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the small systems journal

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PORTABLE COMPUTERS IN DEPTH

- Pied Piper
- Corona
- HP-75
- TI Compact
- Access
- How to Buy Wisely

Report from Japan

Jerry Pournelle on The Next Five Years

Just Rewards for Programmers

Making Hard Disks Portable

Build a Solid-State Video Camera

How to quickly re

If you'd like to turn the agony of small business bookkeeping into the ecstasy of total control, you've come to the right place.

Because even if you're starting with a shoe box full of invoices or a pile of checks hiding under a pile of deposit slips, we can tell you how to centralize, organize and monitor all that information, and manipulate it in ways that will make your business a pleasure—all with an Apple® III Personal Computer.

Attain instant financial status.

An Apple III, teamed with the BPI General Accounting Package, can put every basic accounting function right at your fingertips.

Technically, that means General Ledger, Accounts Payable, Accounts Receivable and Payroll—all in one package.

Meaningfully, that means you can turn numbers into answers.

With BPI, your Apple III can give you a snapshot of your company's financial condition, an up-to-the-instant balance sheet. It can also generate instant and detailed reports

gain your balance.

on your customers and vendors.

So you know who owes whom, how much, and how come.

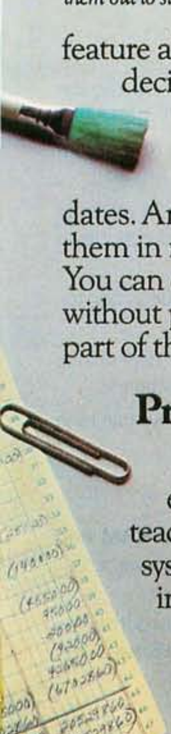
And just how well your cash flow is flowing.

And where to give credit where credit is due (a customer inquiry

Ichiban Fish Supply Company
Consolidated Income Statement
Current Comparative
Periods Ending May 31, 1983 and May 31, 1982

	May 31, 1983	%	May 31, 1982	%
Income				
Contract Sales	52,818.02	91.3	44,176.52	92.7
Retail Sales	5,016.88	8.7	3,500.00	7.3
Total Income	57,834.90	100.0	47,676.52	100.0
Cost of Sales				
Cost of Contract Sales	37,330.00	64.6	31,806.55	66.7
Cost Of Retail Sales	4,879.85	8.4	3,409.35	7.2
Total Cost of Sales	42,209.85	73.0	35,215.90	73.9
Gross Profit	15,625.05	27.0	12,460.62	26.1

Your Apple can generate instant income statements (with expense ratios) or balance sheets, and let you compare them to last month's or year's, then print them out to suit your banker.



feature allows you to make credit decisions based on the most current information).

You can also list your purchases by discount dates. And take advantage of them in no uncertain net terms. You can even keep payroll records without paying more, because it's part of the same package.

Profit from history.

In business as in life, experience is the best teacher. And the Apple/BPI system can provide you with instant comparisons of this-month-this-year vs. this-month-last-year, or this-year-to-date vs. last-year-to-date.

So you can quickly spot changing expense ratios and make decisions with 20/20 foresight.

The BPI General Accounting Package also lets your income statements be coded by location, department or product line. So you know where your money's coming from.

And where it's not.

Ichiban Fish Supply Company
Merchandise Purchased By Due Date
As Of 05 31 83

Date	Vendor No. Name	Invoice Number	Acct No	Detail	Net Amt
05/02/83	1 Herring World Due: 06/03/83	35278532	5010-01		501.23
05/05/83	2 Consolidated Cod Due: 06/05/83	4562	5010-01		209.36
05/05/83	3 Levy Sushi Farm Due: 06/05/83	212	5010-01		459.00
05/05/83	4 Mussel Men, Inc Due: 06/05/83	657	5010-01		68.26
	Total				1,237.85

It can also allow you to take full advantage of merchandise discounts. So you'll know whom to pay, when to pay, how much to pay—and save a lot of clams in the process.

Make a timely statement.

Add an Apple Dot Matrix or Daisywheel printer to your Apple III, and you can print out your entire balance sheet in minutes.

Or any number of reports, from cash receipts to payroll ledger to income. You can even print checks and customer statements.

The impressively professional

results will make an important statement to everyone you deal with—including your banker.

More ways Apples pay.

There are more people in more places doing more things with

As of 05/31/83 — Ichiban Fish Supply Company — Accounts Receivable Ledger — Page 1

Customer No Name	Folio	Balance Forward	Current Month	Balance
1 Moser's Sole Food		892.79		
Invoice 1124	IR		212.23	
Invoice 1199	IR		156.56	
Invoice 1326	IR		820.00	
05/15/83	CR		250.00-	
				1,831.58

To avoid fishy transactions, you can instantly display customer's payments, charges and current balance. In this case, a few more cans of tuna would put Mr. Moser over his $2,000 limit.

Apples than with any other personal computer in the world.

Because for one thing, there's more software for Apples than for any other personal computer in the world. So the same Apple that handles all your accounting needs can also handle financial spreadsheets, word processing and electronic filing.

You'll also find programs that are designed specifically for your kind of business. Be it dentistry, architecture or swine herding.

Of course, the best way to learn all the ways Apples can help you make better business decisions is to visit any one of over 1500 authorized Apple dealers.

So drop in. For a full account.

apple®

Call (800) 538-9696 for the location of the authorized Apple dealer nearest you, or for information regarding our National Account Program. In Canada, call (800) 268-7796 or (800) 268-7637. Or write Apple Computer Inc., Advertising and Promotion Dept., 20525 Mariani Ave., Cupertino, CA 95014.

Circle 29 on inquiry card.

In The Queue

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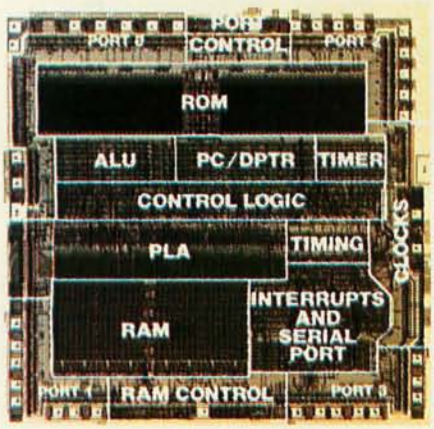

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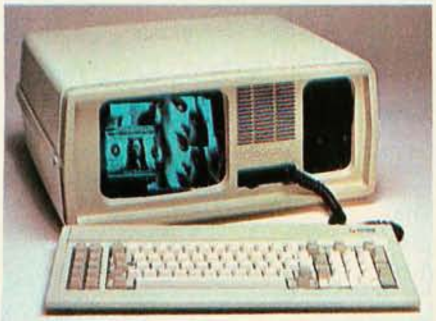

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Reviews

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Nucleus

Cover Painting by Robert Tinney

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the small systems journal

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Editorial

The FAA and Portables

Lawrence J. Curran, Editor in Chief

The next time you use your portable computer on a commercial airliner, the flight attendant may eye you with some interest, and it won't be because you've switched to an after-shave lotion that has made you suddenly more attractive. The attendant's interest will stem from the fact that Federal Aviation Administration regulations prohibit the use of portable computers on commercial airliners, and it's the flight attendant's duty to seek compliance with that regulation. The use of portable computers is also banned on private aircraft unless the operator—the pilot—has determined that use of the machine will not interfere with the safe operation of the plane's navigation or communications equipment.

Section 91.19 of Federal Aviation Regulations outlaws the use of all but a few portable electronic devices aboard a commercial airliner or other aircraft flying under instrument flight rules because there's a risk that electromagnetic interference (EMI) from the device could hamper reception of navigation and communications signals, jeopardizing the safe operation of the plane. The only exceptions allow the use of heart pacemakers, hearing aids, tape recorders, and electric shavers in flight. If the regulation were strictly enforced, even electronic watches and hand-held calculators would be outlawed.

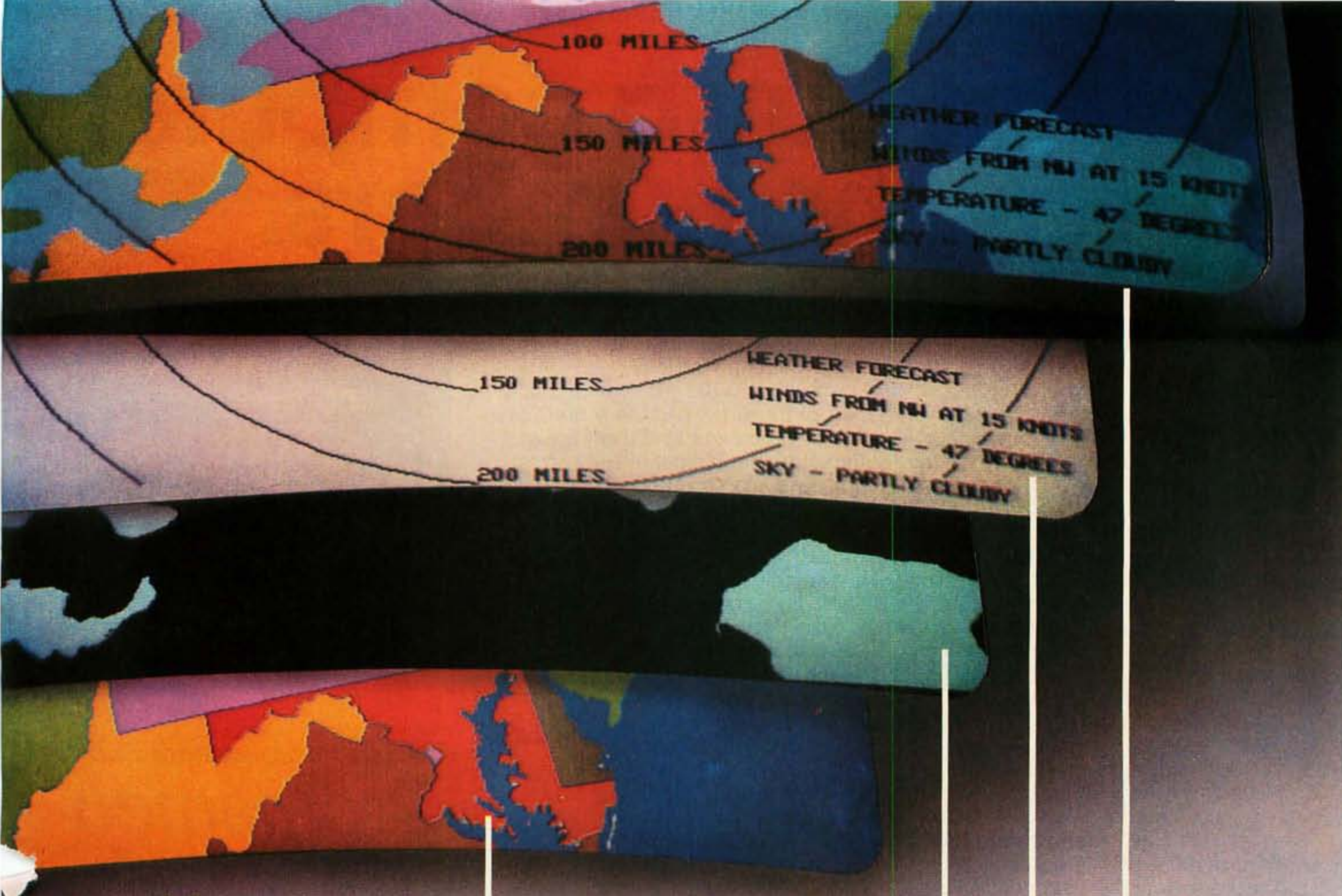
But the regulation isn't strictly enforced; it would be impossible to expect flight attendants or private pilots to enforce it. The FAA wants the airlines and private pilots to enforce the rule, but the airlines are especially chary of enforcing a regulation that may drive passengers away.

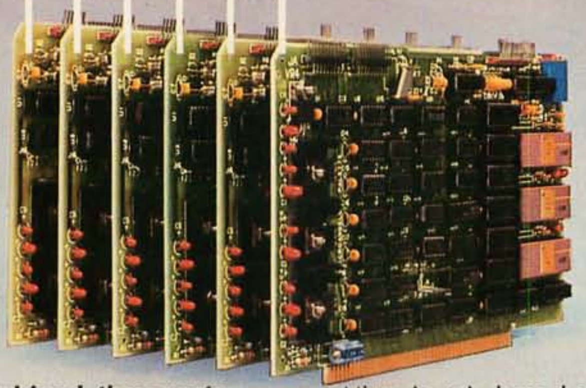
Bill Walters, product line manager for Radio Shack's *TRS-80 Models 4* and 100 (portable), has some thoughts on the issue. He compares the FAA's position on EMI from portable electronic devices to that of the Federal Communications Commission on EMI from home computers interfering with television signal reception six years ago. Walters, a former commercial airline pilot, believes the FAA should establish an EMI standard with which all makers of portable electronic devices would have to comply, just as the FCC did in the case of home computers. We agree.

In order to gain certification to use electronic devices on aircraft under the current regulation, the device manufacturer would be required to demonstrate that use of the device does not interfere with the navigation and communications equipment on every type of aircraft that every airline uses. The cost of such testing to the device manufacturer would be prohibitive.

Walters says it's time for the FAA to establish and enforce an emission standard and bandwidth guidelines governing portable electronic devices. Certainly some reasonable test procedures can be established that would allow portable computers to be certified for safe operation aboard aircraft that wouldn't also bankrupt the FAA to administer.

Or perhaps there's a simpler alternative that would not require testing of any kind. No smoking is permitted aboard aircraft at takeoff and landing times to lessen the chance of fire in case of an accident. Warning signs and flight attendants alert passengers to this short-term smoking ban. Perhaps the use of portable computers could be banned for similar periods and in a similar manner when their use would be most likely to interfere with aircraft instrument landing systems. It's worth considering.■


100 MILES
150 MILES
200 MILES
WEATHER FORECAST
WINDS FROM NW AT 15 KNOTS
TEMPERATURE - 47 DEGREES
SKY - PARTLY CLOUDY



MICROBYTES

Staff-written highlights of late developments in the microcomputer industry.

CONVERGENT TECHNOLOGIES INTRODUCES A NOTEBOOK-SIZE COMPUTER

Convergent Technologies, Santa Clara, CA, has introduced a portable computer that measures 8½ by 11 by 1 inches and weighs 3 pounds. The Convergent Workslate uses a 6303 processor—the CMOS version of the Motorola 6800—and comes equipped with 16K bytes of RAM and 64K bytes of ROM, including a ROM-based spreadsheet and datebook software. A microcassette drive, a speaker phone, a 300-bps modem, and a 15-line by 46-character liquid-crystal display are built-in features. The Workslate will be available through American Express in September for $895.

DATA GENERAL UNVEILS A MULTIUSER MICROCOMPUTER

Data General, Westboro, MA, has announced a 16-bit microcomputer that includes both an Intel 8086 and a Data General Microeclipse processor. The Desktop Generation Model 10 can use CP/M-86, MS-DOS, or Data General's RDOS or AOS operating system. It also can run different operating systems simultaneously in a multiuser configuration. A single-user system with 128K bytes of memory, a single 5¼-inch floppy-disk drive, and either MS-DOS or CP/M-86 costs $3265. A four-user version with 256K, a 15-megabyte hard-disk drive, three terminals, and RDOS and CP/M-86 sells for $10,960.

LEADING EDGE PRODUCTS ANNOUNCES A COLOR WORD PROCESSOR FOR THE IBM PC

Leading Edge Products, Needham Heights, MA, has announced its first internally developed product, a $300 color word processor for the IBM PC. Featuring an extensive help facility, a user-definable glossary to store any series of keystrokes, and the ability to restore deleted or overwritten text, the word processor will be the basis for an integrated package to be released later this year. The package will include spreadsheet, graphics, database-management, and spelling-checker capabilities.

DOCUTEL/OLIVETTI SHOWS AN INK-JET PRINTER, UPGRADES M20 COMPUTER

Docutel/Olivetti Corp., Dallas, TX, has introduced an ink-jet printer for $549. The PR2300 uses a single-jet replaceable printing head and either a Centronics parallel or an RS-232C serial interface. Docutel/Olivetti has also added an 8086 processor to its 8001-based M20 computer. The M20 BP with two floppy-disk drives and 128K bytes of RAM will sell for $3295. An 8086 expansion board for the standard M20 will cost $395.

BALCONES, STRATEGIC TECHNOLOGIES, OTRONA PREPARE 16-BIT PORTABLES

Balcones Computer Corp., Austin, TX, is at work on a portable computer based on the Xerox 820 8/16 computer. The Xport will include an 8-bit Z80 with 64K bytes of RAM and a 16-bit 8086 with a separate 128K-byte RAM (expandable to 256 or 512K). The two processors will run concurrently; the Z80 runs CP/M-80, and the 8086 runs MS-DOS 2.0. The system, which will probably only be available with one 3½-inch hard-disk drive and one 5¼-inch floppy-disk drive, may cost as little as $3000.

Strategic Technologies, Norcross, GA, is preparing a portable computer with a full-size plasma display. The PC Traveler will come in a briefcase measuring 14 by 19 by 6 inches and weigh less than 28 pounds. It will include an Amlyn 5-disk cartridge drive, a built-in full-size dot-matrix printer, dual 80186 processors, 128K bytes of RAM, an 80-character by 25-line gas-plasma display, and a bundled software package. The PC Traveler will sell for less than $5000 starting in November.

Otrona Advanced Systems Corp., Boulder, CO, has introduced a dual-processor version of its portable computer. The Attaché 8:16 includes an 8-bit Z80A and a 16-bit 8086 processor, the CP/M 2.2 and MS-DOS operating systems, two floppy-disk drives, and an IBM-compatible display format for $3795. An upgrade board to convert an Attaché to an Attaché 8:16 will cost $1495.

RADIO SHACK AND SHARP INTRODUCE NEW POCKET COMPUTERS

Radio Shack's newest pocket computer, the PC-3, fits into a shirt pocket and can run programs written for the PC-1. Weighing in at 4 ounces, the PC-3 has 1.4K bytes of memory and a 24-character liquid-crystal display for $99.95. A PC-3 interface and recorder and a PC-3 printer/cassette interface each cost $119.95.

Sharp Electronics Corp., Paramus, NJ, has introduced a nearly identical computer, the PC-1250, for $110. The PC-1250 measures 5-5/16 by 2½ by 3/8 inches.

TEXAS INSTRUMENTS RELEASES DOW JONES NATURAL LANGUAGE INTERFACE, DOT-MATRIX PRINTER

Texas Instruments' new Dow Jones Natural Language interface for its Professional computer enables users to request information in "plain English," translating requests into Dow Jones' command format. The $130 package includes a $50 account fee and an hour on the Dow Jones News/Retrieval service. Texas Instruments is also expected to announce its Omni 800 Model 855 dot-matrix printer. Using a 32 by 18 printing head, the printer will include graphics capabilities and selectable fonts for under $1000.

MICROS GAIN MORE ATTENTION AT SIGGRAPH

Microcomputers received increased attention from vendors showing new products at the Siggraph convention in Detroit. Micro-based products announced at the show included a graphics board for the IBM PC from **Number Nine Computer Engineering Inc.**, Hartford, CT, for less than $1200. The board, which NNCE plans to begin shipping late in the third quarter, is based on an NEC 7220 VLSI graphics display controller. The company has been shipping a similar board for the Apple for several months . . . .**3Design,** Seattle, WA, announced an optional Wordstar interface for its graphics card for the IBM PC. The interface lets users mix Wordstar-generated text and graphics. The basic graphics card, which costs $250 and requires 128K bytes of memory in the PC, enables users to create designs, then rotate, translate, and scale them independently or in reconfigurable groups, relative to any coordinate in the system . . . . **Cubicomp Corp.,** Berkeley, CA, displayed its CS-5 graphics system for three-dimensional solids modeling. The under-$9000 system, which includes an interface adapter and a CS-5 graphics module, requires an IBM PC with at least 320K bytes of RAM and a high-resolution RGB monitor with long-persistence phosphors. The software runs under IBM PC-DOS . . . **Precision Visuals,** Boulder, CO, announced that it will support NAPLPS videotex standards in its DI-3000 graphics software.

NANOBYTES

Zilog has announced the Z80000, a 32-bit microprocessor chip that is compatible with the 16-bit Z8000. Featuring a 256-byte on-chip cache, instruction pipelining, and memory management, the Z80000 can run at 10 to 25 MHz. It should be available in late 1984 for $150 in 1000-unit lots . . . . Silicon, the basic material in microprocessors and memory chips, may be in short supply later this year if semiconductor companies fail to plan now for future needs, warns **Monsanto Electronic Materials Co.,** Palo Alto, CA. The company bases its prediction on trends in the economy and the semiconductor industry and on the sustained increase in orders for semiconductor products. Monsanto is the leading supplier of single-crystal CZ silicon, the primary ingredient of semiconductor devices . . . . **Hewlett-Packard**, Palo Alto, CA, has introduced a new 6-pen graphics plotter, the HP 7475A, for $1895. The company has dropped the list price of the HP 7470A 30 percent from $1575 to $1095 . . . . **Olympia USA Inc.**, Somerville, NJ, has introduced the People computer, which includes both CP/M-86 and MS-DOS and two floppy-disk drives for $3595. Concurrent CP/M-86 is also available . . . . **American Bell** has unveiled a videotex terminal to be sold through Bell Phone Center Stores. The terminal, which includes a 1200-bps modem and keyboard, connects to a standard television. As part of a videotex program in southern Florida, the terminals will sell for $600 there; elsewhere, they will retail for $900 . . . . Coin-operated computer terminals with attached printers are being marketed by **Data and Research Technology Corp.** (Pittsburgh, PA) in an effort to become "the McDonald's of information." Users with valid accounts can access local nodes of such popular networks as Compuserve, the Source, and Dow Jones for $1 for 3 minutes. The company hopes to have terminals in 50 cities by the end of the year . . . . **Tandy**, parent of Radio Shack, says its preliminary sales figures for the year ending June 30 were $2,472,484,000, up 22 percent from fiscal 1982 . . . . **Microsoft's** MS-DOS operating system is now being supported on Digital Equipment Corp.'s Rainbow 100 and Fujitsu's Micro 16s . . . . **Corvus Systems Inc.** has lowered the prices of its Concept personal workstations to $3995 for the 256K-byte version and $4695 for the 512K-byte model . . . . **The American Society of Interior Designers**, New York, NY, has introduced a hardware-software package for interior designers, architects, and space planners. Based on a Victor Technologies 8/16-bit computer, the package includes drafting, accounting, word-processing and mailing-list software. Priced under $10,000, it includes training for end users and a hot-line query service . . . . **Apple Computer Inc.** announced that the one millionth Apple computer was produced in June . . . . The British-designed Dragon computer (January 1983 BYTE, p. 46) is being manufactured and sold in the U.S. by Tano Corp. (New Orleans, LA). For $399, the machine includes 64K bytes of RAM, sound, 256 by 192 color graphics, and Extended Microsoft BASIC.

Letters

Multiplying without Zero

Multiplication by doubling and halving ("Novel Methods of Integer Multiplication and Division," June, p. 364) is discussed by Karl Menninger in his excellent book, *Number Words and Number Symbols* (MIT Press, 1969). Menninger credits the Egyptians with the invention of the algorithm.

Multiplication and division are difficult in any number system that does not have a zero, such as Roman numerals. The Romans bypassed the problem by doubling and halving on a counting board.

Joseph J. Brigham
1293 Brighton Sq.
St. Paul, MN 55112

Bug-Free But Meaningless

Those seeking a textbook illustration of the dictum "garbage in, garbage out" need look no further than John Merrill's article ("Regression Fitting to Economic Indexes," May, p. 474). The author presents a lovely piece of code, perfectly logical and internally consistent, which nonetheless produces completely meaningless output because it is based on the fallacy that holds that economic data can be treated in the same way as a continuous function in mathematics—i.e., that it can be analyzed by the methods of calculus.

The reasoning that refutes this fallacy is quite straightforward and need not be rehashed here. Rothbard, among others, has argued persuasively against the notion that it is possible to treat market phenomena in terms of "infinitely small" differences (*Man, Economy, and State,* Van Nostrand, 1962, p. 440n). Intuitively, it should be clear that economic data, by its very nature, is discrete because it is ultimately resolvable into *individual* decisions to buy or not to buy, and the buying population is finite. (It does not help to argue that the population is large enough to "approximate" infinity because the market for any given good at any given time cannot be predicted in advance and may in fact consist of only a handful of people.)

Even if we concede that it is sometimes permissible, for the sake of simplicity, to work with smoothed-out supply and demand curves, it makes no sense at all to maintain that an "underlying rate of inflation" can somehow be measured by cataloguing the history of prices. Such a measurement, if it could be made at all, would have to be derived from money-supply figures. The econometricians claim to be able to use the methods of statistics in order to "fit" Consumer Price Index data to a smooth logarithmic curve and then to be able to "see" the effects of the Viet Nam war in the result! Even if the CPI were accurate and consistent (and it's neither), so many variables go into determining a market's equilibrium price that you might just as well claim you can "see" the next president's face in a lump of soggy tea leaves.

The moral for programmers is that our work can be logical, consistent, and bug-free, yet still produce meaningless results. If seemingly plausible, these results may mislead vast numbers of people, particularly when the government has involved itself in the matter. I have no fear of 10 million machine-readable files in private hands, but when the state uses its coercive authority to collect even one small database, I tremble. The issue for society is compulsion, not computerization.

G. M. Harding
POB 7556
Carmel, CA 93921

Kudos for the Model 100

The warts to which Rich Malloy alluded ("Little Big Computer: The TRS-80 Model 100 Computer," May, p. 14) are, in fact, beauty marks! I'm a 25-year veteran of the computer field who cut his teeth on tubes and drum memory, but the bubble hasn't burst even after the first two weeks of 22-hour days of reveling in the delights of the Model 100. The designers seem to have been blessed with a Midas touch that has enabled them to turn what initially seem like drawbacks into delightful and surprising assets.

I've yet to see a criticism of the Model 100 that doesn't wither under close scrutiny. Malloy's review is the best in-depth effort I've seen so far. My only query is about the surprise of the author regarding the individual who put an $800 deposit on one the day he read

With all the clamor about personal computers, a fundamental fact is often overlooked: some simply *work* better than others.

Consider the COMPAQ Portable.

A computer will make you more productive. A computer will make you more efficient. You hear it everywhere. But you don't hear much about which computer actually *works* best.

The COMPAQ Portable fits under a standard airline seat for business trips.

Works in more places

With the COMPAQ™ Portable, you can be as productive in your hotel room or your lake house as in your own office. It's a reliable companion on a business trip. It's a powerful sales aid in your customer's office.

You can move it from office to office to share its resources. You can move it into the conference room to answer questions.

What's more productive than a computer? A computer that works for you in more places.

Works with the greatest number of programs

The most important consideration when choosing a computer is "what programs will it run?"

The COMPAQ Portable runs more programs than any other portable. In fact, it runs more than most non-portables because it runs all the popular programs written for the IBM® Personal Computer without any modification. There are hundreds of them. They are available at computer stores all over the country.

Imagine the power of a *portable* word processor. There are dozens of word processing programs available for the COMPAQ Portable.

Planning, problem-solving, and "what-ifs" are a cinch with a variety of popular electronic spreadsheet programs. The COMPAQ Portable runs them all.

There are accounting programs for anything from computerizing your family budget to full-scale professional management of payables, receivables, inventory, and payroll.

There are programs for making charts and programs for communicating with other computers.

So you get portability and you don't give up problem-solving power. The combination adds up to the most useful personal computer on the market today.

Add-on options make it work the way you work

Inside the COMPAQ Portable are three open slots. Most portables don't have any. Electronic devices called expansion boards fit those slots and give the COMPAQ Portable new powers. As with programs, expansion boards designed for the IBM will work. With them, you can make your personal computer more personal.

Want to check a stock price? One expansion board enables the COMPAQ Portable to handle those communications over ordinary phone lines.

Want to use your company's central computer files while you're on a trip? There are boards that allow the COMPAQ Portable to communicate with a variety of large computers.

Other boards let you hook up controllers for computer games, increase memory capacity, or connect several personal computers in a network.

The added usefulness is free

The COMPAQ Portable doesn't cost any more than an ordinary desktop computer. In fact, it costs hundreds less than a comparably equipped IBM or Apple® III. The COMPAQ Portable comes standard with one disk drive and 128K bytes of memory, both of which are usually extra-cost options. The bottom line is this—you just can't buy a more practical, useful, productive computer. Compare the COMPAQ Portable.

All the popular programs written for the IBM PC run as is on the COMPAQ Portable.

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about it. I went out and bought 12! I now do all my correspondence with it, keep office records on it, relish the sounds of my text-to-voice synthesizer, and enjoy threatening the wags and critics with my bar-code reader wand. I estimate that I will recoup the cost of the machines within a few months.

Radio Shack has caught at least one customer hook, line, and sinker.

R. E. Cassidy
DC Consultants
38 Riddell St.
Woodstock, Ontario
Canada

Eek: Another Mouse?

I am sorry to see Apple, Visicorp, and possibly Microsoft jump onto the Xerox bandwagon and introduce a mouse into their new integrated computing software. The mouse is an inherently bad pointing device for at least three reasons: it consumes one to two square feet of flat desk space; it requires users to move their hands one to two feet from the keyboard in order to point at a screen object; and, because the mouse is not in a fixed place relative to the keyboard, users must look away from their work to find the mouse whenever it is to be used.

A much better solution to the problem of efficiently pointing at the screen is to use a trackball device located just below the space bar of the keyboard. This requires only four square inches of space, allows users to keep their fingers on the home keys of the keyboard during use, and does not require users to divert their eyes from the work. Trackballs are not more expensive than mice when both are manufactured in quantity.

Henry Hoeksma
112 Minota Hagey Res.
University of Waterloo
Canada

The Price Is Wrong

I was very excited by the article by Larry Sarisky, president of Syquest Technology, on the company's removable media hard-disk drive ("Will Removable Hard Disks Replace the Floppy?" March, p. 110). Too bad the prices quoted in the article don't come close to the actual figures on the price list Syquest sent me. (Unless, of course, I buy 50 or more units. Do your readers often buy 50 or more units when purchasing hard-disk drives?)

The article said "3.9-inch drives cost less than $800, the 3.9-inch (cartridge) about $35." Also, "The drive costs only slightly more than a floppy-disk drive. The cost of a cartridge is comparable to the cost of a box of 10 floppy disks."

The price list that I was sent quotes the price of the removable media drive and cartridge in quantities less than 10 as $995 for a drive and $70 for a cartridge. Please be more sensitive to such exaggerated claims in the future.

K. S. Scriba
4602 Alpine
Enid, OK 73701

Larry Sarisky replies:

At the time my article was submitted, our pricing was $800 for either the SQ306R or SQ306F disk drive. The Q-Pak cartridge was $35. Recent cost increases in material and manpower resulted in a price increase on the SQ306R and Q-Pak. To quote all of our existing customers and prospects who have signed up to the slightly higher prices, "It is still the best deal around."

I am sorry for any inconvenience this may have caused you.

Make Mine Modula-2

"Modula-2: A Worthy Successor to Pascal" by Joel McCormack and Richard Gleaves (April, p. 385) is by far the best exposition to date on Modula-2. However, the subtitle of the article might have read "And a Worthy Competitor to Ada." Clearly, Modula-2 could give Ada a run for the money, if only the Modula Research Institute had a tenth of the funds the Department of Defense (DOD) has allocated for Ada promotion.

In Earl McCoy's "Strongly Typed Languages," (May, p. 418) he says that Ada "is expected to attain wide use in both civilian and military applications." Obviously, the many firms and organizations on the military "gravy train" will indeed use Ada because it is being forced upon them. Civilian applications, however, are a different matter. Ada has not established its superiority to even extended Pascal, let alone Modula-2. *It is a* nightmare for compiler writers and is clearly top-heavy with complex features, whereas Modula-2 is a simpler and much more readable systems programming lan-

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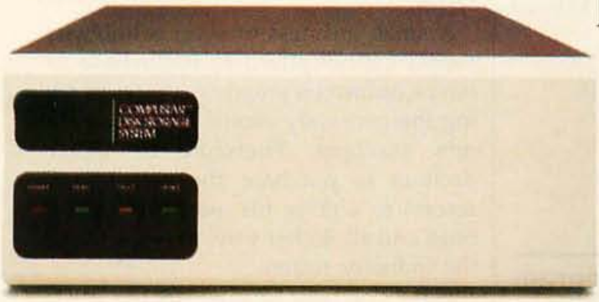

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guage.

Perhaps it would be useful to follow the example of David Packard, founder of Hewlett-Packard. Having witnessed the DOD as an insider (he held the title of Deputy Secretary of Defense), he later ran H-P on the principle that it should stay as far away from military business as possible. Maybe he knew something we all should know.

Luckily, the nonmilitary option is available, and it happens to embody the best elements for successful systems implementations.

Lee Scott Jacobson
Bebo White
1440 Catalina St.
San Leandro, CA 94577

Wanted: a Conversion Program

I find myself viewing the advent of 16-bit personal computers with mixed emotions.

Having purchased an 8-bit personal computer some years ago, I have invested considerable time and money in software for the 6502 MPU. A good deal of this investment was expensive "uncopyable" business and business-related programs.

My initial reaction of elation for the IBM PC quickly disappeared when I realized the limited software available at that time and the inability to convert my existing software to the new OS/DOS used by that machine. Despite the relatively low cost of the IBM PC and its obvious advantages, I was discouraged from purchasing it due to the tremendous expense in time and money to convert my existing software to the new system.

As other newer MPUs and machines are released to the general market with expanded capabilities, the companies who published their proprietary programs push their early supporters to either repurchase the same software (if it exists) to upgrade to a new system or simply to make do with a smaller, less efficient system.

The personal computer industry takes justifiable pride in the tremendous strides it has made toward industrial standards, while the software industry struggles mightily to maintain parity (no pun intended). The introduction of new MPUs results in new OS/DOS systems—CP/M, CP/M-86, Concurrent CP/M, CP/NET, Unix, Xenix, and the UCSD p-System, to name a few. While some of these are cross-translatable and others can be used on a variety of MPUs, some tremendously brilliant software is compatible with only one or two systems. No system = no software.

Now, I'm no expert, and it may be that an inexpensive conversion program exists, but I haven't seen it advertised at any price. On the other hand, if a translator doesn't exist, someone stands to make a fortune on a single program series.

A small business or serious hobbyist simply cannot afford to repurchase or retype numerous programs after expending the necessary capital to purchase a new machine. Therefore he either declines to purchase the machine or resorts to writing his own programs—bugs and all. Either way, one portion of the industry suffers.

It may be poor form to discuss price, but for me at least, cost-effectiveness is of paramount importance. If I want to purchase $8000 to $10,000 worth of equipment and then be forced to repurchase a similar dollar value of software that I already own, cost-effectiveness ceases to exist.

John Winney
8326 228th St. SW
Edmonds, WA 98020

Corrected CASE Structure for Fig-FORTH

Your August 1980 issue featured several excellent articles on FORTH. Since that time, the issue appears to have become a reference for individuals and companies as more and more attention is paid to FORTH. Peopleware Systems specializes in FORTH products, and we have received inquiries about the Miller and Miller article, "Breakforth into FORTH," (p. 50).

An example on page 180 has a subtle bug. The example as it appeared in essence is as follows:

```
: CASE <BUILDS SMUDGE ] DOES>
  SWAP 2 * + @ EXECUTE ;
: 0PET ." AARDVARK " ; : 1PET
  ." BEAVER " ; : 2PET
  ." COUGAR " ;
  CASE: ANIMAL 0PET 1PET 2PET ;
```

where 1 ANIMAL will print BEAVER,


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etc.

The problem revolves around terminating the list of cases after CASE: (0PET 1PET 2PET) with { ; }.

The function of the terminator is to reset STATE to 0, which indicates execution mode. While { ; } does this, it also does some other things in fig systems . . . it toggles the SMUDGE bit, and hence the need for SMUDGE in the <BUILDS clause in the definition of CASE: . { ; } also executes ?CSP, and here lies the bug.

If the above example is keyed in as shown, it will work as expected. However, if the stack is altered after defining 2PET but before defining ANIMAL by putting a number on the stack, the ?CSP test will fail, giving an error message #14, "definition not finished."

If { [} is used to terminate the list of cases, no ?CSP test will be performed, and the problem will be eliminated. If this is done, SMUDGE should be omitted from the definition of CASE:.

Better yet, a synonym for { [} can be defined to terminate the list of cases—

```
: ENDCASE [COMPILE] [ ;
  IMMEDIATE
```

Note that { [} is IMMEDIATE and, therefore, requires the use of [COMPILE]; note also that ENDCASE must be IMMEDIATE.

This bug can show up if CASE: is made part of your FORTH kernel. Thus, if you boot your FORTH system after turning power on and the first definition uses CASE: to define a word, CSP will contain garbage, and the ?CSP error will result. Our P-FORTH card automatically saves compiled FORTH code in nonvolatile EEROM, which makes this bug more likely to appear.

The correct example would then be

```
: CASE: <BUILDS ] DOES> SWAP 2
  * + @ EXECUTE ;
: ENDCASE [COMPILE] [ ;
  IMMEDIATE
: 0PET ." AARDVARK " ; : 1PET
  ." BEAVER " ; : 2PET ." COUGAR " ;
CASE: ANIMAL 0PET 1PET 2PET
  ENDCASE
```

Note the definition of CASE: is a fairly advanced FORTH topic, but the use of CASE: is very simple.

Fred Olson
Peopleware Systems Inc.
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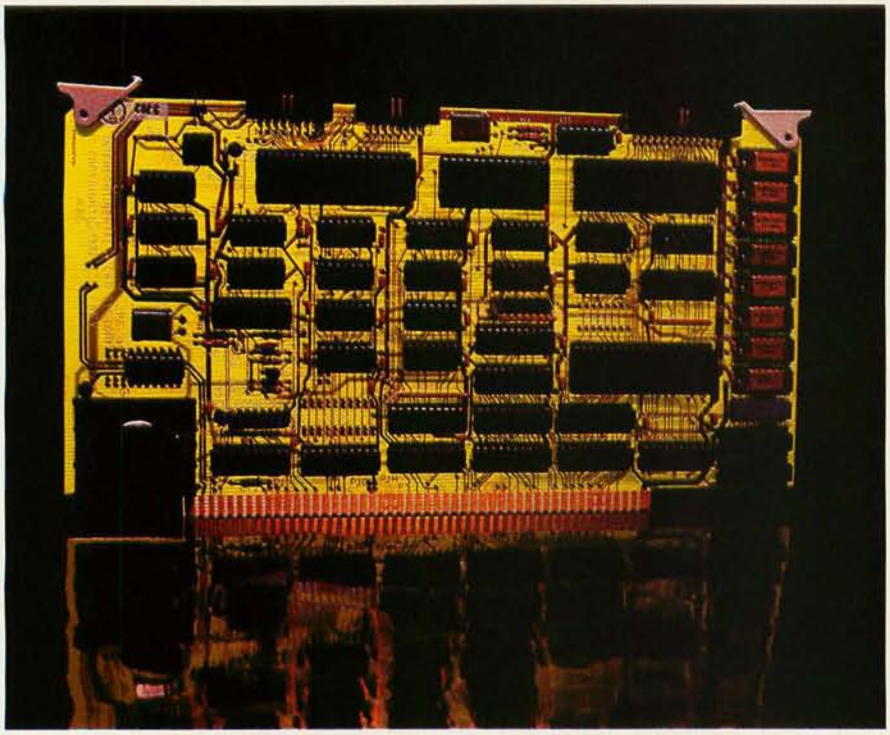
Minneapolis, MN 55435

Coding between the Lines

I was considering buying the Apple Logo for my children until I read Gary Drescher's letter (March, p. 20). I have no intention of paying for the advertising of his favorite cause or anybody else's. I wonder what he would think if, for example, his or his friend's child received a FORTRAN compiler error message such as "Evolution stinks." Would he send the ACLU to the rescue or recognize the rights of anti-evolutionists to resist? Certainly, in a democratic society there are less sneaky ways of exercising one's rights to differ from and/or resist prevailing public opinions.

George Jerinic
7 Robinwood Rd.
Acton, MA 01720



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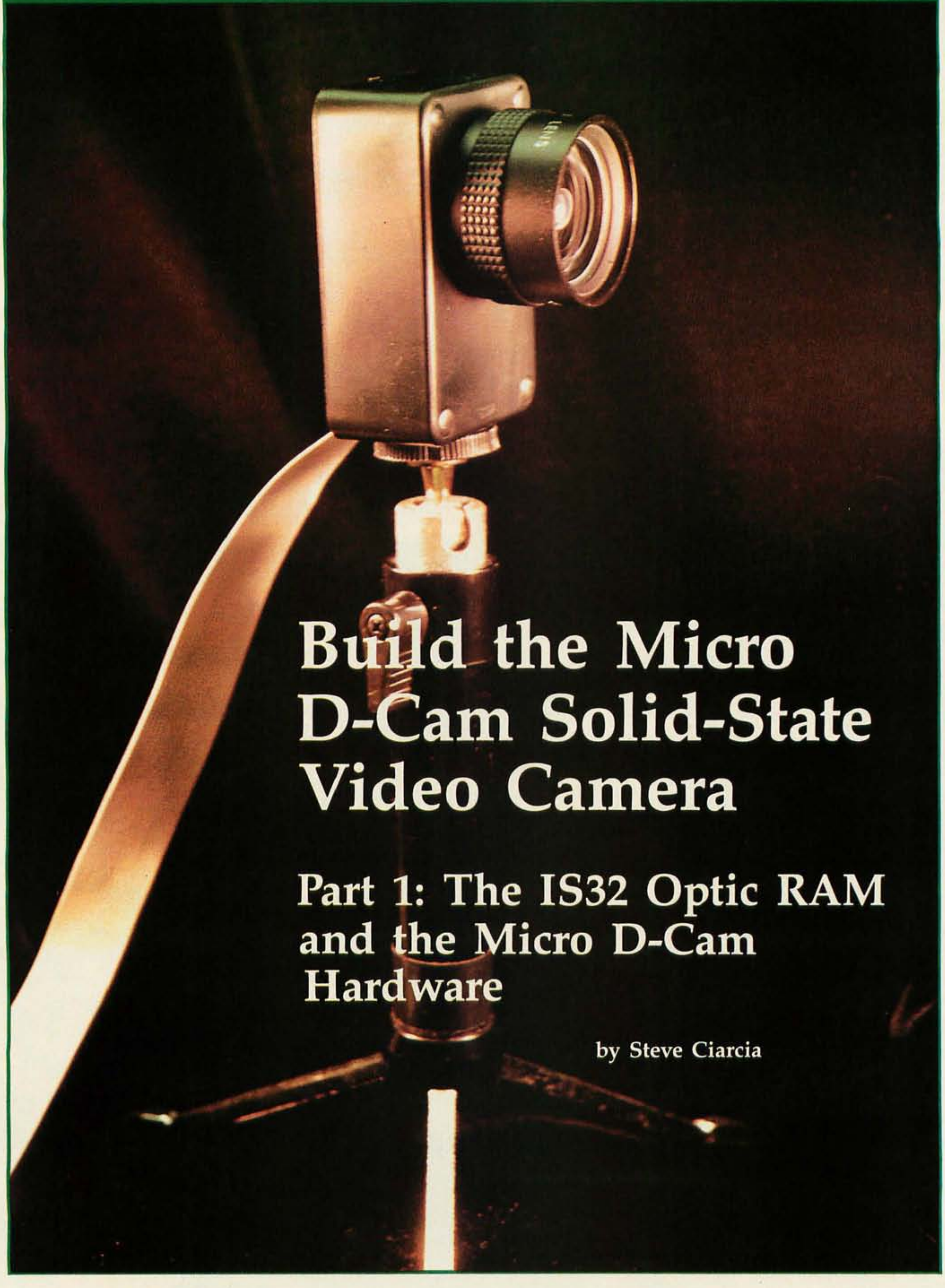

Build the Micro D-Cam Solid-State Video Camera

Part 1: The IS32 Optic RAM and the Micro D-Cam Hardware

by Steve Ciarcia

A 64K-bit dynamic RAM chip is the visual sensor in this digital image camera

If you've followed the activities in the Circuit Cellar for any period of time, you have probably realized that my writing a monthly column is just an excuse to investigate and experiment with whatever I find currently fascinating. One of my longtime fascinations has been the input of visual data to a computer. While I've presented interfaces that allow computers to determine direction and measure distances, receive a variety of sensory inputs via touch or remote signal, and even speak their minds through voice synthesis, until now I have not presented a project that enables a computer to see.

There was a time when most computers communicated via klunky teletypes at 10 characters per second. Improving output technology—high-speed video graphics displays, dot-matrix printers, and voice synthesis—has vastly improved the computer's ability to communicate results and conclusions to its user. Except in specialized applications, however, input technology has been discouragingly static. We still plod along using keyboards or mice as the primary input device even when the input data may be graphical.

So much of our existence involves visual recognition that it only stands to reason that the potential applications of computers would be enhanced if a versatile sensory-input channel were available to the machines. Then, instead of spending hours entering digital coordinates from a picture or map into a computer using a keyboard, you could easily use a "computerized camera" to make a visual snapshot of the material, instantly producing a digitized picture. Once you had such a picture in the computer, it could be interpreted, enhanced, or stored as the application might dictate.

Photo 1: *In this prototype, the Optic RAM is mounted inside a light-tight box with a C-mount lens focusing light onto one of its cell arrays. The ribbon cable leads straight from the Optic RAM to the interface card in the Apple.*

Computers and Vidicon Cameras

Computerized-image cameras are not new, but up to now they have always been too expensive for widespread practical use and casual experimentation. Most of the computer image-input devices currently available use a conventional black-and-white television camera as the image sensor. The camera's video output must be converted to digital logic levels for the computer: a difficult task, because the output, produced using a Vidicon-type pickup tube, is a high-frequency analog signal divided into 30 complete frames of picture information transmitted and scanned each second (or 25 frames for most TV systems outside North America).

Most high-quality TV-camera interfaces convert the analog signal for computer processing through "frame grabbing," in which one of the frames is sampled, digitized, and stored during a 1/30-second frame-scan interval. In these sophisticated visual sensing systems, a high-speed A/D (analog-to-digital) converter digitizes the analog signal in real time at sampling rates exceeding 5 megahertz (MHz) and stores the PCM (pulse-code modulated) data in a high-speed buffer made of semiconductor memory. Because they operate so fast, such units are insensitive to camera motion and fast scene changes.

In less sophisticated TV-camera interfaces, the designer has assumed that the camera and the object in its view will remain still long enough for the picture to be processed by slower, cheaper circuitry. When the TV picture is stationary, all frames in the signal are identical, so a sequential line-sampling technique is often employed. In units of this type, a low-speed A/D converter (sampling from 100,000 to 1,000,000 times per second) operates in bursts of activity shorter than a frame interval, with each successive period of activity, or *sampling window*, triggered at a slightly later time during the frame interval by line and pixel (picture element) position counters. In between the sampling windows, the support circuitry has time to store the digitized information and get ready for the next burst of activity. As a result, the interface assembles the single image from pieces snatched from many frames.

High-speed frame grabbers generally cost more than $10,000, while the slower units cost somewhat less, depending upon speed and resolution. You can expect a 256 by 256 pixel-resolution low-speed interface, the kind used in the computer systems often seen at conventions printing images on T-shirts, to cost between $500 and $1000; half of that price is for the camera and lens.

Solid-State Arrays to the Rescue?

The problem with the Vidicon-type camera is that it is an analog device, which must be adapted to work in digital applications. It would be far better to have a computer video camera that is inherently digital and dispense with the analog-to-digital conversion. Why not use semiconductor devices, the outputs of which are digital signals that change as a function of light level?

The barrier has been price. A variety of semiconductor optical sensors, such as photodiode and charged-coupled-device (CCD) arrays, fill the bill nicely. When I first started to think about building a solid-state image camera, I thought I could just order a 256 by 256 pixel CCD array and add a few binary-counter chips for a quick project. This idea evaporated quickly when I discovered that CCD arrays cost from $800 to $2000, depending upon the number of bad pixels you get.

My success with photodiode arrays wasn't much better. It seems that for about $100 you can buy a 128 by 1 or 256 by 1 array, but arrays more than one element wide are hard to find. To create a 256 by 128 or 128 by 128 picture, I would have needed to devise an optical, mechanical, or electronic way to move the array across the image plane, or move the

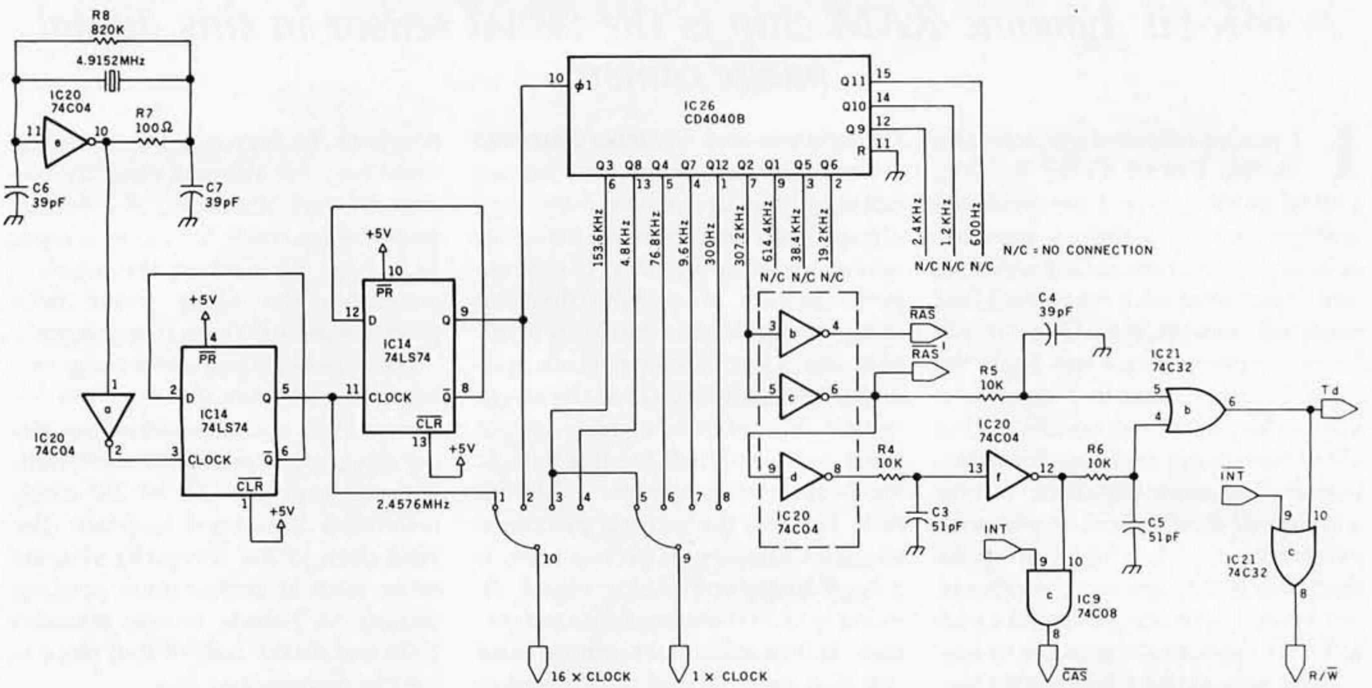

Figure 1: *A schematic diagram of the timing-generator circuit, which contains a CMOS oscillator circuit to generate the fundamental clock rate. This signal is divided down to produce the frequencies for various possible output data rates and controlling the IS32. The data-rate-clock signals control the sequence of operation of the interrupt generator and the transmitter circuit.*

image across the array, stopping periodically for the values of the picture elements to be registered and stored. After tentatively sketching a screw drive and its associated control electronics, I gave up in disgust at the thought of how hard it would be to build.

If Memory Serves...

I had almost decided to join the bandwagon and use a Vidicon camera when I remembered experimenting with the optical sensitivity of dynamic RAM (random-access read/write memory) chips back in 1976. I had even seen a design published for a 64 by 64 pixel resolution camera that used a type-1103 1K-bit dynamic RAM chip as an optical sensor. If the bit-storage cells in those early dynamic RAMs were light-sensitive, could the newer ones be also? If I popped the top off a 64K-bit dynamic RAM chip, wouldn't I find a 256 by 256 array?

Well, yes and no. I took the lids off a few brands of 64K-bit dynamic RAM chips, and it does appear that they are light-sensitive. The problem, however, is that they were designed only as memory devices and not optical arrays. To my knowledge, none of the 64K-bit dynamic RAMs on the market are configured as an orthogonal array laid out 256 elements long by 256 wide. In fact, most have 4 or 8 sections of 16K or 8K bits, and many include redundant sections that can be wired in to replace bad sections on the chip. The bit addresses don't proceed linearly through the chip either; one bit may be in the upper-left corner and the next bit in the lower-right corner.

Just as I was about to abandon all hope, I found an unconventional dynamic-RAM manufacturer that has recognized the light-sensing potential of its 64K-byte device. Micron Technology Inc., of Boise, Idaho (certainly an unconventional place to make integrated circuits), produces a dynamic RAM chip that has its memory cells laid out in only two sections, both of which are 256 by 128 cells, as shown in figure 7 on page 31. With this configuration, the chip can easily be used as an optical sensor. One specially tested 64K-bit dynamic memory device, called the IS32 Optic RAM, comes in a package with a see-through quartz lid (see photo 4 on page 30).

Per pixel, the Micron Technology IS32 Optic RAM costs 1000 times less than the earlier generation of image-sensing chips such as the CCD. The Optic RAM's spectral sensitivity is generally the same as that of other silicon-based light-sensing media, but its bit-for-bit uniformity is not as good as CCDs. Nevertheless, the Optic RAM can bring capabilities to your computer that were previously available only to large industrial users.

Build the Micro D-Cam

This month, using the IS32, I'll show you how to build a relatively low-cost digital image camera I call the Micro D-Cam (see photo 1). Its resolution of 256 by 128 pixels is adequate for many applications in graphics, pattern and character recognition, robotics, process control, and security. (Of course, the output of the Micro D-Cam is a digital signal; it cannot be used to directly drive a composite-video monitor.) I've put together versions of the Micro D-Cam for use with the Apple II computer (II-Plus and IIe, see photo 3, page 30) and the IBM Personal Computer; however, the Micro D-Cam is serially interfaced and requires only

five wires for connection, so I'm also working on an RS-232C version that can be attached to any computer that has a serial port.

The Micro D-Cam project is rather complex, so I'll present it in two parts. This month I'll explain how the IS32 Optic RAM and the Micro D-Cam hardware work. Because appropriate software is vital to the success of this project, next month I'll include a lengthy listing of a typical control program for use with the Apple II-Plus version of the Micro D-Cam. We'll also look at some of the Micro D-Cam's capabilities.

IS32 Optic RAM

The IS32 from Micron Technology is an all-digital image-sensing device. Its pertinent characteristics are shown in table 1.

The IS32 contains 65,536 (64K) light-sensitive memory cells laid out in two planar, rectangular arrays of 32,768 elements, each a matrix of 128 rows and 256 columns. The two arrays are separated by an optically nonsensitive "dead" zone about 25 elements wide. To avoid having a gap in the image or using complicated optical systems to eliminate it, only one of the arrays is usually used as an image sensor. Each of the memory elements in the matrix can be accessed randomly when the control circuitry strobes in the appropriate row and column address of the element being accessed.

Theory of Operation

An image camera built around the IS32 focuses reflected light from the viewed object and passes it through a lens onto one of the 32,768-element arrays. When an individual element is struck by photons of light, the capacitor in the cell, which is initially precharged to a fixed voltage, begins to discharge toward zero volts. The capacitor discharges at a rate proportional to the light intensity throughout the duration of the exposure.

After the exposure interval has elapsed, the circuitry reads the element by addressing it as a memory cell. During the cell access, sense amplifiers within the IS32 read the capacitor's voltage value and compare it to a fixed threshold voltage. If the potential is above the threshold, the picture element is deemed to be black; if the potential is too low, the picture element is declared white. The D_{out} pin of the Optic RAM is set to a logic 1 or 0 during the corresponding bit interval as a result of this decision. The raw "gray scale" of the IS32, therefore, has only two shades, white and black. (We'll see how to compensate for this shortly.)

All dynamic-memory devices require refreshing for operation; the charge representing the data stored in each cell capacitor will leak away if left alone (exposure to light merely hastens the leakage). The charge must be sensed and brought back to the nominal voltage for the logic state it represents. This can happen when the computer reads a bit value from the cell, but more frequently it happens when circuitry external to the memory chip periodically activates the cell's address just for the purpose. (Many memory chips, including the IS32 Optic RAM, can refresh their cells a whole row at a time.) The IS32 can be used this way as a regular memory device can, but in optical service there is a twist in the refreshing. The chip is light-sensitive only when it is not being refreshed; the key to using it in a camera is to carefully control its sensitivity by performing the refresh operation in a special way.

In the beginning of an image-sensing cycle, the Micro D-Cam's circuitry addresses all the cells in the active array, filling them with the positive voltages that represent logic 1s. The exposure begins with the receipt of a SOAK command, which is the equivalent of opening the shutter (to allow the array to "soak" in light). Then, after the appropriate exposure interval has elapsed, the control circuitry issues the refresh command, which freezes the states of the memory cells (or pixel cells, if you will). Then the control circuitry activates the interrupt state, during which the value of one cell is fetched and transmitted. Interrupt cycles are continued until all the bits in the array have been transmitted. (The interrupt

Photo 2a: *The Micro D-Cam can focus on UPC bars. Both photos shown here used the Apple II's high-resolution graphics routines to reproduce the camera's output.*

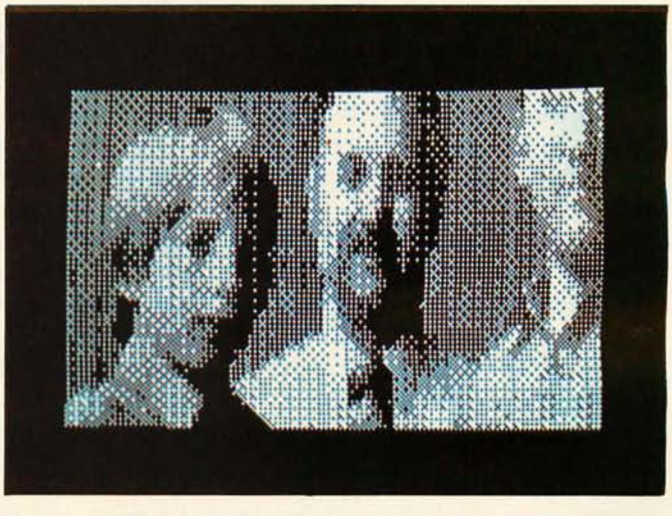

Photo 2b: *The Apple II's display represents gray levels as different densities of white dots. Several different-length exposures are combined to form the gray-scale image.*

mode is not maintained constantly because the IS32 cannot be refreshed during the interrupt.) The Micro D-Cam then causes all the cells to again be set to 1, and the image-sensing cycle starts over.

A white pixel (logic 0) in the output indicates that the capacitor was exposed to a light intensity sufficient to discharge it past the threshold point. A black pixel (logic 1) indicates the light intensity was not enough to discharge the capacitor past the threshold point.

How fast the camera can scan the image varies according to the light intensity. The faster the elements are scanned, or read, the greater the light intensity required. The Micro D-Cam can scan approximately 15 frames per second at maximum speed.

1. 128- by 256-element array measuring 5.504 by 1.088 millimeters
2. Element size: 8 microns by 9 microns
3. Vertical center-to-center spacing: 21.5 microns
4. Horizontal spacing: 8.5 microns
5. Spacing between left and right arrays: 150 microns

Table 1: *Specifications of the Micron Technology IS32 Optic RAM, a 64K-bit memory chip that has the extra talent of serving as a digital image detector.*

The Optic RAM Resembles Film

The operation of the digital image sensor can be compared to that of a black-and-white film emulsion in a conventional photographic camera. Like the film, the IS32 contains many light-sensitive elements lying in a single plane. The image is focused (optically) on the plane, the user can adjust the aperture (measured in f-stops) and the length of exposure. The aperture is an adjustment of the size of the opening through which the light is allowed to pass on its way to the light-sensitive medium (changed in both cases by mechanically opening or closing an iris). The length of exposure (corresponding to photographic shutter speed) is adjusted in the Optic RAM by the scanning function of the drive electronics. And in the Optic RAM, the film is advanced, so to speak, by refreshing the voltage on all the memory elements.

Also like film, the Optic RAM's elements respond to light in a binary fashion, indicating only black or white, the presence or absence of a certain amount of light during the exposure. However, in a photographic film, the light-sensitive elements (grains of silver-halide compounds) come in different sensitivities and respond to different intensities of light, whereas the IS32's cells all respond at about the same intensity for any given condition. To circumnavigate this limitation with the Optic RAM, varying shades of gray can be recorded by making multiple scans of the same optical image, averaging the results obtained from either changing the sensitivity of the cells, using a different threshold voltage for each scan, or varying the scan rate.

By changing the threshold voltage and keeping both the scanned image and light intensity constant, areas on the Optic RAM where intermediately bright portions of the image fall will give differing output levels. The nominal threshold potential, 2.1 volts (V), can be adjusted though pin 1 (Analog Threshold) on the IS32 from 1.5 V to 3 V, but Micron Technology suggests that gray-scale capability be achieved by varying the scan rate rather than by adjusting the threshold voltage. Changes will be exhibited in the response of the pixels where the image is gray (of intermediate brightness) so that the amount of light striking the cell capacitors is near the threshold voltage. Of course, a darker area of the image will generate more logic 1s as output than logic 0s, and a lighter area will generate more logic 0s. By averaging these outputs over a number of scans, the appropriate shade of gray can be produced in a composite image representation.

The Micro D-Cam may not contain a mechanical shutter, but its electronic equivalent is easily controlled by sending the appropriate commands to the control circuitry. The Optic RAM's sensitivity to light varies according to the electrical voltages present on it, allowing for precise continuous control of the Micro D-Cam's exposure values.

Ease of Use

Hooking up the Micro D-Cam to a computer is easy. The unit's control circuitry provides all the requisite timing signals and circuitry to execute commands received from the computer. The Micro D-Cam automatically sequences the Optic RAM so that each image-sensing cell is accessed and the appropriate video information transmitted to the computer for display or processing.

The Micro D-Cam uses a C-mount lens (the type commonly used in 16-millimeter movie cameras and small television cameras) with variable focus. The lens I chose was designed for viewing objects from a distance of at least 18 inches (45 cm); from this distance, the Micro D-Cam can distinguish characters of the size you are now reading. For viewing objects under greater magnification, you can insert a close-up adapter between the lens and its mount to extend the focal length of the lens. (See photo 2.)

The link between the computer and the Micro D-Cam is a TTL-(transistor-transistor logic) level serial interface. The external data-rate clock signal allows the computer to be synchronized to the Micro D-Cam, so the camera can operate at a speed of its own choosing.

Five lines run between the camera and the computer, carrying the transmit, receive, ground, and external clock signals and +5-V power. A general-purpose type-6850 ACIA (asynchronous communication interface

Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for each month's current article. Most of these past articles are available in reprint books from BYTE Books, McGraw-Hill Book Company, POB 400, Hightstown, NJ 08250.*

Ciarcia's Circuit Cellar, Volume I *covers articles that appeared in BYTE from September 1977 through November 1978.* Ciarcia's Circuit Cellar, Volume II *contains articles from December 1978 through June 1980.* Ciarcia's Circuit Cellar, Volume III *contains articles from July 1980 through December 1981.*

adapter) buffered chip performs serial-to-parallel and parallel-to-serial data conversion, mating the Micro D-Cam's nonspecific circuitry to the host computer, as illustrated by the Apple II Plus in this article.

Hardware Details: Timing, Refreshing, and Interrupts

The timing-generator circuit (see figure 1), which generates the timing signals for the operation of the Micro D-Cam, contains a CMOS (complementary metal-oxide semiconductor) oscillator circuit that generates the fundamental clock rate. This signal is divided down to produce the frequencies for various possible output data rates and controlling the IS32. The data-rate-clock signals control the sequence of operation of the interrupt generator and the transmitter circuit.

The oscillator circuit emits a fundamental 4.9152-MHz signal, which is buffered by a type-74C04 inverter section (IC20a). This clock signal is divided again by a type-D flip-flop and brought out to a set of data-rate-selection jumper connections. IC26 divides the frequency by increasing powers of 2; these various subharmonic outputs lead to other data-rate-selection jumpers. Jumper connections 5 through 8 select the data rate used in the transmitter and interrupt-generator circuit (figure 5 on page 28), while connections 1 through 4 are 16× clock signals used in the receiver circuit. The output of IC26's pin 7 drives the Optic RAM's timing circuitry, which generates the familiar $\overline{RAS}$ (row-address strobe), $\overline{CAS}$ (column-address strobe) and $R/\overline{W}$ (read/write) signals as used by most dynamic RAM chips.

When the camera is transmitting data from the Optic RAM, it is in the interrupt mode, and the $\overline{CAS}$ and $R/\overline{W}$ signals are provided to the Optic RAM. When the camera is not transmitting, the interrupt mode is off, and $\overline{CAS}$ and $R/\overline{W}$ are disabled; the active-high interrupt signal INT is low and its complement $\overline{INT}$ is high, so the output of the AND gate driving $\overline{CAS}$ remains high and the OR gate driving $R/\overline{W}$ remains low.

During an interrupt cycle, INT goes high and $\overline{INT}$ goes low, enabling $\overline{CAS}$ and $R/\overline{W}$. The high state of $\overline{RAS}'$ (RAS-bar-prime) passes through a delay line consisting of two inverter sections (IC20d and f) and an R/C (resistance/capacitance) network, and then, combined with INT through an AND gate (IC9c), causes $\overline{CAS}$ to go high. When this happens, the column address is latched into the Optic RAM. At this time the $R/\overline{W}$ signal is still high, so the value stored in the accessed pixel is read out. After another delay period, $R/\overline{W}$ goes low, writing a 1 bit into the accessed cell to restore its charge and make it again able to react to light. When $\overline{RAS}'$ returns low, the interrupt cycle is terminated and $\overline{CAS}$ and $R/\overline{W}$ are disabled.

Command-Receiver Circuit

The serial command line carries commands from the computer to the camera. This data enters the command-receiver section (figure 2) a single bit at a time and is assembled according to the following protocol. The first bit to arrive is the start bit, followed by 8 data bits and then the stop bit. The start bit enables operation of the input shift register and starts the shift-register clock, which is initially low. When the clock goes high, the start bit, always a high level, is latched into the first of eight data positions in the shift register. When the clock goes low, the first data bit arrives at the shift register's input.

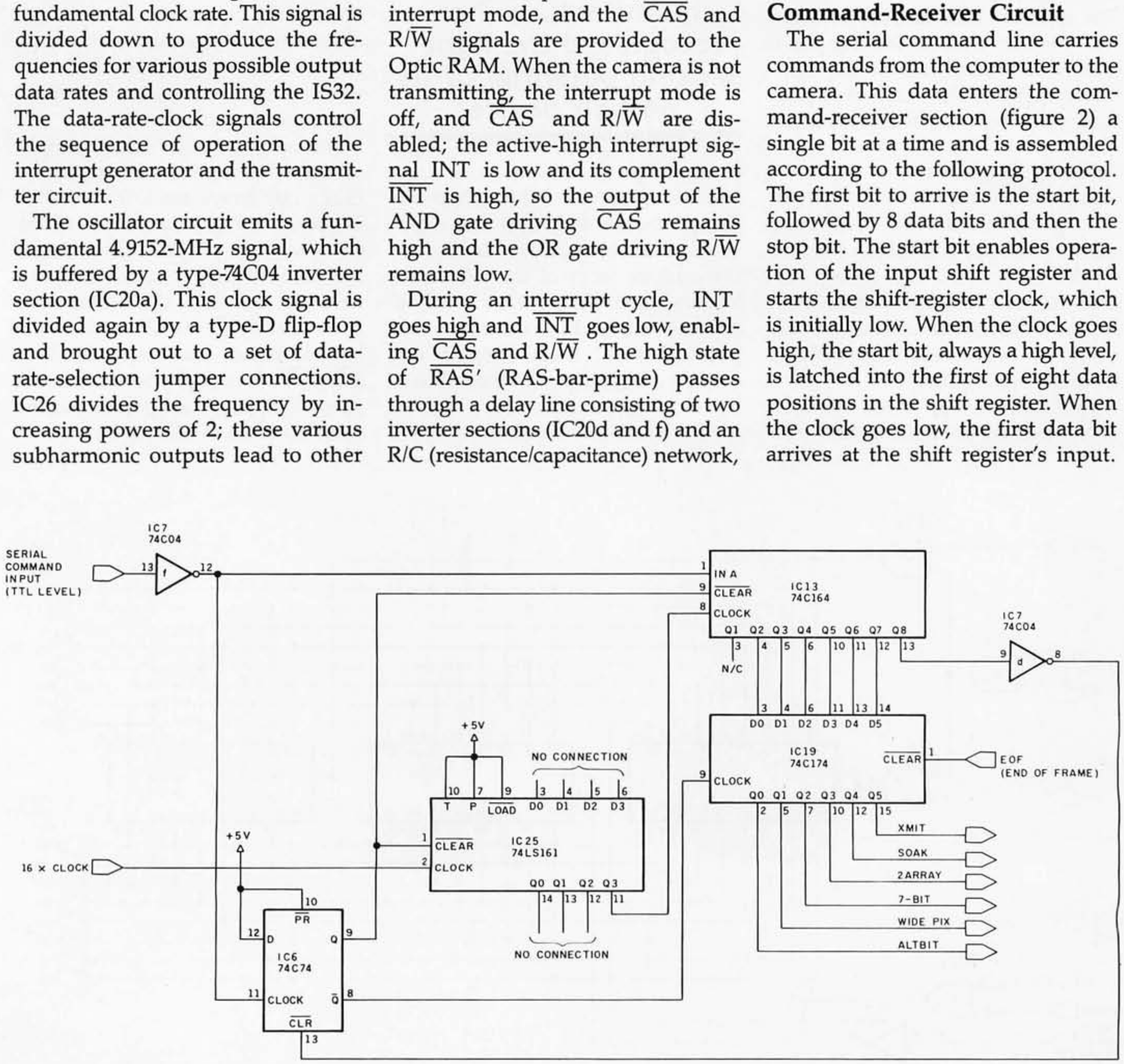

Figure 2: *The serial command line carries commands from the computer to the camera. The data enters the command-receiver section serially and is assembled by the shift register into a decodable word stored in the latch.*

When the rising edge of the clock pulse is detected, the shift register moves the high start bit from position 1 to position 2 and shifts the first data bit from the shift register's input into position 1. As successive bits arrive, each one is shifted into the shift register when the rising edge of the clock pulse is detected.

When the start bit finally reaches position 8, the camera has received the entire command byte, so the first 6 data bits are transferred from the shift register into a latch (a 1-byte memory) called the *command register*. The clock is then disabled and the shift register cleared, leaving the 6 camera-command bits in the command register. The receiver is now ready to accept another command.

Address Registers

The address registers of the circuit (see figure 3) latch the row-address, column-address, and refresh pointers for the Optic RAM addressing. Address registers IC22 and IC16 hold the row and column addresses, respectively, while the third register, IC10, is the *refresh register*.

The first two registers are activated only when the camera is to fetch and transmit a single bit of information from the Optic RAM. (This fetch operation is the interrupt cycle, which, as we saw before, is initiated by the INT signal going high.) The cycle starts on the occurrence of the falling edge of the $\overline{\text{RAS}}$ signal and ends on the next falling edge of $\overline{\text{RAS}}$. When the camera is not fetching in an interrupt cycle, the refresh register is active. This third address register

An unconventional dynamic-RAM manufacturer has recognized the light-sensing potential of its 64K-bit device.

continually increments the row-address value from 0 through to 255. Except during interrupts and exposures, this value passes through to the address lines of the IS32, performing a refresh operation. All three address registers have three-state outputs (that is, their outputs can assume a high-impedance condition, not driving the bus either high or low), and only one register is active at any one time.

The selected register drives its data onto a common bus called the *present-address* bus. The present address passes through the descramble-and-soak circuitry (which will be discussed shortly) to the Optic RAM, where it is used to select a row or column. The present-address bus also connects to the address circuit, where a value of 0, 1, or 2 (depending upon software-selected options) is added to the present-address value. The resulting sum is driven out of the adder onto the *next-address* bus, which connects to the inputs of each of the address registers. The value on the next-address bus is latched into the selected address register, and then that register is disabled.

