply an external modem with power, meaning another gizmo to plug into the wall, and yet another cable to lead through the snakes' nest to your computer.

The third problem is horrible.

Table 1: *The RS-232C connections in my cable. These connections are for a female DB-9 to a male DB-25. All I know is that it worked for me. I don't attempt to explain this.*

9-pin (DB-9)		25-pin (DB-25)
1	is connected to	8
2		3
3		2
4		20
5		7
6		6
7		4
8		5
9		22

Cables

The real reason I've always preferred internal modems is that I don't understand the RS-232C connector system. Now, sure, I've read books on it, and one reader kindly supplied me with a videotape, but the fact is I forget that stuff about as fast as I learn it. I have some evidence that I am not terminally stupid; but for the life of me, I *cannot* remember the difference between DTE and DCE and why DTR is important and all the rest of it. Pity, but there it is.

However, one afternoon I got three busy signals in an hour, meaning that I had to turn off Fast Kat three different times, and enough was enough. Cables or no cables, it was time.

Fast Kat, like all IBM PC AT compatibles, has a 9-pin male connector for his serial port. The Courier HST modem has a 25-pin female connector. The US-Robotics documents have a lot about which of those 25 pins connect to what; but there's not word one about what comes out of a 9-pin male connector. Now what?

The Logitech Serial Mouse terminates in a 9-pin female connector so that you can connect it to an AT's serial port. They also provide, for people with PCs and XTs, a small gizmo with a 9-pin male connector on one end and a 25-pin female connector on the other end. Nothing is said about the internal mapping of those connections, but it works; we've used one to connect a 9-pin LogiMouse to Lucy Van Pelt, our ancient genuine IBM PC. I tried using that with a straight-through 9-pin-female-to-9-pin-female extension cable. Of course, that required a 25-pin gender-change connector, but I have those.

It made a weird lash-up, and when I got it connected, nothing happened. The modem wouldn't work. Then I tried putting a 25-pin connector thing that called itself a "null modem connector" in the lash-up. That didn't work either.

Then I remembered the LapLink cables: four-headed monsters with both 9- and 25-pin connectors on each end, designed to link ATs with XTs. It took a sex changer to connect one, and then it didn't work. Putting the null modem connector into the loop didn't help.

Clearly, it was time for a breakout box—only someone had lifted my wonderful little Hall-Comsec Wiretap gadget. Now what?

I must live right. In desperation, I rooted around in the cable closet—a horrible place infested with monsters—and eventually discovered a cable that had a 9-pin female connector on one end and a 25-pin male connector on the other end. I

continued

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have no idea where it came from, but it had the sexes right, so I tried it.

Voilà. Worked first time. What with my having tamed Crosstalk, I didn't even have any trouble altering my Crosstalk files to look for the modem at port 1. Everything went swimmingly. Later, I traced that cable's connections; they're listed in table 1, and they sure aren't intuitive. I don't have the foggiest notion of which connections are critical; I can say that a cable like that will connect a USRobotics Courier HST modem to an IBM PC AT clone.

Once I had the proper cable, it was smooth sailing. I did have some problems with hanging up, but that turned out to be one of the little DIP switches on the back of the modem. USRobotics, bless them, prints nearly the entire manual on the bottom of the modem; using what's printed there you can, if you know what you're doing, set up the modem perfectly. I didn't know what I was doing, but fortunately Brett Glass ("glass" on BIX) knows more than I ever will, and from my reports of symptoms, he was able to tell me how to change my DIP-switch settings.

The result is that I've been using the Courier HST for 2 weeks now, and it's wonderful. It may just be coincidence, but there seems to be less line noise now; and when there is line noise, it seems to be handled in a more comprehensible manner than the OmniTel modems used to do it. I've used the Courier HST at 1200, 2400, and 9600 baud; at 9600 baud on long-distance lines I've sometimes been blown off, but not too often, and it's sure the way to go if you want to transfer big files like this column.

The really odd part is that I went to an external modem so I could handle busy signals by turning the modem off; but since I got the Courier HST connected up properly, it has been able to handle them itself. The Crosstalk `BYE` command works fine with this modem.

I'm now rethinking my position regarding internal and external modems. An internal modem certainly has less clutter and fewer cables. I thought it would be more convenient when I had to connect two machines serial to serial, but that turns out not to be the case. If I need to get at Fast Kat's serial port, it's not much more trouble to unplug the modem than it is to plug in the cable to link him to another machine. An external modem really shines if you temporarily need one on another machine; and, of course, it doesn't take up a slot in the computer.

The USRobotics Courier HST comes with *very* complete documentation, including a satisfactory but not remarkable index and table of contents; as I've said, you could pretty well connect it up with just the information stenciled on the Courier's bottom. And if there's anything you really need to know (other than how to connect it to a 9-pin system when you don't understand RS-232C), it's in the book somewhere. The box is rugged; I've managed to drop it on the floor half a dozen times, and that hasn't harmed it yet. There are plenty of winking red lights to show that you're connected.

I can think of two improvements. I wish, first, that they'd put the vents on the side, since the temptation to put stuff on top of the modem is nearly irresistible; and second, that they'd put the switch on the front of the box. If I have to turn it off, it's not too easy to reach around behind it.

Those are minor complaints. The fact is, 9600 baud is the wave of the future—more on that another time—and the Courier HST is an elegant little gadget. Recommended.

Live and Learn

Just after I finished writing this, Federal Express brought the galleys of *The*

continued

The Modem Book has just about everything you need to know about modems and communications.

Modem Book by Michael Banks (Brady Books/Simon & Schuster). Banks has put together just about everything you need to know about modems and communications (as of late 1987). There are chapters on information services (like CompuServe and BIX), hardware, software, and on-line databases. Also, in an appendix, Banks covers cables. If I'd had this book, I could probably have saved myself considerable trouble.

It's the best reference work on small computer communications I know of. It also reads well enough to serve as a pretty good introduction. If you've been thinking of getting into modem communications, get this book first. I definitely recommend it.

Incidentally, the reason I'm getting this book is that I told Banks that if I liked it I'd do a short preface. I do, and I will. I'm getting paid, too: Banks owes me a drink at the next convention. I may even make him buy me a double.

Sundial

If your problem is that you have to bill your time to any one of a bunch of clients, and you spend a lot of your time on the phone, and you don't like having to clock yourself, I have a solution.

Sundial is not a communications program, although it wouldn't be too hard to make it one. It needs a modem, but that's just so it can dial the phone for you.

What Sundial can do is keep track of your telephone calls: time them, bill the time to the proper account, and generate reports. It also lets you organize your notes and thoughts and keep track of those by client, phone call, or both.

It works this way. If you call out, you tell Sundial to whom the call should be billed. You then let Sundial dial the number and use the program's built-in editor to make notes. If you don't have a modem, you can dial the call yourself and Sundial will still do its thing.

Incoming calls are handled in much the same way: you tell Sundial which account the call should be billed to, and it does the rest. If you want to review notes of previous phone conversations, store or retrieve data about the caller, and suchlike, that's easy enough, too.

Sundial doesn't look like a very sophisticated program, although I understand it employs some pretty clever programming devices to make it look so simple. Written in Turbo Pascal, it's memory-resident and eats about 160K bytes plus whatever workspace you set aside (a stand-alone nonresident version is available as an option, but, of course, it can't automatically handle incoming calls).

It doesn't use the Lotus/Intel/Microsoft Expanded Memory Specification 4.0. Sundial's programmers are studying ways to do that. Since Sundial is an overlayed terminate-and-stay-resident program, this isn't simple.

On the other hand, if you're a lawyer, a consulting engineer, or in any business that requires you to keep track of your time and bill it to particular accounts, Sundial can be a lifesaver. It eats too much memory, but it does leave a 640K-byte system enough memory to run WordStar or to access an on-line data-

continued

base. It works with most private-branch-exchange systems. There are rival programs, but I haven't seen any I find preferable.

All in all, Sundial is one of those things most readers won't need, but those who do need it need it a lot.

HyperDialer

Sundial wants a modem to dial your phone for you. Surely there's a better way?

There is, if you have a Macintosh. DataDesk, the people who brought keyboards up to a high standard, have a new gadget: HyperDialer.

HyperDialer is about halfway in size between a box of pocket matches and a box of kitchen matches. It has two lines and can attach to the side of your Macintosh or to your telephone. One line goes into the Mac's speaker port; the other connects to your telephone.

Once that installation is made, the Mac can make phone calls for you; unsurprisingly, you access it through HyperCard programs. If you're a Mac and HyperCard user, you probably don't want to be without this or something like it. While you're ordering HyperDialer, also get a DataDesk Turbo-101 keyboard for your Macintosh; it's sure better than the one Apple furnishes.

Business Class

If all the hype about HyperCard were laid end to end, it would probably circle the earth; but, in fact, much of it is deserved. HyperCard really is a bright new idea, easy to use and very powerful. I don't suppose there's anyone left who doesn't know what HyperCard is, but just in case, it's a Macintosh programming system that organizes data and activities around logical "card stacks." A card can contain text, phone numbers, maps and graphics, or even instructions telling the computer to play music.

The key concept of HyperCard is that cards can also contain "buttons": areas on the card that, when clicked on with the mouse, transfer you to other cards containing more data and still more buttons. What's really neat is that it's not just a static "product"; HyperCard is more like a language that anyone can use to create new concepts in computer information service.

Activision's Business Class, written by Danny Goodman, is an early example of what HyperCard can do. Business Class is, at bottom, a travel-information database that contains the same information a small atlas would. The novelty is in the way you use the program.

The first time you use Business Class, you answer some questions about time zones and your local currency. When you've done that, a world map appears, bright in the areas currently in sunlight, dim elsewhere. Click on a country, and Business Class zooms in on its region. Click again, and it selects the country.

Meanwhile, across the bottom of the screen is a series of icon buttons: a folded envelope to indicate post office information, an interracial handshake to indicate "local customs," a picture of a wall outlet to indicate electrical power systems, and so on. Click on one of those, and you get information about the country you're currently looking at.

The electrical button, for example, will tell you the voltage and frequency used in the selected country and show you a picture of the favored electrical plugs. Click on the time button (a clock, naturally), and you'll be told not only the time difference, but what time it is in the selected country *right now* (assuming that your Mac knows what *your* local time really is).

You can get information on visa requirements, weather, local travel, cur-

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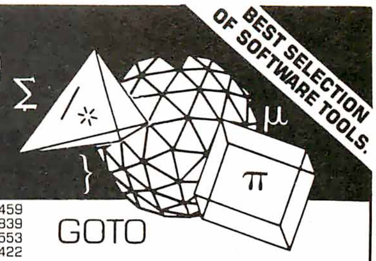

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Business Class is an intriguing program, and it makes me anxious to see other HyperCard products.

rency exchange rates, and a whole bunch of other stuff. It's a lot of fun to browse through the world, finding out the names of currencies and what kind of electrical power they use.

There's also a telephone button. Click on this, and you'll be told how to dial the particular country—and there are places to add local phone numbers that you can have the machine dial for you.

That's the good news.

The bad news is that there's no information at all on a number of countries, and what Business Class does give you is pretty sparse compared to what's in even the cheapest guidebooks. The maps aren't much use either; they show only the capital and maybe one or two other large cities. No terrain features, no roads or railroads; just a political-boundaries outline.

Even worse: given the success Washington has had in overcoming the "too strong" dollar, much of the information in Business Class is already obsolete, and much more will be shortly. Experienced hackers could get in and make changes, but there's no real provision for user edits of the database; so even if you find new information on currency exchange rates in the *Wall Street Journal*, you can't make corrections.

In other words, Business Class is easy to learn and use, and fun to browse through; but if you want to plan a real trip, you'll probably still have to buy maps and guidebooks and keep notes on changing conditions. As an example, an Itinerary Planner lets you print out dates, hotels and their phone numbers, flight information, and all the background and currency information in loose-leaf format. This is a great idea, but you'll still have to check most of that data to be sure it's not obsolete.

Business Class is intriguing, and it makes me anxious to see other HyperCard products. Imagine this program with a simple editor interface that would let you update the background data and add your own; then give it a provision to let you enter your trip expenses and get out a travel expense report. None of this would be very difficult.

I can think of lots of things you can do with HyperCard programs; but I do wonder if they'll all suffer from lack of sufficient depth. HyperCard lets you build a lovely database, but it eats memory and disk storage space. Business Class, for example, fills two floppy disks and still has only 300 words per country on "local customs." The entry for Saudi Arabia doesn't even mention their fanatical laws regarding alcohol. (Foreigners living in Riyadh often have walk-in vaults in their homes; this isn't where they keep their money, but their scotch.)

Where HyperCard—or something like it—would really shine would be in managing the enormous floods of data that will be available on CD-ROMs. I can imagine a program updated quarterly that had encyclopedic data on countries, cities, and even individual firms. It would need a provision for electronic data files to update really volatile information, but that shouldn't be too hard to manage.

HyperCard is one of the Mac's main weapons in the battle with IBM PCompatibles. It's too bad the new CD-ROM reader Apple announced costs more than a complete Atari Mega ST *with* a CD-ROM reader, but overpricing to skim early cream is pretty traditional with Apple.

Physics and Geometry

The success of Apple's Macintosh rests partly on myth (its graphics don't really have any higher resolution than other monochrome PCs), partly on enthusiasm transmitted by Apple II users, and partly on solid achievement.

The major achievement has been ease of learning; people with no computer background at all are often able to sit down and use the Macintosh with little assistance or training. This gives the machine a strong boost as a possible tool for education.

Case in point: two programs, Physics and Geometry, by Sensei and published by Broderbund Software. Both are high-school-level tutorials I sure wish I'd had when I was studying the subjects. You don't have to know much about the Mac to use them; the interface is sufficiently intuitive that 5 minutes of mucking about will let you use the programs without ever opening the manual.

Alas, I suppose because the manual isn't needed, these programs are copy-protected with the key-disk scheme. It's worse than that. I couldn't even get Geometry to work from its own disks on my Mac Plus; if I booted with the Broderbund disk, the Mac Plus kept insisting that their disk 1 wasn't a Macintosh disk and kept offering to format it. I solved the problem by copying both disks to the AST 2000 hard disk drive—I'm really fond of that thing—and running from that, inserting the key disk (which happens to be disk 2, the one without a system track) when asked. This all seems a bit complicated.

At the same time, I understand that schools are among the worst violators of copyright law—I once visited a school where the teacher had used the school's Xerox machine to make 40 copies of one of my books and was actually proud of it—and the key-disk scheme may be the best solution to the problem.

Anyway, if you sit a reasonably bright kid down with these disks and a Mac, there's a chance that some learning will take place. Both Physics and Geometry compress a lot of really good knowledge—I use that word deliberately since they are teaching some of the most important principles of science—into a couple of disks.

The programs aren't perfect. They have the approach of a reasonably bright but somewhat distracted schoolmaster. The student had better want to learn physics and geometry, because the programs don't provide any motivation: no rewards for success in the problems, and little connection between what you're learning and reality.

It has been my experience that if you tie abstract theory to something practical, students are more willing to work at learning; that, indeed, is what good teaching is all about. I may be hoping for too much from a computer program, but I don't think so; I suspect you could make physics and geometry more fun to learn than these programs do.

On the other hand, I sure wish I'd had them when I was in high school. If your kids have access to a Mac, it's worth getting them these programs.

I Wish I'd Thought of That

One recent phenomenon in the science fiction community is the "rented world" book; a well-known author creates a world in a series of books, and another author writes stories about it. Probably the best known of these is the Robot City series, in which a number of younger authors write about a world created by Isaac Asimov (everyone is younger than Isaac...).

I'm not sure what to make of these books: the income is generally divided among publisher, the author who created the setting and whose name will be used to promote the books, the junior author who actually wrote the stories, and often

continued

a packager who got the idea for the series and put it all together. I suppose if all parties are satisfied it must be all right. Anyway, that's irrelevant just now.

The other day I got a packet of materials about a book by Paul Preuss set in Arthur C. Clarke's "future history." One of the features of this book is a series of line-drawing illustrations of spacecraft, a space station, and other equipment. The drawings were done by Preuss using CAD-3D on an Atari ST.

The instant I saw that I slapped myself on the head. "Holy cow!" I yelled, loud enough that my wife came up to see who had been murdered. A couple of weeks later when I was in New York to make a speech, I showed the stuff to my publisher, Jim Baen. He too slapped himself on the head.

I don't know how I missed thinking of the idea first, but once seen it's obvious. Line drawings cost no more per page to print than text, and if one picture is truly worth a thousand words, they're cost-effective. I've sometimes struggled for hours trying to describe a particularly complex piece of equipment. I've also done my own maps by hand.

No more. I'm a lousy draftsman, but a good computer CAD program will solve that problem. It will require a change of habit to think in terms of good diagrams rather than long verbal descriptions, but I think that's the wave of the future. In 5 years—probably fewer—you'll see lots of books that integrate author-produced graphics with the text.

Cyber Studio

Preuss created his drawings with Cyber Studio, the core program of Antic's Cyber series. Studio contains CAD-3D, a program written by Tom Hudson (who also did the DEGAS paint program). CAD-3D uses an icon interface to let you draw objects, rotate or extrude them, and generally create shapes, which can then be shown as solids or as "wire frames" with all lines visible or with some lines hidden. Objects can be stretched, shrunk, glued together, rotated, and generally mashed about.

After you create an object, you can light it. Three studio lights can be moved around and each light's intensity varied until you like the view. When everything's just right, you print the result and send it to your publisher. I've been using the system to draw maps for my new *Prince of Mercenaries* novel.

All this is great, and I haven't seen anything on the Macintosh that's better, but it's not half of what the Mega ST and Cyber can do. What's really great is the animation you can get by invoking Cyber Control, the second program of the Studio package.

CAD-3D lets you create an object—as an example, your own name. Extrude it so that it's solid. Now save the image. Then, using the Cyber Control language—which is something like BASIC—change the lighting and rotate your name. While it's rotating, have it progress from the lower left to the upper right side of the screen, with perhaps a loop-the-loop in the middle. I've done that one, and while it takes a couple of hours of fiddling to learn how, once you know it's not very hard to do. You can get more complicated; one demonstration that comes with the program is a fully articulated human skeleton that does backflips.

Once you've described what you want, you turn the programs loose on it, and they build the series of frames to make full animation. This takes time—up to several hours for something really complex—but it will run by itself, so it can be left to stew overnight.

There's also Cyber Paint, which works on two-dimensional images but adds the time factor; stuff cut from frame 1 and

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pasted into frame 30 of an animation will appear to float across the screen. While you're at it, you can call up the ADO f/x menu—it's said to be named for the Ampex Digital Optics system of the seventies—and by judicious clicking and dragging, you can rotate the object around any axis or all of them, scale it up or down, and draw a complex path for it to follow.

All this takes memory; you'll need the 4-megabyte Atari Mega ST with a hard disk drive to do it right—but that's still a lot cheaper than anything else I've seen with that capability. Antic and Sony are working to create the Cyber VCR that should be out about the time you read this. It's supposed to turn your Mega ST into a video editor that will do serious professional video graphics. I understand that some ad agencies are already using the Atari Mega ST and Antic's Cyber software to block out television commercials for client approval before the really expensive work on finals is begun.

DeskLink and LapLink Mac

Traveling Software has done it again. I've previously mentioned LapLink, a program that connects portable IBM PC-compatibles like my Zenith Z-183 to desktop PCs (and thus makes it easy to move things from 3½- to 5¼-inch disks and vice versa). Now Traveling Software has DeskLink.

LapLink connects machines with a cable about 4 feet long. DeskLink comes with small cable stubs to connect to your machine's serial port (as with LapLink, the DeskLink cables have both 9-pin and 25-pin connectors). The stubs end in normal telephone jack connectors. You then use telephone wire to connect machines up to 75 feet apart.

After that, you have a two-computer network with the ability to transfer files, get programs from one computer and run them on the other, share a printer, and so forth. The user interface is different from LapLink, but it's no harder to use. It does require a memory-resident driver. Once that's installed, there's also a *talk* feature that lets you send messages to the other computer's operator.

When I first saw DeskLink at COMDEX, I asked Traveling Software's Mark Eppley when he'd have a link to the Macintosh. He acted amazed that I'd guessed what they were working on, but it was an easy prediction. I now have that version. LapLink Mac connects a PC to a Mac and allows file transfers at 57,600 baud—somewhat faster than AppleTalk. This is particularly useful when transferring large PageMaker files from the PC to the Mac. Like the other Traveling Software networking programs, LapLink Mac comes with the right cable and works about the way you expect it to. The documentation will help you get it set up, but once that's done you probably won't need it anymore.

I'm not sure how they got Mac and PC computers to talk to each other at 57,600 baud, but they've done it. If you have both a Mac and a PC, you'll want this program around just in case.

Solving Equations

I have TK! Solver Plus, Borland's Eureka: The Solver, and MathCAD. A real comparison would take more room than I have left; I fear it's short-shrift time.

In my judgment, Eureka is the easiest to set up and use. It doesn't cost much, and there's a lot of bang for the buck. It's very intuitive, and no high school student with a PC should be without it. However, college students and advanced users will soon run up against its limits. The number of variables and equations can't be greater than 20, and even within those limits, Eureka can be bloody slow when the problems get hairy.

TK! Solver Plus is extremely powerful. Alas, its cost is based on the professional tool it is; but if you're in the science or engineering business, you really can't afford to be without it, now that it's no longer copy-protected and can run cleanly from a hard disk drive.

Unlike Eureka, TK! Solver Plus isn't particularly easy to learn, what with unit sheets, rule sheets, table sheets, variable sheets, and the like. I may be dense, but I found the introduction confusing on first read through. Still, it won't take more than a couple of hours to get started. Once you get the hang of it, TK! Solver Plus is fairly intuitive, and the manuals are certainly complete enough.

MathCAD is the intermediate program. It's more powerful than Eureka and not as easy to learn; but it's less powerful than TK! Solver Plus. MathCAD incorporates a vanilla text editor and some very clever tricks for creating mathematical symbols and simple graphs, making it easy to write mathematical documents. It would be quite suitable for a professor who wanted to write an engineering textbook. The program is billed as "The Engineer's Scratch Pad," and to a large extent it lives up to that.

For small problems of the sort one usually encounters in college engineering classes, MathCAD is very intuitive—you basically just copy the problem out of the book, entering your equations with a sort of FORTRAN-like system, whereupon they are transformed on-screen into fairly standard mathematical symbols.

MathCAD also includes a numerical integrator and differentiator; that is, it won't solve derivatives and definite integrals, but it will give a numerical approximation of their value. TK! Solver Plus has differentiation and integration in one of the library modules. It's considerably more powerful, but, of course, more complex.

I don't think any college student should be without either TK! Solver Plus or MathCAD. My subjective opinion is that lower-division students will probably find MathCAD more useful. Because it's easier to learn and incorporates a text editor, it will be used more often to do homework and extra credit assignments.

When the student gets to upper divisions and more difficult problems, TK! Solver Plus's extra power and the availability of a whole raft of TK! Solver Plus libraries—some keyed to standard engineering textbooks—make it the weapon of choice; and it will probably be more useful in professional life. Of course, TK! Solver Plus can be used by lower-division students and even in high school.

I'm sending both down to my son, who's a sophomore in aerospace engineering; we'll see which one he prefers. Either one will probably raise his grade point average a good half point.

Flash: as a result of a recent deal with McGraw-Hill, college students can now buy TK! Solver Plus for $50 a copy; this is about the best deal in town, and no student should be without it.

There's also a mini version of TK! Solver for $20; this is comparable to Eureka, but it's cheaper and handles more variables. Unlike Eureka, TK! Solver makes you do explicit guesses in cases where the equation system is indeterminate; Eureka will assume arbitrary values (which you can change if you like).

Winding Down

I'm completely out of space, and my "ready line" is still covered with nifty stuff. I have a new Amiga 2000, which adds a vanilla PC to a much-improved Amiga. There's a new speech synthesizer from Heath; we plan on using that with Roberta's reading program. I've got a Datacam 35mm screen camera attached to the Zenith Flat Technology Monitor; this thing uses a Polaroid kit to make instant 35mm slides of things like the NASA CD-ROM pictures of Jupiter, as well as my briefing charts. I can't think how I ever got along without that.

The game of the month is King of Chicago on the Amiga 2000. The Mac version of that game was horrible, and the Amiga version is unplayable unless you have a hard disk drive or lots of extra memory; but on the 2000 it's actually kind of fun.

The book of the month is *Hex Witch of Seldom* by Nancy Springer (Baen Books). I'm not usually a witchcraft and fantasy fan, but I met the author at a convention and started her book to see how she writes. Next thing I knew, it was morning.

The computer book of the month is *Inside OS/2* by Gordon Letwin (Microsoft Books). Whether you like OS/2 or hate it or don't care at all, you'd still better read this book; it will tell you things you'll need to know later this year. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.

Items Discussed

Business Class $49.95
Activision Inc.
P.O. Box 7287
Mountain View, CA 94039
(415) 960-0518
Inquiry 939.

Courier HST $995
USRobotics Inc.
8100 North McCormick Blvd.
Skokie, IL 60076
(312) 982-5001
Inquiry 940.

Cyber Studio $89.95
Antic Publishing Co.
524 Second St.
San Francisco, CA 94107
(415) 957-0886
Inquiry 941.

DeskLink $169.95
LapLink Mac $139.95
Traveling Software
19310 North Creek Pkwy.
Bothell, WA 98011
(206) 483-8088
Inquiry 942.

MathCAD $349
MathSoft Inc.
One Kendall Square
Cambridge, MA 02139
(617) 577-1017
Inquiry 943.

Physics $99.95
Geometry $99.95
Broderbund Software
17 Paul Dr.
San Rafael, CA 94903
(415) 492-3200
Inquiry 944.

Sundial $89.95
Metroplex Digital Corp.
P.O. Box 815729
Dallas, TX 75381
(817) 265-9456
Inquiry 945.

TK! Solver Plus $395
Universal Technical Systems
1220 Rock St.
Rockford, IL 61101
(815) 963-2220
Inquiry 946.

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Pin-Money Programs

Ezra Shapiro

Useful software with an unusual attribute: It's all reasonably priced

The only unifying thread this month is that all the programs covered cost less than a C-note. What's encouraging about this is that more and more of the software I receive is falling into that category. While I won't state flatly that prices are going down—quite a few counterexamples are stacked in my computer farm in the basement—at least I'm getting a higher percentage of reasonably priced packages. Here's hoping the trend continues.

It Had to Happen

Well, I'm not really sure what to say about this one. Years of watching the computer industry have taught me to be surprised by nothing, but I almost lost my studied composure over a Macintosh program entitled Electronic Call Screening (Kanode Associates, $49.95). If you have been wondering what the world was going to do with HyperCard, this is your answer.

Electronic Call Screening (subtitled "The Professional's Receptionist") is a HyperCard stack designed for anyone who wants to bluff the world into thinking that he or she is successful enough to employ a secretary. Here's how it works: Somehow you've managed to construct an interface between your Mac's speaker jack and your telephone line. You're working at your computer, perhaps writing a letter, when suddenly the telephone rings. In a flash (courtesy of MultiFinder), Electronic Call Screening pops onto your screen and answers the phone.

"Hello?" says your caller. "Is that you, Ishmael?"

You're sitting there, scanning a list of phrases provided by Electronic Call Screening, and you click on one of them. "Good afternoon, Ishmael's Whale Emporium," says a digitized female voice to the caller. "May I help you?"

"Uh, er, may I speak to Ishmael?"

Chuckling to yourself, you click another button. The digitized female voice says, "May I say who's calling?"

"Sheesh," mutters your caller. "I didn't know Ish could afford a secretary. But tell him it's Ahab."

"Sorry, he's in a meeting." You click more buttons. "Would you like to hold?"

And so it goes. Electronic Call Screening gives you 69 digitized secretarial phrases to unleash on unsuspecting callers, ranging from "Please hold" and "May I take a message?" to "There's no one here by that name" and "I'm happily married, and I don't date clients." Your $49.95 gets you 65 stock phrases like these, plus 4 customized with the name of your company. You can even have additional custom phrases recorded (the basic list does not include "Your check is in the mail") at five bucks apiece.

And if, perchance, your caller says something for which you're unprepared, the sixty-ninth item on the list is labeled "punt"—a recording that sounds like an accidentally broken connection.

I do not recommend or denigrate this program; I merely report its existence for your edification.

A Magnificent Toolbox

Is Lotus 1-2-3 a spreadsheet program or an operating system? Every time I uncover another excellent 1-2-3 add-in, I find myself wondering. Each new product makes 1-2-3 a stronger, healthier, and better integrated environment, both now and for the future. It has reached the point where there's practically no reason left to exit to DOS; there's an add-in for just about every need.

The latest offering in this category is The Worksheet Utilities (Funk Software, $99.95). Unlike the majority of add-in packages, which extend 1-2-3 beyond its primary function as a spreadsheet, The Worksheet Utilities is a terrifically solid collection of widgets that supercharge 1-2-3's basic capabilities. It's a Swiss army knife in software, a six-in-one assortment of tools that will quickly become indispensable to the heavy-duty spreadsheet jockey.

The product is so strong, I'd be willing to bet that within a year it's going to be hard to find a serious 1-2-3 user who doesn't own a copy. Another SideKick? Quite possibly. The individual utilities range from convenience items all the way up to dramatic improvements.

You get an auto-save utility, which backs up work in progress at an interval of your choosing. A search-and-replace utility lets you look for (or substitute) labels, values, formulas, and/or cell references throughout your worksheet or within a selected range. Another utility lets you set the column width for a range of columns, rather than one at a time.

The flashiest utility in the package is the step-by-step formula editor. It fits logically into 1-2-3, but it's quite Macintosh-like in operation. Editing a formula is a point-and-shoot procedure; you select @ functions from a pull-down menu. A pop-up window displays full explanations of each function, a list of parameters, and guidelines for usage. You're prompted for the correct number of function arguments as you enter your formula. Syntax and parenthesis errors are highlighted until you correct them. And the editor shows your entire formula, even if it's longer than the 80-character single-line display you get in 1-2-3. It's not quite a full debugging environment, but it's pretty close.

Next is a wonderful file-management utility. It lets you do all the expected directory stuff (copying, moving, deleting, and archiving worksheets), but it doesn't stop there. You can attach keywords and/or full descriptions to filenames for easy recall of worksheets. You can view sections of files without having to load complete spreadsheets. Also, you can

continued

search an entire directory for labels and range names.

A handy little print manager allows you quick access to a screen full of printer settings. You can store settings by name (for different jobs or printers) and develop libraries of printer-initialization strings; in tandem, these two capabilities effectively give you style sheets for spreadsheets.

I've been using The Worksheet Utilities for about two months, which covers the final beta-test phase and the earliest official-release version. I have never experienced anything remotely resembling a crash, or even a minor glitch. These programs are as solidly built as they come.

The product requires either version 2.0 or 2.01 of 1-2-3 and a minimum of 384K bytes of RAM (that's for both 1-2-3 and itself). It runs in expanded memory if you have it. The box includes both 5¼- and 3½-inch disks.

While The Worksheet Utilities doesn't cover all the holes in Lotus 1-2-3 (which can now be classified as a real senior citizen of the software world), it can certainly make 1-2-3 significantly simpler and faster to use.

Items Discussed

Celebrity...................... $89.95
Good Software Corp.
13601 Preston Rd.
Suite 500W, LB 226
Dallas, TX 75240
(214) 239-6085
Inquiry 935.

Electronic Call Screening .. $49.95
Kanode Associates
4709 East Sandra Terrace
Phoenix, AZ 85032
(602) 482-3155
Inquiry 936.

LaserSpeed...................... $99
Think Technologies Inc.
420 Bedford St.
Lexington, MA 02173
(617) 275-4800
Inquiry 937.

The Worksheet Utilities $99.95
Funk Software Inc.
222 Third St.
Cambridge, MA 02142
(617) 497-6339
Inquiry 938.

A Better Spooler

If you're doing desktop publishing on a Macintosh with PageMaker and an older PostScript laser printer with limited onboard memory (like Apple's original LaserWriter, for example), you absolutely, positively *must* get a copy of LaserSpeed (Think Technologies, $99). It's the only print spooler I've encountered that lets you use either the Aldus laser driver or the standard-issue one from Apple.

If you create documents that use a large selection of PostScript fonts, you already know why the Aldus driver is essential. The driver flushes downloaded fonts from your printer's memory as soon as it's done with them, so you can use as many typefaces as you'd like. There's no flushing with the Apple driver; once you've downloaded three fonts or so, that's it. Thus, the Aldus driver gives your creativity much freer rein than the stock Apple answer.

Unfortunately, you pay for this creativity with time. As fonts are downloaded when you need them, a complex document can take eons to prepare. I've had some single pages take as long as half an hour to print—and that's without graphics. A spooler with Aldus capability is therefore a major convenience.

LaserSpeed is a print-to-disk spooler; output intended for the printer is dumped into a temporary file, then spit out to the printer as a background task while you continue to work in the foreground. When you've enabled the Aldus option, the temporary file is built to include any necessary downloadable fonts. LaserSpeed throws everything it needs into the disk file in a few seconds. Note that this procedure requires a goodly chunk of hard disk drive space; I've watched a 300K-byte PageMaker document grow to over a megabyte and a half of temporary spool file.

The version of the program I tested (1.5) is controlled with a desk accessory that's a snap to use. This version was not equipped to deal with MultiFinder, but MultiFinder-compatible version 1.6 was just about to ship when I wrote this and ought to be available now.

I should point out that the product works just as well on routine spooling from word processors, databases, and suchlike. I love it because of its magic with PageMaker, but that doesn't mean it isn't a great spooler in its own right.

Top marks.

YAWP

"Yet another word processor." And yes, Celebrity (Good Software, $89.95) is yet another *MS-DOS* word processor. But it costs less than $100, and it's an excellent program, though not without a few limitations. Celebrity is certainly equal to—or better than—many programs priced much, much higher.

It has all the basic features you'd expect, plus a few extras: mail merge, a spelling checker with an 80,000-word main dictionary, an acceptable thesaurus, a built-in calculator, an appointment calendar, and some macro programmability. Rudimentary databases, like those for mail merge, can be managed with well-designed entry forms. Formatting is done by means of multiple ruler lines and dot commands, like classic WordStar, though the dot commands are English rather than cryptic abbreviations.

I like Celebrity's interface, which lets you enter commands in any of the three most popular fashions: select items from a Lotus/Microsoft-style horizontal menu; type in commands at a command line; or use function-, Control-, and Alt-key sequences. This flexibility makes Celebrity an easy migration path, whether you want to change to it or from it.

Celebrity runs beautifully on any IBM PC AT-class machine with a fast hard disk drive, but I also tried the program on my old 4.77-MHz two-floppy-disk-drive Compaq portable to see whether it could be used in simpler environments. Sure enough, it performed quite nicely; speed was more than adequate, and there wasn't an overbearing amount of disk-thrashing. There are enough support files (remember the dictionary and the thesaurus) to strongly suggest a hard disk drive, but you could get by with floppies.

Limitations? No table of contents or index. No footnoting. File conversion only from WordStar and Volkswriter. No word count. Stuff like that; mostly minor annoyances.

I guess I would class Celebrity as an intermediate-level editor. If you don't have to do anything fancy, it has enough power to be your primary word processor, but I wouldn't recommend it for complex projects. It would definitely make a good first word processor for someone just starting out.

Does the world really need a midlevel program like this one? Hard to say. I have my doubts, but the program does seem to be growing in popularity. And my testing showed it to be relatively bulletproof; it won't hit you with any ugly surprises.

Your move on this one. ■

Ezra Shapiro is a consulting editor for BYTE. Contact him c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Because of the volume of mail he receives, Ezra, regretfully, cannot respond to each inquiry.

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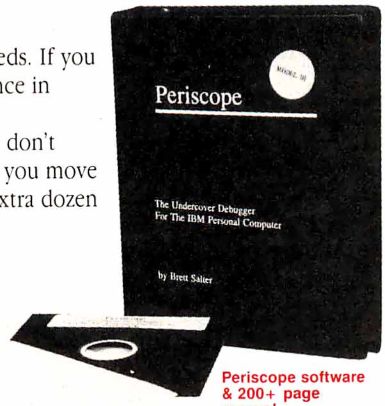
A Periscope I user who recently began using Periscope III writes, *"I like the fact that within the first half hour of use I was debugging my program instead of learning to use the debugger."*



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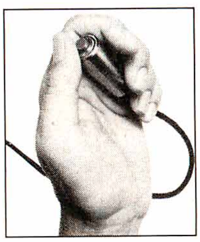
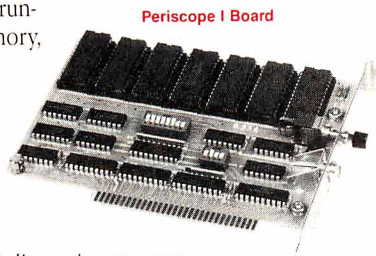


Periscope Break-Out Switch

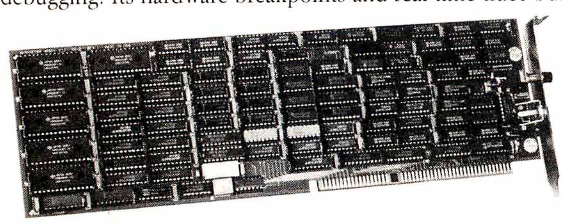
Periscope I has a board with 56K of write-protected RAM. The Periscope software resides in this memory, safe from run-away programs. DOS memory, where debugger software would normally reside, is thus freed up for your program.



Periscope I Board

Periscope III has a board with 64K of write-protected RAM, which performs the same function as the Periscope I protected memory. AND...

The Periscope III board adds another powerful dimension to your debugging. Its hardware breakpoints and real-time trace buffer let you track down bugs that a software-oriented debugger would take too long to find, or can't find at all!



Periscope III Board

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"I am very impressed with Periscope II-X ...it has become my 'heavy duty' debugger of choice, especially if I need to work on a memory resident utility or a device driver." **Periscope II-X user**

". . . Periscope III is the perfect answer to the debugging needs of anyone involved in real-time programming for the PC . . . The real time trace feature has saved me many hours of heartache already." **Periscope III user**

- **Periscope I** includes a half-length board with 56K of write-protected RAM; break-out switch; software and manual for $345.
- **Periscope II** includes break-out switch; software and manual for $175.
- **Periscope II-X** includes software and manual (no hardware) for $145.
- **Periscope III** includes a full-length board with 64K of write-protected RAM, hardware breakpoints and real-time trace buffer; break-out switch; software and manual. Periscope III for machines running up to 8 MHz is $995; for machines running up to 10 MHz, $1095.

REQUIREMENTS: IBM PC, XT, AT, or close compatible (Periscope III requires hardware as well as software compatibility); DOS 2.0 or later; 64K available memory; one disk drive; an 80-column monitor.

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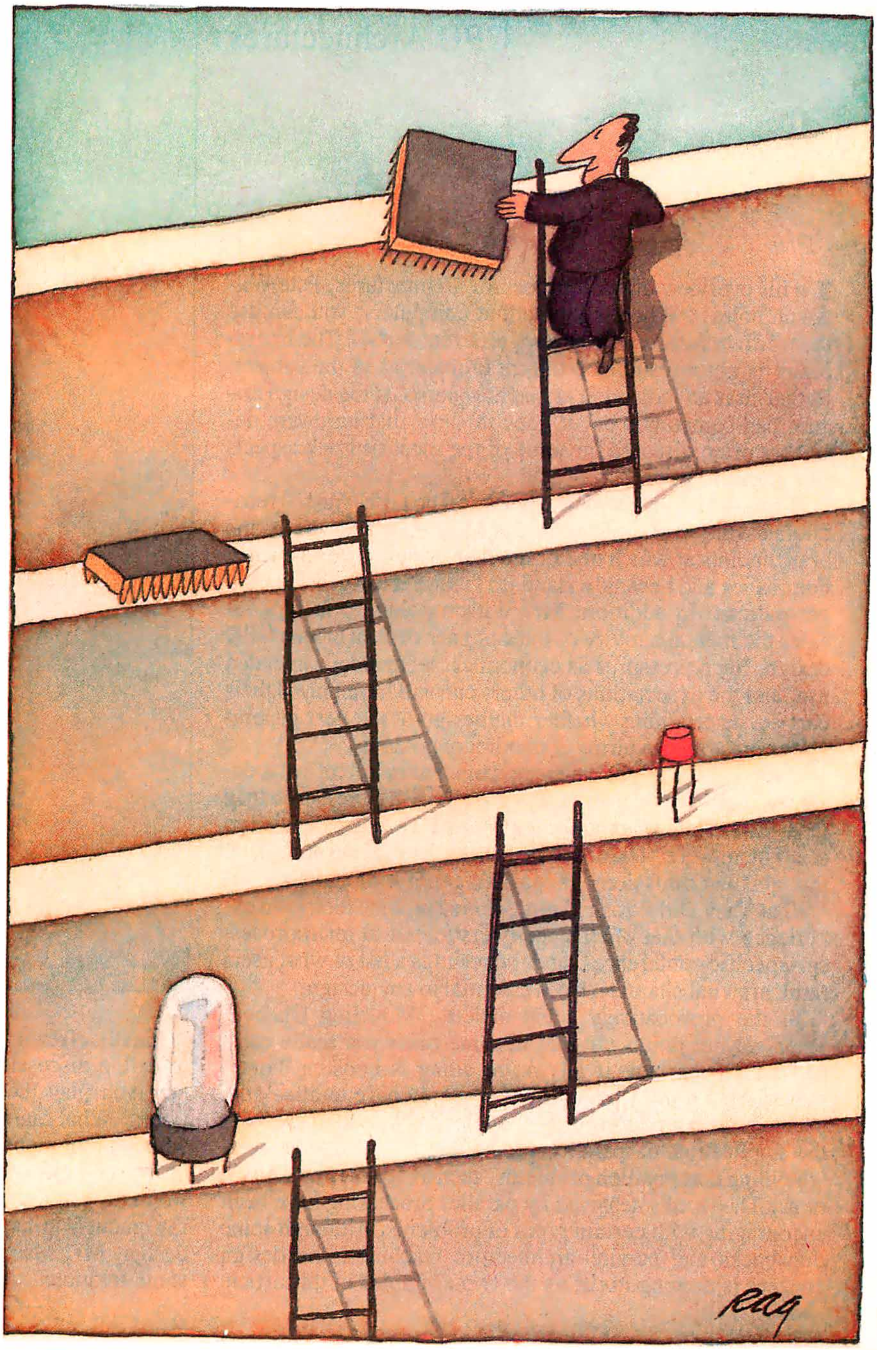
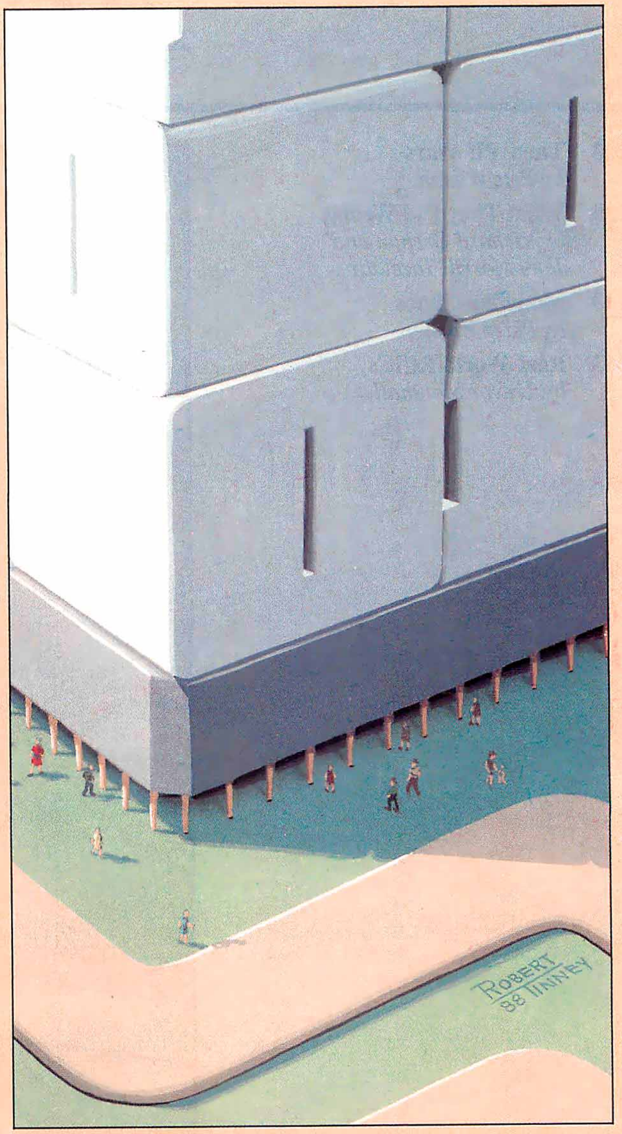
CPU Architectures



Introduction

CPU Architectures



In his overview of microprocessor architectures, Pete Wilson notes, "When talking about computers, you can use the word *architecture* in several different ways." The imprecision is not a result of a failure to understand the subject. Rather, it is an indication of just how personal the design criteria can sometimes be. It goes to show that hardware designers often disagree on some of the most bedrock aspects of computer design.

This month's In Depth overview, "The CPU Wars," recapitulates the evolution of microprocessors and shows the branchpoints at which one or another design factor assumed dominance and became a standard feature of succeeding chip generations. In addition, Mr. Wilson points to factors besides the mental activity of the designer that influence CPU design. Such pressures as economics, technology, intended use, and the expectations of others can and have played their parts in determining whether the design of the next generation is presented in terms of maximum potential.

Bearing in mind the intensely personal nature of what designers consider worthwhile, as well as the pressures they face, Richard Grehan and Jane Morrill Tazelaar decided to see if there were "lessons to be learned by looking at some of the glaring omissions in earlier-generation CPUs." In "What They Did Wrong," our editors combine their own experience with that of BIX members joined to microprocessor-specific conferences, and the result is a list of what users think are vital characteristics essential to any design.

In the provocatively titled article "Modeling Chaos," Peter Wayner points out that in some cases you really can't get there from here if all you're doing is boosting horsepower. Sometimes, he notes, you simply have to attack the problem from an entirely new angle. Such is the case with the application of parallel processing to otherwise overwhelming computation problems, such as fluid-flow simulations. The results achieved by parallel processing have been encouraging with certain types of problems. Although some drawbacks nag parallel-architecture machines, the design concept is proving itself, as the two examples in this article show.

Finally, Trevor Marshall presents "Real-World RISCs," a revealing discussion of the proposition "it's not important how you play the game, but how you design the playing field." What matters these days is not so much how fast or what kind of memory a computer has, but the configuration of the memory interface. Put another way, a fast processor won't do you much good if you can't get the data in and out fast enough to capitalize on the high points of the CPU's design. Mr. Marshall looks at the problems and proposes some solutions.

—Glenn Hartwig, Associate Managing Editor

The CPU Wars

An overview of the microprocessor battlefield, and how it got that way

Pete Wilson

MACINTOSH AND IBM PC machines differ in a more essential way than in their mutual inability (sans extra goodies) to read from or write to each other's disks. The PC family uses the Intel 8086-family architecture, and the Mac, the Motorola 68000-family architecture. The differences between these two processor designs are quite fundamental. What led Motorola and Intel in such different directions?

For the next few pages I'll look at the issue of processor architectures—that is, the fundamental design decisions inherent in a processor—and come to some conclusions about how the varying choices can be compared and how the decisions got made. Articles that follow in this section look at some of the problems that classic CPU designs exhibit, and explore new designs, such as reduced-instruction-set computer (RISC) processors and parallel-architecture systems.

When talking about computers, you can use the word *architecture* in several different ways. While it always refers to something fundamental to the issue being discussed, the implications can be quite fuzzy ("The 6502 is an 8-bit architecture") or surprisingly focused ("The SPARC is an overlapping-windows RISC architecture"). I'll use the word to indicate the major functional decisions embodied in a design without being overly concerned about, for example, the size of the data object the processor can easily deal with. This makes it possible to discuss 6502s, 80286s, and T800s on an equal footing, which is more fun.

The various microprocessors available today show that competent designers can disagree strongly on fundamental aspects of computer design. To see how this arises, I'll recapitulate the evolution of microprocessors. I'll design (in broad outline) a series of computer architectures, starting with a very simple one whose capabilities will be strongly constrained by technology and advancing through successive designs using better technology. And for each paper design, I'll show a commercial design that reflects similar decisions.

Constraining Factors

Before jumping into that, though, it's worthwhile pointing out that computer architecture is not a purely cerebral activity; a company implementing a microprocessor is constrained by several factors: chiefly economics, technology, needs, and fads. Economics—that is, general market forces—is perhaps the strongest. It can cut both ways: It can allow the continued existence of a relatively poor design despite the ready availability of better ones (because there's so much software investment in the poorer design that no one wants to risk putting effort into a new machine); and it can facilitate the entrance of a new design (e.g., because Sun has put SPARC architecture into the public domain, anyone can build it; this could well be the opportunity the Japanese semiconductor vendors have been waiting for—a competent design suitable for mass production that won't result in lawsuits when they churn them out by the million).

Technology must always be a factor; the choice made when you've got a million transistors to play with may not be the same as when you're limited to 10,000. But technology and economics intertwine; most customers like some sort of continuity in the products they buy, so the decisions made for a design restricted to a small number of transistors can haunt a vendor even when the technology allows better decisions.

What you want the thing to do must also have some effect on a machine's architecture. A machine designed to be used in low-speed logic replacement may be out of place in a Unix system; a processor optimized for Pascal can be a poor fit to Prolog.

Finally, what everybody expects of you (or your own pet theory) can constrain architectures. This year, it would be hard to introduce a new architecture as complex as a VAX or 32x32; the masses demand RISC designs. And within designs, the architects' predilections show: for instance, SPARC's register windows and the T800's message-passing instructions.

From Simple Beginnings

Let's put these issues to one side and look at the purely technical issues. To begin with, assume we've got only a primitive technology and we want a reasonably general-purpose processor. We need some memory (to hold the program and data), an ALU (to do useful things like ADD and exclusive-OR), and something to tell us what instruction to execute next. To get the machine to do something, we have it execute a program, which is a col-

continued

Architectural Metrics

How can we compare one proposed architecture to another existing one? If we cannot measure the goodness of an architecture, we're going to have major difficulties designing a competitive processor. The first thing to note is that we cannot usefully compare architectures, since the point of an architecture is as a specification for a real computer. Instead, we can say that if we compare implementations of architectures at constant technology, then we should get an indication of comparative worth.

This really is a lot like a benchmarking exercise, but with two subtle twists—first, it's necessary to be fair to the other guys, and second, the notion of cost is a bit different. When comparing two personal computers with roughly equivalent performance and different prices, you can pretty quickly decide on the cheaper one; however, the price of a system is only loosely based on physics and is more strongly affected by the manufacturer's accounting practices, expectations, positioning, and other economic factors (of course, cost is one factor).

Being fair to the other guys involves, for example, noticing that when your machine comes out it will be implemented in 1-micron CMOS while theirs—which already exists—is done in 1.5-micron CMOS. Your machine will go faster than theirs simply because the transistors are smaller and switch faster. So whatever performance figures you use, you must normalize to keep technology level.

The real cost of a processor is fairly difficult to estimate. There are two portions—the cost of the chip (or chips) itself, plus the cost of the memory to hold the program and data. If the processor is very small and cheap but with horrid code density, it will be cheaper than a competitor's product with a bigger chip and good code density—only up to the point where the cost of memory for the cheap processor swamps the processor chip cost.

Using these factors, we can imagine a method for comparing architectures. First, identify a range of programs spanning the spectrum from small code/small data up to large code/large data, and including large code/small data and small code/large data. Examples (in the same order) might be a washing machine controller, a banking application, a complex real-time signal processing system, and a Lisp interpreter; in reality, many examples are needed. Now measure the machines using these benchmarks, normalize the results (to constant technology), and plot the machine's performance surface. This is a three-dimensional surface where the height is the normalized performance and the *x* and *y* axes are code size and data size (see figure A).

On such a graph, we can say that if architecture A's surface is always below the surface of architecture B, then A is worse than B. What's more likely to happen, though, is that the surfaces intersect, as in figure B. Then we can still say something very useful, such as A is 20 percent better than B for all systems requiring less than a megabyte. In real use, we'd have to be careful about what we mean by "big programs." Some big programs, for example, spend all their time in one of a small number of loops. The end result would probably be that, rather than a surface, we'd end up with a fuzzy "performance volume."

To introduce cost-effectiveness rather than simply raw performance, we need only to replace the vertical axis with performance/cost, where we compute cost as the sum of the processor chip cost plus the cost of the memory. We can compute the normalized cost of the chips by estimating their areas (at constant technology)—cost goes up exponentially with area, making small chips attractive—and adding in the cost of the appropriate memory system.

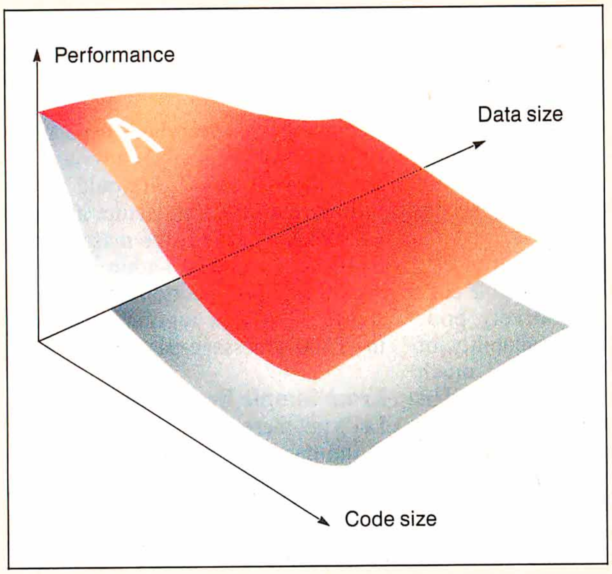


Figure A: *A method for comparing CPU architectures. The height of the surface is its normalized performance, and the* x *and* y *axes are code and data size.*

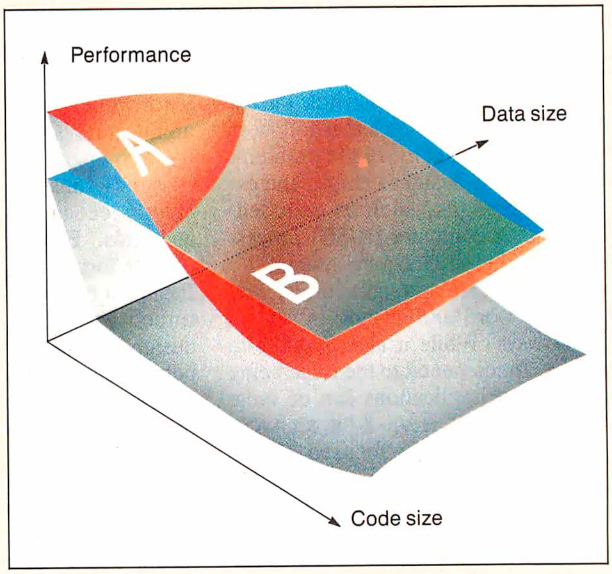


Figure B: *Typical performance plot comparing two CPUs.*

lection of commands stored in the memory. We have to encode the desired operations in some reasonable manner, so that we can represent reasonably well what the machine should do, and also so that it can decode our intentions and obey them without using too much hardware.

To start somewhere, look at all the things we want the ALU to do. We'd like it to do addition and subtraction (we'll let it use two's complement binary numbers, because they fit the technology well) and a bunch of logical operations, shifts, comparisons, and so forth. If we list them all (omitting multiplication and division, since they're too complicated to be done in roughly zero transistors), we'll find that there are fewer than 256 and more than 16; this makes it attractive to think about using a byte to indicate the operation we'd like performed.

Now we can say `add`, but we haven't said what to add to what. The simplest thing is to have a special register—call it the *accumulator*—belonging to the ALU, and to say that `add` means "take something and add it into the value in the register, leaving the result in that register." Because we have few transistors, the accumulator can be only 8 bits in size. Now, all we have to do is to specify the "something"; the obvious solution is to be able to add something from the memory into the accumulator. If we do the sensible thing and limit the size of the memory to 64K bytes (if we don't have enough transistors to build a complex processor, we won't be able to afford much memory, either), we can specify any address in 16 bits. So that gives us 24-bit instructions (8 bits of op code and 16 bits of address). And we'll add `load` and `store` instructions to allow movement of data between the accumulator and memory.

The number 24 looks nasty; not only is it not very binary, it's also very big—our programs will use up lots of expensive memory. And besides, we want the machine to do more than loads, adds, and stores—we'd like, for example, to be able to look at each member of a collection of values in memory. We can do this by inventing another operation—an *indirect load*. A normal load instruction uses the 16 bits to select a memory cell whose value we copy into the accumulator; an indirect load selects a memory cell whose value we use to select another memory cell whose value we load into the accumulator. Now, by messing around with a memory cell's value, we can play with data structures.

But such an indirect load has two problems. First, it involves two memory accesses, and the first rule of microprocessor design says that it's always easy to build a processor that can do something much faster than affordable memory can cycle. So we've just put a performance bottleneck into our machine. Second, playing with the address location in memory means destroying the value we had in the accumulator (so if we want to add up the values in 50 locations, we'll be doing a lot of loading and storing, which involves memory accesses and tends to be slow).

Luckily, experience indicates that when we're playing with collections of values, we often play with successive elements (or elements related in some way). This means that we will keep going back to play with a single address location—for example, to increment it by 1. Suppose we give the processor another register to be used as an address register?

The only problem with this is that there aren't enough transistors to make this address register 16 bits—we can manage only 8. So we can't address all the memory. Since we need to, we'll have to keep the original idea of indirect loads, but we'll change the meaning to "add the value of the address register to the value in the specified location to form an address." Now we've still got the memory access, but we can meddle with the address register (useful things like adding 1 to it) with a small number of extra instructions, so we can compute a sequence of addresses without destroying the value in the accumulator.

Now we can make one more optimization. We'll make the instructions 16 bits long instead of 24 bits by restricting the address portion of the instruction to 8 bits. Now we are restricted to using the bottom 256 locations of the memory as our indirection values, but the programs have all shrunk by 33 percent, and the machine goes faster (we need fewer memory cycles to read the instructions from memory, since the instructions are smaller).

A few more details, and the design is done. We need a few more registers—the program counter, a 16-bit register to indicate the next instruction to execute, plus some instructions to manipulate this (so we can jump). We need some method of comparing values so that we can write programs that are data-dependent; the simplest method is to have a set of bits in the ALU set on arithmetic or logical instructions to indicate the result was 0, or greater than 0, or that overflow occurred, and so forth. And we need some instructions that change the program counter if a particular bit is set.

Finally, both common sense and a sense that memory is expensive lead us to want some method of having just one copy of a piece of code that does some-

continued

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Designing an Architecture

However you do it, comparing your proposed architecture with others is necessary before you commit to silicon. This exercise is made more difficult because you don't have any silicon to measure.

Instead, architects will normally build a simulation of their proposed machine. There are three major options: One is the traditional one of building some real hardware from logic gates; the trouble with this is that it's very hard to get the design right, and quite often the simulator bursts into life only after the first real microprocessor chips have been built and made to work.

Another option is to purchase a design automation suite from a CAD company. You can buy a software package to run on your workstation, superminicomputer, or supercomputer that lets you design the architecture and all the implementation and simulate the machine executing programs. This way, you can do a traditional top-down design, sketching in the big picture and gradually refining it as the issues become clearer; then you try different hardware implementations of various portions (iterating the high-level spec as appropriate) while getting a very accurate picture of the performance and—equally important—being sure that the hardware actually implements exactly what it's supposed to. The trouble with this approach is simply up-front cost; the packages and the computers are hardly free.

The final option is to do it yourself. Since the computer is going to be a collection of black boxes that work together to get the program executed, simply writing an instruction-set interpreter in C isn't enough; it won't tell you the performance effects of prefetching instructions, or how big the cache should be, and so forth. (It will let you see what instructions get executed most, though, which should give you some hints as to what instructions must be quick and what could be left out.)

You have to somehow simulate the effect of all these boxes (e.g., the instruction prefetcher, the register bank, the ALU, the cache, the memory, and the I/O) working in parallel. The most obvious way to deal with this is to write a description in a suitable parallel programming language; it turns out that Occam—the language designed for programming collections of T800s—is a very good fit for this, allowing concise descriptions of the way the pieces interlock.

Simply running the program gives you a simulation of the proposed design, and if you've got many T800s, you can run the program on the collection to speed things up. Then, using techniques similar to those outlined in my article "Floating-Point Survival Kit" (March BYTE), you can transform the design into a microcoded implementation and be pretty sure the actual silicon will do just what you want. If you don't mind missing out on the transformation stuff, you could just as well do the description in Definicon's Parallel C, which contains the same functionality as Occam for these purposes.

If, however, you've missed out on getting a transputer into your PC or workstation, then you can't use Occam. Under those circumstances, you can build a simulator as a *discrete event simulation.* This says the world is made up of separate events that affect each other and that happen at specific times. When an event happens, it can trigger the occurrence of other events (including recurrences of itself).

You write a procedure for each event type and then build a little time-ordered queue of event requests. The simulation simply looks at the front request on its queue, sets the simulation time to that event's time, and calls the corresponding procedure. The procedure does whatever is appropriate—including putting requests for other events onto the queue—and returns, whereupon the cycle repeats. This allows the time-dependent behavior of the design to be modeled just as we did in Occam, but somewhat more clumsily.

---

thing interesting, so that a program wanting to do that function can make use of it. We've invented subroutines; all that's needed is another register and a couple of instructions: A `call` saves the current program counter in memory whose address is specified by the new register, and then increments that register, while a `return` decrements the register and reloads the program counter from the indicated memory location.

The resulting machine is very close to the 6502, originally designed by Mostek and used in the Apple II and the Commodore PET. The 6502 has a few more fea-

continued

tures, but the major ones have been covered in the design process I've gone through. It uses fewer than 10,000 transistors.

Segmentation Rears Its Ugly Head

Time passes. Now we have more transistors available. What can we do to improve the machine? Obviously, we want to get all the registers up to 16 bits. Let's put in multiply and divide as instructions rather than having to call those subroutines. And, now that memory is cheaper, let's somehow get the size of memory up.

Increasing the registers to 16 bits is simple enough. So is adding multiply and divide. (And—allowing economics into the picture—we can let the machine deal with its registers as either 16-bit or 8-bit values, so last year's programs can be ported without any real difficulty.) But those 16-bit registers simply won't address more than 64K bytes.

To fix this, we remember what happened with our first machine when we wanted to address more than 64K bytes; between the processor and the memory we put a little register—perhaps 4 bits or so—and the value in this register was always added to the 16 bits the processor generated to provide 20 bits of address. Using a program, the processor wrote the correct values into the little register. To make sure it all worked, we made the logic use the 20-bit addresses only under certain circumstances, such as the address having its most significant (sixteenth) bit set.

Well, that worked well enough. It's got limitations—we can skip around all over a big memory, but we can never see more than 64K bytes from any one place. But who's going to write programs that big? So let's implement it inside the processor (i.e., add some address-extension registers to the processor itself), and tidy it up a bit. We want to be able to execute a program anywhere in the memory, but it's just possible that the chunk of program could be about 64K bytes in size, and this would make the size of data the program could easily play with somewhat small. So we'll provide one magic register for addressing code and another one for data. And sometimes the code will want to play with two different collections of data, so we'll add a third. That's not very binary, so we'll give the machine four such base registers.

The base registers will be 16 bits (other sizes are difficult to deal with). We could stick the 16-bit base value beside the (up to) 16-bit value of the address to get a 32-bit address, but that's far too large. No one can afford a 32-bit address space. And having increments finer than 64K

continued

bytes in base addresses makes it simpler to have a new base address set up for each module of the program. A megabyte sounds large enough; let's arrange things so that the base address is shifted four places left and then added to the machine's 16-bit address. Sounds like a good compromise.

That machine, of course, is the 8086 design (which actually sprang from the 8085, not the 6502, but the story is still legitimate). The 8086 uses about 30,000 transistors.

Removing Bottlenecks

Again, technology doesn't stand still. What are the bottlenecks in our design? First, the machine is using that memory too often. Although memories have speeded up, the processor can still be faster; those loads and stores are crippling our performance. We need somewhere to put a reasonable amount of data that we can get hold of at processor speeds. Second, that megabyte of memory has people writing more ambitious

continued

Listing 1: *A C program containing the inner loop of an instruction set simulator, a complex integer expression evaluator, and a matrix addition.*

```
/*
code fragments to show processor architecture differences
*/

#define TRUE  1
#define FALSE 0

interpret()
{
#define add      1
#define subtract 2

register int PC, acc, instruction, opcode, operand, running;
int memory[1024];

running = TRUE; acc =0; PC = 0;
while (running) {
  instruction = memory[PC++];
  operand = instruction & 255;
  opcode = instruction >> 8;
  switch (opcode) {
    case add:
      acc += operand; break;
    case subtract:
      acc -= operand; break;
    default:
      running = FALSE; break;
    }
  }
}

evaluate(x)
int x;

{
register int a, b, c, d, e, f, g, h;
a = x; b = x/2; c = x + 1; d = x + 2;
e = x + a; f = x + b; g = x + c; h = x + d;
a = ((a + b) * (c + d))/((e + f) * (g + h));
return a;
}

matrix(m1, m2, m3, x, y)
int x, y;
register int * m1, * m2, * m3;
{
register int i, j;
for (i = 0; i < x; i++) {
  for (j = 0; j < y; j++) {
    *m1++ = *m2++ + *m3++;
    }
  }
}
```

continued

```
int mat1[4][4], mat2[4][4], mat3[4][4];

main()
{

interpret();
matrix(mat1, mat2, mat3, 4, 4);
evaluate(5);

}
```

Listing 2: *The compiled 80286 code emitted by Turbo C given the source code in listing 1. Compare with listings 3 and 4.*

```
============= Turbo C output for a 286 ===============

_interpret      proc    near
        push    si          ! save registers on entry
        push    di          !
        push    bp          !
        mov     bp,sp       !
        sub     sp,2056
        mov     word ptr [bp-2050],1    ! running is [bp-2050]
        xor     di,di                   ! acc is di
        xor     si,si                   ! PC is si
@2:
        cmp     word ptr [bp-2050],0    ! see if running is 0
        je      @3                      ! give up if it is
        mov     bx,si                   ! copy PC into a
                                        ! temporary register
        shl     bx,1                    ! multiply by two for
                                        ! a byte offset
        lea     ax,word ptr [bp-2048]   ! memory[] starts at
                                        ! [bp- 2048]; put its
                                        ! address into ax
        add     bx,ax                   ! compute address of
        mov     ax,word ptr [bx]        ! mem[PC], read from
        mov     word ptr [bp-2056],ax   ! it and and put it
                                        ! into 'instruction'
        inc     si                      ! increment PC
        mov     ax,word ptr [bp-2056]   ! read 'instruction'
                                        ! into accumulator
        and     ax,255                  ! AND with 255
        mov     word ptr [bp-2052],ax   ! write into 'operand'
        mov     ax,word ptr [bp-2056]   ! get 'instruction'
                                        ! again..
        mov     cx,8                    ! set up for a shift..
        sar     ax,cl                   ! shift 8 places
        mov     word ptr [bp-2054],ax   ! and write into
                                        ! 'opcode'
        mov     ax,word ptr [bp-2054]   ! reload it..
        dec     ax
        cmp     ax,1
        ja      @7
        mov     bx,ax
        shl     bx,1
        jmp     word ptr cs:@8[bx]      ! computed jump
                                        ! through jump table
@8      label   word
        dw      @5                      ! jump table entries
        dw      @6
@5:
        add     di,word ptr [bp-2052]   ! the 'add' case
        jmp     short @4
@6:
        sub     di,word ptr [bp-2052]   ! the 'subtract' case
        jmp     short @4
@7:
        mov     word ptr [bp-2050],0    ! default -
```

continued

programs, so they write in a high-level language to finish in a reasonable time. The use of high-level languages has three effects: First, programs are getting bigger (because the compilers aren't doing too good a job); second, programs are getting bigger (because more complicated programs can be written more safely and more quickly); and third, these programs are using procedures all over the place.

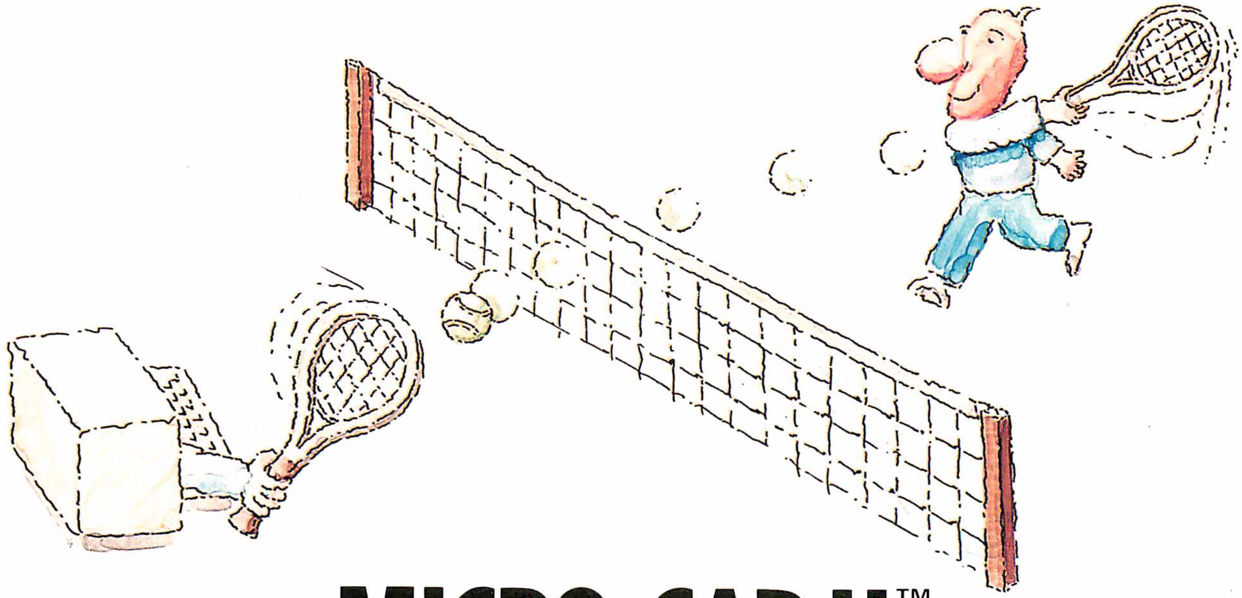
Let's first deal with the memory-access bottleneck by giving the processor several data registers. These will be on the same chip, so they can be accessed quickly (things slow down cruelly when your signals have to trickle off the edge of a chip, across a board, into a chip, and then retrace their steps). A nice number would be 16. Looking at our programs we see that we often—at the bottom of a loop, for example—have to increment or decrement a value by some amount. It's too complicated to put special hardware into each register so it can do this itself, so we'll do it by instructions.

To do that in an instruction sounds like a Good Idea—but then we'll need to break with our instruction encoding (remember, it's of the "add to accumulator" type). Rather than our one-address instructions (one-address because the instructions literally specified just one operand, the other being the accumulator), we'll have two-address instructions that say things like "take 13 and add it to register 8" or "take register 6 and multiply it by register 5."

We've gained performance because we no longer need to go messing around putting things into an accumulator, adding stuff into that, and copying it out again. Now we can combine any two registers any old way we want. Given the registers, we'll see a much reduced need to access memory, and programs will go faster. But the compilers are still fairly stupid (actually, close to brain-dead), so the code's exploded in size. The limits imposed by 16-bit registers are too constraining. So we'll use up some transistors making them 32 bits.

Now we've got a problem. When we encode all the things we want to do with the registers, we find that we need more than 16 bits to encode the typical instruction. Looking at a program running on our shiny new machine, we notice that it's keeping addresses in those registers about as often as it keeps data. The machine does different things with addresses (they access memory) and data (you do sums with data). If we split our registers between address registers and data registers, then we can encode most of the frequent instructions in 16 bits, and the performance doesn't seem to suffer. Also,

continued



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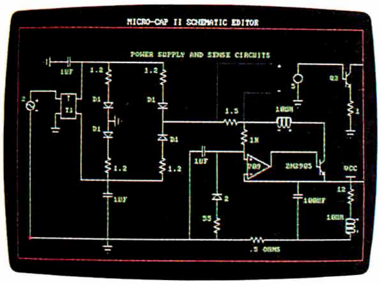

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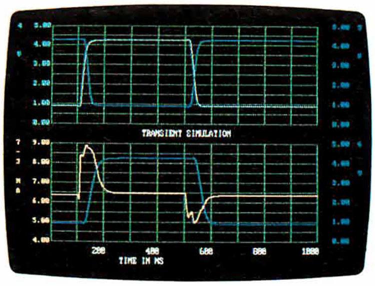

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Circle 279 on Reader Service Card

```
                                        ! clear 'running'
@4:
        jmp     short @2
@3:
@1:
        mov     sp,bp                   ! exit -
                                        ! restore registers
        pop     bp
        pop     di
        pop     si
        ret
_interpret      endp
_evaluate       proc    near
        push    si
        push    di
        push    bp
        mov     bp,sp
        sub     sp,12
        mov     si,word ptr [bp+8]
        mov     ax,word ptr [bp+8]
        mov     bx,2
        cwd
        idiv    bx
        mov     di,ax
        mov     ax,word ptr [bp+8]
        inc     ax
        mov     word ptr [bp-12],ax
        mov     ax,word ptr [bp+8]
        add     ax,2
        mov     word ptr [bp-10],ax
        mov     ax,word ptr [bp+8]
        add     ax,si
        mov     word ptr [bp-8],ax
        mov     ax,word ptr [bp+8]
        add     ax,di
        mov     word ptr [bp-6],ax
        mov     ax,word ptr [bp+8]
        add     ax,word ptr [bp-12]
        mov     word ptr [bp-4],ax
        mov     ax,word ptr [bp+8]
        add     ax,word ptr [bp-10]
        mov     word ptr [bp-2],ax
        mov     ax,si                   ! now begin the
                                        ! computation; copy
                                        ! 'a' into ax
        add     ax,di                   ! compute 'a+b' in ax
        mov     dx,word ptr [bp-12]     ! load 'c' into dx
        add     dx,word ptr [bp-10]     ! add 'd' to dx
        mul     dx                      ! ax = dx * ax
        push    ax                      ! we save that result
        mov     ax,word ptr [bp-8]      ! (e + f) * (g + h)
                                        ! done same way
        add     ax,word ptr [bp-6]      !
        mov     dx,word ptr [bp-4]      !
        add     dx,word ptr [bp-2]      !
        mul     dx                      ! the other
                                        ! multiplication
        mov     bx,ax                   ! save ax in bx
        pop     ax                      ! get the save result
        cwd
        idiv    bx                      ! do the division
        mov     si,ax                   ! copy result to 'a'
        mov     ax,si
@9:
        mov     sp,bp
        pop     bp
        pop     di
        pop     si
        ret
_evaluate       endp
_matrix proc    near
        push    si
        push    di
```

continued

we can do interesting things with an address register and a data register, like read a value from memory at the location indicated by an address register and load it into a data register.

Trouble is, we can now call for some pretty complex operations in one instruction. Things that used to be done by a whole sequence of instructions now fit into one; it's really difficult to build logic that does all those complicated things. So let's implement the thing as an interpreter. We'll build a much simpler machine whose instructions are unbelievably crude but very quick to execute, and have a tiny program in a ROM on-chip that will cycle our crude machine through the contortions necessary to do the complex stuff its instruction set calls for.

The little program is called microcode, and since it's there, we can add facilities to the machine. We can have several different instruction sizes, with the longer ones specifying a complex sequence of operations involving multiple steps (e.g., add this constant to an address register, look into memory, take the value, use that as an address, read from memory, and multiply register 7 by that value). Real power at last!

This machine, though our description is hardly complete, is 68000-flavored. A 68000 needs around 70,000 transistors.

Small Is Beautiful, Revisited

More time passes. Programs get written. Then we notice something about the machines: Those compilers aren't making much use of all the clever things in the instruction set. The machine's spending too much time on procedure calls. Technology is much better now—you can use a couple hundred thousand transistors if you want. What's the best way of making use of these extra transistors?

Let's take these one at a time. The compilers aren't making good use of many of the instructions—sounds like the time has come to fire our compiler writers for incompetence. But a closer look shows that our COBOL compiler is using a subset of the instructions, as is our Pascal compiler. Unfortunately, they're different subsets. So the compilers are not the root of the problem. It looks like different classes of problems need different resources—a general solution could be mediocre for everyone. And the instructions that every compiler does use are the straightforward ones that mess around between the registers; and these aren't executing as quickly as they could because there's all that microcode control (necessary for the complex instructions) in the way.

The procedure calls are taking too

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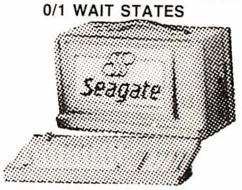

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Circle 67 on Reader Service Card

```
        push    bp
        mov     bp,sp
        xor     si,si
        jmp     short @14
@13:
        xor     di,di
        jmp     short @18
@17:                                    ! now we do *m1++ =
                                        !     *m2++ + *m3++
        mov     bx,word ptr [bp+10]     ! get the value of m2
                                        ! into bx
        mov     ax,word ptr [bx]        ! read from that
                                        ! address into ax
        mov     bx,word ptr [bp+12]     ! get the value of m3
                                        ! into bx
        add     ax,word ptr [bx]        ! add value from that
                                        ! address into ax
        mov     bx,word ptr [bp+8]      ! get value of m1
        mov     word ptr [bx],ax        ! copy ax into that
                                        ! location
        add     word ptr [bp+8],2       ! increment m1, m2, m3
        add     word ptr [bp+10],2
        add     word ptr [bp+12],2
@16:
        inc     di
@18:
        cmp     di,word ptr [bp+16]
        jl      @17
@15:
@12:
        inc     si
@14:
        cmp     si,word ptr [bp+14]
        jl      @13
@11:
@10:
        pop     bp
        pop     di
        pop     si
        ret
_matrix endp
_main   proc    near
        call    near ptr _interpret
        mov     ax,4
        push    ax
        mov     ax,4
        push    ax
        mov     ax,offset dgroup:_mat3
        push    ax
        mov     ax,offset dgroup:_mat2
        push    ax
        mov     ax,offset dgroup:_mat1
        push    ax
        call    near ptr _matrix
        add     sp,10
        mov     ax,5
        push    ax
        call    near ptr _evaluate
        pop     cx
@19:
        ret
_main   endp
```

Listing 3: *The compiled T800 code emitted by Logical Systems' C TCX version 87.8H (beta release) given the source code in listing 1. Compare with listings 2 and 4.*

```
========= TCX beta release output for T800 ==============
;       Compiled by TCX v87.8H (PC->Transputer)
        .T800
```

continued

long; of course they are. Here we are in one procedure, putting interesting values in registers for speed, when suddenly we need to dash off to another routine that wants to put its interesting data into the registers. So we have to save all the registers to memory, call the new procedure, play around in there, exit, restore the values from memory, and carry on. A procedure call can easily use up 32 memory cycles (save 16, restore 16 registers). But on average we execute only 20 to 30 instructions between the execution of a call and a return, so that easily half the machine's time is spent in this ridiculous save/restore registers nonsense.

We can attack both these issues at once. First, let's have a simple machine. Some instructions will do arithmetic between the registers. Other instructions will move values between memory and registers. We'll make the operations simple so that they'll go blindingly quickly—goodbye, multiplication. It's so rare that having to call a subroutine to do a multiply makes the program less than 1 percent larger and actually run faster.

The same solution is to be used for the various application-specific operations that we used to do in microcode—write a subroutine. The microcode used to take a clock tick per step, and so does our new approach—with the advantage that if you want to do something we didn't think of, you're not left there cursing; you just write a subroutine to do it. Because the machine's so simple, we don't need microcode, so the thing will execute instructions at raw logic speeds.

With all the silicon space we've saved, we can now tackle the register save/restore problem. Let's have lots of registers, but access them a few at a time. At any one time, let's limit ourselves to, say, 24. When we call a procedure, we'll access a new bunch of registers inside the new procedure. When we exit the procedure, we'll be back with the original set. The register sets are arranged as a circular buffer, so that if we do exceed their capacity, we start over with the first register set (first storing to memory the contents of that set, of course).

Given the statistics on how deeply calls are nested, we can choose to have enough registers (say, 8) to have to do a save/restore only rarely. And even when we do run out of registers, examination of programs suggests that we tend to get to a certain call depth and then bounce down only a limited amount from there; the situation shows quite strong locality, behaving better than a random walk would suggest. In other words, we continue to have the benefit of our multiple register sets, even at great call depths, since we tend to

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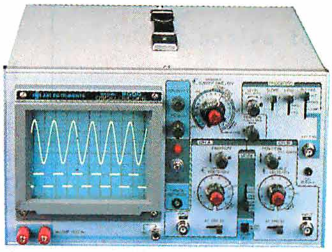

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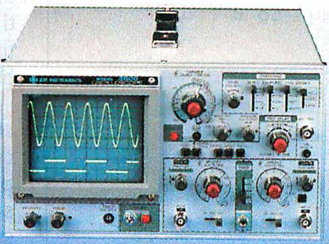

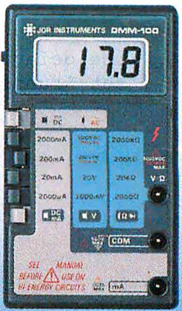

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Circle 152 on Reader Service Card

```
        .MOD     0
        .PUB     interpret
interpret:       .VAL     ?ws,1030
! PC is in ws - 1030
! acc=1029  instruction=1028   opcode=1027
! operand=1026   running=1025
        .VAL     ?tb,0
        AJW      -?ws
        .LDC     +1
        STL      ?ws-1025     ! running = TRUE
        .LDC     0
        STL      ?ws-1029     ! acc = 0
        .LDC     0
        STL      ?ws-1030     ! PC = 0
?2
        LDL      ?ws-1025     ! look at running
        CJ       @?3          ! jump to label 3 if it's zero
        LDL      ?ws-1030     ! load PC
        DUP                   ! copy it
        ADC      +1           ! increment
        STL      ?ws-1030     ! store PC++
        BCNT                  ! convert to a byte offset
        LDLP     ?ws-1024     ! load the address of 'memory'
        ADD                   ! address of 'memory[PC]'
        LDNL     0            ! load the value 'memory[PC]'
        STL      ?ws-1028     ! write it into 'instruction'
        LDL      ?ws-1028     ! load 'instruction'
        .LDC     +255         ! load the constant 255
        AND                   ! AND instruction with 255
        STL      ?ws-1026     ! write result to 'operand'
        LDL      ?ws-1028     ! get 'instruction' again
        .LDC     +8           ! load up shift distance
        SHR                   ! do the shift
        STL      ?ws-1027     ! store result in 'opcode'
        LDL      ?ws-1027     ! load 'opcode'
        DUP                   ! make a copy
        ADC      -1           !
        CJ       @?5          ! if it was '1' jump to label 5
        DUP
        ADC      -2
        CJ       @?6          ! if it was '2' jump to label 6
        J        @?7          ! default
?5
        LDL      ?ws-1029     ! add 'opcode' to 'acc'
        LDL      ?ws-1026
        ADD
        STL      ?ws-1029
        J        @?4          ! jump to end of switch
                              ! statement
?6
        LDL      ?ws-1029     ! subtract 'opcode' from 'acc'
        LDL      ?ws-1026
        SUB
        STL      ?ws-1029
        J        @?4
?7
        .LDC     0            ! the default case -
                              ! set 'running' to 0
        STL      ?ws-1025
        J        @?4
?4
        J        @?2

?3
        .RETF    ?ws
        .PUB     evaluate
evaluate:        .VAL     ?ws,9
        .VAL     ?tb,0
        AJW      -?ws
        LDL      ?ws+1
        STL      ?ws-8
        LDL      ?ws+1
        .LDC     +2
```

continued

stay near a given level for a while. The need to save/restore occurs only as the call depth crosses multiples of 8 (the hypothetical number of register sets).

Given this multiple set of registers, there's just one other problem: How does a procedure pass parameters to a procedure it's calling? The simplest solution is to have the successive sets of registers overlap by some amount, so that a calling procedure can scribble in some of its registers information that will be visible to the procedure it calls.

Because the machine is simple and fast, we don't want to have lots of different instruction sizes; they'd best all be the same size to keep the logic small. Since we've got a 32-bit address space, we'll need more than 16 bits of instruction to be able to jump around the place effectively, so the instruction size had best be 32 bits. Now we can make the instructions a bit more general than in our earlier design: Rather than having instructions like `add R1, R2`, we can have three-address instructions like `add R1, R2, R3`, meaning add `R1` to `R2` and put the result in `R3`.

This can also speed up the machine, since we can pipeline the register reads (two reads of the register bank per instruction) and write (one write to put the result in) so that the instruction cycle is faster than the time to read, operate, and write. This works as long as the next instruction doesn't use as a source operand the register this instruction has just written to; we rely on the compiler to arrange this for us.

This approach is the one adopted in the Sun SPARC. Currently implemented as a gate array, its performance is on a par with optimized custom designs like the MIPS R2000 and the Motorola 68030.

Division of Labor

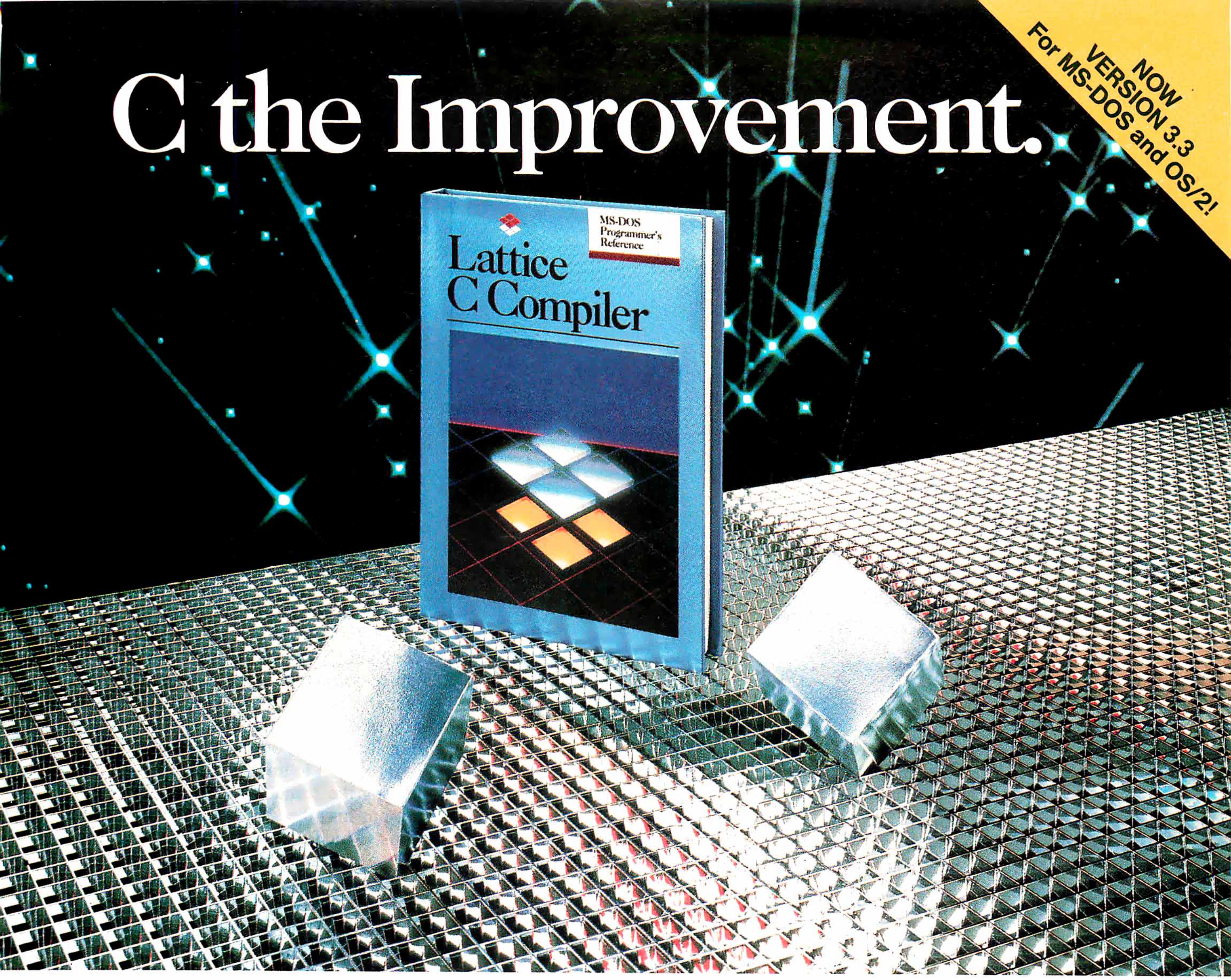
This architecture, however, is based on the fallacy that all interesting computer programs are single-processor applications broken up into procedures. Any reasonable analysis of reality will show that procedures are used, not because they're useful to the processor, but because they're useful to the programmer. And there's a much better modularization vehicle than the procedure—the process.

A process has its own private data that stays intact between activities by the process. Unlike procedures, you can scatter processes over a collection of computers so they can all run at once to give you a system speedup proportional to the number of machines you've got. Processes on separate computers can't call each other—they have to use some form of I/O to get data from one machine to the next.

A computer needs a lot of processes

continued

C the Improvement.



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Circle 163 on Reader Service Card

```
        DIV
        STL     ?ws-7
        LDL     ?ws+1
        ADC     +1
        STL     ?ws-6
        LDL     ?ws+1
        ADC     +2
        STL     ?ws-5
        LDL     ?ws+1
        LDL     ?ws-8
        ADD
        STL     ?ws-4
        LDL     ?ws+1
        LDL     ?ws-7
        ADD
        STL     ?ws-3
        LDL     ?ws+1
        LDL     ?ws-6
        ADD
        STL     ?ws-2
        LDL     ?ws+1
        LDL     ?ws-5
        ADD
        STL     ?ws-1
! and now the complex expression
        LDL     ?ws-4           ! load 'a'
        LDL     ?ws-3           ! load 'b'
        ADD                     ! a + b
        LDL     ?ws-2           ! 'c'
        LDL     ?ws-1           ! 'd'
        ADD                     ! c + d
        PROD                    ! (a + b) * (c + d)
        STL     ?tb             ! save it somewhere temporary
        LDL     ?ws-8           ! do same for (e + f) * (g + h)
        LDL     ?ws-7
        ADD
        LDL     ?ws-6
        LDL     ?ws-5
        ADD
        PROD
        LDL     ?tb             ! get the previous result back
        DIV                     ! do the divide
        STL     ?ws-8           ! store it to 'a'
        LDL     ?ws-8
        .RETF   ?ws
        .RETF   ?ws
        .PUB    matrix
matrix: .VAL    ?ws,2
        .VAL    ?tb,0
        AJW     -?ws
        .LDC    0
        STL     ?ws-2
?10
        LDL     ?ws+4
        LDL     ?ws-2
        GT
        CJ      @?9
        .LDC    0
        STL     ?ws-1
?13
        LDL     ?ws+5
        LDL     ?ws-1
        GT
        CJ      @?12
! the code for *m1++ = *m2++ + *m3++
        LDL     ?ws+2           ! get m2
        DUP                     ! make a copy
        ADC     +4              ! increment (byte address)
        STL     ?ws+2           ! store new value
        LDNL    0               ! load what m2 was pointing at
        LDL     ?ws+3           ! same for m3
```

continued

running on it, so that when one is waiting for a process on another machine to respond, it can be running another of its own processes. In such a system, the tidy stack-flavored behavior of the multiple overlapping registers just doesn't occur, and the approach becomes a memory save/restore hog like the simple single-register architecture, but with the added disadvantage of all that silicon space being given over to the useless registers.

Now that we can build 200,000-transistor systems, the sensible thing to do is to use most of them for memory on the same chip as the processor, and to build a simple processor. Then most of the data accesses will be to the on-chip memory, which is as fast as the processor. So we don't need registers and can simplify the instructions back to an accumulator-shaped architecture.

We'll modify this, because with an accumulator every instruction has to be able to access memory; the hardware is simpler if a number of accumulators are arranged as a stack so that an add instruction always adds one accumulator (the top of the stack) to another (next to the top), leaving the result in the top. The values get put into the stack with load instructions, which will push their values onto the stack; loads will pop their values.

Because all the values are kept in memory, process switching can be horribly quick (there's hardly any context to save). Procedure calls are quick, too, since there's no register save/restore overhead. Interrupts (the real world is full of interrupts) are just as quick. And because the encodings of the operations are separated from the loads, stores, and other housekeeping activities, code gets much denser and programs shrink.

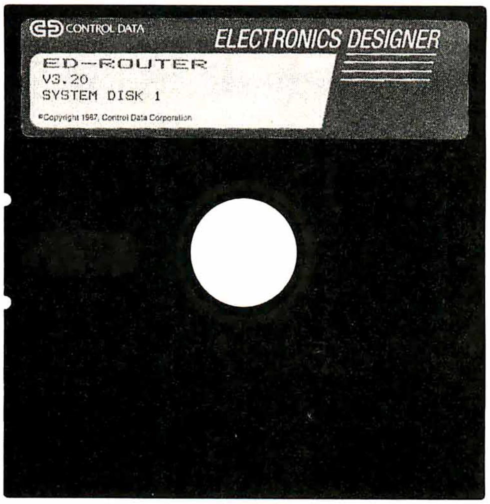
It's actually easier to implement such a simple machine design as a very fast microcoded machine; this lets us do complicated things in the microcode to improve code size with no speed penalty. We can have instructions for process scheduling, message passing, event handling—a complete real-time kernel—in the microcode, along with multiplication, division, and so forth.

That set of choices characterizes the INMOS T800, whose processor is about a sixth the size (at constant technology) of the 68030's (the chips are about the same size, but they use the remaining space in different ways; the T800 chip includes a floating-point coprocessor, for instance).

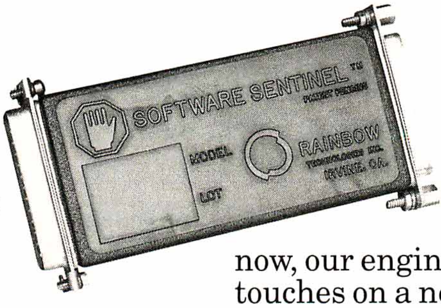
The way this discussion has been laid out, it seems a natural conclusion that the T800 is "better" than the other architectures; this (whether true or not) is hardly fair, since the discussion was guided by a desire to reveal the sorts of decisions that

continued

This Software Won't Run.



Without This.