The array-selection circuit simply selects whether one or both of the IS32's cell arrays are to be used. If $\overline{\text{2ARRAY}}$ is high, the output of the OR gate (IC21, pin 11) is always high, and the row-register value (IC22) will never be less than 128, so only the second array (rows 128 to 255) will be addressed and transmitted. If $\overline{\text{2ARRAY}}$ is low, however, the OR gate will appear transparent and the value on the next-address-bus line D7

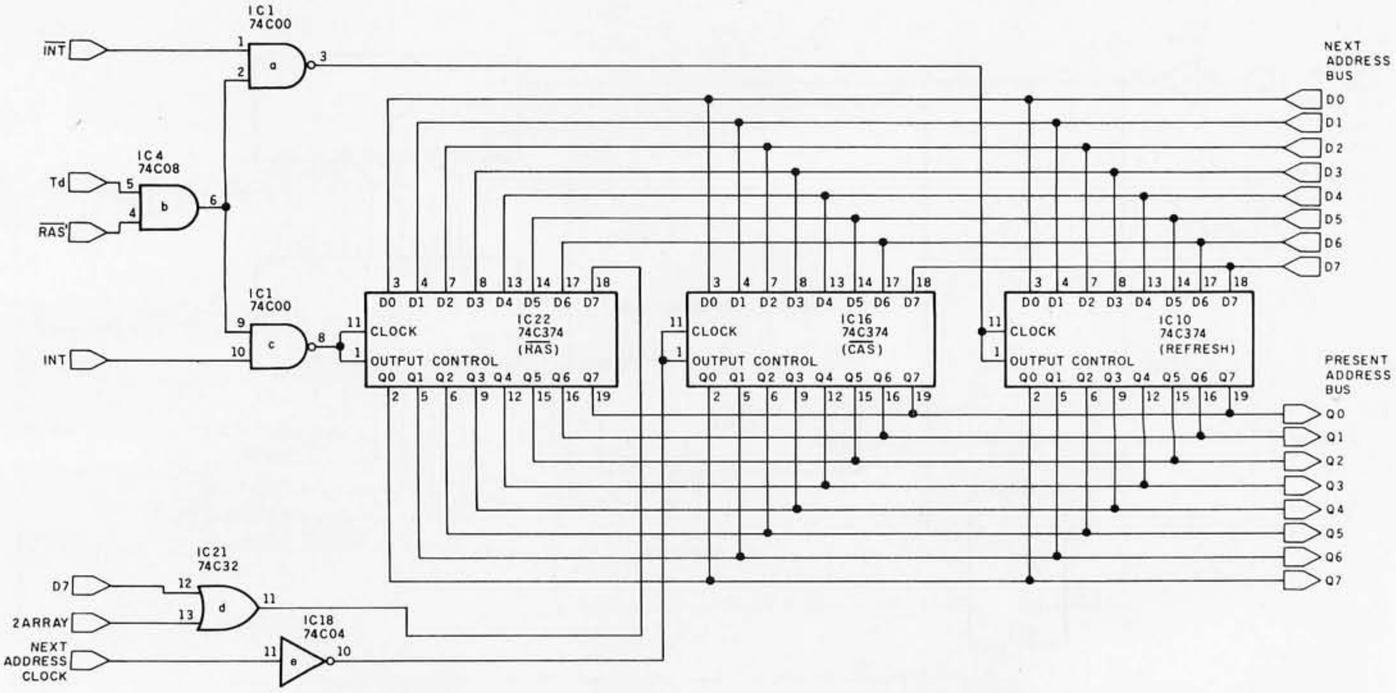

Figure 3: *This section of the circuit latches the row-address, column-address, and refresh pointers for the Optic RAM addressing. Address registers IC22 and IC16 hold the row and column addresses, respectively, while the third register, IC10, is the refresh register.*

will be driven onto IC22. This means all addresses from 0 to 255 will be selected and the values in both arrays will be transmitted.

Address Descramble and Array Soak

The internal circuitry in the Optic RAM scrambles the row and column-address values when accessing a cell. (After all, the IS32 chip was designed for use only as a memory device, not as an optical sensor.) But because element location is a critical issue in optical work, the address-descramble circuit (see figure 4, below) unscrambles the values into a new address, which the Optic RAM decodes to access the desired pixel.

Charged with the task of transforming the data from the address registers into a new address, which the Optic RAM decodes to access the desired pixel, the descrambling circuit consists of two inverters, three exclusive-OR gates, and a multiplexer (IC11). The inverters and exclusive-ORs do the actual descrambling on the row and column addresses; the multiplexer selects between the descrambled row and column addresses at the appropriate times and transmits the address to the Optic RAM.

The multiplexer uses $\overline{RAS}$ to determine which address is selected. If $\overline{RAS}$ is low at the multiplexer's SELECT input (IC11, pin 1), the descrambled row addresses (on the B inputs) are selected. When $\overline{RAS}$ is low, the A inputs, or descrambled column-address inputs, are selected.

The purpose of the $\overline{SOAK}$ circuit is to prevent the refresh addresses from reaching the Optic RAM during the exposure cycles. (Remember, the Optic RAM is light-sensitive only when it is not being refreshed.) During periods when INT is inactive-low (with the refresh register therefore active) and $\overline{SOAK}$ is active-low, the

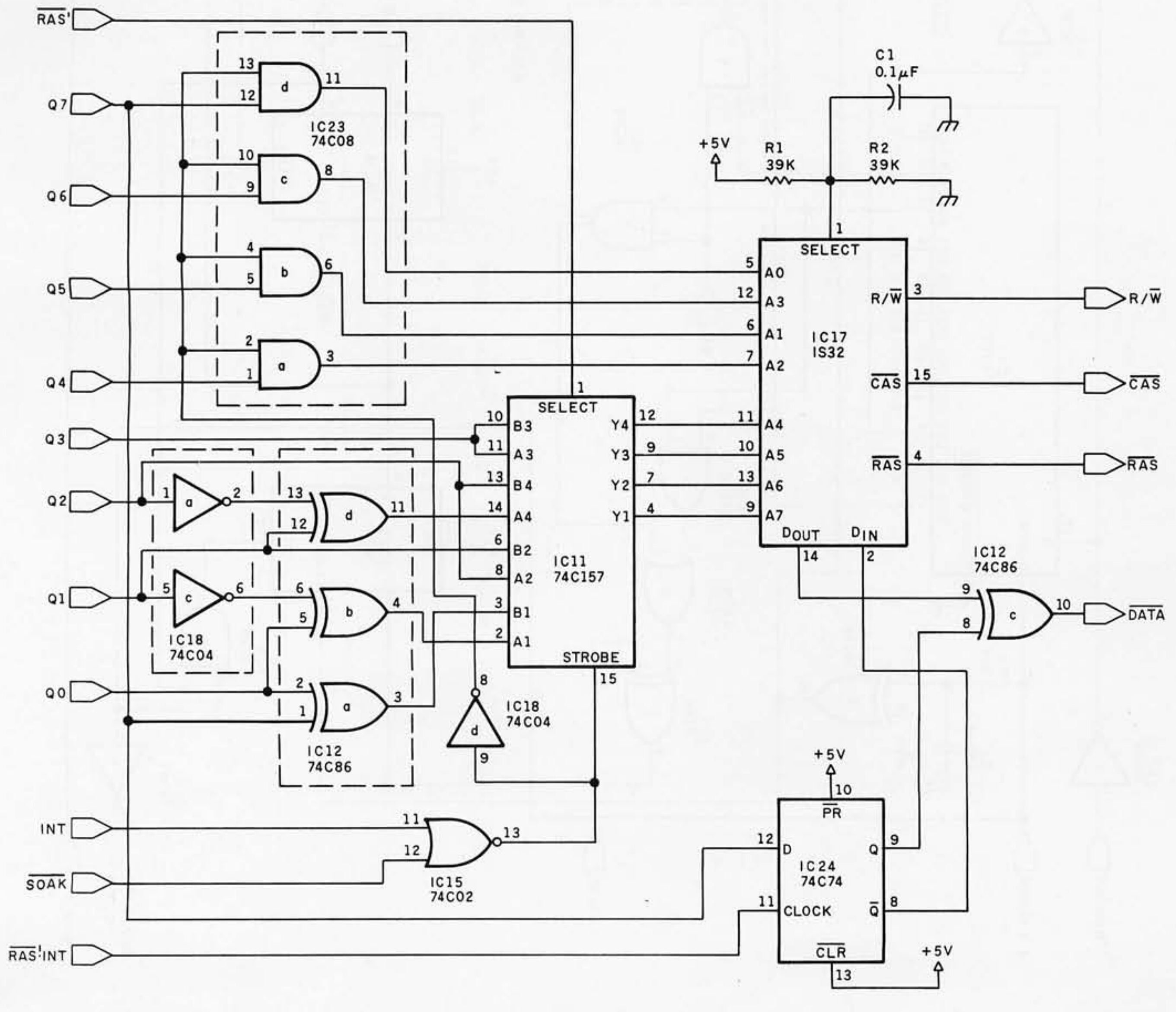

Figure 4: *Consisting of two inverter sections, three exclusive-OR gates, and a multiplexer, the address-descrambling circuitry undoes the internal address scrambling done by the Optic RAM. The soak circuit makes the Optic RAM light-sensitive by depriving it of refresh cycles.*

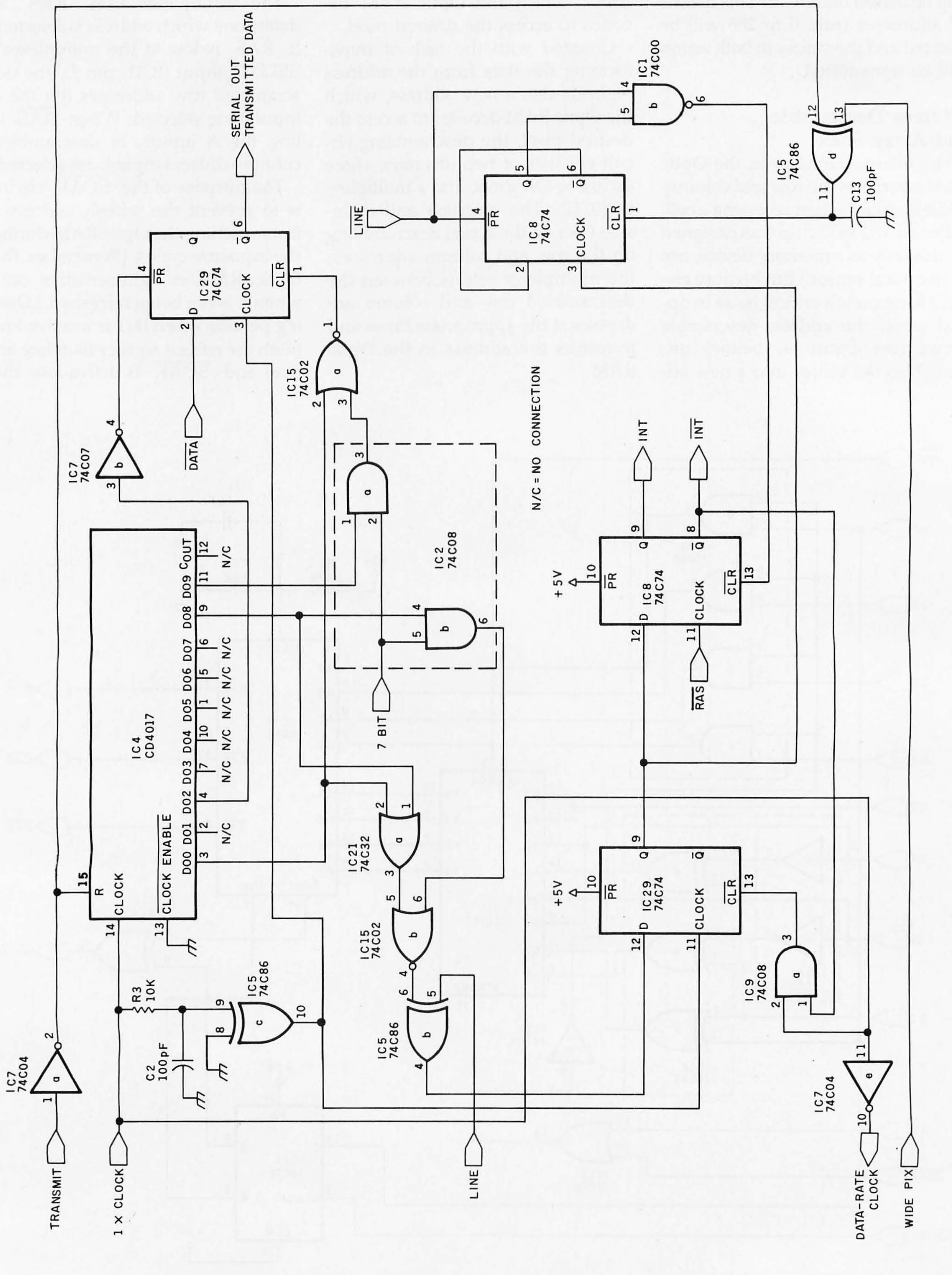

Figure 5: *The circuitry for transmitting the pixel data to the host computer and for generating the interrupt states that allow data to be read from the pixels in the IS32.*

output of NOR gate IC15d is high. This sets the multiplexer's enable input high and drives the multiplexer's outputs low. The high NOR-gate (IC15d) output also forces a low state at the inverter output IC18d, which forces the outputs of the four AND gates IC23a, b, c, and d low. These AND gates stand between the present-address bus and the IS32's four low-order address inputs. Thus, the Optic RAM's address inputs remain low, and the refresh function is performed on only address 0. When $\overline{\text{SOAK}}$ goes inactive-high, the multiplexer and AND-gate outputs are enabled and the refresh addresses reach the Optic RAM so that the entire chip is refreshed, making it insensitive to light.

Transmitter and Interrupt-Generator Circuit

This circuit, shown in figure 5, transmits the pixel data serially to the host computer, inserting start and stop bits where appropriate, and generates the INT and $\overline{\text{INT}}$ signals for fetching the pixel information from the IS32.

At the heart of this circuit is the ripple counter, IC4, enabled when the Micro D-Cam has been commanded to transmit data. It inhibits the interrupt generator when start and stop bits are being transmitted (preventing accessing of the Optic RAM) and enables the interrupt circuit when it is transmitting data. The transmitter's frequency is determined by the data-rate clock. During each clock cycle only one start, stop, or data bit is transmitted.

The interrupt generator is enabled by both the ripple counter (IC4) and the data-rate clock, but the interrupt cycle itself is clocked by $\overline{\text{RAS}}$. Because the purpose of the interrupt cycle is to fetch a single pixel for transmission, only one pixel can be transmitted on each clock cycle. The rising edge of the data-rate clock enables the interrupt circuit. The next falling edge of the $\overline{\text{RAS}}$ waveform initiates the interrupt cycle, causing a pixel to be read from the Optic RAM. The $\overline{\text{INT}}$ signal feeds back into the interrupt circuit, resetting the interrupt enable.

When $\overline{\text{RAS}}$ goes low again, the interrupt cycle is terminated. The next falling edge of the data-rate clock enables the interrupt circuit again (unless a start or stop bit is to be transmitted). Thus, only one pixel is transmitted during each data-rate-

The output of the Micro D-Cam is a digital signal; it cannot be used to directly drive a composite-video monitor.

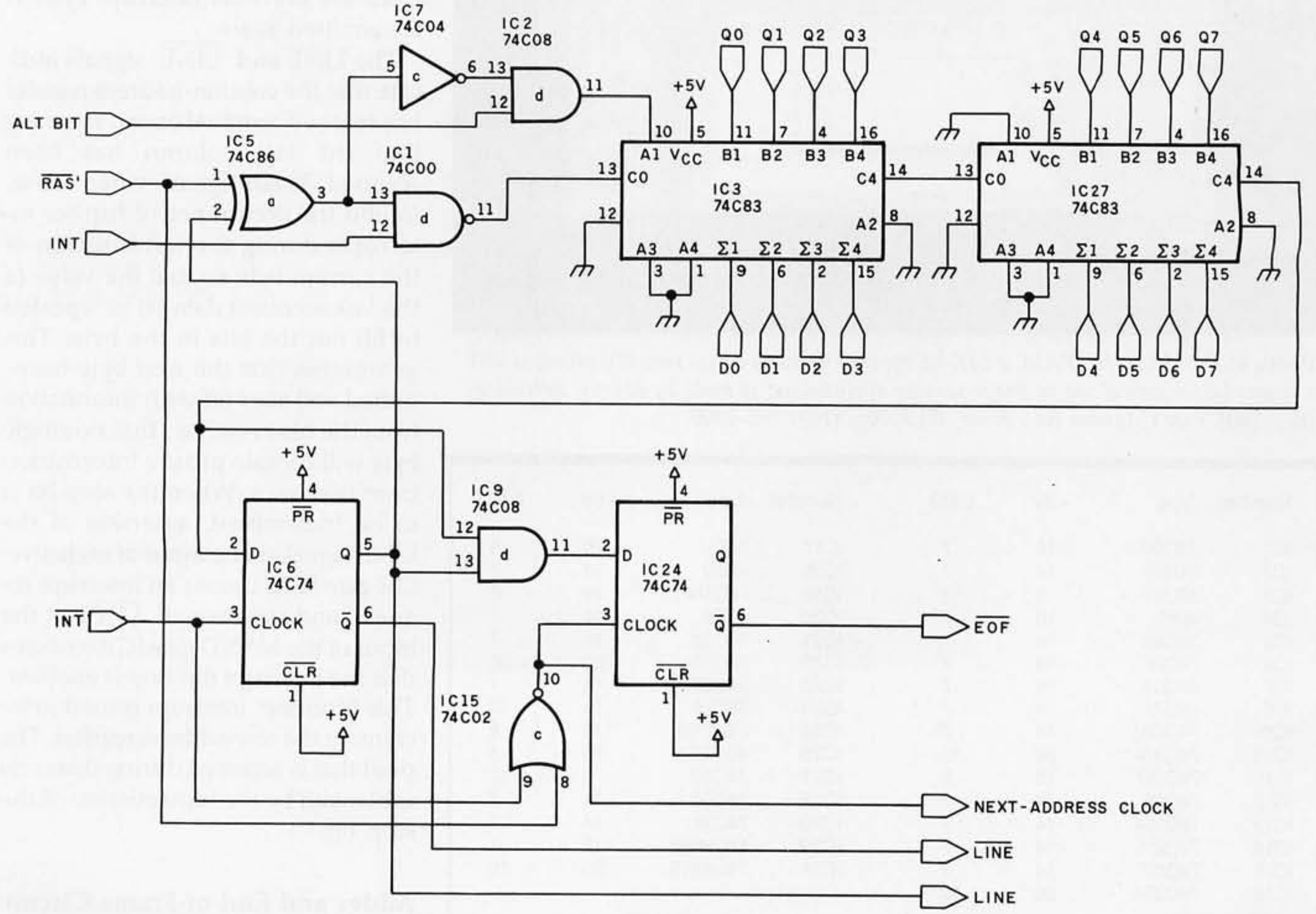

Figure 6: *The adder circuit allows the Micro D-Cam to keep track of the proper values for the row, column, and refresh registers.*

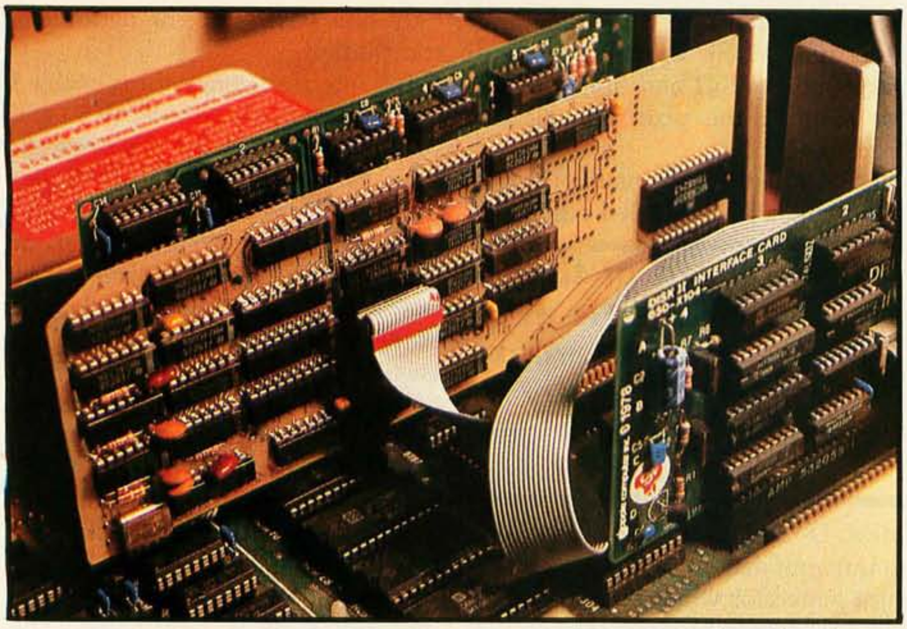

Photo 3: *The control circuitry for the Micro D-Cam image camera is shown here in prototype form mounted in an input/output slot in an Apple II Plus computer.*

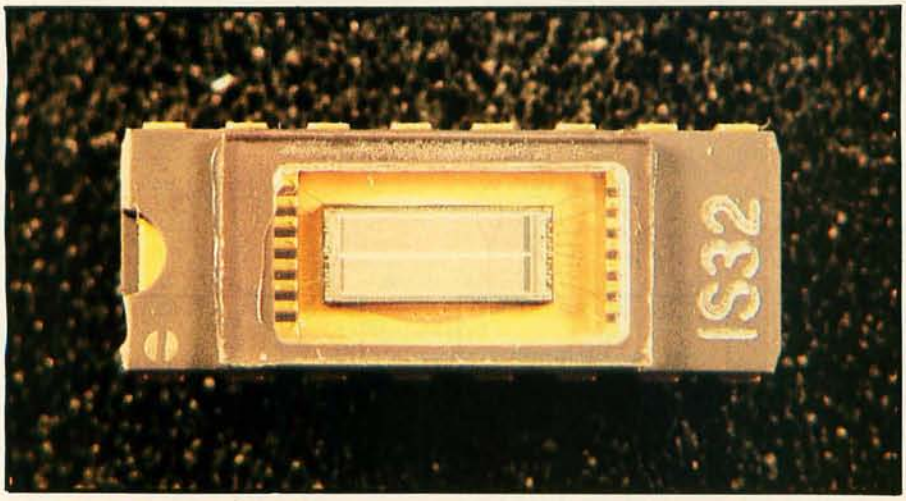

Photo 4: *The IS32 Optic RAM, a 64K-bit dynamic memory device specially packaged with a quartz lid for optical use in image-sensing applications, is made by Micron Technology Inc., 2805 East Columbia Rd., Boise, ID 83706, (208) 383-4000.*

Number	Type	+5V	GND	Number	Type	+5V	GND
IC1	74C00	14	7	IC17	IS32	16	8
IC2	74C08	14	7	IC18	4069	14	7
IC3	74C83	5	12	IC19	74C174	16	8
IC4	4017	16	8	IC20	4069	14	7
IC5	74C86	14	7	IC21	74C32	14	7
IC6	74C74	14	7	IC22	74C374	20	10
IC7	74C04	14	7	IC23	74C08	14	7
IC8	74C74	14	7	IC24	74C74	14	7
IC9	74C08	14	7	IC25	74LS161	16	8
IC10	74C374	20	10	IC26	4040	16	8
IC11	74C157	16	8	IC27	74C83	5	12
IC12	74C86	14	7	IC28	74C00	14	7
IC13	74C164	14	7	IC29	74C74	14	7
IC14	74LS74	14	7	IC30	MC6850	12	1
IC15	74C02	14	7	IC31	74LS245	20	10
IC16	74C374	20	10				

Table 2: *Power wiring for integrated circuits in the Micro D-Cam.*

clock cycle.

The WIDEPIX circuit is used to help compensate for the mismatch in aspect ratios of the Optic RAM and most computer graphics screens. The Optic RAM has a ratio of 2.5:1, compared with the 4:3 aspect ratio of most cathode-ray-tube (CRT) displays, and the pixels are not square. If the image data is displayed on a screen with an aspect ratio that close to 1:1, the image will appear to have been squeezed horizontally. The WIDEPIX circuit helps compensate for this by causing each pixel to be transmitted twice, doubling the width of the image. The circuit is enabled when the Micro D-Cam is transmitting and the WIDEPIX command line is high. This causes the flip-flop IC8a's output to toggle on every data-rate-clock cycle. This flip-flop inhibits the interrupt cycle on alternate data-rate clock cycles. During data-rate-clock cycles in which the interrupt is inhibited, the pixel from the previous interrupt cycle is transmitted again.

The LINE and $\overline{\text{LINE}}$ signals indicate that the column-address register has reached terminal count, meaning that the last column has been scanned. These signals, when active, inhibit the occurrence of further interrupts during the transmission of the current byte so that the value of the last accessed data bit is repeated to fill out the bits in the byte. This guarantees that the next byte transmitted will start off with information from the next row, i.e., that no single byte will contain picture information from two rows. When the stop bit is to be transmitted, assertion of the LINE signal at one input of exclusive-OR gate IC5b causes an interrupt request, and assertion of $\overline{\text{LINE}}$ at the input of the NAND gate IC1b ensures that the interrupt flip-flop is enabled. This "dummy" interrupt is used to increment the row-address register. The pixel that is accessed during this cycle is blanked by the transmission of the stop bit.

Adder and End-of-Frame Circuit

The adder and end-of-frame section, shown in figure 6, adds the

proper increments to the row, column, and refresh registers and generates signals indicating end-of-frame (EOF) in the Optic RAM.

When any one of the address registers drives a value onto the present-address bus, the adder circuit receives this value, adds a 0, 1, or 2 to it (depending on the control inputs $\overline{RAS}$, LINE, ALTBIT and INT), and places the sum onto the next-address bus. When the refresh register is active, the INT line causes a 1 to be added each cycle. During interrupt cycles, the row and column registers are active. The adder sequences these registers through the Optic RAM in a "column-fast" mode, i.e., the adder adds 0 to the row address and 1 to the column address until the end of the column (or end of the line) is reached. The adder then adds a 1 to both the row and column, thus incrementing the row register and resetting the column register to 0.

The ALTBIT input simply adds an extra 1 to the value on the present-address bus during interrupt cycles; thus the row and column registers are incremented by a total of 2 rather than 1.

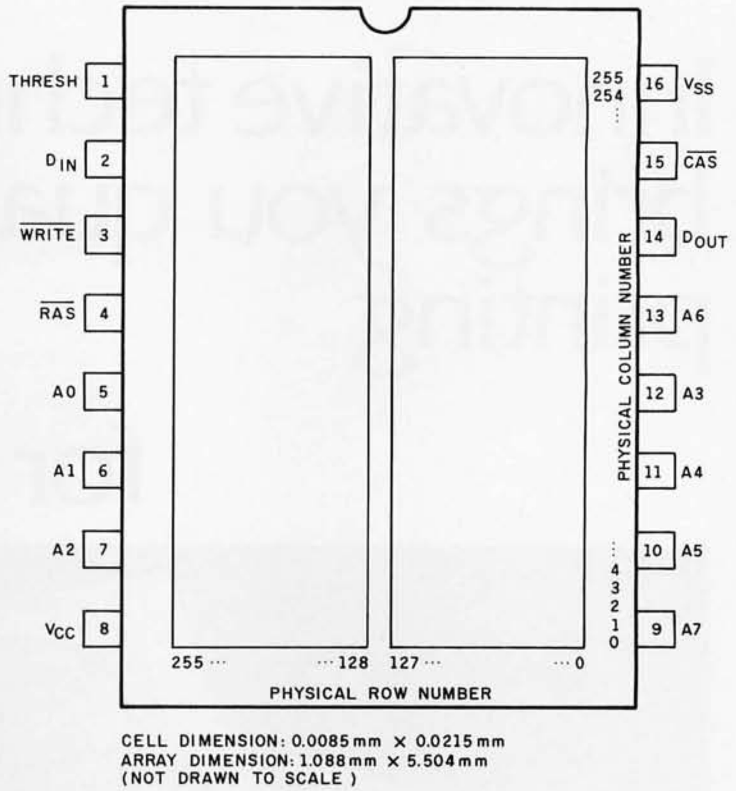

Figure 7: *A diagram of the topology and pinout configuration of the IS32 Optic RAM (not to scale). Each of the two cell regions, visible through the quartz package lid, contains a 128-by 256-cell array.*

Control and Use

The software routines that control the Micro D-Cam are menu-driven. While the camera is running, several real-time commands are available to alter the operation of the camera from frame to frame. The real-time options are displayed on the screen.

When the camera is first turned on, you start the image-gathering process by selecting one of the options from the menu offered by the software, which I'll discuss in detail next month. If everything is working properly, an image of what the Micro D-Cam is seeing is shown on the computer's video-display screen. If the display screen remains dark, the exposure interval may be insufficient; this situation may be remedied by increasing the exposure time. If the exposure time is excessive, the screen will be white. This situation may be remedied by decreasing the exposure time or changing the aperture on the lens. Eventually, a clear picture will appear on the computer's screen as you reach the proper adjustments.

Next Month:

In part 2, we'll look at the software you'll need to read the Micro D-Cam's images, including a complete listing for the Apple II Plus, and I'll explain the computer interface and how the Micro D-Cam communicates with its user. ■

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Special thanks to Carl Baker and Jim Herrud of Micron Technology for their contributions to this project.

To receive a complete list of Ciarcia's Circuit Cellar project kits, circle 100 on the reader service inquiry card at the back of the magazine.

The following items are available from:
The Micromint Inc.
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   Complete kit $260
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   IS32 each $42
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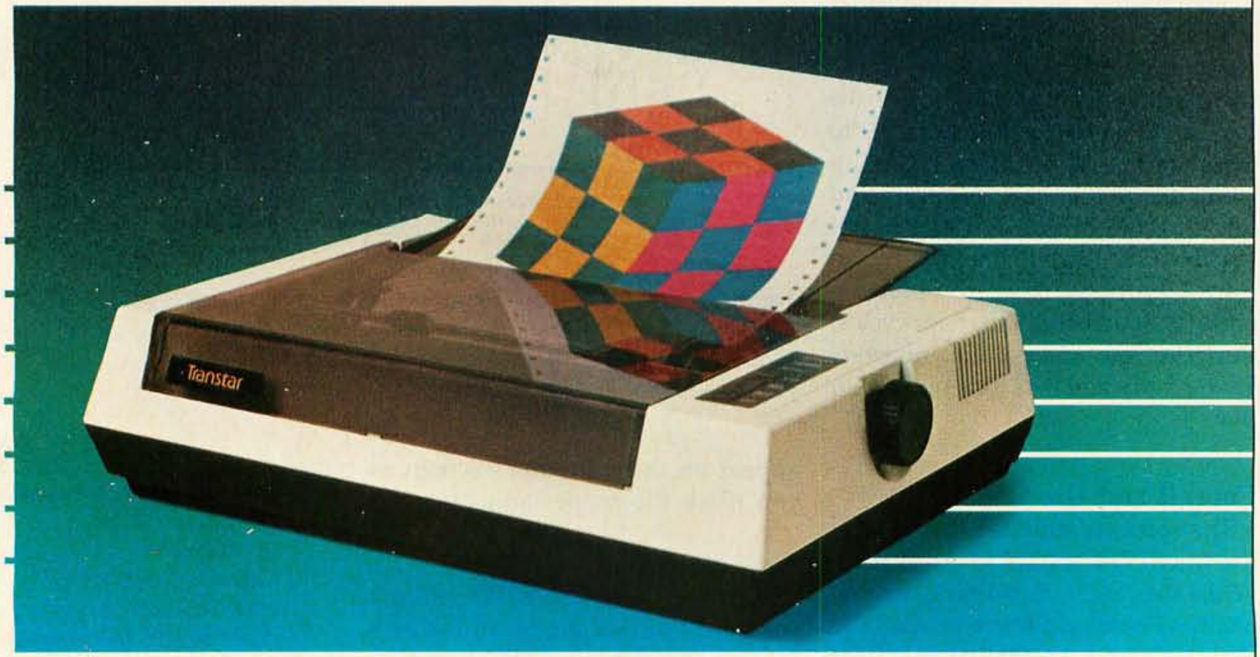

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Computing on the Run

Portable computers are definitely the wave of the future. Incorporating new design concepts, innovative hardware, and easy-to-use software, these diminutive machines are bound to change the way we think about computers. This month's theme articles will take you on a guided tour of the industry, the main features portables offer and how to choose from among them, and the computers themselves.

Practically every major computer manufacturer has introduced, has plans for, cr is in the process of introducing a portable computer. Not a month goes by that BYTE doesn't get wind of a new portable computer system. According to the Venture Development Corporation's report, "The Portable Briefcase Computer and Terminal Industry, 1982-1987: A Strategic Analysis," portable computer sales are expected to reach more than $4 billion by 1987. That figure is just for briefcase and transportable computers; it doesn't include hand-held computers.

This plethora of portables gives buyers more computing power and convenience for their money than ever before. But it also means that selecting a portable computer for personal or business use is more involved than ever. Each manufacturer has a different design philosophy for producing a portable. Sorting through the number of features and options available on the portables makes selecting the right one for your needs even more difficult than choosing a desktop computer.

This issue will help to eliminate some of the confusion surrounding portable computers. In addition to Mahlon Kelly's analysis of the Radio Shack Model 100, we'll take a look at the Pied Piper, a briefcase CP/M system; the powerful HP-75; and the Access Matrix portable, which some disparagingly refer to as the "Swiss army knife" of portables, while others swear by its conveniently built-in printer and acoustic modem. We also review the Kaypro II and its big brother, the Kaypro 10, with its built-in 10-megabyte hard disk; you'll see why these portables are giving the Osborne a run for its money. The Corona Portable PC, which comes under one reviewer's scrutiny, is described as an IBM-compatible portable that goes beyond being a mere clone.

In addition to system reviews, this issue offers in-depth views of the larger issues that affect the portable marketplace. A comprehensive article on CMOS technology explains how improvements in chip-fabrication technology have brought down the price of CMOS RAMs. The problems of moving delicate equipment are addressed in "The Challenge of Hard Disk Portability." To top off the issue, you can read about how the designers of the new Gavilan portable computer decided on which features to include in their computer.

To start you off, the article that follows offers a general overview of the portable field and covers some of the major features of portable computers, their pros and cons, and how to choose the portable that best suits your needs. The Portable Computer Comparison Table starting on page 36 lists the latest portables available and their specifications.

—Stanley J. Wszola

How to Choose a Portable

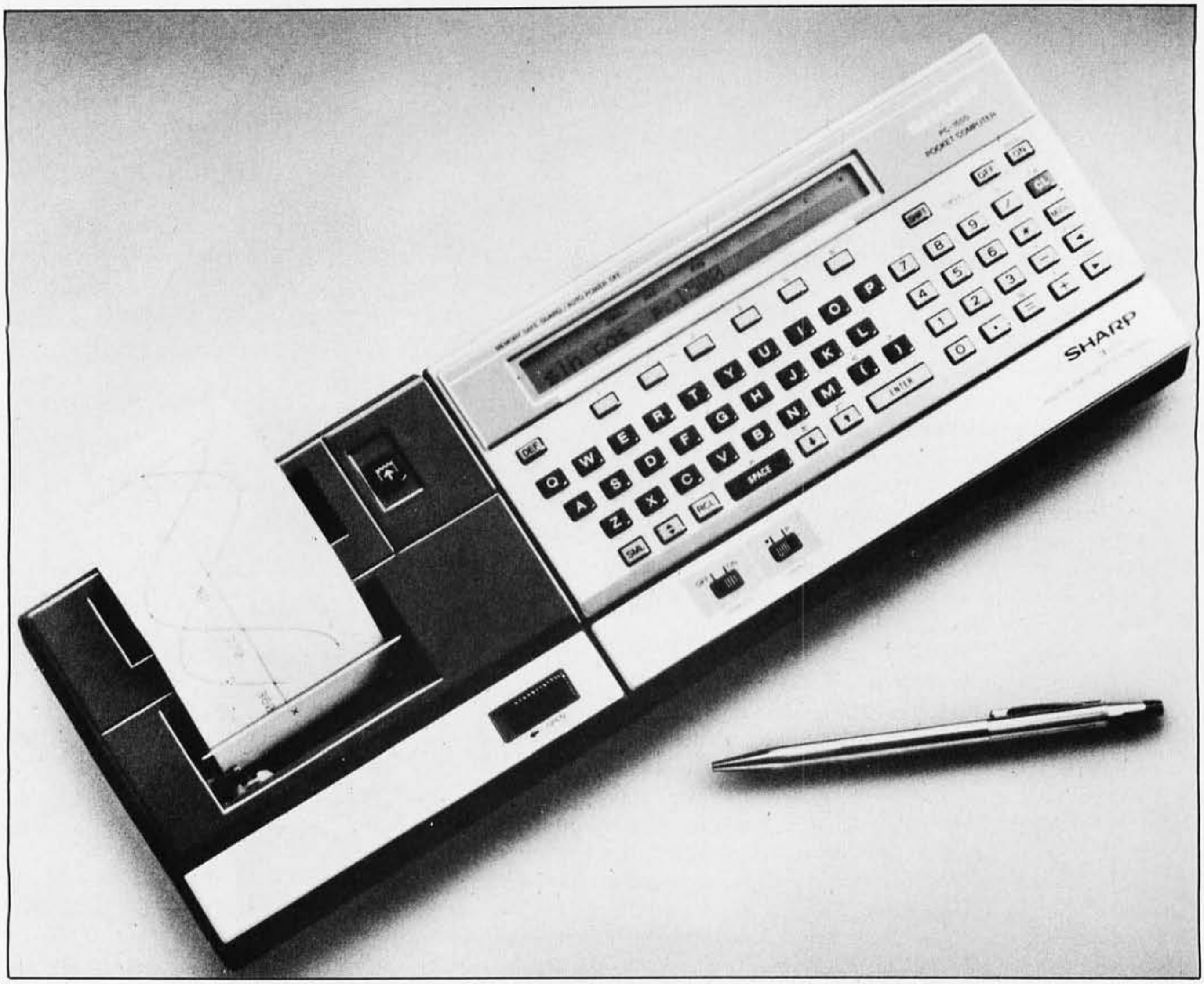

Photo 1: *The Sharp PC-1500 is a typical pocket computer.*

Factors to consider before you take the plunge

by Stanley J. Wszola

Just a year and a half ago the Osborne 1 portable microcomputer had no competitors. Today at least 50 portables fight for a share of the market, and new machines are announced almost daily.

There's definitely something going on out there, and it bodes well for the consumer. Manufacturers, trying to outdo the competition, are offering better, more powerful, and more attractive portable computers. It's the free market at its best. The only problem with this abundance of portables is that buyers often don't know where to begin. To that end, we'll start with an explanation of what a portable computer is and then explore its various components. While that won't tell you which portable to buy, it will provide some signposts to help you make an informed choice. (For a directory of portable computers, see table 1.)

The sudden appearence of portable computers results from a convergence of technologies. Many features found on portable computers have been used and refined on products such as digital watches and pocket calculators. In addition, the products of the years of research and development that went into creating today's desktop microcomputer have finally come together in the portable computer. What we have is reliable hardware and proven software in a machine that can be shuttled easily from office to home or wherever. Por-

table computer users include business people who like the flexibility of working at home or on the road, scientists and engineers who take their portables into the field for on-site computer applications, and people who simply like to take their computing power with them.

What Is a Portable?

A portable computer is, of course, a computer first and foremost. It must have a central processing unit, memory, a method for data entry, a device for or method of displaying data output, and usually a means of storing data.

A portable computer must be easy to carry from place to place. Don't confuse "portable" with "transportable." Any computer can be transportable if you have a big enough truck. For the purposes of this article, a portable computer is one that can be carried by one person—but not necessarily easily carried. Currently, portable computers can be divided into three rough categories:

Pocket computers: These can be characterized as pocket-size, battery-powered, lightweight computers with a 1-line display, limited memory (0.5 to 10K bytes), and usually BASIC in ROM (read-only memory). Most use cassette tape for data storage. The keyboards on these computers are not suitable for touch-typing, and the 1-line display is adequate only for simple programming. Many of these computers can accept accessories (i.e., printers, serial- and parallel-port interfaces, and modems) to increase their usefulness. A good example of an adaptable pocket computer is the Sharp PC-1500 pictured at left.

Briefcase computers: As the name implies, these computers are small enough to be placed in a briefcase. They usually have a 4- to 8-line display, a full-size keyboard, provision for increasing internal memory, serial and/or parallel ports, and AC or battery power. Most briefcase computers feature BASIC in ROM, and some include applications programs for word processing, telecommunications, and appointment scheduling. Data storage can involve micro- or full-size cassette tapes, auxiliary floppy-disk drives, or bubble and CMOS (complementary metal-oxide semiconductor) memory cartridges. Most have full-size keyboards that are suitable for touch-typing. Their light weight (5 to 10 pounds) and small size let you use them almost anywhere. One example of a briefcase computer is the Radio Shack Model 100.

Transportable computers: These are the heavyweights of the portable-computer field in terms of size, weight, and capabilities. I've used the term transportable because some so-called portable computers are nothing more than a boxed desktop computer with a handle on top. Most are the size of a small suitcase, weigh 15 to 40 pounds, and usually have a CRT (cathode-ray tube) display with one or more floppy-disk drives. Most use CP/M-80 or CP/M-86 and MS-DOS operating systems. These computers can do anything the desktop models can do, but their portability is limited by the necessity for AC power or a heavy battery pack. The Osborne Executive is a transportable computer.

Any computer can be transportable if you have a big enough truck.

Power Sources

The growing use of low-power CMOS RAM (random-access read/write memory) chips and CMOS microprocessor chips, such as the 80C85 used in the Radio Shack Model 100, has decreased dependency on AC power sources. Battery-powered portables can be used almost anywhere. But batteries can be a curse as well as a blessing; they add overall weight to the package and always run out just when you need them most.

Most portable computers can run from 2 to 10 hours before they need a recharge. Battery life depends on the power requirements of the computer, the length of time it has been operating, and the rating of the battery. Some portables have low-voltage indicators to alert you when the batteries run low. The transportable models are more power hungry than the smaller portables. The CRT and the disk drives in the transportables require a lot of energy.

Some briefcase computers use CMOS memory chips and an auxiliary nickel-cadmium battery to preserve data in memory if the main batteries fail. For example, the nickel-cadmium batteries in the Model 100 can maintain data for 8 to 30 days, depending on how much memory the computer has. This gives you an extra margin of safety if you are unable to replace or recharge the main batteries right away.

Many transportable computers have auxiliary battery packs as options. Of course, you still face the problem of carrying the batteries as well as the computer. Finally, some manufacturers offer an optional auto adapter, which lets you plug your computer into your car's cigarette lighter. They recommend using the computer with the engine off to eliminate lost data due to voltage spikes and surges. That's just as well; you don't want to be downloading a program and downshifting at the same time.

Video Displays

The new portables use one of three types of displays: CRT, LCD (liquid-crystal display), or ELD (electroluminescent displays). CRTs have been around for a long time and are a proven medium. LCDs, although limited in their ability to display graphics, are lightweight and don't consume too much power. The newer ELDs have the same display capabilities as CRTs with an extra advantage—their flat shape makes them ideal for use in portables. I'll explain each in detail.

The most commonly used display for portable computers is the reliable, flexible, and easy-to-use CRT. Most users are already familiar with it. Its primary disadvantages are a bulky shape and high power consumption. The CRT itself, a large, fragile glass tube, must be protected from harsh environments and airport baggage handlers.

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Manufacturer/Location Model	Size (Inches)	Weight	Power Supply	Price	Type of Microprocessor
Access Matrix Corp. San Jose, CA Access	16.5 by 10 by 10.8	33 lbs.	AC	$2495	Z80A
Adcock Johnson Fort Worth, TX Model 3000 (TRS-80 Model III in a briefcase)	19½ by 14½ by 8½	28 lbs.	AC	$2895	Z80A
Athena Computer and Electronics Systems San Juan Capistrano, CA Athena I	3⅜ by 11⅞ by 14½	15 lbs.	batteries or AC	$3950	NSC-800 (low-power Z80)
Casio Inc. Fairfield, NJ Model FP-200	12½ by 2¼ by 8⅘	4 lbs.	batteries or AC	$499	proprietary
Casio Inc. Fairfield, NJ Model FX-700P	6½ by 2⅜ by ⅜	4.2 oz.	batteries or AC	$99.95	proprietary
Casio Inc. Fairfield, NJ Model FX-801P	6⅞ by 3½ by ¾	9.1 oz.	batteries or AC	$149.95	proprietary
Columbia Data Products Inc. Columbia, MD Columbia VP	18 by 16 by 8	32 lbs.	AC	$2995	8088
Commodore Business Machines Wayne, PA Executive 64	14½ by 14½ by 5	27.6 lbs.	AC	$995 to $1495	6510 (optional Z80 for CP/M)
Compaq Computer Corp. Houston, TX Compaq Portable Computer	20 by 15⅓ by 8½	28 lbs.	AC	$2995	8088
Computer Devices Inc. Burlington, MA DOT 3000B	18 by 14¾ by 7½	31 lbs.	110 or 220V AC (optional battery pack)	$4344	8088
Compal Beverly Hills, CA Electric Briefcase	9 by 20 by 15	26 lbs.	AC	$1995	Z80A
Computershop Cambridge, MA STAR-Lite	16 by 16 by 7½	34 lbs.	AC	$2695	Z80A
Computer Systems St. Clair Shores, MI PC/8088	19 by 16 by 7½	25 lbs.	AC (optional 12V DC battery-power supply)	$3388	8088
Corona Data Westlake Village, CA Corona Portable PC Models PPC-1 and PPC-2	20 by 20 by 8	30 lbs.	AC	$2395	8088
Digital Microsystems Oakland, CA DMS-3/F Fox	17½ by 14¾ by 7¾	30 lbs.	110 or 220V AC	$3995	Z80A
Digital Microsystems Oakland, CA DMS-15	17½ by 14¾ by 7¾	36 lbs.	110 or 220V AC	$7495	Z80A

Table 1: *The portable computer comparison table.*

Operating System	RAM Memory Min./Max.	Mass Storage Type, Size	Display Type, Size	Color or Graphics	Software Included	Comments
CP/M-80	64K	2 5¼-inch floppy-disk drives	7-inch CRT, 80 characters by 24 lines	n.a.	Perfect Series and Fancy Font	
TRS-DOS 1.3	48K min., 64K max.	2 5¼-inch floppy-disk drives	9-inch CRT, 64 characters by 16 lines	n.a.	n.a.	
CP/M-80	68K	1 megabyte RAM disk, optional 5¼-inch floppy-disk	LCD, 80 characters by 4 lines	n.a.	JRT Pascal, Profit Plan, Mini-Vedit	
n.a.	8K min., 32K max.	cassette, n.a.	LCD, 20 characters by 8 lines	n.a.	built-in electronic spreadsheet	
n.a.	2K min. 2K max.	cassette, n.a.	LCD, 20 characters by 1 line	n.a.	program library for math, science, finance, other uses	
Casio BASIC	2K min. 2K max.	n.a.	LCD, 20 characters by 1 line	n.a.	program library for math, science, finance, other uses	
CP/M-86 MS-DOS	128K min., 256K max.	2 5¼-inch floppy-disk drives	9-inch CRT, 80 characters by 25 lines	graphics	Perfect Series, Home Accountant Plus, Fast Graphs, and others	IBM PC compatible
Commodore DOS	64K min. 64K max.	1 or 2 5¼-inch floppy-disk drives	7-inch CRT, 40 characters by 25 lines	16 colors and graphics	n.a.	compatible with all software for the Commodore 64
Compaq-DOS (same as MS-DOS)	128K min., 512K max.	1 or 2 5¼-inch floppy-disk drives	9-inch CRT, 25 lines by 80 characters	graphics	n.a.	IBM PC compatible
MS-DOS	128K min., 704K max.	2 3½-inch floppy-disk drives	5- by 9-inch CRT, 25 lines by 80 characters	graphics	n.a.	IBM PC compatible, optional built-in modem and printer
CP/M-80	64K	2 5¼-inch floppy-disk drives	9-inch CRT, 80 characters by 24 lines	n.a.	n.a.	
CP/M-80	64K min., 1 MB max.	2 5¼-inch floppy-disk drives	9-inch CRT, 80 characters by 24 lines	n.a.	Perfect Series	S-100 system bus with 4 expansion slots for peripherals
MS-DOS	64K min., 512K max.	2 5¼-inch floppy-disk drives	7- or 9-inch CRT, 80 characters by 24 lines	color and graphics	n.a.	IBM PC compatible with optional color CRT
MS-DOS or CP/M-86	128K min., 512K max.	1 or 2 5¼-inch floppy-disk drives	9-inch CRT, 80 characters by 25 lines	graphics	GSX graphics interpreter, Multimate word processor and an assembler	IBM PC compatible
CP/M-2.2	64K min., 64K max.	2 5¼-inch floppy-disk drives	9-inch CRT, 80 characters by 25 lines	n.a.	n.a.	can link with HiNet local-area network, HiNet electronic mail
CP/M-2.2	64K min., 64K max.	2 5¼-inch floppy-disk drives, 1 15-megabyte hard-disk drive	9-inch CRT, 80 characters by 25 lines	n.a.	n.a.	can link with HiNet local-area network, HiNet electronic mail

Manufacturer/Location Model	Size (Inches)	Weight	Power Supply	Price	Type of Microprocessor
Dynalogic Info-Tech Ottawa, Ontario Hyperion	18⅓ by 11⅓ by 8⅘	18 lbs.	120 or 240V AC	$3395	8088
Dynalogic Info-Tech Ottawa, Ontario Hyperion Plus	18⅓ by 11⅓ by 8⅘	21 lbs.	120 or 240V AC	$4995	8088
Epson America Inc. Torrance, CA Epson HX-20	11⅓ by 8½ by 1¾	3 lbs., 13 oz.	batteries or AC	$795	Dual 6301 CMOS
Gavilan Computer Corp. Campbell, CA Gavilan Computer	11⅖ by 11⅖ by 2¾	9 lbs.	batteries or AC	$3995	8088
GRID Systems Mountain View, CA Compass	11½ by 15 by 2	10 lbs., 12½ oz.	110 or 220V AC	$9210	8086, 8087
Hewlett-Packard Palo Alto, CA HP-75C	1¼ by 5 by 10	26 oz.	batteries or AC	$995	CMOS HP Series 80
Jonos Anaheim, CA Escort C1100	17¼ by 13¼ by 7¼	25 lbs.	110 or 220V AC	$3995	Z80A
Jonos Anaheim, CA Escort C2100	17¼ by 13¼ by 7¼	25 lbs.	110 or 220V AC	$3995	Z80B
Management Techniques Inc. Boston, MA Escort Assistant	7½ by 17¼ by 13¼	25 lbs.	AC	$3995	Z80
Management Techniques Inc. Boston, MA Escort Administrator	7½ by 17¼ by 13¼	25 lbs.	AC	$5995	Z80
Micro Source New Lebanon, OH M6000P-Voyager	17 by 20 by 7	32 lbs.	120 or 220V AC	$3900	Z80A
Modular Computer Systems Inc. Ft. Lauderdale, FL Zorba 2000	17½ by 5 by 9	21 lbs.	AC	$1995	Z80
Modular Computer Systems Inc. Ft. Lauderdale, FL Zorba 2000/4	17½ by 5 by 9	21 lbs.	AC	$2495	Z80A

Operating System	RAM Memory Min./Max.	Mass Storage Type, Size	Display Type, Size	Color or Graphics	Software Included	Comments
MS-DOS	256K min., 256K max.	5¼-inch floppy-disk drive	7-inch CRT, 80 characters by 25 lines	graphics	Microsoft BASIC	IBM PC compatible, can be upgraded to Hyperion Plus level
MS-DOS	256K min., 256K max	2 5¼-inch floppy-disk drives	7-inch CRT, 80 characters by 25 lines	graphics	Microsoft BASIC, Multiplan, In:scribe, In:touch	IBM PC compatible with built-in direct connect modem
n.a.	16K min., 32K max.	microcassettes, 35K/side	LCD, 20 characters by 4 lines	graphics	Skiwriter word-processing program in ROM	built-in 24-column dot-matrix printer
MS-DOS	80K min., 336K max.	3-inch microfloppy-disk drive	LCD, 66 characters by 8 lines	n.a.	optional word-processing	communications scheduling and electronic spreadsheet packages in capsules
INGRID (proprietary) or MS-DOS	256K min., 256K max.	348K nonvolatile bubble memory	6-inch ELD, 80 characters by 24 lines	graphics	GRID-PLAN, -PLOT, -FILE, -TERM, -WRITE	built-in modem, software update and more file storage in GRID Central main-frame computer
proprietary	16K min., 24K max.	magnetic card, n.a.	LCD, 32 characters by 1 line		text editor, time of day, scheduler, optional HP-IL interface loop for printer, digital cassette drive, and CRT adapter	
CP/M	64K min., 128K max.	2 5¼-inch floppy-disk drives	9-inch CRT, 80 characters by 25 lines	n.a.	BASIC-80, Multi-Plan, Spellbinder, Spellcheck	optional dot-matrix printer attaches to back of computer
CP/M	128K min., 128K max.	2 3½-inch floppy-disk drives	9-inch CRT, 80 characters by 25 lines	n.a.	(see above)	(see above)
CP/M	64K min., 64K max.	2 3½-inch floppy-disk drives	9-inch CRT 80 characters by 24 lines	n.a.	BASIC-80	Multiplan, Spellbinder, Spellguard
CP/M	64K min., 64K max.	2 3½-inch 10-Mb hard-disk drives	9-inch CRT 80 characters by 24 lines	n.a.	(see above)	(see above)
CP/M	64K min., 512K max.	2 5¼-inch floppy-disk drives	9-inch CRT, 80 characters by 24 lines	n.a.	BASICZ, Wordstar, Calcstar, Mailmerge, Spellstar, Superfile, Archivist, 6 expansion slots	6 expansion slots; can add 8086 processor for IBM PC compatibility
CP/M	64K min., 320K max.	5¼-inch floppy-disk drive, DS/QD	9-inch CRT, 80 characters by 24 lines	n.a.	word processor, spelling checker, spreadsheet, database manager mailing list, and CBASIC	optional 8088 coprocessor and and internal 300- to 1200-bps modem; can read other disk formats.
CP/M	64K min., 320K max.	2 5¼-inch floppy disk drives, DS/DD	9-inch CRT, 80 characters by 24 lines	n.a.	(see above)	optional 8088 coprocessor and internal 300- to 1200-bps modem; can read, write, and format disks for 30 different microcomputers.

Manufacturer/Location Model	Size (Inches)	Weight	Power Supply	Price	Type of Microprocessor
Modular Computer Systems Inc. Ft. Lauderdale, FL Zorba 2000/8	17½ by 5 by 9	21 lbs.	AC	$2495	Z80A
Modular Computer Systems Inc. Ft. Lauderdale, FL Zorba 2000/16	17½ by 5 by 9	21 lbs.	AC	$2995	Z80A, 8088
NEC Electronics Chicago, IL PC-8201	11⅘ by 8½ by 2½	3.8 lbs.	batteries or AC	$675	80C85
Non-Linear Systems Solana Beach, CA Kaypro II	19 by 16 by 8	26 lbs.	110 or 220V AC	$1595	Z80A
Non-Linear Systems Solana Beach, CA Kaypro 4	19 by 16 by 8	26 lbs.	110 or 220V AC	$1995	Z80A
Non-Linear Systems Solana Beach, CA Kaypro 10	19 by 16 by 8	27 lbs.	110 or 220V AC	$2795	Z80A
Olympia USA Inc. Somerville, NJ Portable Computer OL-H004	1¼ by 9 by 3¾	21 oz.	batteries or AC	$380	proprietary
Olympia USA Inc. Somerville, NJ Portable Computer OL-0008	1½ by 9 by 3¾	21 oz.	batteries or AC	$480	proprietary
Osborne Computer Corp. Hayward, CA The Executive	20½ by 13 by 9	28 lbs.	AC	$2495	Z80A
Osborne Computer Corp. Hayward, CA Executive II	20½ by 13 by 9	28 lbs.	AC	$3195	8088
Osborne Computer Corp. Hayward, CA Osborne 1	20½ by 14½ by 8½	23 lbs., 8 oz.	AC	$1795	Z80A
Otrona Corp. Boulder, CO Attache	12 by 13½ by 5¾	18 lbs.	120 or 220V AC	$3995	Z80A
Panasonic Co. Secaucus, NJ Hand-Held Computer RL-H1800	1 by 9 by 3	21.9 oz.	batteries or AC	$380	proprietary
Panasonic Co. Secaucus, NJ JR-800	10¼ by 5⅝ by 1⅜	1 lb., 10 oz.	batteries or AC	$499.95	80C85

Operating System	RAM Memory Min./Max.	Mass Storage Type, Size	Display Type, Size	Color or Graphics	Software Included	Comments
CP/M	64K min., 320K max.	2 5¼-inch floppy-disk drives, DS/QD	9-inch CRT, 80 characters by 24 lines	n.a.	word processor, spelling checker, spreadsheet, database manager, mailing list and CBASIC	optional 8088 co-processor and internal 300- to 1200-bps modem; can read other disk formats.
CP/M, CP/M-86, MS-DOS	64K min., 512K max.	2 5¼-inch floppy-disk drive, DS/QD	9-inch CRT, 80 characters by 24 lines	n.a.	(see above)	optional internal 300- to 1200-bps modem; can read other disk formats.
proprietary	16K min., 64K max.	cassette, n.a.	LCD, 40 characters by 8 lines	n.a.	built-in text processor and communication software	optional 32K bubble memory cartridge
CP/M	64K min., 64K max.	2 5¼-inch floppy-disk drives	9-inch CRT, 80 characters by 24 lines	n.a.	MBASIC, SBASIC, Profitplan, Perfect-Writer, -Speller, -Calc, -Filer	
CP/M	64K min., 64K max.	2 5¼-inch floppy-disk drives, DS/DD	9-inch CRT, 80 characters by 24 lines	n.a.	MBASIC, SBASIC, Profitplan, Perfect-Writer, -Speller, -Calc, -Filer	
CP/M	64K min., 64K max.	5¼-inch floppy-disk drive, 1 10-Mb hard-disk drive	9-inch CRT, 80 characters by 24 lines	n.a.	MBASIC, SBASIC, Profitplan, Perfect-Writer, -Speller, -Calc, -Filer	
proprietary	4K min., 4K max.	n.a.	LCD, 26 characters by 1 line	n.a.	n.a.	
proprietary	8K min., 8K max.	n.a.	LCD, 26 characters by 1 line	n.a.	n.a.	
CP/M, UCSD Pascal	128K min., 256K max. (with copro-cessor)	2 5¼-inch floppy-disk drives	7-inch CRT, 80 characters by 24 lines	n.a.	Wordstar, Mailmerge, Supercalc, Personal Pearl, CBASIC, MBASIC	
MS-DOS, CP/M-86, UCSD Pascal	256K min., 384K max.	2 5¼-inch floppy-disk drives	7-inch CRT, 80 characters by 24 lines	n.a.	(see above)	IBM PC compatible
CP/M	64K min., 64K max.	2 5¼-inch floppy-disk drives	5-inch CRT, 52 characters by 24 lines	n.a.	CBASIC, MBASIC, Wordstar, Mailmerge, Supercalc	optional double-density disk drives
CP/M	64K min., 156K max.	2 5¼-inch floppy-disk drives	5½-inch CRT, 80 characters by 24 lines	graphics	BASIC-80, Wordstar Plus, Charton, Valet	modular construction allows 1-hour repair
n.a.	8K min., 8K max.	cassette, n.a.	LCD, 26 characters by 1 line	n.a.	n.a.	
proprietary	16K min., 24K max.	cassette, n.a.	LCD, 32 characters by 8 lines	n.a.	n.a.	

Manufacturer/Location Model	Size (Inches)	Weight	Power Supply	Price	Type of Microprocessor
Peripheral Systems Marlton, NJ Eagle	18 by 17¼ by 8	18 lbs.	110 or 220V AC	$3495	Z80A
Quasar Franklin Park, IL Quasar Hand-Held Computer	3¼ by 8⁹⁄₁₀ by 1¼	14 oz.	batteries or AC	$329	6502
Radio Shack Fort Worth, TX PC 1	6⅞ by 2¾ by ¹¹⁄₁₆	6 oz.	batteries or AC	$149.95	proprietary
Radio Shack Fort Worth, TX PC 2	7¹¹⁄₁₆ by 3⅜ by 1¹⁄₁₆	1 lb.	batteries or AC	$199.95	proprietary
Radio Shack Fort Worth, TX TRS-80 Model 100	11⅞ by 8½ by 2	4 lbs.	batteries or AC	$799	80C85
Sarasota Automation Sarasota, FL Husky	9½ by 8 by 1¾	4.5 lbs.	batteries or AC	$2995	Z80
Seequa Computer Annapolis, MD Chameleon	18 by 15½ by 8	28 lbs.	110 or 220V AC	$1995	8088
Sharp Electronics Corp. Paramus, NJ PC-1250	5⁵⁄₁₆ by 2¾ by ⅜	4 oz.	batteries or AC	$110	proprietary
Sharp Electronics Corp. Paramus, NJ PC-1500	7¾ by 1 by 3⅖	2 lbs.	batteries or AC	$300	proprietary
Sharp Electronics Corp. Paramus, NJ PC-5000	12¹³⁄₁₆ by 12 by 3⁷⁄₁₆	11 lbs.	batteries or AC	$2995	8088
SKS Computers Inc. Columbus, OH SKS 2502 Nano	15⅝ by 18⅛ by 6½	30 lbs.	AC	$2495	Z80A
SKS Computers Inc. Columbus, OH SKS 252 Pico	15⅝ by 18⅛ by 6½	22 lbs.	AC	$2495	Z80A
SMC Corp. Atlanta, GA Compucase	5½ by 18 by 13	25 lbs.	AC	$7995	Z80A
SORD Computer Tokyo Japan M23P	17¼ by 15⁷⁄₁₆ by 5³⁄₁₆	16 lbs. 8 oz.	110 or 220V AC	$2595	Z80A
STM Electronics Corp. Menlo Park, CA *Pied Piper I*	20⅕ by 10⅘ by 4	11 lbs.	115 or 230V AC	$1299	Z80A

Operating System	RAM Memory Min./Max.	Mass Storage Type, Size	Display Type, Size	Color or Graphics	Software Included	Comments
CP/M	64K min., 156K max.	2 3½-inch floppy-disk drives	7-inch CRT, 80 characters by 24 lines	graphics	electronic spreadsheet, spelling checker, word processor, inventory control	optional built-in modem and hard-disk drive
n.a.	2K min., 8K max.	cassette, n.a.	LCD, 32 characters by 1 line	n.a.	n.a.	
n.a.	1.9K min., 1.9K max.	cassette, n.a.	LCD, 24 characters by 1 line	n.a.	n.a.	
n.a.	2.6K min., 16K max.	cassette, n.a.	LCD, 26 characters by 1 line	n.a.	n.a.	
proprietary	8K min., 32K max.	cassette, n.a.	LCD, 40 characters by 8 lines	n.a.	built-in text editor, scheduler, address handler, and communi-cations program	built-in direct-connect modem
CP/M	16K min., 144K max.	n.a.	LCD, 32 characters by 4 lines	n.a.	n.a.	
MS-DOS or CP/M-86	128K min., 700K max.	2 5¼-inch floppy-disk drives	9-inch CRT, 80 characters by 25 lines	graphics	MBASIC, Perfect-Writer, -Calc	IBM PC compatible
n.a.	2.2K min., 2.2K max.	cassette, n.a.	LCD, 24 characters by 1 line	n.a.	n.a.	
n.a.	16K min., 20K max.	cassette, n.a.	LCD, 26 characters by 1 line	n.a.	n.a.	
MS-DOS	128K min., 256K max.	128K bubble-memory cartridge	LCD, 80 characters by 8 lines	graphics	word processing, electronic spreadsheet, database man-ager and scheduler	optional printer, floppy-disk drive, modem, and cassette recorder
CP/M	80K min., 80K max.	2 5¼-inch floppy-disk drives	5- by 9-inch CRT, 80 characters by 24 lines	n.a.	Perfect Series	optional 80186 microprocessor
CP/M	80K min., 80K max.	2 3½-inch floppy-disk drives	5- by 9-inch CRT, 80 characters by 24 lines	n.a.	Perfect Series	optional 80186 microprocessor
CP/M	64K min., 64K max.	5¼-inch floppy-disk drive	gas plasma, 50 characters by 12 lines	n.a.	n.a.	
CP/M 3.0	128K min., 128K max.	2 3½-inch flopppy-disk drives	LCD, 80 characters by 8 lines	color and graphics	SORD BASIC, PIPS	optional port for bit-mapped graphics with color or mono-chrome monitor
CP/M	64K min., 128K max.	5¼-inch floppy-disk drive	n.a.	graphics	Perfect-Writer, -Speller, -Calc, -Filer	requires a monitor or television screen, optional LCD with 80 characters by 2 lines

Manufacturer/Location Model	Size (Inches)	Weight	Power Supply	Price	Type of Microprocessor
Sunrise Systems Inc. Carroltown, TX KP-C8	16 by 9 by 2	4½ lbs.	batteries or AC	approx. $2000	NSC800A
Teleram Communications White Plains, NY Teleram 3000	13 by 9¾ by 3½	8 lbs., 13 oz.	Built-in rechargeable 12-V battery (3-10 hrs.)	$2995	Z80L
Televideo Systems Inc. Sunnyvale, CA Teletote I	18 by 8 by 15	23 lbs.	AC	$1499	Z80A
Texas Instruments Inc. Lubbock, TX CC-40	9½ by 5¾ by 1	22 oz.	batteries or AC	$249.95	TMS 9995
Toshiba America Inc. Tustin, CA T100	16½ by 4 by 11	n.a.	AC	$1995	Z80A
Universal Data Inc. Clarkston, MI UDI-500	11 by 13 by 3⅛	12 lbs., 13 ozs.	batteries or AC	$3995	LH5080 (CMOS Z80), 1805

But the advantages of the CRT outweigh the disadvantages. First, it is a luminescent display—it produces light. Therefore, it can be used under poor lighting conditions. Second, it is extremely flexible. Given a monitor with sufficient resolution, you can display any type of image upon it, including color, such as with the Commodore Executive 64. Finally, there's enough software available to take advantage of that flexibility.

The second most popular form of display is the small, lightweight LCD, which usually requires little power and is relatively immune to damage. One disadvantage is that an LCD's response time is slower than that of a CRT display in terms of speed required to write and erase a character on the display. Additionally, the LCD bit-mapped graphics are at best crude because the individual pixels (picture elements) aren't small enough to give sharp definition. And at temperatures below freezing, the LCDs may slow down even more or stop altogether.

The Sharp PC-5000 has the largest LCD currently available on a portable computer, 8 lines by 80 characters (see photo 2). Whether such a display is large enough for effective work is a matter of personal taste. Portable computers with a 1-line display are minimally usable. The HP-75 has a 1-line by 32-character display. The Epson HX-20 (see photo 3) has 4 lines by 20 characters. The Radio Shack Model 100 has an 8-line by 40-character display. You can work with all of these displays, but they are only a fraction of the size of a standard CRT display of 80 characters by 24 lines. You should carefully consider the display size in terms of your particular application and choose the portable that best fits your needs. Word processing on a 4-line display is awkward at best.

Finally, the new ELD and gas-plasma display technologies provide still another choice. ELDs use a chemical coating and a wire grid placed between two glass plates. The chemical coating emits light when an AC voltage is applied to the wires. Alphanumeric characters can be formed by applying the voltage to the correct sequence of wires. The gas-plasma display is similar to the ELD except that a gas fills the space between the two plates. The Grid Compass computer has an ELD screen.

ELDs combine the advantages of the CRT and the LCD. They can display a full 80 characters by 24 lines, offer good bit-mapped graphics resolution, and their flat shape makes them ideal for portable applications. The only disadvantage is that both their price and power consumption exceed the level of other displays. For now, field testing will have to determine whether the electroluminescent and gas-plasma displays are economical and reliable enough to replace the CRT display for portable computers.

Data Storage

Developments in data-storage technology have enabled portable computer users to take their data along

Operating System	RAM Memory Min./Max.	Mass Storage Type, Size	Display Type, Size	Color or Graphics	Software Included	Comments
proprietary	80K min., 144K max.	microcassette, 512K	LCD, 40 characters by 6 lines or 80 characters by 3 lines	color and graphics	built-in word processing, calendar, communications, and auto-dialer	optional flat-pack expansion box for 8088 microprocessor and floppy-disk drives
CP/M	64K min., 64K max.	256K nonvolatile bubble memory	LCD, 80 characters by 4 lines	n.a.	Teletalk communications program	optional portable disk drive can read Apple, Osborne, and IBM formats; optional office station with CRT, disk drive, and 8 ports
CP/M	64K min., 160K max.	5¼-inch floppy-disk drive	9-inch CRT, 80 characters by 24 lines	graphics	Wordstar, Visicalc	includes mouse port
proprietary	6K min., 16K max.	n.a.	LCD, 31 characters by 1 line	n.a.	22 applications packages	optional plotter, printer, and stringy-floppy drive
CP/M	32K min., 64K max.	2 5¼-inch floppy-disk drives	LCD, 40 characters by 8 lines	graphics and color	Word Right word-processing package	optional CRT display
CP/M, Micro DOS	64K min., 256K max.	2 3½-inch floppy-disk drives	LCD, 40 characters by 8 lines	n.a.	Vedit text processor and communications package	built-in 300-bps modem and card slot for use with RCA CMOS microboards

with them. The newer half-height 5¼-inch and 3½-inch floppy-disk drives have as much storage capacity as the older 8-inch drives. Hard disks are also becoming portable. For example, the Kaypro-10 has a built-in 10-megabyte hard-disk drive. Some portables feature bubble-memory cartridges for convenient long-term data storage.

Memory is the working medium of any computer, and portables are no exception. Yet portables, because they incorporate the latest technology, offer more memory options than standard desktop computers. You can have a portable with CMOS RAM, bubble-memory cartridges, mini- or micro-floppy-disk drives, or hard disks. Each option has its own particular advantages and disadvantages.

CMOS memory is widely used in briefcase computers because of its

Photo 2: *The flip-up 80-character by 8-line LCD screen on the Sharp PC-5000 is only one-third the size of a standard CRT screen.*

Photo 3: *Space limitations on the front panel forced the designers of the Epson HX-20 to use a 20-character by 4-line display.*

Photo 4: *The Kaypro II has the ability to read and write to a variety of disk formats.*

low power consumption. The recent improvement in chip-manufacturing technology has lowered the price and increased the performance of these memory devices. CMOS chips are still slower in operation than corresponding TTL (transistor-transistor logic) memory devices, but their speed is improving. In actual use the speed of a CMOS memory chip does not adversely affect the operation of a portable computer.

Bubble-memory cartridges have been around for a while but haven't been widely used because of their high price. But, like CMOS memory, their price is dropping and their use is increasing, especially for the briefcase computers. Bubble-memory cartridges offer several advantages over other storage media such as floppy disks. They operate like a floppy-disk drive but much faster; they have no moving parts and no disk-drive head to move from track to track. Data is stored in the cartridge as a pattern of magnetic bubbles, and when the cartridge is removed or power fails, the stored data is retained. The cartridges do not require an auxiliary battery to retain data. They require very little power to operate and are much more rugged than conventional floppy disks.

Floppy disks are still very much the medium of choice for people who work with portable computers. They are *widely* used, dependable, and have a broad base of available software. With the introduction of half-height and microfloppy-disk drives, floppy disks remain the primary data-storage medium. The disadvantages of floppy disks include occasional incompatible recording formats for 5¼-inch disks and the confusing differences between the various standards for the microfloppy-disk drives.

Before buying a portable or transportable computer, find out if it can read and write to disks from other computers. The Kaypro II (see photo 4), for example, can read and write to disks created with a Xerox 820-II. And the Kaypro Users Group has software available that will enable the Kaypro II to read other disk formats.

Rather than carry a lot of floppy disks, you can opt for a portable with a built-in hard-disk drive. Portables such as the Kaypro-10 (see photo 5) with its 10-megabyte hard disk and the Starlite HD20 (see photo 6) with its 20-megabyte hard disk can serve users with very large data-storage needs. Both have a staggering amount of storage for a portable computer system and can handle almost any application.

Photo 7: *The Columbia VP is one of the best of the IBM-compatible computers.*

Hard-disk-drive manufacturers carefully studied the typical environment of a portable computer and have developed drives that have special shock mountings and head-positioning controls to withstand shock and vibration. For example, both the Kaypro-10 and the Starlite HD20 have utility programs to position the read/write head in a "safety zone" on the disk that is isolated from the data tracks; if a head crash occurs while the computer is in transit, you will probably be able to recover your data. In addition, the read/write heads have been redesigned to be lighter and less prone to shock.

Hard-disk drives are an expensive option, but their price is dropping. However, they are heavier than floppy-disk drives and consume more power because the disk is constantly spinning while it's on. Another potential problem is the possibility of data loss due to a head crash. This occurrence is more serious with a hard disk loaded with great quantities of data than for a set of floppy disks.

For most of the transportable computers that use the Z80 micropro-

Photo 5: *With its 10-megabyte hard disk preloaded with the bundled software, the Kaypro-10 can store 50 disks' worth of information.*

Photo 6: *The Starlite HD 20 offers a staggering 20 megabytes of storage in a portable computer.*

cessor, the de facto operating system is CP/M. Compatibility is reasonably assured regardless of the type of computer, magnetic media, or display used. Practically every major software application package is available in a CP/M format. By using a standard operating system, you have access to a tremendous number of programs, programming utilities, and languages.

But the issue of compatibility becomes much more complicated when computer manufacturers try to make their computer emulate the functions of another machine, as is the case with the many IBM Personal Computer work-alikes. This continues to be a confusing issue because three levels of compatibility have emerged.

Incompatible disk formats or different-size media characterize the first level. For example, the DOT computer uses an 8088 microprocessor and runs MS-DOS, but it uses the Sony 3½-inch floppy-disk drives, which are not compatible with the standard 5¼-inch drives used on the IBM. As a result, you would have some work to do to transfer programs from the IBM to the DOT computer.

The second level is data compatibility. Most "IBM-compatible" computers fall into this category. With a data-compatible portable, you can transfer data created on an IBM disk to a portable computer. But you cannot transfer the program used to create those data files. For example, you can create a data file with an electronic spreadsheet program on the IBM and use that data on a compatible portable as long as you have the same version of the spreadsheet program for the portable.

The last level of compatibility includes computers that are "almost a clone." These systems, such as the Columbia VP (see photo 7), offer the same graphics capabilities and keyboard as the IBM and use the same software. They differ from the IBM PC only with respect to the information stored in ROM. The PC has a copyright notice in its ROM. Some programs such as Visicalc only work correctly after locating the copyright notice in ROM. Most software will work correctly, but in some cases you need to get a version of the program specifically tailored to your computer. Before choosing a portable, find the software you want, and then make sure it runs on the computer you like.

Software

Bundled software is a great value. It lets you get the computer up and running as soon as you take it home. Manufacturers usually offer word-processing, electronic spreadsheet, database-manager, and perhaps communications packages. Some portable computers have as much as $2500 worth of software bundled with the hardware. Bundled software also enables you to try the various programs before you buy a complete system.

But don't let the lure of bundled software sway your decision on which portable computer to buy. You may not like a particular software package that is included with the portable computer you choose. Selecting software is sometimes a very subjective decision. The software and hardware must combine to meet your needs. If they don't do what you need, you shouldn't buy them.