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Circle 256 on Reader Service Card (DEALERS: 257)

```
          DUP
          ADC       +4
          STL       ?ws+3
          LDNL      0
          ADD                       ! add the two values
          LDL       ?ws+1           ! get m1
          DUP                       ! make a copy
          ADC       +4              ! increment
          STL       ?ws+1           ! store new M1
          STNL      0               ! and write the addition result
                                    ! where m1 points
?11
          LDL       ?ws-1
          ADC       +1
          STL       ?ws-1
          J         @?13
?12
?8
          LDL       ?ws-2
          ADC       +1
          STL       ?ws-2
          J         @?10
?9
          .RETF     ?ws
          .ALIGN
          .PUB      mat1
mat1:
          .DS       +64
          .ALIGN
          .PUB      mat2
mat2:
          .DS       +64
          .ALIGN
          .PUB      mat3
mat3:
          .DS       +64
          .PUB      main
main:     .VAL      ?ws,0
          .VAL      ?tb,0
          CALL      @interpret
          AJW       -2
          .VAL      ?ws,?ws+2
          .VAL      ?tb,?tb+2
          .LDC      +4
          STL       +1
          .LDC      +4
          STL       0
          .LDC      mat3
          .LDC      mat2
          .LDC      mat1
          CALL      @matrix
          AJW       +2
          .VAL      ?ws,?ws-2
          .VAL      ?tb,?tb-2
          .LDC      +5
          CALL      @evaluate
          .RETF     ?ws
          .END
```

Listing 4: *The compiled 68000 code emitted by Mark Williams Atari ST C given the source code in listing 1. Compare with listings 2 and 3.*

```
============ Mark Williams Atari ST C for 68000 ==========

          module name byte

          .shri

          .globl interpret_
```

continued

get made during the design process as ideas, technology, and perceptions change. It's pretty simple to point at areas that could be improved in the T800 in the same way we improved on the other machines: For example, the performance begins to drop noticeably as soon as the on-chip memory is too small to hold all the frequently accessed data. And its premise—that the world is process-shaped rather than procedure-shaped—may well be true, but the majority of available software doesn't reflect *that* belief.

Fitting Software to Silicon

Enough of the unreal discussion. What's the effect of different architectures in the real world? Let's look briefly at the instruction sequences used by three different architectures to implement some carefully chosen examples. The CPUs are the 80286, the 68000, and the T800. For simplicity, the code shown is compiled from C (using Borland's Turbo C, Logical Systems' C for the T800, and Mark Williams C for the Atari ST). The little fragments of code aren't intended as benchmarks—I've chosen them to illustrate certain points. And, of course, they don't allow the machines to show off all their characteristics—there isn't room. The idea is simply to highlight some of the differences.

There are three examples, for which the source code is given in listing 1. The first is the inner loop of an instruction-set simulator for an invented accumulator-based architecture. The second is a procedure that evaluates a complex integer expression. The third does a matrix addition. The resultant assembly language code emitted by three different compilers for three CPUs is shown in listings 2, 3, and 4.

The first example is typical of an interpreter application; for speed, we'd like the "registers" of the simulated machine—its program counter, accumulator, and so forth—to be implemented as quickly as possible. Looking at the code for the 80286, the effect of not having enough registers is obvious (see listing 2); perhaps half the instructions access memory, since there are only enough 80286 registers for two of the simulated machine's registers. The T800 code also uses memory for its variables (see listing 3), but there aren't very many of them, so they are all bound to fit in the very fast on-chip memory. The 68000 code has nearly enough registers for all the variables to fit in and will provide good performance too, since very few memory accesses are needed (see listing 4).

Note, too, the different styles of the

continued

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QNX

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Circle 250 on Reader Service Card

```
! PC is in d7 acc=d6 instruction=d5 opcode=d4
interpret_:
        link    a6, $-2070
        movem.l $248, (a7)
        moveq   $1, d0           ! copy 1 into d0
        move    d0, -2(a6)       ! running at -2(a6); set to 1
        moveq   $0, d6           ! acc = 0
        moveq   $0, d7           ! PC = 0
L3:
        tst     -2(a6)           ! does running=0?
        beq.s   L1               ! give up if so
        move    d7, d0           ! copy 'PC' into d0
        addq    $1, d7           ! increment PC in place
        ext.l   d0               ! make 'PC' a 32 bit value
        lsl.l   $1, d0           ! d0 * 2
        movea.l d0, a0           ! copy the value int a0
        adda.l  a6, a0           ! add to the address of the
                                 ! local variables
        move    -2050(a0), d5    ! get memory[PC] into
                                 ! 'instruction'
        move    d5, d0           ! now compute
                                 ! 'instruction & 255'
        andi    $255, d0
        move    d0, d3           ! into 'operand'
        move    d5, d0           ! and 'instruction >> 8'
                                 ! into 'opcode'
        asr     $8, d0
        move    d0, d4
        move    d4, d0           ! get 'opcode'
        cmpi    $1, d0           ! is it 1?
        beq.s   L5               ! if so jump to label 5
        cmpi    $2, d0
        beq.s   L6               ! if it's 2 goto label 6
        clr     -2(a6)           ! default - clear 'running'
        bra.s   L3               ! jump to top of loop
L5:
        add     d3, d6           ! acc = acc + operand
        bra.s   L3
L6:
        sub     d3, d6           ! acc = acc - operand
        bra.s   L3
L1:
        movem.l (a7), $248
        unlk    a6
        rts
        .globl evaluate_
evaluate_:
        link    a6, $-26
        movem.l $248, (a7)
        move    8(a6), d7
        move    8(a6), d0
        ext.l   d0
        divs    $2, d0
        move    d0, d6
        move    8(a6), d0
        addq    $1, d0
        move    d0, d5
        move    8(a6), d0
        addq    $2, d0
        move    d0, d4
        move    8(a6), d0
        add     d7, d0
        move    d0, d3
        move    8(a6), d0
        add     d6, d0
        move    d0, -2(a6)
        move    8(a6), d0
        add     d5, d0
        move    d0, -4(a6)
        move    8(a6), d0
        add     d4, d0
        move    d0, -6(a6)
```

continued

compilers. Turbo C implements the switch statement as a jump table, while the other two compilers use a succession of tests and jumps. The Mark Williams compiler even manages to optimize away the wasteful jumps to jumps that the T800 compiler exhibits (but remember that this compiler is only a beta release).

The next example is of arithmetic expression evaluation. Here again, the 80286 has to shuffle stuff to and from memory. We can see that it can happily compute $(a+b)\times(c+d)$, but then it has to put it somewhere safe—so it pushes it into a memory stack. The T800 does the same thing, but it uses a temporary variable instead. The 68000 has enough registers for all but three of the variables, so it can do the job quite nicely.

Let's look at these examples a bit more closely. The 80286 not only spends a fair amount of time messing with memory, it also has to move values into special places for some operations (like multiply and divide). The T800 doesn't—all the operations are available on the stack-held variables, saving a load of housekeeping work. Of course, it will slow down from memory traffic if we use up the on-chip memory, but that can be avoided by common sense (e.g., `malloc`ing arrays so they are off-chip).

The 68000 looks good, but it spends a good deal of its instructions shuffling stuff between registers (quicker than memory traffic, but still functionally useless). Also, we can see several examples of successive instructions adding something into a specific register; the 68000 is using a register as an accumulator (which in a T800 or a 6502 doesn't need to be mentioned in the instruction—its use is implicit) and having to waste instruction bits doing so. This tends to make 68000 programs bigger than T800 programs.

Then there's the matrix example. This shows the 68000 to its best advantage. The code shows that the machine directly understands the C phrase `m2++` ("use a variable as an address, read what it's pointing at out of memory, and then increment the pointer"). As a result, the 68000 code for the inner loop of the matrix procedure is by far the shortest of all the examples. The T800 is more longwinded, but pretty straightforward, and the 80286 is similar to the T800. The apparent advantage of the 68000 isn't so real, though; the processor still has to access the memory and to actually do an addition. The code looks smaller on the page but doesn't run faster than the other machine's approach of doing it by hand.

Finally, you can look at what it takes to call a procedure. The code in the `main` subroutine shows what each machine

continued

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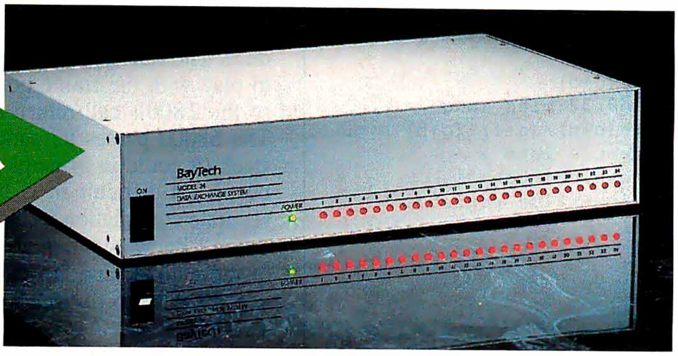

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```
    ! and now the computation
        move    -6(a6), d0          ! 'h' moved to d0
        add     -4(a6), d0          ! add 'g' in to d0
        move    d3, d2              ! 'e' into d2
        add     -2(a6), d2          ! add 'f' into d2
        muls    d0, d2              ! d2 = d2 * d0
        move    d5, d1              ! 'c'
        add     d4, d1              ! 'c' + 'd'
        move    d7, d0              ! 'a'
        add     d6, d0              ! 'a' + 'b'
        muls    d1, d0              ! (a+b)*(c+d)
        ext.l   d0                  ! make d0 32 bits long
        divs    d2, d0              ! (a+b)*(c+d)/(e+f)*(g+h)
        move    d0, d7              ! put result into a
        move    d7, d0              ! put result into
                                    ! function-value register
        movem.l (a7), $248
        unlk    a6
        rts
        .globl matrix_
matrix_:
        link    a6, $-20
        movem.l $14528, (a7)
        movea.l 8(a6), a5
        movea.l 12(a6), a4
        movea.l 16(a6), a3
        moveq   $0, d7
L12:
        cmp     20(a6), d7
        bge.s   L9
        moveq   $0, d6
L15:
        cmp     22(a6), d6
        bge.s   L13
        move    (a4)+, d0          ! a4 is m2 - read from memory
                                   ! then increment m2,
                                   ! putting result into d0
        add     (a3)+, d0          ! add *m3++ into d0
        move    d0, (a5)+          ! write result into *m1++
        addq    $1, d6
        bra.s   L15
L13:
        addq    $1, d7
        bra.s   L12
L9:
        movem.l (a7), $14528
        unlk    a6
        rts
        .comm   mat1_, 32
        .comm   mat2_, 32
        .comm   mat3_, 32
        .globl main_
main_:
        link    a6, $0
        jsr     interpret_
        moveq   $4, d0
        move    d0, -(a7)
        moveq   $4, d0
        move    d0, -(a7)
        move.l  $mat3_, -(a7)
        move.l  $mat2_, -(a7)
        move.l  $mat1_, -(a7)
        jsr     matrix_
        adda    $16, a7
        moveq   $5, d0
        move    d0, -(a7)
        jsr     evaluate_
        addq    $2, a7
        unlk    a6
        rts
```

does. The 80286 pushes the procedure parameters onto the stack and then calls the procedure. The first thing the procedure does is spend some time saving a few registers.

The T800 passes three parameters on its processor stack, putting the others in locations in memory where they'll look like local variables to the called procedure. The called procedure itself has only to play with the frame pointer on entry, so the T800's call/return is pretty slick. The 68000 passes its parameters on the stack (it could in principle use registers, but that's difficult in C because of the separate compilation facilities—the caller doesn't know anything about the innards of the callee), and the called procedure doesn't have to do much more than the T800.

Out of the Armchair

You should see by now that there is no satisfying answer to the question of which architecture is the best. It all depends—on the technology, the problem, and the politics. But architecture is a fuzzy question; it's more practical to compare implementations, and this can be accomplished to a certain degree of precision, given the weary task of collecting lots of data. The text box "Architectural Metrics" on page 214 provides some suggestions as to how the measuring might be done.

This discussion has glossed over the many very difficult technical decisions about what to put in and what to leave out of a design when only finite resources are available. During the actual design of a machine, more rigor is brought to bear; see the text box "Designing an Architecture" on page 217 for a look at some of the available methods.

The discussion has taken us from the simplest practicable microprocessor to extremely advanced architectures. I've ignored other facets of computer design, such as prefetching instructions, the use of a cache, the effects of virtual memory, the provision of support for vector operations, floating-point coprocessors, and how to handle I/O. While it's not possible to claim that the designers of the real machines I referred to actually used the same metrics suggested here, the progression of ideas is legitimate. From it, you should have some idea of the technical forces shaping the machines on our desks, and why they are the shape they are. ■

Pete Wilson is a computer architecture engineer at Prisma Inc. (Colorado Springs, Colorado), working on the design of a new gallium arsenide supercomputer. He previously worked on the design team for the INMOS transputer.

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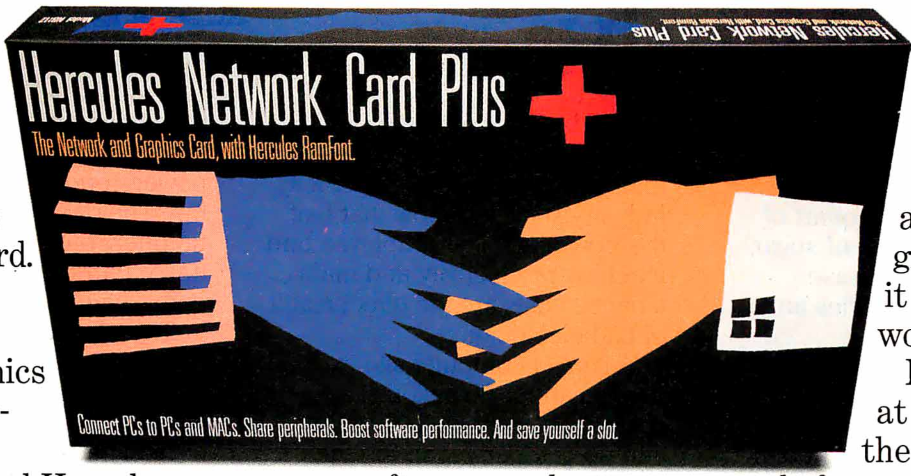

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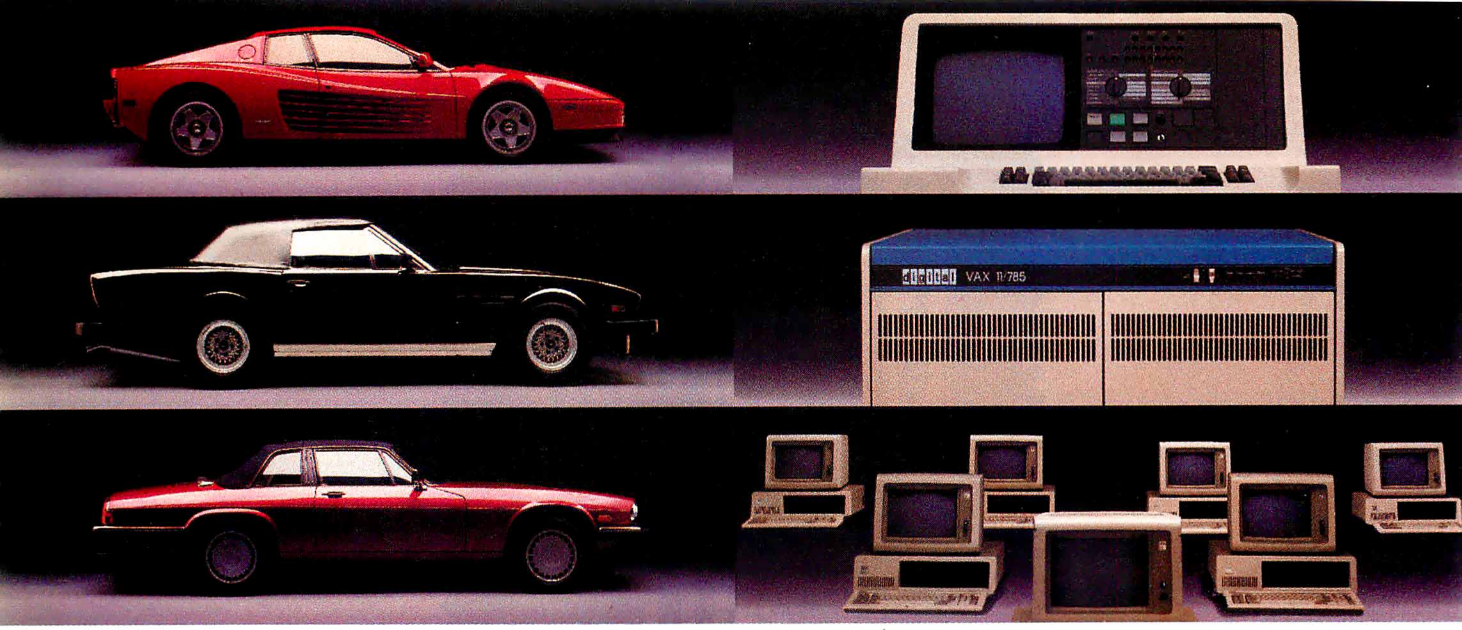

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What They Did Wrong

The shortcomings and inadequacies of various CPU architectures

Richard Grehan and Jane Morrill Tazelaar

LET'S FACE IT—no CPU architecture is perfect. No matter what approach you take in designing a microprocessor, some aspect of it could be better if it were designed another way. The perfect logic of any approach runs into roadblocks from time to time. And no matter how much you include in the design, there's always something you missed, or found unimportant, that is essential to someone else.

Other articles in this section explore the way CPUs have evolved and explain where the newest generation of microprocessors is headed. They examine some other issues, like CPU-to-memory interfacing, that influence computer performance. But maybe there are lessons to be learned by looking at some of the glaring omissions in earlier-generation CPUs.

To add to some of our own experiences—and frustrations—with various architectures, we informally polled the members of some microprocessor-specific conferences on BIX to find out what peeves them about their favorite—or not so favorite—microprocessor. (See table 1 for a comparison of the architectures discussed.) Our emphasis is on assembly language programming, as that comes closest to the nitty-gritty. Here, then, are some of their comments, with some of ours, about the limitations and inadequacies of various CPU architectures.

Intel's 8080

Some of the S-100 machines, such as the Altair, use the 8080 chip as their CPU. It has 8-bit registers (although some registers can pair up for a 16-bit total), an 8-bit data bus, and 16-bit addressing (for an address limit of 64K bytes). Registers are specialized. All jumps are absolute, making relocatable code extremely difficult—if not impossible—to create. The 8080 has no multiply or divide instructions, and addition is the only thing you can do in the 16-bit paired registers; there is no 16-bit subtract instruction.

Originally, Mostek's 6502

The Apple II computer contains the 6502 CPU. It has 8-bit registers, an 8-bit data bus, 16-bit addressing, and is limited to 64K bytes of physical address space. It has no multiply or divide instructions (you couldn't have done much with them anyway). It has only one accumulator—you *must* use register A for math and logic operations. The maximum stack size is 256 bytes—it's restricted to page 1 of the memory area. The 6502 has no separate I/O instructions, so I/O devices must be mapped to memory addresses.

Two instructions that would really be nice to see on the 6502 are `TXY` and `TYX`. Instead, you have to do some kind of push/pop or store/load sequence to transfer a byte from one index register to another. And how about that carry flag? All you want to do is a quick 8-bit add—no muss, no fuss. But *no*. If you're writing modular code, you've got to eat up that extra byte *just* to make sure there's nothing sitting in `CY`.

Henry Vanderbilt from Roxbury Crossing, Massachusetts, says: "The first thing that comes to mind is [the omission of] 2-byte relative addressing. All the relative branch instructions take only a 1-byte operand, limiting their range severely. [And then there's] absolute addressing only when you're going farther than plus or minus 128 bytes or so. Relocatable code? Not on a 6502. A minor peeve—there's no unconditional branch. You have to use

```
CLC
BCC FOO
```

`BNR` (branch for no reason) would eliminate that."

From John Fachini in Manchester, New Hampshire, comes a reply: "The 65C02 gives you `BRA` (branch always), and the 65C02 is, without doubt, what the 6502 should have been way back when. The biggest 6502 weakness is the fact that when you want to move something you've got to put it in the accumulator. The 65816 has the `MVP` [block move positive] and `MVN` [block move negative] instructions (fair to middling); the 80x86 series has `Rep MovSB/W` (great); and—sigh—the 6502 has

```
LDA ITEM,Y
STA DEST,Y
INY
. . . "
```

Landon Dyer from Sunnyvale, California, responds: "On the other hand, there are probably more 6502s in the world than 80x86s and 680x0s combined. Might makes right. Quantity *is* quality. Naturally, most of those 6502s are sitting in closets...I can't think of many changes I'd make to the 6502 that wouldn't also

continued

One item that irks me about the 65816 that I love about the 8086 is the switching between 8- and 16-bit modes.

involve a complete redesign. I mean, if you're going to make just *one* change, what's it worth? Can you write commercial code that depends on it? I can just see your game cartridge coming with a 65C02 to install as well. But, at one time, I would have *killed* for an `LDY (n,X)`!"

Henry Vanderbilt: "The 6502 *is* a bit short on frills. After learning to write on one, the reduced-instruction-set-computer (RISC) concept seemed natural. However, I hear RISC chips tend to have a few more registers to work with than the 6502. One feature I always wanted: the ability to set the 8 most significant bits of the address bus to other than `$00` [hexadecimal zeros], for use with the zero-page addressing mode. I heard it said once that the 6502 actually has 256 8-bit registers, due to the speed and brevity of the zero-page mode. It would be useful to [be able to] keep more than one area of memory as zero-page."

John Fachini: "There is a problem with the use of the `JMP` instruction where the address field falls on an `FF/00` page boundary. The 6502 would look at, say, `$3FF` and `$300` for the vector. The 65C02 and above look at `$3FF/$400`."

And from Randy Hyde in Norco, California: "When considering the 6502 architecture, don't forget to look at the Mitsubishi 50750 family of CPUs. These are single-chippers based on the 6502 that include such goodies as memory-to-memory operations (in page zero) and lots of bit-test, set, and clear operations."

Zilog's Z80

The TRS-80 and some S-100 machines use the Z80 chip: 8-bit registers and data bus, 16-bit addressing with a 64K-byte address limit, and no multiply or divide instructions. The Z80 made a lot of improvements over the 8080. Relative jumps were a nice addition, as were the `LDD`, `LDDR`, `LDI`, and `LDIR` instructions (and others with built-in repeats and register increments and decrements). But why did the Z80 designers require an offset every time you use the `IX` or `IY` registers as index registers? You can't do `LD (IX),n`; you have to do `LD (IX+d),n`. Sure, *d* can act as an index into an array for which `IX` is the base, but *d* has to be hard-coded. So, unless you like writing self-modifying code, it doesn't buy you much.

From William Smith in Hamilton, Massachusetts: "Things that would be nice on the Z80 are things like `LD (IX+C_REG),(IY+B_REG)` and, one of my personal favorites, `LD HL,(HL)`, which all comes down to having a complete instruction set where you can use any and all addressing modes with any and all instructions. This is why the VAX and National 32000 architectures [interest] me: You don't have to remember that something isn't allowed. But it wasn't possible to *make* 64-bit machines with 256 registers and complete instruction sets that run at 25 MHz and execute every instruction in one clock cycle, so we are 'stuck' with the Z80."

Ray Duncan from Marina del Rey, California, responds: "It would have been nice if the `(IX)` and `(IY)` instructions weren't so bloody slow. They make great-looking code on paper, but in general you can get better results by just saving and loading the `HL` register as though the chip was an 8080. Also, they should have had a special set of op codes for `(IY)` and `(IX)` addressing without displacement, instead of requiring the zero displacement byte to always be there."

From Larry Sonderling in Los Angeles, California: "I've always wished for 2-byte relative jumps. Relocatable code would surely be a lot easier that way. Also, [the ability] to swap any two single or double registers would be handy. And the `IN (HL)` form would be great if it worked."

Steve Russell from Butler, Pennsylvania, adds: "Gee, remember way back when the Z800 was 'just about' out, and it was going to do all the things we wished the Z80 would do? Actually, the 64180 did a nice job of making the index instructions clock respectably; only by then, who cared? We already had neat stuff making slick use of two index registers as word-size register variables or some such." (For a build-it-yourself 64180 system, see "Ciarcia's Circuit Cellar" in the September and October 1985 BYTE.)

And from Ralph Becker-Szendy in Honolulu, Hawaii: "Come on, the Z280 closes a lot of holes the Z80 instruction set has. But I have no clue as to how fast the new instructions are."

Table 1: *CPU chip capacities.*

CPU chip	Register size (in bits)	Data bus size (in bits)	Address size (in bits)	Physical addressing limit
8080	8	8	16	64K bytes
6502	8	8	16	64K bytes
Z80	8	8	16	64K bytes
8088	16	8	20	1 megabyte
8086	16	16	20	1 megabyte
65816	16	8	24	16 megabytes
80286	16	16	24	16 megabytes
68000	32	16	24	16 megabytes
68020	32	32	32	4 gigabytes
80386	32	32	32	4 gigabytes

Intel's 8088, 8086, and 80286

The Intel family of chips is very familiar. The 8088 is the CPU for the IBM PC and some of its compatibles. Although it still has the 8-bit data bus, it has moved up to 16-bit registers and 20-bit addressing, allowing an address space of 1 megabyte. Some PC compatibles use the 8086 chip, which moves fully into the 16-bit world: registers *and* data bus. It maintains the 20-bit addressing and the 1-megabyte address space. The 80286, which resides in the IBM PC AT and its clones, keeps the 16-bit data bus and registers and expands addressing to 24 bits for a maximum of 16 megabytes of addressable memory.

These architectures have their problems as well, such as those nasty segment registers. Even though the physical addressing capability is in the megabytes, segments can be only 64K bytes long.

continued

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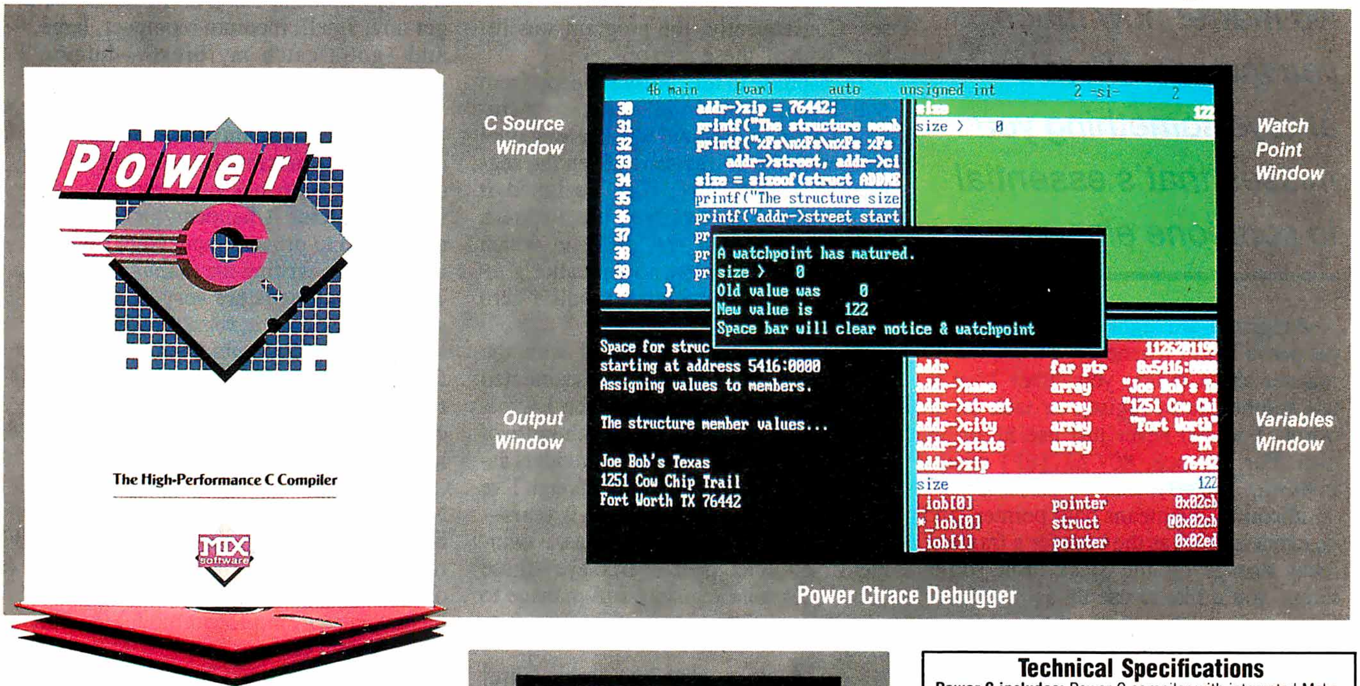

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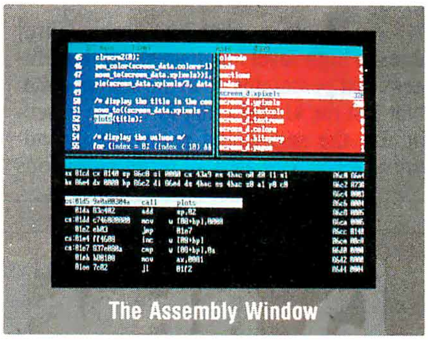
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No matter how much you include, there's always something you missed that's essential to someone else.

And registers are highly specialized. One pet peeve is that whenever you use the BP register as an index, you either have to use another index register or tack on an offset. You can never just use BP on its own. For instance, `MOV AX,[BP]` results in `MOV AX,[BP+0]`.

Of course, BP means base pointer, and its intent is to act as the base for a frame of local storage on the stack. But sometimes, you'd like to use BP as just an index into the stack with no displacement; so why do you have to carry around that extra byte or two that you don't need? Too bad they didn't take the r/m field designator for BP+DI+DISP and let it be just BP. Working on a small, Forth-like language some time ago, Richard decided to use separate data and return stacks. He ended up using BP a lot, and often with no offset. Consequently, the program was littered with all these zero offsets.

In response to this, Russ Schnapp from San Diego, California, writes: "Actually, I have no problem with the way Intel went with the BP register. Given the segmented architecture, they designed it quite well. You typically use BP as a frame pointer into the stack, in which case BP tends to point to the caller's BP and is seldom dereferenced with a zero offset.

"I am constantly disgusted with the whole concept of the iapx86 segmented architecture. It was a pain when I wrote code generators for it; it is much more of a pain when you try to write (shudder) assembly language code for it. Though I've been writing iapx86 code for 9 years—yes, back when the 8088 was just a twinkle in an Intel developer's eye—those darned segment registers still manage to reach out and 'byte' me [from time to time].

"And look at what [the architecture] does to high-level languages! All the silliness that percolates up to the source code. Not just the kludges that force you to recognize the segmented nature of the address space, but also all those ridiculous memory models! Look at Turbo C: You get tiny, small, medium, compact, large, and—gotta catch my breath—humongous!"

Terje Mathisen from New York, New York, says: "My main problem when trying to wring maximum speed out of the segmented 8086 has been too few segment registers. It happens far too often that I need to process input from two different areas, writing the output to a third. The only solutions are very ugly. Either swap the segment registers back and forth, or use SS to hold the third segment for a *short* time, while disabling *all* interrupts. The last solution, copying one set of input into local stack variables, is often impossible due to stack-size limitations."

From Edmund Burnette in Cary, North Carolina: "In the same vein, not being able to move or exchange segment registers without going through memory or another register is a pain. Besides the inconvenience, in protect mode, the hidden-segment cache is lost."

A question from Cheyenne Wills in Mechanicsburg, Pennsylvania: "In [80286] protected mode, what is the overhead of reloading a segment register with the same value? Is this something to

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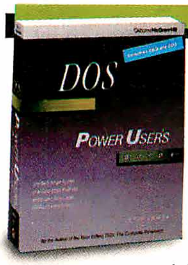

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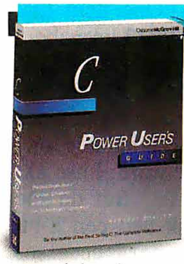

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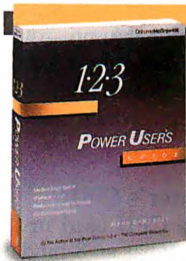

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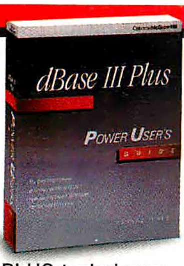

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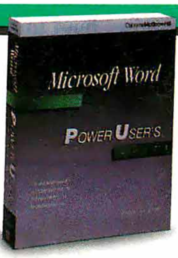

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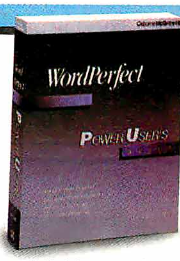

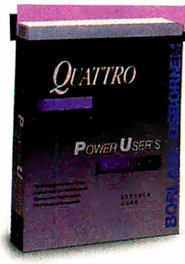

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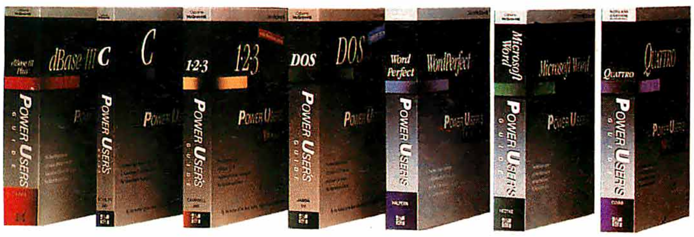

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be avoided, or are the checks for a segment exception avoided in this case?"

An answer comes from Bartosz Milewski from Bellevue, Washington: "Good question. The answer is: Reloading takes the same amount of time as loading a new descriptor. In fact, if you are expecting a lot of reloads, it is worth the trouble to write the code that would compare the new descriptor with the old value and do the conditional jump around the loading code. The same goes for the 80386. The latter, however, has two more segment registers, which can be really helpful."

Western Design Center's 65816

The 65816 chip is the CPU used in the Apple IIGS computer. It has an 8-bit data bus, 16-bit registers, and 24-bit addressing with its 16-megabyte memory-addressing capacity. The segmentation is the same as on the 8088, 64K-byte maximum size, only here the segments must align on 64K-byte boundaries—the 8088's segments align on 16-byte boundaries. Basically, this is a souped-up 6502, and it *still* has no multiplication or division instructions, but it does have TYX and TXY.

Why did the 65816 designers decide to force the direct-page register and the stack pointer onto the zero bank? The data-bank register is a step in the right direction, but why didn't they attach it to the direct-page register and the stack pointer? It seems that if the direct-page register also used the data-bank register, it would be easier to attach local storage to transient or shared routines.

From John Fachini: "One item that irks me about the 65816 that I love about the 8086 is the switching between 8- and 16-bit modes. If I want to handle character input and output into a string of bytes on the 8086, I use AL (accumulator low) or AH; if I want to use the word, I use AX. Same for BX, CX, and DX. But on the 65816, I've got to clunk between 8-bit memory and 16-bit memory accesses with the status register. Since, for example, the LDA instruction is the same and the processor checks the M flat in the P register for sizing instead of generating a different byte for the LDA, you're stuck. I assume this has to do with the 1-byte limit on the op code with fields coming in up to 3 bytes after it. I'm not sure this is making sense, but I think you get the picture. At least, 8086 folks will get the picture."

Morgan Davis from La Mesa, California, adds: "I have a lot of gripes about the 65816 (that are also applicable to the 65x02 series as well), but here's something I just had some experience with that I wish the 65x02 series had: Stack relative instructions *and* instructions such as PER (which basically pushes the program counter onto the stack, or the address of an object from PC plus an offset). If you write relocatable code, that sort of thing is indispensable.

"Randy Hyde has written a tome about a proposed upgrade to the 65816. You'll find it in apple/long.msg [apple conference, long.msg topic, on BIX] (four messages in all). Randy's put a lot of good thought into it—an understatement. [It reads like a thesis for] a master's in computer science."

Motorola's 68000

The 68000 chip is the power behind the Macintosh. It has a 16-bit data bus, 32-bit registers, and 24-bit addressing. However, even though the registers are 32-bit, the multiply instruction can multiply only 16-bit quantities. (The 68020 chip solves this and moves up to 32-bit addressing and the 32-bit data bus as well.)

Was it really such a good idea to have the MOVE instructions set the condition

continued

flags? It's frustrating when you run into situations where you've got to move something into a register, but you don't want to mess up the flags.

Also, how much throughput do you gain by requiring words and doublewords to be on even-address boundaries? Consider the case of compilers—C compilers, in particular. Let's say you have a function that looks something like this:

```
func1(x) int x;
{ char a,b,c;
...
```

The function `func1( )` will attempt to set aside 3 bytes of local storage—for `a`, `b`, and `c`—on the stack. On the Mac, at least, this sends the machine into the weeds. The situation can get worse if the function includes mixed `char` and `int` definitions:

```
func1(x) int x;
{ char a,b;
int y,z;
char c,d;
```

There's at least one compiler that has a switch you can set to either allocate local storage as it appears in the source code, or to rearrange local variables to minimize "holes" on the stack. (This would amount to grouping all the `char` definitions above so that at most only 1 byte would be wasted on the stack.)

From Chris Green in Champaign, Illinois: "The 68000 is desperately in need of a `SWAP.B` op code. Relative branch-instruction offsets waste 1 bit. You can't branch to an odd address, so why not provide 256 or 65536 either way? Then just about every non-C program could avoid long branches. I [also] wish the 68000 allowed you to pop `PC` in a `MOVEM` from the stack. Then you could pop all your saved registers from the stack, along with the return address, and save an instruction."

Mark Riley in Simi Valley, California, adds: "I think the way the 68000 affects status flags in the `MOVE` instruction is OK. It's very handy to be able to move data and know if it's zero or negative. However, I'm not sure why the carry bit is cleared. If your destination is an address register, then the flags aren't set; this is sometimes a problem—other times it's great. The `MOVEM` instruction very wisely does not alter the flags, as this allows subroutines that are restoring registers to return flags unaltered.

"Now as to a problem: The `X` flag bit is poorly implemented, in my humble opinion. You should be able to branch on whether or not it is set. Since `MOVE` clears the carry, this would be desirable. Also, manipulating the `X` flag is a bit of a hassle. I mean, getting it out of `SR` (and changing it) can cause you problems, depending on whether you're 68000, 68010, or whatever. In this respect, the 68010 is not 100.000 percent compatible with the 68000. Bummer.

"Here's a quirk: There's both an `AND sadr,Dn` and an `OR sadr,Dn` but no `EOR sadr,Dn` in sight. In most respects, though, the 68000 series allows you to write straightforward, no-tricks type of code."

From Tom Zerucha in Southfield, Michigan: "Problems with the 68000 architecture [include]:

1. The 68000 needs a 32 × 32 multiply and a 32/32 divide.
2. They should have left a 100 percent compatibility mode in the 68010 and 68020, so you wouldn't have to change anything to change processors but 'turn on' the extended mode, like the cache is turned on or the vector base register moved.
3. I don't think that the `MOVE` instructions

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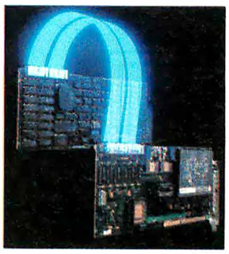

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setting the flags are bad, especially since moving addresses around doesn't affect them. Otherwise, you have to do a separate test/compare each time you want to check them. And you don't normally care what the status flags are until you do a conditional jump, when you probably have just moved the thing you want to test. The DBcc instruction (especially in the 68010 loop-mode cache) makes use of this nicely.

4. They should load the initial SP and PC from somewhere else—the interrupt vector table is normally in RAM, but the resetting is normally done from RAM.

5. They should have had relative branches that can jump farther than 32K bytes (i.e., using a longword offset). It is not a big problem unless you have large modules that you want to be completely relocatable. They fixed this in the 68020. Also, some of the addressing modes take only word displacements. With completely relocatable code, you don't need fix-up information."

Ed Tomlinson in Dorval, Canada, writes: "If you ever want to implement Forth on a 68000 machine, the NEXT instruction takes two instructions: MOVE (AN)+,AM and JMP (AM). Why not allow JMP (AN) +...? I like the way MOVE sets the status flags. Another thing I would like would be the ability to tell the 68000 which address register to use as SP. This would take 3 bits in the status register."

Tom Zerucha: "You could emulate SP changes by doing an exchange with the other register. And there are very few instructions you would use a stack for that don't work on the other registers. I agree a SWAP.B would help (ROR.W #8,Dn is slow except on the 68020, and it is often needed).

"In terms of odd word access, I don't code these into my programs, but if I have to work with other data files, I could use a 'move-from-odd-address' instruction. The idea of an extended status bit that is different from the carry flag looked strange, but I find it very useful."

32-bit Architecture

What about Motorola's 68020 and Intel's 80386? Well, since they were designed as evolutionary extensions of the previous architectures, many of the problems have been solved. They have 32-bit registers, 32-bit data buses, and 32-bit addressing, to a maximum of 4 gigabytes of physical address space. This doesn't mean that all the problems have been solved; it just means that new ones haven't surfaced to any great degree yet.

Never Satisfied

When you're in the middle of a field of assembly language code, wishing for that one instruction that will make it all perfect, it's easy to believe that CPU designers neglected certain obviously critical instructions, and did so because they thought "No one will need *that* instruction anyway." It's more often the case that the designers were faced with a trade-off in design complexity (read: costs) versus a more "complete" instruction set. Still, good programs do exist.

We'll probably whine about processors' shortcomings until the day when we type in a series of assembly language instructions and the CPU looks up at us and says, "I'm sure you really meant to do *this*," then proceeds to change two or three of the instructions automatically. And when we get there, we'll probably wish we were back where we are now, where computers aren't so smart and *we* can still tell *them* what to do. ■

Richard Grehan and Jane Morrill Tazelaar are senior technical editors for BYTE.

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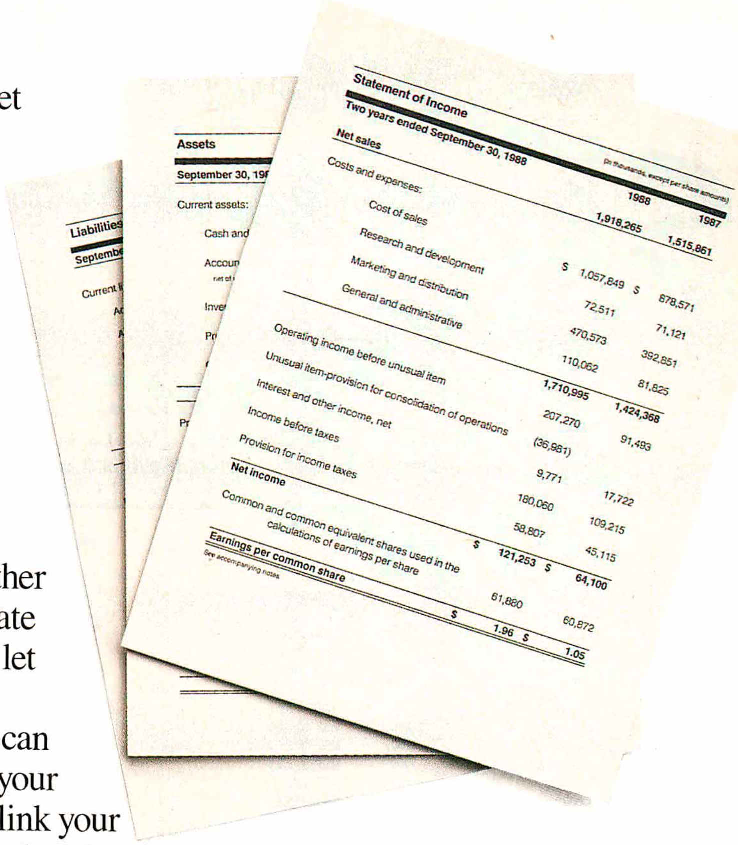

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Modeling Chaos

A parallel CPU architecture can take you where shorter clock ticks, smarter instructions, and more on-chip memory can't go

Peter Wayner

WHEN SCIENTISTS ATTEMPT to model the flow of water or air or any fluid, they write a Navier-Stokes differential equation that describes how a small part of a continuous stream will behave. In easy cases, such as water flowing down a straight pipe, calculus and clever guessing can provide an exact solution that describes the flow. But in more difficult problems, such as the turbulent flow of air around the wing of a new airplane (see photo 2 on page 258), the answer cannot be found with paper-and-pencil mathematics; numerical analysis by computer is required.

Solving this type of problem on a traditional, serial-architecture computer—even a very fast one—can be impractical because of the large number of separate and independent calculations to be performed. The problem seems tailor-made for a parallel architecture, and, in fact, it has become a primary application for parallel-architecture machines. The approach has been so successful that many companies are replacing their wind-tunnel tests with computational models running on parallel-architecture computers.

A look at two such computers illustrates many of their strengths and some of the technical issues that come up in using them. In the Connection Machine, from Thinking Machines Inc. (Boston, Massachusetts), several thousand extremely simple CPUs are hooked into a large array with carefully arranged channels of communication between them. The design allows many thousands of similar calculations to be executed literally at once (not just apparently, as is the case with multitasking architectures). Another radical new design, implemented by researchers at Princeton, involves CPUs with only one instruction that is custom-designed to solve a single problem at a very high speed.

Instead of using standard numerical methods requiring accurate real-number arithmetic to simulate a process, both the Connection Machine and the Princeton computer use a cellular automaton to model the interaction between particles on a grid. It may not be elegant to the classical mathematician raised on smooth functions, but its simplicity makes it easy to compute in parallel. Before looking at the details of these machines, I'll briefly explain the cellular automaton model used on both of them to simulate fluid flows. Having the practical application in front of you makes the strengths and drawbacks of parallelism much clearer than would an abstract discussion.

Fitting the Problem to the Architecture

The cellular automaton model discussed here was proposed by a team of three scientists at the Los Alamos National Laboratory: Uriel Frisch, Brosl Hasslacher, and Yves Pomeau. Further studies have been made by others, including Jim Salem, Bruce Nemnich, and Steve Wolfram at Thinking Machines.

The model follows the movement of particles on a large hexagonal lattice. The particles interact according to a set of easily computed rules that specify the outcome for every possible collision. After each time step, the computer checks for particles colliding. The hexagonal lattice lets up to six particles collide at once from six different directions; this yields $2^6 = 64$ possibilities. However, the 64 possibilities can be reduced through reflection and rotation of axes to a more manageable 14, and that is the number of rules the working model actually contains (see figure 1).

All the particles are assumed to be moving at the same speed. Every rule conforms to the Newtonian law of conservation of momentum. Put differently, the vector sum of particles moving inside each grid is the same before and after each time step.

The model can be adjusted to handle fluids and gases with different viscosities by adjusting the density of the grid. The dynamics of a fluid are measured by a number known as the Reynolds number, which is proportional to the particle velocity and size, and inversely proportional to the viscosity of the fluid. Slow-moving objects in thick liquids, like raisins in molasses, have a low Reynolds number; fast objects moving through slippery fluids, like bullets through air, are described by large numbers.

In the simulation, the relative density of the grid determines the Reynolds number. If there are many nodes close together, the automaton behaves like a fluid with a high Reynolds number. If there are relatively fewer nodes, the simulated fluid will be thicker. Experiments have shown that the number of nodes per square inch is roughly proportional to the square of the fluid's Reynolds number.

continued

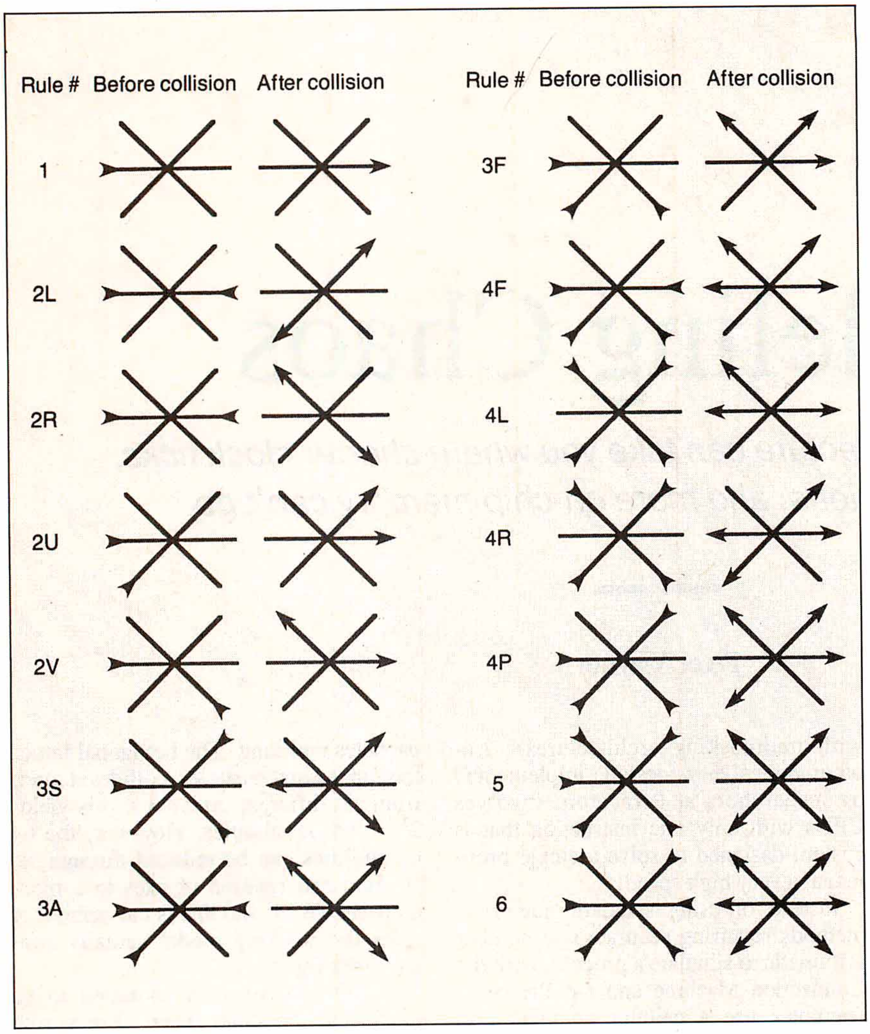


Figure 1: *These 14 rules determine the effects of particles colliding in the fluid-flow cellular automaton. By rotating and reflecting the axes, the rules cover all 64 possibilities.*

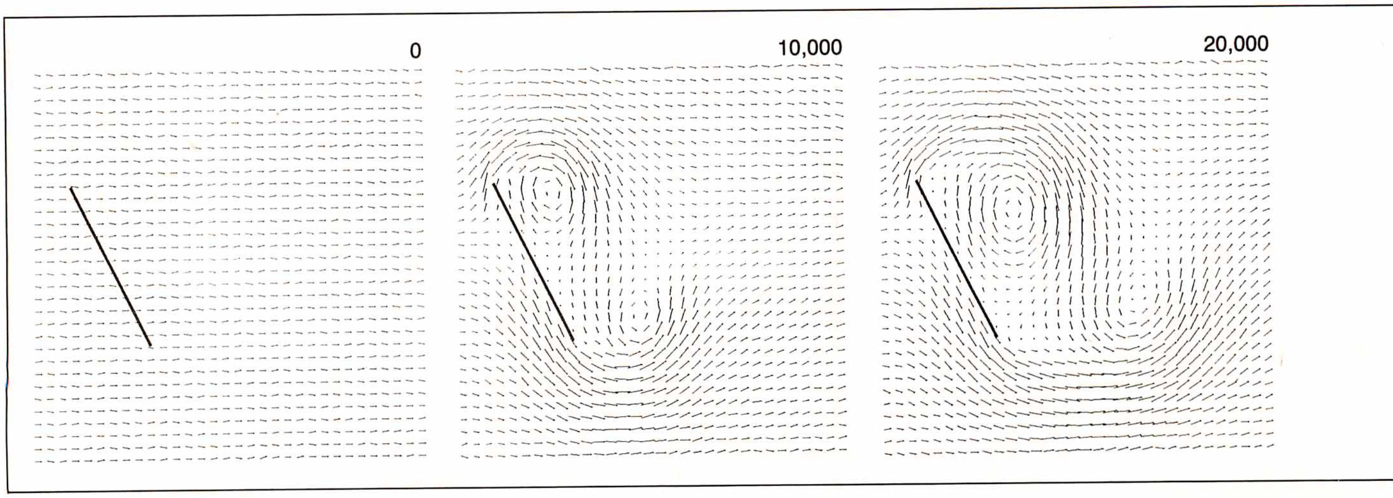
Figure 2: *The successive generations of a 2048- by 2048-cell automaton show how a plate can introduce turbulence into the model. Each arrow represents the average velocity computed over a 64- by 64-cell region. The frames are shown for 10,000-generation intervals, starting at generation 0.*

Using a Macintosh with Lightspeed Pascal, I wrote a program for calculating and displaying a microscopic version of the model (see the editor's note at the end of this article). At this cut-down level, the behavior of particles appears random. A better picture of what happens at the macroscopic level requires that we use a much larger grid, divided into quadrants, and calculate an average direction for the particles in a given quadrant. Figure 2 shows a sequence of "snapshots" made every 10,000 time steps using the Connection Machine. Each of the arrows in figure 2 represents the average direction of the particles in a 64 by 64 group of cells; the entire model consists of 2048 by 2048 cells altogether. At this level, the restrictions of the model begin to disappear and the behavior of the averages looks much more like a fluid. It would clearly be impractical to do work on this scale using a single-processor microcomputer.

A Special CPU for the Cellular Automaton

Parallel computing is the obvious solution to speeding up this problem, but it is not so easy as simply throwing more processors into the box. The chips must communicate with each other, and if the architecture of the machine is not carefully designed, most of the gain in computation power can be lost to communication time. In the fluid-flow automaton, the communications step is even more significant than in most parallel applications because the computation phase is almost trivial: Rules can be implemented by feeding the 6 bits that describe a node into a small set of Boolean gates.

At Princeton University, Professor Kenneth Steiglitz and graduate student Steve Kugelmass have built a specialized computer with custom very-large-scale-integration (VLSI) chips to process the fluid-flow automaton particles. The speed of the machine comes from lining



up many simple machines. In early designs of the chip, the individual processors were placed in a hexagonal lattice with data lines running between them. Each processor computed a single node.

This approach to the problem had an intuitive appeal, but it quickly ran into problems with the communications overhead. While it was quite easy to send the information about the particles between the processors on a chip, it was difficult to arrange the communications between two chips because of the physical limitations of the package. A simple chip with 37 processors arranged in concentric hexagons needed 84 pins just to handle the data coming to and from the neighboring chips. These obstacles could have been overcome using multiplexing and other techniques, but not without sacrificing speed and simplicity.

Steiglitz and Kugelmass scrapped the one-processor-per-site architecture in favor of a pipeline of slightly more sophisticated processors. Each processor has a shift register that holds three lines of the hexagonal grid (see figure 3). In an n by n array, the shift register holds $2n + 1$ cells at once, mapped as shown in figure 3 for a 4 by 4 array. It takes n^2 steps to compute an entire generation, but when x shift registers are lined up, the x generations are done simultaneously in the same n^2 steps. (This doesn't include the time required to fill the pipeline with initial data, of course.) The size of the largest feasible shift register limits the width of simulations that can be done with the pipeline machine, but not the overall length. Long wind-tunnel experiments are particularly easy.

This design removes the intercommunication bottleneck and interconnect difficulties associated with the original two-dimensional model. It also makes it easier to present a picture of the current state of the automaton for display or other

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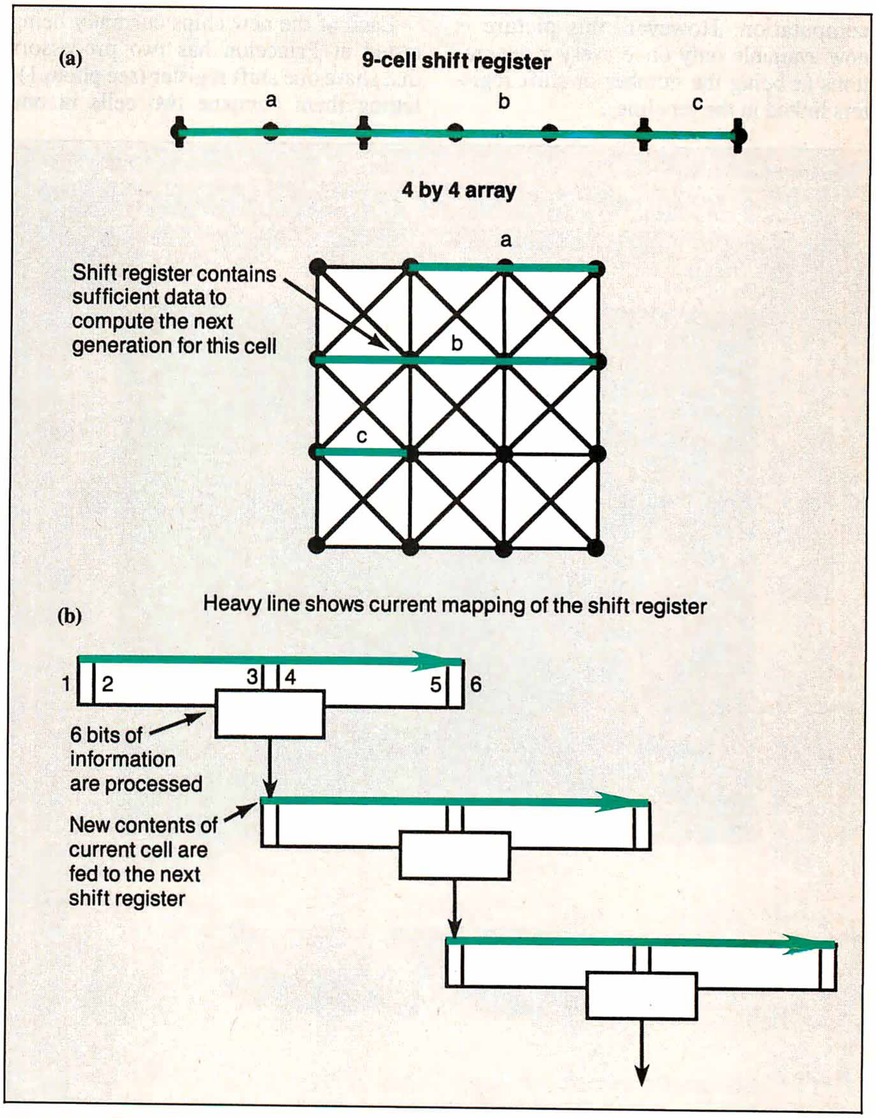
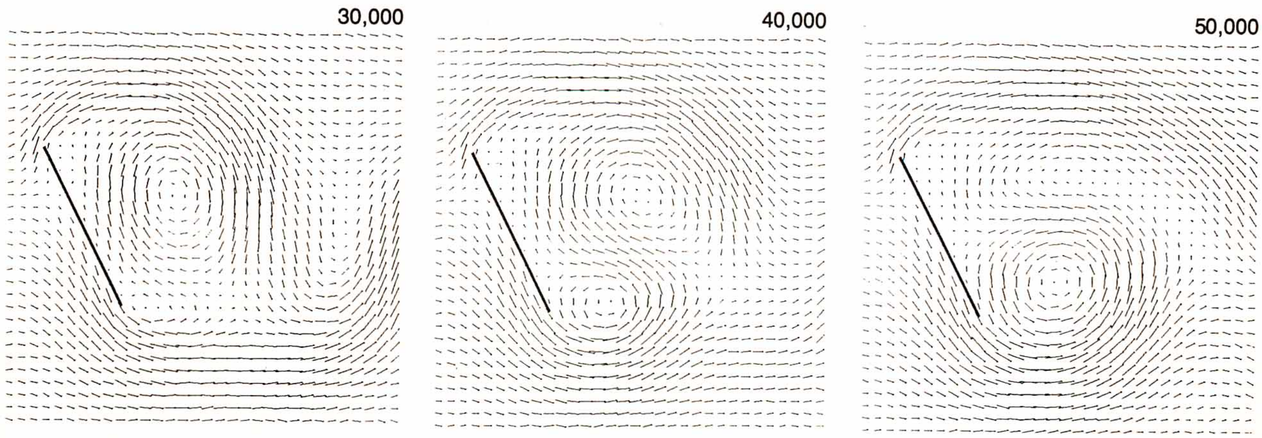


Figure 3: *The Princeton machine's pipelined architecture.* **(a)** *The two-dimensional array of cells is mapped onto a shift register. The illustration shows the case for a 4 by 4 array and a 9-cell shift register. At any given time step, the register has enough information to compute one cell's next generation. It takes 16 time steps to do the entire 4 by 4 array.* **(b)** *By pipelining multiple shift registers, multiple generations can be computed at once.*



computation. However, this picture is now available only once every x generations (x being the number of shift registers linked in the pipeline).

Each of the new chips currently being tested at Princeton has two processors that share one shift register (see photo 1), letting them compute two cells in one clock cycle. To accomplish this, the shift register is simply extended in length to $2n + 2$. Using this design, each chip is capable of doing 20 million cell updates per second. The prototype machine, however, is connected to a Sun-3 workstation with a bus that can process only ⅓ million sites per cycle. Once the pipeline is filled with data, the machine can process ⅔ million sites per second per chip.

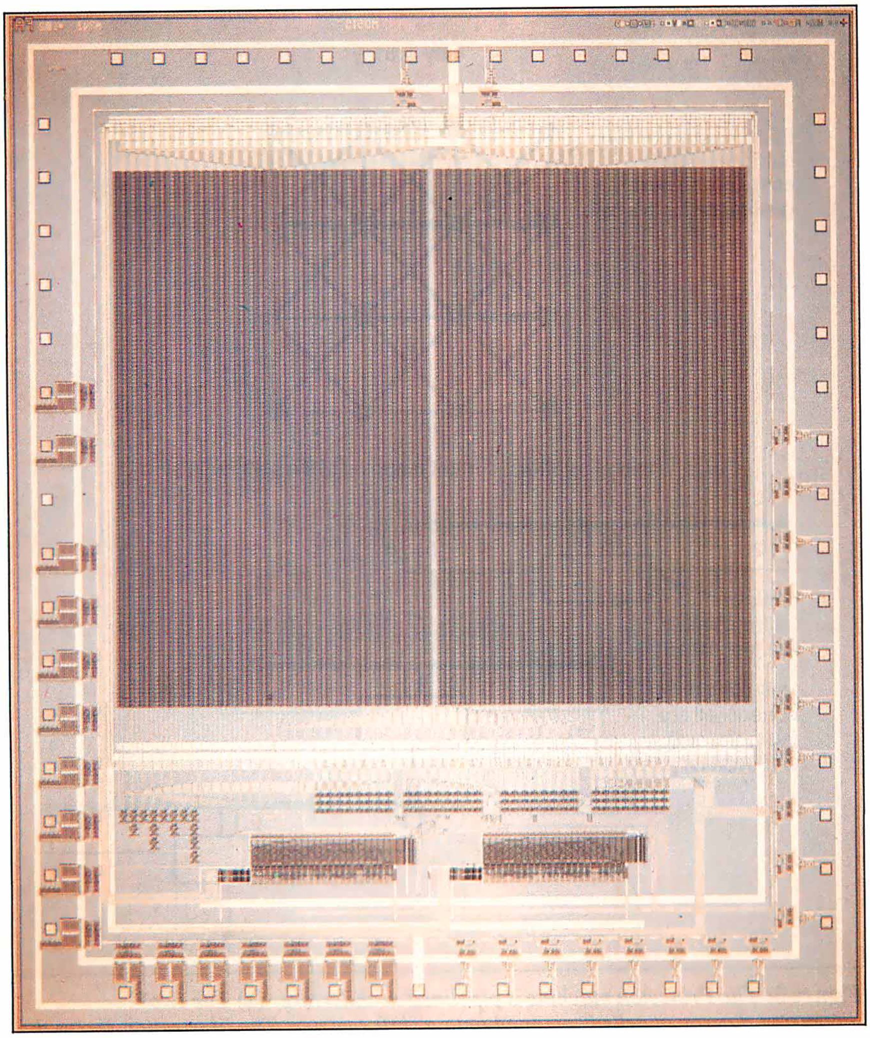


Photo 1: *The Princeton parallel-processing chip. The shift register dominates the top three-quarters of the photograph while the two processors are at the bottom. The shift register contains 512 memory words. The entire chip contains the equivalent of 68,000 transistors implemented in 3-micron technology.*

The Connection Machine

One of the original implementations of the fluid-flow automaton was done on the Connection Machine (CM) by Jim Salem, Bruce Nemnich, and Steve Wolfram. The CM uses 65536 processors in a very flexible architecture. Each processor has links to 12 neighbors, letting it act as a "hypercube" in up to 12 dimensions. A front-end computer compiles the program and loads the code into the parallel processors. Each time step consists of a communications phase and a computation phase.

Each processor is a simple bit-oriented computer with its own 8192 bytes of memory. In the newer CM-2, each processor also has its own floating-point chip attached for very fast scientific computing. Extensions and new data types are provided for Lisp, C, and FORTRAN to make the parallelism transparent or at least accessible to programmers.

Most of the limitations that exist with Steiglitz's initial prototype of one processor per site are removed by the general-purpose architecture of the CM and its special software. The machine was designed to be a parallel-processing computer and can easily be programmed for any purpose, so wires run from each of the processors back to the front-end computer handling the input and output.

For the fluid-flow automaton, the CM was configured as a plane with links between each processor and its four neigh-

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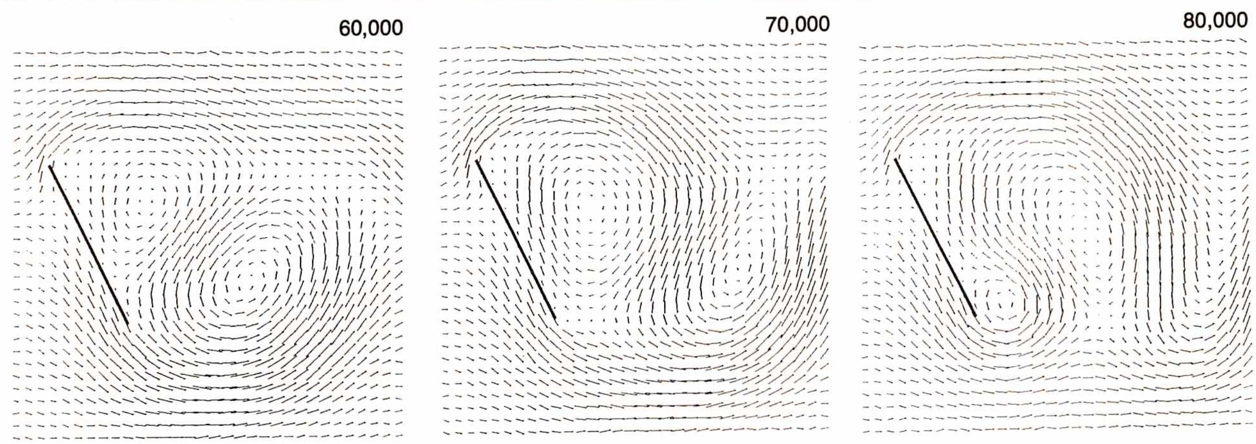

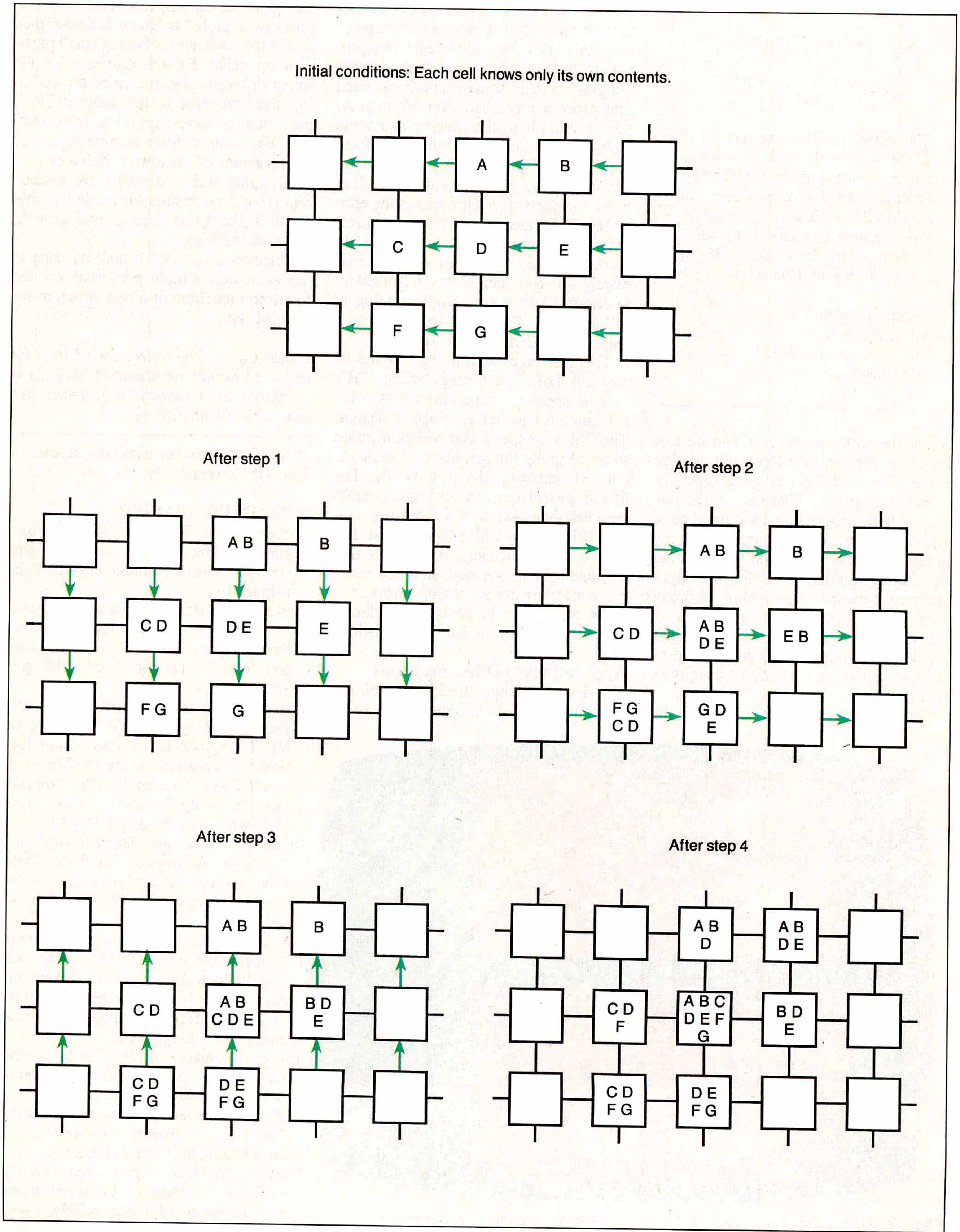

Figure 4: *A section of the square grid of the Connection Machine, illustrating how information about a cell's six neighbors (A, B, C, E, F, and G; D is the center cell) is funneled through four pathways per cell using a four-step process. At each stage, the letter inside the cell indicates how much is "known" to that cell.*

A Processor for the PC

Personal computer owners aren't left out of the cellular-automaton game altogether; the CAM-6 Processor, a $1500 plug-in board for the IBM PC, includes a specially designed processor with a 2- by 4096- by 4-bit lookup table and a 256- by 256- by 4-bit grid. Contact:

Systems Concepts
55 Francisco St.
San Francisco, CA 94133
(415) 984-1000

bors to the north, south, east, and west. A specially synchronized communication phase simulated the hexagonal grid, as shown in figure 4. (The CM is flexible enough to be programmed for any type of grid or random connections, such as my hexagonal arrangement, but not without slowing communications for messages that pass between chips lacking a direct wire. In these cases, intermediate processors must act as messengers. The planar grid with four connections keeps the process moving at the maximum capacity of the machine.)

One particularly clever addition to the software lets the programmer define virtual processors. The front-end computer turns this into code that lets each real processor multitask the virtual processors assigned to it. In some simulations, each real processor handled over 200 virtual processors, giving the effect of a machine with over 14 million individual processors. (The CM-2, with its increased memory, can simulate up to 550 million virtual processors.) This was made easy by the CM's design for straightforward, easy-to-program parallel processing. In these tests, the CM could update approximately 10^9 cells per second—equivalent to about 50 Princeton chips running at full capacity. (But about 1500 Princeton chips are hooked up to the Sun-3.)

This general programming ease has its costs. A larger percentage of the CM's time is spent on communications overhead than is true in the Princeton design. The CM must spend four communication steps sampling the neighbors of each site before computing the next result. The 65536 processors are also much more complex than necessary for this problem. The Princeton machine, by contrast, has very simple, efficient processors that communicate in one step, so it can easily calculate more per processor; however, it lacks the ability to analyze the data—hence the need for the Sun-3 workstation.

Applications to Other Problems

The design precepts used in the cellular automaton models of liquids and gases can easily be adapted to simulate any system whose global behavior is determined by the local behavior of many small particles or cells. Experimenting with the many different possible rules for updating the automata is the most difficult part. In many cases, applying first principles like conservation of momentum or conservation of energy to the rules succeeds quite well. Scientists are already reporting good results for modeling phenomena like forest fires, crystal growth, and bird flocking.

Once good rules are found, it is easy to design a new simple processor for the Princeton machine or a new program for the CM. ■

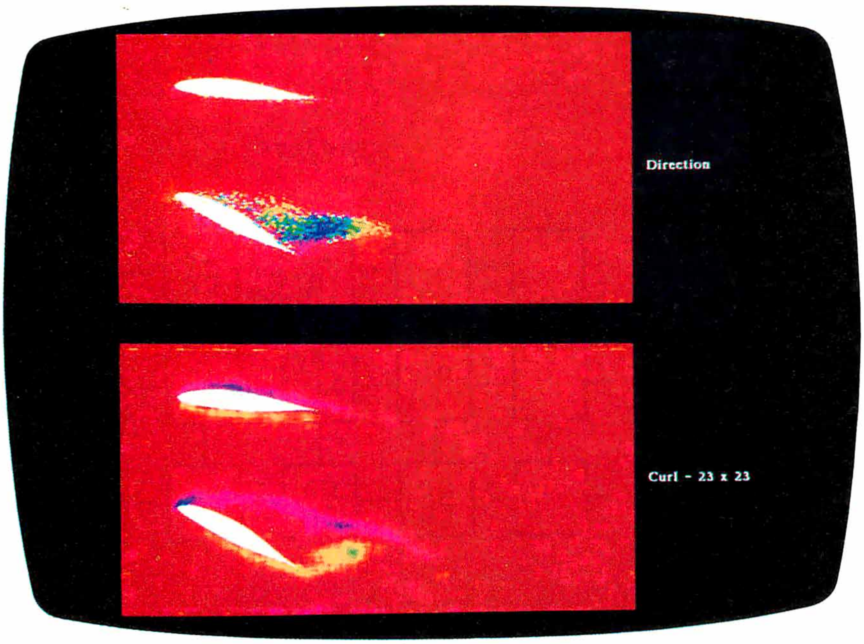

Photo 2: *Airfoil simulation made using the Connection Machine. In the upper section, red represents cells moving to the left, green is cells moving up, and blue is cells moving down. In the lower section, red represents straight flow, green is counterclockwise rotation, and blue is clockwise rotation.*

Editor's note: *The source code listing for the wind-tunnel simulator (*FFA.PAS*) is available in a variety of formats. See page 3 for further details.*

Peter Wayner studies computer science at Cornell University, Ithaca, New York.

SUGGESTED READING

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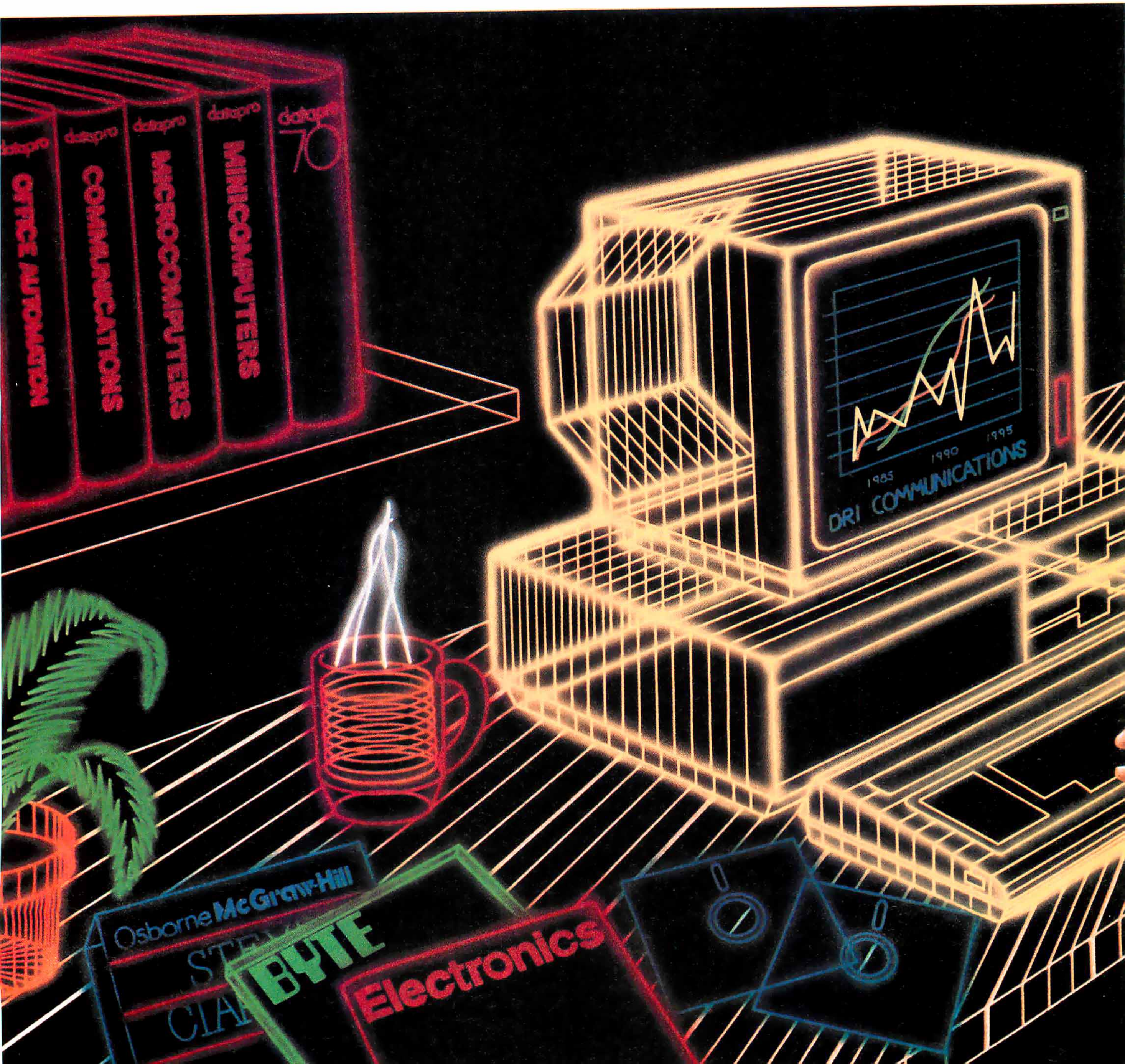

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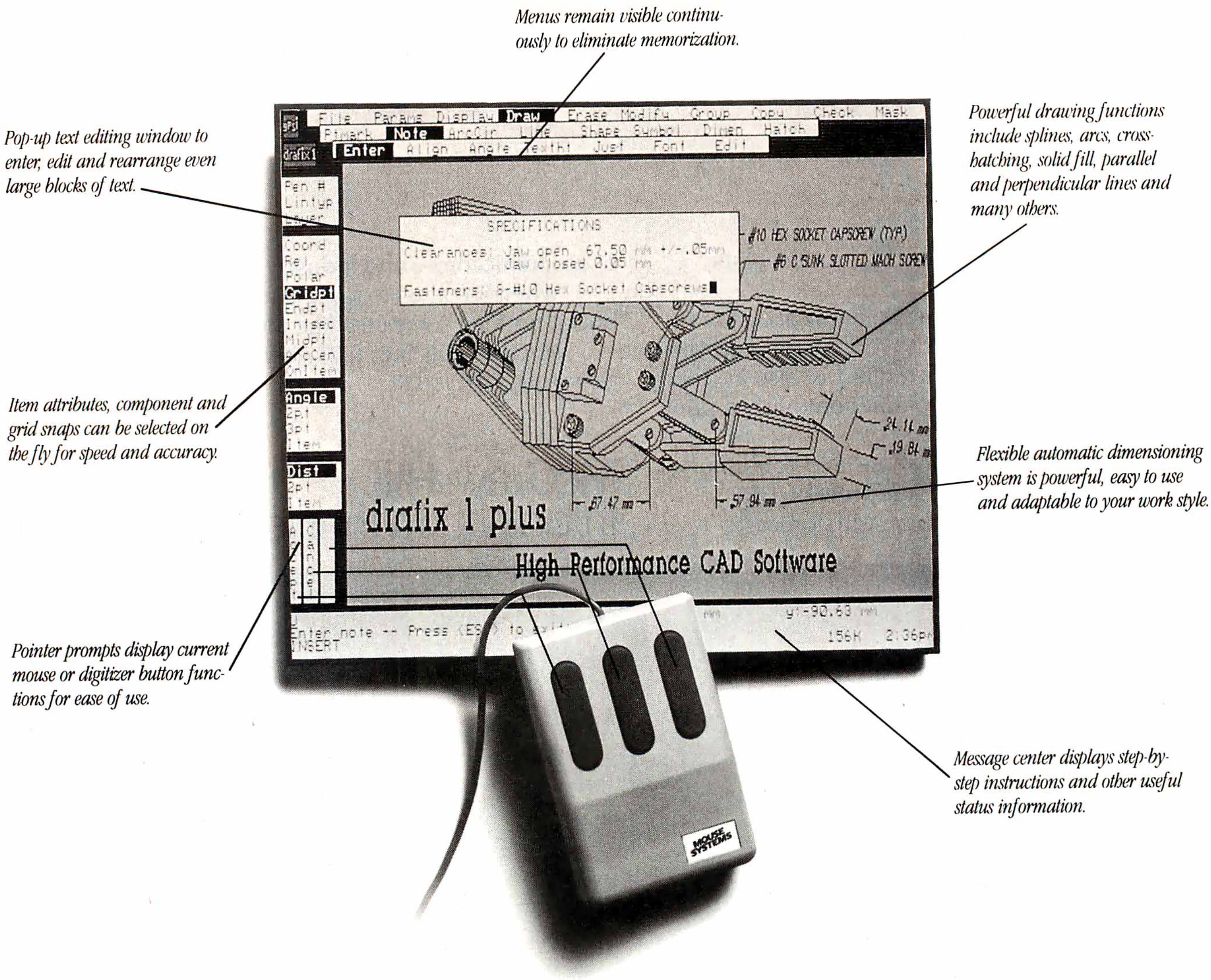

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Trevor Marshall

IT'S NOT IMPORTANT how you play the game; what matters is how you design the playing field. The speed and type of memory in a computer no longer play a big role in determining that system's performance. The configuration of its memory interface has become the key factor.

To achieve maximum benefit from the ultrafast internal CPU architectures of modern microprocessors, it is essential that the external hardware (RAM, ROM, and peripherals) keep the internal CPU execution pipeline supplied with an instruction stream and data flow at the CPU's clock speed. In the case of a 25-MHz reduced-instruction-set-computer (RISC) processor like Advanced Micro Devices' Am29000 (see the text box "The Am29000 Chip Set"), this means making a new 32-bit word available to the CPU every 40 nanoseconds (ns).

Linking CPUs to memory has historically generated a great many techniques. But, as RISC microprocessors usher in another CPU era, the time has come to create still newer designs.

Implementing a conventional zero-wait-state static RAM (SRAM) interface (see figure 1) at 40-ns speeds requires an access time of better than 40 (one clock cycle) − 14 (address delay) − 5 (data-setup time), or 21 ns (see figure 2). Even this number allows for no delay in any address or data interface buffers. Such access speeds are really not practical, especially if the SRAM is part of a cache memory, where control logic and additional buffers may introduce more delays.

So why would a manufacturer produce a processor that cannot operate at full speed with the fastest available RAM? The answer lies in the basic precept of the memory access-speed calculation—conventional memory-design techniques. Although conventional memory technology has served the microcomputer industry well during its first 20 years, a new, more complex technology must be developed to meet the challenge of the 1990s.

New-generation microprocessors, like the Am29000, the MC88000 (see the text box "The MC88000 RISC"), and even the Intel 80386, use techniques such as interleaving, pipelining, and burst mode to get maximum efficiency from modern memory devices, such as static column dynamic RAM (SCRAM).

New memory-interface techniques are able to achieve mostly zero-wait-state system performance with these new high-speed CPU engines, even with low-cost memory.

Simulating RISCs

To test the performance of a variety of interface architectures without needing to actually assemble any hardware, AMD has released to BYTE readers an MS-DOS-based simulator for the Am29000 streamlined instruction RISC processor. The simulator is available as `29KSIM.ARC` in the ibm.arc listings area of BIX, or as `C:/29000/29KSIM.ARC` on the 1000 Oaks Technical Database at (805) 492-5472 or (805) 493-1495. Consequently, I will use this simulator to examine Am29000 memory-interface technology, although the techniques are equally applicable to other devices.

The Am29000 execution unit uses a four-stage pipeline, allowing a peak execution rate of one instruction every clock cycle (40 ns). It has three nonmultiplexed 32-bit buses (see figure 1): separate buses for instruction and data transfers, and a common address bus. Simultaneous instruction and data transfers can be achieved using pipelined and burst-mode transfers.

No Waiting

The conventional memory design shown in figure 1 shows a zero-wait-state SRAM design. Figure 3 shows the simulator output (using the Dhrystone program as the test code) for this condition. The simulator predicts a rating of 20.71 million instructions per second (MIPS) and 39,698 Dhrystones per second. Although these numbers may seem exceptional, this is a normalized performance of only 94.7 percent when compared to the peak performance possible with this processor.

If we used instruction burst mode with this zero-wait-state SRAM, we could obtain 41,290 Dhrystones and 21.83 MIPS. But how can this be? How can anything improve on zero-wait-state performance?

Bursting Through

To understand what's happening, we need to look at how the CPU's four-stage execution pipeline operates. Instruction fetches overlap with data fetches; thus, they can occur simultaneously. Although the data and instruction buses are separate, they share a common address bus; thus, occasionally, they will both need the address bus at the same time. Burst

continued

mode allows sequential accesses to occur when only the first (starting) address has been placed on the address bus.

Figure 4 shows the timing of a short burst-mode instruction-fetch access. The address of the first data word is placed on the address bus for only the first cycle. It then becomes the responsibility of the RAM control hardware to provide incrementing addresses to RAM for every clock cycle in which the burst-request signal (*IBRQ) is active. Thus, the address bus is freed for data accesses. Most instruction-stream fetches tend to be sequential, so burst mode effectively speeds up RAM instruction access. However, if a BRANCH instruction takes execution to a new area of the code, the sequential fetch will be interrupted.

The Am29000 has a *branch-target cache* that keeps the four instructions immediately following each branch in internal CPU memory. After executing a branch instruction once, you don't need to access external memory on its second and subsequent executions. This leaves the burst sequencer four cycles in which to terminate and start fetching instructions from the new (nonsequential) address.

Waiting for Memory

Large memory systems with access times of 20 ns just aren't practical. If you simulate the system in figure 1 with one-wait-state RAM—access time is 80 (two clock cycles) − 14 (address delay) − 5 (data-setup time) = 61 ns, not including buffers—you get 26,907 Dhrystones and 14.08 MIPS—only 64 percent of peak performance.

Simulating performance with three wait states (approximately the best dynamic RAM (DRAM) cycle time currently available) gives 14,104 Dhrystones and 7.42 MIPS, or 34 percent of peak performance.

Clearly, much of the advantage of these faster processors is lost unless they are matched by unusually high-speed memory systems.

This explains why the performance of the current generation of RISC computer systems is often so disappointing. If the test software has good locality of reference (it works well with conventional SRAM cache technology), its speed of operation approaches that of the SRAM simulation. If it doesn't, then performance leans toward that of the DRAM (main memory).

The benchmark performance of RISC machines using conventional technology is usually excellent, since the benchmarks are small enough to fit entirely within the SRAM cache. When actual applications software using matrix algebra or data in large arrays is assessed, however, the cache becomes much less effective and performance drops. We need to adopt new computer system architectures to realize the real performance potential of RISC technology.

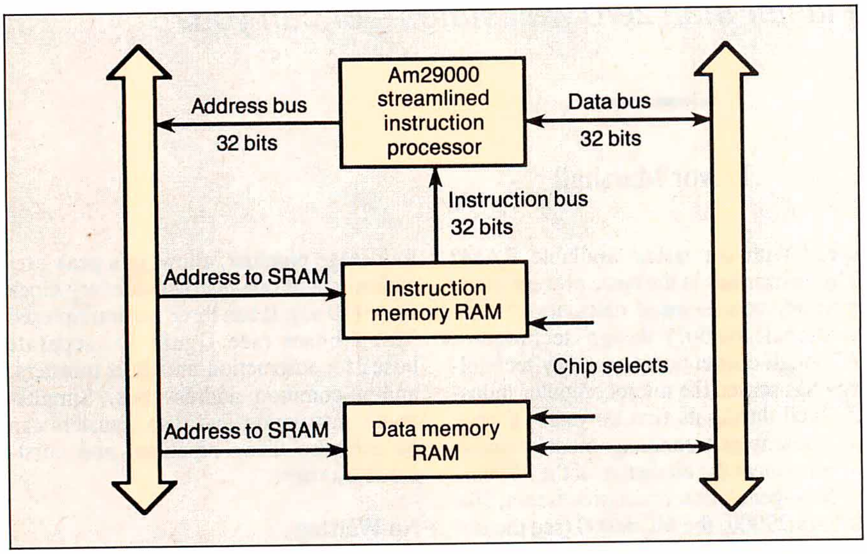


Figure 1: *A conventional zero-wait-state SRAM interface design for the Am29000 microprocessor. Notice the separate instruction and data buses with the common address bus.*

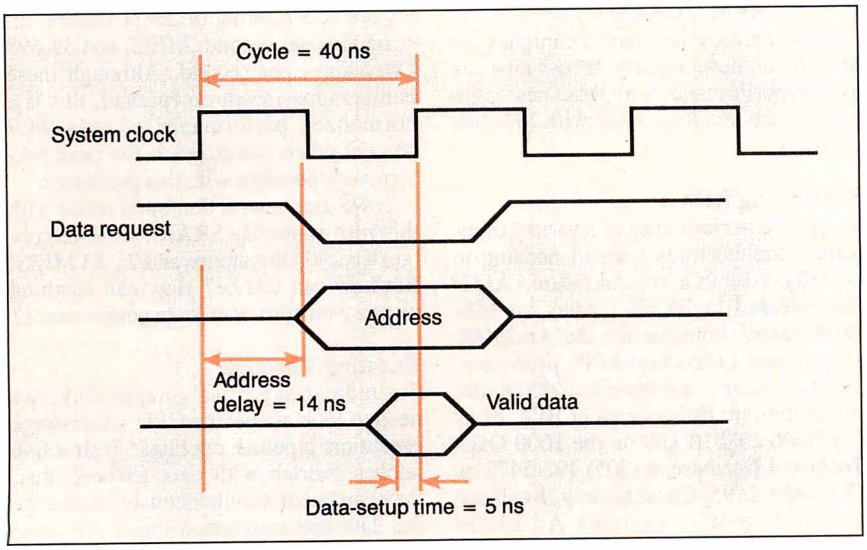


Figure 2: *The timing diagram for the interface design in figure 1. To implement the design at a 40-ns speed, you need an access time of less than 21 ns (clock cycle − address delay − data-setup time).*

Speeding Things Up

Interleaving uses two banks of memory instead of one. One bank handles even addresses, and the other handles odd addresses. If we assume that an instruction-fetch sequence occurs at sequential addresses, then only one bank is active at any one time; the other bank can be in its row-address strobe (RAS) precharge cycle (for DRAM) or getting the next data ready (for SRAM).

This process achieves its peak efficiency with the instruction-burst-access mode of the Am29000. When the Am29000 requests an instruction-burst access, the first bank of RAM is addressed (see figure 5). It has approximately 60 ns to get its data ready. The next word of data, however, comes from the second bank of memory. If the system design is such that the *next* address is placed on the second bank at the start of the cycle (using an external incrementer), then that bank has approximately 100 ns to prepare its data.

Furthermore, the second bank can present its data to the CPU only 40 ns, or 1

The MC88000 RISC

The MC88000 is the first RISC processor from Motorola. Although the part number might seem to indicate some relationship with the MC68000 family of complex-instruction-set computer (CISC) processors, nothing could be further from the truth. The MC88000 shares no common instructions, architecture, or pin-outs with its CISC predecessors.

Like the Am29000, instruction and data memories are accessed through separate ports. Unlike the Am29000, however, the MC88000 has two completely separate address buses for the two memory spaces, thereby preventing the possibility of contentions. As a result of the 32 extra interface pins, the MC88000 comes in a larger pin-grid-array package, totaling 182 pins and measuring 1.8 inches square. It supports both big-endian and little-endian byte orderings. Figure A shows a block diagram of the system.

The MC88000 has 32 general-purpose 32-bit registers. It uses register-to-register addressing for all data manipulation instructions. Registers are written to or read from memory only by load and store operations.

The internal floating-point capability is a unique feature of the MC88000. The floating-point unit is actually organized as separate adder and multiplier units that can operate concurrently.

Integrated within the MC88000 family are the MC88200 cache/memory management units (CMMUs); there is one for use with each of the instruction and data spaces. The cache is 16K bytes of 4-way set-associative SRAM that can achieve 1-cycle pipelined access on cache hits and can be used in write-through or write-back modes.

It is not mandatory to use these CMMUs, although the level of technology implemented in them certainly makes their use attractive. For interfacing to main memory, they use the Motorola M-Bus, a multiplexed, multi-master protocol. A single read cycle on the M-Bus interface takes two CPU clock cycles. Although the burst-mode read improves the data transfer rate to four words every five cycles, burst mode is unlikely to be of much use in data memory applications. Nevertheless, the M-Bus is an excellent compromise between the requirements of a bused memory system and the performance of a high-speed, closely coupled memory system.

By contrast, the MC88000 CPU P-Bus timings make it quite easy to operate high-speed SRAM with no wait states. The P-Bus is a pipelined protocol, with the reply signals not being required until the cycle subsequent to the access. This gives a peak transfer rate of 80 megabytes per second at the 20-MHz CPU clock rate of the current MC88000 family. The worst-case access time is 50 + 5 − 5 = 50 ns (no buffers) from address valid to data setup. No Dhrystone performance figures are available at this time.

Motorola says that the MC88000 is scheduled for production in the first quarter of 1989.

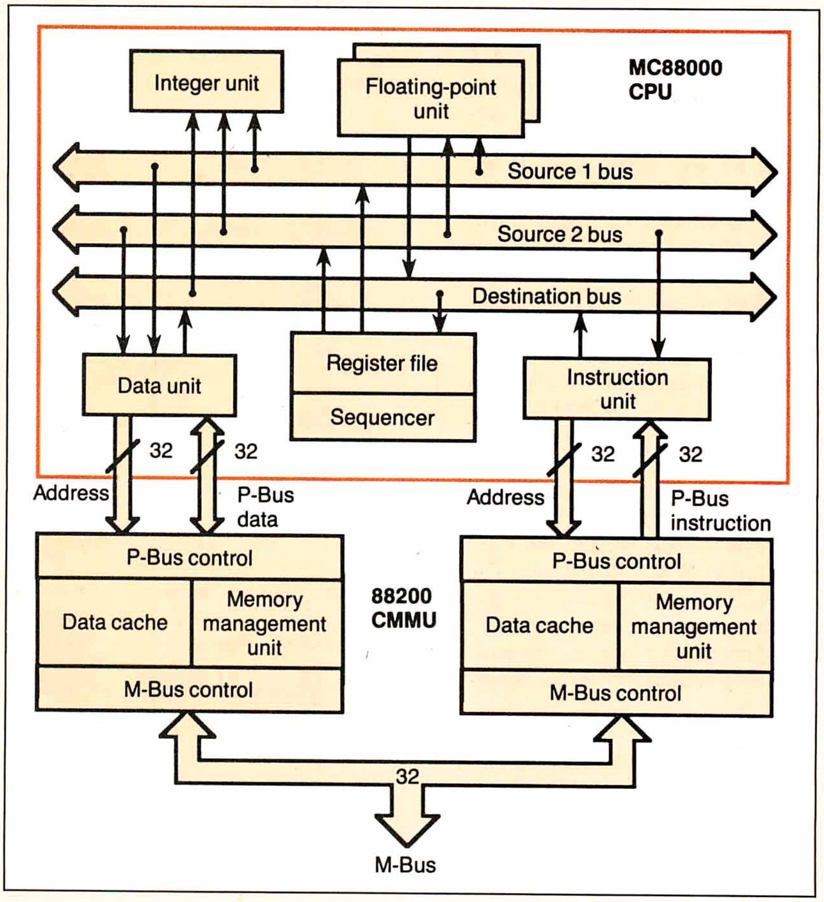


Figure A: *The Motorola MC88000 RISC processor and support chip block diagram.*

cycle, after the first bank does. Similarly, while the second bank is being accessed, the first can be preparing to present its next data word to the CPU just 40 ns later.

Thus, interleaved burst access with practical SRAM could take just one wait state to set up the burst, then zero wait states within it. Simulating this combination yields 35,760 Dhrystones per second and 18.67 MIPS (85 percent of peak). The use of the instruction burst-mode configuration improves performance by 21 percent. The simulator output also shows that the CPU pipeline had 25.3 percent idle time, split mainly into 10.2 percent instruction-fetch waits and 12.3 percent data-transaction waits. There was also a 1.8 percent `load/load` transaction wait due to the wait states on the data RAM, and to CPU pipeline holds when switching from a write to a read cycle.

Compared to peak performance, the

continued

The Am29000 Chip Set

To quote from the Am29000 user's manual, "The Am29000 Streamlined Instruction Processor is the result of a design philosophy which recognizes that processor performance must be considered in the light of the processor's hardware and software environment." Thus, the Am29000 draws on system concepts not only from early RISC technology, but also from the bit-slice and interface technologies that Advanced Micro Devices has pioneered.

The Am29000 has 192 internal general-purpose registers and a full 32-bit architecture, and it currently operates with a 25-MHz clock, giving a 40-ns cycle time (the most ambitious for any of the currently released RISC chip sets). Instructions are of three-address architecture; that is, of the form `ADD Ra,Rb,Rc`, where the source operand in register a is added to the operand in register b, and the result placed in register c.

The CPU includes demand-paged memory management (on-chip), a timer, and, like the MC88000, master/slave redundancy checking.

For floating-point operations, the Am29027 Arithmetic Accelerator supports not only the IEEE floating-point data formats but also the DEC D,F,G, and IBM 370 formats. The Am29027 has an 8-deep 64-bit register file that can be programmed in flow-through (for scalar computations) or pipelined (for vector operations) mode.

The floating-point speed predicted for the Am29027 is exceptional. AMD predicts a LINPACK rating of 3 million floating-point operations per second (MFLOPS), single precision, before the end of 1988. Although 3 MFLOPS represents a tenfold speed increase over 1987's technology, the MC88000 is also expected to deliver this order of performance. For reference, the CRAY-1S supercomputer achieves 13 MFLOPS.

The Am29000 chip set is rounded out with the Am29041 Data Transfer (DMA) Controller. It attaches the high-performance local data bus of the Am29000 to asynchronous peripherals and includes DMA buffering to more effectively utilize the Am29000's burst-transfer modes.

interleaved burst-instruction memory with *real* SRAM gives only 2.8 percent more instruction latency than perfect zero-wait-state memory using this Dhrystone code. Thus, little is to be gained from further improvements (or complications) to the instruction memory design.

Pipelining

In pipelining, the address of the next instruction is placed on the address bus prior to the completion of the current cycle. External hardware *latches* this address, freeing the bus for the other channel (either the instruction bus or the data bus). Performance improvement is minimal, 2 percent to 6 percent typically, and can be easily examined with the simulator.

SCRAM is becoming prominent as the memory of choice for low-cost, high-speed computer systems. Even the 80386 clone on which I am writing this article uses it.

SCRAM is just like normal DRAM with RAS and column-address strobe (CAS) cycles, except that the column address is not latched on the falling edge of CAS, but can be changed while RAS and CAS are held low. In this mode, the RAM looks just like a 256K-bit (64K-bit×4) SRAM. Thus, for minor address changes within the same row of the RAM array, SCRAM has the fast access times of SRAM (typically 40 to 55 ns).

There is a problem, however. When a new row address needs to be latched, the RAS precharge interval plus a normal access time must elapse. This typically leads to extra wait states at the beginning of a burst sequence. The simulator has been designed to estimate additional SCRAM penalties.

Since the instruction stream only rarely (less than 10 percent of the time) goes outside the current page, interleaved

```
Dhrystone time (in cycles) for 50 passes = 31487
This machine benchmarks at 39698 dhrystones/second
Loading Am29000 Memory from file: mw_dhry.bin.
loading section " at address 00002000 [228 bytes of type data]
loading section " at address 00001000 [1924 bytes of type text]
loading section " at address 00003000 [10632 bytes of type bss]
loading section " at address 00000000 [564 bytes of type data]
loading section " at address 00001784 [1568 bytes of type text]
Entry at Address: 00001784


Advanced Micro Devices Am29000 Simulator Ver 4.21-PC -
              Copyright 1987
Sim complete -- successful termination
_________________________________________________________________

Environment of "mw_dhry.bin" simulation:

Instruction Memory:
1 Cycles for a Simple access. (0 Wait States)
No Burst accesses are allowed and no Pipelined accesses are
              allowed.
(0 Cycles To Decode an Address)
Instruction ROM Memory:
1 Cycles for a Simple access. 0 Cycles To Decode an address.