Defining the Workplace

When considering the purchase of a portable computer, ask yourself one more question, "Where do I need a computer most?" Do you really need a heavy-duty CP/M system that can be transferred from the office to home? Or do you need a computer that can go on the road for data collection in the field? You may be the ultimate computer junkie who likes to work in pajamas in bed at 2 o'clock in the morning. Your ideal working environment is critical in your choice of a computer.

Summary

Choosing a portable computer isn't easy. The number of portables and the variety of available features make the choice a tough one. But with the right background and some in-depth research, you'll be able to find one that suits your needs.■

Stanley J. Wszola is a BYTE technical editor.


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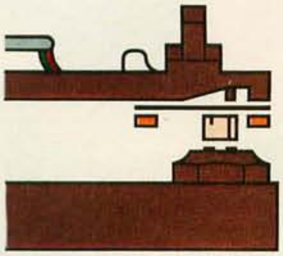

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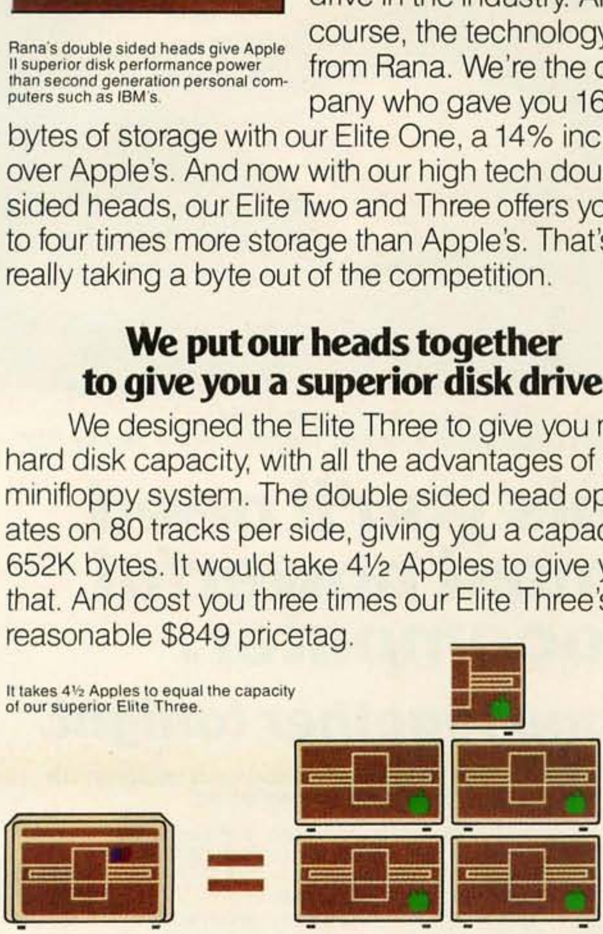

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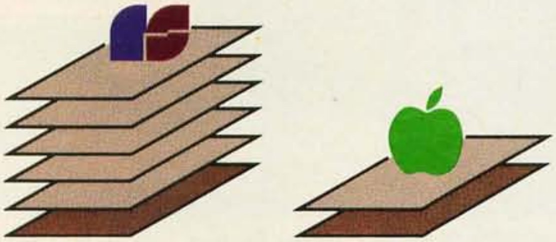

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High-IQ Modems

A new generation of intelligent modems lets users concentrate on applications rather than on modem-interfacing details

by Stephen Durham

With the incorporation of sophisticated microcomputers, high-density RAMs, and advanced communications ICs, the so-called dumb modem is being replaced by a new generation of intelligent modems. These modems not only offer features that enhance data-communications applications, but also can determine the parameters of the systems in which they're installed and adjust their operation to meet system requirements. Some models, for example, can learn such system specifications as a host computer's bit speed and parity and set their own operation accordingly.

The high degree of "intelligence" contained in this new generation of modems allows telephone links between computers to be operated virtually unattended. This capability makes possible a wide range of new telecommunications applications, including electronic mail, central-database access, remote diagnostics, and remote-peripheral sharing.

The level of intelligence incorporated into modems determines their ability to disappear into the background of your computer system and to provide unattended communications capability.

By and large, while most of these new-generation high-IQ modems provide such features as automatic dialing, automatic answering, and automatic disconnecting, they do not take full advantage of the advanced microprocessor and memory technologies with which they are built. Largely ignored are a wide range of what can be called "system configuration" problems, which result from differing transmission proto-

Photo 1: *A command-driven auto-dial, auto-answer modem (Cermetek's Info-Mate 212A).*

cols, differing modem bit rates, lack of automatic dial-mode selection, conflicting parity states, and the lack of any means of testing the computer, the modems, or the transmission line to determine where potential failures could occur.

The traditional solution to system-configuration problems has been no solution at all. Hence, the user has been left to take care of all those nasty little details by either tweaking the hardware or reconfiguring specific application programs. In neither case is the modem operating procedure transparent to the user.

How well intelligent modems perform system-configuration functions depends not so much on how sophisticated and advanced the built-in microprocessor is or on how advanced the applications software used by the computer to operate the modem is but on the efficiency and cleverness of the modem's firmware design. In other words, the degree to which a modem performs such functions depends on how transparent its implementation can be made to the user by incorporating functions into the internal operation of the modem itself.

While the price difference between a dumb modem and an intelligent modem is still substantial, it is much less so between a moderately intelligent modem and one with a maximum of transparency. That's because the ability of an intelligent modem to perform is not a function of how much expensive and sophisticated electronics hardware it uses but of how much thought has gone into its overall design and into the internal firmware instructions that tell the microprocessor what to do. To determine a modem's IQ and therefore how easily it can be integrated into a data-communications system, you can examine its ability to handle auto-dial, auto-answer, and auto-disconnect operation as well as automatic system-configuration tasks.

Auto-Dial Operation

First, consider modem auto-dial operation, which is much more complex than simple automatic generation of dial tones or rotary-dial pulses. The modem must resolve all of the call-failure conditions that commonly exist when dialing to allow its host to make efficient use of the communications facility. Common call-failure features include line busy, no modem-answer tone, voice answer, no answer (constant ringing), no dial tone, and inability to break dial tone.

These functions are roughly equivalent to the functions of an operator making a call, including lifting the telephone handset, waiting for the correct dial tone or tones, dialing each digit of the telephone number in proper sequence, waiting while the phone rings until the dialed number answers, hanging up and possibly redialing later if the number is busy or if the call has not been answered after a reasonable length of time, and hanging up the handset at the end of the completed call.

When properly implemented, the auto-dial feature dramatically increases line utilization.

Auto-Answer Operation

When integrated into a modem, an auto-answer feature enables the modem to be placed in the answer mode automatically upon receipt of a telephone-line-ringing signal. A modem with this feature makes it possible for data transmission to occur between a remote terminal and a computer or another terminal interfaced to a modem with auto-answer capability without operator intervention at the receiving end. A modem with auto-answer capability is also useful in timesharing installations where a large calling population calls a number of computer dial-in lines on a random basis.

Auto-Disconnect Operation

An auto-disconnect feature permits a modem to either disconnect if a carrier signal is not maintained after a data call has been set up or upon command from the host computer. This feature is useful in preventing the tie-up of expensive computer facilities due to such things as wrong-number calls, failure of the distant party to disconnect from a timesharing system, or line failures.

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- 32-digit last-number-dialed storage
- DTMF (dual-tone multifrequency) and pulse-dialing: adaptive or interpretive selection of DTMF or PULSE-DIALING
- Auto/manual answer
- Auto speed select
- Auto parity select
- Call-progress-tone detection: DIAL, BUSY, RING-BACK, MODEM-ANSWER TONE, and THE HUMAN VOICE
- Eight diagnostic test modes

Table 1: *Info-Mate 212A features.*

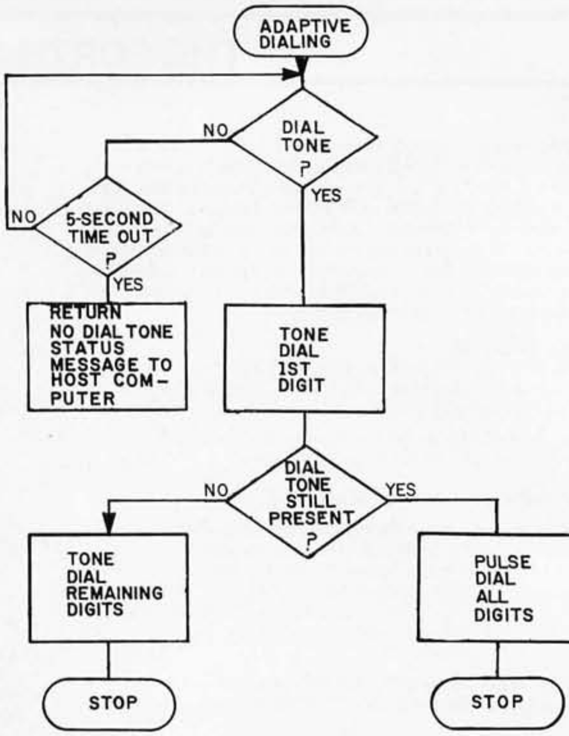


Figure 1: *The adaptive-dialing procedure, in which tone-dialing is preferred. If the local telephone equipment does not accept tone-dialing, the intelligent modem uses pulse-dialing.*

Automatic System Configuration

What good is a highly intelligent modem if its installation into the host terminal or computer system is unmanageable or difficult? While it's not absolutely essential in an intelligent modem, automatic system configuration does make such devices much easier to use. And incorporating this capability into the modem does not add significantly to its cost.

It is not uncommon to encounter computer- or modem-option incompatibilities during installation. Such parameters as serial speed, data bits per word, parity, and stop bits per word can initially have settings that prohibit data transmission through the modem. An installer can, of course, get out the users manuals of all the equipment involved and, through a detailed process of positioning option straps on each machine, effect a compatible installation. Many times, however, determining the specific parameters that are not aligned can be complex, especially for someone who is not an expert in communications technology.

System-configuration features enable a modem to be installed and used by a nonspecialist in communications, assuring that the modem user can concentrate on data-communication application problems instead of modem compatibility.

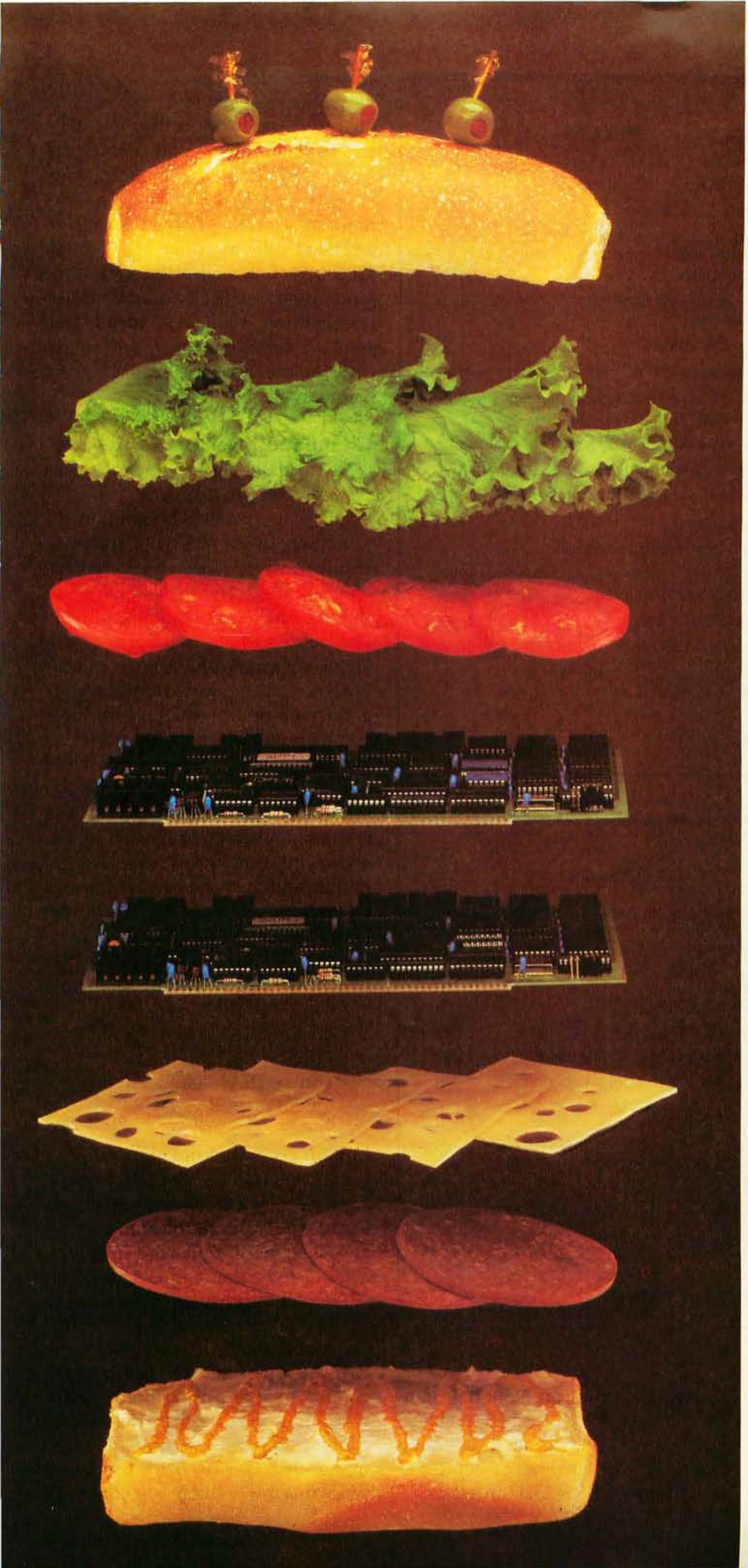
A Typical High-IQ Modem

Typical of the more advanced "high-IQ" modems now becoming available is Cermetek's Info-Mate 212A, shown in photo 1. This modem's architecture bears a strong superficial resemblance to others now on the market.

Where it does differ, however, is in the nature of the instructions incorporated into its firmware. As shown in table 1, this 212-type intelligent modem incorporates not only the standard automatic dial, answer, and disconnect features but a wide range of system-configuration enhancements as well. All of these features may not be necessary for any one application, but the degree to which they are implemented in a modem is a good indicator of how much thought and design went into the modem.

The Info-Mate modem automatically selects tone- or pulse-dialing, as shown in figure 1. Tone-dialing is preferred, but if it is not accepted by the local telephone equipment, the modem falls back to pulse-dialing. After dialing is completed, the modem monitors the following call-progress conditions and reports them back to the host data terminal or computer over the serial RS-232C link: dial tone, busy tone, ring-back tone, modem-answer tone, and voice. Each call-progress signal detected is indicated to the host through a serial status message.

The host can direct control over the selection of pulse- or tone-dialing through the DIAL command. Call-progress monitoring can also be deleted under host-command control, which enables the modem to auto-dial on telephone systems that use nonstandard call-progress tones. This method of dialing is generally referred to as "blind" dialing, but a more accurate term would be "deaf" dialing. In either the automatic or blind-dialing modes, the modem supports the following dialing pro-



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Command Summary

Command	Description
<com> Answer <CR>	Force off hook and answer call
<com>Break n<CR<	Send break, n × 250 ms
<com> Count n<CR>	Ring and ring-back counter: 0—ignore ring signal, 1..9—answer after n rings; give up dialing after n + 4 ring-back signals
<com> Dial s<CR>	Dial last, immediate, from memory, next number, or until answered
<com> End<CR>	Hang up immediately
<com> List<CR>	List stored telephone number or log-on messages
<com> Message n<CR>	Send stored log-on message or messages to the remote modem
<com> New n<CR>	Set new value of command character <com> to n
<com> Originate<CR>	Force off hook and enter originate data mode
<com> Program n<CR>	Set internal modem options
<com> Query<CR>	Return modem status
<com> Reset<CR>	Reset modem options to defaults
<com> Store n 's' <CR>	Store telephone number or log-on message at location n (32 characters maximum)
<com> Test n<CR>	Start/stop modem tests
<com> Unlisten n<CR>	Set modem to LISTEN or UNLISTEN to commands during data transmission
<com> Zzzz<CR>	Make modem quiet

Table 2: *Info-Mate 212A command notation.*

Command Notation	Description
<com>	Command character; defaults to control N at power-up but can be set to another character with the NEW command
<LF>	Linefeed
<CR>	Carriage return
[ ]	Optional parameter
[ ]^n	Optional parameters that may occur 0 to n times
n...m	Specifies the inclusive set n through m
<SP>	Space
<letter>	A...Z or a...z
<command>	Command, including argument if needed
<n>	Number
<quote>	Single quote or apostrophe
<number>	Dialed-number string

Table 3: *A description of the Info-Mate 212A's commands.*

cedures: dial last number, dial immediate, dial from memory, dial alternate number(s), and dial until answered.

All modem functions are controlled by ASCII (American National Standard Code for Information Interchange) encoded commands issued from the host terminal or computer over the serial RS-232C interface.

The Info-Mate automatically adapts to the host's speed (110, 300, or 1200 bps) and parity (odd, even, mark, and space) using a simple training sequence. To train the modem, you must send the sequence "XY. The modem uses the trained speed to originate calls at either 110, 300, or 1200 bps. On answering calls, the modem automatically adapts to the transmitting modem's speed but sends a serial change-speed status code to the host at the old speed before switching.

Command Structure Is the Key

Key to an intelligent modem's ability to protect the user from the dirty details of its operation is its command structure, or its ability to interpret commands from the host. In this context, the Info-Mate supports 16 different host commands (see table 2), each of which is preceded by a single command character <com>. Each command line is terminated by a carriage return <CR>. Multiple commands can be placed on one line and separated by commas. Table 3 describes the commands available.

Each command consists of the command character followed by the command word, a delimiter, all arguments, and then the closing carriage return or comma. The maximum length of any command line, however, is 40 characters. Two examples of commands include the following:

<com> DIAL '(408) 996-1010'
<CR>
<com> DIAL '(408) 996-1010',
QUERY <CR>

In both cases, the notation <com> is equivalent to the single command character. The delimiter separating the command from the arguments is always a space. Only the first character of the command is significant. All remaining characters are ignored up to the first space following the command. In other words, DIAL and DANCE are treated identically by the command interpreter. Both uppercase and lowercase characters are accepted. You can transmit the command character itself by sending it twice in a row—<com><com>—if

the modem is in the middle of a data call. Two other methods of transmitting the command character exist: changing it to another character and then transmitting the former command character, or placing the modem in the UNLISTEN mode to be discussed and then transmitting the character.

If an argument is not given in the command, the modem assumes the default value as the argument. The arguments are all ASCII numbers and/or characters. The numbers themselves are ASCII-encoded hexadecimal (0 to 9 and A to F) characters. All commands are absorbed by the modem, which means it doesn't send them on through the telephone line.

Once a command is received by the modem, it returns a status message to the host. These status messages are framed as follows:

<com> <status character>
<LF> <CR>

A command character precedes each message to let the host know that the message regards status and not data from a remote modem. All status messages are made up of a single status character, except for those resulting from the commands LIST, QUERY, and DIAL. These three commands are necessarily longer to return command information. Table 4 summarizes the Info-Mate's repertoire of status messages.

Dialing Command Variations

There are five basic variations of the dialing command: dial last, dial immediate, dial-immediate alternate, dial from memory, and dial-from-memory alternate. All dialing commands can initiate either DTMF or rotary-pulse dialing.

Each dialing variation refers to a number string as a source for the number to be dialed. For immediate-type dialing commands, the number string is supplied with the command, whereas the dial-last- and dial-from-memory-type commands refer to number strings previously entered into the modem.

Along with the telephone digits, the number string can contain con-

trol characters that direct the Info-Mate to dial adaptively or interpretively using tone- or pulse-dialing. Pause or wait characters can also be inserted that enable tandem dialing through PBXs or carrier facilities such as MCI or SPRINT. Table 5 shows the characters allowed in the number string. Table 6 shows some typical number strings.

After a dialing command is given to the Info-Mate, it interprets the appropriate number string to determine how the dialing process should proceed. As the number is dialed, the dialed number string is returned to the host in the form of a status message:

<com> <NUMBER>
<LF> <CR>

This message enables the host to follow the progress of the number dialed.

During the dialing process, if the modem is directed to pause and wait for the dial tone, and if the tone is not found after 5 seconds, the modem aborts the call, returning a number string that terminates with the failed-pause-for-dial-tone character. In addition to this character, a NO DIAL TONE status is returned:

<com> <TERMINATED NUMBER
STRING> <LF> <CR>
<com> X <LF> <CR>

After a call has been successfully dialed, the modem monitors the telephone line for call-progress tones. If the number string is terminated with a Z, however, the modem takes no further action. Instead, the modem is left OFF HOOK, with its modulator silenced. Employing this OFF-HOOK mode is typically how you would use the modem to initiate a voice call.

Phone Number Storage

The modem can store as many as fifty-two 32-character strings, either phone numbers or log-on messages, or a combination of both. Each entry is stored by sending the following command from the host to the modem:

Status	Description
<com>A<LF><CR>	Data call answered
<com>B<LF><CR>	Busy number reached
<com>D<LF><CR>	Modem disconnect
<com>N<LF><CR>	No answer or command failure
<com>R<LF><CR>	RING-BACK tone or ring signal
<com>V<LF><CR>	Voice received
<com>W<LF><CR>	Modem answer but host is at wrong speed
<com><LF><CR>	Command-complete acknowledgment
<com>?<LF><CR>	Command-entry error
<com><DIALED NUMBER><LF><CR>	Number dialed
<com><H_1H_2><LF><CR>	H_1H_2 represent hexadecimal status of the program register

Table 4: *Info-Mate 212A status messages.*

Character	Number-String Positions	Meaning
0...9	1	Dialed digits
* and #	1	Dialed digits, tone only
A	2	Adaptive dialing; pauses for dial tone, then automatically selects tone- or pulse-dialing for the remaining number-string digits. At the beginning of each number string, adaptive dialing is assumed unless otherwise specified.
T	2	Pauses for dial tone, then dials the remaining digits in the number string using DTMF tones
P	2	Pauses for dial tone, then dials the remaining digits in the number string using pulse-dialing
TB	4	Inserts a blind wait of 2 seconds into the dialing sequence without monitoring dial tone, then continues to dial the remaining digits in the number string using DTMF tones
PB	4	Inserts a blind wait of 2 seconds into the dialing sequence, then continues to dial the remaining digits in the number string using rotary-type pulses
B	2	Inserts a 2-second pause in the dialing sequence
0	2	If the number string is terminated with an "0," only the modem-answer tone is monitored for call-progress after dialing
Z	2	If placed as the last character in the number string, the modem terminates the dialing command without going into the originate-data call mode. The modem stays OFF HOOK with its modulator squelched
@) (_	2	Placeholding characters
<SP>		Spaces are illegal

Table 5: *Permissible dialing-string characters.*

Number Strings	Meaning
767-1111	Dials 767-1111 and adaptively selects tone- or pulse-dialing, if unspecified adaptive dialing is assumed
T767-1111	Dials 767-1111 using tones after pausing for *dial tone*
P767-1111	Dials 767-1111 using pulses after pausing for dial tone
BT767-1111	Dials 767-1111 using tones after waiting 2 seconds. After dialing, call-progress-tone detection is limited to modem answer tone.
TB767-1111	Dials 767-1111 using tones after waiting 2 seconds. After dialing, call-progress-tone detection is limited to modem answer tone.
PB767-1111	Dials 767-1111 using pulses after waiting 2 seconds. After dialing, call-progress-tone detection is limited to modem answer tone.
PB767-1111Z	Same as previous number string except after dialing 767-1111 the modem does not go into the originate-data mode. It stays off hook with its modulator squelched, waiting for the next command. This is very useful for placing voice calls.
T9A(408)745-0450	Tone-dials 9 after pausing for dial tone, then adaptively selects tone- or pulse-dialing to dial 745-0450. This is a typical format used for dialing tandem calls through a PBX.
T9P7771234T12345T4087671111	Tone-dials 9 after pausing for dial tone, then waits for dial tone again before pulse-dialing 777-1234. After pausing for dial tone a third time, the number 12345 is tone dialed. Finally, after a fourth pause for dial tone, the number (408) 767-1111 is tone dialed. This is a typical number string used for calling through long-distance-carrier facilities such as MCI or SPRINT. It should be noted that the number string is 31 characters long, one less than the maximum allowed.

Table 6: *Typical dialing commands.*

<com> STORE <LETTER>
' MESSAGE ' <CR>

In this command sequence, LETTER specifies one of fifty-two 32-character memory locations. Although it can be a word of any length, it must begin with an alphabetical letter (A to Z or a to z). The message to be stored—MESSAGE—can be a telephone number or a log-on message, but it must be bounded by single quotes or apostrophes. Any character except <com>, QUOTE, and Control-H can be embedded between the quotes, even <CR> and <LF> characters. QUOTEs are reserved as delimiters, while Control-H or the backspace key is used to backspace over entry errors. If a <com>is entered in the message, the entire command is aborted and a new one is begun.

The @ sign is a special storage character that, when entered as the first character in the message, inhibits display of that memory location when using the LIST command. Only an @ is listed as a placeholder, which is meant to ensure log-on or password-message security.

To list the numbers or log-on messages stored in the modem, a host need only send the following command to the modem: <com> LIST<CR>. In response, the list appears on the video screen, with the last number stored listed first, followed by as many as 52 stored number or log-on-message locations.

For example, to send a message stored in location A to a remote modem for database-password access, the following command would be sent to the modem:

<com> M A <CR>

As many as 16 letters can be specified within the message (M) command. After the message referred to by the first letter, the modem sends the sec-

Query-Status Table

O	OFF HOOK asserted
C	carrier detected
H	high speed (1200 bps)
S	self-test enabled
A	analog loop test enabled
R	remote originated digital loop
D	digital loop locally enabled
U	UNLISTEN mode enabled
X	modem Xecho's transmitted data
Z	remote digital loop enabled
/X1X2	current hexadecimal TEST error count

Table 7: *Query-status symbols.*

ond referenced message, and so on. Each message can be any length but must begin with an alphabetical letter. Only the first letter is interpreted to determine which one of the fifty-two 32-character memory locations is selected. Messages sent are not displayed in order to protect the log-on password security.

Questioning the Modem

At any point during the operation of the modem, it is useful to determine its current status. With the Info-Mate, status can be determined by entering the following command:

<com> QUERY <CR>

If modem status is normal, the message <com> OCHSARDUXZ/X1X2<LF><CR> is sent to the host system. Each character has a specific meaning, as shown in table 7. If a period (.) replaces any of the status characters, it implies the negative or opposite status condition.

Testing the System

No matter how sophisticated or intelligent the modem, if, for some reason, you cannot communicate *your data,* all the features in the world are no help at all. When a failure occurs, it is normally a rather long and drawn-out process to determine where in the system the error has occurred: in your modem, in the telephone line, or in the other modem. This diagnostic process is simplified considerably in the Info-Mate, which can perform any of eight different tests (see box, "Info-Mate Test Modes") upon transmission of the command <com>TEST n<CR>, where the argument n indicates the appropriate test mode.

Info-Mate Test Modes

When a problem occurs during transmission of a message over your modem, you can direct the Info-Mate 212A to perform any of eight self-diagnostic tests. The test numbers shown in parentheses replace the argument n in the test command described in the main text.

Analog loop tests (0,1). *In these two tests for the originate and answer modes, respectively, the host's transmitted data is modulated and looped back through the modem's demodulator, and the resultant received data is transmitted to the host. This mode lets you determine if the modem and data-terminal host are operating correctly together by checking to see if the received data matches the transmitted data.*

Analog loop self tests (2,3). *These two tests are similar to the analog loop tests, except that the modem transmits a pseudorandom data pattern in place of the host data. It then checks to see that the correct data pattern is received. These tests check the modem itself.*

Digital loop test (4). *This test loops the demodulated received data back to the transmit modulator, enabling the modem to retransmit all data sent to it from a remote modem.*

Remote digital loop (5). *In this test, a remote modem rather than the local modem is requested to begin the digital-loop test. The procedure enables the host computer to send data through the local modem to the remote modem and inspect the returned data for accuracy. This test verifies that both local and remote modems and the telephone line are operational.*

Remote digital loop self test (6). *This test is the same as the remote digital loop test, except that data from the modem's internal random pattern generator and checker is substituted for the host's data.*

Self test, end-to-end (7). *In this test, the local modem sends a pseudorandom test pattern to the remote modem and expects to see that same pattern from the remote modem. This test can isolate data errors down to the direction of transmission.*

To Listen Or Not to Listen

The Info-Mate's on-board command interpreter supports two operational modes: LISTEN and UNLISTEN. In the LISTEN mode, host commands are decoded and executed. But in the UNLISTEN mode, host commands are transmitted just like data and are not interpreted. This mode allows the modem to ensure total data transparency. A unique algorithm allows the host terminal or computer to dynamically direct the modem to move in or out of the LISTEN mode.

Either of these modes is initiated using the UNLISTEN command: <com>UNLISTEN n<CR>, where n is either 0 or 1.

When n=1, the modem does not listen for commands in the data mode. When n=0, the modem does not listen for commands in the data mode until the host transmits a break (a start bit, all-0 data bits, and a 0 stop bit). Thereafter, the modem listens for the host until it is commanded to again UNLISTEN. The host's break signal is absorbed by the command interpreter and does not pass through to the phone line. This command assures that inadvertently embedded commands in blocks of data sent through the modem do not affect the data transmission. Both binary and ASCII files can therefore be passed through the modem with complete data transparency ensured.

Quiet, Please

Finally, there is the ZZZZ command—<com>ZZZZ n <CR>—which, appropriately enough, makes the modem quiet. When the command is given, the modem silences its transmitter and stays OFF HOOK. This command typically serves as a transition from data mode to voice-communication mode. To return to the data mode, the ORIGINATE or ANSWER command may be issued. ■

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Developing a Truly Portable Visicalc

Now you can use an electronic worksheet on your HP-75 portable computer

by William T. Johnson

One of the most flexible and useful tools busy professionals can have in a portable computer is an electronic spreadsheet. In addition to providing standard analysis capability, a spreadsheet can help keep track of travel expenses, sales transactions, and data collection in the field, and answer urgent "what if" questions for the user on the run.

With the goal of providing such capability, Hewlett-Packard's Portable Computer Division decided to adapt Visicorp's popular electronic spreadsheet, Visicalc, to the HP-75 portable computer. The primary objective was to provide a truly portable version of this powerful software while retaining its close compatibility with other Visicalc products. Users already familiar with Visicalc will quickly recognize its characteristic features in the adapted version.

Another design criterion was to take full advantage of some of the HP-75's sophisticated capabilities—in particular, the computer's multiple-file structure in RAM (random-access read/write memory), which permits a variety of file types: BASIC programs, text and appointment files, and, with the introduction of Visicalc, worksheet files. This structure permitted development of some unique Visicalc features, including multiple worksheets in RAM, data references from one worksheet to another, and formulas in cells that call BASIC programs. In addition, BASIC programs can operate on worksheets.

To meet these criteria, an HP software team generated all-original code. The result was a 32K-byte plug-in ROM (read-only memory) module that connects to one of the HP-75's three expansion slots. To speed development, the team programmed the functional shell (VCBASIC) in 11K bytes of BASIC. VCBASIC is supported by 21K bytes of assembly language that assist in speed-critical areas and allow interaction with the HP-75 operating system. Assembly support for VCBASIC is called via keywords, which also enable other BASIC programs to create and manipulate worksheets. Table 1 lists those keywords and their functions.

The Portable Environment

The HP-75 provides the power and sophistication of a high-level-language computer in a portable system. Measuring 10 by 5 by 1¼ inches, it weighs 26 ounces and is fully battery operated. The unit features a single-line, 32-character LCD (liquid-crystal display) and has a built-in Hewlett-Packard Interface Loop (HPIL), so it can be used with a full-sized video display and other peripheral devices (see photo 1). A built-in magnetic card reader can be used for storing RAM files, or a digital cassette connected through the HPIL can be used for mass storage.

Standard memory consists of 16K bytes of CMOS (complementary metal-oxide semiconductor) RAM, expandable to 24K bytes. The 48K-byte BASIC operating system includes time- and appointment-mode capabilities. The keyboard is fully redefinable and overlays are available for special user needs. The HP-75 can also run BASIC and assembly language from up to three plug-in ROM modules with as much as 32K bytes apiece.

To adapt Visicalc to this portable environment, the design team had to decide how to implement the single-line display as a window into the worksheet while preserving the program's character. It chose to have the display show one cell of a worksheet at a time. Each cell can be accessed using either standard cell coordinates or user-defined labels for column and

Photo 1: *Visicalc spreadsheets can be viewed on the HP-75's single-line display, on a video monitor, or on printouts.*

row headers. Pressing the Time key toggles between a cell's default headers (columns A, B, C, etc. and rows 1, 2, 3, etc.) and such user-defined headers as January, February, March (columns) and Rent, Auto, Taxes (rows). Similarly, touching the Appt key toggles between the result-display mode for a cell and the formula-display mode.

For example, suppose the column C header is defined as March and the row 4 header is Expenses, which covers the sums of items in rows 1 to 3. If March expenses were $1000, this figure can be accessed by using either the default coordinates:

C4: 1000

or the user-defined coordinates:

March ˆ Expenses: 1000

You can also choose to view the formula that was used to calculate the $1000 figure, either in terms of default headers:

C4: SUM(C1 . . . C3)

or as more meaningful, user-defined headers:

March ˆ Expenses:
SUM([March ˆ Rent] . . .
[March ˆ Taxes])

A problem that arises with this arrangement is how to examine a cell's entire contents when they exceed the 32-character capability of the LCD. If you are viewing (not editing) the worksheet, arrow keys move the window framed by the display from cell to cell, across the columns or up and down the rows. Then, within a cell, the Run key scrolls the contents forward and Shift-Run scrolls them backward. To help you read very long contents, Tab and Shift-Tab keys cause the contents to skip forward or backward across the display one window length at a time. However, during the editing of cell contents, movement within the cell is controlled by the arrow keys.

To gain the full benefit of using the portable spreadsheet, you must also be able to use peripherals freely, as with a conventional desktop system. To permit such use, the HP-75 Visicalc must use the HPIL capability to full advantage. Provisions have thus been made to vary column width for video and printer outputs and to set line length and width parameters for HPIL video interfaces. A special printing option allows column-order listings of all the formulas used in a worksheet, along with their cell coordinates. Finally, Visicalc was also

made compatible with the HP-75 mainframe COPY command to permit storing worksheets on a magnetic card or digital cassette tape.

Product Design

Rather than running as a program, Visicalc was added to the HP-75 as another operating mode, along with Time, Appt, and Edit. One advantage of this approach is that the Attn key does not halt Visicalc but instead always returns you to the top operational level. The top level is used for viewing the spreadsheet and entering the other two operational levels, cell-entry and command. Several operations can be carried out at the top level, including window movements. In addition, a Go To operation moves the window directly to the cell specified, and an alternate window can be defined to allow single-key toggling between two closely related cells.

The cell-entry level is entered automatically by merely selecting a cell and beginning to enter data. Full cell editing is allowed during cell entry; user-defined headers in formulas can also be entered there. Several functions are available at the cell-entry level to help create formulas, including AVERAGE, which computes the average of numbers in a list; MAXL, which computes the maximum value of numbers in a list; and SUM, which computes the sum of numbers in a list. Moreover, you can create additional extension functions using BASIC programs that can be used in formulas in the same manner as standard cell-entry functions.

You enter the command level by pressing the slash (/) key, which brings a command menu onto the display. Commands are then chosen by pressing the corresponding letter keys, which include D (deletes the column or row in which the cell display resides), M (moves the column or row within the worksheet), R (replicates cell entries across a column or row), I (inserts a blank column or row), and H (enters user-defined headers). Using BASIC programs, you can also define extended commands, which then have their own letters added to the command menu. (This capability will be discussed later in more detail.)

Keyword	Description
ACTIVE$	returns the file name of the active worksheet
AVERAGE	returns the average of a list
BLANK	blanks a cell
CALLVC	similar to the HP-75 CALL statement
CELLTYPE	returns the type of a cell
CHOICE$	returns the legal choices from a message
CLRLCD	clears the LCD
CLRSCR	clears the video
COL	returns the column number of a coordinate
COLWIDTH$	returns a local column width
COORD$	returns a coordinate given the column and row
CURSOFF	turns off the cell cursor on the video
CURSON	turns on the cell cursor on the video
DECOMP$	returns a formula from Visicalc scratch space
DELCOL	deletes a column in a worksheet
DELROW	deletes a row in a worksheet
DIR$	returns file names chronologically
DSP$	returns the name of the DISPLAY IS device
DUMP	sends a worksheet to the printer or video
ENDVC	ends Visicalc
ERROR	returns the value ERROR
FIRSTREF$	returns the first cell reference in a formula
GETFORMAT	returns a local format from a cell
GETFORMULA$	returns a formula from a cell
GETLABEL$	returns a label from a cell
GETSETUP$	returns a printer-setup string from a worksheet
GETSTATUS	returns status information from a worksheet
GETVALUE$	returns a value from a cell
GETWIDTH	returns a local column width from a worksheet
HIGH$	returns a string that is highlighted
INCAT	checks the existence of a file
INLINE$	extends keyboard input capabilities
INPBUF$	returns the contents of the input buffer
INPPTR	returns the position of the edit cursor
INPWIN	returns the position of the first character in the LCD window
INSCOL	inserts a column in a worksheet
INSROW	inserts a row in a worksheet
INTERP$	calculates a formula in Visicalc scratch space
IRFLAG	returns the cursor type
LEGAL	checks the syntax of a coordinate

Table 1: *These 82 keywords were developed in assembly language to support VCBASIC.*

To program these capabilities expeditiously, Visicalc was broken down into functional modules. One module, for example, handles top-level functions and another defines special-key functions. Each command-level function has its own module. Additional support modules perform functions that are generally transparent to you, including video support, user interface and memory management, and parsing, interpreting, and decompiling formulas. Many of these functions can be invoked using the keywords developed in assembly language to support VCBASIC. The capability to implement user-defined column and row headers was integrated into all modules.

Product Development

As much of the software as possible was developed in BASIC because that language is easier than others to write, debug, and modify. Its disadvantages are that it is not compact, presenting ROM space constraints,

Keyword	Description
MARK	marks a cell reference as being relative
MAXCOL	returns the maximum column from a worksheet
MAXL	returns the maximum of a list
MAXROW	returns the maximum row from a worksheet
MEAN	returns the mean of a list
MESSAGE$	returns a message
MINL	returns the minimum of a list
MOVCOL	moves a column in a worksheet
MOVROW	moves a row in a worksheet
NA	returns the value NA
NEXTREF$	returns the next cell reference in a formula
PARSE	converts a formula into its internal form
PRT$	returns the name of the PRINTER IS device
PRWIDTH?	returns PWIDTH
PUTFORMAT	puts a format into a cell
PUTFORMULA	puts a formula into a cell
PUTLABEL	puts a label into a cell
PUTRLABEL	puts a repeating label into a cell
PUTSETUP	puts a printer setup string into a worksheet
PUTSTATUS	puts status information into a worksheet
PUTVALUE	puts a value into a cell
PUTWIDTH	puts a local column width into a worksheet
RCLVAR	recalls variables
RECALC	recalculates a cell or a worksheet
REPLICATE	performs replication
ROW	returns the row number of a coordinate
SETWIN	sets the LCD window
SOURCE	establishes the source range for REPLICATE
SPEW	displays the internal form of a formula
STOVAR	stores variables
SUM	returns the sum of a list
TARGET	establishes the target range for REPLICATE
UNMARK	unmarks marked cell references
UPCOL	returns the column boundary to be displayed or printed
UPROW	returns the row boundary to be displayed or printed
VALCHK	similar to the HP-75 VAL function
VC	runs Visicalc
VLENGTH	sets the length of the video
VWIDTH	sets the width of the video
WAITKEY$	similar to the HP-75 KEY$ function
WINSIZ	returns the size of the LCD window
WORKSHEET	specifies the active worksheet

nor does it effectively perform speed-critical calculations. Many functional modules that would eventually be converted to assembly language, at least in part, were initially sketched out in BASIC. An example of how this approach was followed can be seen in the development of the parser module.

The parser's role is to check for proper syntax of formulas entered into worksheet cells. One problem is that a variety of nonstandard syntactical combinations are possible. A formula can, for example, include user-defined headers, such as

```
January ^ Remain:
  [Net Pay] - [January ^ Expenses]
```

or include cell references to other worksheets:

```
April ^ Sales:
  1.02*[April ^ Sales]:FY1982
```

where FY1982 is the name of another worksheet in RAM. It can also include calls to BASIC programs, such as

```
Group A ^ std dev:
   STD ([Group A]1 . . .
          [Group A] 47)
```

where STD is a program that calculates the standard deviation of a list of parameters. Making a first pass in BASIC permitted rapid development of the parsing algorithms needed to take into account all these combinations. Assembly-language subroutine calls to the HP-75 mainframe parser were then used to gain speed in critical areas.

Once assembly language had been used to develop display and keyboard-control keywords, BASIC proved adequate for producing the LCD user interface for each functional module. Care was taken in designing key functions to optimize user friendliness. For example, to alleviate potential confusion over the dual role of arrow keys, a flashing cursor appears when the arrows are used for cell editing, and no cursor appears when, in the top level, arrows are used to move the display window about the worksheet. Similarly, the split-window feature of other Visicalc versions was adapted by creating an alternate window that can be accessed via one keystroke. Assembly language was also needed to program other support modules such as memory management.

The memory-management module stores worksheet data in a compact format as it is entered into cells. Each data item is matched to its cell location by a pointer table. A goal of the design was to return every usable byte to the user. Visicalc overhead in RAM, plus HP-75 operating system overhead, is approximately 4600 bytes, which means that you have either 12K bytes (with standard HP-75 memory) or 20K bytes (with the HP 82700A memory module added) available to store worksheets and other files. Even the coordinate location 0,0 of the pointer table was utilized, providing an intercept for BASIC programs at start-up, cell entry, and end of Visicalc. This efficient memory management thus permits the HP-75's 20K-byte RAM to hold 31K bytes of HP-86/87 worksheet in-

formation or 27K bytes of HP-85 worksheet information when the system is used in conjunction with HP-85, 86, and 87 personal computers.

Although the maximum allowable number of rows or columns is 255, available RAM determines the practical limits on the size of worksheets. How much of this space is actually available depends on how many cells are filled as well as the information in them. An empty worksheet of any size requires only 22 bytes of memory. As cells are filled in, the memory-management module dynamically reconfigures the worksheet to accommodate the data into a rectangle just large enough to include the highest-numbered column and row that contain filled cells.

The interaction between VCBASIC and assembly language in a functional module can be illustrated using the Insert command to insert a new column. VCBASIC first sets up the following prompt in the LCD:

Insert: Col Row

After the C key is pressed, a VCBASIC routine checks to see that this input is valid and branches to the appropriate line in the functional software shell. Assembly language, meanwhile, provides VCBASIC with necessary information on the spreadsheet—using the keyword MAXCOL, which returns the last active column on the right—and performs the required memory management for a column insert, using the keyword INSCOL. The line of VCBASIC that initiates the inserting of a column is thus IF MAXCOL<255 THEN INSCOL C, which translates into: "If the maximum column number in the worksheet is less than 255, then insert another column at the current column position designated by the VCBASIC variable C."

Using Keywords

A total of 82 keywords have been developed in assembly language to support VCBASIC. Some, such as those just described, are involved in memory management. Others are

Listing 1: *A BASIC program for recording travel expenses.*

```
10 ! travel expense data collector - wtj - 05/11/83
100 CLRSCR @ WORKSHEET "trvlexps" @ M$=STR$(MAXCOL-2)
105 INPUT "Enter day number: ",M$;N
110 N=INT(N) @ IF N<1 OR N>9 OR N>MAXCOL-1 THEN BEEP @ GOTO 105
120 FOR C=1 TO MAXCOL-2
130 IF C=N THEN 300
140 NEXT C
150 DISP "Please wait..."
200 INSCOL C @ PUTFORMAT C,1,4 @ PUTFORMAT C,2,4
205 PUTLABEL C,0,"Day "&STR$(N) @ PUTRLABEL C,8,"-" @ PUTRLABEL C,20,"-"
208 C$=CHR$(64+C)
210 PUTFORMULA C,9,"sum("&C$&"3..."&C$&"7)"
220 PUTFORMULA C,21,"sum("&C$&"11..."&C$&"19)"
230 PUTFORMULA C,23,C$&"9+"&C$&"21"
300 C$=GETLABEL$(C,0)
305 FOR R=1 TO 2
310 V$=GETLABEL$(C,R)
320 DISP COORD$(C,R,5);": "; @ INPUT "",V$; V$ @ PUTLABEL C,R,V$
330 NEXT R
400 B=3 @ E=7 @ GOSUB 1000
410 B=11 @ E=19 @ GOSUB 1000
490 DISP "End of program"
500 END
1000 FOR R=B TO E
1010 IF CELLTYPE(C,R)=6 THEN V$="" ELSE V$=GETVALUE$(C,R,0)
1020 DISP COORD$(C,R,5);": "; @ INPUT "",V$;V$
1030 ON ERROR GOTO 1050
1040 PUTVALUE C,R,V$
1050 OFF ERROR @ NEXT R
1060 RETURN
```

Listing 2: *An empty travel-expense worksheet.*

```
Travel Expense Report

83/05/30 23:45:33

TRVLEXPS     :    A     B      C
             :  Day 1        Total
-------------+--------------------
  1 date     :          :
  2 city     :          :
  3 air      :          :       .00
  4 auto     :          :       .00
  5 mileage  :          :       .00
  6 parking  :          :       .00
  7 addtrans :          :       .00
  8          :----------+----------
  9 Transpor :       .00:       .00
 10          :          :
 11 room     :          :       .00
 12 brkfast  :          :       .00
 13 lunch    :          :       .00
 14 dinner   :          :       .00
 15 bus conf :          :       .00
 16 porter   :          :       .00
 17 laundry  :          :       .00
 18 phone    :          :       .00
 19 addlodge :          :       .00
 20          :----------+----------
 21 Lodging  :       .00:       .00
 22          :          :
 23 Expenses :       .00:       .00
```

Listing 3: *A filled-in worksheet of travel expenses.*

```
Travel Expense Report

83/05/30 23:47:10

TRVLEXPS:  Day 1   Day 2   Day 3   Day 4   Day 5       Total
--------+----------------------------------------------------
date    :  May 4   May 5   May 6   May 7   May 8:
city    :     SF      SF      LA      LA  Prtlnd:
air     : 217.87          112.34          256.10:     586.31
auto    :  45.13   12.47   45.32                :     102.92
mileage :  11.54    2.45   10.34                :      24.33
parking :   5.00            6.00                :      11.00
addtrans:          13.39           15.12   15.00:      43.51
        :---------------------------------------+------------
Transpor: 279.54   28.31  174.00   15.12  271.10:     768.07
        :                                       :
room    :  35.57   43.67   48.89   48.89        :     177.02
brkfast :   5.87    4.33    7.89    5.13        :      23.22
lunch   :  12.65   10.03    5.12    7.56    3.77:      39.13
dinner  :  15.34   21.44   17.76   16.34        :      70.88
bus conf:          30.00                        :      30.00
porter  :   7.00    5.00                        :      12.00
laundry :           6.70           12.00        :      18.70
phone   :  12.72            4.62   14.62        :      31.96
addlodge:                                       :        .00
        :---------------------------------------+------------
Lodging :  89.15  121.17   84.28  104.54    3.77:     402.91
        :                                       :
Expenses: 368.69  149.48  258.28  119.66  274.87:    1170.98
```

used in the parser and decompiler or for user-interface support. Together these keywords comprise what could be called a spreadsheet language, which provides the programmer with the tools to access and manipulate HP-75 Visicalc worksheets from BASIC programs. Use of this powerful language extension is fully described in a programmer's reference manual included with the Visicalc software.

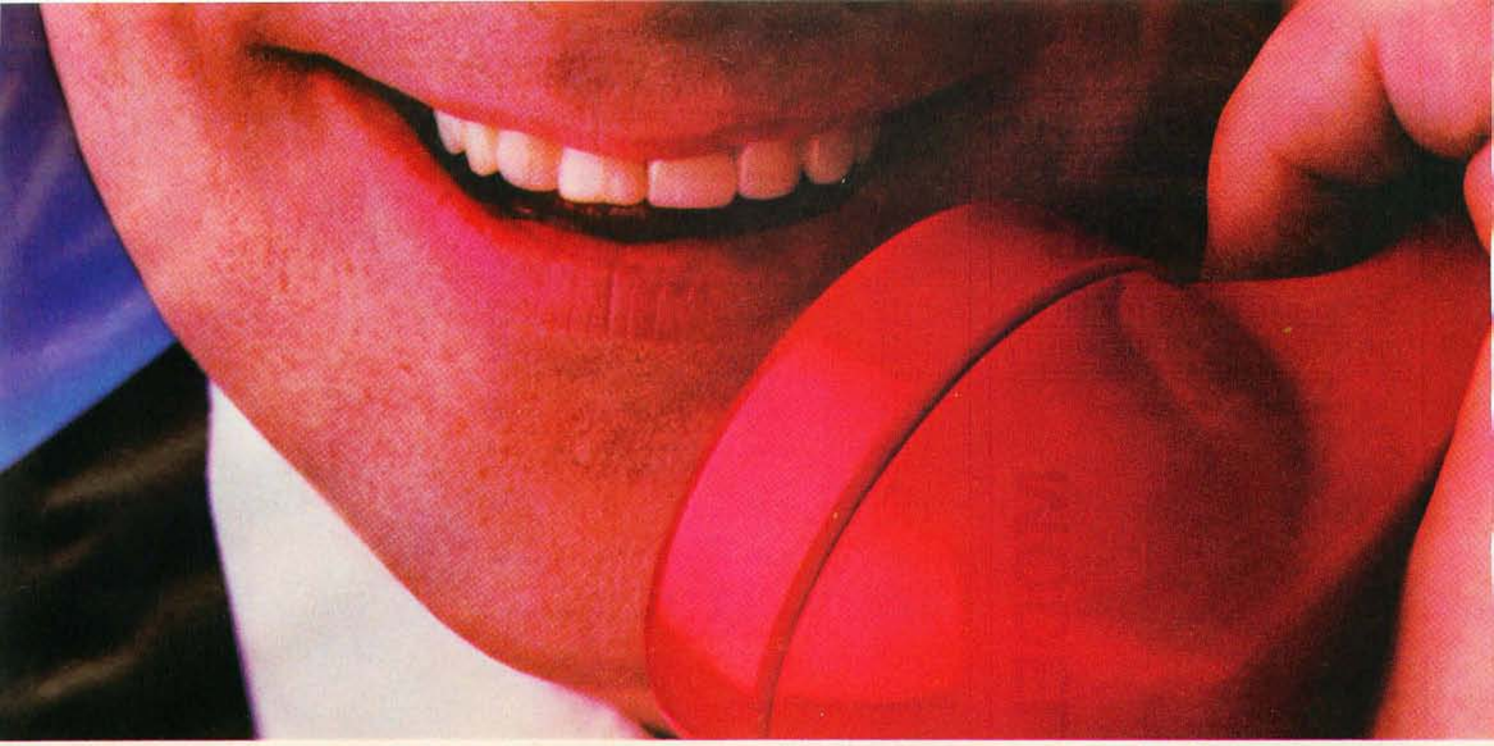
The use of keywords can best be introduced by an example. The BASIC program in listing 1 uses the spreadsheet language to prompt you for travel-expense items and enters the collected data into the appropriate worksheet cells. Listing 2 shows the initial appearance of the travel-expense worksheet.

The BASIC program uses keywords to create and open the worksheet "trvlexps" (line 100) and to prompt you for day entry number. If a new day number is specified, the program expands the worksheet by inserting a new column and puts the appropriate formulas into the new column (lines 200 to 230). Next, the program steps through the worksheet, accessing column and row headers and current cell entries, then prompts for more information using the worksheet headers and the cell data as default values. Finally, the program puts the collected inputs into the worksheet (lines 305 to 1060). An example of a completed travel-expense worksheet appears in listing 3.

Calling BASIC Programs

BASIC programs can be called from cell formulas because HP-75 Visicalc uses its own interpreter in assembly language instead of the HP-75 mainframe interpreter. In addition, this module also interprets VCBASIC (Visicalc thus interprets itself) and a Visi-command BASIC program that extends the Visicalc command set. Using this interpreter gives Visicalc two important types of control. First, it allows Visicalc to intercept any errors from called BASIC programs, so that you are returned to the worksheet and not locked out. Second, it prevents the Attn key from halting VCBASIC and therefore exiting Visicalc.

Calling BASIC programs from formulas in cells introduces a new



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Listing 4: *This investment-analysis worksheet includes worksheet formulas.*

```
Investment analysis on the sale of property.

83/05/31 14:51:11

INVEST        :      A          B            C
              :   amount     number       period
--------------+------------------------------------
   1 cf1      :   -4850.00       1          11/80
   2 cf2      :    -180.00       7    12/80-06/81
   3 cf3      :    -192.00       4    07/81-10/81
   4 cf4      :    -310.00       1          11/81
   5 cf5      :    -192.00      11    12/81-10/82
   6 cf6      :    -350.00       1          11/82
   7 cf7      :    -192.00       9    12/82-08/83
   8          :------------------------------------
   9 total    :  -11378.00 <-----cash invested
  10          :
  11 selling:    25000.00
  12 balance:   -10767.00
  13 closing:    -2290.00
  14          :-----------
  15 net      :   11943.00 <-----cash returned
  16          :
  17 IRR      :       2.40 % per year
  18 NFV      :   -1174.33    7.00 % discount


Worksheet formulas:

83/05/31 14:52:25

INVEST

amount^total: A1*B1+A2*B2+A3*B3+A4*B4+A5*B5+A6*B6+A7*B7
amount^closing: -.1*A11+210
amount^net: A11+A12+A13
amount^IRR: TVM(1,2,A1...A7,A15,B1...B7,1)*12
amount^NFV: TVM(2,2,A1...A7,A15,B1...B7,1,B18/12)*(1+B18/(12*100))^SUM(B1...B7)
```

dimension in spreadsheet capability and is a unique feature of HP-75 Visicalc. Again, the easiest way to introduce this capability is through a brief example, this time a program (listing 4) for analyzing investments.

Here, calls are made in two formulas to the custom program TVM (time value of money). In cell A17, TVM is called to calculate the internal rate of return (IRR) realized by sale of property. In cell A18, TVM is called to calculate the net future value (NFV) of the cash returned, assuming a 7-percent discount rate. The multiple-file-structure capability is used here for passing parameters between a worksheet and a BASIC extension function. At recalculation, TVM reads the worksheet values written to a data file named VISIDATA and returns the calculated value back to the worksheet cell through that file.

Other BASIC programs can also be called from the command level of HP-75 Visicalc, although the process is somewhat more complicated. First, a change must be made in the command-level prompt. This prompt is built from message 21 (command) and message 22 (DFGHIMPRVW-) in the Visicalc ROM. The keyword MESSAGE$ is used by VCBASIC to access these messages. Alternative messages can be accessed through MESSAGE$ if they reside in the text file named VISIMSGS. By entering a replacement for message 22 into VISIMSGS:

22 DFGHIMPRVW-E

the command-level prompt will appear as

Command:
DFGHIMPRVW-E

The final letter E provides the hook needed to call a BASIC program that defines a new command-level function. Such "Visi-command" programs are numbered sequentially in the order of the letter or letters that follow the hyphen in the command-set message. Pressing the letter E in response to the new command-set

message above would call a user-written BASIC program called VISICM1. If another letter were added, it would call VISICM2, and so forth.

Visi-command programs define a set of commands that act as extensions of those defined in VCBASIC. They provide the means by which you can customize Visicalc in an unprecedented manner. Using this capability, for example, you can command the sorting and alphabetizing of data by column or row. Worksheets can be translated into other data formats. Considerable amounts of text can be entered and then formatted. Other possible command extensions include plotter and printer graphics output, creation of schedule charts, and utilities for collection and management of data.

The Resulting Product

The final HP-75 Visicalc package contains the 32K-byte plug-in module that supports the features described here, an owner's manual and a programmer's reference manual, and a keyboard overlay indicating redefined keys used with Visicalc. In addition, magnetic cards provide you with a sample worksheet, a sample BASIC program (that solves for internal rate of return), and some BASIC Visi-command programs for use with the command-extension feature. Command extensions provided include sorting, alphabetizing, and clearing data from worksheets.

The HP-75 Visicalc offers at least five unique features: (1) the first spreadsheet capability on a fully portable personal computer that can also operate as a desktop system, (2) the ability to define extended functions as BASIC programs, (3) the ability to extend the feature set for special applications, (4) the ability to overlay multiple worksheets in RAM, and (5) the ability to automate the creation and manipulation of worksheets from BASIC programs using a spreadsheet language.

The designers anticipate that by combining sophistication and portability, this new version of Visicalc will find a wide market. First-time users of an electronic spreadsheet will be able to use most of the important product features within a few hours, and sophisticated users can take advantage of its hooks to develop enhancements for an almost unlimited variety of special applications. In addition to providing the features described here, the portable Visicalc can support multilingual prompting for international markets.

In short, the HP-75 Visicalc provides the active professional with worksheet capability that can be used almost anywhere. Its unique features promise to set a new standard for power and convenience in software designed for the truly portable computer market.■

William T. Johnson, a research and development engineer at Hewlett-Packard's Portable Computer Division (1000 NE Circle Blvd., Corvallis, OR 97330), headed the team that designed the HP-75 Visicalc.

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The Gavilan—A Full-Function Portable Computer

CMOS logic, LCDs, and increased integrated-circuit density helped designers fit the computer and its printer into a briefcase

by F. John Zepecki

Gavilan Computer Corporation designed its mobile computer to meet the needs of the traveling professional. The company's main goal was to create a completely self-contained, full-function computer system small enough to slip into a briefcase and light enough to be easily carried.

The self-powered Gavilan (see photo 1a) has a full-size keyboard and numerical keypad, an easy-to-use display, and an internal memory large enough to support popular applications. In addition, it has removable mass storage, a modem, and serial port, and can perform everyday computer functions such as word processing and number crunching with well-integrated software. The system comes with an add-on printer that uses 8½-inch-wide paper and everything is built into a case that measures approximately 11 by 17 by 3 inches (see photo 1b).

Design Criteria

At Gavilan, we decided that several criteria had to be met if the mobile computer was to be useful to the traveling professional. The computer had to be able to run for a long time on an internal battery pack (ideally, for at least 8 hours without recharging), yet it could not weigh more than 15 pounds. It had to have a standard QWERTY keyboard with a numeric 10-key pad (we felt that miniature keyboards did not lend themselves to touch typing) and a bit-mapped display that could reproduce at least 8 lines of text as well as graphic symbols and icons. The computer also had to have 64K bytes of memory expandable to 1 megabyte, a built-in or add-on cassette for disk storage, an integrated modem, a serial port, and a printer. Furthermore, it had to support a standard operating system.

The Gavilan's mouse is actually a touch panel formed by two parallel resistive membranes separated by spacers.

Incorporating all these features into a small package was not as much of a problem as anticipated because of the industry's progress in increasing integrated-circuit density, the availability of CMOS logic, and the perfection of relatively large-area flat liquid-crystal displays (LCDs).

A Portable 64- by 400-Pixel Display

To ensure the usefulness of the new computer's display, we agreed that it would have to present considerable amounts of data without scrolling. Furthermore, a graphics capability was essential to support anticipated applications.

A 24-line, 80-character LCD would have been ideal, but no such displays were available. Eventually a 64- by 400-pixel bit-mapped LCD was decided upon.

Resident firmware was then developed to produce lines of 80 characters. And, because the display is bit-mapped, icons and other graphic elements can be displayed.

Use of the large LCD complicated the design of the display controller. Because crystal fluid's persistence is shorter than the time it takes to scan through the display's 64 pixel rows, the LCD is divided into the horizon-

(1a)

(1b)

Photo 1a and 1b: *The Gavilan mobile computer offers a full-size, full-travel keyboard with a numeric 10-key pad and a fold-up 8-line, 80-character liquid-crystal display. The snap-on printer adds less than 5 inches to the computer's length, yet provides 50 cps throughput onto standard plain paper. The computer and printer fit easily into a standard-size briefcase and weigh less than 15 pounds.*

tal halves of 32 rows each, and the drivers are multiplexed so that both halves are scanned simultaneously. As a result, the display controller supplies two data streams, one for each half of the display. This way, the display's 64 rows are painted in the time it takes to paint 32 rows.

Although getting an 8-line, 80-character display in the limited space available was an achievement, an 8-line page restricted our ability to process lengthy files. To simplify this, a special Zoom function was added in firmware. The Zoom function presents an outline image of a document with the positions of the eight active lines shown in a rectangular overlay. Using this function, the overlay can be placed anywhere on the page outline, and the enclosed eight lines are displayed by a single-stroke command. Conventional scrolling is also available through a set of pressure-sensitive scroll keys located on a panel above the keyboard. Because an 8-line display might not be ideal for all applications (even with Zoom), additional provisions make it possible to feed a 24 by 80 composite video signal to an external monitor.

The LCD, its logic, and associated row and column drivers are housed in a separate assembly attached by hinges to the computer case over the keyboard. A pair of spring-loaded posts at opposite ends of the keyboard raise and lower the display for easy viewing. The display lowers for stowing as the keyboard cover.

The mechanical interface is made by hinges fastened to the top of the posts and bottom, or screen side, of the display lid (see photo 2). The electrical interface is provided by a ribbon cable in one of the posts. To operate the computer, the user pushes a button on the right side of the case, releasing the posts, which lift the bottom of the display lid above the top of the computer case. The lid then swings manually into an upright position. Mechanical detents providing 15-degree indexing beginning at 90 degrees let the user lock the display into a comfortable viewing angle. When the user is done computing, he or she folds the display lid over the keyboard and pushes the case until it locks in place.

The Gavilan has a typewriter-like keyboard with full-travel keys on the industry-standard ¾-inch spacing. The keyboard meets the DIN standards for home-row height and angle. A numeric 10-key pad was integrated into the keyboard design to suit the needs of the mobile executive.

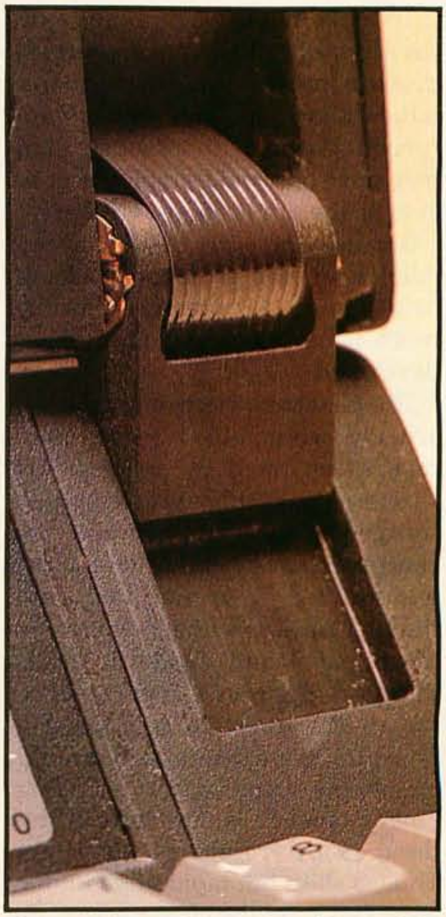


Photo 2: *Keys to the user-friendliness of the Gavilan's packaging are the two spring-loaded posts and the hinge assemblies that attach the display housing to the computer. The posts permit the housing to form a cover that seals the keyboard when not in use yet rises to lift the display into its operating position.*

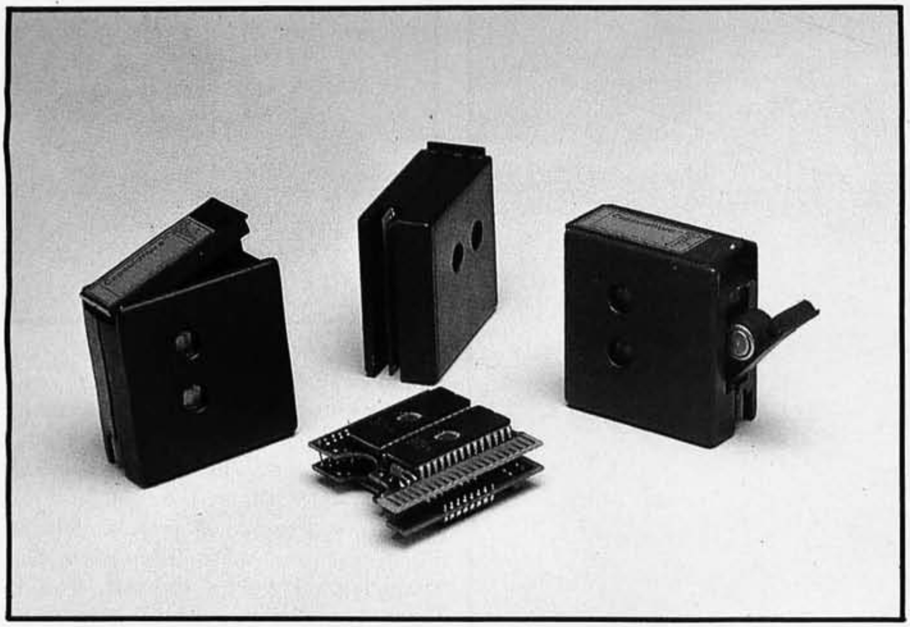


Photo 3: *Memory expansion is provided in the form of unique capsules that contain the appropriate memory chips and the boards required to support them.*

An Electronic Mouse

To make the new computer more user-friendly than a conventional desktop machine, we used a mouse rather than an individual cursor and function keys. With a mouse, symbols and icons could simplify user access of the applications software.

Because the size of the system didn't lend itself to the use of a handheld mouse, a pressure-sensitive touch-panel electronic mouse was developed.

The Gavilan's electronic mouse is actually two parallel resistive membranes separated by spacers. The sheets in the membrane assembly are scanned so that the location of any contact closure is quickly determined and encoded. To operate the mouse, the user presses a finger against the touch panel and moves it in the direction he wants the cursor to move. The direction and speed of finger travel are determined through membrane scanning and encoding. Finger speed is converted into distance by a squares algorithm. Thus, a short but rapid finger movement can send the cursor across the entire display. Conversely, very slow finger movement results in pixel-by-pixel cursor movement, providing precise control of the cursor position. The location of the finger's contact with the touch panel is unimportant.

The touch panel supports software presenting various directories. The user selects a listing, positions the cursor next to it, and taps the panel to execute the selected action. The listing is then highlighted in reverse video. The cursor does not have to be in a specific location; it need only be positioned in the cell containing the desired listing.

The entire panel above the keyboard is a membrane assembly. On either side of the centrally located touch area are pressure-sensitive function keys that call up menus, scroll the display, and permit other communications with the processor. The panel is covered with a layer of mylar that should wear indefinitely.

Expandable Memory

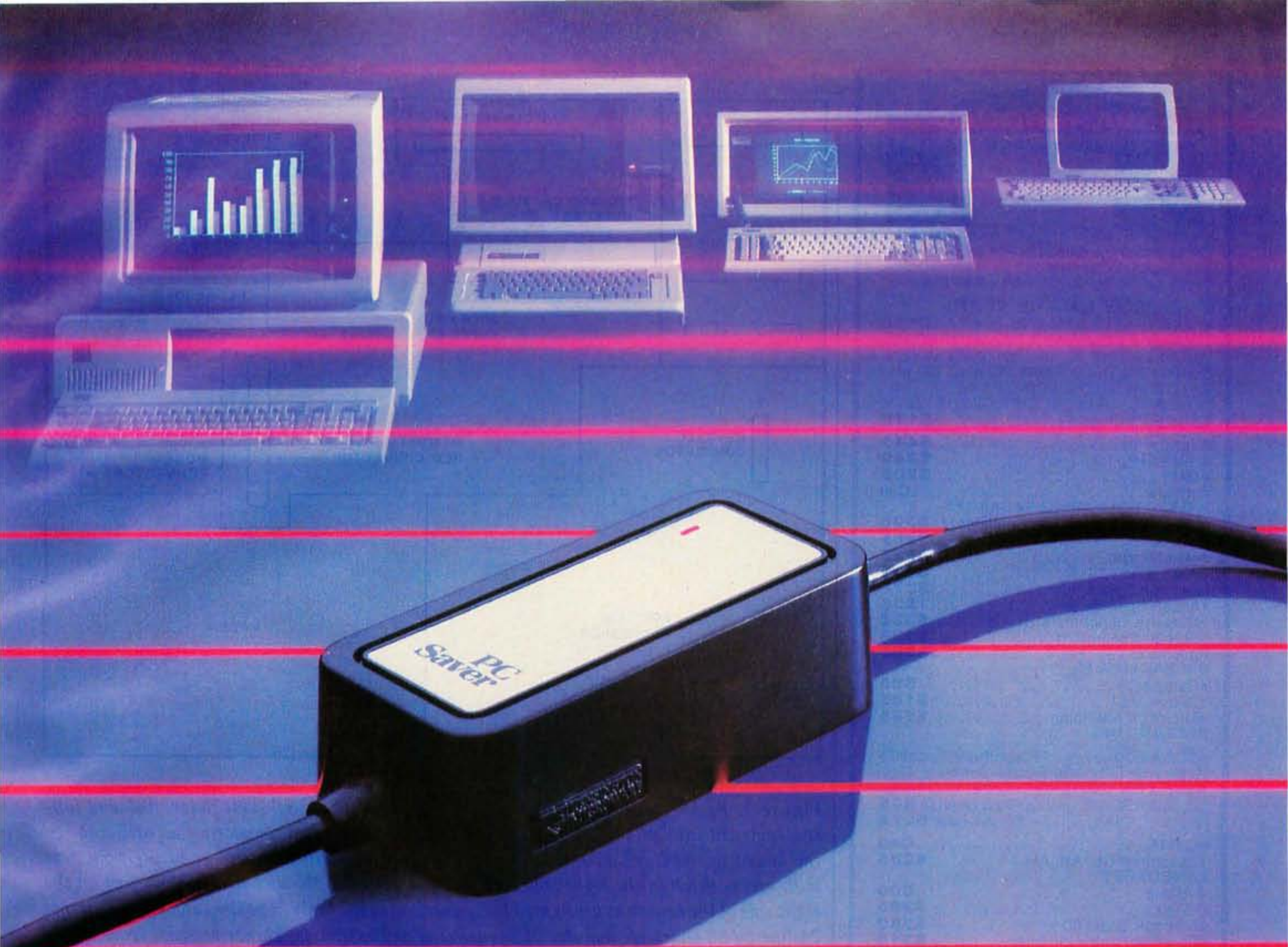
The basic Gavilan has 64K bytes of user RAM (random-access read/write memory); 32K bytes are housed on the main printed-circuit board, and the remaining 32K bytes are supplied in a special capsule designed to fit into the limited space available. This memory provides better protection for the circuitry than plug-in cards or chips.

Inside each capsule is a pair of printed-circuit boards (see photo 3). The edge of one board protrudes from an opening in the capsule's bottom and serves as a male connector. There are four mating connectors used for capsule inserts on the main printed-circuit board in the left-rear corner of the computer, next to the 3½-inch floppy-disk drive.

Levers are built into the top of each capsule to facilitate removal of the capsules from their mating sockets. (Lack of space prohibits manual removal of the capsules from the sockets.)

A lithium-thionyl-chloride battery in each capsule provides memory backup. With ordinary use, the battery will last more than a year. The condition of each lithium battery is monitored through an A/D converter by a resident 80C51 CMOS single-chip microcomputer. When the battery needs to be replaced, the 80C51 signals the computer, which notifies the user through a message on the display. The contents of the capsule can be loaded onto disk before the battery is removed. Replacement of the battery involves little more than swinging out the bracket in the capsule's side and swapping batteries.

Although each expansion capsule contains 32K bytes, the memory is mapped as 64K bytes, with the remaining 32K bytes in ROM (read-only memory) on the main board. This ROM holds the Gavilan operating system. Although mapping the operating system into four expansion modules may seem redundant and wasteful, it provides much faster response to commands because the processor doesn't have to go somewhere else to pick up operating instructions. Even more significant, mapping the operating system into the memory space of all the capsules permits them to be used as applications modules containing both programming and operating-system instructions. Plugging in a capsule with an applications program in ROM converts the computer into a dedicated business machine preprogrammed to provide user support with no other instructions. If more than one applications capsule is installed, the program names appear in the main desktop, or directory. In this case, the touch panel is used to select and execute the desired application.