Data Memory:
1 Cycles for a Simple access. (0 Wait States)
No Burst accesses are allowed and no Pipelined accesses are
              allowed.
(0 Cycles To Decode an Address)
Statistics of "mw_dhry.bin" simulation:

User Mode:           32404 cycles         (0.00129616 seconds)
Supervisor Mode:       189 cycles         (0.00000756 seconds)
Total:               32593 cycles         (0.00130372 seconds)

Instructions Executed:            27006

Simulation speed: 20.71 MIPS (1.21 cycles per instruction)
```

Figure 3: *Simulator output for the interface design in figure 1. Note the Dhrystone (second line) and MIPS (last line, this page) predictions.*

burst-mode SCRAM instruction memories can be very effective.

It Really Works

I recently designed a Macintosh II coprocessor board using the Am29000. It is typical of the designs that you can achieve using these memory interface architectures.

Possibly the most important factor you need to determine in a design is how much memory you need and how much space you have available to hold it. This is usually the prime determining factor in choosing between SRAM and SCRAM and between externally bused and closely coupled (nonbused) systems.

Deciding to go with an external bus (e.g., the VME bus) for your memory interface immediately sets an upper bound on the performance of memory-intensive applications. Buses have considerable overhead when they have to match 40-ns cycle times. You just can't use interleaved burst mode in a bused system and achieve anywhere near the zero-wait-state performance of a closely coupled configuration, even when the bus is combined with an SRAM local cache. Thus, the necessity for a memory bus structure must be carefully balanced against the need for performance.

Conversely, there is a limit to the amount of memory that can be closely coupled to a CPU. This limit is determined not only by loading the CPU address and data outputs to capacity but also by the available space on the CPU board itself. At the moment, loading 512K bytes of SRAM (256K-bit technology) or 2 megabytes of SCRAM (1-megabit technology) to capacity would fully load each internal bus of the Am29000.

In my case, I elected to use the Macintosh NuBus for access to peripherals,

continued

```
---------- Pipeline ----------
 17.14% idle pipeline:
      12.70% Instruction Fetch Wait
       2.50% Data Transaction Wait
       0.00% Page Boundary Crossing Fetch Wait
       0.03% Unfilled Cache Fetch Wait
       0.00% Load/Store Multiple Executing
       1.54% Load/Load Transaction Wait
       0.38% Pipeline Latency

---------- Branch Target Cache ----------
Branch cache access:            13511
Branch cache hits:               8197
Branch cache hit ratio:        60.67%

---------- Translation Lookaside Buffer ----------
TLB access:                      9433
TLB hits:                        9426
TLB hit ratio:                 99.93%

---------- Bus Utilization ----------
Inst Bus Utilization:          71.44%
       23285 Instruction Fetches

Data Bus Utilization:          18.11%
        3380 Loads
        2523 Stores

---------- Instruction Mix ----------
       3.24% Calls
      14.41% Jumps
      12.52% Loads
       9.34% Stores
       6.49% No-ops

---------- Register File Spilling/Filling ----------
           0 Spills
           0 Fills

(Simulator Performance:       592.60 cycles per second)
```

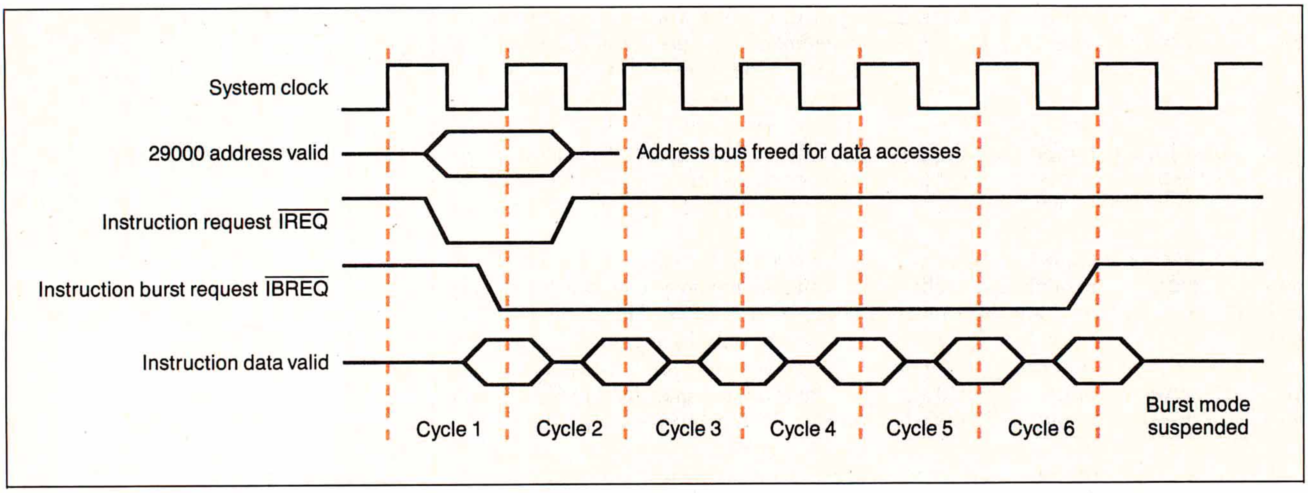


Figure 4: *The timing of a short burst-mode instruction-fetch access. Notice that the instruction fetch overlaps with the beginning of each cycle except the first.*

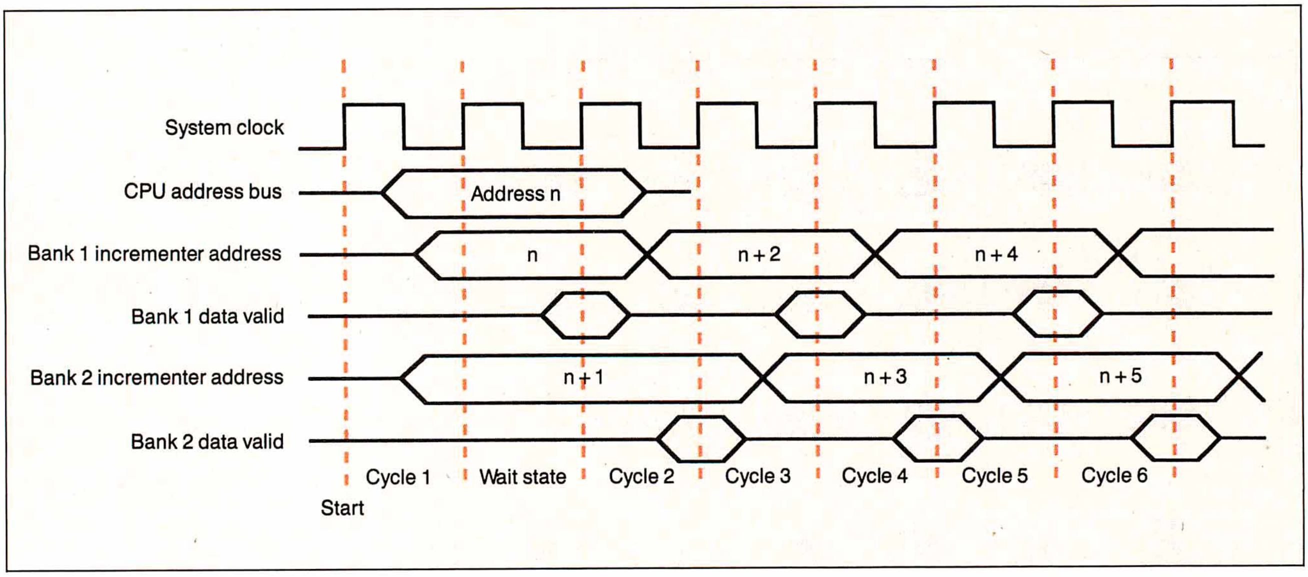


Figure 5: *The timing for an interleaved instruction-burst access. Notice that the access switches back and forth between the two data banks. This process avoids the wait between accesses on a single bank.*

keeping the memory closely coupled to the CPU. I chose SCRAM for instruction memory, but due to the performance penalty incurred by SCRAM page-miss cycles, I selected SRAM for data memory. Size considerations then led me to choose 512K bytes of 64K-bit×4 chips in both technologies. It's interesting to note that the 512K bytes of SRAM costs almost 10 times what the same amount of SCRAM costs.

The performance simulation shows that the penalty for using SCRAM in the instruction memory was about 10 percent in this case. Although that may seem quite high, if you run the simulation for the same parameters using a 512-word page size (which is what you would get with 1-megabit SCRAMs), the penalty is only 2.3 percent.

The usefulness of these new memory designs is intimately interwoven with the sophistication of the software they will execute. It's obvious that the early version of the MetaWare C compiler (and associated run-time libraries) that I used makes frequent branches or calls that are not within the current page of 256K-bit SCRAMs. The real performance potential of these new architectures will require further development of compiler and linker technologies. For example, placing small subroutines in-line rather than calling them makes a major difference in the performance of SCRAM-based systems.

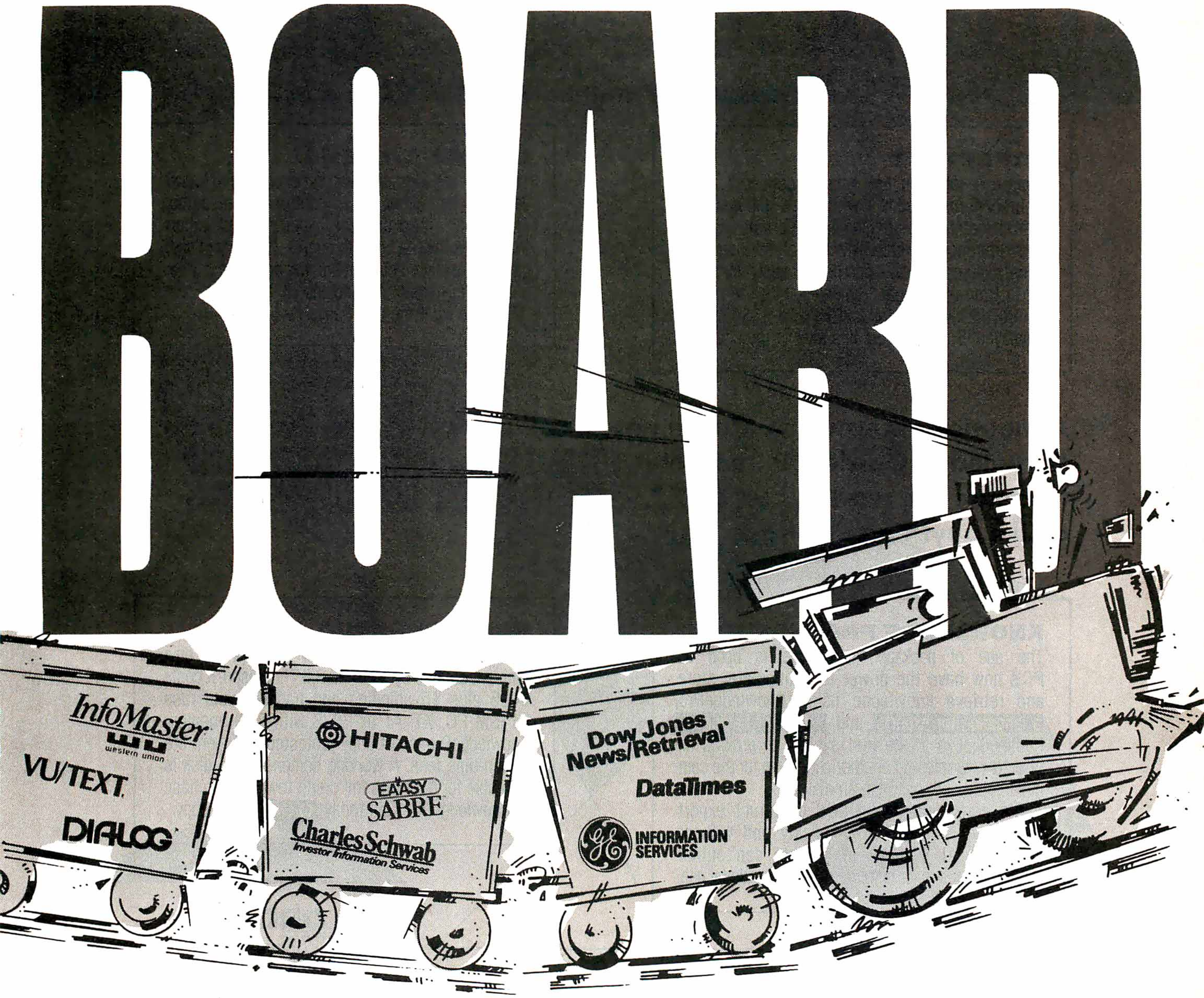
Pushing Beyond

In 1985, the performance of microcomputers rivaled that of minicomputers. When the DSI-32 achieved 1500 Dhrystones (August 1985 BYTE), it was cause for celebration; yet today's high-end *personal* computer is capable of much greater performance.

Today's RISC microprocessors aim their performance squarely at the supercomputer user. Consequently, they are pushing operational speeds beyond the capabilities of current computer systems.

As both hardware and software architectures change to complement the improvements in the CPUs themselves, a world of performance will open up that we couldn't even dream of just 3 years ago. ■

Trevor Marshall, Ph.D., is chief engineer at Yarc System Corp. in Thousand Oaks, California.



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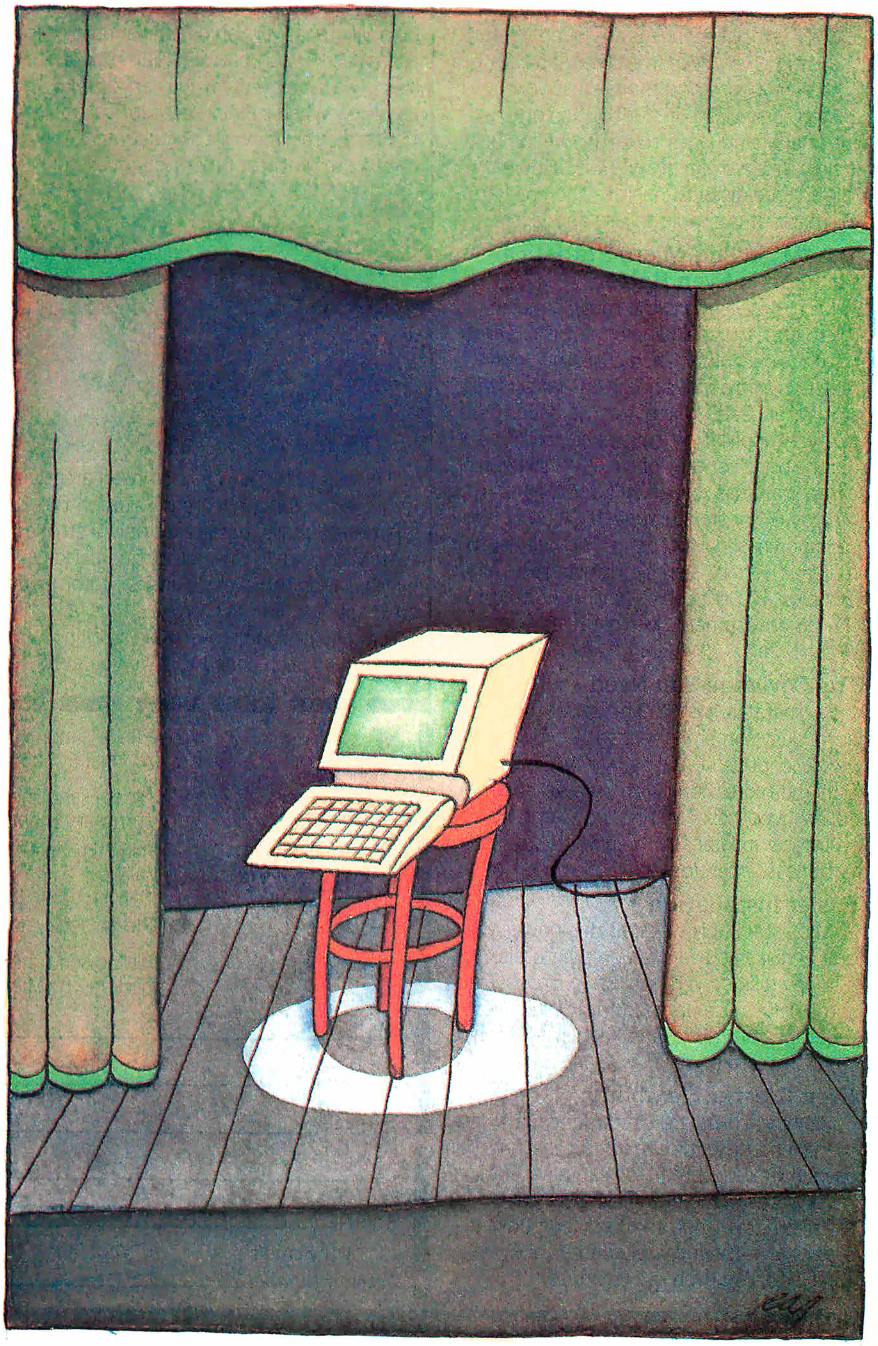

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The SmartSpooler

Part 2: Software and Operation

SmartSpooler can function as a complete remote data-processing computer to analyze data

Last month, I introduced my version of the ultimate printer buffer: SmartSpooler. While SmartSpooler has 256K bytes of memory and supports both serial and parallel printers, it also has features that improve its versatility and ease of use. These features include a "switchbox" capability (i.e., for routing serial or parallel computer input to serial or parallel printer output), multiple-copy printing, a single-sheet-feeding mode, and buffer capacity indicators. Also, you can daisy chain multiple SmartSpoolers to control a whole network of peripherals.

Most important, SmartSpooler is intelligent. While I've presented it primarily as a printer buffer, SmartSpooler lets a host computer completely control its operation. You can even download executable code to SmartSpooler. Rather than being merely a simple printer buffer, SmartSpooler can function as a complete remote data-processing computer that analyzes and interprets the data flowing through it.

This month, I'll finish the hardware discussion by explaining the user interface and then briefly describe SmartSpooler's operation.

Push Buttons and LEDs

A 6821 peripheral interface adapter (PIA) neatly connects four front-panel push buttons, eight front-panel LEDs, and an eight-position DIP switch. The PIA, which is IC24 in figure 1, provides two 8-bit ports (port A and port B) and four multipurpose handshaking lines (CA1, CA2, CB1, and CB2). The DIP switches connect to port A, which is programmed as an 8-bit input port. The switches specify options like data transfer rates and operating modes. Figure 2 contains switch settings and functions.

The four front-panel push buttons set configuration, pause the output, enter copy requests, and clear present settings. The combination of a simple resistor/capacitor circuit and a Schmitt-trigger inverter debounces each push-button input. The conditioned inputs are connected to the handshaking lines, which are programmed so that any switch closure will generate a CPU interrupt.

The eight LEDs with current-limiting resistors connect to port B. SmartSpooler sets this port up as an 8-bit output port. (Be aware that port B has the extra 10-milliampere current needed to drive the LEDs.) Four of the LEDs signify SmartSpooler's operating mode: Config, Copy, Pause, and Clear.

The remaining four LEDs indicate which ports are enabled: Parin (parallel in), Serin (serial in), Parout (parallel out), and Serout (serial out). During initial setup (Clear), these LEDs display the I/O port configuration (serial/parallel). When SmartSpooler is making copies (Copy), these LEDs display the number of copies requested (1 to 4) and then the number of copies remaining to be printed. During normal operation, the LEDs indicate how full the SmartSpooler buffer is: 0 percent, 25 percent, 50 percent, 75 percent, or 100 percent.

The two DB-25S IBM PC–compatible parallel printer input and output connectors are mounted on the printed circuit board. I've mounted two 20-pin headers behind these connectors for the serial ports. These headers accommodate a pair of optional ribbon cables with DB-25P serial connectors on the end. You can operate SmartSpooler with either or both pairs of connectors installed. If you need only parallel-to-parallel operation, you use only the DB-25S connectors.

Buffer-Manager Software

The basic algorithm at the core of SmartSpooler is a FIFO buffer manager. A FIFO, whether a single chip or a box like SmartSpooler, consists of an input port and an output port, connected by a buffer memory (perhaps 256 bytes for a FIFO chip and 256K bytes for SmartSpooler). The buffer memory decouples the input and output data rates: fast dump from the computer, slow dump to the printer.

A good analogy for a FIFO is a water tank with fill (input) and drain (output) pipes, each pipe having a pump (see figure 3). The input can pump faster than the output, so the rate difference is absorbed as the tank fills. As is true with the water tank, the FIFO has to handle two special cases: full and empty. When the tank is full or empty, the respective pump (input or output) should be turned off.

We can immediately dismiss the intuitive software algorithm for implementing a FIFO (i.e., actually moving the data). While suitable for very small FIFOs, such an algorithm would choke on a full 256K-byte buffer. Instead, we use a scheme called a *ring buffer*, which manipulates input and output pointers, instead of actually moving the data (see figure 4).

Interrupts and Direct Memory Access

You can divide the implementation of the FIFO into three components: determining when an I/O port is ready for transfer, performing the transfer, and updating the pointers.

You could use a pure software approach in which you poll the I/O ports for readiness, transfer data with `IN` and `OUT` instructions, and have the program update buffer pointers. However, this scheme has some problems.

First, polling is extremely inefficient. Consider the typical case of simultaneous high-speed input and low-speed output. For each input character, you have to check whether the output is ready, even though it normally won't be. Actually, it's much

continued

worse, since you also have to check for handshaking, front-panel switch closure, and a number of other mundane events. The overhead adds up quickly, limiting performance.

Second, software to access the buffer and maintain the buffer pointers is difficult to write for buffer sizes larger than 64K bytes. Eight-bit CPUs like the HD64180—and even 16-bit CPUs like the 8086/80286—must monitor each access and calculate memory-management-unit (HD64180) or segment-register (80286) reload values to manage a large buffer.

continued

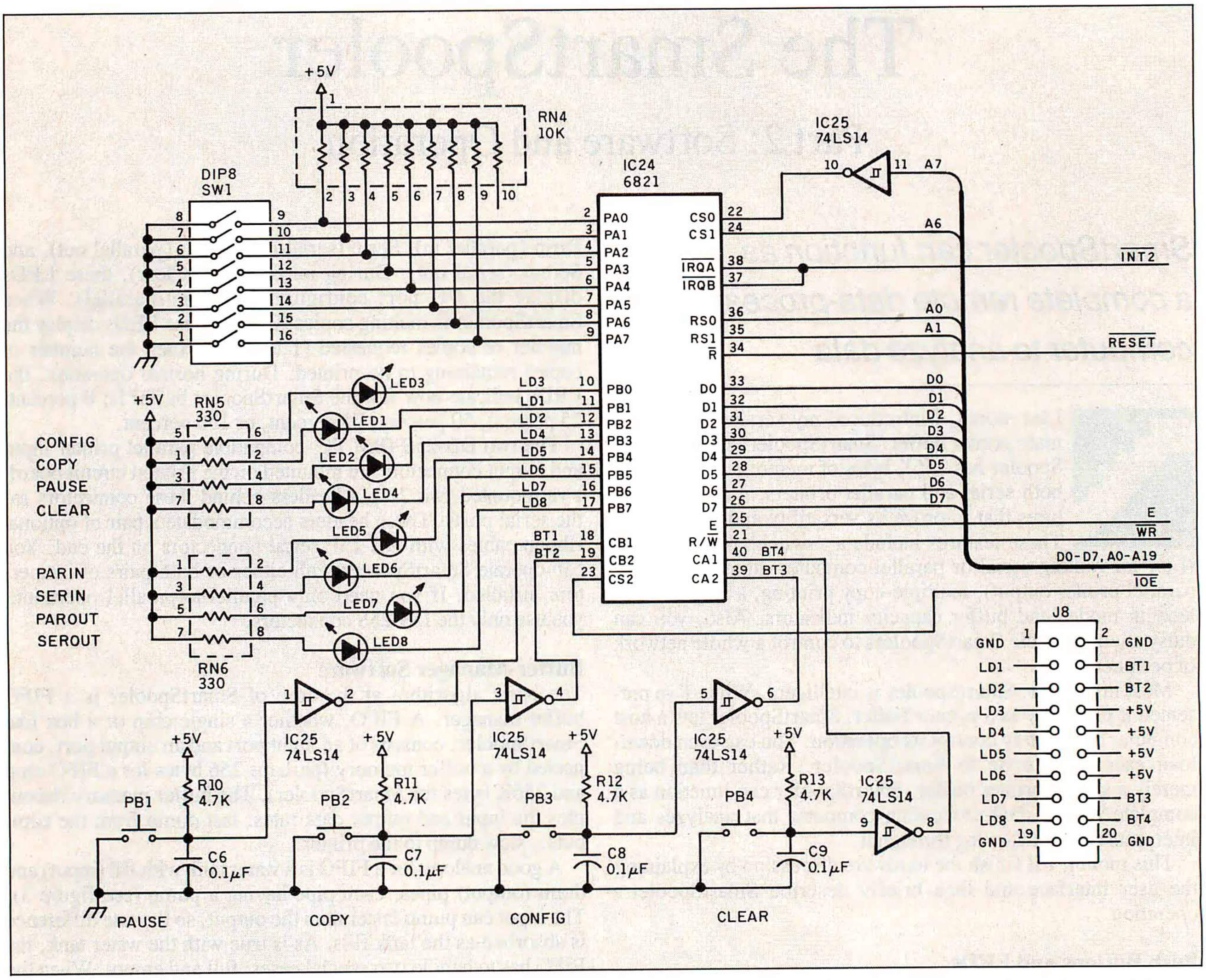

Figure 1: *Schematic for SmartSpooler's DIP-switch and LED I/O circuitry. A single 6821 peripheral-interface-adapter chip handles all the switches and lights.*

Off / On	Mode: Local	Host	Test
(MSB) 1	IBR2	On	On
2	IBR1	On	On
3	IBR0	On	On
4	OBR2	Note	On
5	OBR1	Note	On
6	OBR0	Note	On
7	IPORT	Note	On
(LSB) 8	OPORT	Off	On

(Shipping position, all off: Parallel → parallel mode)

Local mode

	38,400	19,200	9600	4800	2400	1200	300	N/A
I/O BR2	Off	Off	Off	Off	On	On	On	On
I/O BR1	Off	Off	On	On	Off	Off	On	On
I/O BR0	Off	On	Off	On	Off	On	Off	On

I/O port Off = parallel, On = serial

Host mode

Note: Positions 4 to 7 off = last node in chain

Test mode

Push any button → memory test

Terminal on serial output port (<cr> . . <cr>) → monitor

Figure 2: *DIP-switch settings and their effects on SmartSpooler's various operating modes.*

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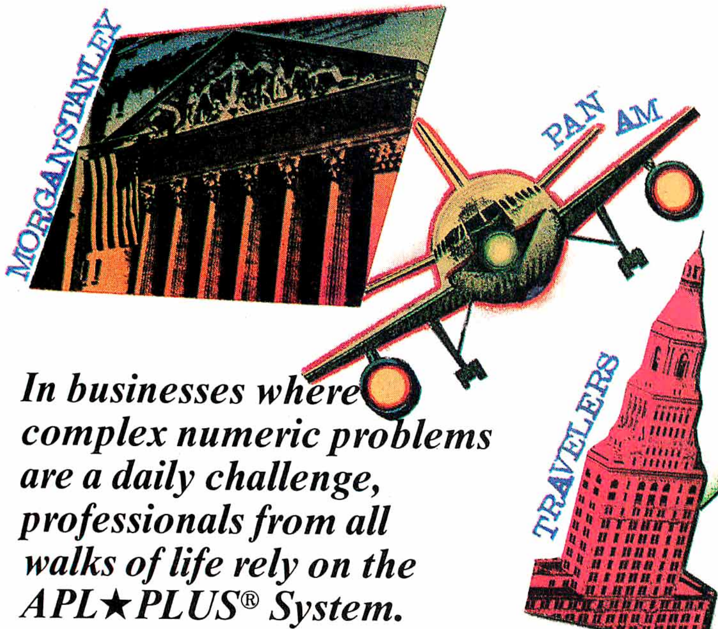

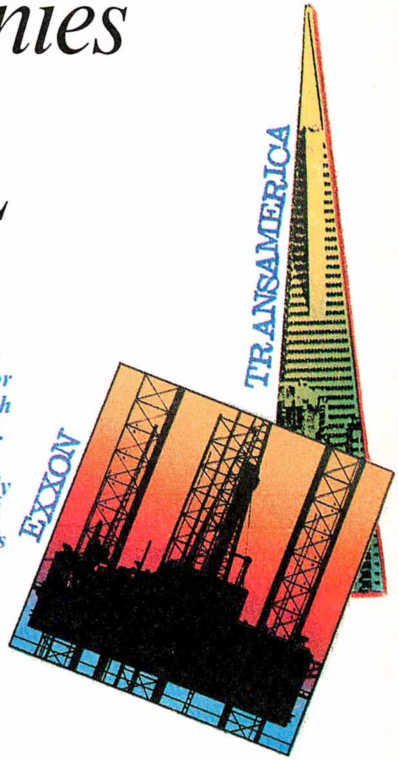

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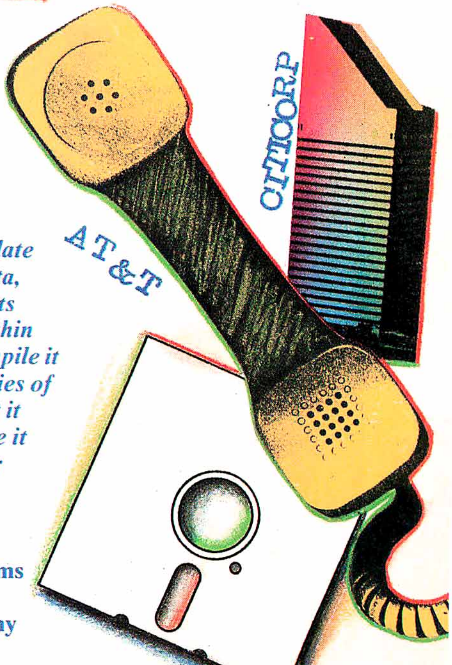

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Circle 282 on Reader Service Card

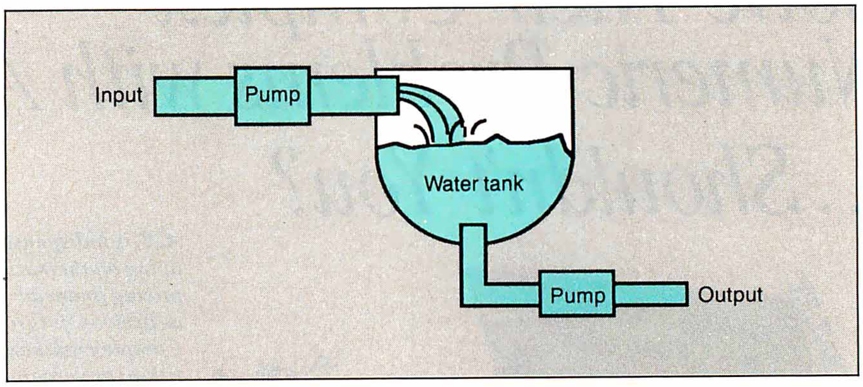

Figure 3: *A FIFO buffer is like a water tank, absorbing the difference between input and output rates. In a typical printer buffer task, the input is faster than the output. A basic function of the FIFO/tank is to control the pumps for the special cases of tank full and tank empty.*

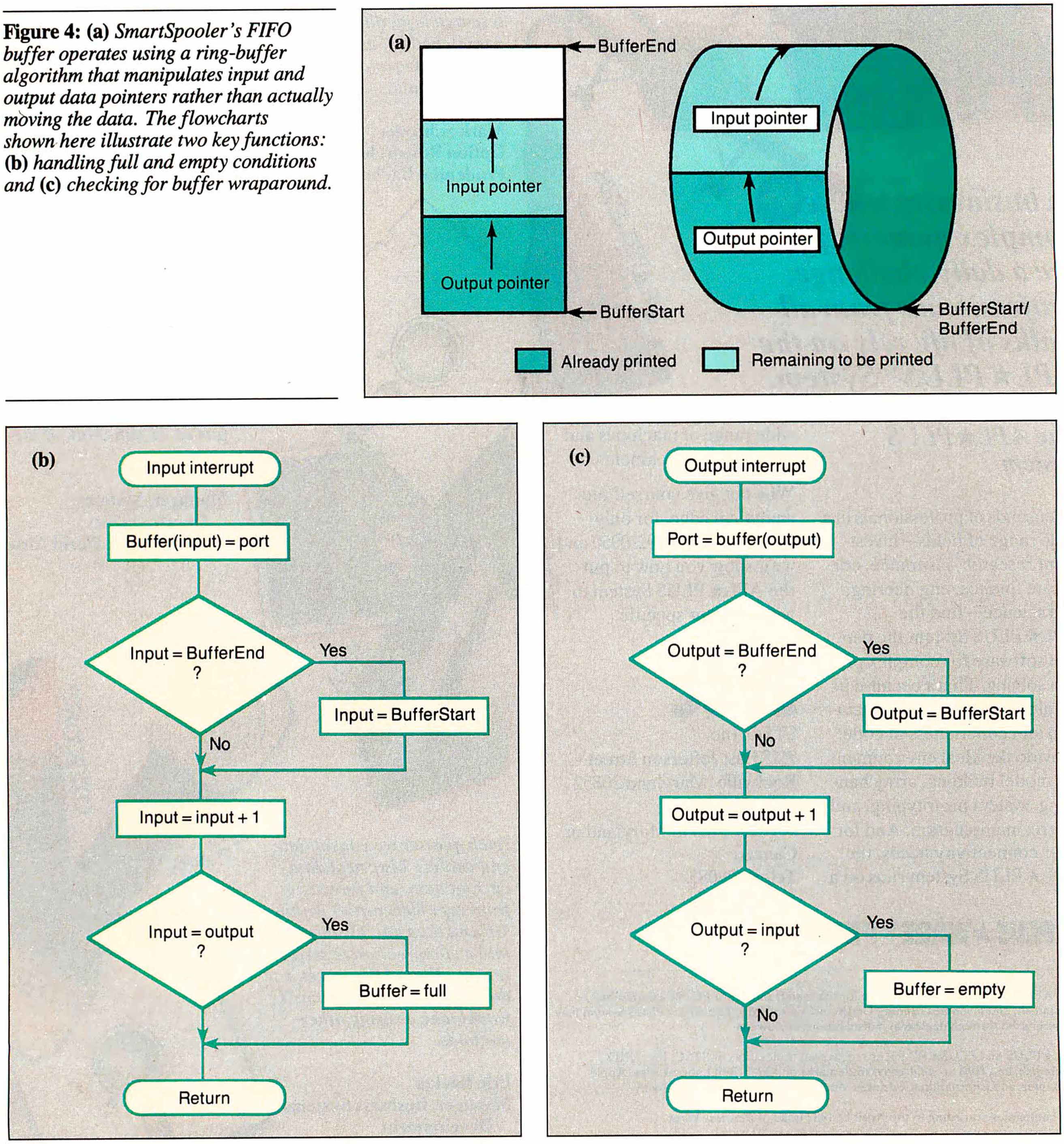

Figure 4: (a) *SmartSpooler's FIFO buffer operates using a ring-buffer algorithm that manipulates input and output data pointers rather than actually moving the data. The flowcharts shown here illustrate two key functions:* **(b)** *handling full and empty conditions and* **(c)** *checking for buffer wraparound.*

The solution to the problem of inefficiency is to exploit the HD64180's excellent interrupt capabilities. SmartSpooler's I/O is totally interrupt-driven, including the serial and parallel ports as well as the front-panel switches. Table 1 lists these interrupt assignments.

To solve the problem of large buffer maintenance, SmartSpooler uses the HD64180's direct-memory-access controller (DMAC), which has direct access to the entire physical address space. Besides performing the actual `IN` and `OUT` operations, the DMAC maintains the buffer pointers (using built-in DMA address registers with auto-increment). Channel 0 is the input channel, configured to perform I/O-to-memory DMA. Channel 1, as output, is configured for memory-to-I/O DMA.

Usually, I/O DMA occurs by request of the I/O device itself. Unfortunately, this doesn't easily handle special cases like buffer full, buffer empty, Pause button, copies, and handshaking. To get more flexibility, SmartSpooler uses a "soft" DMA technique. The HD64180 $\overline{\text{DREQ}}$ inputs are connected to CPU I/O ports instead of directly to the I/O peripheral ports. This lets the software initiate DMA.

Hands Across the Buffer

Both input and output ports need to provide handshaking. On the input side (host to SmartSpooler), the host must be signaled to stop when the buffer fills, to prevent overflow (remember the water tank example). On the output side (SmartSpooler to printer), SmartSpooler needs to pause when the printer is busy printing or goes off-line. In the formal world of data communications, this is known as flow control.

Flow control requires handshaking, which is a way of conveying start/stop information between the various devices. Hardware handshaking uses extra signal lines dedicated to flow control. Software handshaking conveys flow-control information over the data channel itself.

The Centronics parallel interface uses hardware handshaking signals: $\overline{\text{STROBE}}$, $\overline{\text{ACK}}$, and BUSY. The RS-232C ports provide both hardware handshaking ($\overline{\text{RTS}}$ and $\overline{\text{CTS}}$) and software handshaking (XON/XOFF).

The problem with serial handshaking ($\overline{\text{RTS}}$, $\overline{\text{CTS}}$, and XON/XOFF) protocols occurs when the receiver can't shut off the sender in time to prevent overflow. Those of you who have spent time trying to get terminals or computers to run at 19,200 or 38,400 bits per second know what I mean (the beeping terminal syndrome). Also, some sending devices check for handshaking only at the end of each line, rather than for each character. To avoid overflow, SmartSpooler's serial port drivers incorporate a 256-byte "pad," allowing plenty of time for handshaking delays.

Table 1: *SmartSpooler takes full advantage of the HD64180's interrupt capabilities. Note that the NMI and INT0 signals are also gated with XBUS inputs, allowing I/O expansion boards to use them.*

$\overline{\text{NMI}}$: Not used (parallel output port $\overline{\text{ERROR}}$ input is optional)
$\overline{\text{INT0}}$: Parallel input port
$\overline{\text{INT1}}$: Parallel output port
INT2: Front-panel switches
PRT(Timer)0: Software delay timer
PRT(Timer)1: Real-time timer
DMA0: Not used
DMA1: Not used
CSI/O: Not used
ASCI(UART)0: Serial input port
ASCI(UART)1: Serial output port

Local, Test, and Host Modes

SmartSpooler's operating mode is determined at power-on by DIP-switch settings.

Local mode is the normal mode of operation. In this case, SmartSpooler enters the default port configuration (parallel to parallel) and is ready to spool incoming data. Using the front-panel switches and LEDs, you can enter commands to change the port configuration, pause the output, and request copies.

Test mode works with a standard RS-232C terminal connected to one of the serial ports (see photos 1a and 1b). Instead of entering the spooler routines, SmartSpooler executes a built-in monitor program, which contains routines to test the ports, switches, and LEDs, as well as a complement of traditional monitor commands (`display`, `enter memory`, and so on). Test mode is useful for diagnosing hardware, cable, and host driver software problems.

Host mode lets the host computer download commands to

continued

(a)

(b)

Photo 1: (a) *This screen shows the commands available while SmartSpooler is in test mode.* **(b)** *From this screen, you can individually test all four buttons, all eight LEDs, and all eight DIP switches. The right-hand column shows the SmartSpooler modes for several different DIP-switch settings. Whatever setting is last selected determines the default mode SmartSpooler enters when you reset it or power it up.*

Operation Summary for SmartSpooler

Power-on:
- Clear LED goes on.
- Config LED goes on, and the default port configuration is shown.
- Clear LED goes off, and the LEDs switch to show buffer capacity.
- SmartSpooler is ready for operation.

Changing the port configuration, changing the pause mode, and aborting printout:
- Push the Clear button.
- Push the Config button to change the port configuration and the Pause button to toggle the pause mode on/off.
- Push the Clear button (Clear LED off) to start SmartSpooler operation.
- The LEDs switch from showing the port configuration to monitoring the buffer capacity.

Suspending/resuming printing:
- Push the Pause button to suspend printing.
- Push the Pause button again to resume printing.

Making copies:
- Press Clear prior to sending document to copy.
- Send the document to SmartSpooler.
- Push the Copy button.
- Push the Config button to select the number of copies (0 to 4) desired.
- Push the Copy button again (Config LED off) to finish the copy request.
- The Copy LED will remain on until all copies are printed.

Single-sheet printing:
- Make sure you've selected the pause mode during power-on or Clear setup.
- Make sure your computer transmits a formfeed character to SmartSpooler prior to each new page (including the first).
- When the Pause LED goes on, insert a new page into the printer.
- Push the Pause button to print the next page.

Check buffer capacity, port configuration, and the number of copies remaining:
- During normal operation (Clear LED off), the parallel/serial In/Out LEDs show percent full (0, 25, 50, 75, or 100) the SmartSpooler buffer is, and the Pause LED controls print suspend/resume.

SmartSpooler. One benefit of host mode is that it lets you use software—instead of switches and LEDs—to set the port configuration and serial port format (data transfer rate, start/stop bits, parity, and so on). In fact, you can remove SmartSpooler's switches, LEDs, and corresponding circuits if you never use SmartSpooler for local mode operation.

For the ultimate in versatility, the host can even download a new control program to totally replace SmartSpooler's control program. SmartSpooler's ROM vectors all HD64180 interrupts through a RAM-based vector table, letting the new control program take over interrupt response. Combining SmartSpooler's hardware with optional XBUS expansion boards (e.g., the Circuit Cellar GT180 color graphics display or the COMM180 modem/small-computer-system-interface [SCSI] board) and your own control program opens the door for lots of interesting applications.

Using SmartSpooler

SmartSpooler is easy to use. The following is a summary of specific button functions.

Pushing the Clear button stops any operation (I/O) in progress, initializes SmartSpooler, and lights the Clear LED. Any data in the buffer is lost upon Clear.

You use the Clear button in the following instances:

- to change the port configuration
- to change the pause mode
- before receiving a document that will be copied
- to cancel a printout
- to finish the Clear request (Clear, Config, and Pause LEDs off)

The Pause button has two functions, one after the Clear button is pushed and another during normal operation. After you've pushed the Clear button (Clear LED on), pushing Pause toggles the pause mode on or off. When pause mode is on (Pause LED on), SmartSpooler will suspend output after transmission of a formfeed character to the printer. Use this mode for single-sheet feeding; position the next sheet and push the Pause button (Pause LED off) to resume printing. When pause mode is off (Pause LED off), SmartSpooler will not check formfeed characters. Use this mode when printing continuous (i.e., platen or tractor-fed) forms.

Push the Copy button (Copy LED on) to make copies of everything SmartSpooler has received since the last Clear. Then, increment the number of copies desired by pushing the Config button (Config LED blinks).

The LEDs show how many copies are selected: One LED on means one copy (plus original); four LEDs on means four copies (plus original). After entering the number of copies desired, push the Copy button again (Config LED off) to complete the copy request.

The Config button toggles the I/O (serial or parallel) port configuration when the Clear LED is on. The configuration is reflected on the parallel/serial In/Out LEDs.

Two Functions

SmartSpooler is actually two projects. One of these is a high-performance printer buffer; the second is a configurable intelligent peripheral controller. Most people will assemble it as a printer buffer, but others will find applications ideally suited for the host programmed mode. While SmartSpooler is not a trivial

continued

project, you can extend it to perform tasks that separate it from a mere buffer. One possibility is to use SmartSpooler between a host computer and a modem to filter incoming data, initiate and time calls, or encrypt and decrypt data.

As a printer buffer, 256K bytes is more than adequate. However, as a specific-application peripheral controller, SmartSpooler might need additional capability.

As I mentioned previously, it is not inconceivable to add 8 or 16 additional I/O ports, a 20-megabyte SCSI hard disk drive, or the GT180 color graphics display to SmartSpooler through its XBUS expansion connector. The necessary hardware for such peripherals already exists for SmartSpooler from previous Circuit Cellar articles.

Experimenters

While printed circuit board kits for SmartSpooler are available, I encourage you to build your own. If you don't mind doing a little work, I will support your efforts as usual. You can download a hexadecimal file of the executable code for SmartSpooler's system EPROM (27128) from my bulletin board at (203) 871-1988. Alternatively, you can send me a preformatted IBM PC floppy disk with return postage, and I'll put all the files on it for you (add $6 for the SmartSpooler User's Manual). Of course, this free software is for noncommercial personal use only.

Next Month

The first part of a two-part article on a two-channel "biofeedback" EEG brain-wave analyzer. ■

I'd like to personally thank Tom Cantrell for his extensive work on this project. Without his software expertise, I'd be hopelessly mired in an ocean of bits forever.

Editor's Note: Steve often refers to previous Circuit Cellar articles. Most of these past articles are available in book form from BYTE Books, McGraw-Hill Book Co., P.O. Box 400, Hightstown, NJ 08250.

Ciarcia's Circuit Cellar, Volume I covers articles in BYTE from September 1977 through November 1978. *Volume II* covers December 1978 through June 1980. *Volume III* covers July 1980 through December 1981. *Volume IV* covers January 1982 through June 1983. *Volume V* covers July 1983 through December 1984. *Volume VI* covers January 1985 through June 1986.

It's virtually impossible to provide all the pertinent details of a project or cover all the designs I'd like to in the pages of BYTE. For that reason, I have started a bimonthly supplemental publication called Circuit Cellar Ink, which presents additional information on projects published in BYTE, new projects, and supplemental applications-oriented materials. For a one-year subscription (6 issues), send $14.95 to Circuit Cellar Ink, P.O. Box 3378, Wallingford, CT 06494. Credit card orders can call (203) 875-2199.

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1. SmartSpooler RAMless full printed circuit board kit for parallel-to-parallel operation. Comes complete with printed circuit board and all printed-circuit-board-mounted components, including HD64180, IC sockets, SmartSpooler software on EPROM, and User's Manual. Less DRAM chips. SS01-KIT $119
2. SmartSpooler experimenter's kit for parallel-to-parallel operation. Comes with printed circuit board, crystal, HD64180 and plastic-leaded-chip-carrier socket, software on EPROM, and User's Manual. Available only through September 30, 1988. SS02-EXP $89

Optional serial port ribbon cables are available. Call for pricing.

The SmartSpooler design is available for licensing to qualified manufacturers. Call for information.

All payments should be made in U.S. dollars by check, money order, MasterCard, or Visa. Surface delivery (U.S. and Canada only): add $5 for U.S., $8 for Canada. For delivery to Europe via U.S. airmail, add $14. Three-day air freight delivery: add $10 for U.S. (UPS Blue), $25 for Canada (Purolator overnight), $45 for Europe (Federal Express), or $60 for Asia and elsewhere in the world (Federal Express).

There is a multiline Circuit Cellar bulletin board system (running TBBS 2.0M) that supports past and present projects in BYTE and Ink. You are invited to call and exchange ideas and comments with other Circuit Cellar supporters. The 300-/1200-/2400-bps BBS is on-line 24 hours a day at (203) 871-1988.

To receive information about the Circuit Cellar Ink publication for hardware designers and developers, please circle 100 on the Reader Service inquiry card at the back of the magazine.

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.

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Dick Pountain

POP Goes the Macintosh

POP-11, a powerful AI programming language, is finally available on a microcomputer

For me, the ideal language would be an artful blend of Pascal, Lisp, and Forth with a dash of Smalltalk and Prolog. From Pascal, it would take clean syntax and block structure that can make programs both readable and beautiful. From Lisp, it would take weak data typing, list processing, and the notion that procedures are indistinguishable from data. From Forth, it would take the ideas of extreme interactivity with executable subprograms, incremental compilation, and a simple compiler that the programmer can understand and whose services you can invoke from a user program. From Smalltalk, it would take the idea that a class of data objects should have private access procedures, known only to class members. From Prolog, it would take the built-in pattern matching and database facilities.

My ideal language appears to exist already. It's called POP-11, a language I first discussed in a BYTE column in October 1984. Unfortunately, SNAP, the simplified IBM PC version of POP that I wrote about in 1984, was never released; the project ran out of funding and time. Now things are looking up: A full implementation of POP-11, called AlphaPOP, is available for the Apple Macintosh. It requires a Macintosh running the Hierarchical File System (HFS) with 512K bytes of memory. It comes on either single- or double-sided disks. (See the text box "AlphaPOP for the Macintosh" on page 288.)

POP History and Fundamentals

POP-11 started life back in the late 1960s as POP-2, developed in the machine intelligence department of Scotland's Edinburgh University (the same department that produced the Edinburgh Prolog standard) by Robin Popplestone and Rod Burstall. It was designed as a replacement for Lisp, with a more acceptable syntax that would make it easier to learn. After being used as a main research language at Edinburgh for years, it migrated to Sussex University in Brighton, England, where a slightly simplified version was ported to the DEC PDP-11 and christened POP-11. (For the rest of the article, I will refer to it simply as POP.) POP was designed especially to put powerful artificial intelligence (AI) programming techniques into the hands of noncomputer people; at Sussex, it was used in computing courses for arts and literature students. It has found widespread use in European AI departments, as has its relative, POPLOG—a combined POP/Prolog system for the DEC VAX.

POP is an incrementally compiled language, like Forth or Microsoft's QuickBASIC 4.0. New procedures are compiled into a heap-based dictionary in which a procedure can appear only once. Whenever you recompile a procedure, its name remains in place but the old code record is freed, eventually to be gobbled up by a garbage collector that operates automatically when heap space gets too low. Procedures are compiled into a stack-based virtual machine code that has only 17 instructions. You can define new language keywords by using a set of procedures that directly compile these virtual machine instructions. This way, you can alter not just the surface syntax, but the compiler itself; for example, you can add new control structures to POP.

POP is a highly interactive language, rivaled in this respect only by Smalltalk-80. Anything you can do inside a procedure (including looping), you can also do directly from the keyboard, and vice versa. It's a weakly typed language, like Lisp, so the same variable could, at different times, hold a number, a string, a list, a procedure, a vector, or one of many other kinds of objects. You can predeclare variables as in Pascal or C, but if you don't, POP will declare them for you (with a message saying that it has done so).

It supports integer, big-integer, and floating-point arithmetic (the latter are called `decimal` numbers), and, like BASIC, it's happy to let you mix the types in a calculation, performing automatic type conversions. Many trigonometric, logarithmic, and transcendental functions are built in, including even the hyperbolic functions. Decimal precision is up to 16 places, and you

continued

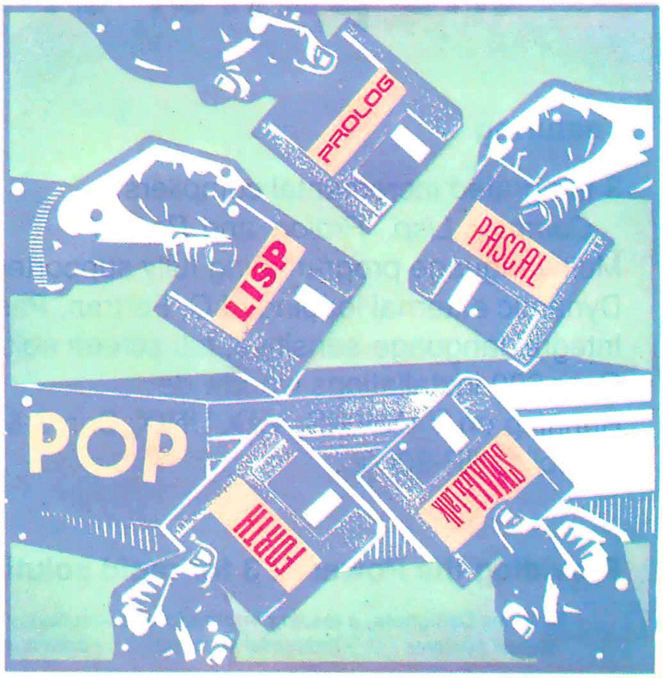


Illustration by Chris Spollen © 1988

can choose to output any number of places. You can also compute in any number base up to 36.

An assignment statement in POP is written from left to right, the assignment operator being represented by the -> symbol; it's best to think of it as meaning "goes into." So, `[cows dogs pigs] -> x;` puts the list on the left of the -> symbol into a variable x. I could have predeclared the variable by `vars x;`.

Input and output parameters for procedures are declared separately. In this procedure definition,