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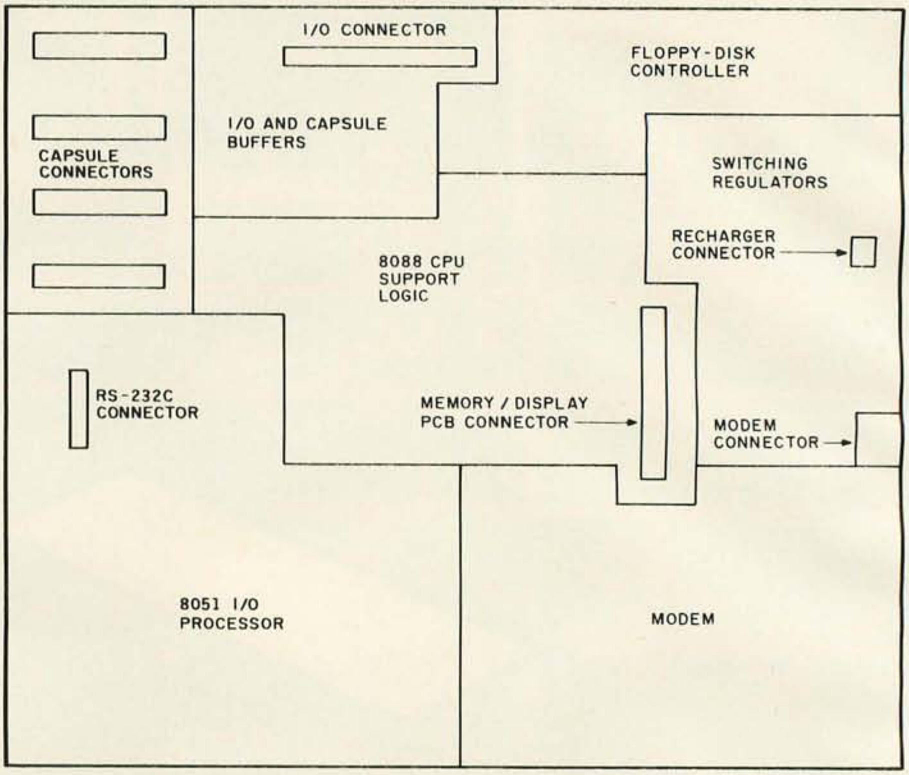


Figure 1: *Packing a 16-bit microcomputer complete with a 360K-byte floppy disk and full-size keyboard into an 11.4- by 11.4- by 2.7-inch case required some creative packaging. In the layout of the Gavilan, the 3½-inch floppy disk is mounted crosswise at the right rear with access through the right side of the case. In front of the disk-drive access port on the right side of the case jacks are located for connection to the built-in modem and for an external 24-line by 80-character monitor. The enclosure at the left-rear corner reserves space for up to four-plug-in memory capsules. The main board fills most of the bottom of the case. Resident memory is contained on two boards mounted above the main board between the disk drive and the keyboard. Above the memory boards is the display controller board.*

Internal Layout

Most of the Mobile Computer's electronics are on the main printed-circuit board on the bottom of the computer's 11.4- by 11.4-inch interior (see figure 1). These electronics include the DC/DC converter, the connectors for interfacing the printer and/or the second disk drive, an RS-232C port, a keyboard, an integrated-mouse/function-key touch panel, and a 300-bit-per-second (bps) modem with auto-answer and auto-dial. The modem accepts domestic frequencies in accordance with Bell 103 and European frequencies in accordance with CCITT V.21.

Two memory boards housing 48K bytes of resident ROM containing the display messages and the operating systems and the 32K bytes of user RAM are mounted above the main board and are interfaced by connectors. These memory boards are located between the battery pack housing and the capsules' housing.

A third board stacked above the two memory boards contains the display controller, which can support not only the computer's own display, but a wide variety of other LCDs. Included in the controller is a proprietary gate array that accesses a local memory to map the display screen, which can be either the computer's 8 by 80 LCD or a 24 by 80 external CRT monitor. Selection of the display format is made under software control via the touch panel.

The computer uses a 3½-inch floppy-disk drive, which offers the ideal combination of large storage capacity and small size. The drive is mounted crosswise at the right rear of the case with disk access on the right side.

Photo 4: *The battery pack consists of 10 ½-D nickel-cadmium cells, seven of which are in tubular form beside the disk drive and memory capsule enclosure. The remaining cells are housed side by side in an upright position in the space between the disk drive and the capsule enclosure.*

Because no industry-standard microfloppy format existed, we initially chose a 3-inch drive for the computer. It was originally the only microfloppy compatible with 5¼-inch drives in terms of rotational speed, disk format, and controller interface. Since then, however, other compatible 3½-inch disk drives have become available and may become the industry standard. With that in mind, mechanical provisions were made so that many different sub-4-inch microfloppy drives can be mounted to the case. The disk controller was also designed to be compatible with any of these drives. Disk access is through a detachable bezel that is easy to replace, simplifying drive changes during assembly.

Making It All Work

The Mobile Computer uses 10 ½-D nickel-cadmium cells that power a DC/DC converter, which in turn produces the voltages required to power specific components or subassemblies (see photo 4). The 12-volt battery's capacity is great enough to continuously power all the electronics and the disk drive in typical intermittent service for at least 8 hours on one charge. The battery can be recharged to 80 percent of capacity in less than 1½ hours.

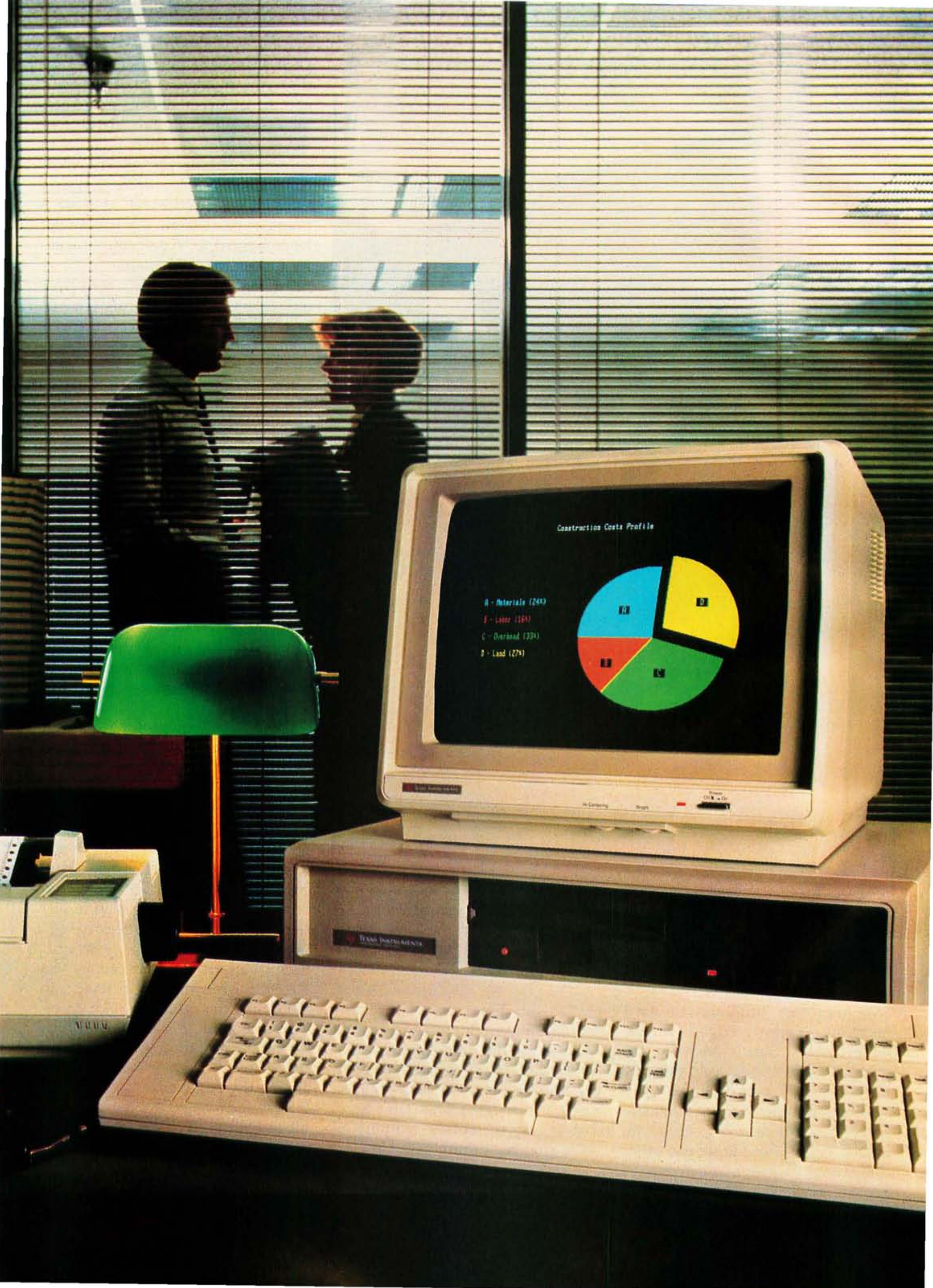
Originally, the DC/DC converter was unable to supply enough power to operate the battery pack for 8 hours. The problem was caused primarily by the NMOS 8088 processor's large power draw. Because there was no way to reduce the 8088's power consumption during operation, a scheme was devised to shut down the 8088 when it was idle. Upon completion of its task, the 8088 writes its internal states into memory and then powers down. When action is again required, the 8088's off-state is interrupted and it powers up.

The 8088 determines which circuits need power and which do not. It turns off power to circuits that have nothing to do (most notably the microfloppy's spindle motor during periods when the disk is not being accessed).

The 8088's power-down feature and its ability to control energy use in other circuits enable the DC/DC converter to supply the required 8 hours of power.

To maximize conversion efficiency while minimizing the size of the DC/DC converter, a flyback circuit converter was used. This converter supplies various voltages to power the logic bus, the EIA interface, and the disk drive. The main nickel-cadmium battery is monitored by the 80C51 microcomputer through an A/D converter (as are the expansion capsules' lithium batteries), which signals the user through the 8088 and the display when it's time to recharge the batteries.

Size and weight limitations prohibited putting a charger in the computer itself, but a separate battery charger comes with the Mobile Computer. The charger can operate the computer while recharging the batteries. The 80C51 monitors the bat-


Construction Costs Profile
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B - Labor (16%)
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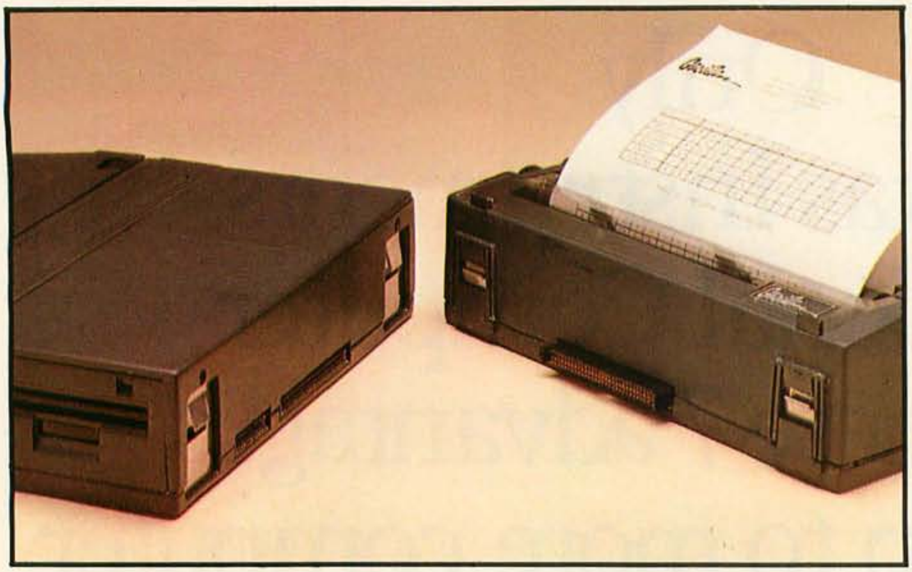

Photo 5: *The snap-on printer is housed in a case measuring 11.4 by 4.9 by 3 inches and weighs about 5 pounds including its self-contained battery pack. In spite of this small size and light weight, the printer can handle standard plain paper.*

tery through an A/D converter during recharge, and at the appropriate terminal voltage or temperature it reduces the charging rate to a trickle to protect the cells.

The printer presented another power problem. The printhead and paper-feed motors required so much power that the battery pack would have had to be twice the size and weight of the one required to power just the computer itself. Although the larger pack could have been accommodated, there was little reason to burden a user with the extra weight. An analysis of computer usage patterns indicated that a built-in printer wasn't essential—it could be a peripheral.

Without the printer, the computer case is 11.4 inches square and less than 3 inches high, and it weighs about 9 pounds.

A Snap-on Printer

The separate printer is housed in a box with the same cross section as the computer. It can be snapped onto the computer's back panel, providing both a mechanical and electrical interface (see photo 5). The electrical interface consists of an edgecard plug on the computer's rear panel mated with a jack on the front of the printer's case. The mechanical interface uses a latching arrangement that provides easy connection and disconnection and a high level of holding tension. The final design uses two spring-loaded clamps (one on each end of the printer's front panel) that bite thin stainless-steel brackets on the computer's rear panel. The combination of the spring loading and the slant of the brackets provides a mechanical attachment between the two units that, in effect, makes them a single package. The mechanical interface is so strong that lifting the computer from its front edge will also raise the printer as if it were built into the same case.

The printer's dimensions are 4.9 by 3 by 11.4 inches, allowing it to be carried in the same standard-size briefcase as the rest of the system. It is a plain-paper thermal graphics type with a special ribbon that transfers dye to plain paper when it is heated. The ribbon rides in a special cassette between the paper and the 16-wire ceramic printhead (see photo 6). The same mechanism that advances the printhead also advances the ribbon; when the ribbon is being used, the printer prints in one direction. When used with thermal paper, however, the ribbon cassette can be snapped out of the printer, which then operates bidirectionally. Unidirectional and bidirectional printing and printhead temperature are controlled by a resident microprocessor, which also manages character formation, the input buffers, and handshaking with the computer.

A standard ASCII character set, along with special characters for six foreign languages, and a graphics character set are contained in ROM. The printer operates at 50 cps (characters per second) with or without the thermal transfer ribbon. Throughput is faster with thermal paper, however, because of the

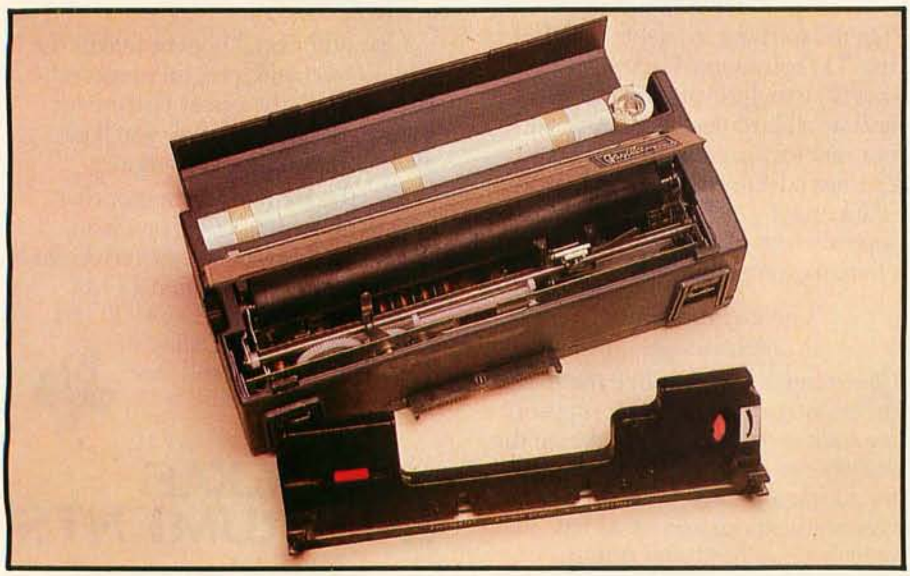

Photo 6: *To conserve space and minimize power consumption, a thermal print head is used. Unlike other thermal printers, however, the Gavilan printer prints on plain paper. The key is a special thermal transfer ribbon contained in a pop-out cartridge, which can be removed when thermal paper is used.*

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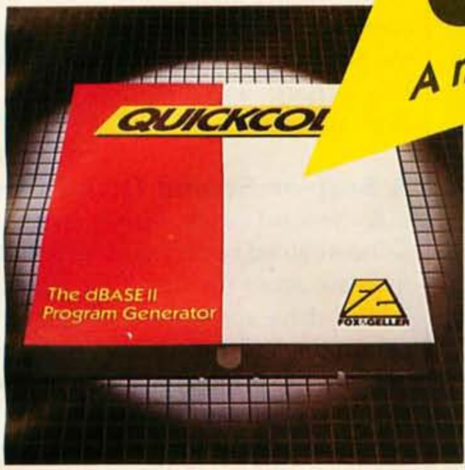

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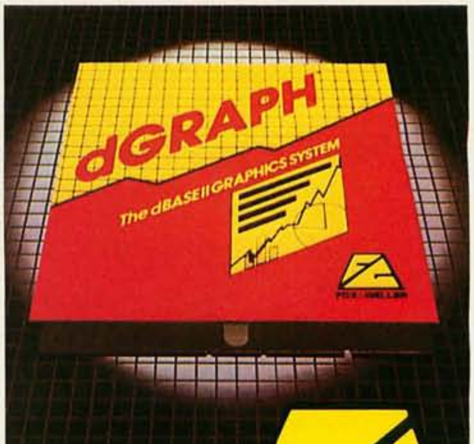

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bidirectional-printing capability. The printer weighs about 5 pounds including the internal battery pack, which consists of 11 sub-C size nickel-cadmium cells. The integrated computer-printer package weighs 14 pounds.

The printer's battery delivers about 60,000 characters between charges. The computer charger will also recharge the printer's battery pack. Control lines handled through the computer-to-printer interface permit the 80C51 to monitor the printer battery's charge and discharge just as it does the computer's.

A Snap-on Second Disk Drive

A second disk drive with a self-contained battery pack is housed in a case about the size of the printer. A dual-drive system consisting of the computer and the second drive (in place of the printer) will also fit easily into a briefcase. The second drive can include an additional 128K bytes of main memory. The computer's 80C51 monitors the voltage and temperature of the add-on drive's battery as it does the battery in the printer. The add-on drive's rear panel is equipped with the same electrical and mechanical interface as the computer, so the printer can be snapped on to form a mechanically stable, fully integrated computer system with nearly a megabyte of removable mass storage and an 8½-inch-wide plain-paper printer.

We feel the Gavilan meets virtually all the computing needs of the traveling professional. This computer is enhanced by a proprietary operating system that enables applications software to take full advantage of the system's hardware. In addition, off-the-shelf MS-DOS programs will run on the system. By integrating these elements plus expanded memory, a snap-on second disk drive and printer, and an external monitor into a single system, we believe the Gavilan mobile computer rivals conventional desktop computers.■

F. John Zepecki is vice-president of hardware engineering at Gavilan Computer Corporation, 240 Hacienda Ave., Campbell, CA 95008.


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Inside CMOS Technology

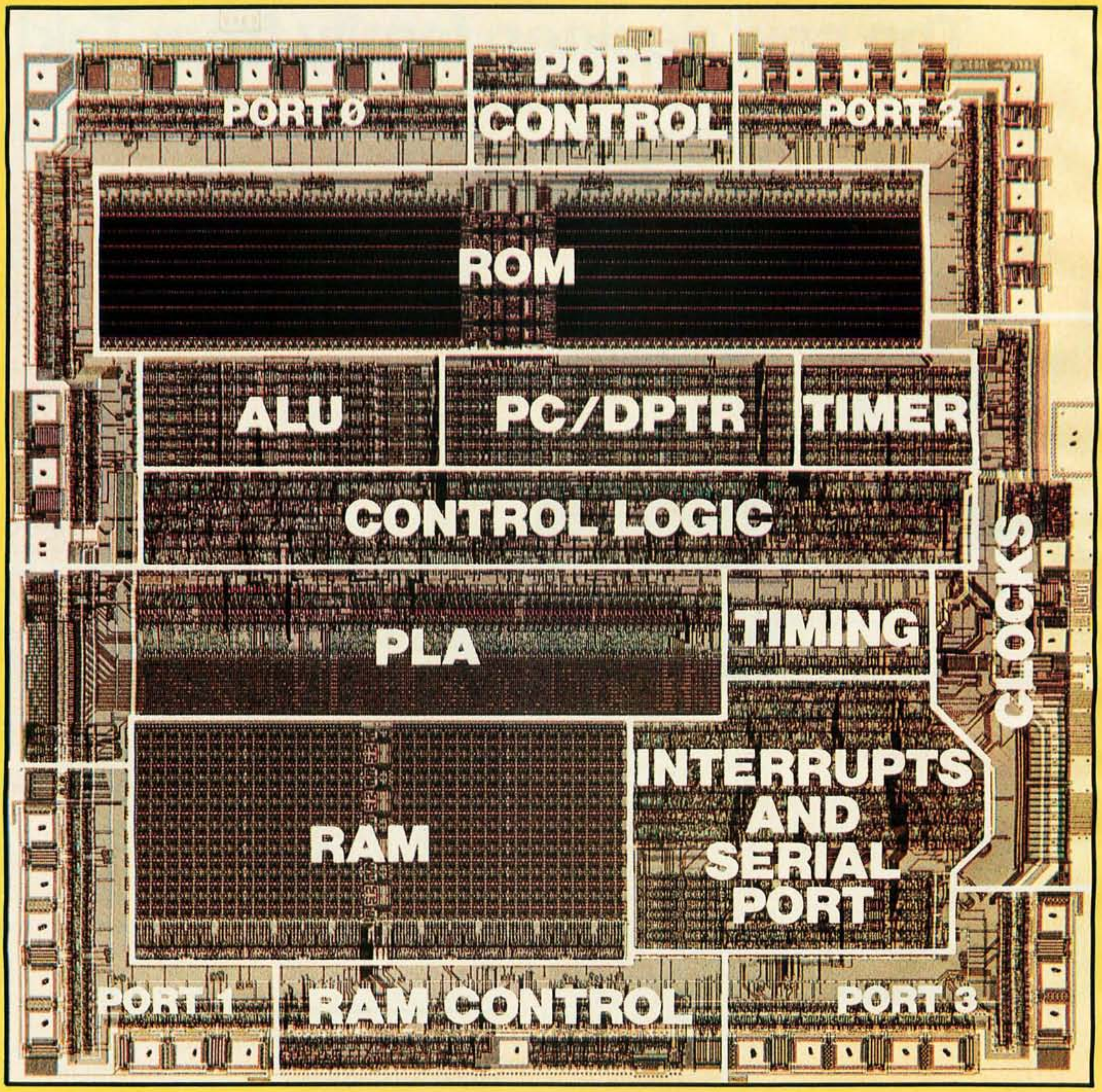

Photo 1: *The die for the 80C51, with the functions of the various sections identified.*

How CMOS devices are manufactured and a look at three of them

by Martin B. Pawloski, Tony Moroyan, and Joe Altnether

CMOS (complementary metal-oxide semiconductor) has often been called the ideal technology. It has low power dissipation, high immunity to power-supply noise, symmetric switching characteristics, and a large supply-voltage tolerance. But CMOS has rarely been used for advanced VLSI (very-large-scale-integration) microcomputer designs. Because of the complexity of the CMOS process, the ICs (integrated circuits) produced have traditionally had a relatively poor price/performance ratio.

As a result, CMOS was used only in applications that required low power and were neither performance conscious (such as in calculators and watches) nor cost conscious (many military applications, for example). Suddenly, however, all major semiconductor companies have announced either advanced CMOS products or the intention of designing their next generation of high-performance microprocessors using CMOS technology.

What has happened to make CMOS both affordable and high performance? For one thing, the dominant VLSI technology, NMOS (n-channel metal-oxide semiconductor), is rapidly approaching the process complexity of standard CMOS. It is not unusual nowadays for NMOS technology to have up to four transistor types with different operating characteristics. Much of the complexity of this process is added simply to help VLSI designers keep the operating power of their circuits under control.

Second, CMOS circuit designers are being more selective in the use of static CMOS logic. Critically placed dynamic logic, creative circuit design, and use of modes that offer varying degrees of power consumption are all tricks designers are using to maintain the advantages of CMOS.

Finally, aggressive reduction in CMOS transistor size is being used to bring CMOS performance in line with that of NMOS. As a matter of fact, many manufacturers are developing CMOS as a derivative of their advanced NMOS processes. This not only improves CMOS performance levels but also boosts reliability and reduces development costs.

The Evolution of LSI

Early LSI circuits were built with p-channel MOS transistors, which permitted high-circuit densities yet were relatively slow and difficult to interface to normal integrated circuits, such as TTL (transistor-transistor logic). As an example, the 1103-type 1K by 1-bit dynamic RAM (random-access read/write memory), circa 1971, required its inputs (address, controls, and data) to swing between 1 and 15 volts (V) although its output was measured in millivolts—hardly TTL compatible! About 1974, NMOS came to the rescue. It provided faster speed, and most of its inputs and outputs were TTL compatible.

Low power requirements are a major advantage of designing a system that uses CMOS.

NMOS was more difficult to manufacture than PMOS because contaminants would vary the thresholds of the n-channel transistors, causing deviations in speed and performance. But this problem was quickly overcome through ultraclean processing rooms, and NMOS became the workhorse technology because it cost less to manufacture, was easy to use, and had good speed-power characteristics. And NMOS technology had potential for greater improvement of its speed-power characteristics through scaling (or shrinking) of the silicon devices. The result of this scaling was HMOS (high-speed NMOS), which accomplished three objectives: increased speed, reduced power, and increased density.

Over the past 10 years, the reduction in transistor size has, at the device level, increased memory density by a factor of 64, increased speed by a factor of 3, and reduced power consumption by a factor of 100. However, the scaling cannot continue ad infinitum because of resolution limitations of the photolithographic equipment used to make the circuits as well as breakdown mechanisms within the devices. More important, even before these limitations are reached, heat dissipation will prohibit major enhancements with NMOS. Heat generation increases exponentially with transistor count, and, at densities approaching 150,000 transistors per integrated circuit, special cooling measures are required. This heat can accelerate failure mechanisms within the silicon, reducing device and system reliability. To hurdle this barrier, low-power devices must be used.

The Importance of Power Consumption

The development of NMOS was spurred on by the semiconductor industry's drive to produce high-volume, large-capacity memory devices, for which high density, rather than low power consumption, was the primary concern. As VLSI began to emerge, however, power dissipation became a limiting factor in continued increases in NMOS packing densities. Thus, the semiconductor industry turned to CMOS as a potential alternative.

CMOS achieves its low power dissipation through the use of both p- and n-channel transistors (hence the name "complementary"). Essentially, no DC power is dissipated in either logical state, and AC power occurs only during the relatively short switching period. Because most circuitry in a complex design is active only 10 to 20 percent of the time, CMOS achieves a dramatic reduction in power dissipation compared with NMOS, which continually dissipates DC power whenever an operating voltage is applied.

Low power requirements are a major advantage of designing a system that uses CMOS. Reducing power requirements has a domino effect that often substantially reduces the cost of the end product:

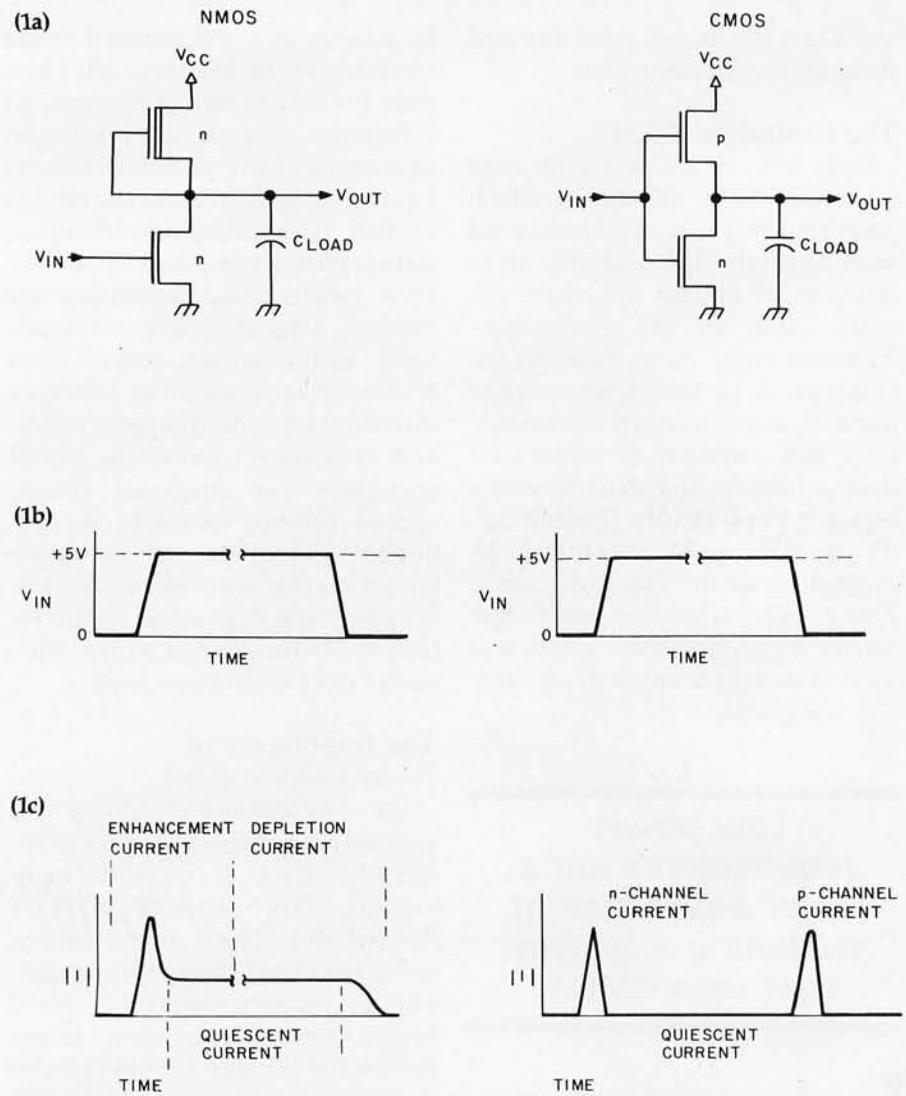

Figure 1: *A comparison of NMOS and CMOS technologies. Figure 1a shows the schematic diagrams of an inverter as implemented in both NMOS and CMOS. A hypothetical input waveform and the resulting transistor currents are shown in 1b and 1c.*

- low power allows smaller, lower-cost power supplies to be used
- power distribution in the system is simplified
- cooling fans can be eliminated
- printed-circuit boards can be packed more densely and can thus become smaller

With smaller power supplies, denser circuit boards, and no fans, smaller cabinets can be used, resulting in savings in chassis and enclosure costs. Also, power fail-safe and hand-held use become possible if battery operation is feasible.

Basic CMOS Operation

To truly understand the promises (and problems) facing both the CMOS VLSI digital designer and the CMOS systems designer, one must first understand some CMOS fundamentals.

Figure 1 compares the circuit diagrams and current characteristics of both an NMOS and a CMOS inverter. The NMOS inverter uses an n-channel depletion-mode transistor as the pull-up device (which drives the output line high) and an n-channel enhancement-mode transistor as the pull-down device (which drives the output line low). The pull-up transistor is used as a load; its operation approximates that of a constant current source. The pull-down transistor is used as the switching device; when active, it discharges the load, and when inactive it lets the pull-up charge the load. MOS loads are primarily capacitive and include the parasitic capacitances of the inverter itself, interconnect capacitances, and the thin-oxide capacitances of all the gates the inverter is driving.

Let's note several characteristics of an NMOS inverter. When the pull-down device is turned on, it not only has to sink the current from the capacitive load, but it also has to sink the current supplied by the pull-up load device. Even in the quiescent state this current component from the pull-up device still exists. Because logic gates spend most of their time in the quiescent state, this quiescent current accounts for up to 90 percent of the total power dissipated in NMOS VLSI designs; the remaining 10 percent is switching or *dynamic* power.

A second related characteristic is that the inverter's output voltage in the low state, V_{OL}, is dependent on the ratio of the impedances of the pull-down and pull-up devices. This ratio affects the noise margin and switching speed and is generally around 4:1. Such a ratio results in a V_{OL} on the order of 0.2 V to 0.3 V. It also causes asymmetric switching characteristics: the fall time of the inverter is significantly faster than its rise time.

The CMOS inverter uses a p-channel enhancement-mode transistor as the pull-up device and an n-channel enhancement-mode transistor as the pull-down device. In a CMOS inverter, both the pull-up and pull-down transistors are used as switching devices. When the input changes from low to high, the p-channel device shuts off and the n-channel transistor *discharges* the load. When the input changes from high to low, the n-channel device shuts off and

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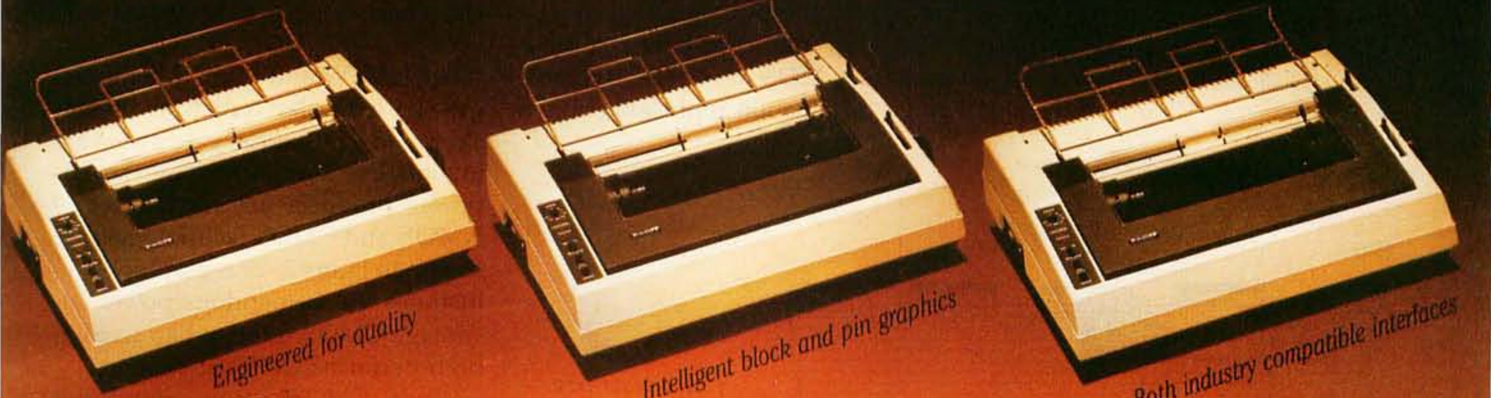

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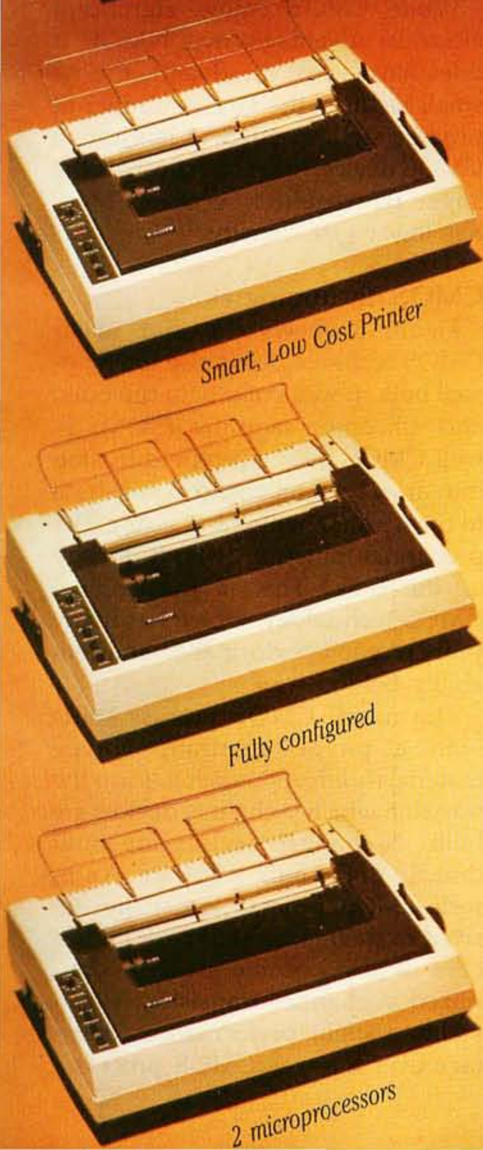

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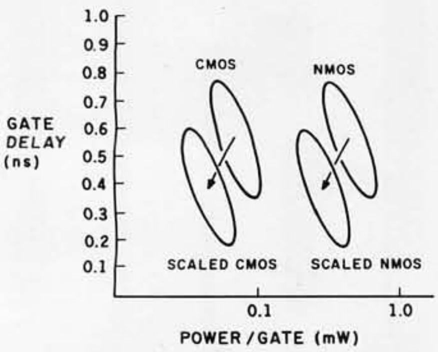


Figure 2: *The speed versus power consumption characteristics of NMOS and CMOS technologies. Note the advantages gained by scaling (reducing the size) of the integrated components.*

the p-channel transistor *charges* the load. While almost all current from the CMOS inverter is used to charge or discharge the load, a small current component does not flow through the load. This is a result of the fact that both the p-channel and n-channel transistors are on for a short period of time during the input voltage transition. This current component is typically less than 10 percent of the total inverter current, though it depends greatly on the rise and fall times of the input signal.

With no quiescent power component, a CMOS inverter's dynamic power dissipation represents only a small fraction of an equivalent NMOS inverter's power dissipation. Also, the CMOS inverter is a "ratioless" design, having only one transistor active after an input transition. This lets V_{OL} go all the way to ground potential, resulting in better noise tolerance than NMOS inverters. It is also a simple matter to design CMOS circuits with outputs that have equal rise and fall times. While this is important in some circuits, it is generally not taken advantage of in VLSI designs because it requires greater chip area.

For NMOS and CMOS technologies with similar transistor dimensions and gate oxides, gate delays are essentially identical. The speed-power products for such a set of NMOS and CMOS technologies are shown in figure 2. This graphically illustrates the tremendous power advantage CMOS offers when used in high-performance VLSI designs.

While CMOS enjoys significant electrical advantages over NMOS, it does have a cost disadvantage. One small factor is the larger number of process steps needed to fabricate a CMOS device. More significant is the larger die required because CMOS has lower gate density.

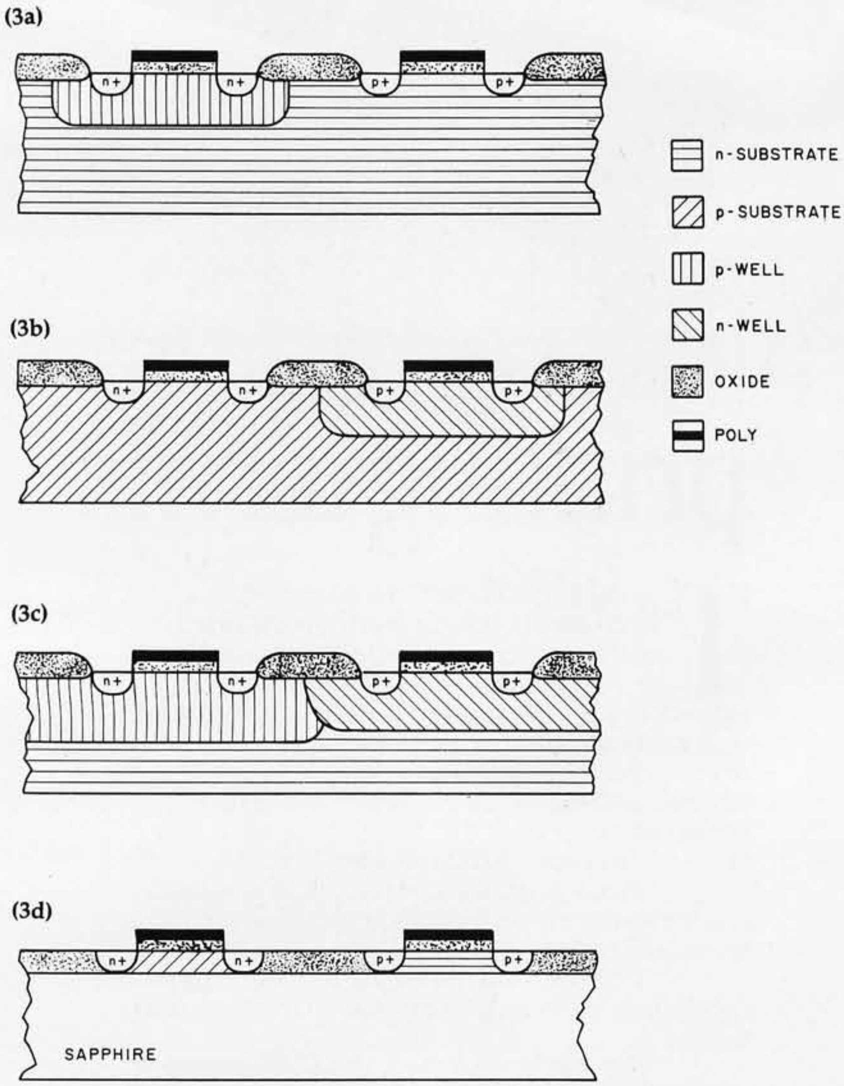
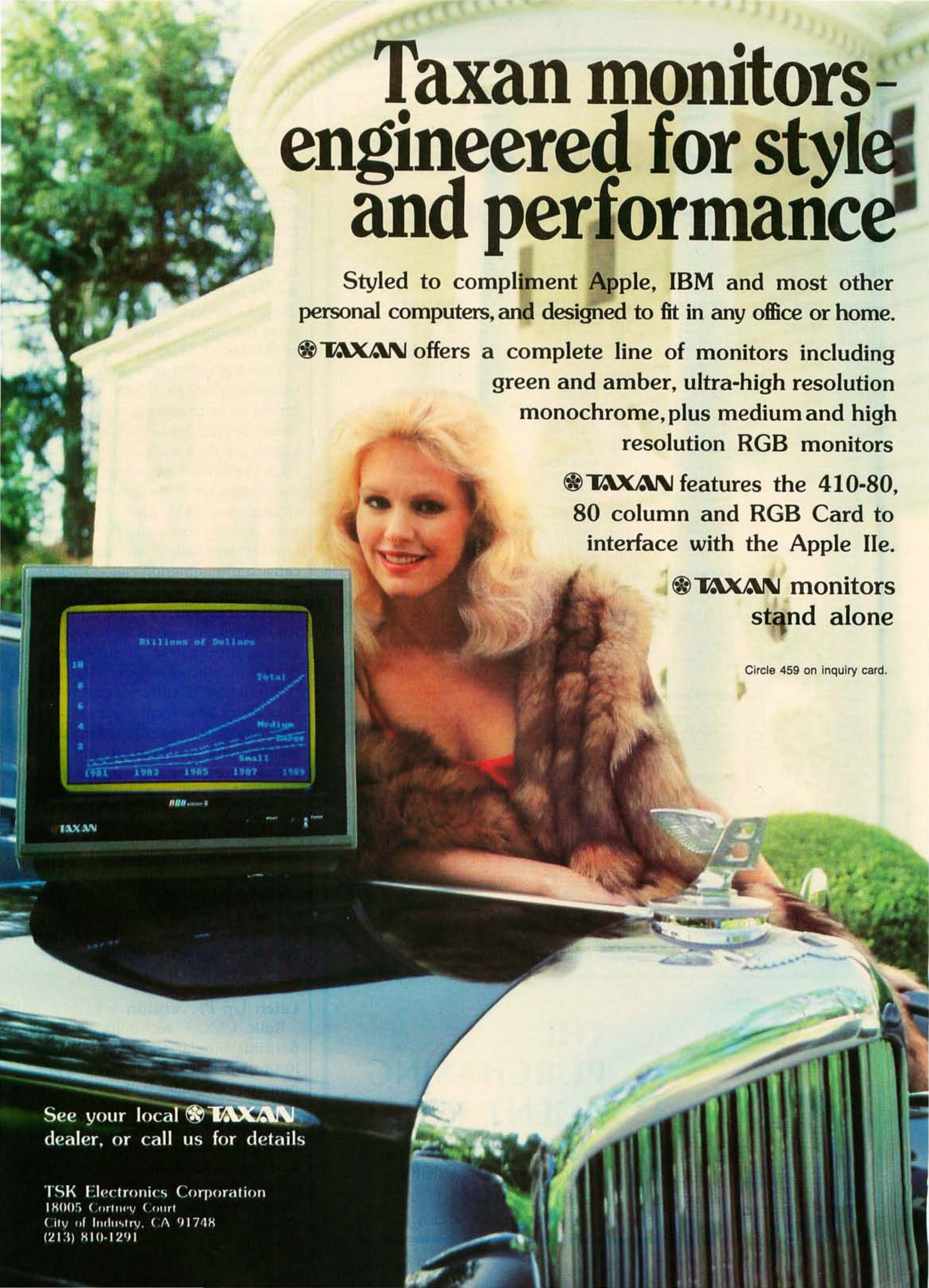


Figure 3: *Cross sections of transistors formed by each of the four major CMOS processes. Figure 3a is a p-well bulk CMOS transistor; figure 3b shows an n-well bulk device; figure 3c is an example of a twin-tub bulk CMOS transistor; the transistor in figure 3d is formed using silicon-on-sapphire technology.*

CMOS Technologies

Figure 3 shows the four major CMOS technologies in use today: p-well bulk, n-well bulk, twin-tub bulk, and silicon-on-sapphire (SOS). P-well CMOS uses a p-type diffusion into an n-type bulk silicon substrate to form an n-channel transistor. The p-channel transistor is built directly in the bulk. This is the original CMOS technology, which has many years of good performance and reliability behind it.

The n-well CMOS process starts with a p-type substrate. N-type material is diffused into it to form the n-well in which p-channel devices are built. N-channel devices are built directly in the bulk substrate. An n-well CMOS process is usually derived from an advanced NMOS process. It also permits a highly optimized n-channel transistor, which yields a slight performance advantage over a p-well CMOS process.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Twin-tub CMOS combines n-well and p-well technologies by diffusing both an n-well for the p-channel transistor and a p-well for the n-channel transistor. The twin wells are usually formed in a lightly doped n-type substrate. While it is a slightly more complex and costly process than either n-well CMOS or p-well CMOS, twin-tub CMOS has the advantage of being able to optimize the performance of both the n-channel and p-channel devices. Thus, this process gives the highest overall performance of the bulk CMOS technologies.

The highest performing CMOS technology is SOS. Silicon islands are grown on an insulating sapphire substrate. N-channel or p-channel transistors are then built on the islands. High performance is achieved due to the significant reduction of parasitic capacitance. SOS also offers good gate density because no parasitic bipolar transistors are around to cause a phenomenon called *latch up*. Unfortunately, SOS devices are difficult and expensive to manufacture. For example, unused sapphire wafers cost approximately 10 times more than bulk silicon wafers.

While CMOS suffers a cost penalty of about 20 percent due to process differences, it generally suffers more significantly because of die size. (While processing steps have a linear relationship with cost, die size has an exponential relationship.) CMOS dies are larger than equivalent NMOS designs even when aggressive transistor scaling is employed. Three major factors contribute to this: the area used in trying to prevent latch up, CMOS logic-gate structure, and static design techniques.

Latch Up Prevention

Bulk CMOS technologies have parasitic bipolar transistors that, if improperly biased, can cause a phenomenon called latch up. This potentially destructive action results from triggering an SCR (silicon-controlled rectifier) formed by the transistors and can cause extremely large currents to flow. Figure 4 shows the construction of the parasitic SCR in an n-well bulk CMOS device.

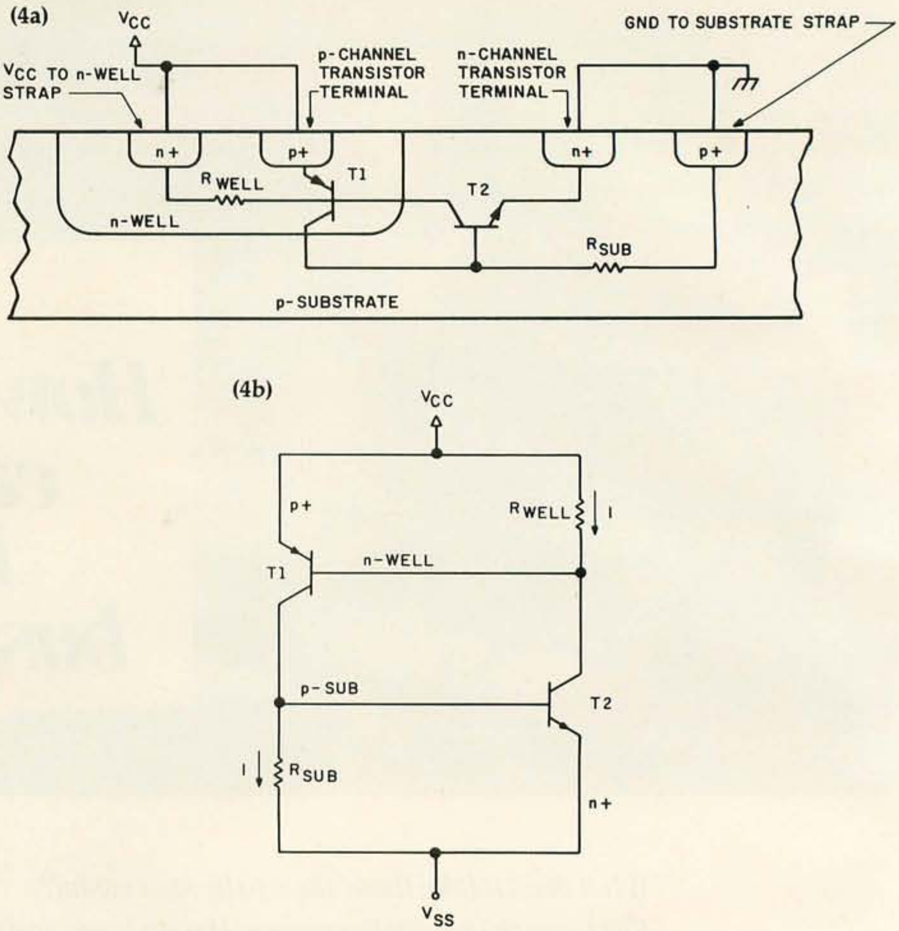


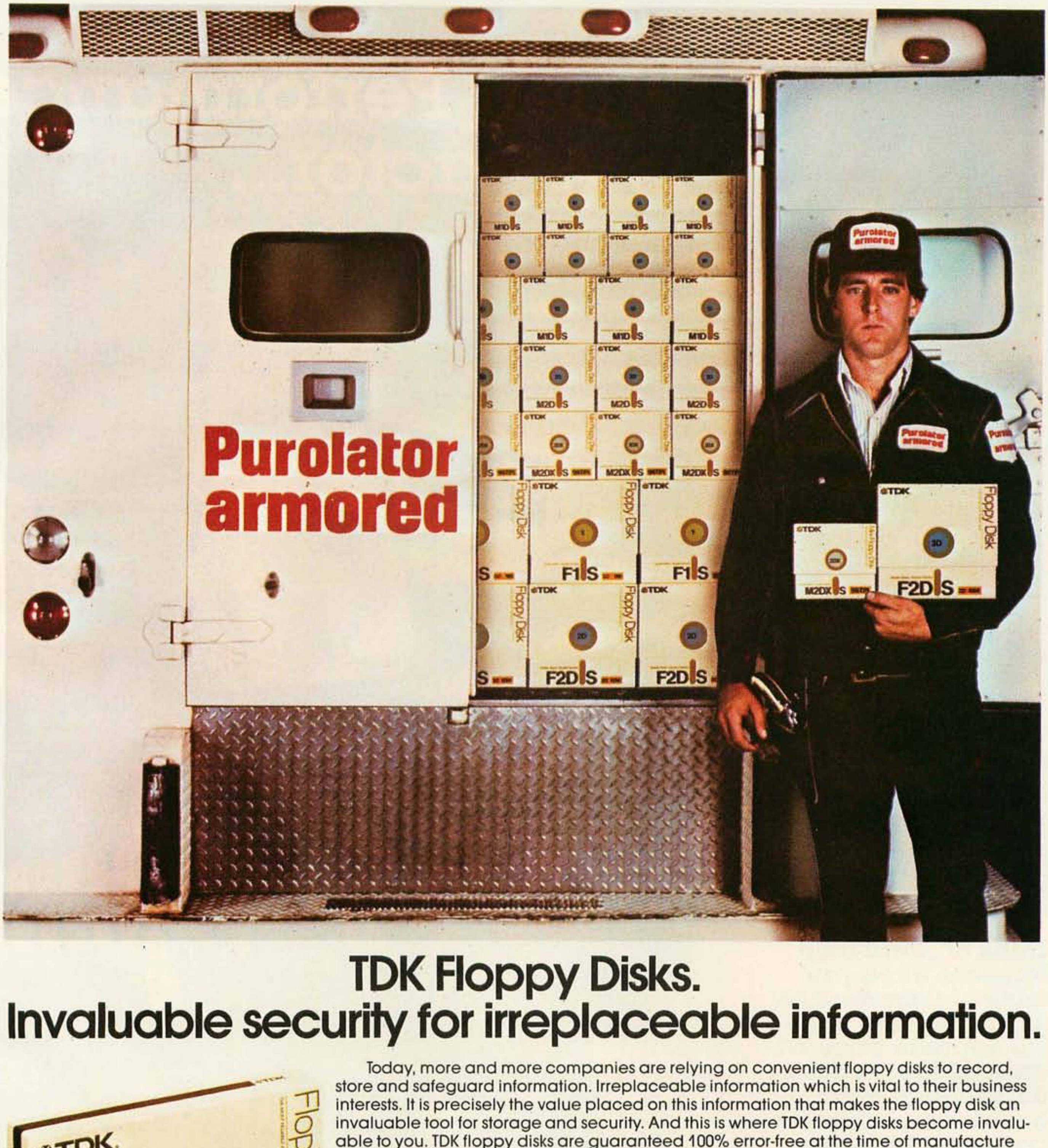
Figure 4: *Parasitic SCR in bulk CMOS can cause latch up. Figure 4a shows how the parasitic transistors are formed in the silicon; figure 4b is a diagram of the equivalent circuit.*

Two well-defined conditions must exist before latch up can occur. First, for the SCR to be triggered, IR_{well} or IR_{sub} must be greater than or equal to 0.7 V. This forward-biases the base-emitter junctions of the parasitic bipolar transistors. Second, to sustain the latch up condition, the product of the βs (gains) of the two bipolar transistors must equal at least 1.

In order to minimize the chance of one of the SCR's transistors being forward-biased, every attempt is made to reduce the resistance values as much as is feasible. This has the effect of requiring significantly larger injected currents before the SCR can be triggered. To reduce the resistance values, *guard rings* are used in the circuitry. (Guard rings are low-resistivity connections to the supply voltages placed around the CMOS p-channel and n-channel transistors.) While guard rings reduce the SCR bias resistor values, they also increase the space between n-channel transistors and p-channel transistors (thus reducing the gate density). To somewhat minimize this effect, particularly sensitive areas (like VLSI component's I/O pins) are heavily guard ringed, while the more protected internal circuitry is less so.

A less controllable method of preventing latch up is to try and decrease the βs of the parasitic transistors. While the vertical pnp transistor's β is set by the process design, the lateral npn transistor is more directly controllable. Its β can be drastically reduced by increasing the n-well-to-n+ diffusion spacing (or p-well-to-p+ diffusion spacing in p-well technology). This method reduces the β by increasing the width of the transistor's base. While this is an effective way of decreasing the gain of the parasitic structure, it also reduces the gate density.

In bulk CMOS technologies, to



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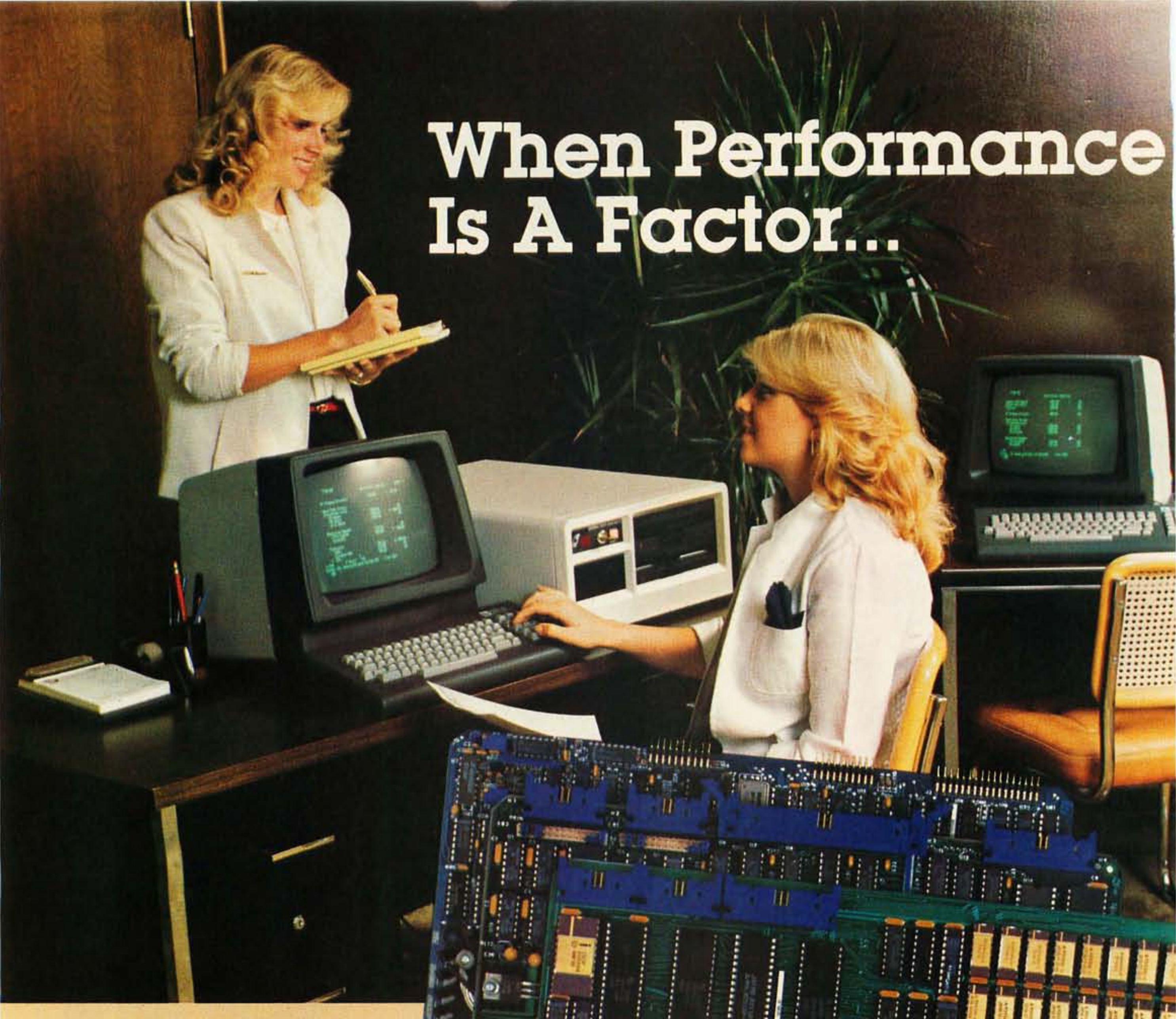

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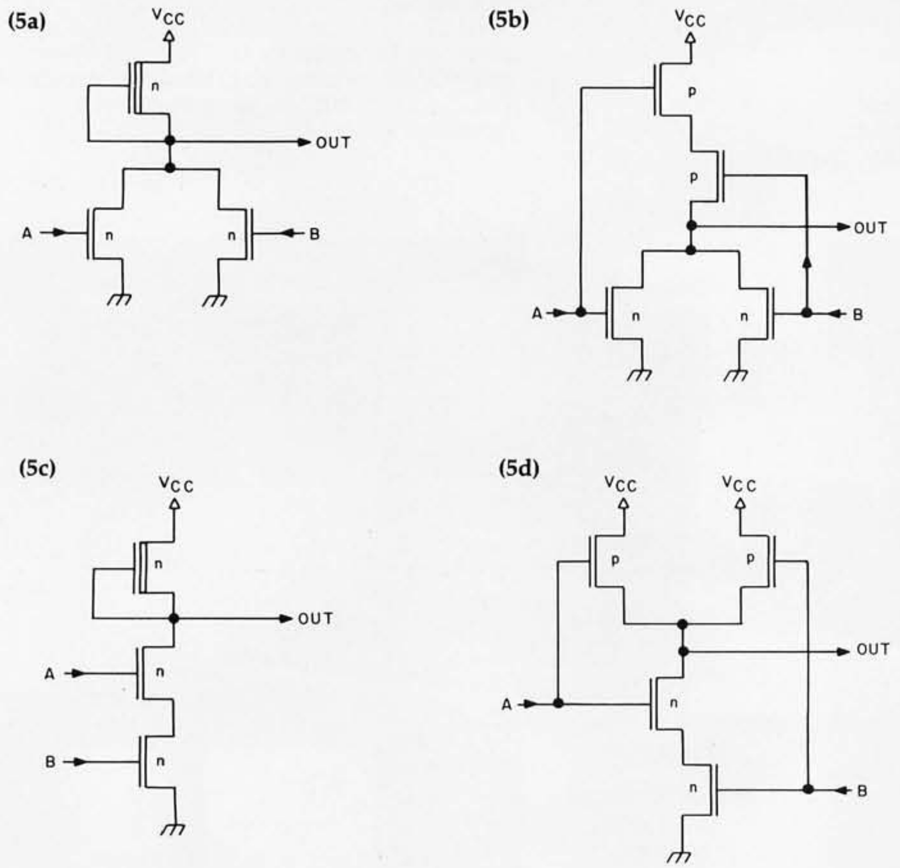

Figure 5: *A comparison of typical logic gates in NMOS and CMOS form. Figure 5a is an NMOS NOR gate, while figure 5b is a CMOS version; figure 5c is an NMOS NAND gate, and figure 5d is a CMOS version.*

give absolute protection against latch up is not only tremendously expensive in silicon area, but it is also virtually impossible. CMOS designers sacrifice area to ensure there is enough margin in their design to protect it from latch up in normal operating-system environments.

Logic-Gate Structures

Gate densities are also reduced in CMOS because standard CMOS logic gates are built from more transistors than their NMOS equivalents. Standard CMOS logic-gate design has a 1:1 ratio of n-channel transistors to p-channel transistors. For example, the two input gates shown in figure 5 take four transistors in CMOS and only three in NMOS. The relative density decreases as the number of inputs increases. For example, three-input gates require six transistors in CMOS and only four in NMOS; four-input gates require eight transistors in CMOS and only five in NMOS, etc. As a matter of fact, it is rare to have a standard CMOS gate with more than three inputs because the self-loading and the transistor stack make the structure inefficient in both speed and area. On the other hand, it is not unusual in NMOS to have gates with as many as eight inputs.

Static Design Techniques

A final reason for the lower CMOS gate densities is the use of static logic (modern VLSI NMOS microcomputer designs rely heavily on dynamic circuitry). Dynamic circuitry essentially uses a small capacitor as a latch to store logic values. This technique saves both area (by reducing the number of transistors in a gate) and power (by reducing the number of gates in structures like latches, flip-flops, shift registers, etc.). Employing dynamic design can reduce an NMOS latch's area by 30 percent and its power consumption by 50 percent. However, the problem with dynamic circuitry is that the capacitor used to store the logic value is leaky and will, over time, discharge and lose its data. This is the same problem faced by dynamic memory designers. The solution is to periodically refresh the capacitor, which forces a minimum operating frequency to be adhered to.

CMOS can also use dynamic circuitry, especially to increase the ratio of n-channel transistors to p-channel transistors. Because static CMOS designs have a 1:1 ratio of n-channel to p-channel transistors, being able to increase this ratio will have the effect of giving CMOS a higher gate density (but the minimum operating-frequency characteristic of dynamic circuitry often conflicts with the CMOS potential of absolutely minimizing power). Therefore, while true static CMOS design does give the lowest possible power consumption (by allowing the device to operate at frequencies all the way to DC), dynamic CMOS designs, being more dense and resulting in smaller die sizes, tend to be more cost-effective. Thus, two trends are developing in the use of CMOS for VLSI microcomputer design.

Designers of the next generation of 16- and 32-bit microprocessors are choosing CMOS. Here, the goal is not to operate at the lowest possible power level but rather to keep the operating power under a maximum level for cooler junction temperatures, higher performance levels, and the ability to use standard low-cost packages. In these designs, extensive use is made of dynamic logic. The ratio of n-channel transistors to p-channel transistors is often as high as 3:1.

Designers of 4- and 8-bit single-chip microcomputers are choosing CMOS to accommodate a host of new portable, hand-held, and ultra-low-power applications. Here, the goal is to minimize the operating power levels consistent with the performance required by the application. In the simpler microcomputers, true CMOS static logic is used—their simpler structure still allows a relatively small die size, while the low-performance applications they

are appropriate for allow low operating frequencies. On the other hand, the more complex, higher-performance, single-chip VLSI components still make maximum use of static logic but are forced into dynamic logic for large arrays to keep the die cost down.

Future CMOS

CMOS will be the technology of choice for VLSI microcomputer designs. For one thing, with the advent of hundreds of thousands of transistors on a die, CMOS is the only technology that offers a cost-effective solution to the power-density problem.

A second and more subtle future issue is reduced supply voltage. As MOS transistors continue to be scaled to smaller dimensions to eke out further performance and density advances, the standard 5-V supply voltage must be reduced, if only for internal circuitry, to limit substrate current and hot-electron effects. CMOS is better suited for lower supply-voltage operation because its switch point is a fixed percentage of the supply voltage. Also, due to its "ratio-less" structures, CMOS enjoys better noise tolerance than NMOS, another important factor at lower supply voltages.

Finally, CMOS has made and will continue to make major strides in its relative cost disadvantage to NMOS. Where CMOS formerly sold at as much as a fourfold premium, today it is selling at somewhat less than twice the price of comparable NMOS devices. With its continued use of standard, low-cost packaging technology as well as the more creative use of dynamic circuitry and hybrid static/dynamic designs, CMOS will rapidly approach the cost of NMOS. As a matter of fact, several major semiconductor manufacturers have stated that CMOS/NMOS price parity will occur this decade, and some manufacturers say it will happen as early as 1985. When CMOS and NMOS cost the same, why would anyone buy NMOS?■

A CMOS Single-Chip Computer: Intel's 80C51

by Martin B. Pawloski

Intel's 80C51 is an interesting example of how the static logic versus dynamic logic trade-off was made in an actual product design. The 8051 is an 8-bit, single-chip microcomputer with 4K bytes of ROM, 128 bytes of RAM, two 16-bit counter/timers, multilevel interrupt control, 32 I/O pins, full-duplex UART (universal asynchronous receiver/transmitter), and on-chip oscillator and clock circuits. A die with the sections identified by functions is shown in photo 1 on page 94.

The CMOS version of the 8051, called the 80C51, is targeted at a number of applications that require both high performance and low power consumption. In areas like telephony, automotive control, industrial control, and portable instrumentation, the 80C51 operates at or near its maximum speed, even if only for short intervals. (For example, most real-time applications need an external-interrupt response time of less than 100 microseconds (μs); more demanding applications require better than 10-μs response. While the response must be quick, and the interrupt routine executed quickly; the processor spends a significant portion of its time idle.)

Once the performance requirements of the application are known, it is possible to specify a minimum operating frequency. For the 80C51, a hybrid static/dynamic design was proposed that allows a minimum die size and includes various modes of operation to minimize power consumption.

First, the only areas of the design that were made dynamic were the (very large) ROM and Control arrays. These arrays contain almost 50,000 transistors and constitute a major portion of the die. By making them

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80C51	CMOS	4–6 V	12 MHz Max	24 mA	3 mA	50 μA
			1.2 MHz Min	2.4 mA	0.3 mA	50 μA
8051	HMOS	4.5–5.5 V	12 MHz Max	150 mA	—	20 mA
			1.2 MHz Min	130 mA	—	20 mA

Table 1: *A comparison of the CMOS and NMOS versions of the 8051.*

dynamic, an area savings on the order of 40 to 50 percent was accomplished.

Second, the processor, all the peripheral functions, the RAM, and the I/O ports were made static. This allowed two modes of operation other than normal operating mode: *Idle* mode and *Power Down* mode.

Because in many applications the processor does nothing more than wait for an event to happen, in the Idle mode the major clocks of the device are stopped and only smaller ancillary clocks operate to drive the peripheral counter/timers, external-interrupt control, and the serial channel. When one of the peripherals generates an interrupt, the processor clocks are restarted and instruction execution resumes in the interrupt-service routine. The Idle mode reduces power consumption by almost an order of magnitude.

In Power Down mode, *all* the clocks inside the device are shut off and only the internal 128 bytes of RAM are "kept alive." The only current consumed is a minute amount due to pn-junction leakage. Static logic was designed in the peripheral sections in order to support this mode because no clocks are available to refresh dynamic logic. In both the Idle and Power Down modes, special provisions are made for the dynamic circuits in the ROM and Control areas to enter a pseudostatic condition that prevents any extraneous power consumption due to voltage drift on capacitive storage nodes.

Table 1 compares the NMOS 8051 to the CMOS 80C51. The 80C51, designed in Intel's HMOS-derived n-well process called CHMOS, is less than 10 percent larger than the NMOS design and consumes only 15 percent of the normal operating power. More significant power savings are possible by operating the 80C51 at lower frequencies or by using the Idle mode.

Martin B. Pawloski (5000 West Williams Field Rd., Chandler, AZ 85224) is involved in the product planning, definition, and implementation of both NMOS and CMOS single-chip microcomputers at Intel Corp.

Z80 in CMOS Clothing: National Semiconductor's NSC800

by Tony Moroyan

A CMOS processor particularly suited to portable-computer applications, National Semiconductor's NSC800 incorporates features typical of state-of-the-art NMOS devices with low-powered, high-density, surface-mounted packages (with both leaded and leadless chip carriers).

Internally the NCS800 has the same instruction set and complement of registers as Zilog's popular NMOS processor, the Z80. Externally, the NSC800 features a multiplexed data and address bus like that of Intel's 8085 processor. It dissipates only 5 percent of the power that NMOS devices in its performance class do, and yet it is capable of operating at speeds up to 4 MHz.

The chip is fabricated using National's P^2CMOS process, a silicon-gate technology that achieves high

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density by employing one level of metal for interconnection and two levels of polysilicon. (Future products will incorporate two levels of metal for further density improvements.)

A major feature suiting the NSC800 to modern computer applications is its compatibility with the wealth of available Z80-based software. Indeed, Z80-based development software, operating systems (such as CP/M), high-level languages, and applications programs will run without modification, and with no speed penalty, on an NSC800 system. This compatibility is a tremendous advantage for the small-systems builder.

With the Z80 architecture, the programmer has 158 instructions with 10 addressing modes, 22 programmable registers, 256 directly addressable I/O locations, and a 64K-byte memory-address space. In addition, the multiplexed bus frees some of the IC's 40 pins for use in implementation of extra functions not found on the Z80. These include:

- three additional interrupt lines for faster interrupt-response times
- two special status lines for decoding processor states
- an onboard clock generator
- a *power-save* feature for further reducing power consumption

The Multiplexed Bus

The NSC800's multiplexed bus uses 16 lines to transfer 16 address bits and 8 data bits. The upper 8 bits of the address bus are present on lines A8 through A15; lines AD0 through AD7 carry the 8 data bits and the lower 8 address bits, at different times. Systems can use the multiplexed bus, or the buses can be separated into a 16-bit address bus and an 8-bit data bus. All NSC800 family components (including the NSC810 RAM-I/O-Timer, the NSC830 ROM-I/O chip, and the NSC858 UART) have a multiplexed-bus structure and thus can interface directly with the NSC800. The ALE (address latch enable) control strobe of the processor controls bus demultiplex timing.

The multiplexed bus requires one-third fewer bus lines to interconnect devices, resulting in reduced circuit-board complexity. (8085-type peripherals and many memory devices support this type of multiplexed bus.)

Interrupts

Three of the IC's freed pins have been used to provide more interrupts than the Z80 offers. The standard NMI (nonmaskable interrupt) and INT (multimode interrupt) are compatible with the Z80 and 8080.

The NMI is used as the highest-priority interrupt line and is useful during, for example, power failure conditions, for which the processor must be alerted for graceful power-down operations. NMI is an edge-sensitive input line and causes a direct restart to memory location 0066 hexadecimal.

The INT input has three modes: 0, 1, and 2. Mode 0 corresponds to the 8080 method of interrupt handling. An interrupting peripheral places a restart instruction on the data bus, and the processor then executes the instruction, usually a call to a subroutine. Mode 1 provides transfer to an automatic restart location (0038 hexadecimal). Thus, in small systems the peripheral need not strobe the restart instruction onto the data bus. With mode 2 interrupts, the processor reads a vector from the interrupting device; that vector is used with the contents of the I register to create a pointer to the address of a table entry that contains the interrupt-handler-routine address. This interrupt is maskable on or off and is controlled by system-interrupt-enable flip-flops inside the NSC800. These can be set by software, as they are in the Z80.

The remaining three interrupt lines, RSTA, RSTB, and RSTC, provide three different but fixed restart addresses. These lines are similar to the 8085 interrupts and are also maskable under program control.

Power Modes

In many applications, power consumption is so critical that it is help-

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ful to put the NSC800 into a standby mode whenever possible. A single power-save input pin suspends processor operation and reduces power consumption by 50 percent. The NSC800 can be held in the power-save mode indefinitely: internal register contents are saved during this time, and the processor can resume operation without interruption. This feature does not stop clock operation, however, so some power is still consumed. With additional circuitry, even the clock can be suspended for maximum power reduction. The new 6-MHz NSC800 (available in the first half of 1984) will have this feature built in for ultralow power dissipation.

The power-save line can also be controlled by a switch to create a single-step function. When the switch moves to the normally open (NO) position, the processor executes one instruction, suspends operation, and waits for the switch to return to its normally closed (NC) position.

Another NSC800 extra pin freed up by the multiplexed-bus structure permits an on-chip clock generator, which reduces system component count and cost. In place of an external clock-generator chip, the NSC800 requires only a crystal or RC-oscillator circuit to produce the system clock.

A final difference from the Z80 is that the NSC800 has an extra bit in the refresh register used to automatically refresh 64K-bit dynamic RAM chips without any extra logic.

Tony Moroyan is marketing manager for the NSC800 family in the Microprocessor Group at National Semiconductor Corp. (2900 Semiconductor Dr., Mail Stop D3667, Santa Clara, CA 95051).

A Look at CMOS Dynamic Memory

by Joe Altnether

The fast-growing portable-computer market is placing severe demands on semiconductor memory. For optimum system performance, these components must limit their power dissipation to suit battery operation and backup, and they must achieve the high data bandwidths and increased speeds needed for fast processing and high-resolution graphics. As the market reaches a projected $4.8 billion level by 1987 (a tenfold increase over 1982 levels), these requirements will combine to fuel the use of high-performance CMOS dynamic RAMs.

One architecture that can increase the speed of a CMOS dynamic RAM incorporates static-column address decoders: static circuits perform the selection of the column address of the RAM. Previously, this architecture has not been used with dynamic RAMs because of the increased power consumption of the static circuits over that of the dynamic circuits, and the advantage of low power consumption would have been lost. But with CMOS, the increased power consumption is negligible.

Memory-device Architecture

RAMs are organized internally as rows and columns of storage cells. Data access occurs at the intersection of a row address and a column address. In dynamic RAMs, the row and column addresses are multiplexed to reduce package size and pin count: the row addresses are clocked into the device with the RAS (row address strobe) signal, causing one row of data (1 bit from each of the 256 columns in a 64K-bit dynamic RAM) to be fed into the 256 internal sense amplifiers. (Because of the low internal signal levels, each column must have an associated sense amplifier to sense and restore memory-cell data.) Next, column addresses are presented to the device and clocked into it with the CAS (column address strobe) signal. These column addresses are then decoded to select one of the 256 bits. Faster access and cycle times are obtained within a row (or "page") after the first access to it because the 256 bits within the row continue to reside in the sense amplifiers and need not be refetched. Reapplying only column addresses, then, in what is known as *Page Mode* operation, provides fast serial accesses and can increase cycle times by a factor of 2.

The CMOS dynamic RAM can incorporate static-column circuits to provide performance equivalent to that of high-speed static RAMs. With CMOS, the static-decoding circuits reduce the internal number of clocks by a factor of 3, eliminating the need to allow for setup and hold times of signals with respect to clocks and the need to compensate for timing skews due to process variances. With static-column circuits, precharge times are drastically reduced (in Page Mode operation of the Static-Column-mode device, precharge time is reduced from 30 nanoseconds [ns] to 5 ns). This precharge time reduction and the faster access times typically increase the memory's bandwidth to 20 MHz. (Performance of memory discussed here is based on the experimental 64K-bit CMOS dynamic RAM that Intel presented at the ISSCC conference in February 1983.)

With static-column architecture, two different types of Page Mode operation are possible: Static Column mode and Ripplemode. Static Column mode uses the RAS line and row addresses in the conventional manner, but once the row has been selected, data can be accessed merely by changing column addresses. As with a static RAM, column addresses must remain stable and valid for the entire address access cycle. Access time is measured from column addresses rather than the occurrence of CAS. (Typically, access from column addresses is 30 ns; from CAS, it is 10 ns.)

In operation, CAS is used to place the output in a high-impedance state or to activate an output buffer. CAS can be held active during the entire page cycle. In fact, it is possible to keep CAS permanently active (i.e., grounded). During a write cycle,

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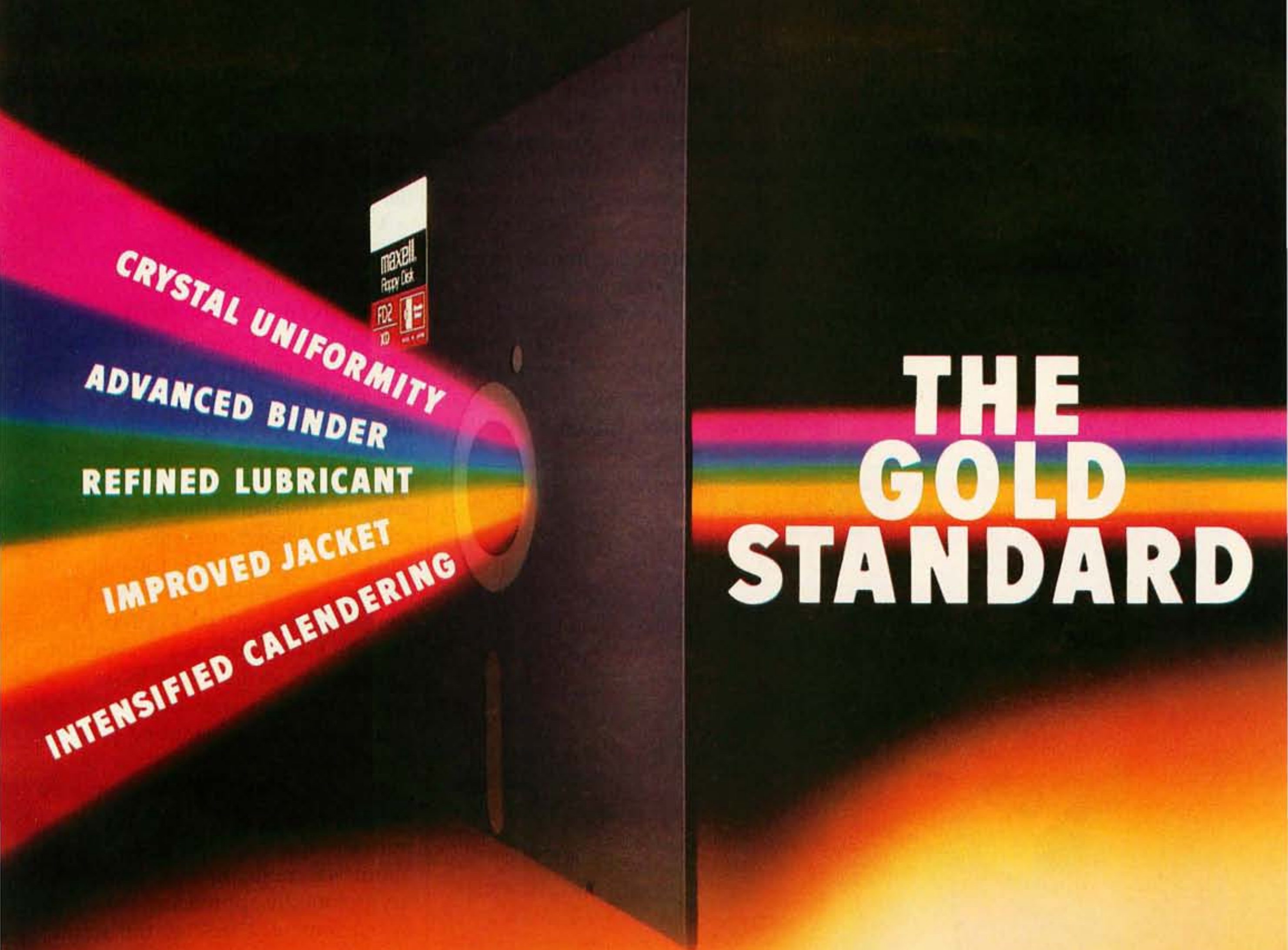
however, addresses as well as data are latched by CAS or WE, whichever occurs last. Operation is identical to that of an NMOS dynamic RAM in this case. This action ensures that the data is written into the proper memory location.

Although Static Column mode provides fast, easy accesses, speed at the system level is limited by how fast addresses for the next cycle become valid; the time to generate and stabilize the addresses must be added to the cycle time. Increased system speed can be obtained by using Ripplemode. With this mode, static-column circuits are again used to obtain access from valid column addresses, but the addresses are latched on the falling edge of CAS, removing the requirement for addresses to remain valid throughout the entire cycle. As a result, during the current cycle addresses for the next cycle can be set up or *pipelined.*

Column addresses enter the RAM through the internal address latch. This latch, controlled by CAS, provides flow-through operation. When CAS is inactive, the latch is open, and addresses pass through continuously to the static-column decoders. Any change in address is transmitted immediately to the decoder. Consequently, access to the RAM is again measured from valid column addresses. The latch captures the current address on the fall of CAS, permitting the system address to change while the access occurs. CAS also serves as an output enable on the data output. Static Column mode and Ripplemode both permit continuous data streams up to 20 MHz.

CMOS technology and static-column architecture provide more than low power consumption and high bandwidth. In addition, static-column decoding simplifies system design by eliminating critical timing relationships while providing higher system speed. Access from column addresses gives usable speed for single random accesses within the RAM. Also, the CMOS technology enhances reliability by incorporating a mechanism to significantly reduce soft errors. Finally, increased stored charge creates larger internal signal



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levels, which can more easily be differentiated from noise. As a result, the CMOS dynamic RAM has wider operating margins and system reliability is improved.

Power Consumption

At the system level, dynamic memory has three components of power: active, standby, and refresh. The system's power consumption is defined as

$$P=V(MI_A+KI_S+NI_R)$$

where P = system power, V = voltage (5.5 V worst case), I_A = active current, I_A = standby current, I_R = refresh current, M = number of active devices, K = number of devices in standby, and N = total number of devices.

CMOS reduces the first term, the active current, relative to NMOS by a factor of 2. In addition, the lower active current reduces supply voltage transients, thus simplifying printed-circuit-board design and reducing decoupling-capacitor requirements.

The second term, standby current, is also reduced by a factor of 2 at TTL input levels. Driving the RAS signal to a CMOS level ($V_{DD}-0.5$ V) places the device in a low-power-standby mode and typically draws 10 microamperes (μA)—a factor of 50 reduction over NMOS!

Refresh current, the third term in the equation, is cycle-time dependent. Current increases with the frequency of refresh. In dynamic RAMs, data is stored on a capacitor that must be replenished or recharged every 2 or 4 milliseconds (ms). This refresh time is a function of the stored charge and the leakage current. With the CMOS dynamic RAM, the cell storage capacitance is 0.125 picofarad (pF) compared to 0.040 pF to 0.085 pF in an NMOS dynamic RAM. This low capacitance, coupled with lower leakage currents, permits the CMOS refresh period to be extended to 64 ms in standby.

At the standard 128 refresh cycles/2 ms (equivalent to a 15.625-μs refresh period), the NMOS device draws about 4.8 milliamperes (mA) and asymptotically approaches the standby current of 4 mA as the refresh period approaches infinity. Even eliminating refresh entirely only reduces the current to 4 mA, which is only a 16 percent improvement. As a result, extending NMOS refresh does not significantly reduce the system's power consumption.

Contrast this characteristic to the improvement CMOS offers. At 15.625 μs, the CMOS dynamic RAM draws approximately 10 percent of the NMOS current, or 0.42 mA at TTL levels. Extending the refresh period reduces the current asymptotically to the standby current of 0.05 mA. At a 64-ms refresh period, the current is reduced to 0.15 mA, a 300 percent reduction. When battery powered, the CMOS system has a 10 times longer life than does the NMOS system, and an extended refresh mode offers another fivefold improvement. A 256K-byte CMOS memory can retain data for nearly one week on only AA nickel-cadmium (nicad) cells—more than sufficient for most portable systems.

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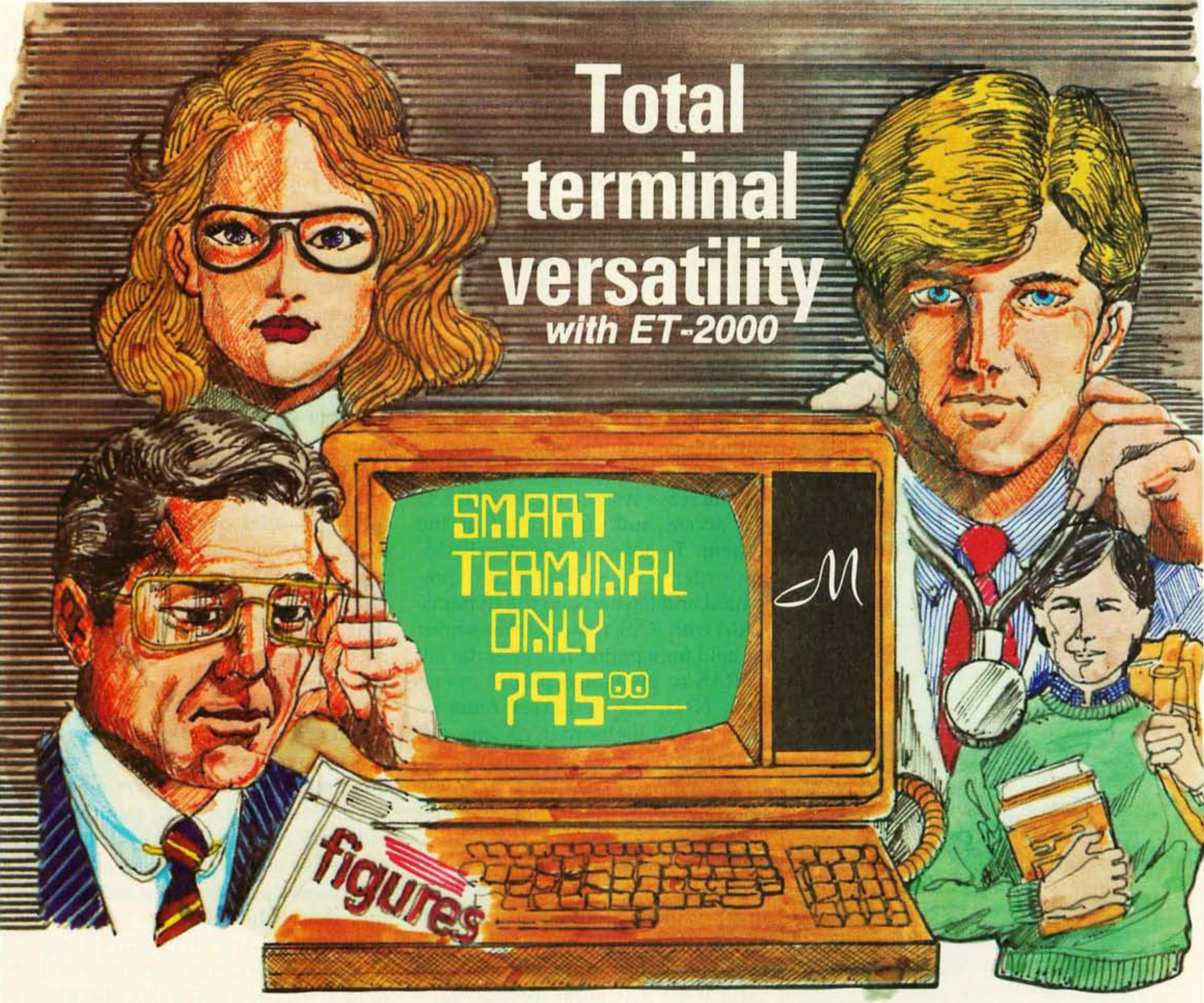
High-Speed Applications

Ripplemode and Static Column mode are ideal for applications involving high-speed buffers, telecommunications, and graphics. Bit-mapped graphics systems would seem to be a natural fit with Page Mode operation. However, this was not always the case. Prior to the Intel 2164A 64K by 1-bit NMOS dynamic RAM, it was difficult to retrieve all 256 bits within a single row of memory because of the RAS-low time limitation of 10 μs. Even with a Page Mode cycle time of 125 ns, to retrieve all 256 bits would require 32 μs—three times longer than allowed. The 2164A extended the RAS-low time to 75 μs, permitting the extraction of all 256 bits during a single Page Mode cycle.

At the end of the cycle, the device cannot be reaccessed again until after a certain off-time allows internal nodes to be precharged to be ready for the next cycle. As a result, the 2164A can stream data at greater than a 7-MHz rate continuously. This function matches the timing and operation of low-performance, bit-mapped graphics memories. One 2164A, for example, can map all the data for the 256 by 256 matrix of a graphics display. During the horizontal scan time, the RAM performs a Page Mode cycle and one full line is displayed. During retrace time, the memory must be refreshed and can be updated with new data if required. This type of update is relatively slow; consequently, it limits the speed of animation on the screen because the processor has access to the memory only 25 percent of the time.

To increase resolution, more lines, each with more pixels, must be used. By performing two sequential Page Mode cycles from two different RAMs, pixel densities to 512 bits per line can be achieved. As pixel density increases, the memory cycle time must decrease to paint more pixels on a line in the same amount of time. This cycle-time limitation plus the fact that memory can be updated only during blanking has precluded dynamic RAMs from use in higher-resolution graphics displays. These systems are usually built with high-speed, expensive static RAMs.

With Ripplemode, memory update during screen display time, also known as cycle stealing, is possible. As an example, a 512 by 384 display requires 512 bits/line and 1 bit every 67 ns. Data is read from four memory devices in a series of eight Ripplemode reads each. Data is temporarily stored in a video-output register file and then shifted to the video screen at a rate slower than the Ripplemode reads. Following this, enough time is available to perform an update cycle before the next eight Ripplemode reads are performed to continue screen refresh. Eight was the number chosen to minimize the time the processor must wait to update the memory. In addition to this cycle stealing, which updates during display time, memory updates are also performed during blanking. Along with this system, a similar sys-



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tem was built using 2164As with Extended Page Mode operation. Each system used an iAPX 86 processor and similar software. A comparison of both systems showed the CHMOS (complementary high-speed metal-oxide semiconductor) system to have a 42 percent higher drawing speed. Animation on the CHMOS system was vastly improved.

Usable Speed

Memory design using dynamic RAMs has always been a challenge. Although multiplexing addresses does reduce the package pin count and increase system density, it limits the access and cycle times in the system. To access a dynamic RAM, low-order row addresses are presented and latched into the dynamic RAM with RAS. Row addresses must be held for a period t_{RAH} after the fall of RAS to guarantee proper operation. Next, the addresses must be changed to high-order column addresses and latched into the dynamic RAM with CAS, creating a timing window t_{RCD}, which is the RAS-to-CAS delay.

Within this window, the designer must guarantee row address hold time, change the addresses, and account for any timing skew on the CAS signal. If column addresses are valid at the maximum specified t_{RCD}, access time t_{RAC} is measured from the high-to-low transition of RAS.

The cycle time is the sum of the access time and the cycle precharge time t_{RP}. The access time is a function of t_{RCD}, which has contradictory requirements. It must be as long as possible to simplify system design and at the same time as short as possible to enhance system speed. Cycle time is affected directly by the length of t_{RP}.

Static-column operation eliminates the t_{RCD} problem. After row addresses have been latched into the RAM, the second portion of the access begins from valid column addresses. In other words, column access does not wait for CAS to become valid, but operates in a fashion similar to that of a static RAM. This is due to the flow-through operation of the CAS latch. CAS serves only to latch the addresses and to provide an output enable. Access from valid column addresses simplifies design by removing the CAS signal from the critical timing path.

Systems using dynamic RAMs are typically CAS access-limited because controllers generate timing signals in discrete clock increments. A CMOS dynamic RAM system might operate at 8 MHz without Wait states. Using any other 64K-bit dynamic RAM would require the injection of one or two Wait states, resulting in a corresponding performance penalty. Consequently, the advantage of higher processor speed is negated without the high-speed dynamic RAM. For systems incorporating either discrete or LSI controllers, the CMOS dynamic RAM simplifies the system design and offers higher system performance.

High Reliability

Soft errors are random, nonrecurring failures caused by ionizing radiation present within the environment. All matter contains small amounts of radioactive material. Alpha particles emitted by an IC's packaging material can penetrate the enclosed circuit. As they do so, they generate hole-electron pairs. Any high-impedance node in the vicinity sensitive to 1 million electrons may be affected, because the difference between a 1 and a 0 (known as the critical charge) is about 1 million electrons. Consequently, data in one cell could change from a 1 to a 0 or vice versa. Correct data can be rewritten into the affected cell and the memory will again function correctly, thus the term "soft error."

When first discovered during tests of 16K-bit dynamic RAMs, soft errors occurred at a rate five times greater than catastrophic or hard-error failures. While device designers worked to eliminate the alpha-particle sensitivity, systems designers added error-correcting circuits (ECC), which increased system reliability, but the systems were larger and more expensive due to the additional components required. Also, the system had to test and correct the data, slowing the system's performance. All this

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was due to soft errors. Obviously, what is really required is the elimination of soft errors.

CMOS technology offers such a solution. The CMOS dynamic RAM cell is built on an n-well in a p-substrate, creating a p-n junction or diode at the boundary. When alpha particles create hole-electron pairs in a CMOS device, something else occurs. First, the n-well is very shallow, and the majority of hole-electron pairs are created in the p-substrate. Holes cannot transfer across the reverse-biased p-n junction, which acts as a barrier to soft-error effects. Any electrons that do cross the junction are gathered at the +5-V node away from the storage cell. The probability that sufficient hole-electron pairs are created within the n-well that cell upset could occur is so low that the soft-error rate of CMOS dynamic RAMs is typically orders of magnitude below that of their NMOS counterparts.

High storage capacitance also plays a role in the reduction of soft errors. The number of stored charged electrons representing a 1 or a 0 is directly proportional to the storage capacitance. Higher capacitance equates to more stored charge, which in turn increases the critical charge. The critical charge is the number of particles that differentiate a 1 from a 0. Increasing the critical charge beyond 1 million electrons significantly reduces the susceptibility to soft errors. This, in addition to the n-well mechanism, reduces the soft-error rate to much less than 0.001 percent per 1000 hours.

Studies were performed to compare reliability of systems with and without error correction for both NMOS and CMOS dynamic RAMs. The results show one surprise: at 256K bytes and below, the CMOS system *without* ECC is more reliable than the NMOS system *with* ECC, because of the cycle-time dependence of soft errors. In small systems, the memory is accessed more frequently, and the probability of a soft error is increased. With a soft-error rate at the very minimum 100 times less than NMOS, the CMOS dynamic RAM does not experience this effect.

Systems below 256K-byte capacities benefit by the elimination of ECC circuits from a cost, performance, and simplicity-of-design standpoint. First, ECC increases the access time of the system by 50 ns to check and correct data. Assuming a 120-ns RAM access, ECC increases the access by 42 percent. Moreover, the penalty on cycle time is even greater, especially when you are writing a single byte into a 2-byte word. In this instance, data must be accessed and corrected, the new byte merged into the word, and check bits generated. Finally, the system must write the new data into memory. Added to this are any system-timing skews. As a result, a 200-ns cycle time stretches to a 335-ns system cycle time or an increase of 68 percent. Therefore, using a CMOS dynamic RAM not only improves system reliability but enhances system speed and simplicity of design.■

Joe Altnether is technical marketing manager at Intel Corp. (2111 N.E. 25th Ave., Hillsboro, OR 97123).

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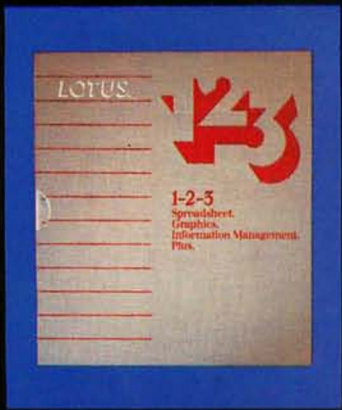

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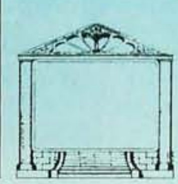

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The Challenge of Hard-Disk Portability

How DMA Systems designed a removable hard-disk unit for the transportable generation

by David A. Sutton

In the Old West, Winchesters were designed to be portable. They could survive weeks in dusty scabbards and still function efficiently when the need arose. These days, portable Winchester disks operate under different constraints to perform different tasks.

This is an account of the portability issues encountered by one hard-disk-drive manufacturer, DMA Systems, and of the design decisions its engineers reached.

Why does a transportable computer need a hard-disk drive? Because many of us need to transfer the power of our desktop computers to other locations, and we don't want to sacrifice software or hardware capability in terms of speed and storage capacity. Ideally, the capabilities of a hard-disk unit should be available whether the system is transportable (requires AC power) or portable (requires battery power).

A designer of a portable hard-disk system confronts a difficult task if reliability, speed, and capacity are to be preserved. The most difficult challenge designers face is developing truly portable hard-disk drives for away-from-the-office data storage, program loading, and backup storage.

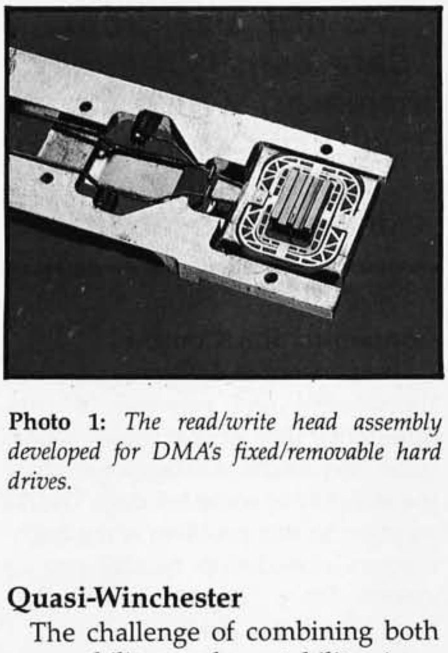

Photo 1: *The read/write head assembly developed for DMA's fixed/removable hard drives.*

Quasi-Winchester

The challenge of combining both removability and portability in a single Winchester-type device means that designers must grapple with the fact that a removable-only cartridge drive (or the removable portion of a fixed/removable drive) is not a Winchester in the classic sense. In 1973, IBM developed Winchester technology and dropped the flying height of the head from 80 microinches to as low as 15 microinches above the disk. This low flying height dictated the characteristics we now consider typical of a Winchester—heads and disk in a sealed environment, heads that land on the disk prior to flying, lubricated media, and stringent air-filtration systems. These controls enable the head to fly lower and the drive to achieve Winchester flying heights.

IBM's original 30-30 project (30 megabytes fixed, 30 megabytes removable) presumed that the only way to guarantee a contamination-proof disk surface for the low-flying Winchester heads was to package heads and disks together in a sealed environment. The cost of a removable Winchester "pack," therefore, would have to include the cost of a complete set of heads and a head-carriage mechanism. It was an impractical approach then and is even more impractical for microcomputers.

In any situation in which a disk drive may be moved, it's equally impractical to have the heads settle onto the disk area during power-down. Allowing the head to touch the media risks damage to both the data on the disk and the head itself.

Hazards of Portability

A portable hard-disk cartridge drive faces a triple set of hazards: to the cartridge, to the drive, and to the combined cartridge and drive

(operating or not operating). Cartridge and drive are both part of an electromechanical assembly that must deliver years of reliable service without requiring maintenance. It would certainly be asking too much of any user to seat the cartridge with anywhere near the level of care used in a factory clean room to align a sealed Winchester disk-and-head assembly. Instead, a drive designer must assume that both cartridge and drive, of either fixed or removable type, will be subject to every conceivable kind of abuse:

- shock and vibration that can cause head or disk-surface damage or cause data to be lost because the balance between aerodynamic lift and head-loading force has been disturbed or because the heads have been thrown off track by spurious sideways movements
- contamination (dust, cigarette smoke, moisture, or chemical fumes) that enters the cartridge or collects on the heads and actuator arm when the cartridge has been removed from the drive
- strong electrical or magnetic fields that can make data and software unreadable
- unsophisticated or unauthorized users who are convinced that their principal mission in life is to enforce Murphy's law personally

Shrinking Size and Costs

As if these challenges were not enough, cartridge-drive designers must face the fact that the requirement for portability or transportability will only encourage the demand for smaller drives (or greater capacity within the same drive envelope). A designer's task is to maintain reliability and performance. As disk size drops, data density steadily increases, making it all the more difficult to maintain *repeatability* (the capability to read recorded data when a cartridge is inserted in a drive) and *interchangeability* (the capability to record data on one drive and read it when the cartridge is inserted into another similar device).

In a cost-conscious market, little allowance is given to the difficulties a drive designer must overcome in this ongoing quest for miniaturization. Instead, the belief prevails that "If it's smaller, it should be cheaper." Maintaining reliability and enhancing performance means that a designer must rethink every aspect of the drive assembly and electronics:

- the read/write heads
- the disk media and motor
- the head-positioning servo system
- the data separator
- the drive enclosure
- the cartridge design

In designing its Micro-Magnum fixed/removable and removable-only drives, DMA Systems attempted to address all of these needs. Charting unknown waters, DMA engineers expected the worst (and have rarely been disappointed).

As disk size drops, data density steadily increases, which makes it difficult to maintain repeatability and interchangeability.

Contamination Control

One concern of designers has been the control and removal of contaminants that could cause severe head and media damage or destroy the integrity of recorded data. DMA's solution to this problem is the high-capacity, closed-loop, recirculating air system for a "double half-height" fixed/removable drive.

A preliminary purge cycle removes all the contaminants that may have entered the drive when a cartridge is inserted. The impeller-drive system then continues to move all air in the drive through a recirculating filter at least once per second. The filter unit was designed to last for five years with no filter changes.

Both the drive and the cartridge have self-sealing doors to keep contaminants from entering their respective compartments and to ensure a clean head-disk interface. Whenever the spindle motor is turned off, the head assembly is completely withdrawn into the drive and the door seals the head-port opening. The cartridge also has a door to protect the head opening and a clamp that secures the hub against the cartridge to prevent foreign substances from entering the cartridge.

Most of the contaminants that enter the system were already inside the cartridge when it was inserted into the drive. The purge cycle removes most of these and also raises the pressure in the cartridge so that any air leaks vent outward and no further contaminants may enter the cartridge. Any loss due to leakage is made up by air pulled into the system through a breather filter.

Head Design

A consistent head-to-media relationship is an absolute must for data integrity and device reliability. The head and disk must maintain their critical distance, yet head and disk surface must not physically touch. This premise is overlooked in the design of most 5¼-inch Winchester disk drives—a fact that becomes critical when transporting the drive introduces the opportunity for violent head-to-disk contact.

When the disk is in a cartridge that is being pushed in and out of several drives, or even in and out of the same drive on a daily basis, elimination of head-to-disk contact is essential. Therefore DMA developed the Cushion-Aire head assembly (photo 1) to allow a Winchester air bearing to be loaded dynamically onto a spinning cartridge disk. Because the head never starts or stops touching the disk, there is no head ringing on the disk, no head-landing on top of contaminants after purge cycles, no damage to heads during transit, and no accidental jostling of the system during use.

Though nickel-zinc-ferrite and manganese-zinc monolithic ferrite heads are commonplace on larger Winchester drives, both present drawbacks when incorporated into a 5¼-inch design. At the data densities required, the signal output of nickel-zinc-ferrite heads is unacceptable,

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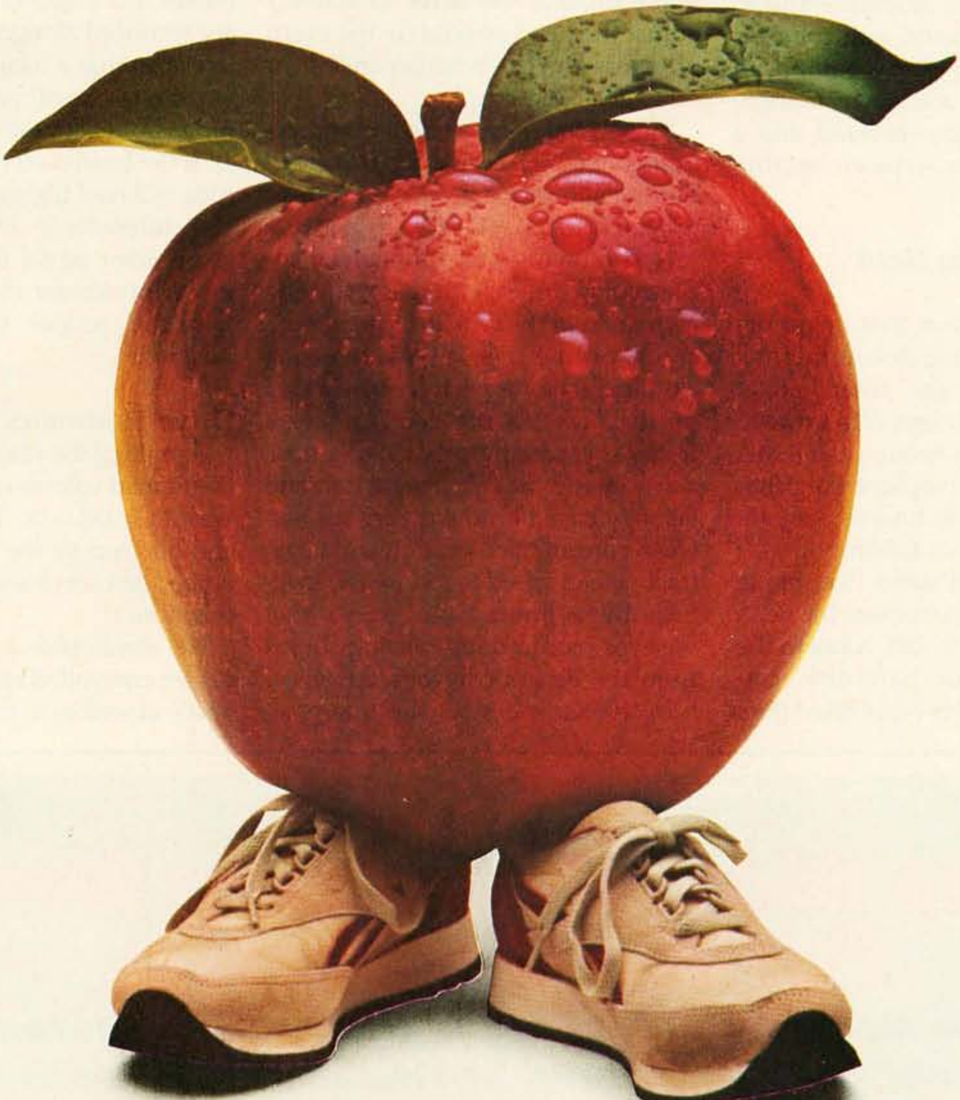

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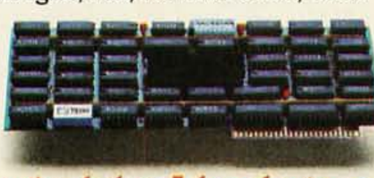

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and manganese-zinc heads are only marginally acceptable. Furthermore, monolithic heads have inherently less signal output due to their relatively long flux path. To remedy the signal strength problem—and to provide less parasitic inductance—DMA chose to develop a composite head employing a discrete manganese-zinc core, glass-bonded into a ceramic Winchester-type air-bearing enclosure.

Embedded-Servo Head Positioning

To overcome errors that might occur in head tracking due to thermal expansion, cartridge interchange, friction in the cartridge, offset due to drive tilt, and disk runout, the DMA engineering staff employed another proven large-disk technique: embedded-servo head positioning.

The embedded-servo technique eliminates any requirement for head alignment and is, in fact, a key to the successful use of hard-disk cartridges. Servo codes embedded (i.e., recorded) on the disk guide the drive heads to the proper position by sending signals to the mechanism controlling the read/write head as the head passes over the disk. This technique enables the drive to actually adjust the head position in the event of errors due to heat expansion or other factors.

Embedded-servo positioning requires two steps. First, course positioning allows the proper track to be located. Embedded-servo data is prerecorded on the disk during the manufacturing process and is typically contained in the first 26 bytes of each sector on the disk. The servo code contains data for each track number on the disk. As the head crosses a track, it reads the servo data and a software routine calculates a demand velocity based on the difference between current track location and target track. Head speed is controlled, in effect, by a linear-motor servo that receives continuous analog input from the drive's control electronics.

In the second step, the fine-positioning servomechanism locates the read/write head within a half-track distance of the desired location. Prerecorded signal segments A and B define the fine-positioning servo bursts. The edges of signals A and B are recorded along the center of the tracks so that a head centered exactly on a track will read equal amplitudes from both segments (see figure 1). If the head is off center, one amplitude will read higher, the other lower. The difference is detected and used as an error signal to drive a linear-motor positioner to seek and maintain the proper track center-line position.

Drive Electronics

Shrinking the control electronics to the limited volume of a 5¼-inch drive was no small task. This mission was complicated by the circuitry for the embedded servo and voice-coil head positioner.

We developed a dual microprocessor-controlled system to conserve space as well as to partition functions

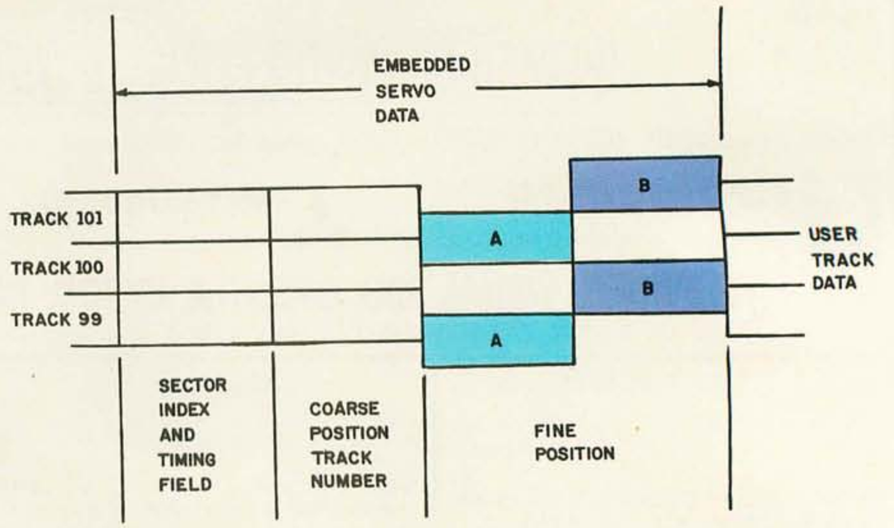

Figure 1: *This diagram shows how the servo data is embedded on the disk to facilitate precise positioning of the heads over the tracks.*

and simplify the hardware. One microprocessor is dedicated to I/O (input/output) status purposes including front-end function, safety checks, and fault algorithms. This microprocessor also preformats all SEEK commands into the form required by the second microprocessor, which controls all the internal command lines of the embedded-servo system.

The second microprocessor also receives embedded-servo information from a servo decoding unit—a custom, large-scale integrated circuit (LSI)—which gives the microprocessor the information required to perform the basic disk-drive servo functions: track following and seeking, rezeroing, and loading and retracting of the heads.

Partitioning these operations between two microprocessors helps achieve faster overall system response. For example, the second microprocessor may perform a SEEK while the first continues to handle all interface and safety functions; two microprocessors can handle emergency situations faster than a single processor.

Two custom LSI gate-array chips were also developed to achieve the needed packing density and to manage the servo data while protecting it from any accidental overwriting.

The first gate-array chip is committed to servo control of the spindle and is a 200-gate array that includes spindle-motor commutation circuits, a spindle-speed control servo, a speed-safety function, and a 10-MHz crystal oscillator. The second, an 800-gate array IC, decodes the digital information within the embedded-servo fields. Erase-gap detection, sector decoding, the location of index marks, track timing checks, and sample pulses for fine positioning of the heads are all controlled by this chip.

If the drive were ever to overwrite the embedded-servo fields, data could be irretrievably lost. To prevent this, a series of hardware and software safety checks works to protect both the embedded-servo fields and the data on the disks. The decoding gate-array chip checks hardware before clearing the way for a WRITE operation. The heads can respond within microseconds to any unsafe condition spotted by the gate-array chip. Software checks are also written into the drive firmware to enable the WRITE functions. The software will not proceed with a WRITE operation until two successive embedded-servo sectors have decoded the same track identification and no fault conditions have been found in the drive.

Packaging and Power Drain

In almost every respect, currently available hard-disk Winchester drives can meet the requirements imposed

by portability or transportability. They are reliable devices with built-in safety features and a high tolerance for abuse. But two issues still need to be addressed: packaging and power.

It is too early to say how the drives will ultimately be integrated into portable or transportable systems. Now, they are packaged as separate accessories that connect with a short cable to the back of the computer. This means that, for the first time, designers of small hard-disk drives will be concerned with appearance and with an exterior that can withstand scratches, heavy weights, and an occasional drop off a desk. Manufacturers will also be pressured to further decrease size and weight, anticipating the day when hard disks are the standard storage medium for portable and transportable computers and have moved inside the "box" to take the place of fading floppy disks.

Most hard-disk drives were designed for integration into a desktop or console cabinet, with no real limitation on the power required for driving the high-speed spindle. Drives now draw more than an ampere of current and dissipate up to 30 watts of power. This would quickly drain any battery pack that a user would be willing to carry. Therefore, despite any designer's best efforts to reduce power requirements, true portability is still unobtainable. Computers with hard-disk storage are still restricted to locations with external power sources, including the 12-volt cigarette-lighter jack available on most automobiles.

Despite this reservation, however, there is no question that the hard-disk cartridge will soon be a feasible storage medium for every class of small computer. In terms of convenience, capacity, and removability, it may soon be the only viable alternative.■

David A. Sutton is the engineering vice-president of DMA Systems (601 Pine Ave., Goleta, CA 93117). Prior to working at DMA, he worked at General Electric and helped found Information Magnetics Corporation.

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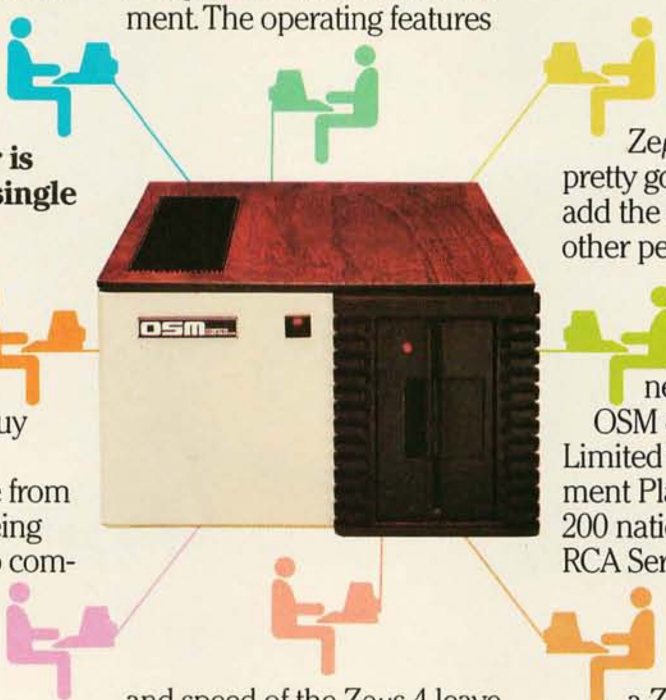

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The Radio Shack TRS-80 Model 100

The power of this machine resides in the strong integration among the built-in software packages

by Mahlon G. Kelly

I first laid my hands on a TRS-80 Model I back in 1978, and I was amazed at what it could do. It seemed obvious to me (and to many others) that the microcomputers that were then appearing—TRS-80, PET, Apple, and their ilk—would revolutionize how many of us do our work. Five years later, it's hard for me to remember what it was like not to have a microcomputer in my office.

Photo 1: *The Radio Shack TRS-80 Model 100.*

I have used more than 20 brands of microcomputers. All had their advantages and disadvantages and most did what was expected of them, but none excited me like that first generation—until now. The excitement is back: the TRS-80 Model 100 is the precursor of another revolution.

The Model 100 is very different from its predecessors: the portable and pocket computers. The portables, all more than 20 pounds in weight and with delicate disk drives, aren't suited to go wherever you want. The pocket machines can be easily carried around but are inadequate for large jobs because of their limited keyboards, displays, memory, and speed. I have often dreamed of a computer—one that had a typewriter keyboard and a useful screen display—that I could hold in my lap, carry from office to office,

and use for jobs I would otherwise do on my desktop machine.

The Model 100 is just what I wanted, a fine stand-alone machine that is also ideally suited for hooking up to other computers, either directly or over the phone. With its excellent text editor, you can use it as an electronic scratch pad and then exchange its contents with machines that have more storage, you can use it to transfer data between incompatible machines, you can use it as a remote terminal, you can use it to gather field data, or you can simply use it as an excellent stand-alone machine.

Physical Description

The Model 100 is a little under 2 inches thick and about the size of a typical sheet of typing paper (see photo 1). The top surface has a full-size keyboard and an LCD (liquid-crystal display) showing 8 lines of 40 characters each that can be adjusted for clarity at various viewing angles. Around the edges are several sockets and switches, which should give you an idea of the power of this computer. There's an on/off switch, two switches for the modem (one for choosing originate or answer mode and another for choosing between a direct connection and an acoustic coupler), and a push button for reset. It also has sockets for a power transformer, a bar-code reader, a tape recorder, a DB-25 connector for RS-232C communication, a modem connection to a phone line, and one for a cable to a Centronics-compatible printer. The transformer and cables aren't included, but they're inexpensive. On the bottom are sockets for additional ROM (read-only memory) and a bus connector, both of which hint at things to come.

Power can come either from an AC outlet or from four AA alkaline batteries. Either source continually charges nickel-cadmium (nicad) cells that maintain the memory. The four AA cells will last about 20 hours; a light on the top warns when they're low. If they run down, the nicads will maintain the information already in the computer for many days. A switch on the back disconnects the nicads when the machine is going to be stored, but that will delete all the information in the memory.

The Model 100 is available with 8K bytes of RAM (random-access read/write memory) for $799 or with 24K bytes for $999; more can be added for a total of 32K bytes. Files and programs remain in memory until they are deliberately killed. This sharing of memory makes the 8K-byte version of the machine virtually unusable for anything serious.

Keyboard

The keyboard is as good as any I have used on a microcomputer or terminal. It's of standard size and the feel is excellent. There's nice audible feedback on each key, and the auto-repeat feature has a natural feel to it. A touch-typist will be right at home. Besides the normal typewriter keys (including a Caps-Lock), it has six special keys. Control and Escape keys are available mainly for use with the telecommunications program. The Model 100 itself also responds to control characters—for example, Con-

CompuServe
Page CIS-1
CompuServe Information Service
1 Home Services
2 Business & Financial
3 Personal Computing
4 Services for Professionals
5 User Information
6 Index
Enter your selection number,
or H for more information.
STOCK
COMS
SORCE
DCONN
NEXT

trol-H sends a backspace and Control-I does a tab. There's also a Tab key, although you cannot define the settings.

The Num key latches in the down position and redefines a cluster of keys on the right half of the keyboard as a keypad for data entry. In some ways this is nicer than a separate keypad, because your fingers are always near the Enter, Backspace, and other keys. Code and Grph sit to the right and left of the space bar. They let you type in special graphics and alphabetic (foreign-language) symbols that are represented by ASCII (American National Standard Code for Information Interchange) numbers higher than 127. The keyboard has different characters for both shifted and lowercase Code and Grph modes. Unfortunately, because these are not standard characters, they won't be recognized by most printers.

Above the main keyboard are 16 special-function keys, eight of which are definable. The right-hand four are arrow keys for moving the cursor. I find them awkward to use; a cluster would be much better. To their left are four permanently defined keys: a Pause/Break key that makes a program pause or stop, a key for sending material to the printer, a Label key that causes the definition of the software-controlled keys to be displayed on the bottom of the screen, and a Paste key that's used with the text editor. The eight left-hand keys are definable, serving different purposes with different software.

The only problem I have found with the keyboard is that, when it's sitting on top of a desk, your thumb is likely to hit the lower edge of the case before it actuates the space bar. It's better if you put something under the back of the case to tilt the keyboard, but it would have been nice if the lower edge of the case had been slightly cut away. Others have complained about the popping noise the keys make when they're pressed. Some people, however, don't mind the sound the keys make: when I loaned the machine to a student to use *during* an exam, none of his neighbors complained.

Software

The way that the programs in ROM are integrated with each other and the machine makes the Model 100 revolutionary. Contained in 32K bytes of ROM are the BASIC interpreter, a versatile text editor, a telecommunications package with advanced features that supports both RS-232C hook-up and 300-bps (bits per second) modem communication, a schedule book, and an address book. The address book also contains the phone numbers for the auto-dial modem.

When you first turn on the machine, you see a menu with the files and programs, the time, day, date, and the available memory. Five programs (BASIC, TEXT, TELCOM, ADDRSS, and SCHEDL) are in ROM. Two RAM files, ADDRS.DO and NOTE.DO, are needed if the address and schedule books are to be used. Files are designated by three suffixes: .DO(cument), .BA(sic), and .CO(mmand). A broad reverse-video cursor covers the file names and is moved by the arrow keys. Pressing Enter either executes the program pointed to by the cursor or, for a .DO file, enters the text editor and loads that file into it.

The way that the programs in ROM are integrated with each other and the machine makes the Model 100 revolutionary.

Microsoft is selling the operating system and BASIC to others, and this system may become a de facto standard. The NEC notebook computer that has recently been introduced is very similar, partly because it uses much of the same software.

Text Editor

The text editor is the most commonly used program. It's used to create and edit documents (including the files for the address and schedule books), and it also serves as the BASIC editor. It's simple but very versatile; it is *not* a word processor, however. When a document is printed, it is presented exactly as it occurs in the memory; no provision is made for page control, variable margins, and the other things that a word processor should do. But a simple BASIC program can be used to format a file (see listing 1).

The text editor is simplicity itself in concept. Only eight things can be done: text can be inserted, marked, deleted, copied, or searched for; the cursor can be moved; and files can be saved to or read from tape. No type-over mode is available. To replace text, it must first be deleted, by either backspacing over it or by marking it and then cutting it out. Being permanently in an insertion mode may be confusing if you're used to more typical text editors, but the strangeness soon goes away. When pressed by themselves, the arrow keys either move the cursor up or down or one character to the right or left. They can also be used to scroll through the text. Pressing Shift and an arrow key either moves to the top or bottom of the screen or one word to the right or left. Pressing the Control key and either horizontal arrow moves the cursor to the beginning or end of a line; with the vertical arrows, Control moves to the top or bottom of the document. When supplemented by the Find function, the arrow keys make it easy to position the cursor anywhere in the text.

Cut-and-paste operations are just as easy. Pressing the key marked Sel (for select—function key F7) and then moving the cursor makes everything that the cursor passes over appear in reverse video. Text can be "unmarked" by pressing the Break key, moving the cursor back over the text, or pressing the Sel key again. Pressing Cut (key F6) removes the marked text, saving it in the paste buffer. If you press Copy (key F5), the text goes to the buffer but isn't removed from the document. At any time, pressing the Paste key puts the contents of the paste buffer into the document in front of the cursor.

I do have some criticisms of the editor. It's easy to find a string, but

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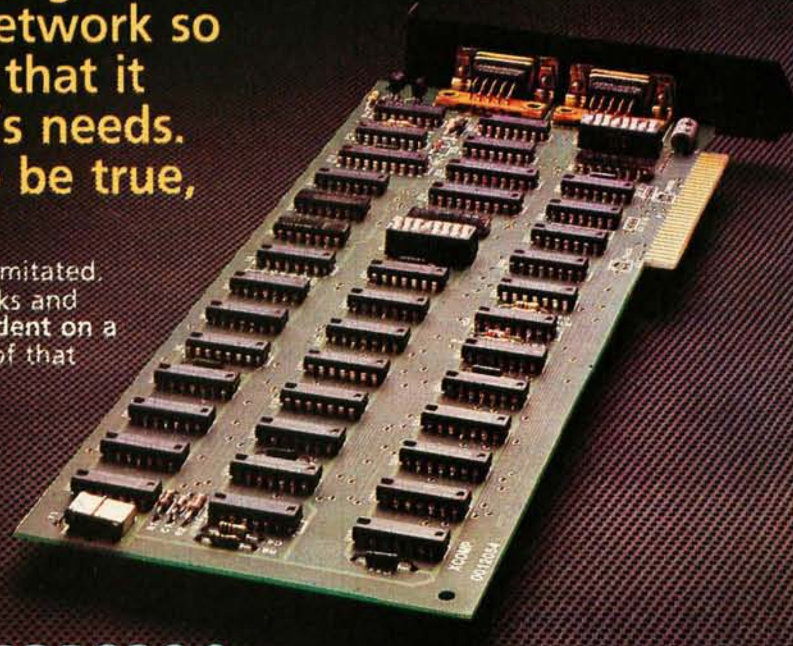

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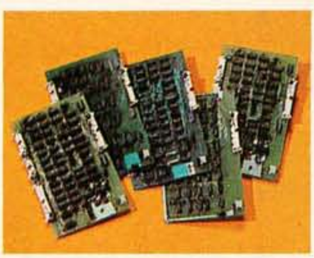

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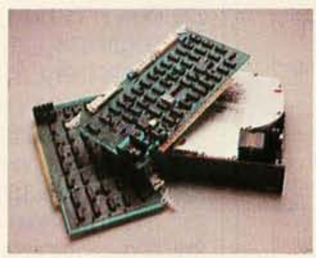

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Listing 1: *A Model 100 BASIC program to format text output. This program was placed in the public domain by Ed Juge of Tandy.*

```
1 'NEWPRT.100    Ed Juge    04/19/83
2 '<GRPH>p causes forced end of page
3 'Defaults for margins (L,R), print
4 '   title on page 1 (HD$) and line
5 '   spacing (LS) exist in line 20.
6 '
7 '
10 CLS:CLEAR2000:S=0:FILES
20 L=10:R=65:HD$="Y":LS=1
30 C$=STRING$(60,32):LN=0:PG=1
40 GOSUB100:INPUT".DO file to print  ";N$
50 GOSUB100:INPUT"Margins (L,R)   ";L,R:IFL=0THENL=1
60 L$=STRING$(L-1,32):GOSUB100:INPUT"Line Spacing (1/2)  ";LS
70 GOSUB100:INPUT"Enter page title";H$
80 GOSUB100:INPUT"Title on Pg.1  (Y/N) ";HD$
85 OPENN$FORINPUTAS1
90 GOTO110
100 PRINT@205,C$:PRINT@205,"";:RETURN
110 CLS:IFH$=""THEN PH$=L$+DATE$:GOTO140
120 PH$=STRING$(R-8,32)+DATE$
130 IFH$<>""THENMID$(PH$,L,(LEN(H$)))=H$
140 IFHD$="Y"ORHD$="y"THENGOSUB 360:PR$=L$
160 PR$=L$
170 IFLN>=50THENGOTO330
180 FORJ=LEN(PR$)TOR
190   PR$=PR$+INPUT$(1,1)
200   IFEOF(1)THENCLOSE:EN=1:GOTO280
210   IFRIGHT$(PR$,1)=CHR$(10)THENPF=1:GOTO270
220 IFRIGHT$(PR$,1)=CHR$(128)THENPR$=LEFT$(PR$,J-1):GOTO330
230   NEXTJ
240 IFMID$(PR$,J,1)=" "THEN260
250 J=J-1:GOTO240
260 NX$=MID$(PR$,J+1,R):PR$=MID$(PR$,1,J):GOTO280
270 PR$=LEFT$(PR$,LEN(PR$)-2)
280 IFMID$(PR$,L,3)="   "THEN300
290 IFMID$(PR$,L,1)=" "THEN PR$=MID$(PR$,2,LEN(PR$)):GOTO290
300 LPRINTPR$:LN=LN+1:IFEN=1THEN330
310 IFLS=2THENLPRINT:LN=LN+1
320 PR$=L$+NX$:NX$="":GOTO 170
330 FOR J1=LNTO65:LPRINT:NEXTJ1:PG=PG+1
340 IFEN=1THENMENU
350 IFX$<>""THEN360 ELSEPRINT@160,"";:INPUT"  <ENTER> = next page, <N> = nonstop";X$
360 CLS:LPRINTPH$:LPRINTL$;"Page ";PG
370 LPRINT:LPRINT:LN=4:GOTO180
```

there is no provision to find a string and replace it with another. Second, it's awkward to add text from other files ("boiler plate" paragraphs and so on). The easiest way is to leave the document, enter the other file, and mark and copy the text to the paste buffer. You can then reenter the original document and paste in the text (that's not as hard as it sounds). You can also add text from tape, but that's really awkward and slow. It would be nice to have a command to insert or append text from other files.

Another problem is that when you add text to the middle of a fairly long file (2000 to 3000 characters) it's easy to type faster than the characters appear on the screen. Because there's a type-ahead buffer, your input won't be lost. Nevertheless, the delay is disconcerting, and long segments of inserted text must be proofread after the screen catches up. However, if you're typing at the end of the file, you can't type faster than the screen will display. In order to insert text into the middle of a very large file, I

Listing 2: *A Model 100 BASIC program that determines the length of a Model 100 text file; it will not work on program files.*

```
5 CLEAR 1000:A=0:B=0:PRINT:FILES:ON ERROR GOTO 200
10 INPUT "What's the file";F$
20 CLS
30 OPEN F$ FOR INPUT AS 1
40 IF EOF(1) GOTO 100
50 PRINT@0," "
60 LINEINPUT#1,A$
70 A=A+LEN(A$)
80 B=B+1:PRINT@0,B
90 GOTO 40
100 PRINT "File ";CHR$(27)+"p"+F$+CHR$(27)+"q contains";A;"bytes"
110 PRINT"or";INT(A/6);"words and";B;"records."
120 CLOSE:GOTO 5
200 PRINT "Error no.";ERR
210 GOTO 5
```

find it easier to insert text at the end of the file, mark it to be cut, and then paste it in where it belongs.

A further problem, and one that doesn't apply to just the text editor, is that there's no way of knowing how much memory is occupied by each file. Listing 2 is a BASIC program that will tell you how long a text file is, although it won't work with BASIC programs.

Finally, when you edit a file you're working directly with the text stored in memory. With disk-based editors, if you make a mistake you can reload the original file. If you do so while editing a file in the Model 100, the mistake is permanent. It's a good idea to save the file to tape or to another file before you edit it. (This rather important point is not mentioned in the documentation.)

The small LCD screen isn't as nice for editing as a 24-line by 80-character video display, but when you get used to it it's not inconvenient. I wrote this article on the Model 100 and then sent it to my LNW-80 computer for final editing and printing (using the Newscript word-processing program). By embedding the proper Newscript formatting commands in the text itself, the file was ready for printing as it left the Model 100.

Address and Schedule Books

These two programs, ADDRSS and SCHEDL, are virtually identical in what they do, and presumably they share the same ROM. They both simply find a block of text that contains a certain string of characters. The block, which can be someone's address and phone number or a description of an appointment, is a long string that ends with a carriage return. The address function accesses a file named ADDRS.DO (which also contains the numbers accessed by the automatic dialing procedure in the communications software) while the schedule program looks at one called NOTE.DO. But the similarity and simplicity of these two programs don't negate their usefulness. You can, for example, create a list of items that have been flagged with special characters; when you search for the special characters, all flagged items will be displayed. The items could be appointments with your boss or the addresses and phone numbers of your field representatives. The files are created with the text editor and can be sorted and rearranged with fairly simple BASIC programs. It's also possible to send the found items to a printer.

Telecommunications

If the address and schedule programs are simple, the communications software (TELCOM) is the opposite. It's not hard to use, it just does so many things that it's hard to describe. When you move the menu cursor to TELCOM and press Enter, you go to mode 1 of the telecommunications package. Four possibilities are then offered by function keys F1 through F4: *Find* a name and phone number in the address file, *Call* the number to log on to a host, *Stat*, which lets you define the RS-232C parameters, and *Term*, which goes into mode 2, the terminal mode.

Let's look first at how you might sign on to a bulletin board system at 300 bps, with the number already in the directory. To use the modem you need a special cable. One end plugs into the Model 100, another into a wall jack, and the third is a socket for your phone. Although the manual is a bit confusing about this, telling you to plug the cable into your phone, the connections are obvious. The modem cable package is a great bargain. At less than $20, it includes an hour each on the Dow Jones and Compuserve information utilities.

The RS-232C parameters must first

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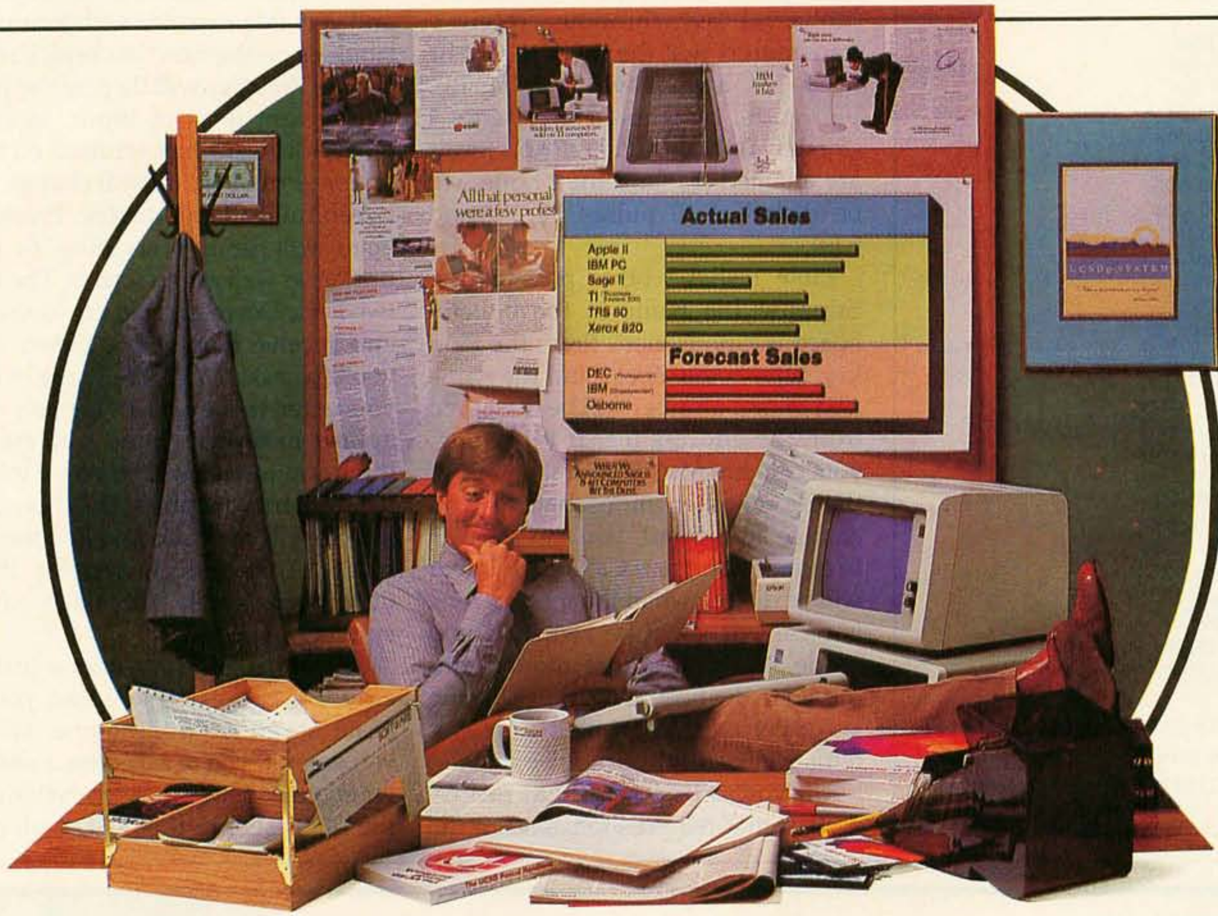

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Data Rate	
M	Modem (internal)—operates at 300 bps
1	75 bps
2	110 bps
3	300 bps
4	600 bps
5	1200 bps
6	2400 bps
7	4800 bps
8	9600 bps
9	19,200 bps
Word Length	
6	6 bits
7	7 bits
8	8 bits
Parity	
O	Odd parity
E	Even parity
N	No parity
I	Ignore parity
Stop Bit	
1	1 stop bit
2	2 stop bits
Line Status	
E	Enable XON/XOFF
D	Disable XON/XOFF
Pulse Rate	
10	10 pulses per second
20	20 pulses per second

Table 1: *RS-232C parameters that can be specified by using the Stat key from within the TELCOM communications program.*

be defined (if that hasn't been done). If you hit the Stat key and enter M8I1E,10, you tell the UART (universal asynchronous receiver/transmitter) that the modem will be used (M), a word will be 8 bits (8), parity will be ignored (I), there's 1 stop bit (1), XON and XOFF protocols are enabled (E), and the phone will be dialed at 10 pulses per second (,10).

Table 1 shows other possibilities. Suppose the name of the bulletin board is "mousenet". Press the Find key, type "mousenet", and the name and phone number will be displayed from the address file. If it's wrong, you can hit M (for more) to see if there's another mousenet; if you change your mind, you can press Q to quit. If you press Call, the number will be dialed; when the modem tone is received, you'll be switched into mode 2, the terminal mode, connected to the host. Only pulse dialing is supported. Most tone-dialing systems will also support pulse dialing, but if you're using a ROLM or PBX system that requires tones, then the number must be dialed manually.

While in terminal mode, you receive whatever comes from the host and you are presented with four possibilities on the function keys. Pressing the Prev key will display the previous eight lines of input, in case what you want has scrolled off the screen. Pressing Full will change between full and half duplex. Pressing Echo will send everything to the printer as well as the screen. The last two keys, Down and Up, let you send and receive files. Press Down and you'll be asked for a file name. After you enter it the word "Down" will appear in reverse video, and everything you receive will be stored in the file. When you press Down again, the file will be closed and its contents saved. That's much simpler than downloading a file with a disk-based system.

Uploading a file to a host is just as easy. Press the Up key and you're again asked for a file name. When you enter it, you're asked for a width; when you answer that, everything in the file is sent to the host, with car-

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Key	Meaning
?	Waits for a specified character to be received by the Model 100
=	Pauses for 2 seconds
!	Immediately precedes a "?" or "=" when those characters are to be transmitted to the remote computer
^	Sends the following character as a control character (e.g., ^K sends a Control-K)

Table 2: *Codes for use when automatically logging onto remote computers.*

riage returns entered at the nearest space to the width you defined so that words will not be broken in the middle. That's all there is to it. When you're done, just press the Bye key and the Model 100 will hang up.

There are several other possibilities in the way TELCOM can dial the phone. First, if you want to call a number that's not in your directory, just press Call while in mode 1 and type in the number. If you're calling a computer, you must put the symbols " < > " after the number to tell the Model 100 to wait for a modem tone. If there's no answer, hitting Break will hang up. You can also call people instead of computers using the address directory and TELCOM: just don't put " < > " after the phone number in the address file. You must pick up the phone before dialing is finished, or the Model 100 will immediately hang up when it's done dialing. The Model 100 can act as an auto-dialer with many, many numbers.

The Model 100 will also log on to the computer for you if there's a coded message between the angle brackets (< >) at the end of the number. Because the code is a bit complicated I won't describe it here (see table 2), but it's fairly easy to use with almost any host.

Making a connection to phone lines can be done in two ways: with an audio coupler or by direct connection. Both work via the same socket, but a switch on the left side of the Model 100 chooses between a direct connection and an acoustic connection. Auto-dialing is possible only in direct-connect mode. The audio coupler lets you use the modem if you're someplace that doesn't have modular jacks on its phones.

The telephone communications capability of the Model 100 is better than I have seen for any dedicated terminal. It lacks a few of the things available in the more sophisticated terminal programs available for larger microcomputers (translation tables and macro transmission, for example), but the deficiencies are slight.

Although not well described in the manual, one of the most important abilities of the Model 100 is that it can transmit data directly from memory into another microcomputer at rates up to 19,200 bps. Direct transmission to another computer is much needed because the small memory space of the Model 100 forces you to transfer files elsewhere to make more space available in the machine. Although programs and data can be stored on tape, it's quicker, more convenient, and more reliable to transfer them to another machine. The ability of the Model 100 to combine its power with that of a desktop machine is one of this computer's greatest assets.

Exchanging data by direct connection to another computer is similar to doing it over the phone except you must connect the Model 100 to the other computer through the RS-232C port. Because both machines try to send data on pin 2 and receive it on pin 3, you must use a "null modem" (a cable with the wires to pins 2 and 3 reversed on one connector) to connect the computers. You can buy one from Radio Shack for about $30, or you can make one from two DB-25 plugs and an eight-conductor cable. Solder it together so that pins 2 and 3 are crossed over while pins 1, 4 through 7, and 20 are connected directly.

Once the two computers are hooked together, you just have to specify the right data rate via the Stat key. For example, the "5" in the Stat parameter "57E1E" would set the data-transfer rate to 1200 bps (see table 2). Then when you press the Term key, you can upload and download data just as for telephone communications, but much more quickly. Of course you need the proper software for the larger machine, but a wide variety of programs are available for most microcomputers. You can use the Model 100 as a terminal, either by direct connection or via a 300-bps modem connection, for any computer that supports an RS-232C port. I have used the Model 100 with mainframes, minicomputers, and several microcomputers (CP/M systems as well as my own LNW-80) at rates up to 19,200 bps. You can also transfer data using BASIC programs.

Using the Model 100 as a terminal has one problem. Data can come in faster than it can be scrolled by the screen. That's usually not a problem at 300 bps or when you're typing, but at faster rates the input can actually overflow the input buffer. When that happens characters are lost. The best way to avoid this is to be sure the host doesn't send linefeeds after a carriage return, thus preventing the scrolling of the screen. The information will be hard to read because it all appears on one line, but it will all go into the file that's being saved. Because of this problem, the Model 100 cannot completely replace a high-speed data terminal.

Some Applications

For me, the TELCOM communications software is the most useful part of the Model 100, and I suspect it will be for many others. In fact, although I can use four TRS-80s, several CP/M machines, and an LNW-80, since I bought the Model 100 I have used it more than any of the other machines. Maybe my experiences will show you how useful this machine can be.

One of the best uses for the Model 100 is in transporting data. I have always suffered when transferring data from a CP/M machine in my office to my LNW-80 at home. Now I can just dump a data file from the office machine to the Model 100, take the Model 100 home, and upload the data to the LNW. At 4800 bps, it takes about 2 minutes at each end, includ-

ing hookup, to transfer any file (Visicalc file, text file, or any other kind of ASCII data) that fills a 32K-byte Model 100. And of course it works with any microcomputer that has an RS-232C port.

Another application is shown by the way I did this article. I wrote a lot of it on the Model 100 while traveling. At my destination, I simply sent the text to our university's mainframe computer. When I got home, I downloaded the text to my LNW-80 and printed it using the Newscript word-processing program.

The Model 100 seems almost ideally suited to engineers, foresters, and anyone else who works in the field. In my own research, I regularly fill out data forms while in the field. I have a little program in the Model 100 that asks me for the data, stores it in an array, and sends it to disk on my office computer, which then prints the form, including the data, that I used to fill out in the field. I no longer have to key the data in by hand at the office, and the Model 100 takes care of a lot of the tedious calculator work that I used to do in the field.

For me, the TELCOM communications software is the most useful part of the Model 100.

By itself, the powerful combination of the text editor and the telecommunications package makes the Model 100 worth its price. But the software I have described so far is only the tip of the iceberg. The Model 100 has what may be the most powerful BASIC interpreter yet written for a microcomputer.

BASIC Interpreter

The Model 100's BASIC, like the BASIC for all other TRS-80s and like the rest of the operating system on this machine, was written by Microsoft. It is as complete and extensive a version of Microsoft BASIC as is available for any machine, and it has a number of enhancements specifically for the Model 100. Its execution

speed (as judged by a number of benchmark programs) seems to be as fast as or faster than that of the Model III. And this BASIC does all its calculations, including transcendental functions such as *sin* and *log*, in double precision (14 digits). You may be confused if you're used to other TRS-80 BASIC or Microsoft interpreters; several statements have different syntax, especially those for opening files, and you must set the number of I/O (input/output) files and the top of memory using MAXFILES and HIMEM statements—the Model 100 does not ask any questions about files and memory when you enter the interpreter.

I cannot review all aspects of the BASIC dialect here. Table 3 summarizes all the statements. A rough count gives 5 operators and 39 statements that are not included in the very powerful Model III extended disk BASIC.

The added arithmetic operators are " \ " and MOD, both of which pertain to integer division. The MOD operator gives the remainder (5 MOD 3 = 2) while " \ " gives the truncated quotient (9 \ 2 = 4). Surprisingly, " \ " is not on the keyboard—you have to use the Grph key and a minus sign. The added logical operators are XOR, EQV, and IMP. XOR does an exclusive or—when one bit is 0 and the other is 1, the result is 1. With EQV, when either both bits are 0 or both are 1, the result is 1. With IMP, the result is 1 unless the first bit is 1 and the second is 0. These new operators can often replace several awkward comparison statements.

Three new numeric functions are CRSLIN, which returns the line where the cursor is located; POS, which returns the column position of the cursor; and MAXRAM, which returns the amount of RAM installed in the computer.

One of the most significant additions to Model 100 BASIC is the use of extended-interrupt commands. Older versions of BASIC had only one—ON ERROR GOTO would make a branch when an error occurred. This BASIC adds four new ones: ON COM GOSUB branches

Numeric Functions

ABS—Returns absolute value
ASC—Returns ASCII code of a string
ATN—Computes arctangent
CDBL—Converts to double precision
CINT—Converts to integer
COS—Computes cosine
CRSLIN—Returns vertical line position of cursor
CSNG—Converts to single precision
EOF—Returns end-of-file status
ERL—Returns the line number of latest error
ERR—Returns the error code of latest error
EXP—Computes natural exponential
FIX—Truncates to a whole number
FRE—Returns current amount of available memory
INSTR—Searches a string for a substring
INT—Converts to integer
LEN—Computes length of a string
LOG—Computes natural logarithm
LPOS—Returns column position of print head within the printer buffer
MAXRAM—Returns Model 100 RAM size
PEEK—Returns value at a memory address
POS—Returns column position of cursor
RND—Returns pseudorandom number
SGN—Returns algebraic sign
SIN—Computes trigonometric sine
SQR—Computes square root
TAN—Computes tangent
VAL—Converts string to numeric value
VARPTR—Returns memory address of a variable

String Functions

CHR$—Returns ASCII character
LEFT$—Returns left portion of a string
MID$—Returns middle portion of a string; may also be used on the left side of the equal sign to replace the middle characters in a string
RIGHT$—Returns right portion of a string
SPACE$—Returns a string of spaces
STR$—Converts a numeric value to a string
STRING$—Returns a string of characters

Simple Control Commands

CALL—CALL is used to execute a machine-language subroutine from BASIC; allows more parameters than USR
IF. . .THEN. . .ELSE—Tests relational expression, then performs THEN clause if the expression is true or performs ELSE clause (if present) if expression is false
FOR. . .NEXT—This command gives BASIC a looping structure; an optional STEP value may be included
GOSUB—Causes the BASIC program to execute the subroutine beginning at the line indicated, and then returns to the statement following the GOSUB when a RETURN statement is encountered
GOTO—Causes the BASIC program to branch to the line number indicated
ON. . .GOSUB—Branches to appropriate subroutine
ON. . .GOTO—Branches to appropriate line

Interrupt Commands

ON COM GOSUB—Calls a subroutine when the computer receives data over the RS-232C line
ON ERROR GOTO—Branches to an error-handling routine if some error occurs while the program is executing
ON KEY GOSUB—Calls a subroutine if you press one of the eight definable function keys
ON MDM GOSUB—Calls a subroutine when the computer receives data over the modem
ON TIME$ GOSUB—Calls a subroutine when the real-time clock reaches a certain time
RESUME—Resumes program execution after an error; RESUME ends the error-handling routine

Graphics/Sound Commands

BEEP—Causes the sound generator to emit a tone for about ½ second
LINE—Draws a line on the screen; optionally may draw a box (outline or filled)
PRESET—Turns off an LCD pixel
PSET—Turns on an LCD pixel
SCREEN ON/OFF—Locks or unlocks the screen label line
SOUND—Outputs a tone of specified pitch and duration
SOUND ON/OFF—Enables or disables sound during cassette loads and while the Model 100 is waiting for a carrier signal from the telephone modem lines

Table 3: *A summary of TRS-80 Model 100 BASIC statements.*

Listing 3: *A BASIC program demonstrating the use of the ON TIME$ extended-interrupt command. This program sounds an alarm when the Model 100's internal clock reaches 15:37 (3:37 p.m.).*

```
10 ON TIME$="15:37:00" GOSUB 100
20 TIME$ ON
30 CLS
40 PRINT @96,CHR$(27)+"p "+TIME$+" "+CHR$(27)+"q"
50 GOTO 40
100 PRINT"press enter to stop alarm" : BEEP
110 A$=INKEY$
120 IF A$="" GOTO 100
130 CLS : RETURN
```

when something comes in over the RS-232C interface, ON MDM GOSUB does it when the modem receives something, ON KEY GOSUB branches when a function key is pressed, and ON TIME$ GOTO makes a branch at a specified time. The potential usefulness of these commands should be obvious; listing 3 gives an example. The various interrupts can be enabled and disabled by commands such as MDM followed by ON, OFF, or STOP.