```
define add_ten(num1) -> num2;
  num1 + 10 -> num2;
enddefine;
```

the output parameter is called num2.

Stack-Based Architecture

POP is a stack-based language, using an open stack like that in Forth to pass all its parameters. Mercifully unlike Forth, however, POP looks after the stack contents automatically so the programmer need not worry about them. Named output variables are just placeholders provided for readability, the results actually being left on the stack. The => operator prints the whole stack contents destructively and is smart enough to recognize all the available data types and print them in a suitable format. You can inspect the value of any item using the print arrow (=>). So, add_ten(3) => prints 13 on the screen, while x => prints [cows dogs pigs].

One consequence of the stack-based architecture is that POP can easily handle procedures that take variable numbers of input parameters or produce variable numbers of results. Such procedures are very useful in certain problem domains, especially when returning lists. For example, you can make a list of the first 100 integers in POP like this:

```
[% for i from 1 to 100 do i endfor %]
                                  -> ints;
```

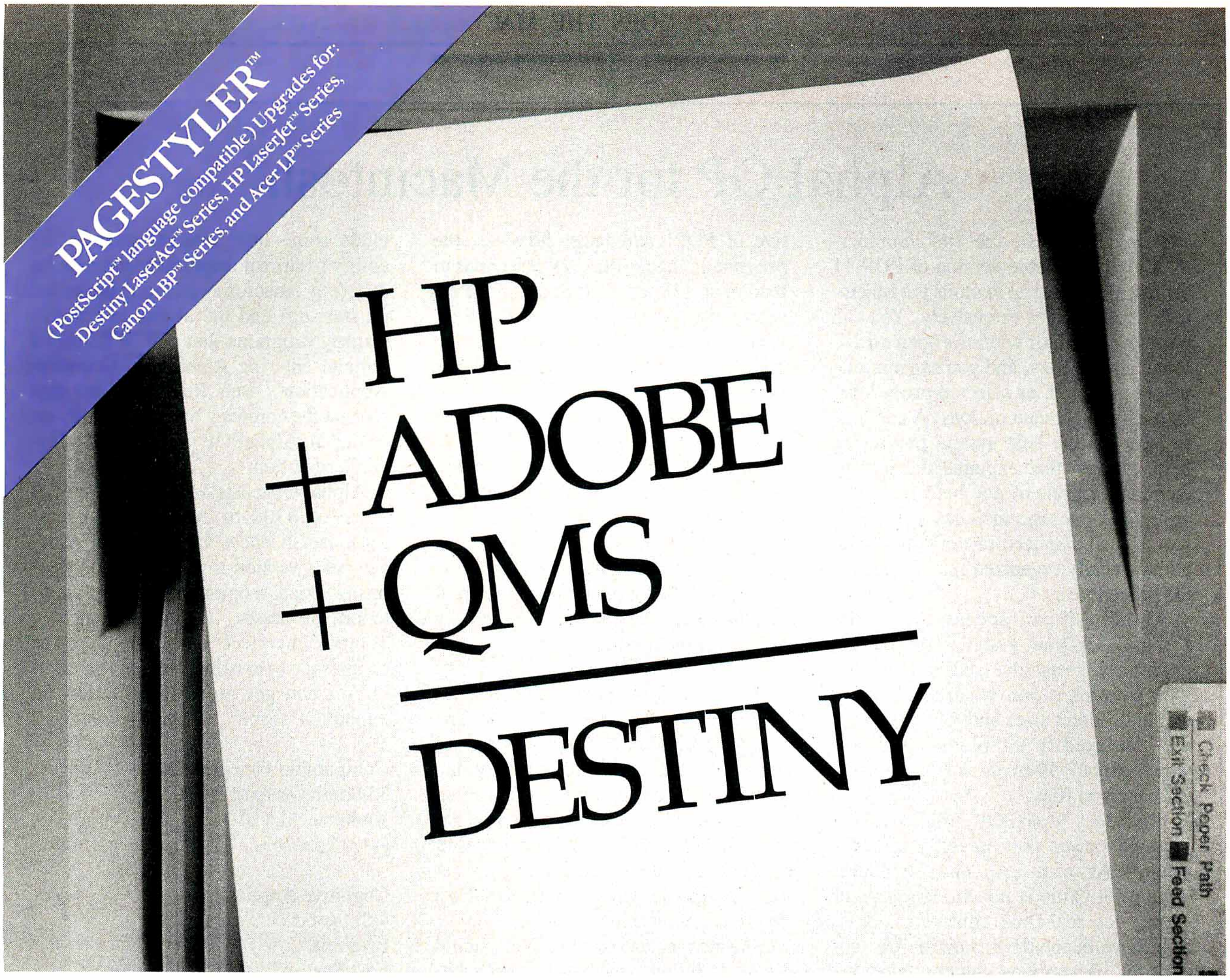
The % symbols tell POP to evaluate the expression lying between them; otherwise, the actual source code would have been assigned to ints as a list. The for loop could be replaced by a procedure that returns a variable number of results.

POP has a rich set of control structures, including ones for list manipulation and pattern matching. Syntactically, they are all fully (if verbosely) bracketed by adding end to the opening word, as in if...endif, until...enduntil. Hence, Pascal's begin...end and C's curly brackets need not enclose code blocks. I love this feature, and I marvel that so few languages adopt it (Modula-2 somehow stumbled at the last hurdle).

The for loop has several special forms for iterating over lists, which is usually more efficient than using recursion, though recursion is supported too. Consider the clarity of this simple list reverse procedure:

```
define reverse(list1) -> list2;
  [] -> list2;
  for item in list1 do
    item :: list2 -> list2;
  endfor;
enddefine;
```

continued



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AlphaPOP for the Macintosh

AlphaPOP 1.0, the first commercially available version of POP-11 for microcomputers, exploits the Macintosh user interface extensively. You can have several editor windows open on different source files, and you can compile whole programs or selected procedures by clicking on menu options. A comprehensive on-line help system provides a help window that explains the parameters and actions of any built-in procedure. The package includes two excellent printed manuals, one of which is an alphabetically organized reference to all the procedures.

AlphaPOP can access the ROM-based QuickDraw graphics so you can draw lines, rectangles, and ovals (filled with patterns if you wish) and display text in different sizes and fonts. Pictures are displayed in Graphics Windows, which AlphaPOP treats as POP devices, equivalent to files.

What does AlphaPOP's high-level expressive power cost in terms of efficiency? As with Lisp and Smalltalk, quite a lot. This is not the language of choice for real-time control systems. The Sieve benchmark runs in 168 seconds for 10 iterations, which is slow for a Mac II. The Sieve is hardly representative of POP's strengths, however; the program in listing 1 takes 9.9 seconds to read in an 11K-byte file and sort the resulting list of 2420 words, while the reverse procedure that I defined in the main text takes 1.8 seconds to reverse the final list.

AlphaPOP comes from Cognitive Applications, a firm that was started on the campus of Sussex University and in which the university has a shareholding; the programmers are all ex-Sussex POP people. The availability of POP on a personal computer has been a long time coming because, even more than Lisp, it is a language that needs lots of memory and lots of processing power.

AlphaPOP consists of a 240K-byte executable kernel with over 120K bytes of source code for library functions. The memory manager adjusts its use of memory to the amount of memory that you have. While AlphaPOP will run on a 512K-byte Mac, I ran it on a 4-megabyte Mac II. There was 2.4 megabytes of free space, which is enough to write serious programs. The Atari Mega ST is a future target machine.

The next release of AlphaPOP should be ready by the time this is published. According to the company, it will include some little tweaks, such as the ability to store a default environment on disk (e.g., macros and fonts to be loaded on start-up) and the ability to compile turnkey programs that can be launched without entering AlphaPOP. Cognitive Application's Ben Rubinstein informs me that the company has successfully attached an AlphaPOP procedure to a HyperCard button.

AlphaPOP costs $400 with a special price of $300 to educational users. Multiuser licences are available. A developer's version is in preparation, featuring lexical scoping, optimized compilation, processes, and full C and Mac Toolbox interfaces; it will be offered as an upgrade to existing users.

You can get more information on AlphaPOP from:

Computable Functions Inc.
35 South Orchard Dr.
Amherst, MA 01002
(413) 253-7637

Cognitive Applications
4 Sillwood Terrace
Brighton
East Sussex BN1 2LR
U.K. (0273)-821600

In a similar way, you can iterate on the successive tails of a list by `for tailitems on list1 do....`

One of the pleasures of POP is its semantic consistency. All the data types supported (including user-defined types) have a set of similar operators for manipulating them. Moreover, the names of these operators are formed by adding the same prefix to the type name, so you can usually guess what an operation is called without consulting the manual.

For example, an operator that starts with `is` recognizes the type of its object. So `isstring(x)` returns true if `x` is a string, false otherwise. The equivalent for numbers is called `isnumber()`. You get the picture.

A *constructor* creates objects of a type (e.g., `conslist()` is the constructor for lists), while an *initializer* creates initialized objects of a variable length type. A *destructor* breaks an object down into its parts (e.g., `deststring()` turns a string into a set of characters). A *subscriptor* operator allows you to access items in a repetitive data structure (like a list or a vector), while an *accessor* does the same for fields in a record structure; the name of an accessor is normally just the name of the field it accesses. For example, the subscriptor for lists is called `subscrl()`, so `subscrl(3,[cat dog pig])` would return `pig`. Because subscripting is used so often, there's a concise alternative syntax modeled on the normal array notation, so `mylist(4)` returns the fourth element of `mylist`.

All types also have a print procedure (`class_print`) that knows how best to display them on the screen, and an *updater* that changes the value of an object. Updaters have no names; they are represented by the assignment arrow. So `frog -> mylist(3);` replaces the third element of `mylist` with `frog`, using the updater for lists.

Benefits of Modularity

POP is object-oriented in a somewhat restricted sense. Because the class system in POP lacks inheritance, it is not usually promoted as an object-oriented language, but it achieves most of the benefits of program modularity. You can define new classes of object, and define the methods for operating on them, within the above-mentioned categories. What's more, you can replace the existing operators for the built-in types. If you want lists to be printed out in some special way, you can write a procedure and assign it to be the `class_print` for lists.

In addition to these class-method operators, a group of universal operators works on most types. These are the equality test `=`; the identity test `==`; the concatenator `<>`; `length()`, which measures the size of objects; `dataword()`, which returns the type of object; and `explode()`, which is a universal deconstructor. If you apply `length()` to a string, it tells you how many characters are in it, but for a list, it returns the number of top-level items, and so on. The `<>` operator joins together two strings, lists, vectors, procedures, or records of the same type.

There is a related operator, `><`, which joins two objects of any type by concatenating their print representations into a string; it is often used for screen output. The equivalent of the Pascal

```
write('That took',count,'seconds');
```

continued

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Listing 1: *I used AlphaPOP for the Macintosh to run this program, which reads in a text file, makes it into a list of words, sorts the list, and returns it as a result. On a Mac II, this program takes 9.9 seconds to read an 11K-byte file and sort the resulting list of 2420 words. The reverse procedure takes 1.8 seconds.*

```
define sortfile(inputfile) -> sortedlist;
  vars readnext, item;

  inputfile.discin.incharitem -> readnext;

  [ %
   until (readnext ->> item) == termin do
    if item.isnumber then consword(item><'');
    elseif item.isstring then consword(item);
    else item;
    endif;
   enduntil;
  % ].sort -> sortedlist;

enddefine;
```

in POP is

```
pr('That took'<>count,'seconds');
```

Where Pascal restricts the smartness to the `write` routine, POP provides a generalized mechanism so you can assign the string expression to a variable or pass it to a user procedure.

Procedures as Data

Procedures in POP are first-class objects, which is to say that you can handle them just like any other data object. For example, you can assign a procedure to a variable and execute it just by passing parameters to the variable name:

```
add_ten -> x;
x(5) => 15
```

This means that you can create arrays and lists of procedures and then use them to devise extremely subtle control strategies. You can concatenate procedures just like strings or lists, and the result is a procedure that performs both the original actions in sequence.

Procedures can be passed as parameters to other procedures. A lovely example is the built-in routine `newarray()`, which, not surprisingly, creates new arrays. It can take a procedure as its last parameter, which is then executed to calculate the initial values for the new array. So you could set up the elementary school multiplication table by saying

```
vars mult_table = newarray([1 12 1 12],
                    procedure(x,y);
                      x * y;
                    endprocedure);
```

which creates a 12 by 12 table of products. The function `procedure` defines anonymous procedures that will be used only once (similar to the function `LAMBDA` in Lisp); indeed, `define` merely calls `procedure` and then assigns the result to a named variable.

Because procedures are first-class objects, they can also be returned as results from other procedures. One area in which POP exploits this ability is for disk I/O. POP-11 was originally designed under Unix, and it has inherited Unix's streamed I/O philosophy, whereby the disk is perceived in terms of an output and an input stream of single characters rather than blocks; C programmers will feel at home here. POP implements streamed input and output by creating procedures. The standard procedure `discin(`*`filename`*`)` returns as its value not a character from the disk file, but another procedure that itself returns characters from the disk; such a procedure is called a *character repeater*.

Every time you call a character repeater, it returns the next character from the file, eventually returning the unique object `termin`, which is POP's equivalent to the end-of-file marker. Disk output is performed in a similar way using a *character consumer* procedure returned by `discout()`; this swallows a character given to it and writes it to the file. If you need to read from different parts of the same file, then you can create several repeaters on the same file. This mechanism is simple and elegant but is limited to sequential access; there are no random-access files.

To get a taste of the way POP works, I wrote a little program to read in a text file, make it into a list of words, sort the list, and return it as a result (see listing 1).

The variable `readnext` gets assigned an *item repeater*. Item repeaters are procedures that read in whole POP objects rather than just single characters, and you make them with the built-in procedure `incharitem`, by passing to it a character repeater produced by `discin`.

The line `inputfile.discin.incharitem` illustrates an alternative syntax called *dot notation* that you can use to make nested function applications easier to read; it means exactly the same as `incharitem(discin(inputfile))`.

The function `incharitem` simply uses the tokenizer that POP itself uses when parsing input; here, then, is a good example of using the compiler as an extra resource. `Readnext` can return words (equivalent to Lisp atoms), numbers, or strings, so I need to convert them all to words by using `consword()`; `Sort()` is a built-in procedure for sorting lists of a single type.

With POP, you can define *closures*, which you could think of as procedures whose arguments have been partially supplied and are looking for the remainder. For example, if you already have a procedure `nth_root(x,n)`, you could economically define a new procedure `square_root(x)` as a closure of `nth_root()`, with `n` frozen permanently to the value 2.

POP supports dynamic lists, which some other languages call *lazy lists*. These are lists whose elements are produced only when they are asked for, so you can use them to represent infinite collections, such as "all the integers," without tying up infinite memory.

POP supports macros, not unlike the preprocessor macros of C. You can use them to customize the syntax, to avoid the overhead of a procedure call with in-line code, or to isolate program features that are subject to frequent changes.

POP supports *properties*, which are hashed lookup tables with the hashing mechanism built in. They can be used to create databases in conjunction with other POP data structures like lists and records.

Popping the Question

Perhaps the most powerful features of POP are the pattern matcher and database. The fundamental operator is `matches`, which tests two lists, the second of which is a pattern (usually containing wild cards) and returns a Boolean result;

```
[ salamander bright shall burn ] matches [ = bright == ]
```

returns `true` because the wild card `=` matches any single word, and `==` matches any number of words. POP can bind variables as

continued

a side effect of the pattern matching, so

```
[ salamander bright shall burn ] matches [ ?x bright == ]
```

not only returns `true` but leaves `x` with the value `salamander`, while

```
[ salamander bright shall burn ] matches [ = bright ??x ]
```

leaves `x` bound to the list `[shall burn]`. This form of matching is most often used in `if` statements and loops where the Boolean value is useful. Where no such return is required, you can use the `-->` operator, which merely binds variables and returns nothing, but which raises an error if it fails to match.

```
[ salamander bright shall burn ]
          --> [ = bright ??x ]
```

You can make these matching statements still more powerful by applying restrictions to the pattern. For example, `?name:4` will bind `name` only to words exactly four letters long, while `??y:10` will bind `y` only to lists of 10 items. A restriction can also be the name of a procedure, which is executed with a found item as its argument; binding only occurs if the procedure does not return `false`. For example `?x:isnumber` will bind `x` only to numbers.

POP's built-in data structure, called database, is a list of lists, and is supplied with a set of procedures for adding and removing assertions and doing sophisticated matching. `Add ( [Jim likes beans] )` would add the assertion about `Jim` to the database.

There are two special forms of the `for` loop that work by matching in the database. One uses `foreach`, which takes a pattern and executes the loop body once for each match, while the other uses `forevery`, which takes a number of patterns and executes the loop for every set of values that satisfies them all. This is getting close to Prolog:

```
forevery
   [[?person likes ?x][?x is nutritious]] do
   [^person is well fed] => forevery;
```

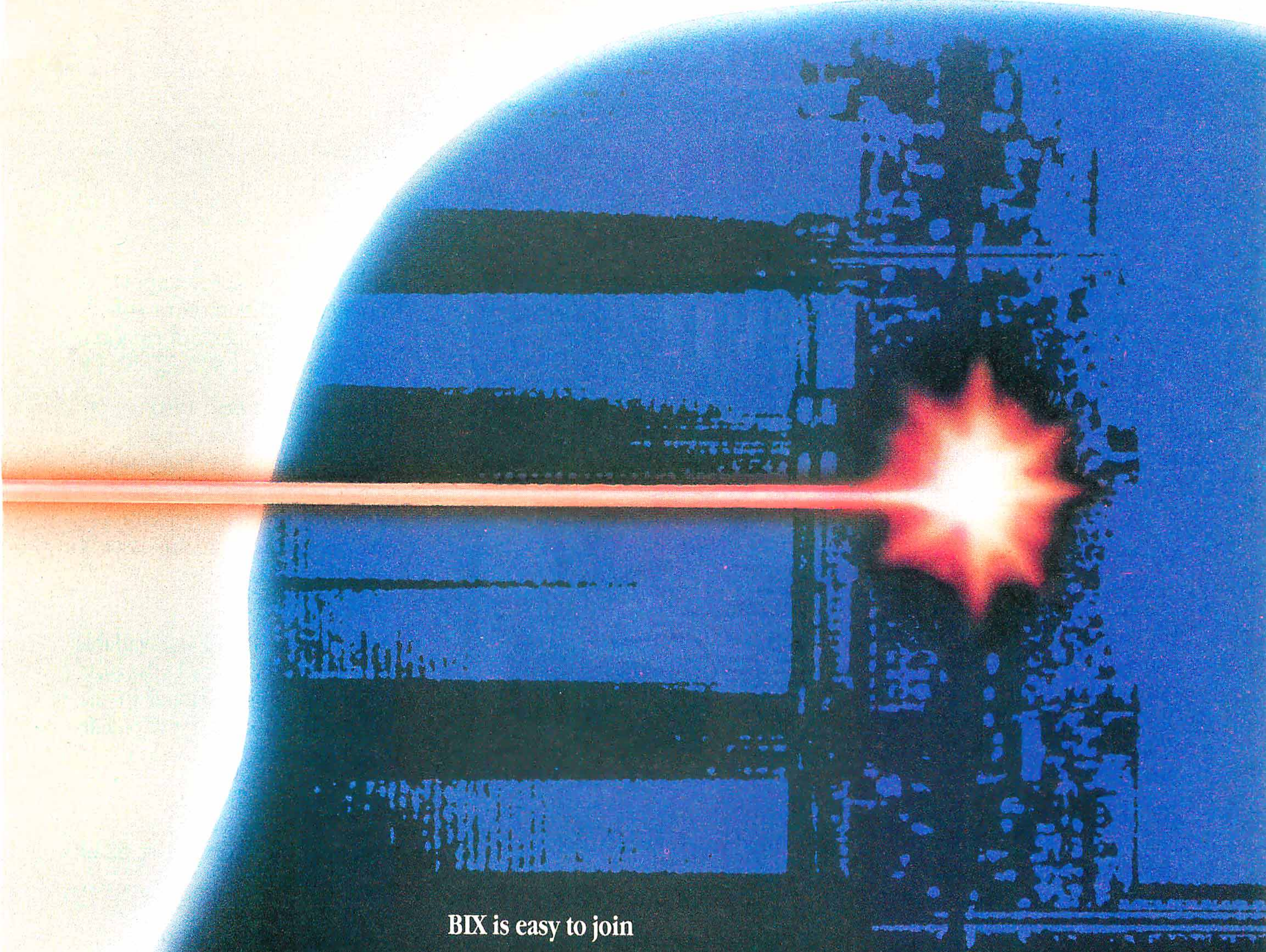
However, POP does not have automatic backtracking, which makes Prolog superior for certain applications (and which is why Prolog has been added to POP in the POPLOG system). Nevertheless, the humble POP database makes writing expert systems very easy and replaces a lot of code that the Lisp user would have to keep reinventing.

Rich and Expressive

In summary, POP is the richest and most expressive programming language I've ever used, and I've used a few. Despite its wealth of features, it is also easy to learn. The advanced features are entirely optional, and a beginner can use POP like BASIC or Logo without even knowing what a closure or a dynamic list is. While learning it, I never once experienced one of those Moments of Great Bewilderment (MGBs) that I remember from when I was learning Lisp and Prolog.

Any programmer who knows C or Pascal should feel immediately at home with POP because it's imperative, procedural, and statement-oriented. While experimenting with the Alpha-POP implementation, I found myself writing for sheer pleasure the sort of programs that AI students get out of their system in their first year: sentence parsers, travesty generators, and the rest. For me, it is almost the ideal programming language. ■

Dick Pountain is a technical author and software consultant living in London, England. He can be contacted c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.



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Searching for Text? Send an N-Gram!

Short character strings called n-grams give every document a unique signature

Here's the problem: You maintain a full-text database of all the stories printed by a large daily newspaper. With several hundred issues stored, you want to find all the stories relating to a particular subject. How do you do it?

The keyword approach is too limited; the database contains too many subjects. Artificial intelligence (AI) won't help much; machines and programs aren't that smart yet. You could use special pattern-recognition hardware, but the cost is prohibitive.

The solution to the problem might be a novel approach developed by Raymond D'Amore and Clinton Mah at PAR Government Systems Corp. in McLean, Virginia. Their technique is simple, elegant, and it works. It uses pieces of words, which they call *n-grams*.

Fingerprinting Documents

An n-gram is a sequence of a specified number of characters occurring in a word. For example, the two-character n-grams (or 2-grams) in the word "duck" are "du," "uc," and "ck." An n-gram vector is a list of the n-grams found in a document and the number of times each was found, as shown in figure 1.

To set up a document-retrieval system using n-grams, you derive an n-gram vector for each document as you are storing it. The n-gram vector comes from the text. It is an index of the document, a unique "fingerprint" that you can use to identify it. To create the n-gram vector, you remove the common words from the text; then you remove the common endings from the remaining words. You count selected n-grams in the word fragments that are left and keep them in a list; that's the n-gram vector.

You then store the n-gram vector with a pointer to the location of the full-text document. You might want to store the vector along with other vectors that are similar to it.

Now you are ready to retrieve documents using words, phrases, or sentences that describe the subjects of interest. You can even use a sample document as a query to find others similar to it. To do this, you create an n-gram vector of the query and compare it to the vectors of the documents. The retrieval program computes the degree of similarity between the query's n-gram vector and those of the documents. When the similarity is great enough, the program selects the document, as shown in figure 2.

Beyond 2-Grams

To differentiate all but the shortest documents, counting only 2-grams is not sufficient. Some 2-grams are very common, such as "te." Others, like "qz," never occur. The common 2-grams don't have much value in indexing a document. For an index to be useful, it must differentiate between dissimilar documents. But if an n-gram occurs often in every document, it doesn't tell you anything. Those that don't occur at all also have no value because they don't tell you anything, either.

Rather than throwing away the common 2-grams, we can extend them to 3-grams. For example, rather than using "te," you would count all the possible 3-gram combinations that use "te"; that is, "tea," "teb," "tec," and so on.

D'Amore and Mah say that about 200 of the 676 possible alphabetic 2-grams (26 × 26) occur frequently enough to be candidates for extension. Unfortunately, many 3-grams are also very common; but you can extend the common 3-grams to 4-grams, and so on. Extending the n-grams improves the system's performance. However, you don't always *need* to go to 4-grams to index a document. The shorter the document, the smaller the size of the n-gram necessary to index it. Short documents of a few hundred words might need only 2- or 3-grams (as common as they are) to differentiate them from one another. For example, 2-grams alone work well enough with directories, such as telephone books.

D'Amore and Mah use about 12,000 different 2-, 3-, and 4-grams to index documents. An n-gram vector created using all these terms won't have 12,000 n-grams in it, however. The number of n-grams occurring in a document increases slowly as the number of words in it rises; a 3000-word document, for example, might have only 600 different n-grams. But if you have to keep track of 12,000 different n-grams, *it would* seem to make sense to use 4-

continued

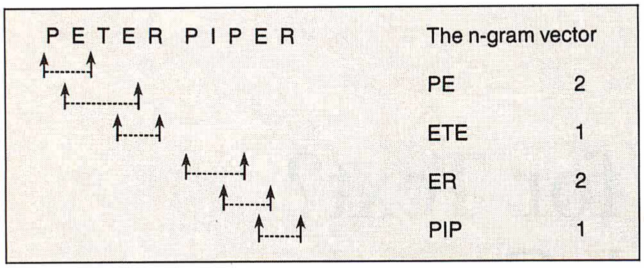

Figure 1: *In this n-gram extraction, four kinds of n-grams are included in the vector for the phrase "Peter Piper." This vector contains two 2-grams (each of which occurs twice) and two 3-grams. Note that n-grams can overlap.*

grams instead. Not so; there are too many of them. There are 676 2-grams if you use only alphabetic characters. But there are 17,576 alphabetic 3-grams, and almost half a million alphabetic 4-grams.

You can also include nonalphabetic characters in n-grams. The only ones generally useful are numbers, which occur frequently in documents and are often the subject of queries. "Commodore 64," "256K bytes of RAM," and "The Belchfire 8000 with 40 megabytes of hard disk storage" could all occur in a document and thus be the subjects of a query.

None of the numeric and alphanumeric n-grams possible are considered common. You should probably store purely numeric n-grams as 3-grams. There are only 1000 possible numeric 3-grams. Compared to the number of alphabetic n-grams, this is a relatively small number.

Cut Out the Noise

Another way to reduce the number of n-grams you need to differentiate documents is by noise reduction. Noise, for purposes of indexing, is information contained in a document that doesn't add much to your ability to find that document. Punctuation is considered noise. Common words such as *a, the, by,* and *for* are also noise.

Table 1 contains a list of 258 of the most commonly used words in American English. They comprise about 55 percent of the words used in the written language. Your database may have different common words. (If your database consists of articles about computers, for example, such words as *mother* and *father* might occur less frequently.) Because they are so common, these words add little information to text analysis. However, you must carefully consider their elimination. *Mother, father, children,* and *school* might be quite common in some contexts, but eliminating them might remove important information, particularly in an academic or sociological-factors database. Some words, too, are homonyms. *Begin,* the name of the former Israeli prime minister, is spelled the same as *begin.* Eliminating *begin* also, unfortunately, eliminates *Begin.*

Listing 1, COMMON.C, provides an efficient method for recognizing these common words. A large table at the end of COMMON.C (not shown in listing 1) was taken from a spelling checker written in Pascal (thus the need for the program to offset subscripts by 1). It contains an array of structures, each with a single character, a `wordend` flag, a `next` index, and an `alt` index.

A word fragment enters the table by converting the first character in the word to an index. This is simple: *a* is 1, *b* is 2, and so on. The `next` index for this entry is taken to be the current index. From this point, the characters of the word aren't used as indexes; they're just compared to the characters in each table entry. The function now works as in table 2. This method is fast, and you can expand it to include more words. You can also compact the table if you wish.

You can even consider common word endings to be noise. *Ended* and *endings* have the same root: *end.* If you reduce both words to their common root, you eliminate superfluous differences, and the similarity measurements will improve. This process of stemming a word down to its root is known as *conflation.*

Digging Up the Roots

Whenever a program must extract meaning from individual words of English text, the word forms are often conflated—that is, normalized or transformed into a simple, common form. Words such as *civilization, fishing,* and *halted* are transformed into their basic forms: *civilize, fish,* and *halt.* At least, that is the goal. To accomplish this, you need a set of rules similar to those used in knowledge-based systems. If you use only a few (20 or 30) rules, some transformations won't be accurate. *Civilization* might truncate to "civiliz." A word like *the* truncates to "th," as do *they* and *these,* when such words really shouldn't be conflated at all.

To deal accurately with this problem, you need 1000 or more rules that specify, for the most part, exceptions and special cases. When very high precision isn't necessary, a few rules

continued

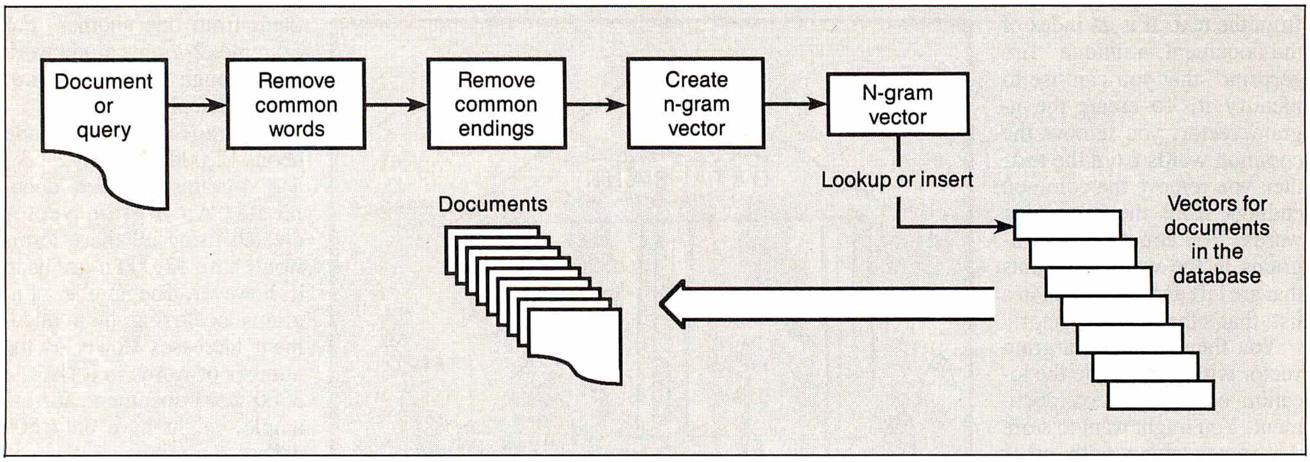

Figure 2: *An n-gram vector is a list of the n-grams in a text document, minus all common words and common endings. The n-gram vector is stored with a pointer to the location of the full-text document. By comparing the n-gram vector of a query to those of stored documents, you can find documents likely to contain what you're looking for.*

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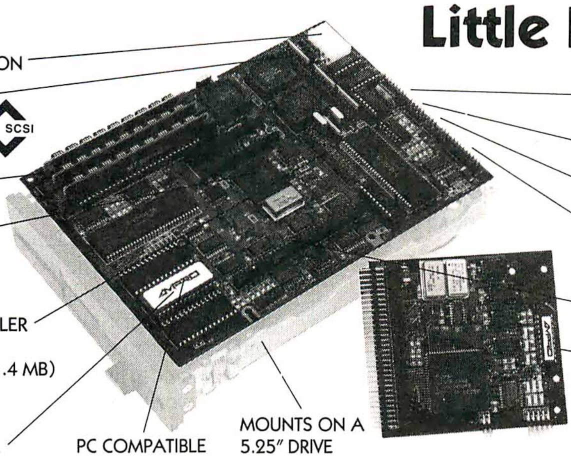

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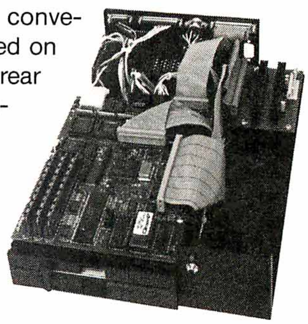

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Listing 1: *COMMON.C, a C program used to recognize common words.*

```
/* this structure holds a directed graph
   used to recognize common words */
#define GRAFSIZE  405
struct {
  char c;
  char wordend;
  int next;
  int alt;
    } stopgraf[GRAFSIZE] { }
/* The data used to initialize stopgraf is
   given later
*/
int stopword(word,wl)
     char word[];
     int wl;    /* word length */
/*
     stopword enters the common word graph
     with the value in word[]; if word[] is
     in the graph, return 1, else 0
*/
{
int j=0, p;
  p = word[j] - 'a' + 1;  /* the first
                entry is 1, not zero */
  while (j < wl-1 && p) {
    j++;
    p = stopgraf[p].next;
    while (p && stopgraf[p].c < word[j])
                p = stopgraf[p].alt;

    if (stopgraf[p].c != word[j]) p = NULL;
    }
  return(p && stopgraf[p].wordend);
  }
```

will suffice, and the odd cases don't really matter.

The C function in CONFLATE.C (see listing 2) does a simple-minded job of conflation. The table `endings` is an array of structures that contains the rules. Each structure has the text of a word ending, its length, a possibly zero-length replacement string, *its* length, and the index of the next table entry so the program can check whether the current word ending matches one stored in the structure.

A word enters the table at `ending[0]`. If the word ends in "ably," the program truncates it. The process repeats, starting at `ending.next`. However, if the word doesn't end in "ably," then "ibly," "ily," "ss," and so on are checked in order. The checking (and replacing) continues until the program reaches the end of the table. Notice that there are three endings where the check string is zero-length. The first two are traps to prevent falling through to the lower part of the table. The last terminates execution of the function.

For example, the word *readabilities* passes the first few rules and then matches "ies." The program removes "ies" and replaces it with "y." The word becomes *readability*. Matching then continues at `ending[14]`. The program matches and removes "ability." The word becomes *read.* The `endings` table is checked at location 24, but matching fails to the end. Notice that these rules don't always create reasonable stems. *Movabilities* conflates to "mov," *invisibilities* to "invis." However, the program also conflates *move* and *invisible* to "mov" and "invis." In other words, all forms of the same word conflate to the same root, although the root may not be the one you'd expect.

Useful N-Grams: Worth the Weight

Rare n-grams are more useful in discriminating between different documents than are common ones because the rare ones are weighted more heavily during similarity computations. The system's performance determines the weighting scheme used. D'Amore and Mah have found the following to work well: $W_i = 1/\sqrt{P_i}$ where W_i is the weight to be used for n-gram number i,

continued

Table 1: *This list contains 258 of the most common words in American English. Such words fail to help distinguish documents from one another, and removing them makes documents' n-gram vectors more unique.*

a	before	each	got	just	more	or	should	things	well
about	began	earth	great	keep	most	other	show	think	went
above	being	end	had	kind	mother	our	side	this	were
after	below	enough	hand	know	Mr.	out	since	those	what
again	between	even	hard	land	much	over	small	thought	when
air	big	ever	has	large	must	own	so	three	where
all	both	every	have	last	my	page	some	through	which
almost	boy	eyes	he	left	name	paper	something	time	while
along	boys	far	head	let	near	part	sometimes	times	white
also	but	father	help	life	need	parts	soon	to	who
always	by	feet	her	light	never	people	sound	together	why
an	called	few	here	like	new	picture	still	too	will
and	came	find	high	line	next	place	story	took	with
animals	can	first	him	little	night	put	study	two	without
another	children	following	his	live	no	read	such	under	word
any	come	food	home	long	not	right	take	until	words
are	could	for	house	look	now	said	tell	up	work
around	country	form	how	looked	number	same	than	us	world
as	day	found	I	made	of	saw	that	use	would
asked	days	four	if	make	off	say	the	used	write
at	did	from	important	man	often	school	their	very	year
away	different	get	in	many	old	second	them	want	years
back	do	give	into	may	on	see	then	was	you
be	does	go	is	me	once	sentence	there	water	your
because	don't	going	it	men	one	set	these	way	
been	down	good	its	might	only	she	they	we	

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and P_i is that n-gram's probability of occurrence.

You can calculate the probability that a specific n-gram will occur by counting all the occurrences of that n-gram in a large, representative body of documents. Then you divide this count by the total number of n-grams. You must calculate a weight for each n-gram used as an indexing term, but you do it only once; after that, the weight is a constant you look up in a table.

Computing Similarity

To determine the similarity between two n-gram vectors, you multiply the frequencies of corresponding n-grams by their weights and sum the results. When two n-gram vectors are dissimilar, the sum of the products of the corresponding frequencies is small: Where one vector has some of a particular kind of n-gram, the other hasn't any or has only a few. When the two numbers are multiplied, the result is zero or a small number. If two n-gram vectors are similar, they have more of the same n-grams, and the result is larger.

There is a scale of similarity, then, from small similarity

continued

Table 2: *The logical operation of the function in listing 1 after establishing a beginning current index.*

While there is a current index and you haven't run out of
  characters in the word,
    Get the next character from the word.
    Set the current index to the *next* value.
    While you have a current index and your current character
      in the word is greater than the character stored in the
      current table entry,
        Set the current index to the value at *alt*.
    Endwhile.
    If the character at the entry for the current index isn't
      the same as the current character in the word, you don't
      have a common word.
Endwhile.
When you finally come to the end of the word, if the current
  table entry's *wordend* flag is set and you haven't otherwise
  eliminated this word, it is a common word.

Listing 2: *CONFLATE.C. This routine will stem a word down to its root.*