All the graphics and sound commands are new. Sounds of varying tone and duration as well as beeps can be produced, individual pixels or points on the LCD can be turned on and off, and lines and boxes can be drawn between any two sets of *x,y* coordinates; the box can be either an outline or filled. The LCD screen has a resolution of 260 by 64 pixels.

Perhaps the most radical new feature is the use of the OPEN statement. We usually think of OPEN and CLOSE statements being associated with disk files. What's OPEN doing in a machine that doesn't use disks? Any RAM file and any peripheral device can be declared as a file for output and input. You can write to a file in memory just as you would write to a disk file. RS-232C and modem I/O are handled by declaring the device to be a file. Even the screen can be treated as a file for output, as can the printer. For example:

OPEN "LPT:" FOR OUTPUT AS 1

sends all output for file number 1 to

Other Commands

CLEAR—Clears all variable values, closes all open files, and optionally reserves string and high memory space
CLS—Clears the screen
CLOAD—Loads a BASIC program from tape
CLOAD?—Verifies a cassette load of a BASIC program
CLOADM—Loads a machine-language file from tape
CLOSE—Closes open files by number, or all files
COM ON/OFF/STOP—Enables or disables communications interrupt
CONT—Continues program execution after a STOP command or press of Break key
CSAVE—Saves a BASIC program on tape; program may be saved in compressed or ASCII formats
CSAVEM—Saves a machine-language program on tape, using start, end, and entry addresses
DATA—Defines a data set within a BASIC program
DATE$—Prints or sets current date in MM/DD/YY form
DAY$—Prints or sets current day of the week
DIM—Defines array size
EDIT—Edits a BASIC program
END—Ends BASIC program execution
ERROR—Simulates an error in a program
FILES—Prints the names of data and program files stored in RAM
FRE—Returns the amount of memory available to BASIC
HIMEM—Returns highest memory address available to BASIC
INKEY$—Returns any keyboard key currently pressed
INP—Returns a value from a CPU port
INPUT—Inputs data from keyboard
INPUT #—Inputs data from a file
INPUT$—Inputs a number of characters from keyboard or from a file
IPL—Defines a BASIC program to run whenever the Model 100 is powered up
KEY—Defines function keys
KEY LIST—Lists function key definitions
KEY ON/OFF/STOP—Enables or disables function key interrupts
KILL—Erases a RAM file
LCOPY—Copies the screen text to the printer
LET—Optional assignment statement
LINE INPUT—Inputs a string from the keyboard
LINE INPUT #—Inputs a string from a file
LIST—Lists the current program to the screen
LLIST—Lists the current program to the printer
LOAD—Loads a BASIC program from RAM, cassette, communications port, or modem for execution
LOADM—Loads a machine-language file from RAM or cassette
LPRINT—Prints data to the printer
LPRINT USING—Prints formatted data to printer
MAXFILES—Specifies the maximum number of files your program can have open at one time
MDM ON/OFF/STOP—Enables or disables modem interrupt
MENU—Returns to the Model 100 menu
MERGE—Combines two BASIC programs; one of the programs will be in current memory, the other will come from RAM, CAS, COM, or MDM
MOTOR ON/OFF—Turns the cassette motor on or off
NAME. . .AS—Renames a RAM file
NEW—Erases the current program
OPEN—Opens a RAM, CAS, COM, LCD, LPT, or MDM file for I/O
OUT—Outputs a byte to a port
POKE—Loads a value into memory
POWER—Controls the automatic power-off feature
POWER CONT—Prevents automatic power-down
POWER OFF—Turns power off; if optional RESUME is added, execution continues where it stopped before power was turned off
PRINT—Prints data to the screen (abbreviated as "?")
PRINT @—Prints at specified position on screen
PRINT #—Prints data to a file
PRINT USING—Prints formatted data to screen or file
PRINT # USING—Prints formatted data to a file
READ—Reads a data set within a BASIC program
REM—Indicates an unexecutable comment
RESTORE—Allows DATA items to be reused; the optional line number specifies which line the DATA pointer is to be set to
RUN—Runs a BASIC program. May include loading the program from RAM, cassette, communications port, or modem. The ,R option tells BASIC to leave open files open.
RUNM—Loads and executes a machine-language program from RAM or CAS
SAVE—Saves the current program to RAM, cassette, communications port, LCD, printer, or modem. Optional ",A" may be used to store an ASCII file to RAM or cassette. Other devices automatically save in ASCII.
SAVEM—Saves a machine-language file to CAS or RAM
STOP—Stops program execution
TAB—Skips to specified column with PRINT or LPRINT
TIME$—Displays or sets the current time
TIME$ ON/OFF/STOP—Enables or disables the time interrupt

the printer. This type of file routing is usually available only in the most powerful operating systems for the most expensive microcomputers and minicomputers.

Several other useful new commands are available. KEY is used to define the function keys. KEY LIST puts the definitions of the functions onto the screen. FILES shows the available files. Two new tape commands, LOADM and SAVEM, are for loading and saving machine-language programs. A particularly important command, one that will be used mostly in direct mode, is NAME, which lets you rename a file. Three commands start with POWER. They specify how soon the power should be turned off (if at all) if the computer isn't used or if it shouldn't be turned off; one turns it off from within a BASIC program and gives you the option of resuming the program when the machine is turned back on. MAXFILES, normally placed at the beginning of a program, specifies how many files will be used. TIME$, DATE$, and DAY$ contain the time, date, and day of the week respectively.

An especially useful BASIC command (normally used as a direct command) is IPL. It lets you specify that a particular BASIC program should be run when the Model 100 is turned on. It allows a form of customization. As such, it can be used to turn the Model 100 into a turnkey computer that automatically runs a given program.

Although BASIC programs can be directly typed in, they are edited using the text editor. If you type EDIT 100, you enter the text editor with line 100 as the text. Any range of line numbers can be specified, although because it takes some time to convert the tokenized program to ASCII, programs should be edited in small pieces. If you try to return to BASIC and there is an error in the format of the edited program, you'll be given the error message "Text Ill Formed"

and you will have to correct the problem before you can reenter BASIC. A danger exists here: it's possible to make the edited program so screwed up that you can't find the error and you can't even get out by hitting the Reset button. (On the Model 100, reset is really a forced break, not a hardware reset.)

If you're used to Microsoft's usual interpreted BASIC editor, this one takes some getting used to. It's easy to use and very powerful, but it lacks some things a programmer would want. For example, there's no way to renumber a whole program. And if you renumber a statement with the editor, it will be moved in the listing, but other statements that refer to it will not be changed. That's a very quick way to create hard-to-find errors. It also has no cross-reference utility that will show you where variable and line references occur. In other words, the editor remains a text editor and not a program editor tailored to BASIC programs. A nice feature is that you don't have to explicitly save programs: they remain in memory even when you return to the main menu unless you type "NEW. Also, if power is turned off while a program is running, the Model 100 will resume running it when the power comes back on.

Technical Details

The manual says absolutely nothing about the system operation of the Model 100—not even a memory map. By the time you read this, however, you'll be able to order a service manual from any Radio Shack store through its national parts division, and a users technical manual is forthcoming. Anyone who wants to understand how the Model 100 works *must* have either the service or technical manual.

The following has been gleaned from a preliminary draft of the Model 100's service manual, which I recommend to anyone who wants to know about the machine's inner workings.

The Model 100 has five main integrated circuits. The microprocessor is an Intel 80C85, which is a CMOS (complementary metal-oxide semiconductor) chip that uses the same instruction set as an 8080. A parallel I/O chip, an Intel 81C55, connects the microprocessor to the outside world; it handles the printer, keyboard, clock, buzzer, UART, and modem. The tape deck connects directly to the 8085, as does the bar-code reader. The UART is an Intersil IM6402, which can be programmed in BASIC by OUT statements. The modem chip is a Motorola MC14412, also easily programmed. The clock chip is an NEC μPD1990AC, and it also can be accessed with machine language.

The powerful combination of the text editor and the telecommunications package makes the Model 100 worth its price.

The Model 100 uses many more I/O ports than do the other TRS-80 computers. The display, keyboard, clock, UART, modem, and buzzer are all controlled by I/O calls. The service manual gives the proper port addresses.

The system has a 40-line bus, with three of the lines not used. The bus includes all the 8085's address, data, and control lines plus optional control lines for an I/O unit and separate RAM.

The 80C85 can directly address 64K bytes of memory; 32K bytes are in low memory as ROM, the ROM that contains the operating system. The ROM in the extra socket can be bank-selected (i.e., it replaces the 32K-byte hard-wired ROM) using an OUT call. RAM can be installed in four DIP (dual-inline pin) sockets; each socket holds a custom-made DIP package that contains four 2K-byte chips wired together (see the lower left corner of photo 2 on page 158). Thus, even with only four sockets for the RAM, 16 address lines are needed. You'll never be able to install standard RAM chips in the Model 100—they aren't what the computer expects to see in the sockets.

Documentation

By now it should be obvious that I think the Model 100 is one of the best microcomputers ever made. The documentation is its only major flaw. It's clear that a lot of work went into producing the manual, which is intended for the first-time user, and clear explanations are given for each software module. Unfortunately, the most elementary points are explained

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over and over again, while some important points are either left out or hidden in the repeated explanations. The manual's index is inadequate—I wasn't familiar with the MOD operator in BASIC and it's not in the index. It took me 10 minutes to find it in the text. Many other things are left out. Another problem is that the manual doesn't encourage the user to understand *why* he or she is doing something. Anyone can learn to make good use of the Model 100 in an hour or two by using the manual, but it is poor at helping you to use the full capabilities of the machine. Even the page numbering is messed up: pages 134 and 135 are reversed.

Finally, the manual does a poor job of showing what the Model 100 can really do. Although an experienced computer user would know that you can easily manipulate text files with BASIC programs, the manual doesn't mention it. The method for inserting boiler plate that I described earlier isn't even mentioned, although it's an almost essential feature of the editor. No mention is made of using the machine to transport data between two other machines, and RS-232C hookup information is relegated to the appendix, where one is led to believe that the Model 100 can be connected only to a Radio Shack Model II, III, or 16.

Some of the following points are either omitted from the manual or are so obscurely buried that they'll be missed by most users. This is probably not a complete list:

- Escape sequences work with strings in BASIC programs. Escape and "p" forces output to be in reverse video while Escape and "q" puts it back. Other escape sequences apparently do other things, but I've not been able to find out what.
- The buzzing noise during a tape save or input can be turned off (or on) by typing SOUND OFF or SOUND ON while in BASIC.
- It's possible to force a cold restart of the Model 100 by simultaneously pressing the Ctrl, Pause, and Reset switches. This wipes out every file saved in memory and is equivalent to moving the memory switch on the back of the machine.
- When setting up telecommunications parameters with the Stat key, the dialing pulse rate must be set to either 10 or 20 pulses per second—no other values work.

Other Complaints

The Model 100 is a well-thought-out machine, but it's not perfect (although most of its problems are trivial).

Some enhancements are provided in other BASICs that are not included here. Perhaps the most glaring deficiency is the lack of any attempt to provide for structured programming. The simple addition of a WHILE. . .WEND statement and the ability to call named subroutines would have been appreciated by many programmers. Some have asked for BCD (binary-coded decimal) arithmetic, which allows many more decimal places but not such large numbers. Personally, I prefer the present system.

Another deficiency is the lack of any indication of file size or status. It would also be nice to have files dated when created and marked when updated.

Although much mention is made of the use of machine-language programs and there's even a nice CALL command in BASIC, there's no way to write a machine-language program other than by poking it into memory—a process that is tedious for short programs and impossible for long ones. Although an assembler is in the works, independent software vendors will be handicapped in their ability to create Model 100 software until it becomes available.

Finally, a few things are just missing. Although almost every use of the function keys is shown on the bottom "label" line of the LCD, function key F5 in the terminal mode, which sends all terminal interaction to a printer, is not labeled. A worse problem is the inability of the terminal program to send a true "break" signal. Luckily, most newer host computers use a Control-C instead.

But the few deficiencies are negligible compared to the machine's tremendous ability. I was unable to find any real bugs, and I understand that the software has been more thoroughly tested than anything else Radio Shack has released.

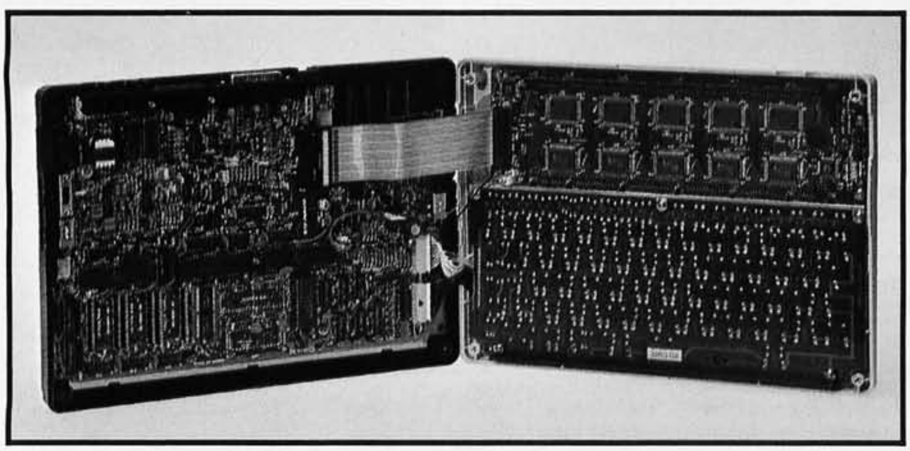

Photo 2: *Inside the Model 100. The main circuit board is on the left, while the keyboard and liquid-crystal-display boards are on the right. Notice the four slots for additional RAM in the lower left corner of the main circuit board.*

The Future

The Model 100 just begs for additions and enhancements, both by Radio Shack and by independent suppliers. The existence of a ROM socket, the bus connector, and a socket for a bar-code reader all speak of things to come. A Tandy executive was reluctant to tell me exactly what to expect, but it's not hard to make some guesses.

Because of the machine's limited memory, the most obvious addition would be a mass-storage device. A good candidate would be one or two microfloppy-disk drives. Even better would be some sort of bubble-memory device. It should be possible to

package 1 or 2 megabytes of bubble memory in about half the volume occupied by the machine itself. But the turmoil in standardizing microfloppies and the cost of bubble memory will probably prevent those options. I'll bet something's coming along, however, and I expect that independent suppliers will get into the act as well.

Another obvious addition would be some sort of compact printer. Although the Model 100 now provides for printer output, it's a bit hard to carry any satisfactory printer around in your briefcase. Present technology should allow design of a unit no larger than the computer itself—and Tandy is one of the larger printer manufacturers around.

An accessory that I would really like to see is a multichannel, 12-bit analog-to-digital converter. The Model 100 is ideally suited for data acquisition in industrial and field applications. This market is smaller than for a printer or disk drive, but the Model 100 could be used as a remote data logger that would be better than anything else produced, even units in the above-$20,000 price range.

The Model 100 presents tremendous possibilities for use by the disabled. If Baudot codes could be sent with the terminal program, it could serve as an inexpensive terminal for the various phone communication services available for the deaf. And its size makes it ideal for use with a head-stick by a quadriplegic. I was disappointed to see that some key combinations require two hands; the keyboard could have been designed for use by an amputee. Perhaps the most far-out fantasy would be a microcomputer for use by the blind. The keys could have braille caps, and it should be possible to design a flat plate like the LCD with tactile "bumps" that present a braille version of the visual display.

As for software, a book/software product called the *Model 100 BASIC Language Lab* should be available from Radio Shack by the time you read this, and I understand that personal-productivity and personal-finance programs are in the works, with business-application software following. And, of course, it doesn't take much insight to guess that there'll be some games available.

Whatever Tandy chooses to sell as accessories for the Model 100, it is certain that programmers and hardware suppliers will recognize the tremendous market presented by this machine. I expect to see a proliferation of hardware and software add-ons that make those available for most other microcomputers seem sparse. As all those Apple ads tell you (and the TRS-80 ads should as well), it's the available body of hardware and software that really makes a microcomputer useful.

Conclusions

I first saw a Model 100 sitting next to a radio-controlled toy car at a Radio Shack store; I quickly passed it off as a toy as well. It was only after reading about it and playing with one for about an hour that I realized how powerful a machine this is. Sadly, it is probably true that a lot of people

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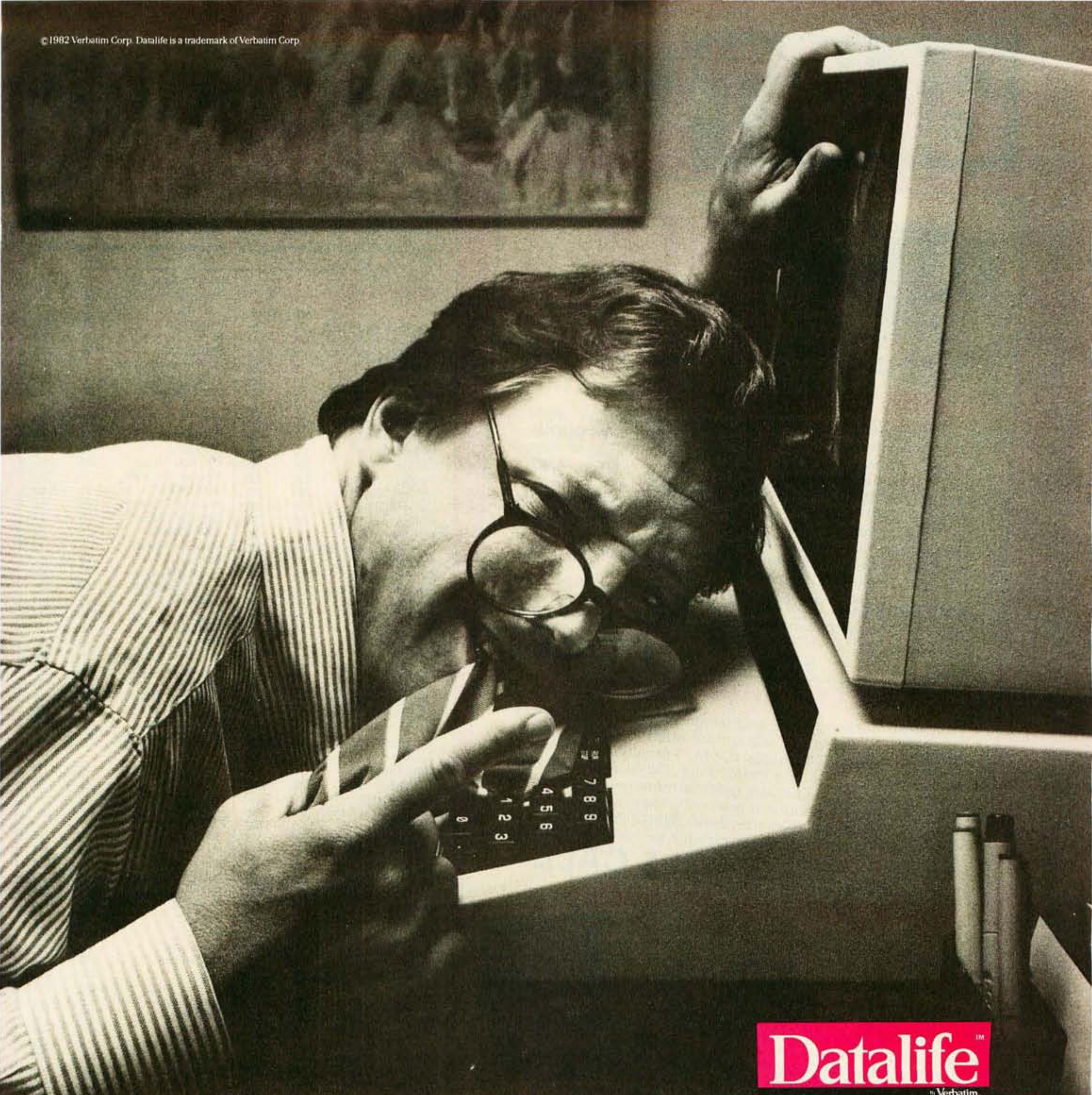
who could make excellent use of the Model 100's abilities still think of it as a toy. It's too bad that Radio Shack is associated with toys and CB radio—its computers, especially the Model 100, are as good as or better than anything available at much higher prices.

I am told that it took a little more than a year from the time the Model 100 was conceived until the first units were on the market. I'm amazed by that. The Model 100 shows tremendous planning and foresight. It can do things that desktop microcomputers of several times its price cannot. The software is extremely well designed and innovative. It has the best features of a disk-based system while using only RAM storage, and the software is so well integrated that it is practically effortless to use the machine for a variety of applications. The Model 100 has a few faults, such as the documentation, but they are minor when one looks at the system as a whole.

Perhaps the most telling test of the Model 100 is that since I bought one I have cut my use of larger machines by about half. I actually prefer to use the Model 100 instead of either an LNW-80 or a TRS-80 Model III for text editing. Even more telling is that at least one executive at Tandy said he uses the Model 100 more than his TRS-80 Model 12 and Model 16 combined.

The Model 100 microcomputer is the first of a generation of really portable machines. Undoubtedly, a host of imitators will appear, and some of them may be on the market by the time you read this (the NEC notebook computer, using a very similar Microsoft operating system, was announced while I was writing this article). But the combination of hardware and software in the Model 100 will be hard to beat. I doubt that, even several years from now, I will regret having bought one of the earliest Model 100s on the market.■

Mahlon G. Kelly (268 Turkey Ridge Rd., Charlottesville, VA 22901) is Associate Professor of Environmental Sciences at the University of Virginia, where he studies the environments of lakes and rivers. His other interests include freelance writing and the application of computers to environmental research.



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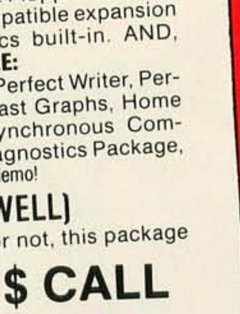

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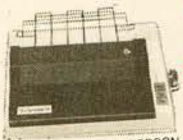

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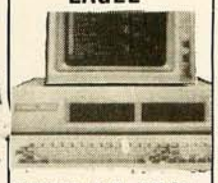

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The New Microfloppy Standards

Only media specifications are settled at this point, but de facto standards for disk drives are already emerging

by Thomas Jarrett

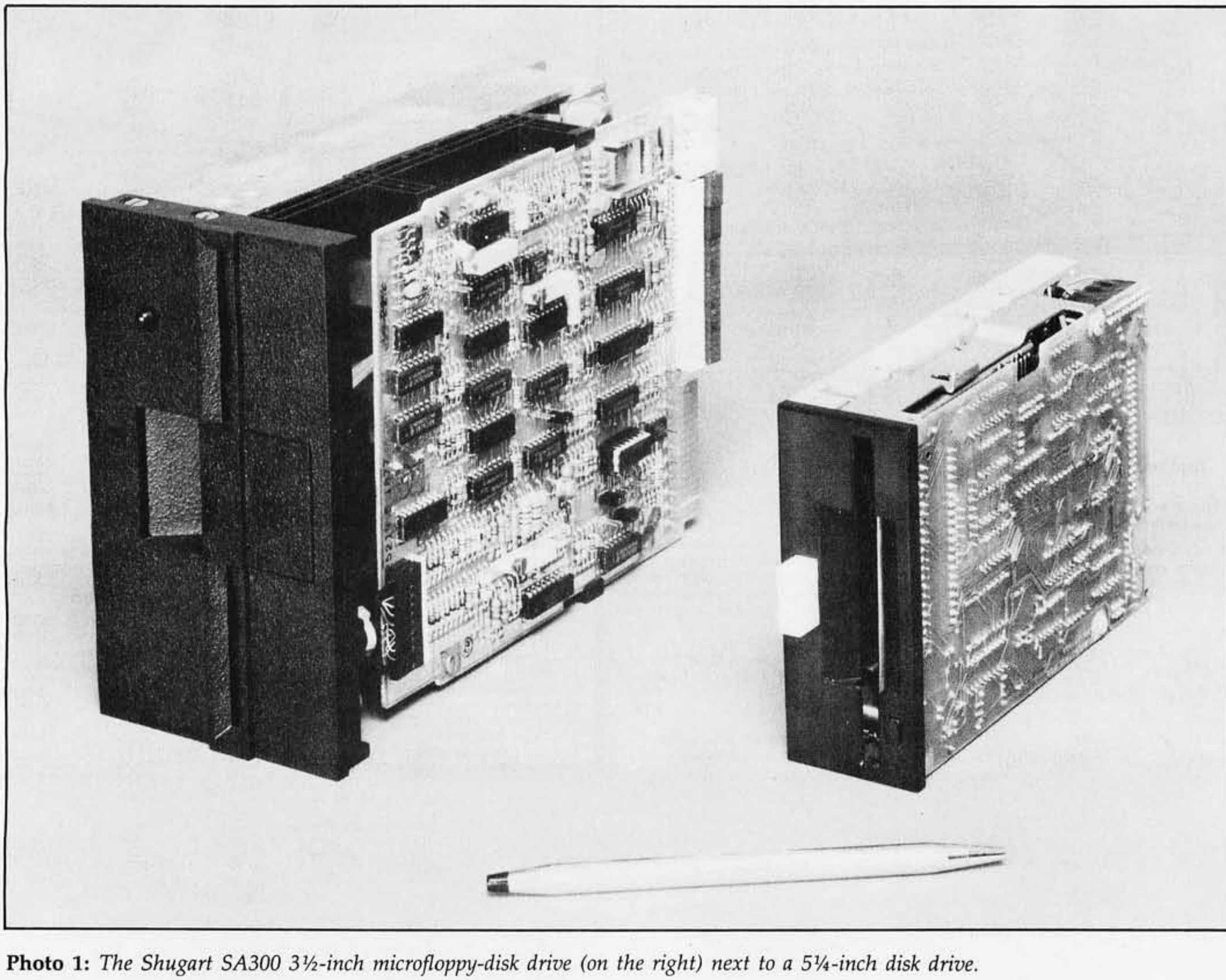

Photo 1: *The Shugart SA300 3½-inch microfloppy-disk drive (on the right) next to a 5¼-inch disk drive.*

One of your next computers will probably have a microfloppy-disk drive that uses a 3½-inch hard-shell cartridge with an automatic shutter. It will also be compatible with the standard interface for 5¼-inch disk drives. More than 30 companies are now supporting this emerging standard in the sub-5¼-inch disk, or "microfloppy," market as a result of an agreement on disk media between the Microfloppy Industry Committee (MIC) and Sony Corporation earlier this year. While the disk drive and media specifications have been presented to the American National Standards Institute (ANSI) X3B8 committee on microfloppies, they will probably become a de facto standard in the marketplace before they gain official acceptance.

Already, many portable computer manufacturers have adopted the 3½-inch disk drive as a standard. The sales of 5¼-inch disk drives are still increasing, particularly now that half-height drives are appearing in products, but experts predict that 3½-inch disk drives will soon outsell any other size.

Microfloppy Applications

Microfloppy-disk drives are small, light, inexpensive, and powerful, representing the newest wave of miniaturization in computer mass-storage peripherals. Their range of applications includes memory typewriters, new office equipment, scientific and engineering instruments, the next generation of smaller portable computers, and other uses still on the drawing boards.

Because of strong market demand for smaller, more powerful components and systems, the greatest potential for microfloppies is in portable computers. They offer better performance and the same capacity as 5¼-inch floppy disks in a smaller and less expensive package. While today's "portable computers" are more easily transportable than desktop models, drives and media will contribute to the development of truly portable computers. Microfloppies are also suitable for any application in which 5¼-inch disks are used.

Reductions in the size and/or cost of silicon chips, displays, and disk drives lead to many new applications for small computer systems. The new semiconductor chips, cheaper memory, flat-panel displays, and sub-5¼-inch floppy-disk drives can help make for a system small enough to be carried in a briefcase. As a result, microfloppies may usher in a new era of freedom from the workplace.

The Advantages of Microfloppies

One of the most crucial factors that determines the cost and size of microcomputers is peripheral storage. In some cases, disk drives account for 60 percent of the cost of a microcomputer system. Today's most popular and powerful microcomputers have two floppy-disk drives, which increase a system's volume and weight considerably. Microfloppy-disk drives, which are one-quarter the size and one-half the weight of conventional 5¼-inch disk drives, consume 50 percent less power.

The microfloppy drives now on the market store from 358K bytes to 1 megabyte per disk; 500K bytes is typical. This is raw, unformatted storage capacity that is typically reduced to a 320K- or 360K-byte format compatible with the IBM Personal Computer disk format. This capacity is less than some of the new high-capacity 5¼-inch disks now appearing on the market, but it is equivalent to most standard 5¼-inch disks.

As microfloppy drives are integrated into consumer products, systems designers and OEMs (original equipment manufacturers) will take advantage of the 3½-inch disk's size, price, and performance to create new uses beyond those of 5¼-inch drives.

Another advantage microfloppies offer is carrying convenience. Early market research revealed that people want disks that can be carried in a pocket or purse. But because microfloppy disks are easy to transport—and therefore easy for inexperienced users to damage—the disk and drive manufacturing companies are supporting a hard-shell cartridge. Further, most disks have an automatic shutter that closes over the media surface when the disk is removed from the drive. Thus the "floppy" in microfloppy is no longer accurate. Such protective measures help ensure that beginners who don't know the meaning of computer messages such as "BDOS Error—bad sector" will not have to learn about them the hard way.

Industry Standards

Standards are essential to the efficiency and growth of every segment of the computer and electronics industry, and microfloppy drives and media are no exception. Standardization lowers costs to manufacturers, OEMs, and consumers alike by allowing the mass production of interchangeable parts. Standards also eliminate the need for expensive redesigns.

Disk and drive manufacturers can compete within the framework of an established standard. That way, OEMs and systems houses won't fail to support a customer if their main source does not have parts available. They can fall back on second sources of standard parts.

When microfloppies were first announced, the market was flooded with incompatible products. Hitachi, Matsushita, and Maxell introduced a 3-inch disk drive and media; Tabor and Dysan presented a 3¼-inch drive with soft-jacketed disks that Seagate Technology later supported; Sony introduced a 3½-inch drive that both transferred information and rotated twice as fast as the standard 5¼-inch drive; Canon had a 3.8-inch drive; and more recently, IBM introduced a 4-inch drive. Disk-media manufacturers were endorsing several disk sizes, but most of the support was behind the 3½-inch format.

The Microfloppy Industry Committee

The Microfloppy Industry Committee (formerly called the Microfloppy Standards Committee) was formed in May of 1982 to establish a microfloppy media standard. The committee announced its activities at the National Computer Conference in June 1982 and opened its member-

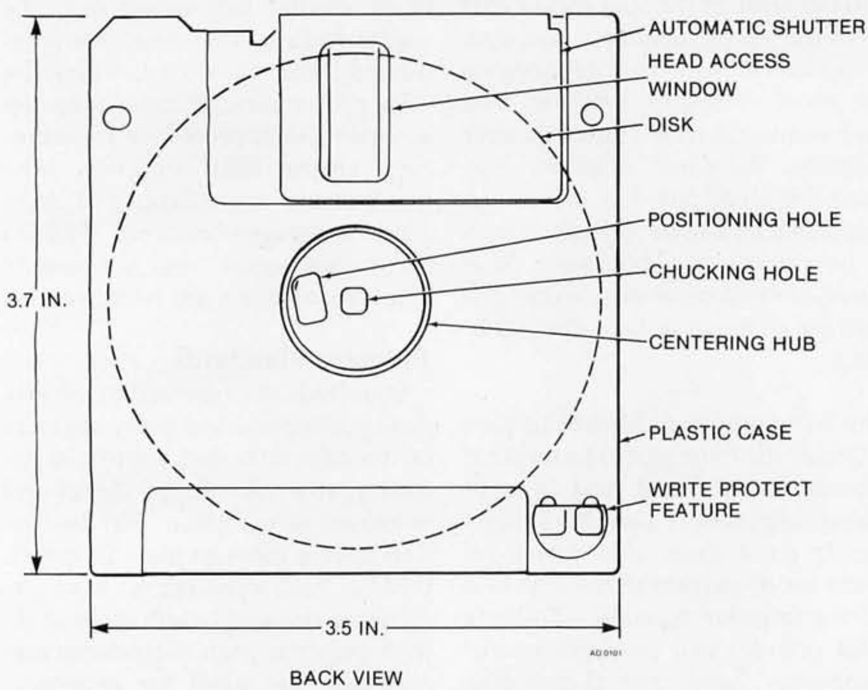

Figure 1: *The 3½-inch disk cartridge endorsed by the Microfloppy Industry Committee has a hard plastic case and an automatic shutter.*

ship to any interested party. Shugart Corporation was among the original four members of the committee, which by April of 1983 included 22 leading disk-drive, media, and personal computer manufacturers.

In September 1982 the MIC proposed the adoption of a 3½-inch hard-cartridge disk standard to the ANSI X3B8 committee on microfloppies. By then Sony had begun to ship its own version of a 3½-inch drive and hard cartridge. The Sony media and the MIC's proposed standard for 3½-inch media, while similar, differed on four main points: the number of tracks (concentric circles) on the disk, coercivity, thickness of the iron-oxide coating, and the type of shutter used to protect the head access window, where the disk drive reads and writes information on the disk.

The Sony drive had 70 tracks of information, while the MIC proposed 80 tracks as standard. Both used metal hubs in their disks to improve centering tolerance. The coercivity of the Sony medium was 580 oersteds (a unit of magnetic resistence), while the MIC had suggested 650 oersteds. Sony's oxide layer was 100 microinches thick, and the MIC's proposal specified 40 to 50 microinches. The thinner oxide layer and higher coercivity allow higher recording densities to be used without sacrificing reliability.

Sony's first shutter on the disk was a simple metal slide that the user had to manually open before inserting the disk into the drive then manually close after the cartridge was removed. That procedure required touching the area around the head access window and possibly ruining the disk. Also, the shutter could slide open accidentally, exposing the head access window to contaminants.

The MIC design, in contrast, includes a spring-loaded autoshutter that automatically opens upon insertion of a cartridge into the drive and automatically closes when the cartridge is ejected. An actuator inside the drive controls the opening of the shutter and loads the read/write head(s) onto the media. This system reduces the possibility of putting the disk into the drive incorrectly and the chances of media damage due to the disk shutter being open when out of the drive. The MIC hard cartridge also has a sliding mechanical write-protect tab instead of a detachable plastic write-protect tab, which can get lost. See figure 1 for an illustration of the MIC 3½-inch hard-cartridge standard.

The most significant development in the microfloppy media standards issue was the compromise agreement Sony and the MIC reached in January 1983. The two groups agreed on 80 tracks per side of a disk, a coercivity of 625 oersteds, and an oxide thickness of approximately 60 microinches. Thus, important progress was made toward solving the thorny issue of microfloppy media standardization. Sony will be manufacturing a second-generation product compatible with the MIC cartridge and will continue to support its original drive and media. Sony will also use an autoshutter on its new media.

The agreement between the first company to ship production quantities of microfloppies and a committee of leading U.S., European, and Japanese manufacturers adds weight and momentum to the effort to establish a single microfloppy configuration as the standard. Table 1 lists the members of the Microfloppy Industry Committee and the supporters of the various disk sizes.

The Microfloppy Competitors

From the beginning, size has been the most basic bone of contention among the microfloppy-drive manufacturers. Four disk sizes ranging from 3 to 4 inches have been proposed, and each one has its supporters.

The 3-inch disk drive: The Hitachi/Matsushita/Maxell 3-inch drive has a 5¼-inch interface and an automatic shutter on its rigid-case disk. Hitachi has not announced any volume agreements with American computer makers yet, although many Japanese manufacturers are lined up behind this proposed standard. Gavilan Computer Corporation introduced its new portable computer with Hitachi's 3-inch drive but has since decided to use the 3½-inch microfloppy. Maxell is owned by Hitachi and is therefore associated with this group. Matsushita is supporting the 3½-inch drive as well as the 3-inch drive.

3-inch	3¼-inch	3½-inch with Shugart interface	3½-inch with Sony interface	4-inch
Canon	Brown Disc	Alps	Computer Devices Inc.	IBM
Fuji	Dysan	Citizen	Hewlett-Packard	
Hitachi	Seagate	Control Data Corp.	Jonos	
Jicoh	Soroc	Epson	RCA	
Matsushita	Tabor	Formmaster	SKS	
Maxell		Fuji	Sony	
Micro Peripherals Inc.		Gavilan Computer	Sord	
Mitsumi		Sankyo	Tandon	
Nihon		Sony	Universal Data Systems	
Sankyo		Sord		
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Teijin		TEAC		
Tokyo Denki		Toshiba		

Microfloppy Industry Committee:
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Media Systems Technology
Memorex
Mitsubishi
Nashua Corporation
Olivetti
Otrona
Phillips
Remex
Shugart
Spin Physics
TDK
Verbatim
Wabash
Xidex
YE Data

Table 1: *The various companies supporting the different microfloppy-disk sizes. Note that some manufacturers are offering more than one type of microfloppy.*

The 3-inch drive has two potential problems. First, because the disk is so small, both sides of it must be used to achieve a capacity of 500K bytes. Because the drive has only one read/write head, this is currently accomplished by reading one side (250K bytes) and then flipping the disk over. The company recently announced a double-sided drive that will access both sides of a disk (500K bytes) at the same time. Second, in order for 3-inch drives to achieve a 1-megabyte capacity, a track density of 200 tracks per inch would have to be used. This would significantly reduce the reliability of an open-loop drive. See Table 2 for more technical comparisons between the different microfloppy drives.

3¼-inch disk drive: The Tabor/Dysan/Seagate 3¼-inch disk also has slightly less recording area than the 3½-inch disk. This is the only group that does not offer a hard-shell cartridge because its 3¼-inch disk is covered by a more traditional soft envelope. These companies feel that the price of their disks will be more competitive because of the less expensive soft jacket (which uses existing 5¼-inch disk technology and has fewer parts). Dysan owns portions of Tabor and Seagate and has financial ties to Brown Disc, so it is not unusual to see these companies together. They have not announced any volume deals on their drives.

The 3½-inch disk drive: The 3½-inch disk format has twice the available recording area of the 3-inch disk. Higher-capacity drives are already

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Tabor	3¼	500K	Single	1.62 by 4.0 by 5.5	Soft	250	80	10	9250	140
Shugart	3½	500K	Single	1.62 by 4.0 by 6.0	Hard	250	80	6	8204	135
Tandon	3½	1000K	Double	1.62 by 4.0 by 6.0	Hard	250	80	3	8776	135
Sony	3½	1000K	Double	2.0 by 4.0 by 5.1	Hard	500	80	12	8717	135
IBM	4	358K	Single	2.62 by 4.5 by 6.6	Hard	333.3	46	40	6865	—

Table 2: *Specifications for some of the different microfloppy-disk drives.*

being announced as improved media and head-positioning technologies become available. Most 3½-inch disk drives use only one side of the disk to store 500K bytes. Adding a second head, a simple redesign of the present drive, will create a 1-megabyte double-sided drive. Sony and Tandon have already announced this upgrade as well as versions of their drives with both the 5¼-inch interface and the Sony interface. Tandon has announced a $310 million agreement with a major microcomputer manufacturer (rumored to be IBM) for its disk drives (probably the 3½-inch disk drive with the 5¼-inch interface).

Sony started delivering the first microfloppies in 1980 in one of its word processors. The company has since offered the microfloppy in its SMC-70 microcomputer. Hewlett-Packard placed a $30-million order for Sony microfloppy drives and recently announced that it had sold 25,000 drives in its various products, among them the Series 200 Model 16 microcomputer, which accounts for half of the estimated 50,000 microfloppy drives that have been sold so far. Computer Devices uses Sony drives in its Dot microcomputer; RCA uses them in development systems; Sord, Jonos, and Universal Data Systems all use Sony Drives in their portable computers.

Sony will continue to manufacture and support its older drives, but now that the company is offering the new 3½-inch drives with the MIC media and Shugart interfaces, it is debatable how many manufacturers will stay with the older Sony disk format or the Sony interface.

IBM's 4-inch disk drive: While the 4-inch IBM disk has more recording area than the 3½-inch disk, it is too

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big to fit easily in a shirt pocket and doesn't offer systems integrators enough of a size incentive to replace 5¼-inch disks. The IBM drive presently stores only 358K bytes—less storage capacity in a larger package than a 3½-inch drive. It has a slow (40-millisecond) track-to-track access time, and both the data-transfer rate and the interface are nonstandard. Until this drive is used in an IBM product, it probably won't go far.

The most popular interface for microfloppy-disk drives is the standard 5¼-inch Shugart interface used on most 5¼-inch floppy-disk drives. This standard defines the data and control lines and specifies a disk rotation of 300 revolutions per minute (rpm) and an information transfer rate of 250K bits per second. Disk drives that use the 5¼-inch interface can be easily interchanged. Systems integrators can then use the new microfloppies directly in place of the older 5¼-inch drives. Computer manufacturers in turn can take advantage of tried-and-true technology (their existing computers and the proven reliability of 5¼-inch interfaces) while getting to the market first with smaller, faster computer systems.

The new microfloppy-disk drives access information on the disk quickly. Transferring that information out of the drive and into the computer, however, can be a slow process. Systems designers may feel limited by the Shugart interface transfer speed of 250K bits per second when they want to use the new, faster microprocessors and memory that microfloppy-disk performance can't keep up with. That's one of the major reasons why Sony is offering its 600-rpm 3½-inch disk drive with a Sony interface that can transfer information at 500K bits per second, effectively twice the speed of the Shugart interface and the same as double-density 8-inch disk drives.

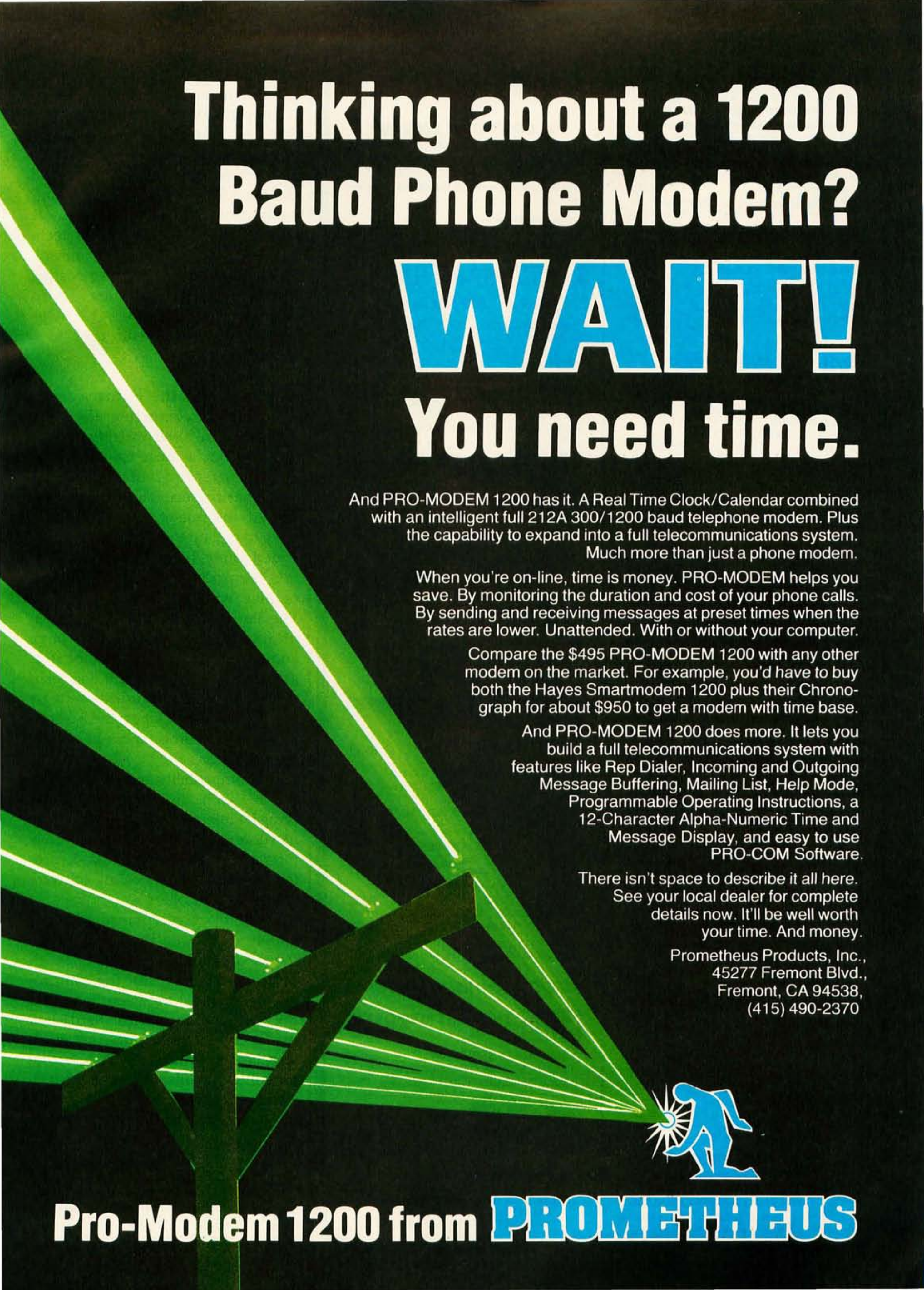
Case Study of a Microfloppy

Shugart Corporation's entry in the microfloppy field is the SA300, a single-sided drive that stores 500K bytes on a 3½-inch disk (see photo 1). The SA300 measures 1.6 inches high, 4 inches wide, and 6 inches deep and weighs only 1.3 pounds. The drive is extremely quiet and has only nine moving parts because of its efficient, brushless direct-drive DC motor, which eliminates the need for belts and pulleys. It records with the MFM (modified-frequency modulation) method at a density of 8204 bits per inch and 135 tracks per inch, with 80 tracks per side. Track-to-track access time is 6 milliseconds. The SA300 uses +12 volts when the disk is being accessed, dissipating less than 8 watts. In a standby mode it uses +5 volts and dissipates less than 4 watts, producing about one-third less heat than standard 5¼-inch disks. In portable computer systems this translates to less draw on a battery pack and thus longer operation without recharging batteries. The lower heat dissipation also means that parts last longer.

In terms of its interface and the

Circle 482 on inquiry card.

Circle 372 on inquiry card. →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configuration of the disk track density and layout, the Shugart SA300 is compatible with computer systems that use standard 5¼-inch disks. Consequently, it can be plugged into any system that has previously used standard 5¼-inch disks. Plug compatibility enables systems designers and OEMs to use the latest technology in data storage while preserving their investment in their existing hardware and software. And alleviating drastic redesigns helps keep costs to the end user to a minimum.

Standards for the Future

Of the four competing disks, the 3½-inch hard-shell cartridge is becoming the de facto standard. Its media is safer and more reliable due to the hard case and automatic shutter. At the outset, consumers will have to pay up to $7 per disk for this added safety, but with mass production the prices will quickly be competitive with 5¼-inch disk prices. The 3½-inch disk is small enough to fit into a shirt pocket and large enough to hold a megabyte of storage without taxing present disk technologies. Just as the audiocassette replaced reel-to-reel tapes, the 3½-inch disk could become a mass-marketing phenomenon.

The compatibility and portability of the 3½-inch disk drive with the Shugart interface also bodes well for its success. The 5¼-inch-compatible interface, it should be added, protects investments in existing software and disk controllers.

Marketplace acceptance will ultimately determine the standard for the next generation of sub-5¼-inch drives and media. But the compromise agreement between Sony and the MIC, along with hard-shell media protection, a plug-compatible standard interface, and a potential for enhancements, make the 3½-inch Shugart-interface disk drive the leading contender for the title of industry standard. ■

Thomas Jarrett is the microfloppy marketing manager at Shugart Associates (475 Oakmead Pkwy., Sunnyvale, CA 94086).

System Review

The HP-75 Portable Computer

This briefcase computer from Hewlett-Packard has powerful real-time scheduling capabilities

by Rowland Archer Jr.

The HP-75 marks Hewlett-Packard's entry into the mid-priced portable computer fray. Truly a portable computer, the HP-75 includes a full-featured BASIC interpreter, a text editor, a real-time clock/calendar, and an appointment scheduler (see photo above).

Low-power CMOS (complementary metal-oxide semiconductor) memory (16K bytes, upgradable to 24K) retains files, programs, and the appointment calendar when the machine is switched off (only the display actually powers down). A rechargeable battery pack keeps the HP-75 running for about 20 hours of active use before it needs to be recharged.

Magnetic cards are used to save and restore programs and data files. Each card holds about 1300 bytes. Optional peripherals, such as a video-display driver, a digital cassette recorder, and a thermal printer, can be connected through the HP-IL (Hewlett-Packard Interface Loop) port on the back of the HP-75.

Display

The HP-75 has a 1-line, 32-character liquid-crystal display (LCD). System software provides automatic horizontal scrolling through a 32-character window, up to a maximum line length of 96 characters. All visible ASCII (American National Standard Code for Information Interchange) characters (uppercase and lowercase letters, numbers, and punctuation) can be displayed by the HP-75, with or without underlining. It also contains a

set of special characters: graphics symbols, a partial Greek alphabet, and several characters needed to support foreign languages, such as the umlaut over the o.

Using a computer with a 1-line display takes some getting used to, though the software makes it more tolerable. Commands such as LIST (list a text file or a BASIC program) cause the text to pause automatically after displaying each successive line. The duration of this pause can be set by a command.

Keyboard

The keyboard contains 65 keys in a standard QWERTY layout. All of the 256 possible 8-bit character codes can be generated from the keyboard. Each key repeats automatically when held down. Three special keys marked TIME, APPT, and EDIT can be pressed at any time to switch into the clock/calendar display, the appointment-scheduling program, or the text editor, respectively. The FET key can be used to fetch the message associated with the most recent error. DEL deletes single characters; CLR clears entire lines. Four arrow keys are used to move the cursor within the current line or to the next or previous line.

The keys give tactile feedback and an audible click when they are pressed, but they have a very short travel. I did not find the keyboard suitable for fast touch-typing; the calculator-like buttons are too small and require too much pressure. However, I would guess that they will remain highly reliable, based on their similarity to HP calculator keys.

A very flexible keyboard reprogramming feature lets you assign a string of characters to any one of 194 valid key codes and key combinations. For example, you could assign a set of BASIC keywords to all the ASCII control characters, so that pressing CTL (control) plus a key would enter an entire keyword. The current set of keyboard definitions is drawn from a file called keys. You can maintain keyboard redefinition files on magnetic cards or in-memory files.

Magnetic Cards

As many multiple program and data files as memory permits can be stored in the HP-75. If you need to store additional files, you can use the built-in magnetic card reader. Magnetic cards are also used to transfer software between machines. Several sample programs come with the HP-75 on prerecorded cards.

The magnetic cards store 650 bytes on each of two tracks for a total of 1300 bytes. You can read or write cards by pulling them manually through a slot in the lower right-hand corner of the machine, as prompted by the system software. It took a while to find the right speed to pull the cards through the reader. Warning messages tell you if you pulled too slowly or too quickly, but only within a limited range of the correct speed. Outside this range, you get a warning of bad read/write. My machine may have had some problems with the card reader, as it would sometimes give an error as soon as I pushed the RTN (return) button; according to the manual, there is supposed to be about a 5-second delay before it presents an error message.

The HP-75 automatically computes the number of cards needed to save a file and prompts you to insert them one by one. When you read a file back from cards, you do not need to read the tracks back in the order you wrote them, as long as you read all the tracks at least once.

Hardware Expansion

The HP-75C comes with 16K bytes of RAM (random-access read/write memory) in addition to 48K bytes of ROM (read-only memory). I tested an HP-75D, which includes an additional 8K bytes of RAM, for a total of 24K. Most of this is available for user programs and data; my machine showed 22,463 bytes free after a system reset. If you buy an HP-75C, you can purchase the 8K bytes

At a Glance

Name
Hewlett-Packard HP-75C Portable Computer

Distributor
Hewlett-Packard
Corvallis Division
1000 Northeast Circle Blvd.
Corvallis, OR 97330

Dimensions
11⅛ by 6 by 1⅛ inches; 1 pound, 10 ounces

Features
Rechargeable battery pack; AC adapter; 16K bytes of memory; HP proprietary microprocessor; 65 keys; HP Interface Loop; full ASCII plus graphics, some Greek letters, some European-accented roman letters; 1 line of 32 characters on liquid-crystal display

Other peripherals
Built-in magnetic card reader

Expansion features
User memory to 24K bytes total; three plug-in ROM sockets; HP Interface Loop peripherals including video display, digital cassette, and thermal printer

Software
BASIC interpreter, text editor, file manager, clock/calendar, and appointment scheduler

Price
$995

Documentation
360-page, softcover, 3-hole punched Owner's Manual with complete operating instructions, tutorial, table of contents, and index; quick-reference manual not received for review

Audience
For programmers and professionals in need of a portable computer with appointment scheduling, editing, and BASIC programming capabilities

of RAM later and simply plug the module in behind the battery compartment.

Three slots on the front of the HP-75 accommodate ROM modules, which can add new functions to the system. There were no details supplied with the review machine on these functions, but reference is made in the owner's manual to expanding BASIC with new features.

The rear of the HP-75 contains an HP-IL port (see "The Hewlett-Packard Interface Loop," by Robert Katz, April 1982 BYTE, pages 76-92). This is a two-wire expansion bus used by HP for connecting peripherals such as a digital cassette recorder, a thermal printer, and a video interface. The same peripherals used by the HP-41C hand-held computer can be used by the HP-75.

File System

An in-memory file system is the basis for storage of text files (or documents) and BASIC programs. Files can be created and modified, renamed, deleted, and copied to magnetic card or any other device on the HP-IL. File names can have as many as eight characters. Files can be protected in two ways: First, a BASIC program can be made private, in which case it can be run and deleted, but not listed or edited. Second, a password can be supplied for any file when you copy it to a card; that card cannot be read unless you supply the correct password.

The system knows about five types of files: BASIC programs, text files, appointment files, LEX files, and interchange files. Appointment files are managed by the appointment-scheduler program. LEX files are language-extension files. They add new commands to BASIC or the operating system. Interchange files are standard-format (not specified) files used to exchange information with other computers. A command is provided to transform files between BASIC, text, and interchange formats.

Text Editor

The HP-75's text-editing capabilities are used by all the other software (BASIC, appointment scheduler, clock/calendar program, and filer). This line editor is both powerful and easy to use.

You can move a blinking block cursor across the line with the left and right arrow keys. Characters can be changed by typing over them. One key deletes the character under the cursor, and another key toggles the editor in and out of insert mode, which lets you insert characters between existing characters.

The two modes of text editing are for BASIC programs and documents. BASIC program statements are checked for valid syntax as they are entered. Both file types require line numbers before every line of text. These line numbers are used to specify a line or range of lines to be listed, printed, moved, deleted, and renumbered.

Appointment Scheduler

The appointment-scheduling program makes extensive use of the clock/calendar system. The HP-75 software is set up so you can switch between editing a BASIC program or text file, running the appointment scheduler, and checking or setting the time, all without losing any work in progress in another mode. By pressing the APPT key, you switch to the appointment-scheduling program. If an appointment is due, it will appear in the display with the time and date underlined for emphasis. If no appointment is due, you are given a template to use to create a new appointment:

Day Mo/Dy/Yr Hr:Mn AM #1N !Note

You fill in the day, date, and time fields to indicate when your appointment comes due. There is a lot of flexibil-

ity and ease of use here; you can fill in the day and time only, and the program will automatically supply the date of the next occurrence of that day. Similarly, the day will be supplied if you fill in the date and time.

The #1 field specifies the alarm type. Nine different types of alarms are provided, from quick beeps to urgent-sounding sirens. The alpha character is the *appointment* type: N stands for normal; R specifies a repeating appointment, in which case a new appointment will be automatically rescheduled at a given interval in the future as soon as this one comes due. A is like R, but you must acknowledge the due appointment before a new one will be scheduled. !Note can be anything you want. Typically it will describe the appointment or reminder, such as "phone home." You can also schedule a BASIC command (including RUN *program*) to be executed when the given time arrives.

When an appointment comes due, the HP-75 will take one or more actions depending on what it is doing at the time. If you are using the machine for something else, the alarm will sound and the letters APPT will show at the bottom of the display. When you are finished using the machine, the action associated with that appointment will be done (either the Note displayed or the BASIC command executed). If the display is turned off when the appointment comes due, the alarm sounds and the action is immediately performed.

I don't think average executives will forgo their secretarial support and carry an HP-75 around all day to keep their schedules. On the other hand, I think that this facility could form the basis for a powerful real-time control system. The relative immunity to power failures and the ability to schedule the execution of BASIC programs provides a great deal of flexibility for a home control system.

Immediate Mode and BASIC

When the HP-75 is in EDIT mode, you can enter arithmetic expressions to be evaluated. This is referred to as *calculator mode* and is like the *immediate execution mode* supported by most BASIC interpreters. The RES (result) function is always equal to the result of the last expression evaluated, handy for long calculations. You can assign values to variables in this mode, and the variables so defined will be kept separate from program variables. I found this concept a bit strange and prefer having one pool of variables shared between programs and calculator mode.

All arithmetic is carried out in decimal format, meaning no precision is lost in conversion between an internal binary format and an external decimal display format. You can enter numbers as long as 13 digits; all values are rounded to 12 places before storage. The range of legal value is $-9.99999999999E499$ to $+9.99999999999E499$. The smallest positive number is $+1E-499$; the smallest negative number is $-1E-499$.

Variable names can be one letter or a letter followed by a single digit. Four types of simple variables are allowed: REAL, SHORT, INTEGER, and STRING. REAL

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Listing 1: *This sample program in HP-75 BASIC illustrates the user-definable function (DEF FN).*

```
10  DEF FNA$
20  H$=TIME$
30  H=VAL(H$[1,2])
40  IF H>11 THEN FNA$='PM' ELSE FNA$='AM'
50  END DEF
```

numbers have the full precision given above. SHORT numbers take up less space, having five digits plus a two-digit exponent, giving a range of −9.9999E99 to +9.9999E99. An INTEGER can have five digits, ranging from −99999 to +99999. A STRING can be of any length up to the amount of memory in the machine. One- and two-dimensional arrays of each numeric type are allowed, but there are no string arrays.

A very complete set of numeric- and string-manipulation functions is included with the HP-75. Logical operators include AND, OR, EXOR (Exclusive OR), and NOT; HP's scientific bent shows up in its selection of trigonometric functions, which goes beyond the usual sine, cosine, and tangent functions to include arc sine, arc cosine, arc tangent, cosecant, secant, and cotangent. Arguments can be in degrees or radians, and functions to convert between degrees and radians are provided. A built-in constant approximates pi to 12 places. String functions can find the length of a string, search one string for another, convert lowercase to uppercase, and convert numbers to strings and vice versa.

There isn't enough space here to describe the BASIC in detail. I can say in general that it has many features, and I found nothing that did not work as advertised. Most HP-75 features can be controlled from within a BASIC program, giving the system a lot of flexibility and power.

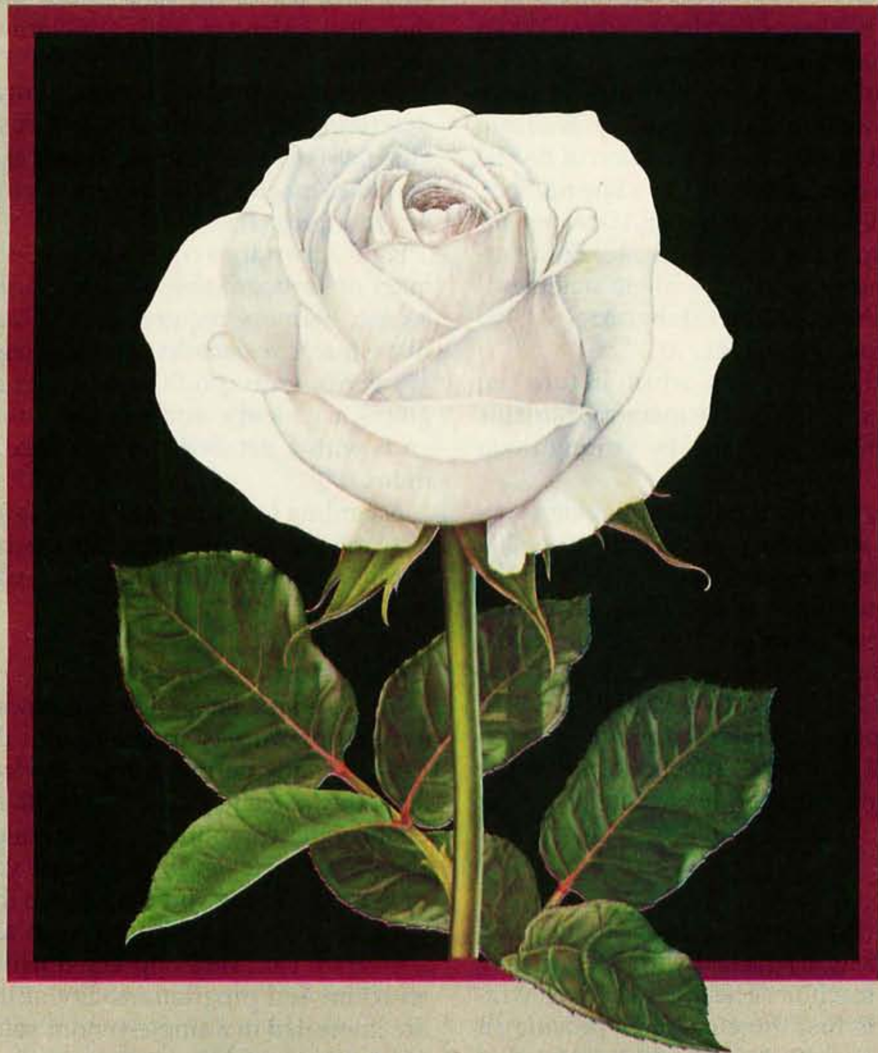
For example, the *user-defined-function* capability (including multiline functions) lets you define a function that returns the string AM if the time is before 12:00 noon, or PM if it is 12:00 noon or later (see listing 1).

TIME$ is a built-in function that returns a string containing the current time (based on the 24-hour clock), such as 10:07:42. Line 30 converts the first two characters (10 in this case) to a number representing the hour of the day. Line 40 sets the value of the function to PM or AM based on a comparison to 11 a.m. If your BASIC program contains a call to FNA$, AM or PM will be supplied according to the time of day.

More BASIC Features

A BASIC program can contain as many as 1001 timers. Each timer can be individually set to delay an event for anything from fractions of a second to centuries. The ON TIMER #<*n*>, <*delay*> <*statement*> statement will set the <*delay*> for timer number <*n*>, and execute

A Little Bug Can Do A Lot Of Damage.



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<*statement*> every <*delay*> seconds. It is possible to write a program that runs, establishes some timers, and turns the machine off, but keeps the timers active. When a timer runs out, the specified action will occur.

A single program can access up to 9999 files; in practice, the actual limit will be determined by available memory. Data is stored in a file by a succession of BASIC DATA statements. Each data statement has a line number, and you can specify a line number in a READ statement to start reading data from any line in the file. Entire arrays can be written and read using a single statement. For example, to write the two-dimensional array A(,) to file number 1, just type "PRINT #1; A(,)".

Programs can call other programs, which in turn can call others up to the limit of available memory. Variable values are passed between programs by writing them to a file.

Hewlett-Packard has provided good debugging capabilities. The TRACE statement can display the line number of the executing statement and (optionally) the value of any simple numeric variables changed in that statement. Programs can be stepped through one line at a time; each line is displayed before it is executed. You can use ON ERROR GOTO and ON ERROR GOSUB statements in your program to take action when an error occurs. The ERRN and ERRL functions return the error number and line number in which the error occurred.

Documentation

The HP-75 comes with a hefty manual (larger and heavier than the HP-75 itself) packed with 360 pages of information about the machine. The manual is well written and organized. The first three chapters provide an overview of the system, with hands-on examples that familiarize you with the editor, clock/calendar, appointment scheduler, and file system. This is an introduction for the beginner, yet it has you doing useful things fairly quickly.

The second part of the manual contains seven chapters that cover every part of the HP-75 in detail, except BASIC, which is covered later. Keyboard redefinition, connection of HP-IL peripherals, immediate mode numeric calculations, use of the card reader, and all the details of the clock/calendar and appointment scheduler are discussed.

The third part of the manual contains seven chapters describing HP-75 BASIC. Numerous examples are provided to facilitate learning. Some examples are on prerecorded magnetic cards; others give you practice typing in a program.

Eight appendixes cover accessories, warranties, a summary of keyboard and display usage, the HP-75 character set, memory requirements of various system functions, machine defaults, a table of legal abbreviations for keywords, error conditions, listings of prerecorded programs, a glossary, and a syntax summary. The manual ends with a detailed subject index and instruction-set index.

According to the preface, there is a smaller, more portable reference manual that summarizes the HP-75's commands; this would certainly be a useful adjunct to the machine.

Conclusion

This is a well-integrated and powerful machine. I did get an opportunity to use it with the optional digital-cassette and thermal-printer devices, and they work smoothly and effectively. The HP-IL loop works well and enables the computer to communicate with other HP peripherals. However, it does tie you to HP's devices, rather than letting you use devices that interface to standard serial or parallel ports such as modems.

Overall, I am very impressed with the quality of construction and programmability of this machine. If you are interested in a single-vendor solution to your needs for a very portable computer with powerful real-time scheduling capabilities, you should look closely at the HP-75. ■

Rowland Archer Jr. (5420 Loyal Place, Durham, NC 27713) earned a master's degree in computer science from Massachusetts Institute of Technology and is software development manager for a major computer manufacturer. He has written several articles and reviews for BYTE.

The Access Portable Computer

This portable offers all the hardware a computer user could want in a small package

by Terry Kepner

Would you buy a computer primarily because it comes with almost all the hardware you'll ever need? The Access Matrix Corporation is betting you would. The Access portable computer includes all the components most users find necessary: a full-sized detachable keyboard, a 7-inch (diagonal) amber display, two double-density disk drives; an 80-column dot-matrix printer; acoustic and direct connect modems; two RS-232C ports; one IEEE-488 port; one 8-bit parallel port; a composite video output jack, and an 8-inch disk driver interface. All this hardware comes in a package that weighs just 33 pounds (see photo 1).

Photo 1: *The Access portable computer system with its keyboard detached.*

Also included with each Access computer is a complete set of software: Perfect Writer, Perfect Speller, Perfect Calc, Perfect Filer, PFONT, CP/M 2.2, Microsoft's MBASIC, and Digital Research's CBASIC.

Setting up the Access is easy: open the shipping box, lift out the computer, and plug in the power cord. If you're familiar with CP/M, you can start using the computer and its software right away. The users manual includes a short tutorial on CP/M but if you're unfamiliar with the program you'll need another source of information to learn CP/M's intricacies.

The Hardware

The Access features a 4-MHz Z80A microprocessor and 64K bytes of dynamic RAM (random-access read/write

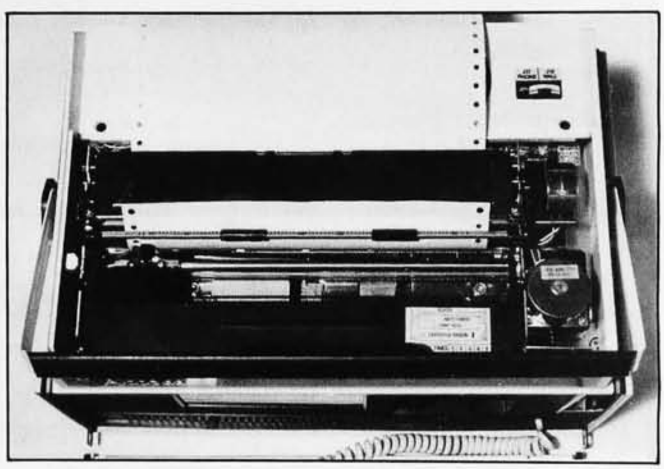


Photo 2: *The Access printer mechanism with its plastic cover removed.*

memory). A separate Z80A controls the video display, the real-time clock, and the keyboard interface. The printer uses two other microprocessors (an 8741 and an 8749), and an 8749 controls keyboard scanning. An additional 4K-byte RAM is used for the system monitor, two 4K-byte system EPROMs (erasable programmable read-only memory) hold the bootstrap firm, and one 256-character EPROM is used as the display generator.

The 7-inch amber screen has 24 lines of 80 characters featuring the full 96 ASCII (American National Standard Code for Information Interchange) character set, both uppercase and lowercase. The characters on the review unit were made up of 5- by 7-dot patterns within an 8 by 11 matrix (the specifications sheet incorrectly stated that the characters are 7 by 9 in a 9 by 11 block). The characters are difficult to read on a 7-inch screen, but, according to Access Matrix, the production units will have 6- by 8-dot characters (a 25 percent size increase), making the characters much easier to identify. A twenty-fifth line on the screen is reserved by the system as a status information line.

The separate processor for the video display makes it possible to assign attributes to the screen. These include inverse video; blinking characters; underlined and double-underlined characters; and half-intensity and full-intensity display characters. It is also possible to define the cursor as either a line or a block, blinking or not blinking. Even special features, such as protected and unprotected fields; insert/delete characters or lines, and erase and other useful functions, can be assigned to the screen.

The Access's video display was designed to emulate the Soroc 120 video terminal and will respond to the control codes used by the Soroc.

Keyboard

The keyboard is full-size and low-profile. In addition to regular typewriter keys, a block of 15 keys does double duty as either a numeric keypad (with plus, minus, and equals signs) or as a set of 15 special-function keys. The keyboard also has cursor-control keys, Caps Lock, Tab, Backspace, Escape, Control, Control Lock, Clear Screen, Print Screen on Printer, Delete, and Video/Printer On/Off-line keys.

When moving the computer, you can fold the keyboard up over the screen. When the computer is in use, the keyboard can be attached or detached from the main unit. When detached, the cord between the keyboard and the terminal stretches 4 feet. The cord's reach allows the user ample room to situate himself comfortably when an auxiliary monitor is attached to the computer.

A tilt stand is built into the two front feet of the computer to lift the video display to a comfortable reading height and angle.

Printer Unit

The printer mechanism is an Epson MX-80, one of the most popular dot-matrix printers (see photo 2). Friction feed moves the paper, and the unit prints bidirectionally at 80 characters per second. Four column widths are available: 80 (normal mode), 40 (expanded mode), 132 (compressed mode), and 66 (compressed-expanded mode). The printer mechanism can print standard ASCII characters (both uppercase and lowercase alpha) as well as 73 graphic characters and special characters in a 9 by 9 dot matrix. For charts and diagrams, it can print dot-addressable graphics.

The platen control knob, located below the printer dust cover, is a geared wheel that you turn. Controlling the printer off line (linefeeding, formfeeding, and setting top of form) is done through software commands from the keyboard. A $40 tractor feed is available as an optional extra.