```
/* A Conflating Function in C */

#define LT -1
#define EQ  0
#define GT  1
slteqgt(s1,s2)
  unsigned char *s1, *s2;
/* compares two strings */
{
  for(;;){
    if (*s1 < *s2) return(LT);
    if (*s1 > *s2) return(GT);
    if (*s1 == *s2 && !*s1) return(EQ);
    s1++; s2++;
    }
  }

/* the following are locations in
   the conflation table */
#define SSend    3
#define Eend     10
#define IONend   12
#define ARYend   14
#define ABLend   20
#define IVend    22
#define ATend    23
#define ISend    24
#define FIN      27
#define ENDINGS 28
struct{
  char *ending;  /* ending string */
  int   offset;  /* length */
  char *replace; /* replacement */
  int   replen;  /* length */
  int   next;    /* goto */
    } endings[ENDINGS] {
        "ably",    4,  "",    0,  ISend,
        "ibly",    4,  "",    0,  FIN,
        "ily",     3,  "",    0,  SSend,
/*SS*/  "ss",      2,  "ss",  2,  FIN,
        "ous",     3,  "",    0,  FIN,
        "ies",     3,  "y",   1,  ARYend,
        "s",       1,  "",    0,  Eend,
        "ied",     3,  "y",   1,  ARYend,
        "ed",      2,  "",    0,  ABLend,
        "ing",     3,  "",    0,  ABLend,
/*E*/   "e",       1,  "",    0,  ABLend,
        "al",      2,  "",    0,  IONend,
/*ION*/"ion",      3,  "",    0,  ATend,
        "",        0,  "",    0,  FIN,
/*ARY*/"ary",      3,  "",    0,  FIN,
        "ability",7,   "",    0,  ISend,
        "ibility",7,   "",    0,  FIN,
        "ity",     3,  "",    0,  IVend,
        "ify",     3,  "",    0,  FIN,
        "",        0,  "",    0,  FIN,
/*ABL*/"abl",      3,  "",    0,  ISend,
        "ibl",     3,  "",    0,  FIN,
/*IV*/  "iv",      2,  "",    0,  ATend,
/*AT*/  "at",      2,  "",    0,  ISend,
/*IS*/  "is",      2,  "",    0,  FIN,
        "ific",    4,  "",    0,  FIN,
        "olv",     3,  "olut",4,  FIN,
/*FIN*/"",         0,  "",    0,  FIN+1};

stem()
/*  if the ending of word[] is in
   endings.ending, it is removed and any
   replacement string is tacked on the
   end; search and replacement is
   controlled by endings.next */

{
int i;
extern char word[];
extern int wl;
  i = 0;
  while(i<ENDINGS){
    if (slteqgt(&word[wl-
            endings[i].offset],
        endings[i].ending) == EQ){
      cpystr(
          &word[wl-endings[i].offset],
          endings[i].replace,NULL);
      wl += endings[i].replen -
          endings[i].offset;
      i = endings[i].next;
      }
    else
      i++;
    }
  }
```

False similarity can occur when the similarity threshold is too low. You're less likely to miss a document but more apt to get dissimilar ones.

values to large ones. When responding to queries against a set of n-gram vectors for documents, you must determine the threshold above which you wish to select a document and below which you wish to reject it. Figure 3 represents the system's ability to discriminate between text items using similarity values.

You can get raw similarity values by multiplying corresponding n-gram counts and weights and adding the products. The size of these raw values depends as much on the n-gram vector size as on the counts in the vectors. That is, two documents might be equally similar to a third, but similarity computations will probably produce different values. The longer document will probably have a longer n-gram vector (because of the greater chance for having some of the rarer n-grams in it). In a longer vector, there is a greater opportunity for matching corresponding n-grams in another vector during similarity computations. This means the similarity value will be larger.

The method for reducing the similarity values to a common measure, called the normalization process, is a little complicated. It requires that you compute an estimate of the standard deviation and the expected value of the similarity values. The standard deviation is a measure of the variability of raw similarity values, and the expected value is a mean, or average, value.

Many of the values needed to compute the standard deviation are constants for a particular set of n-gram indexing terms. In addition, you need the total number of n-grams counted in each vector (the lengths of the vectors). For the formulas to use in normalizing the raw similarity values, see the text box "Making It Work."

The n-gram system is large and complicated and can malfunction. A malfunction occurs when a similarity computation produces a value unexpectedly large enough to cross whatever similarity threshold you have set for document selection. Few, if any, of the words from the query might actually appear in the document. When a query contains mostly common n-grams, the chance for false-similarity matching is relatively high. This happens more frequently when you use only 2-grams or 3-grams as indexing terms. The purpose of extending the n-grams to longer strings is to reduce their frequency and therefore the chance of false similarity.

False similarity can also occur when the similarity threshold is set too low. This reduces the chance of missing a document, but increases the chances of getting documents that don't apply to the query. In a mature system, false similarity can be well controlled and is relatively rare.

Using a Thesaurus

Synonyms can be a problem, particularly in short documents. For example, in a newspaper story about an aircraft accident, the word *airplane* might never appear. Instead, words such as *craft*, *jet*, and *Boeing 747* might be used. Further, *mishap* might not appear, while *accident* or *crash* does. In other words, a query of "airplane mishaps" might fail to produce this story from the database.

To circumvent this problem, you can implement a thesaurus containing groups of words with similar or related meanings as well as synonyms. You create an n-gram vector for each word group. You only need to keep the vectors on-line; you don't need to use the words themselves during similarity matching. You can now compare the query to the n-gram vectors representing the thesaurus. Those vectors that are similar to the query probably contain some of the words in it. Then you can use the query's n-gram vector and the thesaurus's n-gram vectors that are similar to the query and compare them to the documents' n-gram vectors. A similarity above the threshold indicates which documents to retrieve.

Creating the thesaurus is no small task. There are a lot of words to collect into groups and a lot of decisions to make. Your

continued

	Peter Piper picked a peck of pickled peppers	How many pickled peppers did Peter Piper pick?	Pied Piper of Hamlin	Peter Piper	'Twas brillig, and the slithy toves did gyre and gimble in the wabe
Peter Piper picked a peck of pickled peppers	31.5	30.9	16.4	26.0	−2.2
How many pickled peppers did Peter Piper pick?	30.9	28.2	17.2	33.8	−1.9
Pied Piper of Hamlin	16.4	17.2	32.9	23.5	−9.9
Peter Piper	26.0	33.8	23.5	48.9	−1.7
'Twas brillig, and the slithy toves did gyre and gimble in the wabe	−2.2	−1.7	−0.9	−1.9	20.8

Figure 3: *This table shows the similarities between five phrases, four of which resemble one another. The similarities were computed using the method shown in the text box "Making It Work." Higher values indicate greater similarity, while lower (or negative) numbers indicate dissimilarity. If, for example, you set the threshold to 25 and the query was "Peter Piper," the system would select the first two phrases. If the query was "Pied Piper of Hamlin," the system would select neither of those phrases.*

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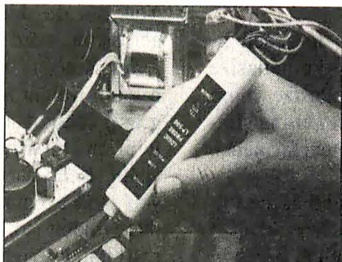

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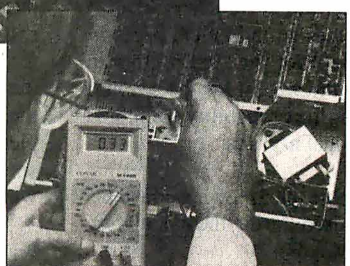

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Making It Work

Step 1: Select the 10,000 to 15,000 2-, 3-, and 4-grams to be used as potential members of n-gram vectors. If the documents are short (such as telephone directories), you may need only 2- and 3-grams, or even just 2-grams.

One way to select the n-grams is to find a large body of text representative of the text you want to store and search. Count the various 2-grams in it. Take the 200 or so most common 2-grams and add characters (at the end). Each common 2-gram will expand to 26 3-grams. Count the number of 3-grams that occur in your representative documents. Expand the 150 or so most common 3-grams to 4-grams. (If you want somewhat better performance, you can also expand the 100 most common 4-grams to 5-grams.)

If your documents are anything like ordinary text, you will end up with about 12,000 n-grams. You won't find many of the expanded n-grams in your representative text; they are either nonsense or very rare—you won't be able to tell which in most cases. For these n-grams, just assign an arbitrary count of 1.

Step 2: Compute the probability of occurrence of each n-gram in the indexing set you've just created. This is the number of times the n-gram was found divided by the total number of n-grams counted.

Step 3: Compute weights for each n-gram. The weight is used to emphasize rarer n-grams and deemphasize more common n-grams when computing similarity. They improve the performance of the system.

D'Amore and Mah found that the following formula works well: $W_i = 1/\sqrt{P_i}$ where i indicates an individual n-gram. W_0 is the weight for the first n-gram in the set, W_1 is the weight for the second, and so on; P_i is the probability computed for the individual n-grams.

Step 4: Compute the following constants (they will be used during the calculation of similarity values):

$$C_0 = sum_i[W_i*P_i^2]$$
$$C_1 = sum_i[W_i*P_i^3]$$
$$C_2 = sum_i[W_i*P_i^4]$$
$$C_3 = sum_i[sum_j[W_i*P_i^2*W_j*P_j^2]] \quad \text{where } i \text{ not } = j$$

The *sum* here means "compute the value inside the brackets for each n-gram and add up the values." In the last, C_3, the weight times the probability squared for each n-gram is multiplied by the weight times the probability squared for every other n-gram. That is, the first is multiplied by the second, third, fourth, etc.; the second by the third, fourth, etc.; and so on. The values for all these multiplications are added together.

Step 5: Create an n-gram weight table. This table will contain the n-grams to be used in n-gram vectors and the associated weight for each n-gram. The table will be large, so storage and lookup might be a problem. While creating the n-gram vector for a document, n-grams are created and looked up in the table. If an n-gram is in the table, it is counted. When computing similarity, an n-gram's associated weight is used.

Step 6: Implement the algorithm to create an n-gram vector. (This is not the optimal way, but it is a simple way.) Scan each word in the text. Try the longer n-grams before the shorter ones. You can do this by sliding a window across the word. At first the window is four characters wide. Look this up in the n-gram weight table. If you find this n-gram, count it. If you don't, narrow the window to three characters and try again. Keep narrowing and trying until you find a countable n-gram. Expand the window to four characters again, shift it to the right, and continue looking for countable n-grams. When narrowing the window, be sure you don't narrow the window so much that it falls completely within the previous window. It should (if possible) overlap the previous window, but extend outside it as well.

The n-gram vector is just a list of the n-grams found and their counts. Rather than saving the character-string representation of the n-gram, you might want to save its index in the n-gram weight table. This makes it easy to compare two n-gram vectors and to look up their respective weights.

Step 7: Implement the algorithm to compute the similarity between two n-gram vectors and thus the similarity between a query and a document or between two documents. Start by computing R, the raw similarity value between them. If you have vectors a and b, then $R = sum_i[W_i*N_i^a*N_i^b]$ where W_i is the weight for each n-gram and N_i^a and N_i^b are the counts for the individual n-grams in each of the n-gram vectors (a and b are superscripts, not powers).

Step 8: Implement the algorithm to normalize the raw similarity value. Because the size of the raw value will depend on the relative sizes of the source documents for the vectors, you have to compensate for the document sizes. You do this by subtracting the expected similarity value from the raw similarity value and dividing by the estimated standard deviation of the raw similarity value.

The formula for the expected similarity value is $E = T^a*T^b*sum_i[W_i*P_i^2]$ where T^a is the total number of n-grams in the a vector, and T^b the total number in the b vector.

The formula for the standard deviation squared is $D^2 = T^a*T^b*(C_0+(T^{ab}-2)*C_1-(T^{ab}-1)*C_2-(T^{ab}-1)*C_3)$ where T^{ab} is T^a+T^b and C_0, C_1, C_2, and C_3 are the constants computed in step 4.

The normalized similarity between the two vectors is then $S = (R-E) / D$. The normalized similarity values computed in this fashion seem to be stable and can be compared to one another and to constant thresholds.

Optional Step: Rather than using raw n-gram counts, in each step where n-grams are counted, you can substitute the square root of the count. This transformation seems to improve performance somewhat.

best bet might be to build the thesaurus a little at a time, as problems appear.

Natural Clusters

One alternative to the thesaurus is clustering. There is a natural tendency for documents with related subject matter to have similar n-gram vectors. You can look at one document as a complicated query and other, similar documents as the results of that query. Those documents that are similar to one another are clustered. You can create an n-gram vector for a cluster of documents by adding the corresponding n-gram counts in each vector to create a new vector that represents the cluster of documents.

When one document in a cluster is selected because the simi-

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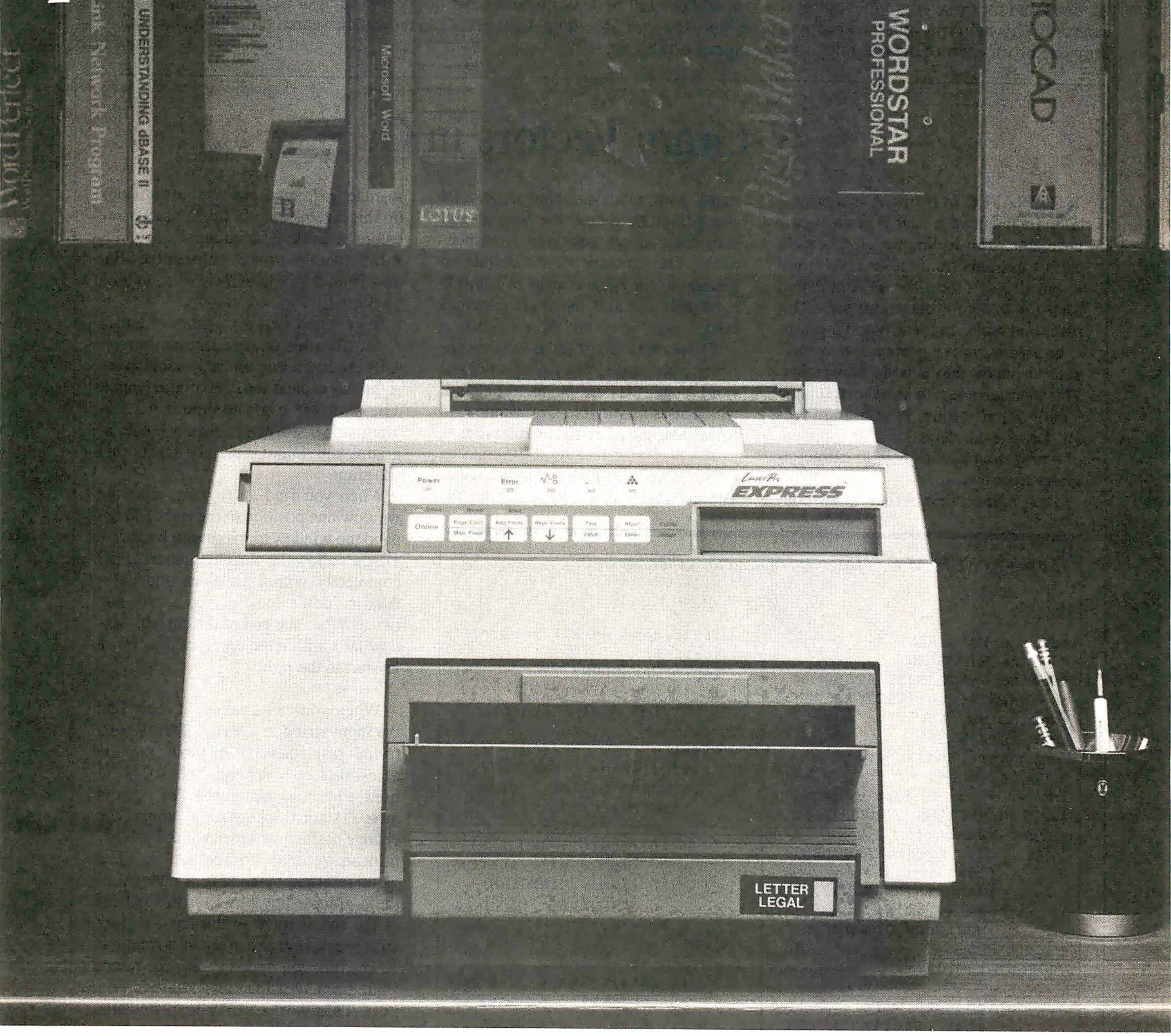

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larity between its vector and that of the query is greater than the threshold, the rest of the documents in that cluster are better candidates for selection. You might want to reduce the similarity threshold for these other documents so more of them will be selected. This helps prevent the synonym problem. However, if only one or very few of the documents in the cluster exhibit any similarity to the query, it is probably a spurious match. Using clustering can avoid false matching and missing valid documents.

When a database contains many documents, computing similarity between a query and each of the vectors can take a long time. Clustering can reduce the search time. Instead of scanning

continued

N-Gram Vectors in C

NGRAM.C in listing A is a central fragment of a real n-gram vector generator. The technique used here to extract n-grams from the text isn't used in practice; it's too slow. D'Amore and Mah use a highly optimized set of bit maps and tables to identify the n-grams to be used as indexing terms and to compute an index into a table of weights. This index also serves as a short, unique identifier for later use in an n-gram vector. Despite this deviation, this fragment of a program explains how to extract n-grams from text.

The program first defines a few constants and static variables. MAXNGLEN and MINNGLEN define the longest and shortest n-grams considered, respectively. The structure NGDATA defines an element of the ngrams array of 108,000 bytes that contains the n-gram strings used as index items and their weights.

The purpose of ngfind is to extract n-grams from words. The word (word) and word length (wl) are inputs to ngfind, which uses a variable-size window to frame possible n-grams. Its rules are:

- Try a maximum-size window first. The maximum size is MAXNGLEN or the word length, whichever is shorter. Look up this size n-gram in the ngrams array using the lookup function.
- If lookup returns 0, shorten the window from the right and continue to look up n-grams.
- If you can't find an n-gram of length MINNGLEN (this is considered an error), shift the beginning of the window to the right and expand it to maximum length. The shortest n-gram should be a 2-gram, and if you can't find any longer n-grams, you should at least be able to find a 2-gram.
- When you find an n-gram, shift the window one position to the right and expand the window to maximum length.
- Don't allow the current window to fall completely within an older window—that is, don't look at the same data twice. When the end of the current window falls within the previous one, move its start to the right.

Listing A: *NGRAM.C, a fragment of a vector generator in C.*

```
#define MAXNGLEN   4
#define MINNGLEN   2
#define VECTORSIZE 12000
unsigned vector[VECTORSIZE];
#define WL  43
char word[WL];
/* longest English word
   is 42 chars */
int wl = 0; /* word length */
#define NNGRAMS 12000
struct NGDATA {
       char ngram[MAXNGLEN];
       float weight;
       } ngrams[NNGRAMS];
int ngcount(gramid)
        unsigned gramid;
{
vector[gramid]++;
}
int ngfind(word,wl)
        char word[];
        int wl;
{
int oldend, len, start;
unsigned gramid;
if (wl < MINNGLEN) return;
oldend = wl;
len = MAXNGLEN;
if (len > wl) len = wl;
start = 0;
for(;;){
 if (gramid =
  lookup(&word[start],len)){
   ngcount(gramid);
   oldend = start + len;
   if (oldend == wl) return;
   start++;
   len = MAXNGLEN;
   if (start + len > wl)
         len = wl - start;
   }
   else{
      if (len == MINNGLEN){
      /* didn't find 2-gram */
        start++;
        len = MAXNGLEN;
        if (start + len > wl)
           len = wl - start;
        if (len < MINNGLEN)
           return;
        }
  else{
      len--;
      if (start-len <= oldend)
         start++;
         }
      }
   }
}
main()
{
init();
while(wl=getword(word)){
      if (!stopword(word,wl)){
         stem(word,wl);
         ngfind(word,wl);
         }
      }
outvec();
}
```

When you call lookup, it must find the input string in ngrams. This is not a trivial task. Several methods are usable—B-trees, hashing, and so on. I used a hashing technique. The ngrams array is static (lookups only), so you can change hashing parameters until you obtain an optimal storage profile. The value returned by lookup is either 0, if the n-gram is not found, or the address of the string equal to the input n-gram string in the ngrams array, if it is found.

The function ngcount uses the return value from lookup as an address in vector. This works fairly well because ngrams is much larger than vector. There are many more locations in vector than you need, but this unused space is your trade-off for speed.

In main, init initializes ngrams. The function getword obtains the next word from the input stream. All characters have been converted to lowercase, and all but alphabetic and numeric characters have been converted to spaces. The function stopword returns a 1 if word is common; stem conflates word. Finally, outvec writes the completed vector to a temporary file.

individual n-gram vectors during a search, you look at the vectors representing the clusters. When a cluster is similar to a query, you can either retrieve each document in the cluster or scan the vectors of the cluster documents for similarity.

To place a new document in a cluster, you must scan existing cluster vectors for similarity and, when you find one that meets or exceeds your threshold, add the n-gram counts in the new vector to the existing cluster vector. If you can't find a similar cluster, you can create a new one.

Fine-Tuning

Once you select a document's n-gram vector, you can retrieve the document. In a large database, you may select many documents. A few may have similarity with only part of the query or may be completely spurious. Rather than present the documents immediately, you can rescan each of the selected documents, eliminating the common words and stemming the rest. This time you compute n-gram vectors for individual words and compare them to the query's n-gram vector. This is a rapid process because a vector for a single word will be short; there are only a few n-gram types and therefore only a few multiplications to do. If there is sufficient similarity, the program considers the word significant and displays it with the document's identification. Then you can see how close the document comes to satisfying the query and choose which documents to select.

You can tune the retrieval operation to ignore mild misspellings in either the queries or the documents. Dropping a character or transposing two characters, for example, "speling mistkaes," is considered a mild misspelling. If, during the search, you lower the similarity threshold a bit, you will select documents with word variations. Some n-grams will match, though probably not the misspelled ones. If you have done some form of stemming, the word variations will not be due to grammatical differences, but to misspellings.

The Theoretical Model

D'Amore and Mah developed a model based on these concepts to convince doubters that these methods are valid and to predict the performance of new systems.

In testing their system, D'Amore and Mah used a variety of documents: about 1700 from the Associated Press, 1200 from the *New York Times*, 3100 from the Foreign Broadcast Information Service, 2800 physics abstracts, a few articles on exotic fuels, 700 articles from the Unix news network (with articles on AI, ham radio, the space shuttle, and others), and 300 miscellaneous messages from the Reuters wire service—altogether almost 10,000 documents. Document size varied from 700 words for the physics abstracts to nearly 12,000 words for the articles on exotic fuels. The average size was 2200 words each.

They used about 12,000 n-grams of various lengths to index the documents. They started with one document and gradually increased the size of their database. As they added documents, the model counted the number of unique n-grams it encountered. This number was proportional to the logarithm of the number of documents in the database.

Much of the work went to developing a theoretical framework for characterizing the statistical properties of n-gram indexes. This is important because D'Amore and Mah wanted to be able to describe the noise in n-gram indexing and calculate an n-gram vector's relevance to a document. This is critical if you are to retrieve documents using an n-gram vector created from a query and to collect similar documents.

Based on some assumptions about how text is generated, they described the statistical distribution of n-grams mathematically. Using this distribution, you can compute the similarity between two text items and the statistical significance of that similarity.

continued

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You can tune the retrieval operation to ignore mild misspellings in either the queries or the documents by lowering the similarity threshold a bit during the search.

To validate their model, D'Amore and Mah took pairs of vectors from random text items to approximate a noise level. They also took pairs from different segments of the same text item to estimate the difference between similar vectors (those from the same text item) and dissimilar vectors (those randomly chosen). They conducted many such experiments and calculated statistical measures for each batch to compare against the model's predictions.

In their words: "The statistical model was validated in extensive experiments with a broad variety of text. The results were especially noteworthy because one seldom can make any good predictions about the general statistical characteristics of language. . . an n-gram description of text does contain significant information about its content." For an example of how to program an n-gram vector, see the text box "N-Gram Vectors in C."

Pluses and Minuses

There are some drawbacks to this new indexing method. First, it's complicated, in terms of both implementation and computation. Getting a new n-gram system up and running requires isolating and selecting thousands of n-gram indexing items and going through many processing steps.

Second, the n-gram method is memory- and processor-intensive. Creating a vector requires the expensive lookup of many more n-grams than there are words. Computing similarity requires many floating-point multiplications and square-root calculations. These take time, especially if you use software to do the floating-point mathematics. Without considerable optimization, looking up individual n-grams can be expensive.

Then, too, the system isn't exact. The *meaning* of the document isn't used to index it. Without this understanding, similarity computations can go astray and either find similarity where none exists or fail to find it when it does exist. Trying to prevent this adds even more complexity to the system.

There are, however, good reasons for using n-gram indexing. For one thing, it works. I know of no better method for doing what n-gram indexing can do. Keyword solutions, the next best thing, are highly limited. Searching thousands of keywords is computationally more intense than n-gram indexing, and the system is biased toward whatever keywords you use. Appropriate keywords may also be inadvertently omitted. When you add new keywords to the system, you must reindex the database. Scanning the entire text to answer queries is costly in terms of time and equipment and doesn't work as well as n-grams do.

The n-gram indexing system is adaptable to several different situations, and you don't need to reindex the system to answer completely new questions. ■

[Editor's note: *Source code listings for COMMON.C, CONFLATE.C, and NGRAM.C are available in a variety of formats. See page 3 for further details.*]

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Juggling Multiple Processes

With Pascal-S, you can experiment with the fundamentals of concurrent programming

Shared resources are the parts of a computer system that more than one process can use simultaneously. They can include such things as common storage memory, I/O devices, and mass storage devices.

Computers can use such resources with a single CPU running more than one program at a time (as in a multiprogramming environment). The resource problems become more complex in parallel processing, where a single program is broken up and simultaneously executed by multiple CPUs on the same machine.

Issues of concurrency control (who gets what, when, and for how long) helped lead to the creation of programming languages that have the control structures to create and manage concurrent processes. Programming languages such as Ada have features that allow you to create and execute concurrent processes on more than one CPU at the same time. In a distributed system this could mean a set of computers totally independent of one another that function together, whose only means of communication is sending messages back and forth to keep the processes synchronized.

Concurrent Programs vs. Sequential Programs

A sequential language is one where execution of its statements proceeds in a predefined sequence. We are all familiar with sequential languages such as Pascal, C, and BASIC. These languages should consistently produce the same program trace for a given set of operating conditions (assuming that the program is debugged and operating properly). There are no issues of shared resources; the flow of the program dictates the order in which it accesses resources.

By contrast, a concurrent programming language allows statements to execute in parallel—this is what is meant by concurrency. If areas of a given program can execute concurrently, you could assign those areas to different CPUs where their execution could proceed in parallel. This "divide and conquer" strategy should execute more quickly than the purely sequential implementation.

Because process scheduling is asynchronous in nature, a given program with a set of operating conditions will most likely produce a different program trace each time you run it. But, if you design the program properly, its outcome should be consistent.

However, due to the random scheduling of processes, there is the additional problem of protecting shared resources such as variables, files, I/O, and so on, from being accessed by more than one process at a time.

Some languages that allow concurrent programming, and the means to synchronize the processes, are Ada, CSP, and Pascal-S (see the text box "Pascal-S" on page 322).

Ada supports the concept of a rendezvous where the transfer of information occurs at a predetermined point in each of two processes. This meeting place also serves as a method of synchronizing the two processes.

CSP supports a structured synchronization tool called a monitor. Shared resources exist only within the monitor, and a process can access them only by calling one of the monitor procedures. In doing so, the system denies all other processes entry into the monitor, as well as access to the shared resource, until the process currently inside the monitor releases the resource.

Pascal-S uses semaphores (described in detail later) to synchronize process flow. Processes that arrive at a semaphore either pass through or are blocked, depending on the value of the semaphore variable. In contrast to the rendezvous and the monitor, processes do not exchange information at a semaphore; only synchronization occurs.

The Precedence Graph

A precedence graph is a directed acyclic graph whose nodes correspond to individual program statements. Such a group shows the dependency relationship of shared resources within those statements.

An edge (which represents a process progression path) from *Sx* to *Sy* means that statement *Sy* can execute only after statement *Sx* has completed execution. Such relationships are critical if one statement or region in a program is dependent on another statement. An example of this is the variable parameter list associated to the `writeln` statement, S7 (in the program fragment below). Its parameters are calculated in the earlier statements S4, S5, and S6, as shown in figure 1. The statements S4, S5, and S6 are in turn dependent on the prior statements, S1, S2, and S3, being executed and those respective outputs being available.

```
          .
          .
a := y + z;           { S1 }
b := (a + 3) * c;     { S2 }
c := t * a;           { S3 }
d := -(b);            { S4 }
e := x + c;           { S5 }
f := y / c;           { S6 }
writeln(d, e, f);     { S7 }
          .
          .
```

From the above example, the precedence graph of figure 1 shows the following relationships to exist:

continued

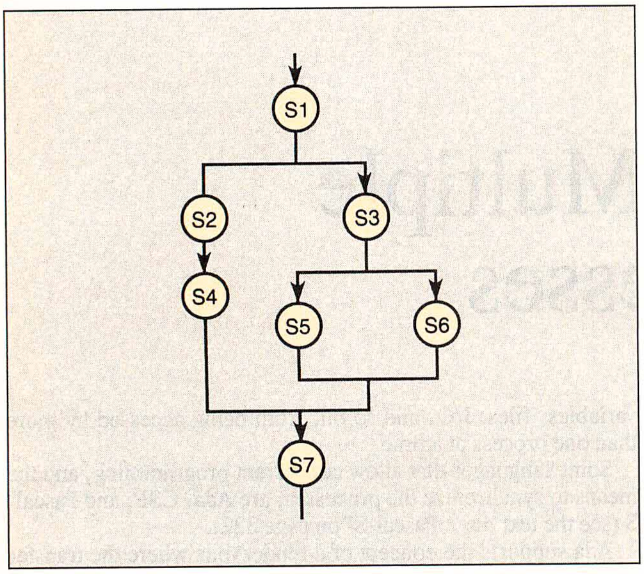

Figure 1: *Precedence graph for sample code fragment (see text), indicating the order in which statements can execute.*

- S2 and S3 can execute after S1 completes.
- S4 can execute after S2 completes.
- S5 and S6 can execute after S3 completes.
- S7 can execute after S4, S5, and S6 complete.

As you might begin to suspect, execution of any program statement without considering its dependence on a previous statement that has not yet executed can lead to disastrous results. You need a method of determining where potential timing problems might arise.

Detecting Concurrency

You can decide whether a dependence relationship exists between one or more items by examining a series of conditions known as Bernstein's conditions. The outcome of this analysis shows whether or not two statements—*Si* and *Sj*—can successfully execute concurrently.

Parallel execution will work if there is no dependence on the output results or the input requirements of any two statements. This holds true whether you test the relationship for variables or some I/O device where overlapping inputs would create a jumble of overlapping outputs.

To make this process work, I'll use a little basic set theory to show what happens when you test two statements for the intersection of input and output dependencies.

Consider the two statements *Si* and *Sj*, which can execute in a program concurrently and still produce the same results as long as *Sj* is not dependent on the outcome of *Si*; that is, if there is no edge from *Si* to *Sj* in a precedence graph. The rules are as follows:

$$(1)\ I(Si) \cap O(Sj) = \{\} \qquad \text{for all } (i,j)$$
$$(2)\ O(Si) \cap I(Sj) = \{\} \qquad \text{where } i \neq j$$
$$(3)\ O(Si) \cap O(Sj) = \{\}$$

where $\{\}$ indicates the empty set; $I(Si) = \{a1, a2, \ldots, am\}$ is the input set for *Si*, the set of all variables that are referenced in statement *Si* during its execution; and $O(Si) = \{b1, b2, \ldots, bn\}$ is the output set for *Si*, the set of all variables whose values change when statement *Si* executes.

If the three rules of Bernstein's conditions all produce empty sets, then we can be assured that there is no dependency between the statements.

Consider the following code fragment:

```
       .
       .
x := y + z;              { S1 }
a := (b + 3) * c;        { S2 }
d := e * a;              { S3 }
w := d - x;              { S4 }
writeln(d,w);            { S5 }
       .
       .
```

Using this fragment, could statements S1 and S2 execute concurrently? First, calculate the input and output dependency relationship sets:

$$I(S1) = I(x := y + z;) = \{y,z\}$$
$$O(S1) = O(x := y + z;) = \{x\}$$

$$I(S2) = I(a := (b + 3) \times c;) = \{b,c\}$$
$$O(S2) = O(a := (b + 3) \times c;) = \{a\}$$

Now perform the set operations to test for dependencies:

$$(1)\ I(S1) \cap O(S2) = \{y,z\} \cap \{a\} = \{\}$$
$$(2)\ O(S1) \cap I(S2) = \{x\} \cap \{b,c\} = \{\}$$
$$(3)\ O(S1) \cap O(S2) = \{x\} \cap \{a\} = \{\}$$

This meets Bernstein's conditions because all three tests produced empty sets. Therefore, S1 and S2 could execute concurrently. However, S1 and S4 could not because the input of S4 is dependent on the output of S1, as shown in the second test:

$$(1)\ I(S1) \cap O(S4) = \{y,z\} \cap \{w\} = \{\}$$
$$(2)\ O(S1) \cap I(S4) = \{x\} \cap \{d,x\} = \{x\}$$
$$(3)\ O(S1) \cap O(S4) = \{x\} \cap \{w\} = \{\}$$

Figure 2 shows the precedence graph of the sequential program execution. As expected, statement S1 is followed by S2 and by S3, and so on.

But what if you wrote the program in a language that allowed the concurrent execution of the same five statements? The graph would then appear as in figure 3, which shows how the statements might execute to take advantage of concurrency based on statements that are not dependent on one another. S1 and S2 proceed on concurrent paths, S4 executes after S1 completes, S3 executes after S2 completes, and S5 executes after S3 and S4 complete.

The Process Graph

The precedence graph described above shows dependency relationships of statements. The process graph, however, depicts both sequential and concurrent process creation and flow. Such a graph can be very useful when a you design a program; it is not always obvious which process will be created next or which processes must complete before another process can proceed. Also, this tool can help you debug code by showing graphically the source and destination of synchronizing abstractions, such as the semaphore. Pascal-S defines a special pair of concurrency constructs, `co-begin` and `coend`. The statement sequence

```
cobegin P1; P2;...;Pn coend
```

initiates processes `P1`, `P2`, . . . , `Pn`, all executing concurrently.

A process graph is a directed rooted tree whose nodes correspond to individual processes. You can use a process graph to express the relationship of the executing processes. An edge from node *Pi* to node *Pj* means that *Pi* created *Pj*, forming a parent/child relationship between the two processes. Any child *Pj* can have no more than one parent process. Also, an edge from *Pi* to *Pj* does not necessarily imply that *Pj* can execute only after *Pi*. It indicates that *Pi* created *Pj*, and that *Pi* and *Pj* may execute concurrently. The point at which concurrent processes are created is called a fork; the point where concurrent processes meet is called a join.

Given the fact that some process can create or spawn other concurrent processes, what can a process graph express? There are several possibilities:

- *Execution.* Either the parent continues to execute concurrently with its children, *or* the parent waits until all its children have completed execution.
- *Sharing.* Either the parent and children share all common variables, *or* the children share only a subset of their parent's variables. Consider the program fragment below.

```
     .
     .
begin
 P1;             {two sequential processes}
 P2;
  cobegin
   begin P3; P4 end  {two parallel processes,
                       each with}
   begin P5; P6 end  {a nested sequential
                       process}
  coend;
   P7     {process dependent on prior outcome}
 end;     {cannot execute until P4 AND P6}
      .   {have completed }
      .
```

The process graph would be like that in figure 4. For this example, assume that process P3 has a considerably shorter execution time than process P5, and that process P4's execution time is considerably longer than that of process P6. The execution steps would be:

1. Process P1 executes, followed by process P2.
2. Process P2 executes, followed by the creation of two concurrently executing processes, P3 and P5 (a fork).
3. Process P3 terminates, followed by process P4, but it is still concurrent with process P5.
4. Process P5 terminates, followed by process P6, but it is still concurrent with process P4.
5. Assume that process P6 terminates, before P4. However, process P7 cannot begin until process P4 also terminates.
6. Process P4 then terminates, and process P7 is released (a join) to execute to the program end.

You can see possible conflicts involving shared resources more easily by using a graphic approach than by slugging it out by inserting tracing information into a program. This becomes especially important if other executing processes act upon the information, resulting in misleading and confusing trace outputs.

Critical-Section Problem

Because several processes can run asynchronous to one another in a concurrent environment, data or shared resources that are common to two or more processes must be protected. These segments of code in the program that reference such shared items are called critical sections.

Consider a program with *n* concurrent processes. Each process has some segment of code that is a critical section containing a single global variable `A`:

```
process Pi code
      .
A := B * 3;        {S1}
writeln(A);        {S2}
      .


process Pj code
      .
A := C - B;        {S3}
D := (A-8) / 9;    {S4}
      .
```

The important feature of this program segment is that when the process *Pi* is executing in its critical section (consisting of statements S1 and S2; I'll call it *Ci*), you cannot allow any other process—such as *Pj*—to execute in its critical section (*Cj*, consisting of S3 and S4) if `A` would be affected. Otherwise, *Pi* could

continued

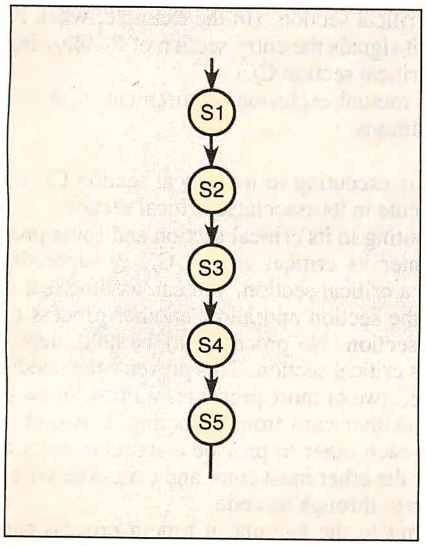

Figure 2: *Precedence graph for a code fragment (see text) whose statements execute sequentially.*

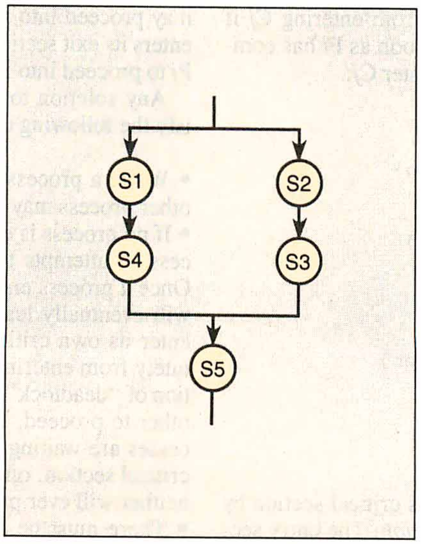

Figure 3: *Precedence graph for the same code as in figure 2. This time, concurrent execution is permitted.*

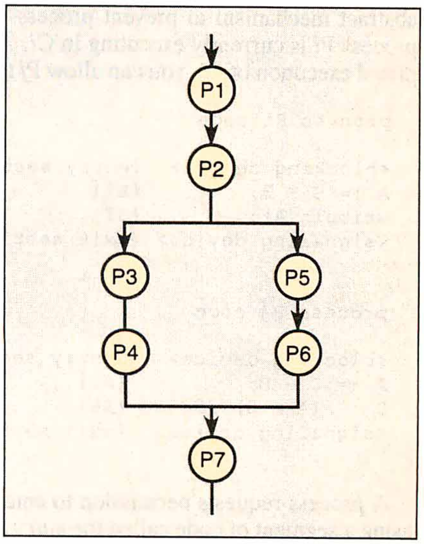

Figure 4: *Process graph for a code fragment (see text), showing sequential and concurrent processes.*

Listing 1: *A program to demonstrate the use of semaphores.*

```
{***************************************}
{ Producer bakes an inventory of up to 8 }
{ loaves, one loaf at a time, and signals}
{ consumer that it is OK to buy. If      }
{ inventory is full, then producer is    }
{ blocked until consumer depletes at     }
{ least one loaf. Producer may then pro- }
{ ceed. If consumer wants to buy bread   }
{ but is blocked from doing so, it must  }
{ wait until the producer bakes at least }
{ one loaf for inventory. When a loaf is }
{ taken, inventory is depleted, thus     }
{ allowing the producer to continue      }
{ baking new loaves for inventory.       }
{ MAIN initiates the two processes and   }
{ passes an identifier along with them to}
{ allow easy tracing of progress of the  }
{ program. The order in which the        }
{ processes are created does not matter. }
{***************************************}

program producer/consumer;

 var           {declare and init semaphores}
 ok_to_buy  : semaphore[0];      {init as
                              nothing to buy}
 ok_to_bake : semaphore[8];      {init to
                            produce 8 loaves}
 proceed :     boolean;         {pseudo "run
                            forever" command}

 procedure producer (pid : char);
      {producer is process id of '1'}

begin

  repeat
    wait(ok_to_bake);        {bake in
                       inventory not full}
    writeln('process #',pid,' baked a
                    loaf and put it on sale);
    signal(ok_to_buy);      {signal
                   consumer produce available}
  until (proceed = false);  {do it
                                  forever}
end;

{***************************************}
procedure consumer (pid : char);
          {consumer is process id of '2'}

begin
  repeat
    wait(ok_to_buy);    {wait until a loaf
                           is available}
    writeln('process #',id,' has
                 purchased a loaf of bread');
    signal(ok_to_bake);
  until (proceed = false); {do it forever}
end;

{***************************************}

begin   {MAIN}
       proceed := true;
       cobegin     {release two concurrent
                                processes}
         consumer('1');  {create consumer
                                  process}
         producer('2')   {create producer
                                  process}
       coend
end.
```

modify A in S1, but then P*j* could modify S3 before P*i* has a chance to print A in S2.

To ensure that this never happens, you must establish some abstract mechanism to prevent process P*j* from entering C*j* if process P*i* is currently executing in C*i*. As soon as P*i* has completed execution of C*i*, you can allow P*j* to enter C*j*:

```
process Pi code
      .
<blocking device>  {entry section}
A := B * 3;        {S1}
writeln(A);        {S2}
<signaling device> {exit section}
      .

process Pj code
      .
<blocking device>   {entry section}
A := C - B;         {S3}
D := (A - 8) /9;    {S4}
<signaling device>  {exit section}
      .
```

A process requests permission to enter its critical section by using a segment of code called the *entry section*. The entry section of P*j* acts as a gate to block a process from entering its critical section C*j* if P*i* has already passed through its entry section and into its own critical section C*i*. If P*i* is not currently in C*i*, then process P*j*'s entry section allows P*j* to proceed into C*j*.

Once a process completes execution in a critical section, it passes through another segment of code called the *exit section*. At that time, if another process is waiting at its entry section, it may proceed into its critical section. (In the example, when P*i* enters its exit section, it signals the entry section of P*j*, allowing P*j* to proceed into its critical section C*j*.)

Any solution to the mutual exclusion requirement must satisfy the following conditions:

- While a process P*i* is executing in its critical section C*i*, no other process may execute in its associated critical section.
- If no process is executing in its critical section and some process P*j* attempts to enter its critical section C*j*, P*j* succeeds. Once a process enters a critical section, you can assume that it will eventually leave the section and allow another process to enter its own critical section. No process may be held indefinitely from entering its critical section. This prevents the condition of "deadlock" (i.e., two or more processes waiting for each other to proceed, but neither can) from occurring. If two processes are waiting for each other to provide a signal to enter a critical section, one or the other must enter and exit; otherwise, neither will ever progress through its code.
- There must be a limit to the amount of time a process can spend in a critical section after some other process has made a request to enter its own critical section. Also, a given process cannot hog its own critical section, entering and exiting indefi-

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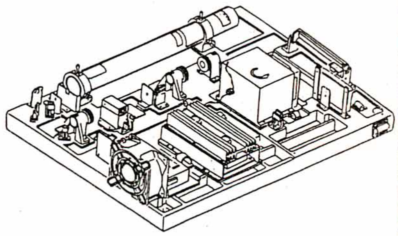

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nitely without allowing other processes into their own critical sections. These fairness requirements prevent "starvation" of a process—indefinitely excluding it from entering into any critical section.

Consider a disk drive with an access queue that sets read requests at a higher priority that write requests. If a process requests permission to perform a write operation, it cannot be indefinitely held off in deference to any number of disk read requests. The write operation might contain an entry of information needed to satisfy some of the queue's read requests. These read requests would never be satisfied if the write operation were not allowed to take place, and the disk might cease to function.

The issues of mutual exclusion, progress, and bounded waiting are the keys to running successful concurrent programs. It is essential that you consider them as part of the "up-front" portion of any design.

Interprocess Communication

Dijkstra introduced the semaphore as an abstract software object that provides a mechanism for blocking processes conditionally. The semaphore blocks processes based on its state. It provides a simple but elegant method of interprocess communication. In general, a semaphore `s` is an integer variable that, apart from initialization, can be accessed only through standard atomic operations: `signal(s)` and `wait(s)` (the original notations for these operations were `P(s)` and `V(s)`). This implementation of Pascal-S treats the semaphore `s` as a special integer data type. The semaphore operates as follows:

1. If a process P encounters a `wait(s)` where `s` > 0, the semaphore counter decrements by 1 (`s := s - 1`) and the process passes; otherwise, the process is suspended (blocked).
2. If some process P encounters a `signal(s)`, then `s := s + 1`.
3. If some process P*j* is blocked at a `wait(s)` where `s = 0`, and some process P*i* encounters a `signal(s)`, `s` increments by 1, as in operation 2. P*j* resumes activity causing `s` to decrement by 1, as described in operation 1.

If the semaphore `s` assumes only the values of 0 or 1, it is a binary semaphore. In contrast, a semaphore that takes any arbitrary nonnegative integer value is a general semaphore. `Wait()` and `signal()` are the only operations allowed on a semaphore. Because of this blocking and releasing mechanism, semaphores provide both mutual exclusion and process synchronization.

Pictorially, you can view a semaphore as a process passing through a gate where the value of `s` determines whether the gate is open or closed. In figure 5, the process P*i* proceeds into its entry section where `s` > 0 and the gate is open. Consequently, P*i* passes into its critical section.

At the same time, P*j* proceeds into its entry section. However, its gate is closed because `s = 0`, so P*j* is blocked (suspended) from passing into its critical section. Once P*i* completes its critical section and proceeds into its exit section, it passes through a "turnstile," causing `s` to increment to a positive number. P*j*'s gate will now open, allowing P*j* to pass into its critical section. At the same time, `s` decrements and P*i* cannot enter its critical section until P*j* reaches its own exit section.

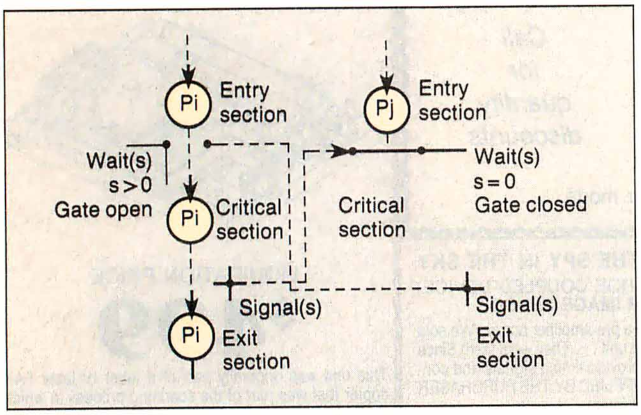

Figure 5: *Using a semaphore* (`s`) *for controlling critical sections of code. Here, as* P*i passes through its entry section, it "closes the gate" for* P*j. When* P*i exits its critical section, the* `signal(s)` *operation will reopen the gate for* P*j.*

I've provided a simple program demonstrating the use of semaphores in listing 1, written in Pascal-S. It is an example of a classic situation known as the "producer/consumer" problem. The problem centers around two processes, a baker (producer) and a customer (consumer). Two semaphores create a bounded buffer limit on how much bread (in this case, eight loaves) the producer can make and inventory ahead of the consumer's consumption rate. The consumer is blocked from buying bread when there is none available. Note that the program requires no separate variables to keep track of how many loaves of bread are in inventory or have been consumed. It is the act of signaling and waiting, and not the contents of the semaphore signals, that prevents either process from acting in an uncontrolled manner. This particular program will run until interrupted. You could impose a limit on the total number of loaves baked, say, in one day, but you must take care to cleanly terminate the two process or a deadlock will occur. A sample output looks something like this:

```
Process #2 has baked a loaf and put it on sale.
Process #1 has purchased a loaf of bread.
Process #2 has baked a loaf and put it on sale.
Process #2 has baked a loaf and put it on sale.
Process #1 has purchased a loaf of bread.
        .
        .
        .
```

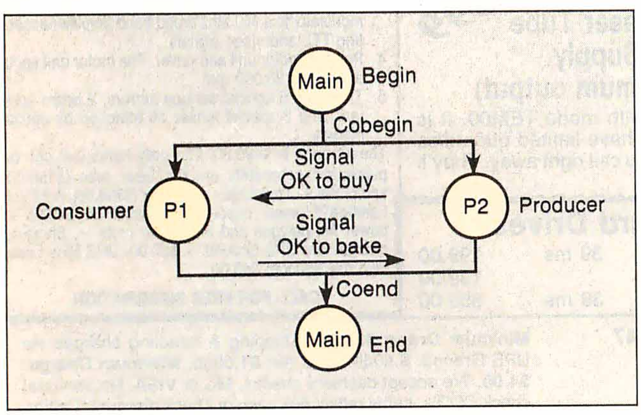

Figure 6: *Process graph for the "producer/consumer" program shown in listing 1.*

The process graph for this program is shown in figure 6. I've shown the two semaphore signal lines, OK to bake and OK to buy, to give an indication of which process is the source of the signal for a given semaphore. In this example, when the consumer (P1) purchases a loaf from inventory, this signals the baker that the inventory of loaves is not full and he may proceed to bake.

Conversely, when the baker (P2) produces a loaf, this sends a

continued

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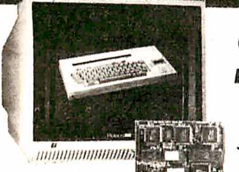

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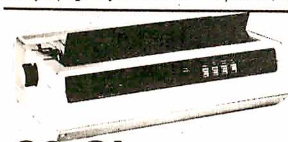

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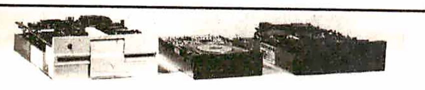

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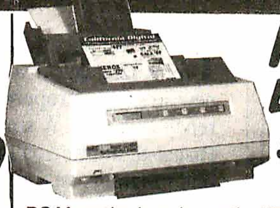

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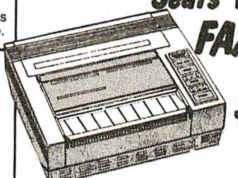

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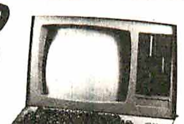

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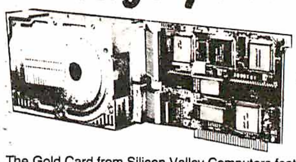

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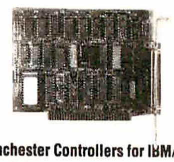

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Pascal-S

If you are accustomed to writing in sequential programming languages, you now have the opportunity to develop new strategies to approach design problems by using concurrency as a tool. A small but versatile concurrent language, Pascal-S, allows you to experiment with developing concurrent programs on a personal computer.

Although Pascal-S is a limited subset of sequential Pascal, it contains several special constructs—namely `cobegin` and `coend`—that enable you to create programs to do operations that might not be practical in a sequential language. The p-code interpreter for Pascal-S even has an underlying process scheduler that gives you a surprisingly realistic feeling of true concurrency and does not require any maintenance by the applications program. Pascal-S provides the synchronization through the use of the semaphore (discussed in the main text).

Pascal-S was originally written by Niklaus Wirth and modified by M. Ben-Ari for experimentation in a small concurrent programming environment. Professor Peter Lutz of the Rochester Institute of Technology separated the original compiler and interpreter so that the compiled p-code output could be stored in a file and interpreted at a later time.

I have further modified Pascal-S for use on personal computers running under MS-DOS using Turbo Pascal 3.0. I used none of the special extensions of version 3.0, so you should be able to implement the language using Turbo Pascal 2.0. I've run this version on five different MS-DOS computers with no apparent compatibility problems. However, due to the nature of the Pascal-S compiler, you cannot use the CP/M-80 version of Turbo Pascal (it does not support recursion, and thus prevents the Pascal-S compiler from working properly). Since the compiled output file is interpreted, Pascal-S will never be known for blazing speed.

For an extensive explanation of how the Pascal-S compiler and interpreter operate, refer to the book written by M. Ben-Ari (see bibliography), in which the implementation kit appears.

signal to the consumer indicating that there is at least one loaf available, and the consumer may proceed to purchase (assuming that the consumer was blocked due to no inventory).

Conway's Problem

Conway's Problem represents a good example of several concurrent processes functioning together in a pipeline manner with only semaphores to synchronize them. A variation of the original problem is as follows: A program is needed to read 80-column "cards" and write them out in 64-character lines. The output includes the following changes:

- If the card has fewer than 40 characters, pad the balance to the fortieth character with spaces. If the card has more than 40 characters, pass only up to the fortieth character and ignore the rest. After the system reads the card image in, always add a space as a forty-first character. (Each "card" corresponds to a line separated by a carriage return.)
- Replace every adjacent pair of pound signs (##) with a caret (^).

Even though it is possible to design a solution using a sequential language, the problem has an elegant solution using three concurrent processes. Process 1, `READER`, reads in the card image, counting the characters and adding padding characters where necessary. This stream passes through a buffer to process 2. Process 2, `SQUEEZE`, modifies strings of ## characters and passes this modified stream through a buffer to process 3. Process 3, `PRINT`, gathers the input stream into 64-character lines and prints them.

The buffers between processes 1 and 2, and 2 and 3, are 8-character circular buffers bracketed with `wait()` and `signal()` semaphores to provide interprocess synchronization. As buffers fill and empty, processes are blocked or released, smoothing out differences in the amount of time allocated to each process by the interpreter.

Part of the beauty of this program is that it requires no counters to test the locations of the buffer pointer to guarantee that they do not overlap. The program simply initializes the buffer semaphores to the limits of the buffer allocation, and the pointers can never overlap. Since these buffers are critical regions—in the sense that only one process can read or write a buffer at a time—the program guarantees mutual exclusion through the use of the semaphore `mutex`. It was not necessary to synchronize the printer process, as it is the only process providing output in this program.

One difficulty of a concurrent program is to provide a graceful shutdown for each process at the program's end. If a process simply terminates and returns to the main program, a deadlock will probably occur, as one of the processes will not be signaled through its final semaphore after the others have exited. One solution is to allow each process to drop to a holding area until all three processes have emptied their respective buffers. Then the final process signals to the others to exit.

New Solutions

Programming in a concurrent language opens up some interesting possibilities that might be neither obvious nor possible when using a sequential language. However, there are a number of pitfalls that you must consider in the program design and implementation that require the use of tools and concepts not always needed in a sequential environment. ■

Editor's note: *Source code listings that accompany this article are available in a variety of formats. See page 3 for details.*

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To add clarity to some of the explanations, the author also used various materials from the course notes of Professor James Heliotis, Professor Andrew Kitchen, and Professor Margaret Reek, all of the Rochester Institute of Technology.

Gary Bricault received his BSEE from the De Vry Institute of Technology in Chicago, and is currently working on his MS in computer science at the Rochester Institute of Technology in Rochester, New York.

continued from page 34

select the one you desire. There are lots of other features (real ones!). If you haven't seen it, I strongly recommend that you find a copy. The price is right: $50 Canadian.

Excellent though Thunder is, I doubt that it will cause you to adopt an Atari for all of your writing. As far as I know, there is no word processor available that comes anywhere close to meeting your specifications (not that they are unreasonable). Your quest for a modern version of CP/M WRITE strikes a chord with me. I had a similar editor/formatter (PIE) on my Apple II Plus. Isn't it strange how perfectly good ideas can get lost forever in the mad forward rush of "new" software development?

As for Atari machines themselves, I have been fortunate to use most of the varieties of microcomputers on the market over the past several years. When it came time to upgrade my personal system (a fully stuffed Apple II Plus), I opted for an Atari 1040ST. Today it is my right hand and my window on the world (via an Ethernet terminal server, a VAX 750, and an Amdahl mainframe). (To be truthful, an IBM PC is also within easy reach for those times when it just has to be done on a PC.)

P.S. I also read your novels, at least those on which you collaborate with Larry Niven. Did I detect a hint of "autobiofiction" in *Footfall*?

Doug Latornell
Vancouver, BC

There is an increasing flood of software for the Atari ST, and now that there's WordPerfect for it, the machine really is good enough for nearly everything; it's certainly more computer than my original Ezekial.

I was sorry to see Batteries Included go under, but I think Electronic Arts is doing a good job of publishing most of BI's stuff.

As to Footfall, *that wasn't fiction; we got to thinking, if this really happened, who would the Pentagon ask for advice? If not Heinlein, Niven, Benford, and Pournelle, then who?*—Jerry

Norton Commander

Dear Jerry,

I was astounded at your dismissal of "DOS Shells" and then took outright umbrage at your rejection of Norton Commander (NC) in your December 1987 column.

Users should ideally learn DOS itself, of course. But then, how many automobile drivers actually drive properly, not to mention understand the combustion motor? It would seem that the emergence of the wide range of shells is a response to the needs of users. Surely, it's all part of seeking true user friendliness, and the law of supply and demand?

In fact, these programs must do more than limit DOS, as you imply. My own company publishes a DOS shell that adds a desktop and a self-configurable, translatable HELP database to DOS, so that users could access information in Shona, Swahili, French, or whatever.

In response to your annihilation of NC, perhaps my own requirements are unusual. I have used NC for some 6 months now, spending a fair amount of time preparing disks, copying files, testing software, and writing text. NC allows me to carry out these functions with seldom more than two or three keystrokes.

The NC windows provide such an elegant and logical representation of disks, directories, and files that, to my mind, they have made the Macintosh interface look gauche—and I've used a Mac for 2 years.

Configuration alternatives within NC let you pick display, performance, and default options and really customize the operation of the system. One example: I simply point the NC cursor at the name of a file and press Enter. Depending on the file suffix, NC will automatically first load Lotus 1-2-3 (.WKS), WordPerfect (.DOC), or Norton Editor (.TXT). (Yes, I know that the Mac does this, but NC seems faster and more logical.)

Finally, thanks for the column. As a longtime personal computer user and BYTE reader, I still read your column first. However, I really feel that your search for purity above all else may this time have caused many more hours of perspiration for new users than necessary.

Tony Mechin
Harare, Zimbabwe

Hey, I didn't mean any disrespect for Norton Commander. I generally recommend it for beginners.

What I meant to say was that Microsoft and Zenith needn't have bothered with their EzPC Shell, since Norton Commander was more than sufficient for those who prefer a shell to learning DOS; but it's better to learn DOS and be done with it. If you're a touch typist, it's much faster to type `COPY A:*.* C:\SMALLTREE` *than to go through the Commander's menus.*—Jerry ■

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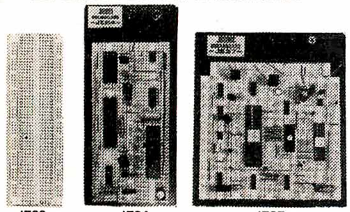

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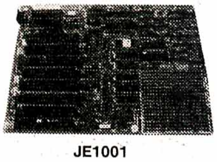

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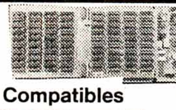
JE1002	4.77/10MHz (PC/XT)	$119.95
JE1007	6/8/10/12MHz (AT)	$349.95

2 & 3MB Memory Expansion Cards for IBM AT and Compatibles



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JE1081	2MB of expanded or extended memory (zero-K on-board) (AT)	$129.95
JE1082	3MB of expanded or extended memory, parallel printer port, serial port and game port (zero-K on-board) (AT)	$169.95

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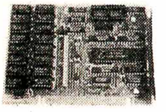
JE1190

JE1190	Power Base	$29.95
JE1191	6-Outlet Power Strip	$11.95

Zuckerboard TANDY 1000 Expansion Memory Half Card



Expand the memory of your Tandy 1000 (128K Version) to as much as 640K. Also includes DMA controller chip.

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IBM AT Compatible Kit Mini-286 6/8/10/12MHz Kit

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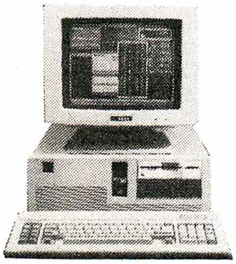

JE1007	Baby AT Motherboard (Zero-K RAM – includes Award BIOS ROMs)	$349.95
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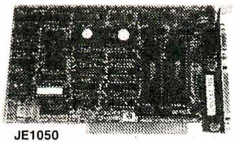

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ST238AT	30MB w/Controller (AT)	$399.95
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ST251XT	40MB w/Cont. Card (PC/XT)	$499.95
ST251AT	40MB w/Controller Card (AT)	$539.95
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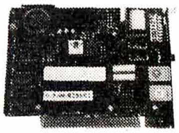

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- One Year Warranty
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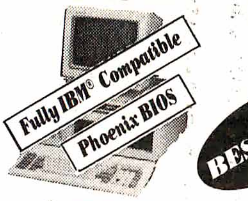
BUS 88

640K 8 MHz
10 MHz Optional



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2. NEC-V20 Microprocessor
3. VGA Systems w/Auto-Switch VGA Card (800x600)
4. EGA Systems w/Auto-Switch EGA Card (640x350)
5. Color Systems w/Color Card (640x200)
6. Everex Memory Expansion Board of 2 MB RAM
7. Everex EVGA VGA Card
8. 10-20-30-40-65 MB Hard Disk
9. TEAC 5¼" 360K and 3½" 720K or 1.44MB Floppy
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9. 180 Watts 110/220 Volts Autoswitching
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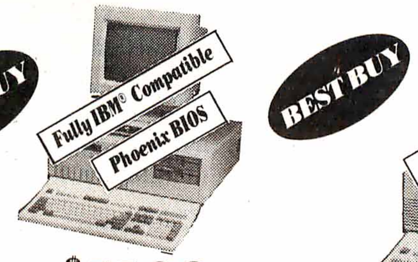
BUS 286

One MEGAbyte
10 MHz "0" Wait
12 MHz/16 MHz Optional



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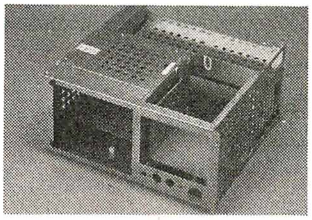

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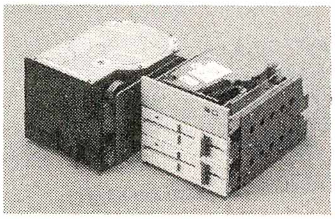

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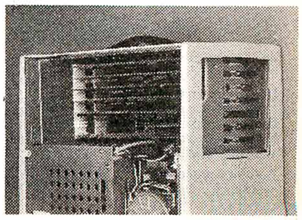

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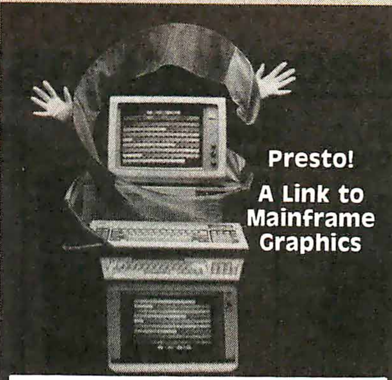

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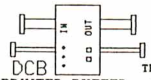

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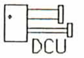

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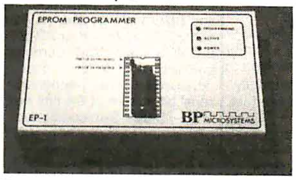

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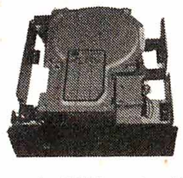

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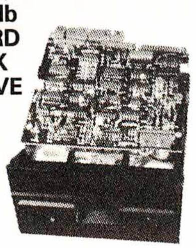

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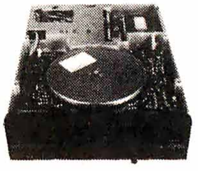

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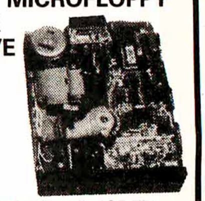
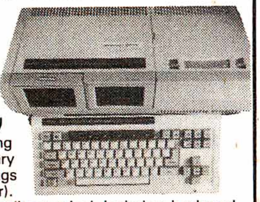
48/96 TPI, 1.2 Mb
Double side, high density; 160 tracks. Mfr — Panasonic #JU-475
Item #10005 **$109.95** New

3½" MICROFLOPPY DISK DRIVE



1 Mb (unformatted), 135 TPI, 3 ms. access time. Power requirements: +12V, +5V. (Removed from operational computers — ***Tested — Like New!)***
Mfr — NEC, model FD1035
Item #17171 **$79.00** ea.
2 for **$150.00**

ADAM COMPUTER



(Less printer)
No wiring necessary (just plugs together).
Hook-up diagram incl. Includes: keyboard, 1 cassette digital data drive, 2 game controllers, power supply & one cassette. Capable of running CP/M, has built-in word processor.
Item #7410 ***Complete*** — **$99.00**

Accessories . . .
- **DATA DRIVE** — Item #6641 **$19.95**
- **PRINTER POWER SUPPLY** — Item #6642 **$14.95**
- **ASCII KEYBOARD** — Item #6643 **$19.95**
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With 60W power supply (fan cooled).
Can accommodate:
2 full ht. drives *our item* #7928
2 floppy drives #1904
1 hard drive & 1 floppy #13250
Input: 115/230V, 50/60 Hz.
Originally for Burroughs computer.
Dim.: 11"W x 8"H x 12" deep
Item #14541 **$59.50**

22" COMPOSITE MONITOR

Black & White, Raster Scan

Standard TV-grade monitor, originally used in arcade games, ignition systems, etc. 115VAC, 60Hz.
Mfr — Wells Gardner 22V1003A
Item #16579 **$49.95** New

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(Does not include monitor.)

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Item #16080 *New*– **$39.95**

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Item #16078 *New*– **$29.95**

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50/60Hz.; 12W. Low noise-level fans. Can be mtd. for blowing or exhaust.

1" Thin — Contains 9 plastic blades. Dimensions: 3⅛" sq. x 1" deep
Mfr — Tobishi #U9201B
Item #10960 **$7.95** RFE

1½" Standard — Contains 7 metal blades.
Mfr — Rotron #SU2A1
Item #5970 **$7.95** New

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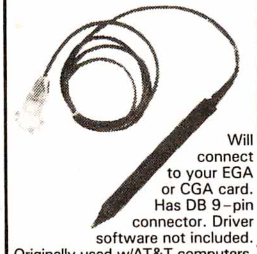
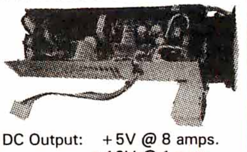
IBM® PC Compatible . . .



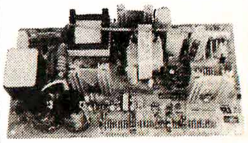
Will connect to your EGA or CGA card. Has DB 9–pin connector. Driver software not included.
Originally used w/AT&T computers.
Item #16454 **$39.95** New

COMMODORE/AMIGA POWER SUPPLY



DC Output: +5V @ 8 amps.
+12V @ 1 amp.
–5V @ 250 ma.
Input: 110VAC/60 Hz., ±20%
Dim.: 12"L x 3¾"H x 5¾"D
Encl. in alum. housing. Fan cooled.
Mfr — Shindengen Electric #130569SXD
Item #14047 **$19.95** New

SWITCHING POWER SUPPLY



DC Output: +5V @ 8A
+12V @ 500ma
–12V @ 200ma
+24V @ 2.0A
Input: 115/230VAC, 50/60Hz.
Dimensions: 8¾" x 4⅝" x 2"H
Mfr — Power Systems #PS1547
Item #16585 **$19.95**

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12VDC, green phosphor. Schematic supplied. Mfr — Motorola MD2003–190.
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Mfr — Dallas Semiconductor
Item #15939 *New* - **$29.95**

★ ★ ★ ★ ★ *TIMEX-SINCLAIR . . .*

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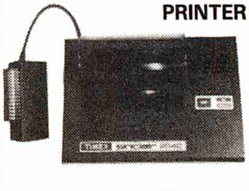

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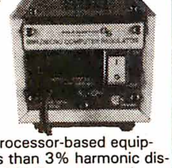
140 VA



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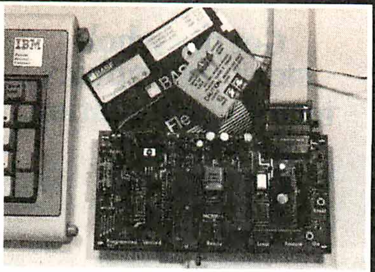

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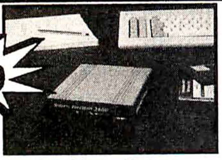

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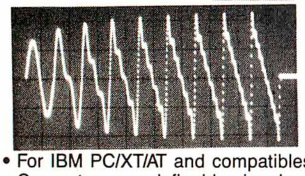

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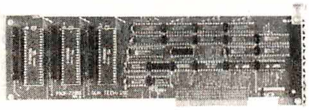

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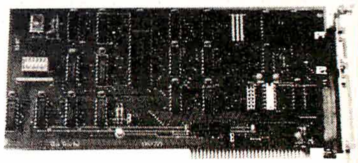

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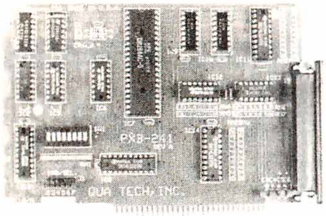

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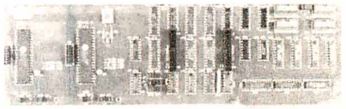

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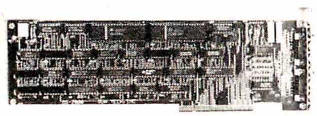

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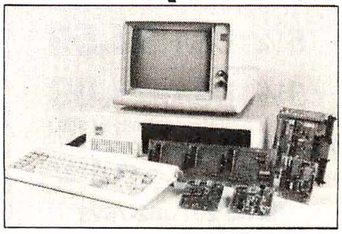

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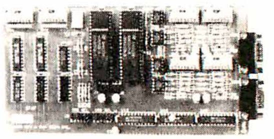

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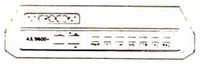

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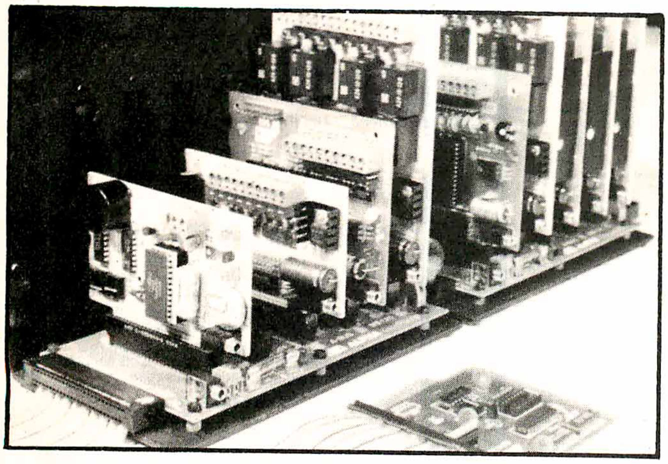


An A-BUS system with two Motherboards
A-BUS adapter (IBM) in foreground

Plug into the future

With the A-BUS you can plug your PC (IBM, Apple, TRS-80) into a future of exciting new applications in the fields of control, monitoring, automation, sensing, robotics, etc.

Alpha's modular A-BUS offers a proven method to build your "custom" system today. Tomorrow, when you are ready to take another step, you will be able to add more functions. This is ideal for first time experimenting and teaching.

A-BUS control can be entirely done in simple BASIC or Pascal, and no knowledge of electronics is required!

An A-BUS system consists of the A-BUS adapter plugged into your computer and a cable to connect the Adapter to 1 or 2 A-BUS cards. The same cable will also fit an A-BUS Motherboard for expansion up to 25 cards in any combination.

The A-BUS is backed by Alpha's continuing support (our 11th year, 50000 customers in over 60 countries).

The complete set of A-BUS User's Manuals is available for $10.

About the A-BUS:

- All the A-BUS cards are very easy to use with any language that can read or write to a Port or Memory. In BASIC, use INP and OUT (or PEEK and POKE with Apples and Tandy Color Computers)
- They are all compatible with each other. You can mix and match up to 25 cards to fit your application. Card addresses are easily set with jumpers.
- A-BUS cards are shipped with power supplies (except PD-123) and detailed manuals (including schematics and programming examples).

Relay Card — RE-140: $129
Includes eight industrial relays. (3 amp contacts. SPST) individually controlled and latched. 8 LED's show status. Easy to use (OUT or POKE in BASIC). Card address is jumper selectable.

Reed Relay Card — RE-156: $99
Same features as above, but uses 8 Reed Relays to switch low level signals (20mA max). Use as a channel selector, solid state relay driver, etc.

Analog Input Card — AD-142: $129
Eight analog inputs. 0 to +5V range can be expanded to 100V by adding a resistor. 8 bit resolution (20mV). Conversion time 120us. Perfect to measure voltage, temperature, light levels, pressure, etc. Very easy to use.

12 Bit A/D Converter — AN-146: $139
This analog to digital converter is accurate to .025%. Input range is −4V to +4V. Resolution: 1 millivolt. The on board amplifier boosts signals up to 50 times to read microvolts. Conversion time is 130ms. Ideal for thermocouple, strain gauge, etc. 1 channel. (Expand to 8 channels using the RE-156 card).

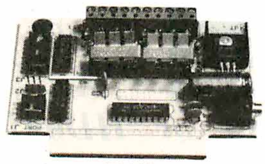
Digital Input Card — IN-141: $59
The eight inputs are optically isolated, so it's safe and easy to connect any "on/off" devices, such as switches, thermostats, alarm loops, etc. to your computer. To read the eight inputs, simply use BASIC INP (or PEEK).

24 Line TTL I/O — DG-148: $65
Connect 24 input or output signals (switches or any TTL device) to your computer. The card can be set for: input, latched output, strobed output, strobed input, and/or bidirectional strobed I/O. Uses the 8255A chip.

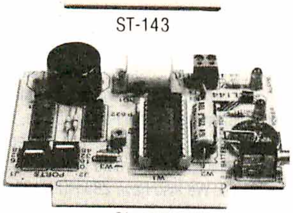
Clock with Alarm — CL-144: $89
Powerful clock/calendar with: battery backup for Time, Date and Alarm setting (time and date); built in alarm relay, led and buzzer; timing to 1/100 second. Easy to use decimal format. Lithium battery included.

Touch Tone® Decoder — PH-145: $79
Each tone is converted into a number which is stored on the board. Simply read the number with INP or POKE. Use for remote control projects, etc.

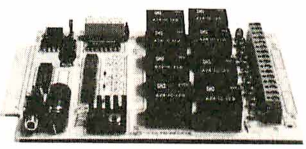
A-BUS Prototyping Card — PR-152: $15
3½ by 4½ in. with power and ground bus. Fits up to 10 I.C.s



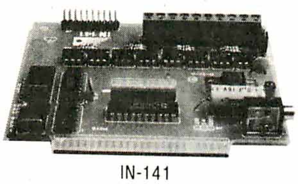
ST-143



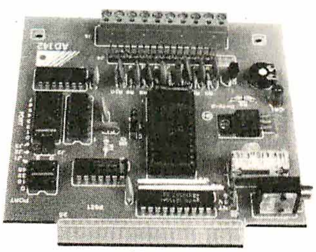
CL-144



RE-140



IN-141



AD-142

Smart Stepper Controller — SC-149: $299
World's finest stepper controller. On board microprocessor controls 4 motors simultaneously. Incredibly, it accepts plain English commands like "Move arm 10.2 inches left". Many complex sequences can be defined as "macros" and stored in the on board memory. For each axis, you can control: coordinate (relative or absolute), ramping, speed, step type (half, full, wave), scale factor, units, holding power, etc. Many inputs: 8 limit & "wait until" switches, panic button, etc. On the fly reporting of position, speed, etc. On board drivers (350mA) for small steppers (MO-103). Send for SC-149 flyer.

Remote Control Keypad Option — RC-121: $49
To control the 4 motors directly, and "teach" sequences of motions.

Power Driver Board Option — PD-123: $89
Boost controller drive to 5 amps per phase. For two motors (eight drivers).

Breakout Board Option — BB-122: $19
For easy connection of 2 motors. 3 ft. cable ends with screw terminal board.

Stepper Motor Driver — ST-143: $79
Stepper motors are the ultimate in motion control. The special package (below) includes everything you need to get familiar with them. Each card drives two stepper motors (12V, bidirectional, 4 phase, 350mA per phase).

Special Package: 2 motors (MO-103) + ST-143: **PA-181: $99**

Stepper Motors — MO-103: $15 or 4 for $39
Pancake type, 2¼" dia, ¼" shaft, 7.5°/step, 4 phase bidirectional, 300 step/sec, 12V, 36 ohm, bipolar, 5 oz-in torque, same as Airpax K82701-P2.

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Tandy 1000, 1000 EX & SX, 1200, 3000. Uses one short slot.	AR-133...$69
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TRS-80 Model 102, 200 Plugs into 40 pin "system bus".	AR-136...$69
Model 100. Uses 40 pin socket. (Socket is duplicated on adapter).	AR-135...$69
TRS-80 Mod 3,4,4D. Fits 50 pin bus. (With hard disk, use Y-cable).	AR-132...$49
TRS-80 Model 4P. Includes extra cable. (50 pin bus is recessed).	AR-137...$62
TRS-80 Model I. Plugs into 40 pin I/O bus on KB or E/I.	AR-131...$39
Color Computers (Tandy). Fits ROM slot. Multipak, or Y-cable.	AR-138...$49

A-BUS Cable (3 ft, 50 cond.) — CA-163: $24
Connects the A-BUS adapter to one A-BUS card or to first Motherboard.

Special cable for two A-BUS cards: CA-162: $34

A-BUS Motherboard — MB-120: $99
Each Motherboard holds five A-BUS cards. A sixth connector allows a second Motherboard to be added to the first (with connecting cable CA-161: $12). Up to five Motherboards can be joined this way to a single A-BUS adapter. Sturdy aluminum frame and card guides included.

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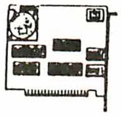

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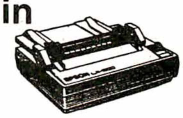

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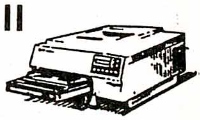

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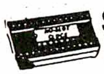

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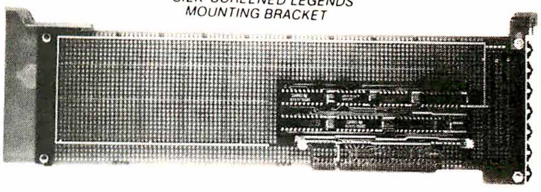

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WIREWRAP HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WIREWRAP HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.63	.89	.95	1.29	1.49	1.69
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	FEMALE	DBxxS	.49	.69	.75	.75	1.39	2.29
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	.49	.69	---	.79	2.27	---
	FEMALE	DBxxSR	.55	.75	---	.85	2.49	---
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	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.

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DESCRIPTION	ORDER BY	CONTACTS 8	14	16	18	20	22	24	28	40
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WIREWRAP SOCKETS	xxWW	.59	.69	.69	.99	1.09	1.39	1.49	1.69	1.99
ZIF SOCKETS	ZIFxx	---	4.95	4.95	---	5.95	---	5.95	6.95	9.95
TOOLED SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
TOOLED WW SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIERS	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
DIP PLUGS (IDC)	IDPxx	.95	.49	.59	1.29	1.49	---	.85	1.49	1.59

FOR ORDERING INSTRUCTIONS, SEE D-SUBMINIATURE CONNECTORS, ABOVE

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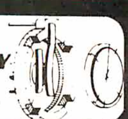

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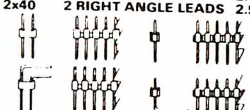

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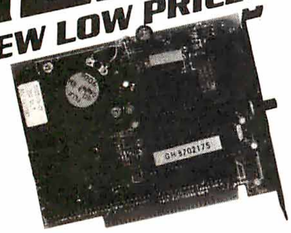

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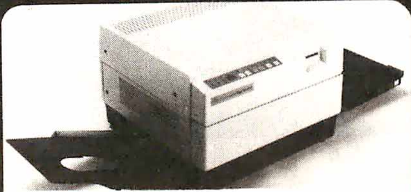

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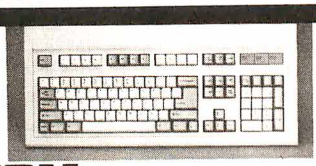

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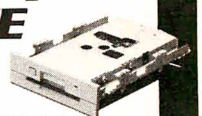

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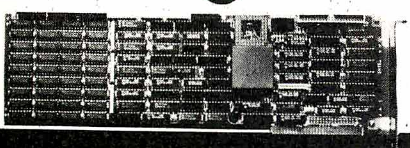

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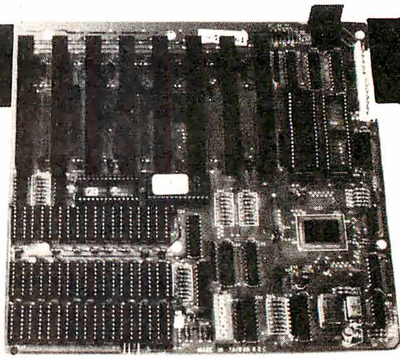

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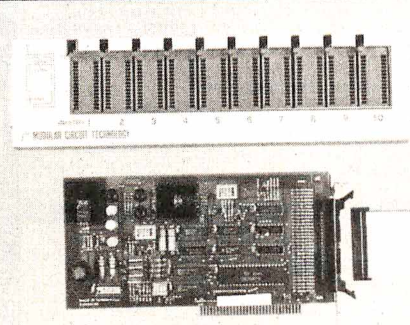

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COMING UP IN BYTE

PRODUCTS IN PERSPECTIVE:

For June, our **Product Focus** will explore the high and low bits of 13 9600-bit-per-second modems.

System reviews commence with Advanced Logic Research's FlexCache 20386 system, which is claimed to be faster and less expensive than the Compaq Deskpro 386/20. Our review should be revealing. This is followed by a look at two hard-disk-drive-equipped laptops: the NEC MultiSpeed HD and Hewlett-Packard's Vectra CS Model 20.

In **hardware reviews**, we show what can be done if you want an 80386 system without buying a whole new computer. Replacement motherboards are an increasingly popular alternative. We'll take a look at examples from Fortron, Micronics, Turn-Point America, and Whole Earth Electronics.

The AST Mac286 installs in your Mac II and gives you the option of running DOS programs with a surprisingly high degree of compatibility.

IBM's OS/2 is covered in **software reviews**. How does it differ from the version for compatibles? What can you expect your DOS software to act like?

ProBAS is a $99 collection of over 200 subroutines, callable from BASIC, that give you useful new control over your computer.

Our **application reviews** begin with a comparison of 4th Dimension and Double Helix database packages, continue with a comparison of Surpass and Quattro spreadsheets for MS-DOS machines, and culminate with a review of Q-Calc, a spreadsheet for Unix machines.

Short Takes for June include Aldus's Freehand graphics package, National Datacomputer's hand-held, MS-DOS-compatible Datacomputer 3.0, Supermac Software's new Pixel Paint drawing program, Peter Norton's OS/2, TOPS 2.0 networking software, and Infostructures' PopDrop and Waterworks' RAM Lord.

In **Computing at Chaos Manor**, Jerry Pournelle introduces a new member of the family, Zanna Lee, the Zenith Z-386. In **Applications Only**, Ezra Shapiro applies his unique point of view to subjects of common interest to microcomputer users.

IN DEPTH:

BYTE takes special pride this month in presenting the first of its **new benchmarks**. An article by Rick Grehan, Tom Thompson, Curt Franklin, and George Stewart—the designers and programmers of our new suite of tests—provides an analysis of what they've done and what you can gain as a result. Since it's an area with direct and obvious importance for the microcomputer community, BYTE has decided to take an active leadership position by formulating new, accurate methods for measuring performance. In addition, a view of benchmarks—their successes and failures—comes from Bill Nicholls, an article on how to design a CPU/FPU/Memory benchmark is Ron Fox's contribution, and a critique of some microcomputer performance tests will be presented by Al Aburto.

FEATURES:

In the **Circuit Cellar**, Steve Ciarcia begins the first of a two-part project on a biofeedback monitor. Dick Pountain takes a look at the technology of the **Abaq transputer**. Peter Wayner's article is on **factorial-base representations**, and David Fox presents a piece on **memory management in C**.

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READER SERVICE

To get further information on the products advertised in BYTE, fill out the reader service card by circling the numbers on the card that correspond to the inquiry number listed with the advertiser. This index is provided as an additional service by the publisher, who assumes no liability for errors or omissions.

* Correspond directly with company

Index to Advertisers by Product Category

READER SERVICE

Advertising Supplement included with this issue:
Selective Software (U.S. Subscribers)

A Message To Our Subscribers

From time to time we make the BYTE subscriber list available to other companies who wish to send our subscribers material about their products. We take great care to screen these companies, choosing only those who are reputable, and whose products, services, or information we feel would be of interest to you. Direct mail is an efficient medium for presenting the latest personal computer goods and services to our subscribers.

Many BYTE subscribers appreciate this controlled use of our mailing list, and look forward to finding information of interest to them in the mail. Used are our subscribers' names and addresses only (no other information we may have is ever given).

While we believe the distribution of this information is of benefit to our subscribers, we firmly respect the wishes of any subscriber who does not want to receive such promotional literature. Should you wish to restrict the use of your name, simply send your request to the following address.

BYTE Magazine
Attn: Subscriber Service
P.O. Box 7643
Teaneck, NJ 07666-9866

TIPS

SUBSCRIBERS ONLY!*

Use BYTE's Telephone Inquiry Processing System

Using TIPS can bring product information as much as 10 days earlier.

SEND FOR YOUR SUBSCRIBER I.D. CARD

1) If you are a new subscriber or have lost your I.D. card, circle #1 on the Reader Service Card; **attach mailer label**. We will immediately send your personal TIPS subscriber card.

GET PREPARED

2) Write your Subscriber Number, as printed on your Subscriber I.D. Card, in boxes in Step 5 below. (Do not add 0's to fill in blank boxes)

3) Write numbers for information desired in boxes in Step 7b below. (Do not add 0's to fill in blank boxes.)

CALL TIPS

4) Now, on a Touch-Tone telephone dial: **(413) 442-2668** and wait for voice commands.

ENTER YOUR SUBSCRIBER AND ISSUE NUMBERS

5) When TIPS says: "Enter Subscriber Number"
(Enter by pushing the numbers and symbols [# or * enclosed in the boxes] on telephone pad ignoring blank boxes)
Enter □ □ □ □ □ □ □ □ □ □ [#] [#]

6) When TIPS says "Enter magazine code & issue code"
Enter [1] [#] [5] [8] [#] [#]

ENTER YOUR INQUIRIES

7a) When TIPS says "Enter (next) Inquiry Number"
Enter one inquiry selection from below (ignore blank boxes)

b) Repeat 7a as needed (maximum 17 inquiry numbers)

1. □ □ □ [#] [#]
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END SESSION

8) End session by entering [*] [*] [9] [1] [#] [#]

9) Hang up after hearing final message
If you are a subscriber and need assistance, call (603) 924-9281.

Available 24 Hours, 7 Days a Week

If you are not a subscriber fill out the subscription card found in this issue or, call BYTE Circulation 800-423-8912.

***Domestic and Canadian Subscribers Only!**

FREE Information Retrieval Service

To assist you in making your evaluations, purchasing decisions, or recommendations, you can request further information directly from the manufacturer or service company on products and services advertised in this issue. There is no charge, no obligation. Just complete and mail the attached post-paid, self-addressed reply card, and we'll do the rest.

1. Circle numbers on reply card which correspond to numbers assigned to items of interest to you.
2. Check all the appropriate answers to questions "A" through "F".
3. Print your name and address and mail.

Fill out this coupon carefully. PLEASE PRINT. Requests cannot be honored unless the zip code is included. This card is valid for 6 months from cover date.

A. What is your primary job function? (Check one only)
1 ☐ Business Owner, General Management, Administrative
2 ☐ MIS/DP, Programming
3 ☐ Engineering/Scientific, R&D
4 ☐ Professional (law, medicine, accounting)
5 ☐ Other

B. How many people does your company employ?
1 ☐ 25 or fewer
2 ☐ 26–99
3 ☐ 100–499
4 ☐ 500–999
5 ☐ 1000 or more

C. Reason for request: (Check all that apply).
1 ☐ Business use for yourself
2 ☐ Business use for your company
3 ☐ Personal use

D. Your next step after information is received:
1 ☐ Purchase order
2 ☐ Evaluation
3 ☐ Specification/Recommendation

E. Please indicate the product categories for which you influence the selection or purchase at your (or your client's) company or organization. (Check all that apply).
1 ☐ Microcomputers
2 ☐ Peripherals
3 ☐ Software
4 ☐ Accessories and supplies

F. For how many microcomputers do you influence the purchase of products at your (or your client's) company or organization?
1 ☐ 1
2 ☐ 2–4
3 ☐ 5–9
4 ☐ 10 or more

Name ____________________
Title ____________________
Company ____________________
Address ____________________
City ____________ *State* ____________
Zip ____________ *Telephone* ____________

CIRCLE FOR FREE INFORMATION

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POSTAGE WILL BE PAID BY ADDRESSEE

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READER SERVICE
PO Box 298
Dalton, MA 01227-0298
USA

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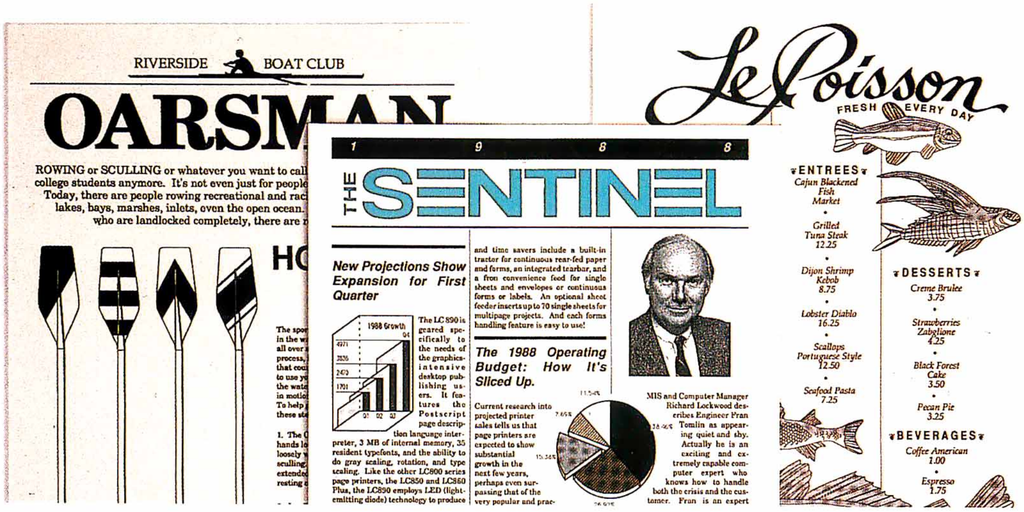
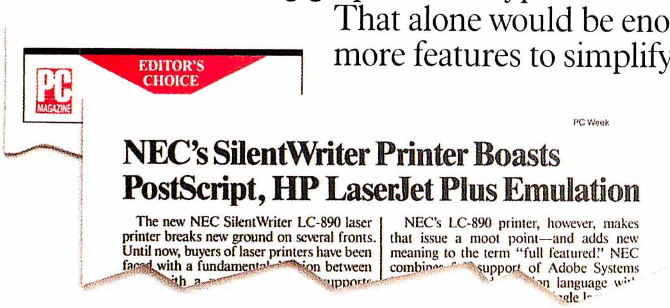
BYTE
READER SERVICE
PO Box 298
Dalton, MA 01227-0298
USA

OUR SILENTWRITER IS CREATING HEADLINES ON SEVERAL FRONTS.



Our Silentwriter™ LC890 is the first desktop publishing printer that gives you both popular standards for creating graphics and type: true Adobe PostScript® and LaserJet Plus emulation.

That alone would be enough to cause headlines. But we also added many more features to simplify desktop publishing. Like both Apple and IBM compatibility. *PC Week* stated, "the LC890 is actually better than having both an Apple LaserWriter Plus and an HP LaserJet Plus on your desk." Equally impressed, *PC Magazine* awarded it an "Editor's Choice." And cited it in their "Best of 1987" issue.


PC MAGAZINE
EDITOR'S CHOICE

PC Week

NEC's SilentWriter Printer Boasts PostScript, HP LaserJet Plus Emulation

The new NEC SilentWriter LC-890 laser printer breaks new ground on several fronts. Until now, buyers of laser printers have been faced with a fundamental ... between ... with a ... NEC's LC-890 printer, however, makes that issue a moot point—and adds new meaning to the term "full featured." NEC combines ... support of Adobe Systems ... language with ...

And because the Silentwriter has a simple, trouble-free printing mechanism, it will be creating headlines for years to come. In fact, it's twice as reliable as ordinary lasers, with an average life of 600,000 pages.

If you don't require the power of our LC890, consider the rest of the family. The LC850 for text applications and the LC860 Plus for text and less complex graphics.

To start producing your own headlines, call 1-800-343-4418 (in MA 617-264-8635). We'll send you reprints of all the great reviews and the name of the NECIS dealer nearest you.

NEC PRINTERS. THEY ONLY STOP WHEN YOU WANT THEM TO.

NEC

Circle 206 on Reader Service Card

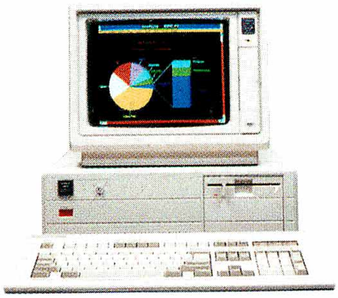
C&C Computers and Communications

NEC Information Systems, Dept. 1610, 1414 Massachusetts Ave., Boxborough, MA 01719.

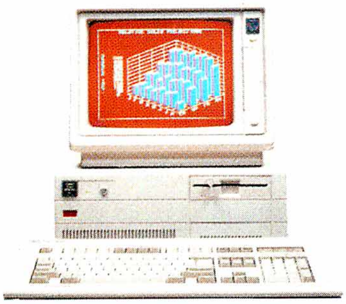
Tandy Computers: Because there is no better value.™

Tandy Business Solutions

Tandy 4000



Tandy 3000



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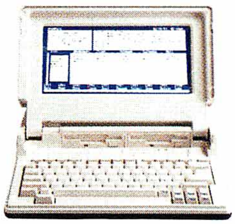

Tandy 1400 LT

Tandy 1000 TX

Tandy 1000 SX

Design your system around the broadest selection of PCs in the industry.

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