Mass Storage

The disk drives, mounted to the immediate right of the video-display terminal (see photo 3), are 5¼-inch,

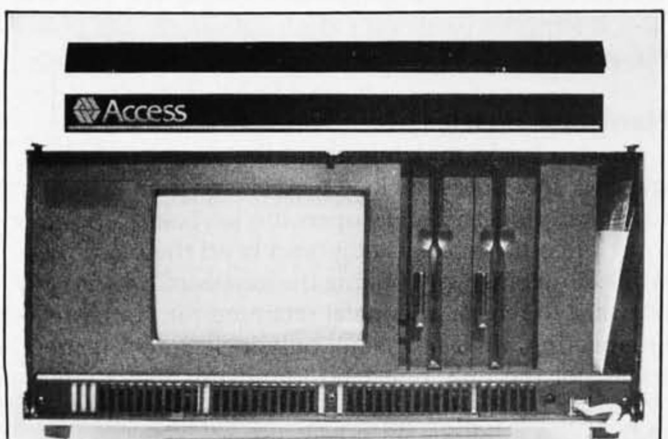


Photo 3: *The front of the Access—note the 7-inch screen, two half-height drives, and the disk compartment.*

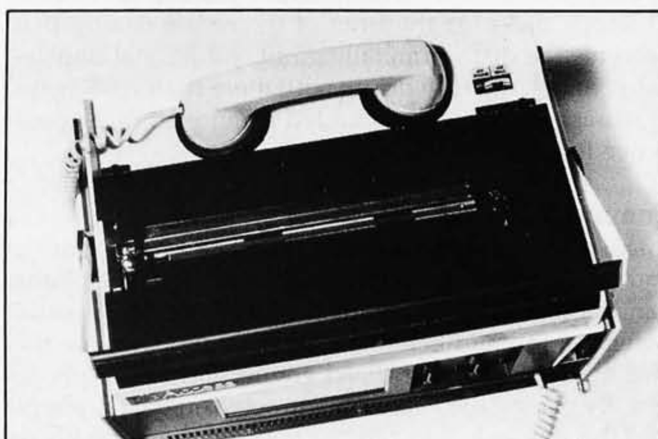


Photo 4: *A telephone handset in the acoustic modem cups.*

At a Glance

Name
Access Portable Computer

Use
General-purpose computing, word processing, programming, spreadsheet, and file management

Manufacturer
Access Matrix Corporation
2159 Bering Dr.
San Jose, CA 95131
(408) 263-3660

Size
$16\frac{1}{8}$ by 10 by $10\frac{13}{16}$ inches

Weight
33 pounds

Standard Features
Hardware: 7-inch (diagonal) amber display (80 characters, 25 lines), dual 184K-byte disk drives, dot-matrix printer, acoustic and direct connect modems, 64K-byte RAM, two RS-232C ports, one parallel port, one IEEE-488 port, composite video output, 8-inch disk-drive interface, and detachable keyboard.
Software: Perfect Writer, Perfect Speller, Perfect Calc, Perfect Filer, MBASIC, CBASIC, PFONT, TELCOMU (communications program), Systems Utilities, CP/M 2.2

Documentation
Manuals for the Perfect programs, Access Manual (three-ring binder)

Price
$2495

Options
Uninterruptible power supply, $239; tractor feed for printer, $40; double-sided disk drives, $100 each; carrying case (not yet available): softcover ($30), hardcover ($130), shipping case ($250)

half-height units. Each single-sided double-density drive has a formatted capacity of 184K bytes, organized as forty 18-sector tracks with 256 bytes per sector. To the right of the two drives is a recess in which you can store about 10 floppy disks. At the front of the recess is a lip that prevents the disks from falling out. Additional double-sided double-density drives with more than 700K bytes of storage on line can be added if more storage space is needed.

Communications

The acoustic modem is mounted behind the printer and is designed to accept a standard Bell telephone handset (see photo 4). On the back of the Access computer, behind and below the acoustic modem, are the two modular jacks for direct connection to the phone line. By placing the Access in line between the telephone and the wall jack, you can use your phone normally or use the computer to auto-dial and connect to another computer. Of course, the auto-dial and auto-answer features will not work if you're using the acoustic

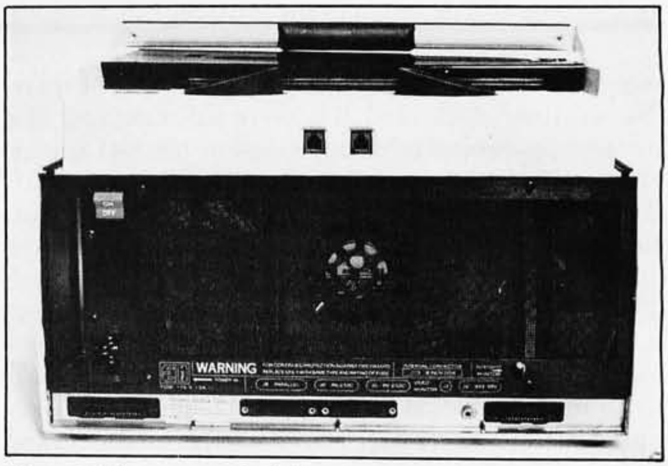


Photo 5: *The rear panel of the Access showing (left to right, top): power cord storage compartment, on/off switch, and fan. Bottom panel (left to right): bidirectional parallel port, two RS-232C serial ports, external video monitor jack, and IEEE-488 port.*

coupler. The modem can be operated from 0 to 300 bits per second (bps), full or half duplex.

The Access computer has two RS-232C ports that support any data rate from 61 to 9600 bps. The two ports, labeled port A and port B, are terminated with DB-25 connectors. Port A is electronically connected to the direct-connect phone jack, so that any information arriving over the phone appears at port A. Incoming phone information can be monitored on a terminal and/or an RS-232C printer attached to port A. Port B is a general-purpose serial port.

The 8-bit parallel port can be configured as a Centronics-compatible printer port for external printers or as a bidirectional port for connecting to outside peripherals.

Power Option

An optional combination battery pack and uninterruptible power supply (UPS) affords both convenience and true portability. Not only does the UPS provide 1 hour of emergency battery-power backup, it also incorporates a line filter to eliminate power surges and voltage spikes. The UPS can be recharged from standard 115-, 220-, and 12-volt supplies (your car's electrical system can power the Access).

Hardware Hassles

I have a few complaints about the review unit. First, the latch that holds the keyboard closed is an invitation to broken fingernails. To open the keyboard, the user must press down on its edge and bend the plastic case while simultaneously pulling the keyboard forward and outward to release the metal retaining pin. In terms of engineering, this latch is not only inelegant, it is inept! I was not the only one who found this inexcusable—Access Matrix has informed me the latch mount has been redesigned to eliminate this problem.

My second gripe concerns the carrying handle, which is not mounted over the computer's center of gravity. When you move the computer, it tilts forward instead

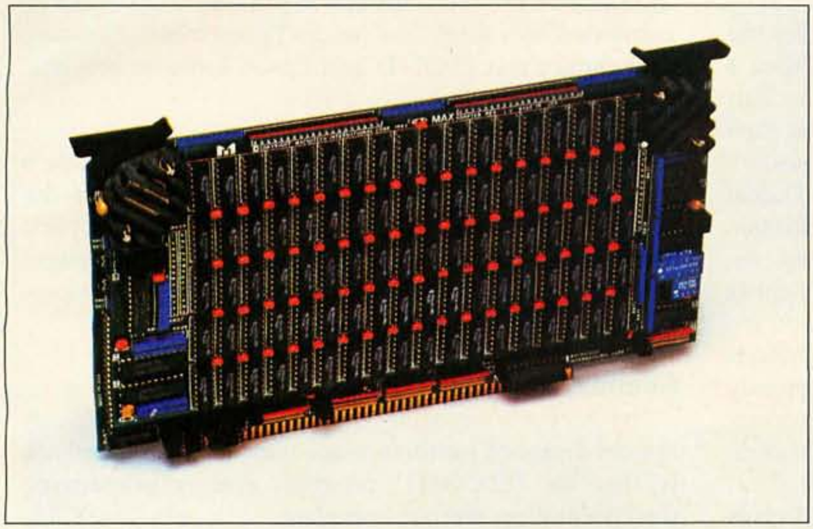
EXTRA

EXTRA

S-100 World News

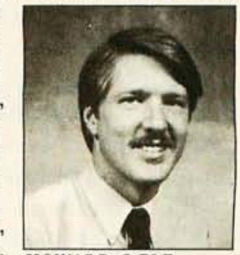
MACROTECH International Corporation — 20630 Lassen Street, Chatsworth, California • 213-700-1501

NOW 1 MEGABYTE *MAX* FOR ALPHA MICRO



CHATSWORTH—June 30, 1983—Mike Pelkey, Macrotech International President, announced today that a special version of ***MAX*** is now running in Alpha Micro Systems.

This special version is available only through Soft Machines of Champaign, IL. (217) 351-7199. Howard Ogle of Soft Machines stated, "The new **AM-*MAX*1** runs full speed with all three Alpha S100 machines." Ogle also said, "The **AM-*MAX*1** is not only the most economical memory for Alpha, but the most versatile as well. The system is even faster with Soft Machines' 'GO FAST' disk cache utilities."



HOWARD OGLE

Bob Rubendunst of Soft Machines reports, "Every ***MAX*** is shipped with software that greatly simplifies implementation on bank switched systems. Also included are detailed installation instructions and diagnostic programs."

Dealer inquiries and orders should be directed to Bob at Soft Machines.

MAX SERIES GAINS WIDE ACCEPTANCE

CHATSWORTH—June 30, 1983—S100 systems manufacturers, integrators and users have been ordering and implementing ***MAX*** for a wide variety of environments and applications. These environments would include both 8- and 16-bit processors. Typical examples would include graphics and virtual disk implementations.

These environments include 16 bit systems such as those manufactured by Empirical Research Group, Dual Systems, Compupro, Cromemco, Lomas and Seattle. ***MAX*** has been used in non IEEE/696 systems such as Alpha Micro.

These ***MAX*** users have taken advantage of the density, high speed and low cost per bit to bring large system memories to S100 buyers.

Ralph Ring of Compatible Systems Engineering of Annandale, VA, (703) 941-0917 has used 4 ***MAX*** boards in a dual system UNIX* environment. Mr. Ring stated, "My application required a 4 megabyte system memory. Quarter meg boards were impractical, the ***MAX*** is ideal for this system."

Systems builders are using the M^3 option to utilize large memories in 8-bit environments. Using the ***MAX*** board in this environment means using a single board for all memory needs. This includes functioning as system memory, virtual disk or cache memory. Some of these 8-bit environments include Compupro, CCS, Tarbell, IMS & Ithaca Intersystems.

M^3 translates the 16 logic bits from an 8-bit processor into 24 physical address bits. This opens up the system to a 16 meg address space. Using software provided in the manual, virtual disk can be implemented using CP/M 2.2,* CP/M 3.0,* or MP/M 2* operating system.

If you think about it—quality, price, performance, and the reputation of Macrotech International—it's no wonder so many demanding systems builders have used ***MAX*** series dynamic memory. The S100 world's only full function one megabyte IEEE/696 memory.

MACROTECH Moves

CHATSWORTH—June 30, 1983—Macrotech has moved to larger facilities located at 20630 Lassen St., Chatsworth, CA 91311. The new phone number is (213) 700-1501. "Due to a healthier marketplace and a phenomenal demand for the ***MAX*** series, larger facilities were necessary. This permits additional staffing, increased production, and customer support levels," said Mike Pelkey, President of Macrotech.

Virtual Disk for CP/M 86*

Dan West, Westcom Systems

BURBANK—June 30, 1983—Most of the CP/M 86* application programs available today fail to take advantage of the possible one megabyte address space. Virtual Disk for CP/M 86* will convert this unused space into RAM resident disk capacity for greatly improved disk access processing. The easily installed Virtual Disk 86 software module has been added to Macrotech's applications software available to owners of ***MAX*** series and **128ST** memory boards.

Virtual Disk Gives *MAX* Split Personality

BURBANK—June 30, 1983—"Many current operating systems permit ***MAX*** to double as both virtual disk and system memory," stated Dan West of Westcom Systems. As an example, an MP/M 2.1* system using ***MAX*-M** could be configured as a 512K system memory and a 512K Vdisk. A typical CP/M 3.0* configuration could be 256K of system memory and up to 768K Vdisk. CP/M 2.2,* of course, only permits a 64K system memory, leaving the balance for a virtual disk. With ***MAX***, or the **128ST**, both functions can run simultaneously in a single memory board.

*CP/M 2.2, CP/M 3.0, CP/M 86 and MP/M 2.1 are registered trademarks of Digital Research Inc. UNIX is a registered trademark of Bell Labs.

Circle 270 on inquiry card.

of hanging level. When set down, the keyboard edge strikes the surface before the rubber feet. Not only is this disconcerting, the unit could receive quite a jolt if the carrier misjudges the surface clearance.

Third, the folks at Access must design a more secure cover for the printer mechanism. The present plastic cover pops off whenever brushed against. And, finally, the entire unit should have some sort of carrying case because the backplate is a perforated metal panel and the external connectors (RS-232C, parallel port, etc.) are exposed (see photo 5).

Software

In addition to CP/M 2.2, Access Matrix includes the following software with the computer: Perfect Writer, a word processor; Perfect Speller, a spelling checker; Perfect Filer, a file manager; and Perfect Calc, an electronic spreadsheet. Two high-level languages are also included: Microsoft's MBASIC and CBASIC from Digital Research. The manuals for these programs are softcover, perfect-bound books, with complete descriptions, examples, and indexes. They also contain summary cards of the commands.

Along with these "canned" programs, Access Matrix includes some "custom" software—programs expressly tailored to the Access portable. The two most important are a telecommunications program and a print control program.

The telecommunications program (TELCOMU) gives you control over the RS-232C ports and the modems. It lets you select the operating modes, ports, and UART settings. The main failing of TELCOMU is that it isn't complete. Several features listed in the menu aren't explained in the manual, and several features mentioned in the manual cannot be implemented. In fairness, the manual is stamped preliminary and the final version may correct these failings.

PFONT, the print control program, is a subset of the text formatter, Fancy Font, and could be used instead of the formatter built into Perfect Writer. PFONT lets you control the usual functions: margins, headers and footers, vertical and horizontal page centering, line centering, page length, tabs, and page numbering. PFONT is important because it offers a number of print fonts: Roman (8, 10, 12, 18, and 40 point), bold Roman (10, 12, and 18 point), italics Roman (10, 12, and 18 point), script (12, 18, and 20 point), sans serif (8, 10, 12, and 18 point), italic sans serif (12 point), and Old English (18, 20, and 40 point). These are in addition to the 10 fonts available on the standard Epson printer. PFONTs can be combined on a single line (as can Epson fonts). However, you cannot mix PFONTs and Epson fonts on one line.

CP/M Utilities

Other programs supplied with the Access include a configuration program to change the defaults of the video monitor, printer, RS-232C ports and parallel port; a program to set the correct time and date on the system clock; a program to format and copy disks; and a program to display a disk file on the monitor.

Summary

The Access is a complete, portable, hardware/software system designed for the average user. Its main drawback is that its TELCOMU program and accompanying documentation are not complete.

In spite of this and its hardware problems, which are being corrected, the Access is a system I can recommend to anyone needing full computer support in a (trans)portable package.■

Terry Kepner is a full-time programmer and writer who has had articles published in BYTE and other periodicals. He can be reached at POB 481, Peterborough, NH 03458.

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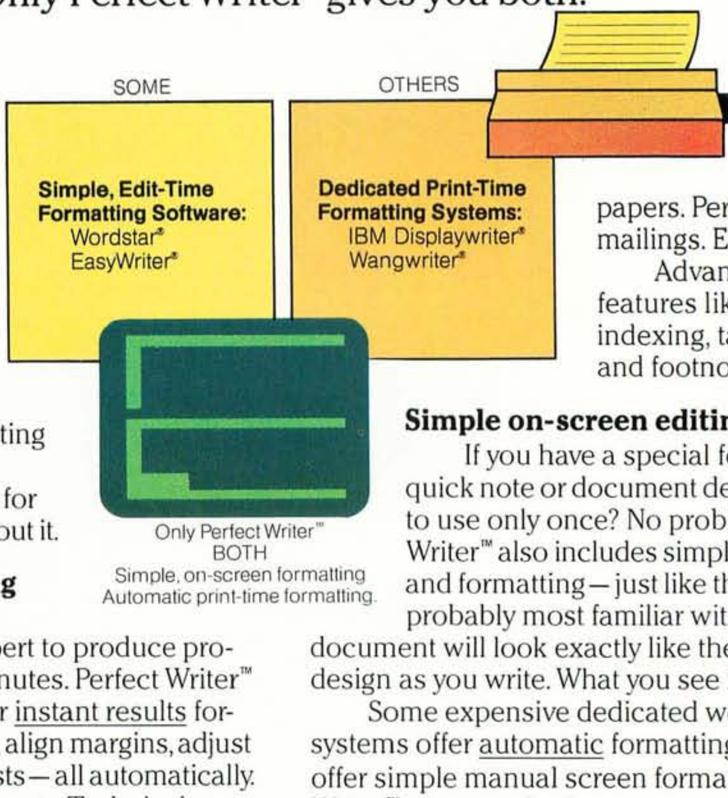
system

Powerful, automatic formatting plus simple on-screen manual editing.
Only Perfect Writer™ gives you both.



Only Perfect Writer™
BOTH
Simple, on-screen formatting
Automatic print-time formatting.

It does the work so you don't have to.

You probably don't want to know how a word processor works.

In fact, even setting margins, tabs, chapter headings, and other format details, is something you shouldn't have to worry about. That's why we developed automatic formatting for Perfect Writer.™ It's powerful enough to do much of the work for you, so you don't have to think about it.

Professional word processing in minutes.

You don't have to be an expert to produce professional word processing in minutes. Perfect Writer™ supplies over 100 commands for <u>instant results</u> formatting your document. Set tabs, align margins, adjust spacing or indent and number lists — all automatically. For business letters. Memos. Reports. Technical papers. Personalized mass mailings. Even books.

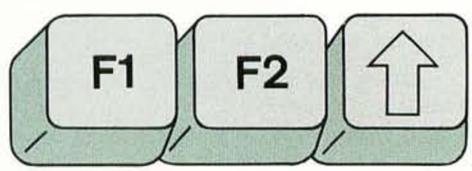
Advanced formatting features like automatic indexing, table of contents and footnotes are built in.

Document Formatting
Print time formatting **AUTOMATIC:** Just write. Perfect Writer™ does the rest <u>for you</u>. Document design formats such as footnotes, indexing, tables of contents, and report formats — they're all automatic.
Screen formatting **MANUAL:** What you see is what you get. Manually control the screen and print exactly what's there.
Only Perfect Writer™ does both!

Simple on-screen editing.

If you have a special format in mind? A quick note or document design you may want to use only once? No problem. Perfect Writer™ also includes simple on-screen editing and formatting — just like the system you're probably most familiar with. Your printed document will look exactly like the document you design as you write. What you see is what you get.

Some expensive dedicated word processing systems offer <u>automatic</u> formatting features. Others offer simple manual screen formatting. Only Perfect Writer™ gives you both.



Full-power function keys.

All Perfect Software™ programs can be configured to take best advantage of the sophisticated features offered with today's computers and smart printers.

You can use <u>all</u> of your function keys — including the more than 50 function keys on the IBM-PC. Perfect Writer™ fully utilizes printers with proportional spacing, too. Print with a choice of up to six typefaces.

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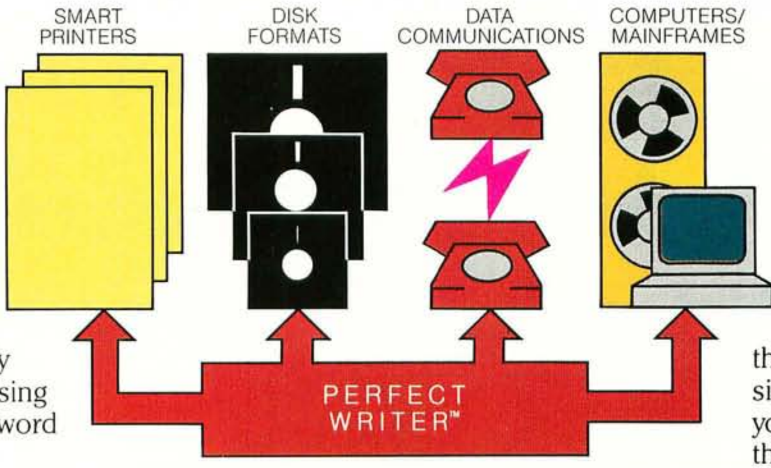
Finally. A word processing program for any computer in your office.



Perfect Writer™ is the most compatible word processing program.

Everything you compose with Perfect Writer™—every chart, every table, every document—everything can be used by virtually any other word processing program or dedicated word processing system.

That's because Perfect Writer™ uses true ASCII data files to store your documents. ASCII is the computer industry standard. It's read and recognized by computer systems worldwide, regardless of disk format or size, whether it's used locally or sent over telephone lines.

Spreadsheets can be included.

Want to illustrate your Perfect Writer™ document with a financial table or graph that's stored in a Perfect Calc™ spreadsheet? You can—easily. In fact, you can even edit the numbers for your Perfect Writer™ document without disturbing the original Perfect Calc™ spreadsheet. That's Perfect Software's™ fully integrated programs at work.

Split screen editing.

You can view and edit two documents on the screen at the same time with Perfect Writer's™ unique split screen feature. One simple command moves you easily between documents. And you can even review a spreadsheet while editing up to six other documents! It makes the preparation of complex documents easier than ever before.

Check your spelling as you write with Perfect Speller.™

Perfect Speller's™ in-text spelling checker finds spelling errors and typos at a rate of 4,000 words per minute. (That's 20 pages every three minutes!) Then, at a single command from you, Perfect Speller™ lists the misspelled words or marks errors in the text of your document.

Self-teaching software makes it easy.

Perfect Writer's™ document design tutorials are matched to the easy-to-read user guide. Eight lessons are included. Learn how to handle form letters, how to write business correspondence, and how to create your own special spelling dictionary. On-line reference and English prompts provide assistance anytime you've got a command question. All tutorials are software-based, interactive programs to make learning easy and fun.

Available for all IBM PC-DOS® and MS-DOS® CP/M® computers.

When you upgrade to new hardware, Perfect Writer™ keeps right on working. All text files are transferable. No other software works with a wider range of personal computers. In fact, Perfect Software™ will soon be available for all of the most popular 8-, 16-, and 32-bit computers.

Only Perfect Writer™ offers you this much flexibility. Write your own success story today. With Perfect Writer.™

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plus multiple v

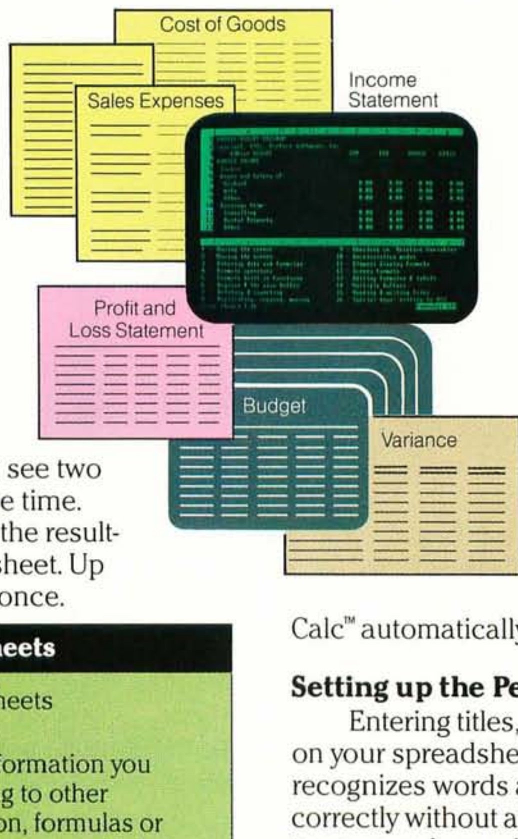
For successful solutions in financial planning.

Perfect Calc™ makes it easy.

Perfect Calc™ gives you the financial planning and analysis tools for success. Automatic associated spreadsheets. Built-in accounting and financial tools. Easy commands.

And only Perfect Calc™ features <u>on-line associated spreadsheets plus split-window display</u>.

With Perfect Calc's™ multiple window display, you can see two different spreadsheets at the same time. Change your figures and see how the resulting variations affect each spreadsheet. Up to seven spreadsheets on-line at once.



Multiple Spreadsheets
Associated Spreadsheets **AUTOMATIC:** No double work—use any information you choose simply by referring to other spreadsheets. Move information, formulas or whole spreadsheets freely between multiple spreadsheets. Permits fill-in-the-blanks automatic forecasting and planning. 16 built-in application programs are included.
Spreadsheet Consolidation **MANUAL:** Simple cut-and-paste spreadsheet entries. Line, column, or whole spreadsheet additions from any one of seven on-line spreadsheets are also easy with Perfect Calc.™
Only Perfect Calc™ does both.

How Perfect Calc's™ multiple file <u>association</u> really pays off.

A good example is the built-in Income Statement Program. The income spreadsheet automatically reads from three other spreadsheets: Cost of Goods Statement, General and Administrative Expenses Statement, and Sales Expenses. All four are on-line simultaneously. All you do is fill in the blanks.

Then use all that information to perform an instant analysis and illustrate the results of potential budget cuts or increases. You change just <u>one</u> spreadsheet using the fill-in-the-blanks style. Perfect Calc™ automatically takes care of the rest.

Setting up the Perfect™ spreadsheet!

Entering titles, labels, and additional information on your spreadsheet is easy with Perfect Calc.™ It recognizes words automatically and handles them correctly without any special commands. If you want to use numbers—like dates—for item labels, that's easy, too.

Individually variable column widths add flexibility in setting up your Perfect Calc™ spreadsheet. And once you've developed one spreadsheet, you can use it as a template for other applications. Simply refer to it.

Self-teaching software.

Easy, software-based lessons are included to make learning spreadsheet techniques simple. The lessons are matched to guides in the user manuals so

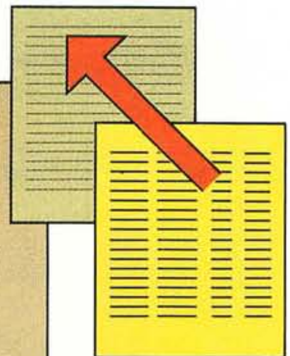
t Calc™
ıted spreadsheets ndow display.

Sixteen applications built in. And that's only the beginning.

you can follow along in the text. Because you learn on the computer at your own pace, there's no pressure to perform. Try new applications when you are ready.

Perfect Calc's™ built-in programs:
(Add custom applications as you like.)

- Income Statement Program • Cost of Goods Statement
- Sales Expense Statement • General and Administrative Expenses • Cashflow Assessment Program • Accounts Receivable Worksheet • Accounts Payable Worksheet
- Payroll Analysis Program • Stock Portfolio Evaluation Program • Real Estate Analysis • Chi-square Analysis
- Professional Fee Analysis • Family Budget • Financial Net Worth Program • Check Register Program
- Individual Tax Return Analysis Program



The most complete applications.

Perfect Calc™ is the only spreadsheet you can buy with 16 applications built in. Standard paper and pencil financial tools are ready to use. All you do is fill in the blanks.

Just a simple command is all you need to start working. And on-screen tutorials and English prompts give you assistance whenever you need it.

Handy cursor commands.

You can move the cursor easily to the top of a column, beginning or end of a line, to the page before or after—with a single command.

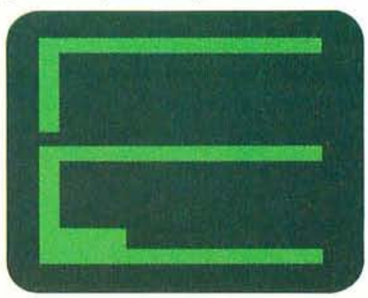
And you can go back and forth between two spreadsheets on split-screen display with just as much ease. That makes multiple spreadsheet handling easier than ever before.

The most compatible spreadsheets.

Perfect Calc™ data is stored in true ASCII files—the files read and recognized by every computer system. So, it's simple to use a Perfect Calc™ spreadsheet in a Perfect Writer™ report or letter. Or, build graphic displays using the information in one of your spreadsheets.

All the functions you need–and more.

You get standard functions for financial, scientific, and engineering applications plus an expandable functions library which allows you to add new formulas as you like. You can write your own complex applications programs by writing it on a Perfect Calc™ spreadsheet and taking advantage of the powerful associated files feature.



Put the solutions for success to work for you.

Using simple plain-English prompts and on-line references, you can do sophisticated forecasting and planning in minutes.

Automatic associated spreadsheet information management. Standard spreadsheet calculation and consolidation. Only Perfect Calc™ gives you both.

Start planning for success today with Perfect Calc™

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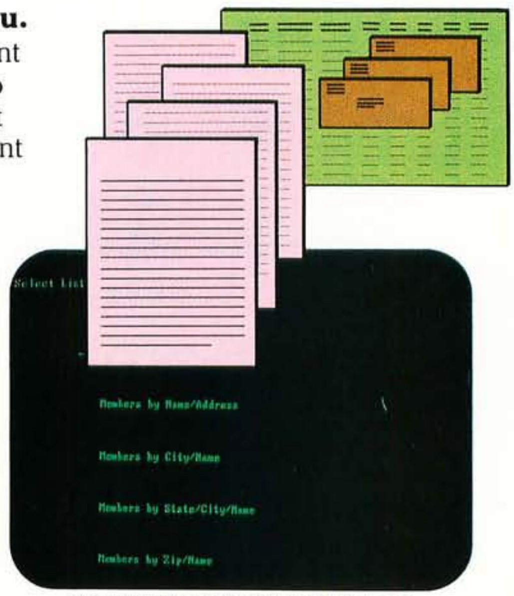
The powerful records management solution for the personal computer user.

Put information to work for you.

Most information management systems are either too small or too difficult to use. Now there's Perfect Filer.™ It's an executive management information system that's easy to use. You can keep track of mailing lists, clients, sales, merchandise, names and addresses, and much more.



INSTANT DATABASES AND REPORTS

Easy to get started.

Two ready-to-use data entry forms are provided so that you can begin using Perfect Filer™ immediately. One is for individuals, the other for companies and organizations. You only type important information once. Perfect Filer™ does the rest for you. No special training is required, and your entire staff can use it.

On-line references and English prompts provide assistance when you have questions. Tutorials are included for improving your skills with Perfect Filer.™

Personalized form letters.

Use Perfect Filer™ together with Perfect Writer's™ powerful word processing features to add a personal touch to mass mailing letters. You can even tag different groups within one mailing list so that their letters include special paragraphs, subsections or operator-typed comments.

And Perfect Filer™ remembers nicknames, titles—even your special salutation for clients or friends.

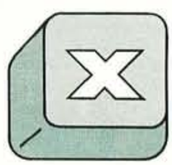
Generate mailing lists. Form letters. Specialized record-keeping forms and sorted lists. You can choose from the two data entry forms provided or from seven data entry groups.

Information Management

Data entry forms
AUTOMATIC:
Use Perfect Filer's™ built-in data entry forms to create your own records file. All of the parameters have been pre-defined. Just enter information on the convenient entry form.

Information management
MANUAL:
Create custom data bases with ease. You can build an entirely new structure or use data entry groups from existing formats to construct a customized data base with exactly the information you want to manage.

Only Perfect Filer™ offers you both.



Creating custom data bases has never been this automatic.

Single-keystroke data entry menus do the work for you. You enter your data just once on a blank Perfect Filer™ data entry form—whether it be client addresses, direct mail sorting codes, payment records, inventory, or standing orders.

Perfect Filer™ makes successful information management simple.

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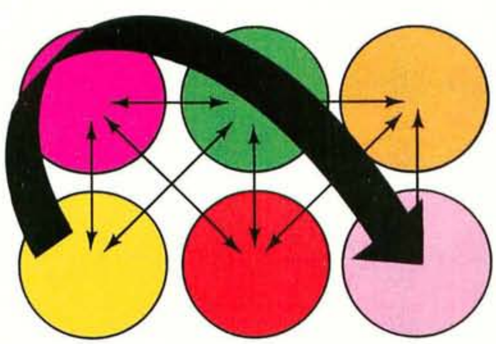
The integrated software solution.

When you learn one program, you've learned them all.

Perfect Software™ All of the most-asked-for business and personal computer applications in one complete package. Word processing. Financial planning. Mail management. Records keeping. Solutions to all those everyday problems in one simple, integrated software package.

Each Perfect Software™ program works efficiently with the others. All share common file structures. They all use the same command structure, so when



you learn one program you can use them all. And all with software-based self-teaching programs.

Perfect Writer.™ Perfect Calc.™ And Perfect Filer.™ Each a powerful program with dozens of extra value-packed features included. Together, they're the top performing software solution available on the market:

Common control commands. Learn one Perfect Software™ program and you've learned them all.

Manual/Automatic functions. Every Perfect Software™ program includes automatic "smart" functions. Intelligent software performance. Also powerful manual operations for the ultimate in flexibility and performance.

Available for IBM-PC DOS,® CP/M,® and MS-DOS.® Perfect Software™ runs on most 8-, 16-, and 32-bit computers available today.

Self-teaching software. Learn at your own pace without pressure to perform.

Solutions for success.

You get more performance, more flexibility and more automatic functions with Perfect Software™ than with conventional software packages. Best of all, you get solutions that save you time and effort. Easy to learn — all Perfect Software™ programs work alike and are fully interactive for greater productivity and ease of use.

Perfect Writer™ is rated #1 by *Personal Computing*, and called "the most comprehensive word processing package" by *Esquire* magazine. It was given the highest marks of any software on the market in the latest *InfoWorld* review of word processing programs. Perfect Calc™ has been unmatched for spreadsheet performance. And all Perfect Software™ offers the added productivity of fully integrated software.

Our advanced programming design offers you the highest level of software compatibility and "intelligent" automatic features. It's Perfect Software™ for today's problems. And tomorrow's solutions.

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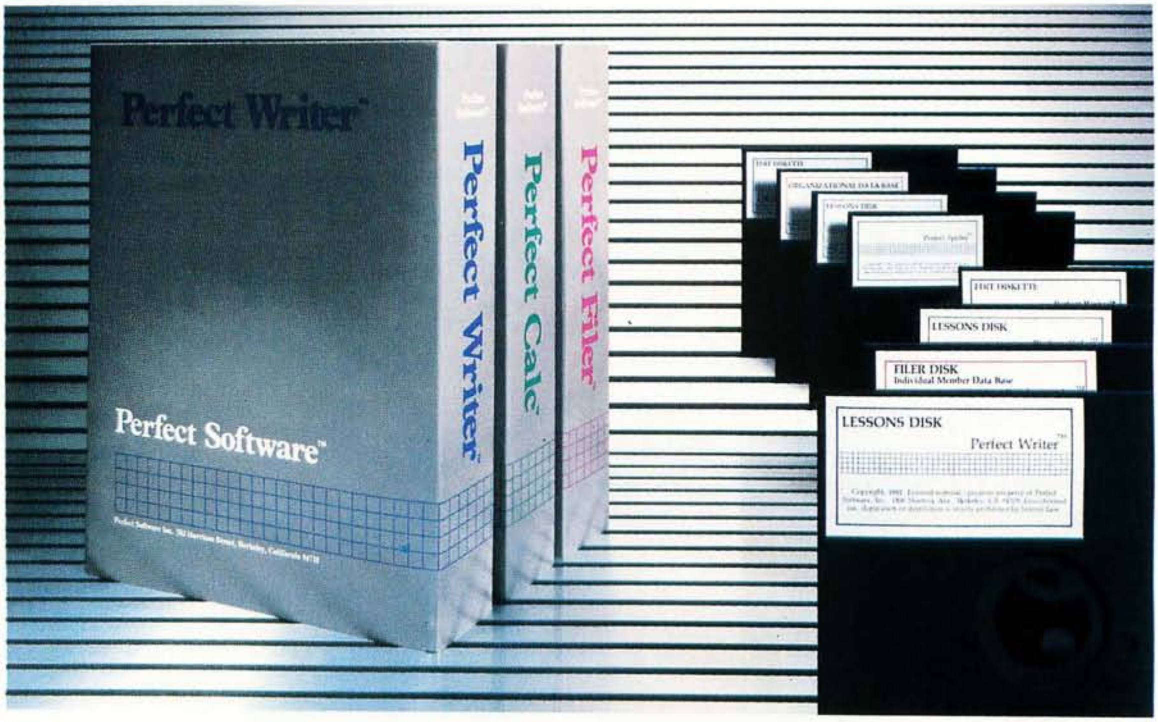
The Rebate



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The first software company to offer personal computer owners a fully integrated easy-to-use software library, offers you an excellent reason to buy now.

Act today! Offer good on all retail purchases from September 1 through October 31, 1983.

Simply clip the coupon and visit your local participating computer dealer.

The Rebate

Get up to $160 back by mail when you buy all four Perfect Software™ packages. I have enclosed the sales slips on the purchased products as indicated.

☐ Perfect Writer™ $50 ☐ Perfect Speller™ $30
☐ Perfect Filer™ $30 ☐ Perfect Calc™ $50

Please send my rebate to:

NAME____________________

ADDRESS____________________

CITY__________ STATE__________ ZIP__________

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This offer is valid only on retail purchases of Perfect Writer, Perfect Speller, Perfect Filer, and Perfect Calc made from September 1 to October 31, 1983. Mail your coupon to: Perfect Software Rebate, 214 West Erie Street, Chicago, IL 60610.

Purchases made as part of computer manufacturer's original equipment are not eligible.

Offer is limited to one $160 rebate per person or household. This form may not be mechanically reproduced. Offer forms not available by mail. Requests must be postmarked no later than November 15, 1983. Allow 4-6 weeks for shipment. Void where prohibited, taxed, or restricted by law.

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Epson's HX-20 and Texas Instruments' CC-40

Portable notebook computers hold more promise than performance

by David Ramsey

The microcomputer revolution caught everyone by surprise. When the first Altairs became available, no one had any inkling that personal computing would be more than an expensive hobby for eccentrics. Things didn't work out that way, of course. And now we're on the verge of a submovement: the portable computer revolution.

In this article we'll take a look at two of the many portables available today: the Epson HX-20 and the Texas Instruments Compact Computer 40.

The Epson HX-20

The Epson HX-20 is the Japanese computer that was going to set America on its ear. It didn't, although its brisk early sales were encouraging. After an initial spurt of interest, people began to note that no accessories or software were available for the machine. In an unusual case of Japanese marketing failure, Epson had the lap computer market to itself for almost a year and did nothing with it.

Fortunately, it looks as if a truckload of new software and peripherals for the HX-20 is just around the corner. Epson has recently upgraded the standard $795 machine, which now includes the formerly optional (at $160) microcassette drive and a simple word processor called Skiwriter. Disk drives for the machine are due out before the end of the year, and a telecommunications ROM (read-only memory) should be available by September.

The basic machine contains two 6301 processors, CMOS (complementary metal-oxide semiconductor) implementations of the 6800 architecture that run at 614 kHz. One processor handles computing chores while the other handles I/O (input/output). Included in the standard machine are 16K bytes of RAM that can be expanded to 32K with the addition of the $150 expansion unit. The standard 40K-byte ROM includes BASIC, the routines to drive the printer and microcassette drive, and the small word processor. BASIC and the word processor share the same addresses—the application not in use at the time is bank-switched out. (See the "At a Glance" box.)

Epson's goal with the HX-20 was to provide a complete portable computer system that includes a printer and mass storage. The HX-20 has a 60-key, full typewriter keyboard, a 4-line by 20-character LCD (liquid-crystal display), and a 20-column impact dot-matrix printer (which is, incidentally, the smallest impact dot-matrix printer in the world). It is also equipped with RS-232C (albeit through a DIN connector) and serial ports and a computer-controlled microcassette mechanism for program and data storage.

The display has an important capability not found in competing machines: the ability to act as a window on a "virtual screen" of arbitrary size. Theoretically, a screen of up to 255 rows of 255 columns can be supplied; realistically, however, the 64K bytes of memory that would require don't exist in the machine. Still, allocating an 80 by 24 screen is as simple as typing WIDTH 80,24 in BASIC. You can use the cursor keys to move around the virtual screen with scrolling in all directions, and various control keys provide larger (more than a single character) jumps in any direction. The display is also dot-addressable as a 120 by 32 array, and commands to plot points and draw lines are included in the BASIC.

Along with the standard typewriter keyboard, the HX-20 has three dedicated keys (Break, Pause, and

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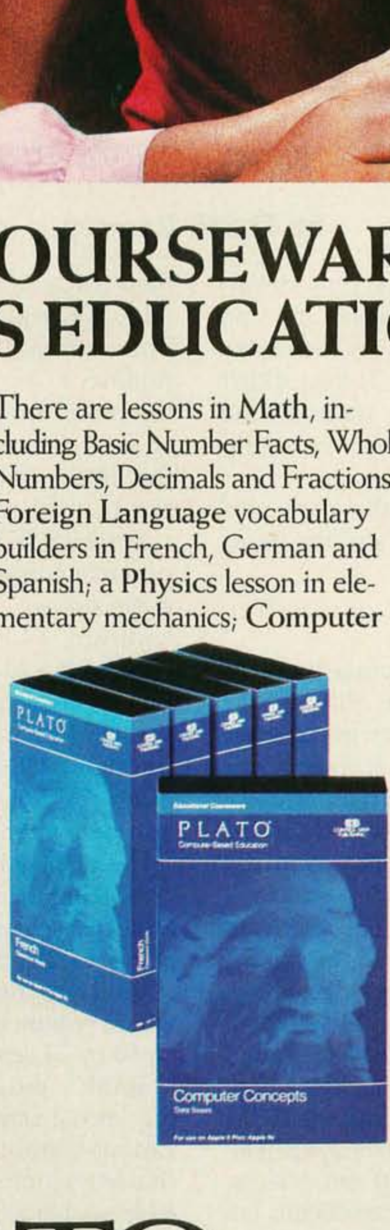

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At a Glance

Name
Epson HX-20 Notebook Computer

Manufacturer
Epson America Inc.
3415 Kashiwa St.
Torrance, CA 90505
(213) 539-9140

Price
$795

Dimensions
11.3 by 8.5 by 1.7 inches

Display
20-character by 4-line liquid-crystal display

Keyboard
Typewriter style

Software
BASIC, Skiwriter (a word processor)

Memory
16K bytes of RAM

Included Interfaces and Peripherals
Microprinter, microcassette, RS-232C interface, bar-code interface, external cassette interface, system bus connector

Documentation
Two-volume BASIC Tutorial and Reference Manual, A Guide to Operations, Skiwriter and microcassette manuals.

Menu) and five user-definable keys that shift to provide 10 functions. System assignments to the function keys allow manual control of the microcassette drive and printer. Interfaces for an external cassette recorder and bar-code reader are also provided, although the former will probably not be used much now that the microcassette drive is standard.

Built-in Software

The HX-20 comes with BASIC in ROM and a small word-processing editor called Skiwriter. Also in ROM are a small machine-language monitor and routines to drive the microcassette, printer, external cassette (including motor control), and serial and RS-232C interfaces. The BASIC, which is supplied by Microsoft, is a fairly standard implementation that supports both single- and double-precision real numbers as well as integers. Epson adaptations include specifying the position of the cursor anywhere on the virtual screen, commands to control the microcassette, and commands to set and read the time-of-day clock/calendar incorporated into the machine. A TONE statement allows precise control of the duration and pitch of notes through the HX-20's piezoelectric speaker.

A notable extension to the BASIC is its ability to load, save, and merge programs to and from the microcassette, external cassette, RS-232C port, or serial port. If you have a larger computer with a serial port, you can edit BASIC

code for the HX-20 on it, connect the two machines, and easily download the text of the program.

The BASIC editor is impressive. Just move the cursor anywhere on the virtual screen, type your changes (using INSERT and DELETE if necessary), and press RETURN to resubmit the line. Why don't we have editors like this on our Apple and Radio Shack machines?

When the HX-20 is turned on, the screen displays a menu of up to 10 options. The standard machine displays three choices: Monitor, BASIC, and Skiwriter. At this point you also have the option of pressing Control-@ to initialize the machine (i.e., clear memory and reset the clock). BASIC programs may be given titles, which will appear as part of the menu until the title is removed or the program is erased. Pressing a menu number immediately executes the desired application.

The HX-20 has an in-memory program and data file system. Five program partitions—P1 through P5—exist, and you can switch between them by entering LOGIN (partition). The memory allocation among the partitions is completely dynamic: any program can expand to fill available memory. In addition, a user-controllable area known as the RAM File, an area of memory whose size is chosen by the user, serves as a random-access data file. The command DEFFIL (record size), (offset) defines the behavior of the special GET and PUT statements. The first parameter defines the size of the record, while the second defines how many bytes into the RAM file record 0 begins. Several files of differing record lengths can be kept in memory at one time.

Built-in Peripherals

The HX-20 is alone in the lap computer market in providing both a printer and mass storage as parts of a standard unit. The little printer is nothing short of amazing: it prints 20 columns on plain paper and consists of four print wires spaced equidistantly across the 20-character width of the platen. As the printer prints, the head wobbles back and forth until one horizontal line of dots is printed. The paper then advances one dot, and the process is repeated. The procedure sounds slow, but the printer finishes a little more than one line per second. The printer is controlled by BASIC LPRINT and LLIST commands. For those cases in which you need more than a microprinter, any printer with a standard serial port can be connected to the HX-20 and used for listings and printouts.

The HX-20 supports the microcassette drive with a minimal set of commands. LOAD and SAVE take care of program storage; WIND winds the tape until the (software) tape counter reaches a specified value, and serial data files can be written by opening the cassette as a file and using the INPUT# and PRINT# statements. A random-access file could theoretically be implemented by determining the amount of tape each record took and using the WIND statement to position the tape before reading and writing, but the procedure would probably be too slow to be useful.

I admit to ambivalence about the microcassette drive. On one hand, it's very handy to have integrated mass storage. On the other hand, it's a pretty minimal implementation. My principal objection to the microcassette implementation, however, is that it's basically just the standard audio recorder moved onto the machine. Convenient, yes . . . but how about keeping directories on the tape? How about a real operating system so I can catalog the tape?

In Epson's defense, the company does provide a set of BASIC programs for manipulating a simple directory on the tape. The program builds a directory by scanning an entire tape at the normal read speed (which takes 15 or 30 minutes, depending on the tape length) and then placing a directory at the start of the tape. The same program then lets you select a directory entry for loading

and winds directly to it. But the slow scanning process must be repeated every time you want to update the directory, and there's no protection against a program growing to overwrite its immediate neighbor. In my opinion, what the HX-20 needs most is an enhanced operating system for its tape drive. Hewlett-Packard does far better with the HP-75, and it doesn't even have the advantage of working with a capstan drive.

The RS-232C port implements lines 1 through 8 of the RS-232C standard on a DIN connector. Espon supplies as options two cables with DB-25 connectors; one has pins 2 and 3 reversed for use with a modem. Although Epson offers a fine CX-20 acoustic modem, no terminal program is commercially available for the HX-20 at present. I've written a terminal program that drives a Hayes Smartmodem through the serial port. The serial port supports a variety of data formats—the user can set the bit-per-second (bps) rate (110 to 4800), the number of bits, parity, and type of handshake, although the very standard XON/XOFF software handshake protocol is curiously absent and must be handled in software. Programs using the port with systems that expect this protocol must query the buffer status to determine the number of characters and transmit XON and XOFF where appropriate.

The serial port obeys the signal level standards for RS-232C but implements only pins 1 through 5. The bps rate goes to 38,400. In Japan, this connection is used for the TF-120, a dual 5¼-inch floppy-disk drive. Epson is working on a drive for the American market that is due to appear before the end of the year. It is rumored to contain its own Z80 processor and a fair amount of CMOS memory. The TF-120 requires AC power, but Epson has said that new peripherals for the HX-20 will be battery powered, which almost certainly means sub-5-inch drives. Rumor also has it that a larger LCD will be a plug-in option.

Skiwriter

Skiwriter, a small word-processing program on a 2764 ROM, was written by Kenneth Skier, who also wrote all of the HX-20 manuals and was one of the programmers for Wang's word processor. Now standard on the machine, Skiwriter is also available as a separate product for those who bought earlier versions of the HX-20.

Skiwriter is well designed and easy to use. A simple program, it offers only three output formatting commands: line spacing and left and right margins (defaults are 1, 10, and 70, respectively). The user enters text in free format, and words wrap at the boundary of the 20-column screen. Horizontal scrolling is not used, presumably because it would make reading a document on the screen more difficult.

Skiwriter lets the user mark, copy, and delete blocks of text, find (although not replace) strings, and reset the format (line spacing and margins) at any point in the

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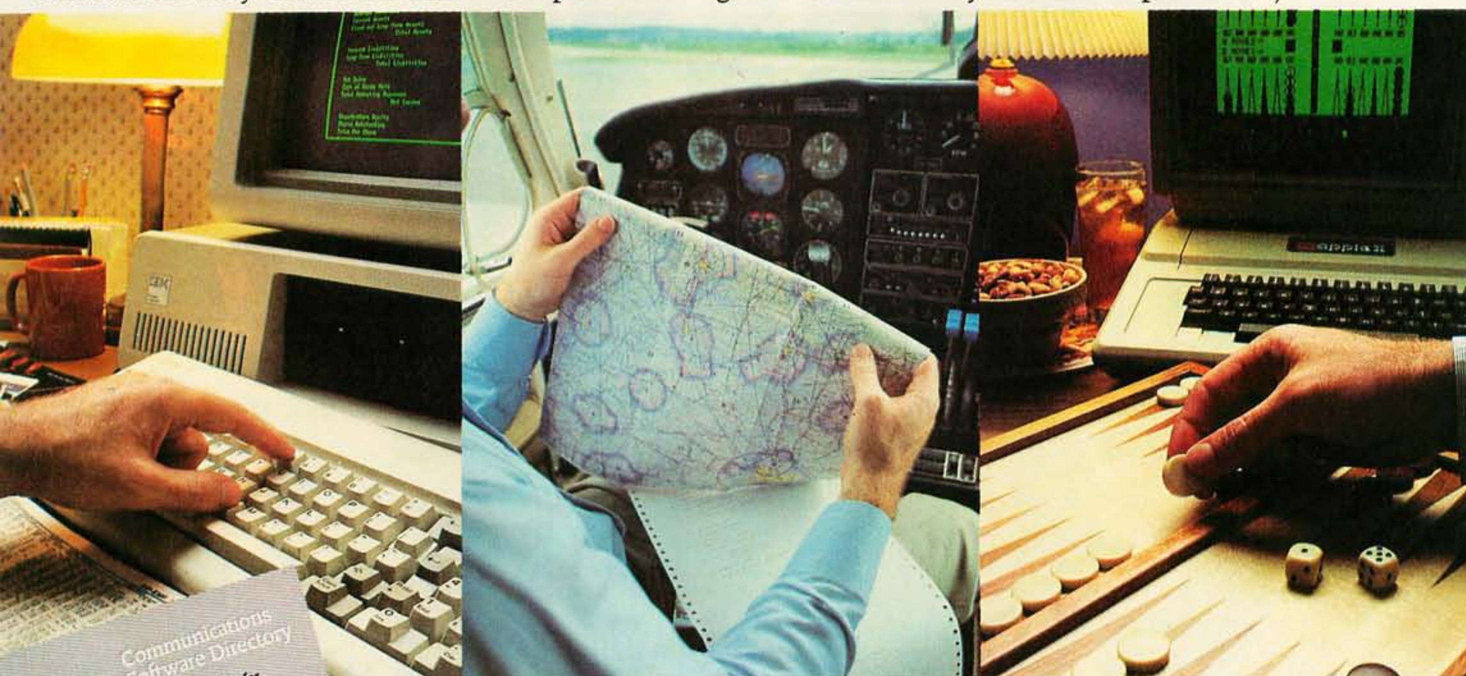

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document. This last feature is useful for setting off sections of documents. You can also insert formfeeds into the document at any time. Skiwriter has two 16-byte buffers whose contents are sent to the printer before printing (for the preprint buffer) and after printing (the postprint buffer). That way, the user can put control and escape sequences in these buffers (which are normally filled with nulls) to get the printer to a particular state. I think Skiwriter would be much more useful if it let you insert control and escape sequence commands directly in the text.

When you make an error, Skiwriter beeps. You can continue, but pressing the Help key displays a help screen detailing the error. This is a nice touch, especially for people who have little previous computer experience.

You can save and restore documents to either the microcassette or an external cassette, and documents can be printed on the internal microprinter or through the RS-232C port. Documents can be read in from either cassette and appended to the document in memory, a useful feature.

You can't use Skiwriter to edit BASIC text, but the standard HX-20 BASIC editor is so good that you don't really mind.

[Editor's note: *Skiwriter may be available for other microcomputers in January 1984. . . .* **R. M.]**

The Monitor

The machine-code monitor comes as a pleasant surprise, especially for those who enjoy digging into the (undocumented) workings of a machine. The monitor uses the physical screen only—you're limited to the 20 by 4 display—and normally displays the contents of the A and B accumulators in the index register, stack pointer, condition code register, and program counter. The following single-keystroke commands are available:

- B Return to BASIC
- K Set the "keystack sequence," a group of keystrokes that is automatically executed whenever the HX-20 is turned on
- D Dump memory (in hexadecimal)
- G Execute a routine in memory with optional breakpoints
- S Set new memory values—used for entering data in hexadecimal
- X Display and (optionally) change register contents
- R Read a file from external cassette, microcassette, serial port, or ROM
- V Verify file saved on device
- W Write file to device
- A Return starting and ending addresses of file as well as the entry point

Documentation

Four manuals are supplied with the HX-20: a two-volume *BASIC Tutorial and Reference Manual,* a *Guide to Operations,* and Skiwriter and microcassette manuals. All

are complete and well written. *The Guide to Operations* is a profusely illustrated work that gently guides the neophyte. Topics such as the virtual screen and the concepts of "programs" and "data" are handled very well. Overall, I'd have to rate the documentation high.

Summary

The HX-20 has a lot of potential. The introduction of the Radio Shack Model 100 has given the HX-20 very stiff competition, and compared to Radio Shack's 40 by 8 display, the HX-20 looks primitive. But Epson's new wave of peripherals and software, if introduced in a timely manner, will probably save the machine. Currently, its big selling points are the integrated microcassette and printer, features no other portable offers yet.

The Texas Instruments Compact Computer 40

I tried to be unbiased and objective about this machine, I really did. I kept reminding myself what a notebook-sized BASIC computer would have meant to me just a few years ago. And the price of the TI CC 40 is only $250.

But there's no clock. No file system. Only one BASIC program at a time can reside in memory, and the user can work with only about 5200 bytes of that. And the keyboard is vile.

There's also no cassette interface. If you want to store programs or data, you have to buy the TI wafertape drive. The CC 40 offers neither built-in storage nor a standard audiocassette interface. It could be argued, however, that you can buy a CC 40, the optional wafertape for mass storage, and another 16K bytes of memory, and still have an inexpensive computer. Unfortunately, none of these accessories was available at the time this review was written.

The CC 40 has a 31-character display, a sort-of-typewriter keyboard, and a separate numeric/cursor keypad. The keyboard spacing is so small that it's essentially impossible to touch-type on it. The Shift and Control keys lock for one keystroke—to type an uppercase character, you press *and release* the Shift key, then press the character key. There's only one Shift key; the space normally occupied by the right-hand Shift key is taken up by the Return key.

The CC 40 does make a dandy scientific calculator, and perhaps that's the market it should be aimed at. Good scientific programmable calculators cost about as much and are not nearly as powerful as the CC 40. Up to 10 user-definable key sequences can be entered, and the Playback feature recalls the line last entered on the display for editing and resubmission. All BASIC keywords can be entered with a two-keystroke sequence (FUNC followed by another key), which is handy considering how difficult it is to type on this machine. There is a slot for ROM or RAM cartridges in the upper-left corner of the machine. None were available at the time of this writing.

Built-in Software

The TI BASIC included is a good extended BASIC with several interesting features, among them a subprogram capability (with local variables); an ACCEPT statement that combines the functions of the normal INPUT statement with automatic positioning of input and length and type checking; a PRINT USING and IMAGE capability that allows some elaborate output formatting; and some real oddities such as SETLANG, which sets the output language for system messages. The standard computer includes English and German, so you can set your error messages to be displayed in German if you wish. Some ROM cartridges presumably offer the option of other languages.

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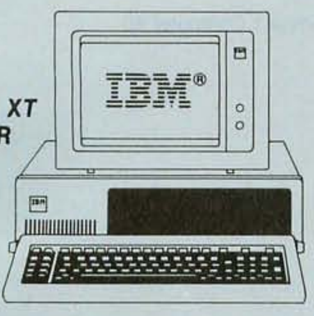

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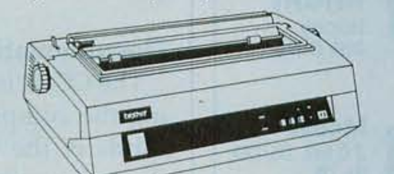

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At a Glance

Name
Texas Instruments Compact Computer 40

Manufacturer
Texas Instruments Inc.
POB 53
Lubbock, TX 79408
(800) 858-4565

Price
$249.95

Dimensions
9.2 by 5.7 by 1 inch

Display
31-character by 1-line liquid-crystal display

Keyboard
Miniature typewriter style

Language
BASIC

Memory
6.2K bytes of RAM

Peripherals
Printer/plotter, RS-232C interface, wafertape digital tape drive, Hex-bus interface, socket for ROM cartridges

Documentation
One 280-page manual

Peripherals

The CC 40 includes an integral Hex-bus interface, which TI describes as "a medium speed (6000 bytes/second) 4-bit interface." The Hex-bus is used to connect peripherals such as the wafertape drive (which old-timers may remember as the Exatron stringy floppy) and printer.

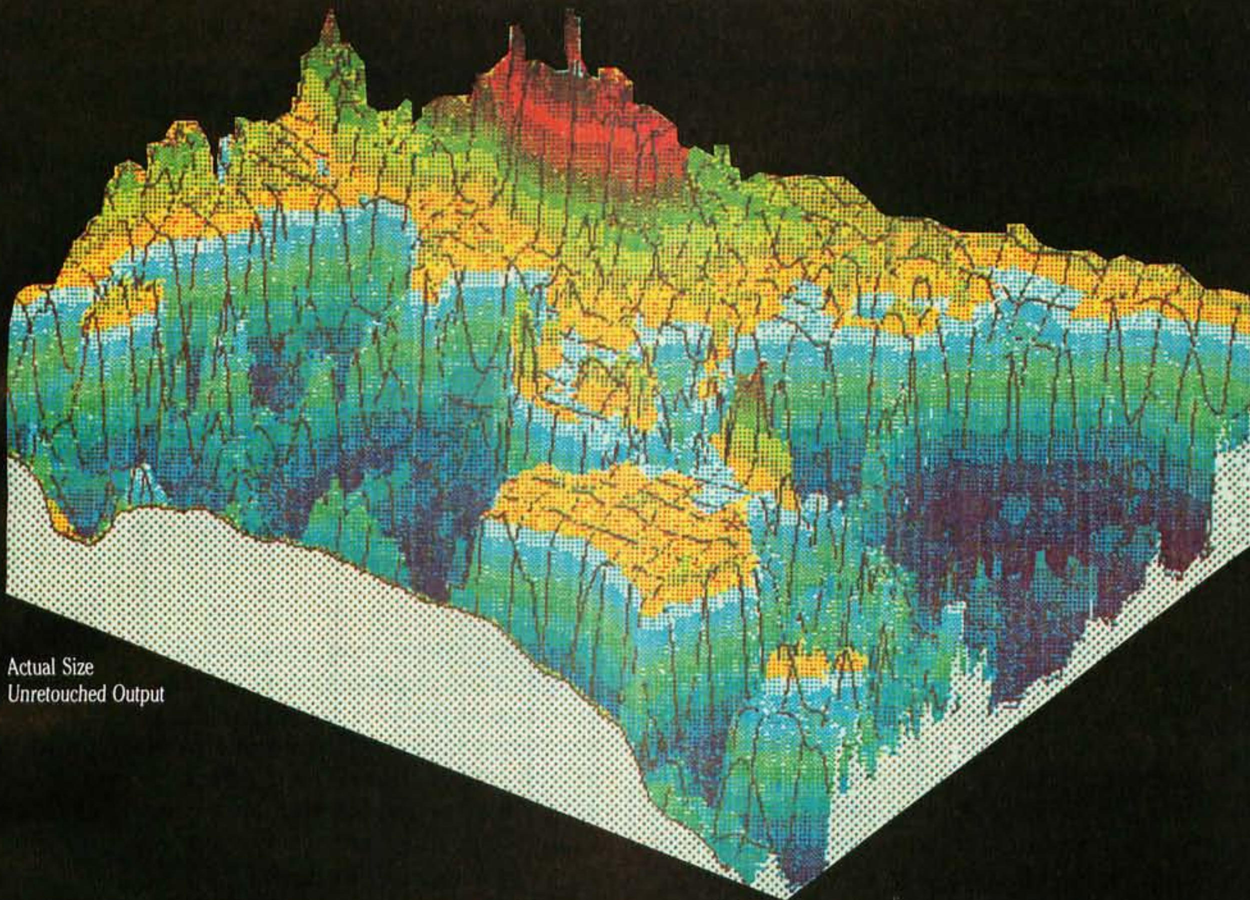
Documentation

The CC 40 is accompanied by a single manual describing the computer and explaining BASIC. About two-thirds of the bulk of the manual is BASIC reference. Several appendixes describe the ASCII code, error messages, the internal structure of the machine (including memory maps), and warranty and service information.

Summary

The redeeming feature of this machine is its low price. Virtually all of its competition vastly outstrips it in power and features. If you don't need portability, TI's own 99/4A home computer will give you much more memory, color graphics, sound, and lots of expansion capability for a mere $99. The CC40's true utility cannot be judged until at least some of the peripherals and software become available. ■

David Ramsey is a programmer in the Concept group at Corvus Systems Inc. (2029 O'Toole Ave., San Jose, CA 95131).



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The Pied Piper Portable Computer

Briefcase styling and low cost in a Z80 machine

by Seth P. Bates

Resembling a small, thin attaché case, the Pied Piper packs 64K bytes of RAM (random-access read/write memory), a single disk drive, and the Perfect Software package into a 12-pound portable computer system for $1299. Because it lacks an internal display device, this lightweight system will cause less muscle strain. To see your work, you must use an external monitor or television set. So although this computer won't do you much good while you're on the road, it delivers a low-cost Z80A system that is easy to move from one location to another.

General Observations

The Semi-Tech Micro (STM) Electronics Corporation designers intended the Pied Piper to be truly portable and immediately usable. The exclusion of the monitor was a decision the machine's designers expected to appeal to those who don't like the thought of carrying the added weight of a video display and its power supply. Even the smaller monitors in the Otrona and the Osborne systems add considerably to the bulk and weight of a computer system. Possibly because of a recent drop in prices of LCDs (liquid-crystal displays), the company plans to offer a 2-line by 80-column display in the near future. Until then, however, an RF modulator provides an inexpensive way to use your television with the computer. You can also plug an 80-column monitor in directly.

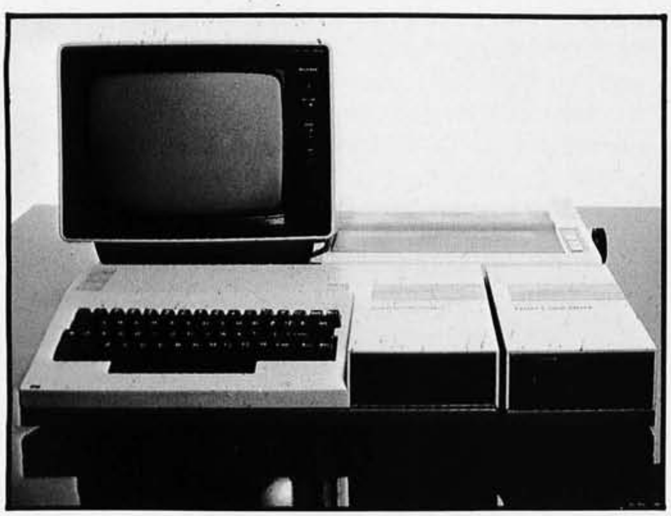

Photo 1: *A prototype Pied Piper portable computer with optional second disk drive, monitor, and printer.*

To further reduce the weight of the system, its designers eliminated a second drive. Instead, a Mitsubishi drive with 784K bytes of formatted capacity is included. With this high density, a single 5¼-inch floppy disk holds Perfect Writer, Perfect Speller, and the Perfect Formatter/Printer software as well as the CP/M command library, with over 400K bytes remaining for user program storage. The single drive increases the time required to transfer files between disks. For example, making a backup copy of the system disk took 8 minutes. One method of avoiding this lengthy procedure is to use the TRANSFER utility when you back up a recently updated text or data file. With this shortcut, a single-disk system works well at home and on the road, but for extended use in the office, a second floppy-disk drive or a hard disk soon becomes a necessity. An additional 784K-byte drive conveniently plugs into a connector on the back panel to provide extra disk capacity.

The company wisely planned for user expansion by including interfaces for both this drive and a hard-disk drive on the motherboard. Two expansion slots will also eventually house serial interfaces and modems. STM offers a serial board and plans to introduce several others, including an integral auto-dial/auto-answer 300-bps modem and dual serial ports on a single board.

The Pied Piper is easier to use than any other computer I know of. Its simple operation, bundled software, and clear documentation make it an ideal first system for business users. The 78-page users manual isn't indexed but includes a thorough table of contents and is logically organized, which makes locating informa-


Photo 2: *The production version of the Pied Piper computer. The indicator lights for power and disk drives were last-minute additions.*

tion a simple task. By writing clearly and from a novice's point of view, the authors present a document particularly suited to the needs of a first-time computer user. The manual contains instructions for starting the Pied Piper and connecting it to a television set or a monitor as well as descriptions of all the major CP/M commands. Guidelines for basic disk usage and file management are also included.

For novices, the *Perfect Software Primer* provides a well-written guide to Perfect Writer, Speller, Filer, and Calc. The primer and its accompanying files not only help you learn about the software but also tell you which of the many lesson files you can safely delete from your working disk. This manual, however, suffers from one fault not shared with the rest of the documentation—it's hard to read. Apparently, the company produced it with a dot-matrix printer on 8½- by 11-inch paper then reduced it to 7 by 9 inches to conform to the dimensions of the other documentation. It's nice to have everything the same size, but I'd rather be able to read the manual.

Problem Solving

The Pied Piper is manufactured for STM in Hong Kong and tested at several points during manufacture and shipping. One test includes dropping the system from nine feet while it's in the carton and dropping it from three feet without the carton. I didn't notice any problems that might have resulted from the testing. But after three hours with a prerelease version of the Pied Piper, I noted several potential problems with the documentation and the system's case. However, in the release version of the machine, every item on my list had been fixed, including a revision of the documentation. The only other problem was some interference with a wireless telephone. After locating the problem in the radio unit, I concluded that the shielding for the Pied Piper may not be adequate for use near those phones.

Although the company believes its testing will eliminate any problem units, it does offer an extended warranty through Xerox Service Centers at $199 per year for those who like a little extra insurance. The service centers promise a 16-hour or two-business-day turnaround on all repair work.

The Perfect Software Package

The four bundled software programs leave me with favorable impressions. Especially impressive were the ease of use, carry-over command structures, and the thorough implementation of the program's features. Only Perfect Filer seemed scant in its features, but it doesn't claim to be a true database system. With its selection of this package of software, STM appears to have correctly addressed the needs of the Pied Piper's intended user. This factor should figure strongly in the machine's success.

Perfect Writer. After two hours I felt comfortable with this package. During that time Jerry Pournelle's comments about word processors that are continuously "nattering" at you seemed appropriate. Perfect Writer uses two lines at the bottom of the screen (called the Mode Line and the Echo Line) to inform you of the status of the system. At least half of this information isn't necessary, the rest of it is essential, and none of it can be altered to fit your particular needs. Most troublesome, however, is that *each time* you press a key, the cursor appears momentarily at the end of the Mode Line. This is very irritating, and the reason for it escapes me. I have learned largely to ignore it, but some users may not adjust to it well at all.

Other aspects of Perfect Writer are more noteworthy. The designers did an excellent job of thinking out the command structure ahead of time. An example is the set of commands for cursor movement. In general, where a Control code is used for local and small-scale movement, equivalent Escape codes are used for larger-scale movements. For example, where Control-P and

Control-N get the previous and next lines, respectively, Escape-P and Escape-N access the beginning of the previous and next paragraphs. An implementation such as this makes it easy to remember most commands.

Perfect Writer, like all of the Perfect packages, is menu driven. If you want to get back to the previous level of menu at any time, the Escape key does the job. Control-Y will "Yank back" the last text alteration. Control-G will "Go back" to before the last unexecuted command (a command in progress); take care not to confuse it with the letter G (Go), which starts an operation selected from a system menu.

Perfect Speller. Proofing with Perfect Speller is fantastic. Words you use frequently can be added to the dictionary, and special dictionaries can be constructed for different projects. Once the program locates misspelled words, it asks you to provide a one-key code indicating whether to mark it for correction, add it to the dictionary, or ignore it. When this is done, you exit directly to Perfect Writer and move through your text to each marked word, correcting your spelling as you go. As yet, Perfect Speller hasn't failed to find a misspelled word.

Perfect Filer. It takes longer to learn Perfect Filer, and some of its advanced features, like reformatting an existing database, require a two-disk system. Still, the program comes with several built-in systems that business users will find immediately useful. As an added bonus the tutorials on modifying existing field and record formats make it simple to develop new databases from the existing ones.

Perfect Calc. While I didn't spend as much time with this program, Perfect Calc appears to include all the major features offered by other spreadsheet packages. The control and command structure remains consistent with the other Perfect programs, reducing learning time. Tutorials in the software manuals assist novices in grasping the basics needed to start using the system. In addition, as with Perfect Writer and Filer, the program disk includes sample files to modify, so you can learn to use the system with a minimum of lost time and effort. Several useful sample spreadsheets are the Family Budget program, the Financial Net Worth program, the Check Register program, and the Individual Tax Return Analysis program.

At a Glance

Name
The Pied Piper I

Manufacturer
STM (Semi-Tech Micro) Electronics Corporation
525 Middlefield Rd., Suite 130
Menlo Park, CA 94025
(415) 326-6226

Price
$1299 (includes software)

Processor
Z80A

Memory
64K bytes of RAM

Storage
5¼-inch floppy-disk drive, 784K bytes

Input/Output
Centronics-style parallel printer port, software-selectable 40- or 80-column display output, video modulator output plug (an external modulator is required), removable power cord

Keyboard
Full-sized—61 keys; 94 printable characters; Escape, Control, Delete, Backspace, and cursor-control keys.

Dimensions
20.2 by 10.8 by 4 inches

Weight
12 lbs.

Software
Perfect Software package including Perfect Writer, Perfect Speller, Perfect Filer, and Perfect Calc; CP/M 2.2; Pied Piper utilities

Documentation
Pied Piper I users manual, 78 pages; **Perfect Software Primer**, 17 pages; Perfect Writer/Speller manual, 380 pages; Perfect Calc manual, 346 pages; Perfect Filer manual, 188 pages

Accessories

External second disk drive (including software):	$550.00
10-megabyte hard-disk drive:	to be announced
Carrying case:	$49.95
Printer interface cable:	$39.95
Monitor stand:	$39.95
Serial interface:	$120.00
RF Modulator (Astec)	$59.95

Conclusion

The Pied Piper offers real business features at toy prices. Although a few of its features might have been designed differently, as with any machine, STM offers a good system for the money. Models II and III are already in the works, and one of them is a 16-bit machine. These additions to the line, along with the promise of the 2-line LCD option, make the Pied Piper's future look bright. ■

Seth P. Bates is assistant professor in the Division of Technology at San Jose State University (San Jose, CA 95192) and president of Teknos, a small firm that does systems integration.

The Pied Piper uses its own disk format. Software in this format is available from selected distributors. Currently available are MBASIC, Pascal, FORTRAN, dBASE II, FPL, Bottom-line Strategist, Wordstar, Condor, T-Maker III, Supercalc, and the American Training Institute training packages.

The Kaypro II

Dependable hardware and extensive software make this affordable portable a winning package

by Roger Fager and John Bohr

One industry pundit insists that for a microcomputer system to be successful, it need only be *adequate*—which is to say complete, reliable, standard, and inexpensive. The Kaypro II from Non-Linear Systems epitomizes these homely virtues.

A complete system encased in aluminum, the Kaypro II contains a single-board computer, two 5¼-inch floppy disks, and a 9-inch (diagonal) green-phosphor video screen that displays 24 lines of 80 characters. A 6-foot coiled cord hooks a high-quality, 76-key detach-

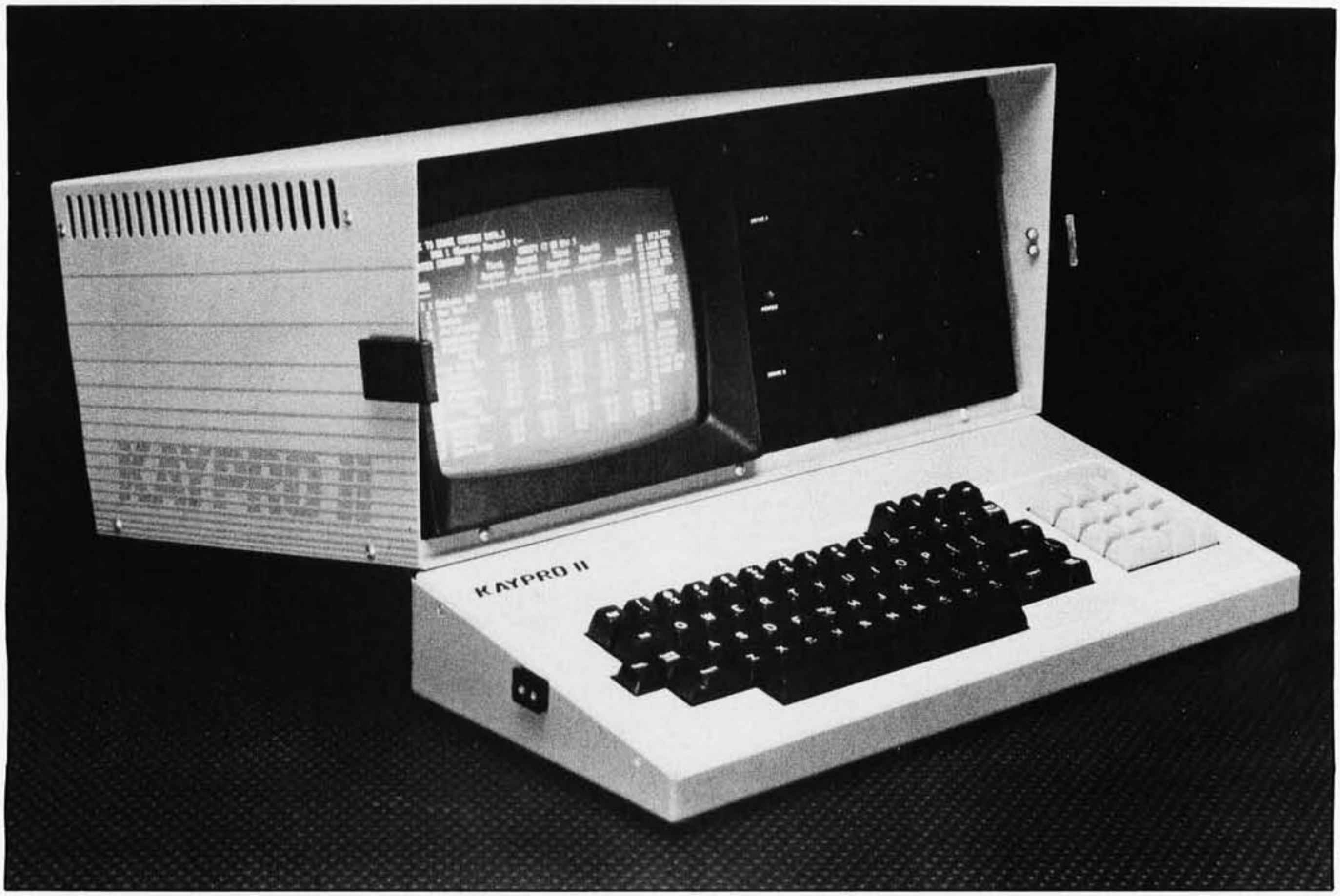

Photo 1: *The Kaypro II portable computer.*

able keyboard to the Kaypro's chassis. It uses a Z80 microprocessor running at 2.5 MHz and has 64K bytes of RAM (random-access read/write memory) plus an RS-232C serial port and a Centronics-compatible parallel printer interface.

The Kaypro II comes bundled with extensive software, including CP/M 2.2 and the Perfect Software series: Perfect Writer (a word processor), Perfect Filer (a database program), Perfect Calc (an electronic spreadsheet), and Perfect Speller (a spelling checker). In addition, the manufacturer supplies Profit Plan (a simplified spreadsheet) and two forms of BASIC: S-BASIC, which is structured, compiled BASIC, and MBASIC, the de facto standard, interpreted BASIC. To round out the software package, Kaypro II includes The Word Plus (a powerful spelling checker) and several game programs.

Hardware

On examining the machine we immediately noticed that the Kaypro II's hardware is solid and obviously designed for transport. When you want to move the Kaypro II, the keyboard snaps onto the case to form an 18- by 15½- by 8-inch suitcase that weighs 26 lbs. Heavy-gauge aluminum surrounds and shields the keyboard and the main chassis.

Inside the case, Non-Linear Systems' test-equipment expertise is readily apparent. The major subsections are firmly mounted to the case, far apart from each other. Not only does isolating components provide space for air circulation and heat removal, it also makes all the major components readily accessible for examination and repair.

The layout of the main circuit board (see photo 2), suggests that the system was designed as four subsections. The main computer subsection consists of the Z80 microprocessor, the ROM (read-only memory) chips, and 64K bytes of dynamic memory. The floppy-disk-control subsection consists of a 1791 disk controller and TTL (transistor-transistor logic) support chips. The I/O (input-output) subsection includes two Z80 PIOs (parallel input/output devices), a Z80 SIO/0 (serial input/output device), TTL buffers, and connectors. The final subsection is the digital part of the video generation system: 2K bytes of static RAM for screen memory and a character-generator ROM. The chips are socketed and easy to get at.

Surprisingly, the system clock rate is only 2.5 MHz (a rate of 4 or 6 MHz is possible with a Z80A or Z80B and corresponding support chips). At least one other potential hasn't been tapped: each of the PIO chips can support an additional 8-bit parallel port. This means that with existing hardware the Kaypro II could easily drive an IEEE-488 port to supplement the parallel and serial ports already available. The IEEE port could be im-

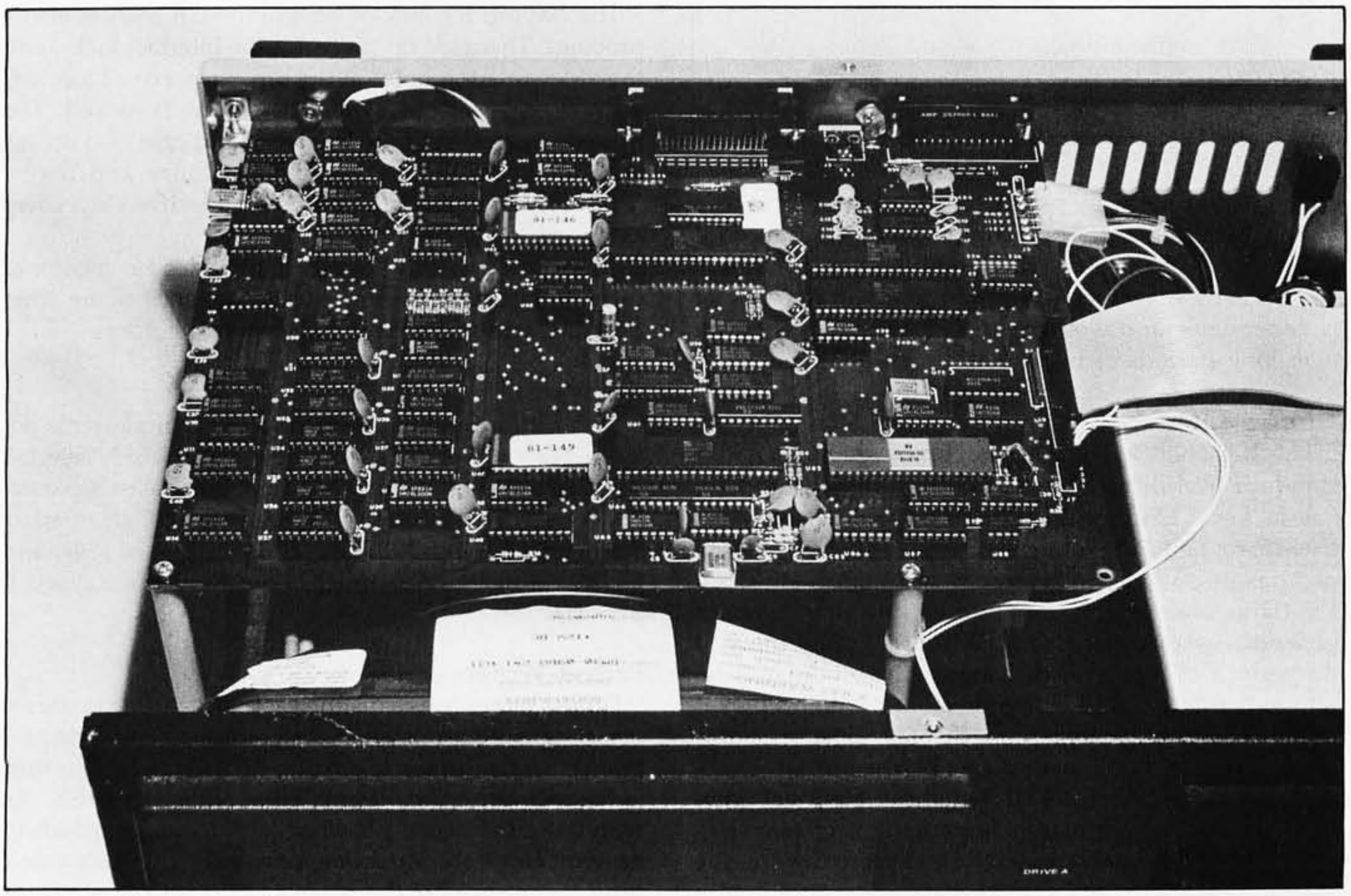

Photo 2: *The main printed-circuit board of the Kaypro II.*

At a Glance

Name: Kaypro II

Manufacturer
Kaypro Division
Non-Linear Systems Inc.
533 Stevens Ave.
Solana Beach, CA 92075
(619) 755-1134

Dimensions
Folds to an 18- by 8- by 15½-inch suitcase-like metal box with a handle; weighs 26 pounds

Components
A Zilog Z80 microprocessor running at 2.5 MHz; 64K bytes of dynamic RAM and 2K bytes of screen memory; an 80-column by 24-line green-phosphor display with brightness control; a selectric-style keyboard with numeric keypad; two single-sided, double-density 5¼-inch drives, each with a capacity of 193K bytes (formatted); RS-232C serial and Centronics-compatible parallel ports

Software
CP/M 2.2; the Perfect Software family: Perfect Writer (word processor), Perfect Files (database), Perfect Calc (spreadsheet), Perfect Speller (spelling checker), tutorial disks; The Word Plus (Spelling checker); Profitplan (spreadsheet); MBASIC (interpreted BASIC with Games); S-BASIC (structured, compiled BASIC); system utilities.

Documentation
System manual; standard CP/M manual; Perfect Software manuals; The Word Plus and Profitplan manuals; S-BASIC and MBASIC manuals (language descriptions)

Price
$1595

Options
Vinyl and nylon cases

plemented by software routines to do the timing for the various control lines. This would enable the Kaypro II to interface directly with intelligent test equipment.

Despite those two missed opportunities, the computer is dependable and well laid out and runs coolly even over long periods of use.

Human Interface

The detached keyboard has contoured keys and a standard IBM Selectric layout supplemented by these special keys: ESC, CTRL, Line Feed, Tab, Caps Lock, Backspace, DEL, and four cursor keys. The numeric keypad has its own period, comma, and Return keys. An LSI (large-scale integration) chip within the keyboard generates serial signals, which are communicated through a 6-foot coiled cord with modular telephone-handset-style RJ12 connectors on both ends.

The 9-inch green-phosphor display gives a sharp, stable image in an 80-character by 24-line format. In addition to the ordinary ASCII (American National Standard Code for Information Interchange) characters—upper- and lowercase, numerals, and punctuation—the Kaypro II displays the Greek alphabet. The only graphics available are simple character graphics.

Storage

The Kaypro II comes with two double-density single-sided disk drives, each of which provides 193K bytes of storage (see the text box on "The Kaypro 4 and the Kaypro 10" for other configurations). The floppy-disk drives can read and write disks in Xerox 820 format; therefore most CP/M software is available to the Kaypro owner. Software is now available from Kaypro to read other 5¼-inch disk formats (including those of the Osborne 1 and Radio Shack Model I).

Hardware Hardships

A machine of this weight needs a comfortable handle; however, the Kaypro's handle will cut two parallel grooves into your hand if you carry the system for more than a short time. A well-designed, padded handle would be a considerable improvement.

Perfect Writer's multibuffer memory architecture allows you to edit as many as seven documents at one time, transferring sentences or paragraphs between them.

The Kaypro II's lack of environmental seals is also a problem. There are no covers for the interface jacks, and the air circulation holes at the top can serve all too well as inlet ports for rain when the system is moved. The unsealed junction of the keyboard and case also invites contaminants into the keyboard circuitry and floppy disks. (The manufacturer offers a protective vinyl cover as an extra-cost option.)

Unfortunately, the Kaypro II provides no means to carry its software treasure. For convenience, some other portable computers have integral disk holders.

Software

Non-Linear Systems, aware that the typical user is not a computer professional or hobbyist, has wisely selected a package of user-friendly software. Purchased separately, Perfect Writer, Perfect Filer, Perfect Calc, Perfect Speller, Profitplan, MBASIC, S-BASIC, Word Plus, and CP/M 2.2 would cost much more than the Kaypro II package.

Perfect Writer

Perfect Writer uses a distinctive command structure for inserting, editing, deleting, and replacing text. The program is similar to the text editor MINCE, which in turn is based upon a mainframe editor called EMACS. As with these forebears, not all of your document needs to be in memory; the virtual memory technique uses a disk *swap* file to extend the size of a document up to or beyond 64K bytes' worth of characters. Another im-

The Kaypro 4 and the Kaypro 10

by Arthur A. Little

Time waits for no man and certainly for no microcomputer reviewer. Since this review was completed, Non-Linear Systems has revamped its product line for 1983 with two new system configurations (the Kaypro 4 and Kaypro 10), new software offerings, and a different pricing structure. The now "venerable" Kaypro II is quite a bargain because NLS recently dropped its suggested retail price to $1595, a $200 reduction.

The Kaypro 4 is essentially an upgrade of the earlier model. Like its forebear, the Kaypro II, the Kaypro 4 is a portable, CP/M-based system with 64K bytes of RAM and two double-density floppy disk drives. The three major differences are that (1) it has double-sided disk drives (each offers 380K bytes of storage), (2) it is packaged in a dark gray case, and (3) it costs $1995. A minor, if inexplicable difference, is in the product name. NLS has shifted from using roman numerals (e.g., II) to arabic numerals (e.g., 4)—a change not without historic precedent.

The big news is the Kaypro 10, which incorporates an internal 10-megabyte hard disk as well as one double-sided, double-density, half-height floppy-disk drive (380K bytes of storage). The Kaypro 10 itself is an upgrade of the Kaypro 5, a 5-megabyte hard-disk portable shown in 1982 but never produced in quantity. The Kaypro 10, including software, will put you back only $2795.

First, let's look at the hard disk. The physical 10-megabyte disk is divided into two logical devices of 5 megabytes each, called drives A and B. The 5¼-inch floppy-disk drive is drive C. Drives A and B are each subdivided into 16 user areas (i.e., A0, A1, . . . A15 and B0, B1,...B15). As delivered from Kaypro, the unit has the following files recorded on the hard disk:

User 0: Kaypro and CP/M utility programs
User 1: Perfect Writer word-processing program
User 2: Profitplan electronic spreadsheet
User 3: Perfect Calc electronic spreadsheet
User 4: Perfect Filer/Individual Member Data Base
User 5: Perfect Filer/Organizational Member Data Base
User 6: S-BASIC
User 7: MBASIC and Games

You can add or delete files to suit your needs as long as you stay within the 5-megabyte limit per logical drive. Note that user areas do not have predefined storage limits—each user area takes from the 5-megabyte common pool.

One file, SAFETY.COM, is hard-disk-specific. Before ending a session with the Kaypro 10, run the SAFETY program. This utility moves the hard disk's read/write heads to an unused area of the hard disk prior to powerdown. Therefore, even if the heads were to hit the surface of the hard disk, no damage would occur to an area on which data was stored. Running this program is a must *for those who will be taking the Kaypro 10 out into the real world and a* should *for the rest of us. (It would have been nice if this procedure had been incorporated into an automatic shutdown process.)*

Aside from the single drive, the exterior of the Kaypro 10 looks much like its predecessors, especially the Kaypro 4. Both systems share the same no-nonsense, gunmetal-gray cabinet and all-black keyboard. One welcome addition is an integral wire stand for the front of the unit that tilts the display up to a comfortable viewing angle. Also, the carrying handle has been redesigned to be more compact. Because of the hard disk, the designers included a fan for cooling the interior components. The whole system weighs 31 pounds, as compared with 26 pounds for the Kaypro 4.

The back panel shows evidence of some changes also: the power cord is removable, there are connectors for one parallel port and two serial ports (one printer and one modem), there is a jack for a light pen, the brightness control has been moved to the back, and the Reset button has been moved to a more accessible location.

In addition to the 80- by 25-character display, the Kaypro 10 has these graphics capabilities: draw/erase a line, draw/erase a pixel, inverse video, half-intensity, blinking, graphics characters (2- by 4-pixel matrix), cursor positioning, and cursor on/off. The display is treated as a matrix 100 pixels high by 160 pixels wide. S-BASIC has special commands that draw geometric figures such as circles, rectangles, squares, and bars.

Non-Linear Systems includes a prodigious amount of applications software with each system. In addition to all of the programs supplied with the Kaypro II, the firm is offering Wordstar as an option to the Perfect Writer program. There is also a new utility that will read and write disks in the formats of several other popular computer systems—at the moment, it can transfer data to and from the Osborne 1, the Xerox 820/II, and the TRS-80 Model I. There is reason to believe that another 10 or more formats are on the horizon.

Arthur A. Little is a technical editor for BYTE.

pressive feature is multibuffer memory architecture, which allows you to edit as many as seven documents at a time, transferring sentences or paragraphs between them. A split-screen feature allows any two documents to be viewed simultaneously.

The documentation for Perfect Writer is excellent. The manual leads you through the program's capabilities one step at a time, always building on previous knowledge. The editing routines are presented in tutorial form with illustrations of the commands (such as CTRL and ESC key sequences), and there are abundant examples of edited documents.

Although the documentation is helpful, the program itself is annoyingly unforgiving of mistakes. Perfect Writer may terminate suddenly if you type in a wrong control code, wiping out your newly created document. The "delete sentence" command will hang up the system if there are no more periods in the file, which could occur when you edit toward the end of your document. Perfect Software is aware of the problem, and later revisions should eliminate this problem—an example of practice making perfect, no doubt.

Perfect Filer

Perfect Filer enables you to create a database record as long as 1024 characters, enter data under cursor-key

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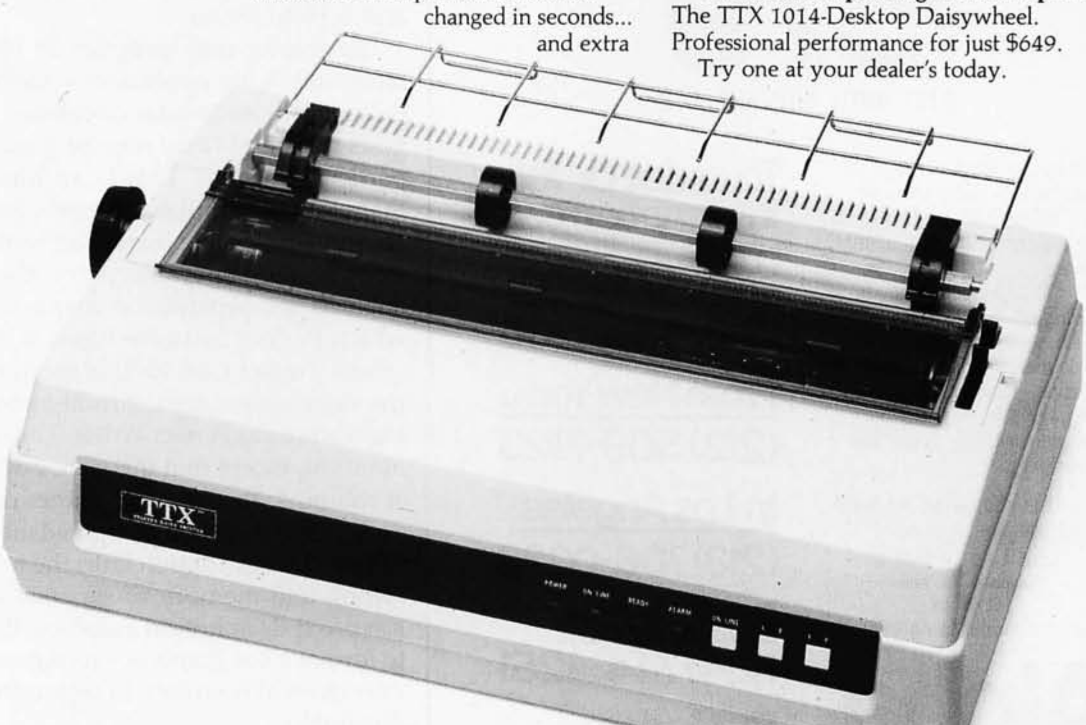

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control, use up to five sort keys, and print out any subset of your stored records in form letters, mailing lists, or specialized forms. You can also change the format of a database without losing your data. Because Perfect Filer is fully menu-driven, you don't have to be a programmer to handle these rather sophisticated tasks.

As examples of how to construct your own file managers, two predefined database templates accompany Perfect Filer: an individual member mailing list (name/address/phone/busphone/organization) and an organizational mailing list (org/address/phone/contact/comment).

Another uncomplicated menu-driven subprogram enables you to define a subset for search (for example: all New York names entered after November 1982). The results of the search can be output to the display, printer, or disk file for use in Perfect Writer.

The Perfect Software programs share commands, facilitating crossover learning from one application to the next.

Perfect Calc

The electronic spreadsheet, Perfect Calc, displays an entry window of 8 columns by 24 rows on a 52- column by 255-row worksheet. Perfect Calc features cursor-key directed movement, instant recalculation of formulas, and a Help menu.

The master disk supplies 29 formatted spreadsheet templates with applications varying from checkbook balancing to income-tax calculation. The users guide suggests that they "may require modification to meet your particular needs." This is an understatement because many of the templates contain bugs. For example, the accounts-receivable worksheet formulas call for variables from accounts-payable entry sheets, and the Payroll analysis set depends on a spreadsheet, "payfacts.pc," which Perfect Software has not included.

Still, Perfect Calc itself is comfortably bug free. It has the same split-screen, virtual-memory, multibuffer editing features as Perfect Writer. The control commands are identical, except that there are extensions for the editing of columns. You can pass entries or blocks of entries between any number of spreadsheets, and a powerful "associate files" option links the formula calculation and calling into memory of separate sheets. Although the Kaypro II does not do graphics, Perfect Calc allows you to format a bar graph as varying strings of asterisks. The user manual is written in jargon-free English and is well illustrated.

The biggest disappointment is the lack of communication between the Calc and Filer programs. If you need totals in Perfect Filer, which does not perform arithmetic, you have to transfer the numbers individually to a Calc file using split-screen editing, then key the totals back by hand.

The Perfect programs in the Kaypro II package were

designed as an integrated package and share command structures, format, and an overall functionality. This means that there is considerable crossover learning from one program to the next—a boon to users. Perfect Software is not perfect, but considering the price, portability, and commitment to improvement, it is very good indeed.

Profitplan

Kaypro also includes Profitplan from Chang Laboratories. This spreadsheet program is appropriate for simple applications: data and formula entry are fairly straightforward, but once you make a "what if" projection, you can't restore your original spreadsheet.

The Word Plus

Although Perfect Speller is still included in the Kaypro II software package, it has been largely superseded by The Word Plus from Oasis Systems. The Word Plus lists words it doesn't recognize and asks whether they need correction. It can display the words in context and will generate a list of likely corrections at your request. Next, it automatically makes the corrections in your text and writes an updated file to disk. The program will even "learn" new words and add them to its dictionary for future use.

Furthermore, The Word Plus displays total word count, frequency of occurrence, homonyms (such as *colonel* and *kernel*), anagrams (*debug* and *budge*), and lists of rhymes. It also assists in solving crossword puzzles and playing Scrabble. These word-puzzle routines are so intriguing and so much fun that The Word Plus may interfere with your time management; sooner or later you will lose a whole morning playing with them.

The 45,000 words of the main dictionary were selected on the basis of frequency of occurrence and frequency of misspelling and were checked for accuracy by proofreaders and by existing lexical programs. In addition, you can create specialized dictionaries (e.g., legal, medical or scientific terminology) and specify them at run time.

Because the S-BASIC manual lacks illustrations of actual code, it takes some trial and error to type certain S-BASIC statements in a way that pleases the compiler.

Down to BASICs

MBASIC from Microsoft is so widespread within the microcomputer world that we need only say that this interpreted BASIC works as expected and makes a huge software base available to the Kaypro owner.

The S-BASIC compiler is an interesting mixture of BASIC syntax and Pascal control structures. BASIC programmers may find little need to change their programming methods except that variables must be declared. (However, if they want to write more readable, debug-

gable, and maintainable code, the means are there.)

S-BASIC offers good internal documentation with its variety of commenting structures. Variables can be declared and documented on the same line, and COMMENT. . .END allows a whole block of comment lines to be entered. S-BASIC supports interactive programming with an assortment of INPUT statements, and a single instruction outputs an entire block of display lines. Its "advanced structured techniques" show a strong similarity to Pascal: WHILE. . .DO; REPEAT. . . UNTIL. . .; CASE. . .OF. . .END; as well as procedures and functions which allow parameter passing and recursion.

Boolean variables are fully implemented although there is not a separate boolean type. A statement such as FLAG = (X < Y) will work whether FLAG is declared as integer, real number, or string. In the latter case, a string that begins with "Y," "y," "T," or "t" is evaluated as true. You might use the variable in a routine similar to the following:

```
INPUT1 "DO YOU WANT DOUBLE WIDTH
  PRINTING"; FLAG
IF FLAG THEN DOUBLE.WIDTH
```

S-BASIC aims to be a tool for the experienced programmer of structured languages, improving on Pascal by adding string variables and random-access file I/O and dispensing with its tedious punctuation (a = b replaces a : = b;). It does not have Pascal's power in describing data types, however. There are no pointer variables, sets, records, or scalar subrange variables.

Parameters in a procedure are used somewhat differently. First, all parameters are of the pass-by-value type. In other words, none of the arguments of a function or procedure can be altered by it. While this may not meet the approval of Pascal purists, I feel that the resulting independence of modules is an aid to program structure. S-BASIC handles the problem of a multivalue function by using global variables. Remember that microcomputer programming is not a likely environment for a major team software project. The clarity of a program that will take up only 60K bytes of memory is not going to suffer from a few extra global variables. Furthermore, arrays are not allowed as parameters. Also, a parameter declaration is not permitted to have the same name as a global variable or as a variable local to another procedure.

Software Problems

The current S-BASIC manual, although an improvement over the original, does not have sufficient illustrations of actual code, so it takes a certain amount of trial and error to type some of the statements in a way that pleases the compiler. The following statement, which is meant to call up the execution of a separately compiled program, is an example:

```
chain "b:program com"
```

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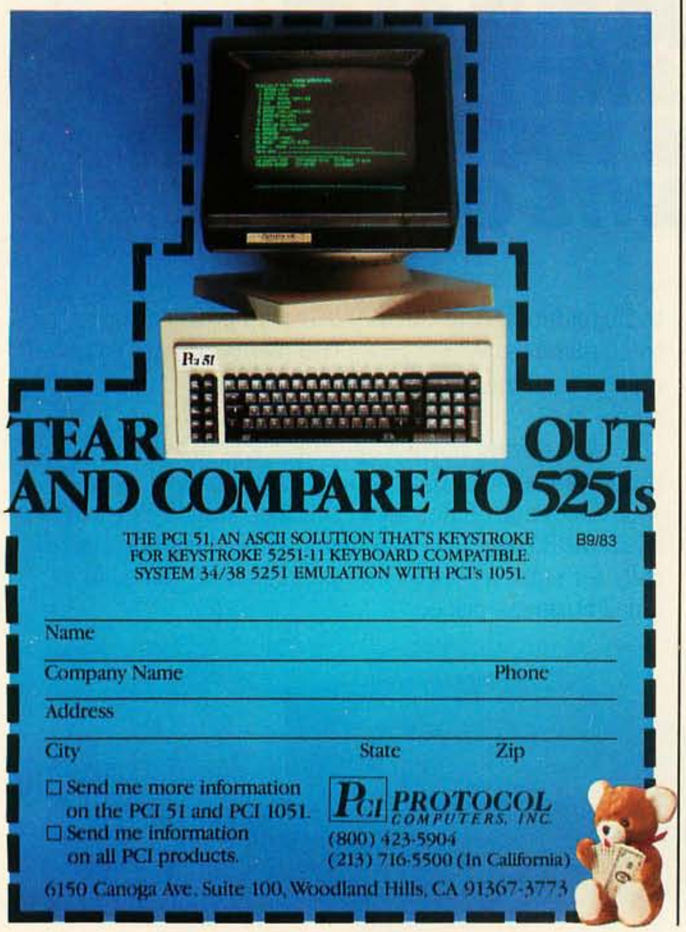

This statement produces run-time errors until you discover that the file name must be typed in uppercase letters. The manual does not make this clear.

Another problem is a statement with more than 65 characters. The compiler uses a linefeed as the delimiter of a program statement, and neither the manual nor the Kaypro II users guide hints that specifying Perfect Writer's "normal" mode is the way to turn off word wrap.

Compiler error messages are noticeably weak. For example, "$$$$$$$ Cannot process this / Statement error" is the only message covering a large class of syntactical errors in REPEAT, WHILE, ELSE, and CASE statements. Incredibly, S-BASIC has no test for an end-of-file condition. Thus, a program will crash unless you take the trouble to define a counter field that you increment when you write a new record. 'Modulo' and 'odd' functions have been omitted for the sake of economy, leaving the programmer to grapple with integer-division expressions.

Aside from these rough edges, writing structured code was easy and natural. With improvements, S-BASIC could be highly suitable for introducing microcomputer users to the advantages of structured programming.

The Company

When you are buying a computer, your scrutiny should not end with the hardware, software, and documentation. The company matters, too. Non-Linear Systems has been around for a long time. In the 1950s the company president, Andrew Kay, invented the digital voltmeter, and Non-Linear has been a major supplier of portable test equipment for the last 30 years. His son, David Kay, is product manager for the Kaypro line. They seem genuinely committed to customer service and are well organized for it. As part of this customer support, Non-Linear Systems publishers *Pro-Files*, a Kaypro users magazine. *Pro-Files* is available free for one year to Kaypro owners.

Conclusion

If Kaypro II is the answer, then the question might be, "What is the best value in a practical portable computer?" Though it has some limitations, the Kaypro II is both good and affordable. For $1595 you get an extensive software package with high-quality documentation, standard hardware that works all the time, a fine keyboard, an 80-character display, standard interfaces, and good floppy-disk drives. That's what we call "best value."■

Editor's Note: *Shortly after this review was written, Non-Linear Systems announced that it has changed its corporate name to Kaypro Corporation. Non-Linear Systems will become a division of the parent company.*

Roger Fager is associate professor in the Physiology Department at the University of Virginia School of Medicine in Charlottesville.

John Bohr has a degree in mathematics and is a part-time computer science student.

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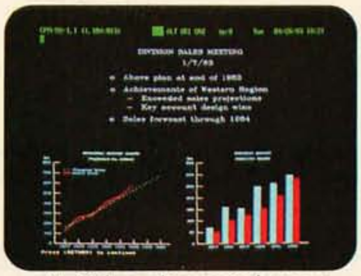

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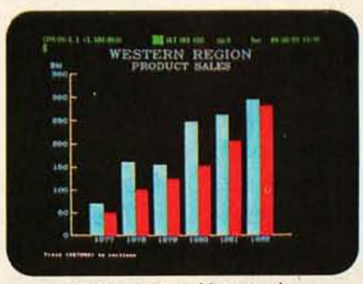

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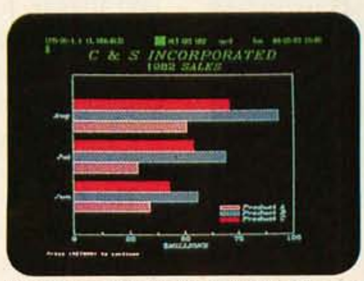

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The Corona Portable PC

A new portable IBM PC-compatible computer with an eye-catching display

by Rich Malloy

If you've attended any of the recent computer trade shows, you've probably seen a reasonably priced portable computer that rapidly flashes a series of eye-catching pictures across a very high contrast green display screen. This machine, the Corona Portable PC (photo 1), along with its sister desktop version, the Corona PC, offers stiff competition to the numerous machines compatible with the IBM Personal Computer.

Corona Data Systems, the manufacturer of the new systems, is one of the several start-up companies spawned by the IBM PC. It was founded two years ago by Dr. Robert Harp, who a few years earlier had been the founding wizard of Vector Graphic. Before announcing its new line of IBM-compatible systems, the new company was known primarily for its hard-disk drives.

The two Corona machines are very similar. The portable has an 8088 microprocessor, 128K bytes of memory, one or two half-height double-density double-sided floppy-disk drives (storing 320K bytes each), a 9-inch high-contrast green monochrome display screen with graphics capabilities, a serial port, a parallel printer port, four IBM-compatible expansion slots, and a fairly sizable bundle of software: Microsoft's MS-DOS operating system and GW-BASIC language, Softword Systems' Multimate (a word-processing program), and PC Tutor, a program to teach you how the system works. The price for all this is $2945 for the two-disk-drive model (the one-disk-drive model is $400 less). The computer weighs 28 pounds and measures 9.6 inches high by 18.8 inches wide by 19.8 inches long.

Photo 1: *The Corona Portable PC, a portable IBM PC clone with a high-contrast display.*

The desktop machine (photo 2) has everything the portable has except that it has a 12-inch screen instead of a 9-inch screen. It will use standard-height disk drives until more half-height drives become available. The two-drive desktop model sells for $2995. The one-drive unit is $400 less.

Because the machines are so similar, it is hard to talk about one without discussing the other. But in keeping with the theme of this issue of BYTE, I'll restrict my observations to the portable version. Bear in mind, though, that most comments apply equally to both models.

Compatibility

The first thing to think about when considering an IBM-compatible computer is, "How compatible is it?" Despite many manufacturers' claims, it is very difficult, and illegal, to produce an exact copy of the IBM Personal Computer. For the machine to be legal, at least some of its parts have to be different (for instance, the copyright notice). It is essential to find out that the software (or expansion hardware) you need will run on the machine you are interested in.

The Corona portable comes with the MS-DOS operating system (essentially the same as IBM's PC-DOS), and Digital Research's CP/M-86 is offered as an option. Any program that is written for MS-DOS or CP/M-86 should run on the Corona. Any program, however, that accesses IBM's proprietary ROM (read-only memory) routines to drive the display and keyboard may not run on the Corona or most of the other IBM Personal Computer clones. The best way to test this, of course, is to try to run your favorite IBM Personal Computer program on the Corona.

For this Product Description I did not have time to do an exhaustive test of the software written for the IBM Personal Computer, but I was able to test one of my favorites, Peachtree Software's Peachtext, configured for the IBM PC, at the spring Comdex show in Atlanta.

After watching an MS-DOS program called PC Tutor running on the Corona, I discreetly asked if I could try to run a Peachtext disk that was in my pocket. The people at the Corona booth hemmed and hawed a bit, but they finally led me to a desktop version of the machine off in the corner where no one would see it should it fail. Their hesitancy was unnecessary. The disk booted up without a problem, and a few keystrokes later Peachtext was processing a text file.

This was, of course, far from an acid test of compatibility, which will have to wait for a future issue of BYTE. But it is a test I highly recommend: take a program you like and see if it actually works before you buy.

Video Display

As mentioned earlier, the most eye-catching feature of the Corona is its green monochrome video display. It has an extremely high contrast, which seems to reduce eyestrain. Photographs may not capture its clarity, so I recommend you visit your local computer store to have a look.

The screen, which also has graphics capabilities, can display 25 lines of 80 characters. According to Corona Data Systems, each character is formed on a 16- by 13-pixel (picture element) grid. That's 16 pixels wide, not high! The horizontal size of the pixels is presumably half that of the vertical size. If you consider that there are 80 characters per line and 16 horizontal pixels per character, the effective horizontal resolution is an incredible 1280 pixels!

Like the IBM Personal Computer, the Corona Portable PC supports two levels of intensity for each character. It also supports reverse-video characters, underlining, and blinking.

Graphics

The aforementioned high-contrast screen is coupled with high-resolution graphics capabilities (640 by 325 pixels). Unfortunately, this is not the same format as the IBM color/graphics display-adapter board (640 by 200 pixels). But the IBM color/graphics board can be plugged into one of the expansion slots, thus giving the Corona more compatibility with programs such as Lotus Development's 1-2-3.

The Corona graphics format is supported by an extra set of BASIC commands in its GW-BASIC interpreter. It should also be supported by the GSX graphics interpreter that can be attached to CP/M-86. GSX (Digital Research's Graphics System Extension) promises to give its users a layer of compatibility in graphics, the same way CP/M gave us a layer of compatibility for general 8-bit software (see reference 2). When CP/M-86/GSX software becomes available, the Corona should be able to run it.

Two other nice features of the Corona are that graphic images can be placed anywhere on the screen, regardless of text-character placement. And graphics information can be placed anywhere in memory. This allows for the quickly changing pictures I mentioned at the beginning of this article.

Keyboard

The Corona Portable PC, like many of the new personal computers, uses an IBM-like keyboard from Key Tronic (see reference 1). This keyboard has a layout similar to that of the IBM Personal Computer, but has an indicator light for the Caps Lock and Num (numeric) Lock keys. It also has a much lighter "feel" for each keystroke and it does not make a loud click as the IBM unit does.

Key Tronic makes two versions of its keyboard. On one, the layout of the keys is exactly the same as that of the IBM. On the other, the keys are arranged in a more traditional layout; that is, the left Shift key is to the immediate left of Z, and the Return (or Enter) key is just to the right of the quotation marks key. These positions are more in line with other keyboards used in the United States.

Corona Data Systems originally offered the exact IBM key layout, but recently it decided to offer the more traditional keyboard because many users had requested it. This is a prime example of the adaptability of smaller companies. I wish IBM could display similar flexibility in its choice of components.

Durability

A prime factor in the selection of a portable computer

Photo 2: *The Corona PC, the desktop version of the Corona portable. The unit shown here has half-height floppy-disk drives, but most units will be shipped with regular-height drives.*

is its ability to survive travel. The unit used at the Comdex show offered evidence of the Corona's ruggedness.

The Corona prototype I saw had been subjected to some rough handling on an airplane flight, enough to break off the front panel. Another prototype was not available, so the broken one had to be used. During the show, the front panel had to be propped up against the machine. But despite what must have been a fairly severe blow, the prototype still worked. Let's hope the mass-produced versions fare as well.

Multimate

Multimate, the word-processing program that comes with the machine, is somewhat similar to the software Wang Laboratories uses on its dedicated word processors. Developed by Softword Systems of East Hartford, Connecticut, Multimate is fairly powerful and has the ability to merge letter files with address files.

Options

One of the options for the Corona Portable PC is Corona's hard-disk drive, which was developed for the IBM Personal Computer. A 10-megabyte hard disk in its own case will sell for $2695.

Up to 512K bytes of memory can be placed on the main circuit board. The standard unit contains 128K bytes, with each additional 128K bytes costing $295.

The four expansion slots on the Corona are not needed to produce a minimal working configuration. The main board of the Corona already includes the video-display interface, the disk-drive interface, serial and parallel ports, and a large amount of memory. Thus, the four slots are left open for cards that will actually expand the system. According to Corona, any IBM Personal Computer card should work. Again, a thorough test of this will have to wait.

Possible Shortcomings

One possible shortcoming of the Corona is its lack of a spreadsheet calculator program in its bundle of software. Such programs have proven to be very popular, and some potential customers may be put off by the requirement of having to buy a spreadsheet separately. Also, some popular programs such as Lotus's 1-2-3 may not be compatible with the Corona's graphics format. You will have to purchase IBM's color/graphics adapter board and a monitor, or wait for a Corona-graphics-compatible version to come out.

Comparisons

Simply speaking, the Corona is an IBM Personal Computer clone, and it is very tempting to compare the copy with the original. If we make the assumption that the quality is equivalent (which may or may not be valid), the pricing offers an interesting comparison. The two-disk-drive version of the Corona costs $2945. An equivalent IBM configuration costs $3800—$2100 for the basic one-drive unit plus $500 for the second drive, $250 for the graphics board, $200 for a monochrome monitor, $120 for the printer port, $120 for the serial port, $170 for an extra 64K bytes of memory, $300 for a word-processing program, and $40 for the operating systems. Even the Compaq portable IBM clone, with a similar configuration, would run about $3900.

Summary

The biggest selling point of the Corona is its fine display. It's a good machine with an attractive price. If you need a general word-processing machine with a keyboard that's easy to get used to and a screen that's easy on your eyes, then the Corona may be for you.■

At a Glance

Name
The Corona Portable PC

Manufacturer
Corona Data Systems
31324 Via Colinas, Suite 110
Westlake Village, CA 91361
(800) 621-6746

Size
19.8 inches long by 18.8 inches wide by 9.6 inches high

Weight
28 pounds

Hardware
8088, 16-bit processor; 128K bytes to 512K bytes of memory; 9-inch green phosphor display, 80 by 25 characters, reverse video, underline, blinking, high-intensity, 640 by 325 pixels; Key Tronic keyboard with modified IBM-PC key layout; mass storage: 1 or 2 half-height floppy-disk drives, 320K bytes each; interfaces: RS-232C serial port, Centronics parallel printer port; expansion: four IBM-PC compatible expansion slots

Software
MS-DOS operating system, GW BASIC interpreter, Multimate word processor, PC Tutor

Options
Extra memory, 128K-byte modules, $295 each; second floppy-disk drive, $450; hard-disk drive, 10 megabytes, $2695

Documentation
Four 3-ring binders, 8½- by 5½-inch pages, User's Guide, MS-DOS Reference Manual, Microsoft BASIC Manual, and Multimate Manual

Price
PPC-1 (one floppy disk), $2545
PPC-2 (two floppy disks), $2945

References

1. Glasco, David B. and Murray Sargent III. "Using IBM's Marvelous Keyboard." BYTE, May 1983, page 402.
2. Langhorst, Fred E. and Thomas B. Clarkson III. "Realizing Graphics Standards for Microcomputers." BYTE, February 1983, page 256.

Rich Malloy is a senior technical editor of BYTE.

A Report on the Consumer Electronics Show

A bird's-eye view of the latest offerings

by Phil Lemmons

A single event dominated the Consumer Electronics Show held in Chicago: the introduction of the Adam, Coleco's personal computer (see the photo above). Just as the Osborne computer once revolutionized the personal-computing marketplace by bundling applications software, languages, and all the basic hardware except a printer for $1795, Coleco now offers a computer system with more standard features than seem possible for $599.

The Adam personal computer contains a Zilog Z80 microprocessor with 80K bytes of RAM and a word processor in ROM. A full-sized keyboard has a diamond-shaped cursor pad, function keys, and built-in numeric pads on the two standard game controller units. According to Coleco, a 512K-byte digital data pack system will rival the transfer rate of a floppy disk. The speed of the bidirectional daisy-wheel printer included with the Adam is less than 15 characters per second (cps), but that doesn't detract from the sharp quality of the characters. The standard Adam lacks a monitor but can use a television screen as a 40-column display and offers an optional 80-column card for those who buy a monitor. The Adam is CP/M-compatible, and Coleco promises to make the most popular CP/M programs available on digital data packs. The company also claims its BASIC is source-code compatible with Applesoft. And if the computer features aren't impressive enough, don't forget the Adam's ability to run games written for Coleco's line of game machines.

The Adam wasn't the only important machine introduced at CES. Atari presented four new machines based on a 6502C microprocessor running at 1.79 MHz. The least expensive of these was the $199 600XL featuring 16K bytes of RAM expandable to 64K bytes and 24K bytes of ROM. In addition, a CP/M module is available as an accessory. Atari also introduced the 1027 letter-quality daisy-wheel printer for the low price of $349.95. The 1027 prints at 20 cps, faster than Coleco's printer by 5 cps. The 1027, the Atariwriter word-processing cartridge, and the 600XL computer are bundled as a word-processing system for $599.95. But keep in mind that the keyboards of all the new Atari machines have only 62 keys, no cursor-control keys, and only four function keys. That's understandable, for the price, but for word processing the Atari can't compare with the Coleco Adam keyboard or the Video Technology Laser 3000, which I'll describe shortly. Atari's 800XL has 64K bytes of RAM and

produces output to drive a monitor, whereas the 600XL has output for a television only. Both the 1400XL and 1450XLD contain a built-in 300-bit-per-second modem and a speech synthesizer but the 1450XLD adds a built-in disk drive to the package.

More Machines

Spectravideo improved its 318—a Z80 running at 3.6 MHz—and introduced the more powerful 328 (see photo 2). Although the 328 lacks the earlier model's built-in joystick, it provides cursor-control keys, a numeric pad, and five programmable function keys. The 328 has 48K bytes of ROM expandable to 96K bytes and 80K bytes of RAM expandable to 256K. The standard ROM contains BASIC, a word processor, a terminal program, and on-line documentation.

Tomy introduced its 16-bit, $129.95 Tutor, a microcomputer that is based on the TMS 9905 microprocessor (see photo 3). Tomy's promotional effort stressed that the Tutor can instruct children without parental supervision. The machine features a rubber keyboard, and a disk drive is available.

The fastest 6502 machine on view was the Video Technology Laser 3000 (see photo 4), which runs at 2 MHz. The machine's keyboard features cursor-control keys, a numeric pad, and eight programmable function keys. A plug-in Z80A cartridge enables the machine to run CP/M software, and its 64K bytes of RAM are expandable to 192K bytes. The Laser 3000 has an Apple-compatible mode, and Video Technology says that two custom large-scale integration chips replace more than 100 discrete integrated circuits that would otherwise be necessary. The chips also perform video processing, memory management, and system control. The Laser 3000 displays 80 columns of text and has 560 by 192 pixels (picture elements) in the color-graphics mode. Standard items include four-channel sound generation, a Centronics parallel-printer port, and a cassette interface. Although the machine can support as many as four disk drives with 164K bytes, neither

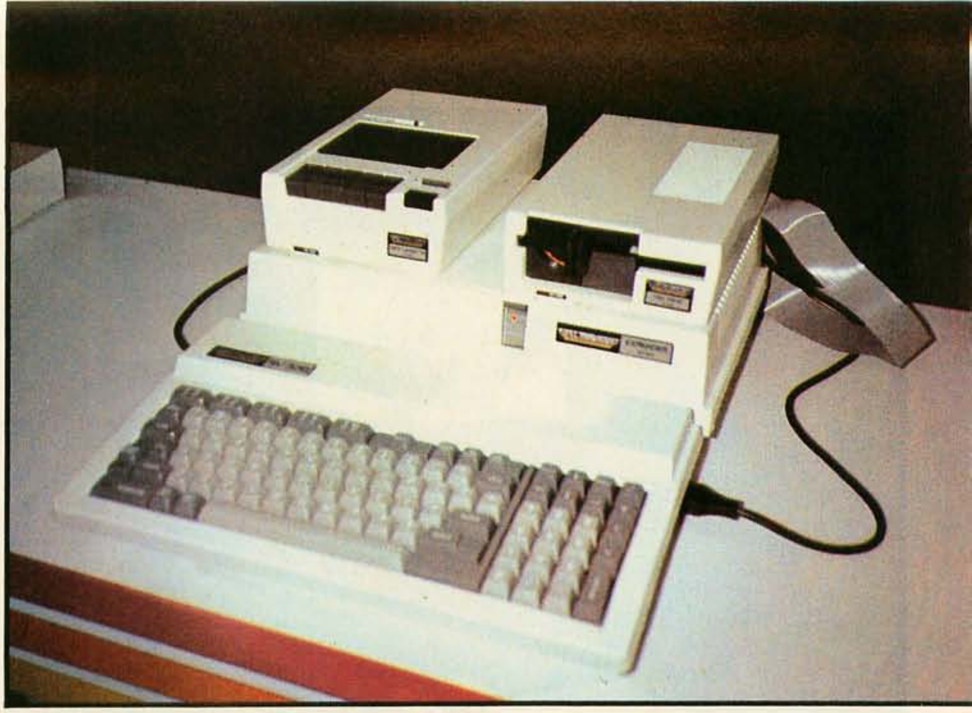

Photo 2: *The new 328 from Spectravideo.*

Photo 3: *The Tutor from Tomy.*

Photo 4: *The Laser 3000 from Video Technology, which runs at 2 MHz, was the fastest 6502 machine at the CES Show.*

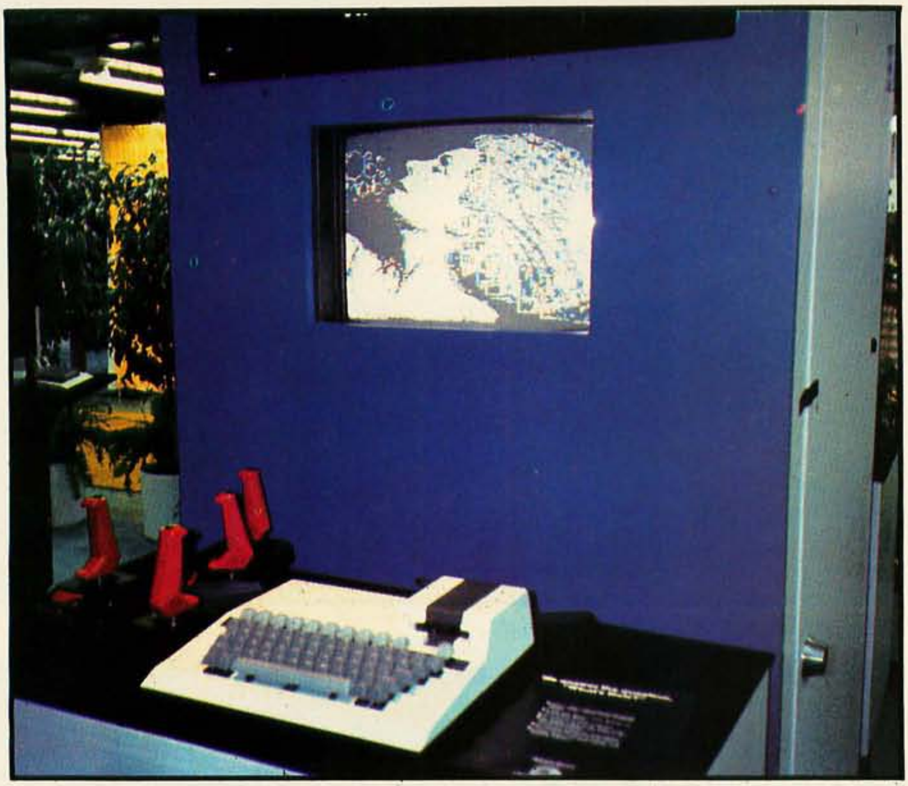

Photo 5: *The Unisonic Wafer-Driven Home Computer System is based on the wafer drive from Entrepo.*

the disk controller nor a serial-communications port is included as part of the standard equipment.

Unisonic displayed a Wafer-Driven Home Computer System (see photo 5), one of the many machines that uses the wafer drive from Entrepo. The wafer drive evolved from continuous-loop recording tape, formerly called a stringy floppy.

General Consumer Electronics introduced a keyboard and light pen for use with the Vectrex Graphic Computer System, its 6809-based game system. GCE also demonstrated programs that used the light pen to compose and edit music and to generate animated graphics. The software helped produce animation by interpolating lines between those drawn with the light pen. The light pen sells for about $40, and the basic system's price has dropped to $100 without a keyboard.

Texas Instruments displayed a cosmetically improved version of the TI 99/4A but declined to announce the forthcoming 99/8. The 99/2, which was announced at the winter CES in January, has been discontinued.

Commodore demonstrated Magic Desk, a desktop manager for the Commodore 64 home computer, dropped prices, and once again introduced its Executive 64 portable computer, which looks just as good now as it did at the winter CES and at the National Computer Conference. The Executive 64 is a portable Commodore 64 with a 6-inch color monitor and one or two disk drives in a compact 27-pound package. It does not come equipped with a printer. The price for a one-drive system with 64K bytes of RAM is $995. An optional Z80 cartridge permits running CP/M programs.

Standard Miracles

As of summer CES 1983, the only low aspect about the low end of the personal computer market is the price of the systems. The one possible exception concerns the speed of mass storage. Depending on how fast the wafer drives and digital data packs prove to be in normal use, people may demand the speed of random-access storage devices as standard equipment in their home computers. The company to be the first to introduce a $600 system that includes both a floppy-disk drive and a letter-quality printer may be the next market leader.■

Phil Lemmons, West Coast Bureau Chief of BYTE, can be contacted at BYTE/McGraw-Hill, 4th Floor, 425 Battery St., San Francisco, CA 94111, (415) 398-7990.

The Next Five Years in Microcomputers

Our user unlocks his crystal ball and becomes a seer

by Jerry Pournelle

I've told this story before, but it's worth repeating. In 1954 I was invited to the University of Illinois to see the ILIAC, which at that time was the world's most powerful computer. Housed in a gymnasium, it was supported by the world's largest air-conditioning system.

ILIAC was a vacuum-tube machine. Two undergraduates had the singular job of rushing about inside ILIAC with shopping carts full of tubes; when one burned out, they'd replace it. It did all its calculations three times and took a majority vote on the answer, because a tube might burn out while it was making a calculation.

For all that, time was scheduled on ILIAC months in advance; it really was the world's most powerful machine.

The TI-59 programmable scientific calculator is considerably more powerful than ILIAC was.

That development took 30 years, but technology always accelerates. Barring nuclear war, there should be nearly as much change in computers in the next 10 years as there was in the preceding 30.

When you try to predict trends, you're usually too far out over the short run and too conservative over the long haul. Still, we can see where the computer revolution is taking us: by the year 2000, anyone in the West who seriously wants to will be able to get the answer to any question, the answer to which is known or calculable.

That's a pretty strange world, but it's nearly inevitable. Microcomputers will contribute to that world: they'll be the link between the big machines and the ordinary citizen. Having stepped that far out, let's get closer to home and look ahead five years.

When the micro world first started, it was all one community: hobbyists. The last time NCC was held in Anaheim, everything—all the microcomputers, software, hardware, support people, the whole works—was hidden away in one back room at the Disneyland Hotel.

Like pariahs. As if AFIPS (American Federation of Information Processing Societies, which sponsors NCC) was ashamed of us.

This year's NCC is dominated by microcomputers. The old high priests of the computer industry may still dislike us, but they can't ignore us.

In those days, hobbyists dominated the micro world. If you weren't a hobbyist, if you were just a user like me, you were not only rare, you had no choice but to team up with one of the wizards. You didn't just walk into a store and buy a computer system. Good equipment was put together, often from kits.

That's all changed now. One of the people who changed it was Adam Osborne, who packaged a working system with enough software to make it useful and sold the whole works—machine, software, and all—for about half what anybody else charged for a comparable package.

That's one of the currents in the micro stream. Another is represented by Bill Godbout and his Compupro team. They sell advanced equipment. Compupro machines are widely used for software development, but you still have to know something about microcomputers, or have consultants who do, in order to take full advantage of the Compupro line.

Another trend is represented by Apple's Lisa: not really all that advanced, maybe even overpriced when you consider what's inside the machine, but sold to a market that's interested in the convenience. Lisa doesn't really compete with Osborne or Compupro; as far as I can see, Lisa is cutting into a market that's used to paying a lot more than $10,000 for machinery. This is the computer as executive perk.

Clearly then, trends will affect the Godbouts and the Osbornes quite differently, and those two won't be the whole story either. Microprocessors are going to appear in all sorts of ways that won't be recognizable as computers. Home appliances, cars, television sets, home security systems, games, and a lot more—all those industries will be affected.

In other words, there's no such

This article is based on a presentation given at the 1983 National Computer Conference. Dr. Adam Osborne was the other speaker at the presentation.

thing as "the" future of the microcomputer industry; it's a bit like asking someone in 1950 to talk about the future of the transistor. We can look only at broad trends.

Adam Osborne is interested in the mass market and predicts that most micros will, in the next few years, be sold to people who don't want *computers* at all. They only want machines that do things.

He may be right, although—given the trends toward making "computer literacy" the new buzzwords and requiring an understanding of computers for graduation from college and perhaps even high school—one could argue that Osborne has misread the trend. In any event, I'll stay mostly with things that look and act like computers.

Hardware

We can sum up the hardware trend in one sentence: more capability for less money. That trend will accelerate.

Memory: the price of memory has fallen every year. When I first bought Ezekial, my late friend who happened to be a Z80, 16K bytes of high-quality (Industrial Micro) static memory cost more than $500. That's $31.25/K. Today, top-quality static memory (Compupro) costs $995 for 128K bytes, or $7.77/K. Dynamic memory has become more reliable, and it's a lot cheaper. This month's BYTE advertises deals such as 256K bytes for $795, or $3.10/K.

I can do even better than that. I have a Macrotec dynamic board: a full megabyte for $1983 list. That works out to $1.94/K. These are advertised retail prices for single quantities.

The next generation in memory requires some new technology; it won't be enough to simply glue a batch of the 64K-byte chips together. However, there's absolutely no reason to suppose the new technology won't be forthcoming, either from here or from Japan. Thus we can in confidence say that five years from now memory will cost no more than 15 percent of what it does now. The smallest machines will have a full megabyte; most will have a lot more. Ten-megabyte microcomputers will be common.

ROMs: ROMs will be cheaper, too, so that it will be easy to have ROM software as part of a computer package. Instead of programs on disks, machines will have their operating system, text editor, and other commonly used stuff built in, the way BASIC was built in on the old TRS-80 Model I.

Use of ROMs as a means for distributing software may cut down a lot on piracy.

EROMs (erasable read-only memory) will let you do things like reconfigure the keyboard and otherwise customize the system. You do that once and forget it.

Mass storage: I've titled this section mass storage rather than disk drives. I think floppy disks will be with us in five years, but they may largely be relegated to their original purpose of transferring information from one machine to another, rather than as a mass-storage device.

Incidentally, my engineering advisers predict that in five years both the 8- and 5¼-inch floppy disks will be a dying breed; they'll be replaced by some kind of hard disk, possibly the cartridge Winchesters, and one of the vest-pocket disk systems. The vest-pocket (3¼- to 3½-inch) disks would already have made great inroads into the 5¼-inch market if the industry could agree on some kind of standard.

Note the trend in disks. Ezekial's disk system—two drives, controller, interface, and cables—cost $2000 for 241 × 2 = 482K bytes of storage, or $4.15/K. This month's BYTE advertises Compupro double-sided quad-density disks with controller at $1595; for that you get 2.2 megabytes, 2200K, or $0.73/K.

The trend in hard disks is just as dramatic. Five years ago, you couldn't afford hard disks. Now, George Morrow will sell you 16 megabytes formatted, with controller, for $1595; that's $0.099, less than a dime per K!

Of course other mass-storage devices are available. We have bubble memory, battery-backed memory, streaming tapes, disk cartridges, and such like. We don't need to know pre-

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cisely what we'll be using five years from now. We can, however, be sure that it won't cost more than a nickel a K, and will probably be a lot less; and it will be fast.

Five years from now it won't be worthwhile building a micro with less than 10 megabytes of mass storage.

CPU: an interesting race is going on: which chip will dominate the next few years? The leading contenders are the 8086 and its successors versus the 68000. The Z8000 seems to have dropped out of contention. The 16032 is a dark horse, with very interesting chip architecture.

Most analysts believe that the 8086, followed by the upward-compatible 2-86, possibly followed by more upward-compatible successors, and the 68000 are the chips to watch. Which one you ought to go with is a financially important decision, but it's not crucial to our analysis.

We're pushing out to the limits of VLSI (very-large-scale integration) technology, but there are bound to be breakthroughs. If we assume CPU complexities will go up by only a factor of two while the price is cut in half, we get a fourfold increase in bang for the buck.

Linking: the main problem with Ethernet is that it's expensive. That won't last. I don't mean that the hardware for Ethernet itself will necessarily fall in price, although that's very likely; I do mean that hardware for linking computers together into networks will be made steadily more available.

Some engineers think the RS-232C system, carried to its full potential, will be more than sufficient. Others reject that. Few, however, believe we won't have reliable, fast, and low-cost intersystem communications hardware well before 1988.

For example, I fully expect one day to talk to my editor in New York while we both have text on our screens. I'll use a light pen, or something similar, to mark my text, and my editor will see the same thing happen on her screen, but we won't have to give up our voice communications to do that. The limiting factor here isn't computer technology, it's the phone company.

Other stuff: Pournelle's Law: Iron is expensive, but silicon is cheap.

Modem hardware, memory-management units, system support, math chips, voice-recognition units, and all that paraphernalia will get cheaper and more plentiful.

The trend in printer equipment isn't quite as dramatic. In 1978 I paid about $3000 for a good letter-quality printer. I'd have to pay about $2000 today, and I'd be surprised if I didn't have to pay at least $1000, possibly $1500, in 1988.

Impact printers require a good bit of machined metal, and that gets more, not less, expensive. The cost of chips has dropped enough that printers can be smarter and still be less expensive, but there's a minimum that mechanical equipment isn't likely to fall below.

However: machines that are a combination of laser printer and copy machine are available this year for about $15,000 in quantity one and about $7000 in quantity 1000. The usual trend is for this year's quantity 1000 price to be next year's quantity one price. Within five years, laser printers that will also be your office copy machine will be available for no more than letter-quality printers cost today. This will give us amazing capabilities for producing camera-ready copy, complete with variable typefaces and excellent graphics.

Bottom line on hardware: hardware costs less for more capability. Total systems costs are coming down.

In 1977 Ezekial, my first Z80 machine, cost about $12,000, including software, systems integration, letter-quality printer, modem, cables, and a maintenance contract. He was a very advanced machine for his time.

In 1983 Zeke II cost about $8500. In speed and other capabilities, Zeke II is at least twice as powerful as Zeke I was. He's three times as fast, has a 1200-bps modem, twice as much memory, and almost 10 times as much disk storage. He has more and better software. Yet he costs only 75 percent as much.

If all I wanted was enough equipment for word processing, I could save even more by getting an

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Osborne, the communications pack, and a tolerable printer. I'd still end up with as much system as Zeke ever was, all for $3500 or so. That's 30 percent of what I paid for Zeke, but the same capability.

That trend will obviously continue. In five years you should be able to get a full business-quality system for what home computers cost now; while microcomputers that will do nearly all that the $100,000 minicomputers can do will be available for less than $10,000. Notice that I'm using real dollars, with no adjustments for inflation.

Software

The general statement is simple: software is going to be cheaper, more universal, and easier to use.

For instance, right here at this show Epson America is showing some pretty radical software: it's Chris Rutkowski's Valdocs system, which in effect uses the text editor as an operating system.

The Valdocs concept is certainly headed in the right direction. You turn on the machine and it comes up in the text editor. If you want to call a friend, you push a couple of keys and you're in communications, either by voice (by picking up your phone) or computer-to-computer. If you want to see today's schedule, you push another button. You can get a printout of your next week's appointments. Another button uses your computer as a desk calculator.

In theory, you don't have to refer to the documentation; you find out how to use Valdocs with online help.

That's where software is going. It isn't there yet, because (in my judgment) the Z80 isn't fast or powerful enough to support all that work with tolerable speeds. No matter. The hardware exists. I think it would be easy to get Valdocs working like a striped ape on a machine like the Eagle 1600, for example, with its hard disk and fast screen.

Other trend-setting programs are on display out there. Lotus 1-2-3 is moving in the right direction. So is Visi On. Richard Frank's people at Sorcim haven't yet integrated Superwriter and Supercalc, but that's only a matter of time.

Voice-controlled systems are available, and of course there's Apple's Lisa.

They're all headed in the same direction: making very complex programs easy to use. They integrate the computer directly into people's lives and make it accessible to people who aren't interested in learning CP/M and BASIC; this trend will accelerate.

Prices will inevitably fall: as the market base expands, it will be possible to make large profits from moderately priced software. Books, after all, sell for less than $25, but there's no shortage of people willing to write them, and some of us make a fair living writing books. Software development will be the same.

As software prices fall, support levels will fall: documents will be better, there will be more and better online help features, and the need for expensive people to answer tele-

phones will disappear. Companies that can't do it right the first time won't survive.

Programming languages are getting more accessible, and a *lot* of people will learn to program. A few years ago, hardware was available, and some people took advantage of it to start new companies. The result was Altos, and Apple, and some other outfits you've heard of.

A number of well-known software houses started the same way.

That will happen again and again over the next five years as development-quality systems become available at popular prices. Languages are falling in price: I've recently been told of a BASIC compiler for less than $100. JRT Pascal isn't likely to be the only high-level language for less than $50.

As micros become more powerful, imagination and program design gets more important than the ability to write efficient code. If you can make your program easy to use, who cares how elegant it is? Not very long ago, what was important was the ability to do fantastic tricks in assembly language. When memory gets cheap, however, it's not worth paying computer wizards to write memory-efficient code.

Even now, what's really important is the ability to describe needed programs—to write what my mad friend MacLean called a *metalanguage description* of a program. Coding Visicalc so that it would run on an Apple was really brilliant work; writing the same program in Pascal to run on the Sage 68000 is a student exercise.

Some other discontinuities are just around the corner. For example, within the next five years, probably a lot sooner than that, someone is going to build what amounts to a LISP machine for micro prices. A *lot* of software is being written in LISP: text editors, spelling programs, that sort of thing, and also a lot of teaching programs. A lot of artificial intelligence people will suddenly be able to write programs with a potential market of tens of thousands of copies.

The educational potential of computers hasn't even been touched. In my judgment, it's better that kids program computers than that the computer programs the kids; I've never been wildly fond of so-called programmed learning. On the other hand, the use of computer *games* to teach valuable lessons has hardly been exploited at all. There's potential for a billion-dollar industry in educational software, but first it has to be created.

Will Micros Really Rival Minis?

Answer: yes.

There are some definite hardware limits to microcomputers. You can do only so much with a single chip before you run into fundamental problems. Those limits won't matter, though, because of parallel processing. Concurrent CP/M-86 is just now catching on; when people realize just what you can do with concurrent processing, it will really take off.

Example: the Valdocs program I mentioned earlier tries to do everything by overlays. When you call the scheduler, or address book, it saves off your text automatically. It effectively logs you out of the editor, and you're limited by the speed of your disk drives.

With concurrent processing you won't have to do that, and programs to accomplish all that Valdocs does, and more, won't be hard to write, especially with a language like Modula-2 to write them in.

A few years ago, those of us who like peering into the future said that the trend was toward "one user, one CPU." We believed that multiuser systems were swimming against the current.

Now I think it's clear: we're headed not just for "one user, one CPU," but several CPUs for each user. We haven't even begun to wring out the potential of parallel processing.

The kind of multiuser system I see coming gives each user several CPU chips connected through a bus and capable of doing concurrent processing; quite a lot of memory; a terminal; and some kind of disk drive, quite possibly a small Winchester. His operating system will allow concurrent processing, so that he can ap-

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pear to be several "virtual terminals"; one of those terminals has his text editor, another his scheduler and card-file box, another is connected to an electronic-mail network.

Locally he'll be connected to other users through a network that lets him share use of a laser printer and a really big hard disk with tape backup.

The only difference between what I've described and a VAX is that the micro system will be a lot easier to use, and it will be cheap.

The trend, then, is clear: micros will get more like minis at the same time their prices are falling, while higher-level languages will be more widely available and cheaper.

That's significant, because the trend will be toward portability and modularity. It won't be necessary to start over when writing a new program. Programmers can bring over a number of modules intact and just write new stuff. They'll also be able to *understand* their programs.

Meanwhile, we'll see a trend toward making graphics available to a wider and wider group of programmers. You won't have to be a wizard in order to write decent graphics. Languages like Modula-2 really lend themselves to this, and I expect in the next couple of years to see Modula graphics modules offered for sale to programmers. Graphics statements in many BASIC languages are available right now. The Otrona has them, and the Zenith Z-100 even has color statements in its BASIC.

All this will make graphics available to the business and educational programmer as well as to the gamer.

Games

Speaking of games: Larry Niven and I are at this moment writing a game around our book *Inferno*. I notice that Infocom, the company that markets Zork and various other script-driven interactive games, has sufficient cash flow to take out really big ads now.

We can expect to see a lot more of this, and gaming rights will become as important to authors as their foreign rights. If you couple video disks to interactive games, you get a possibility of a whole new entertainment form, a story in which the reader can participate. I notice that's already happening in certain comic books, where you're instructed to turn to different pages depending on your decision at various points in the story.

Videodiscs, languages like PILOT, and new cheap, fast processors can create a new entertainment field. I'm not sure when it will happen, but it can't be too long before you can buy a videodisc and game cartridge that lets you be the central character in a *Star Wars* adventure, and when it comes time to fly your ship, or shoot the bad guys, you actually control the ship and the gun turrets: combining interactive fiction with an arcade-type game.

Miscellaneous

So far I haven't even said anything about new languages or trends toward programs like PEARL and The Last One, so-called program-writing programs. Both trends will continue, of course. Computer-assisted programming is one of the goals of the artificial intelligence community. This too will contribute to the software explosion, driving it to the

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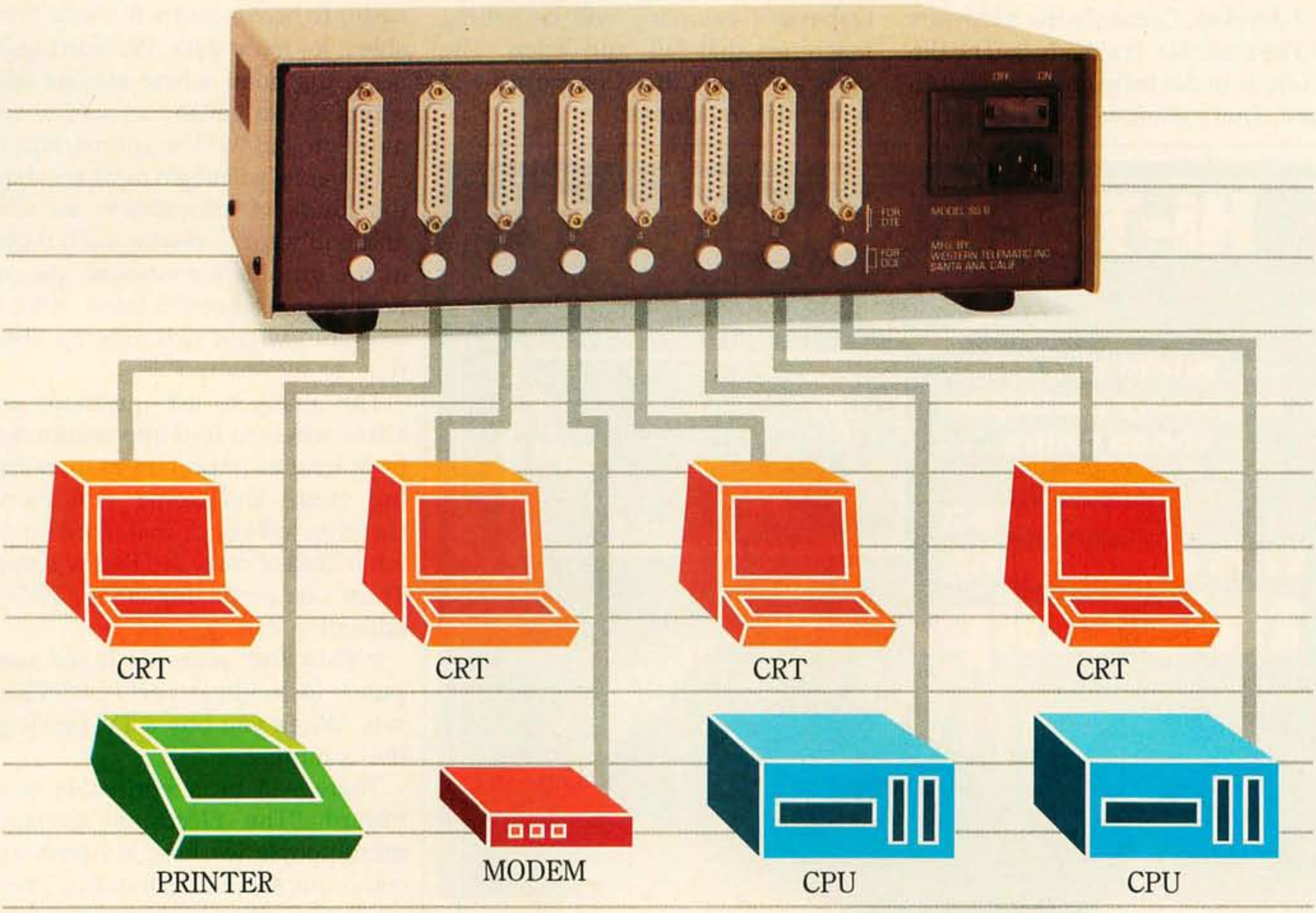

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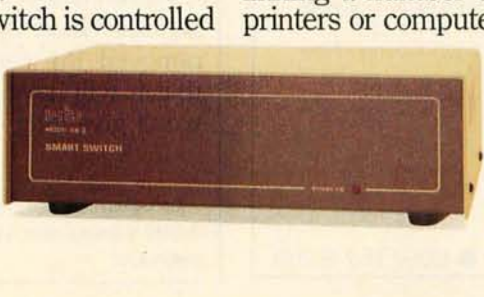

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logical limit: if you can describe what a program does, you can write the program.

I do not think we will reach that limit in five years; but we will have moved a surprisingly long way toward it.

Talking Computers

I've seen some spectacular things done in this field, but I don't really have a good feel for how quickly it will develop. Certainly the hardware will be available. It already is. The difficulty is in devising crashproof software. That's going to depend a lot on the AI community, and predicting the state of AI is a risky business. They're always going to have a breakthrough Real Soon Now.

Then they get one, and things change rapidly.

Specifics

I'll make a few guesses based on the above analysis.

I'll make a guess that there's a 50 percent probability that by 1988 Dr. Osborne's company will be selling machines that talk and listen. The odds are 4 to 1 that Compupro will have such machines.

Interactive fiction and script-driven games will be a significant part of the entertainment industry. Old-line firms like Doubleday and Ballantine and Random House will publish and distribute these games, and they'll be sold in B. Dalton bookstores.

Word-processing systems will outsell typewriters.

The telephone company will offer an information utility service.

Information utilities will be a lot easier to access and will make available a lot more data. We won't quite be to the point where anyone who wants to can get the answer to any question, but we'll be approaching it.

Someone will begin to worry about the kinds of information available and will want to restrict such things as the formula for mustard gas and how to make botulin toxin. A lot of lawyers will get rich arguing about this.

The ability to ask questions and know where to find information will be at least as important as memorizing facts, and some educational theorists will notice that. Lord knows what kind of crazy fad that will start. There's no predicting what a PhD in education can dream up.

Within five years we'll see computers included as part of television sets. When you buy a TV, you'll get the computer.

There will be a noticeable trend toward "The Electronic Cottage": more people working at home with communications by computer. They'll go to the office perhaps one day a week.

Finally: about five years ago, John McCarthy of Stanford bought a Heathkit color television. The intention was to have a robot build the television set.

As of this year, the robot hasn't even been able to open the box.

Within five years, John's robot will certainly have opened the box and removed the components. I doubt that it will have built the set—but I won't give long odds.■

Jerry Pournelle is a former aerospace engineer and current science-fiction writer who loves to play with computers.

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Game: SIZZLE (second prize)
Author: Shawn Day, Kelowna, British Columbia, Canada

Judges' comments: Shawn Day is a teenager who, with about a year's experience on the Apple, wrote this classic arcade game in about a week during Christmas vacation. Sizzle uses the familiar game motif of descending attackers, but Day adds an element of whimsy: your player has to catch the aliens on a moving barbecue grill. If the aliens land, you can't get near them until they explode (of their own accord). You lose a player if a grounded alien touches you or if your barbecue runs out of propane—in that case, the occasional appearance of a floating propane tank (which you have to shoot) becomes quite important.

Sizzle's graphics are excellent, but the game is somewhat flawed by the passive nature of the grounded aliens—unable to harm you if you stay away from them, they can only limit your movement temporarily. Still, Sizzle is the best classic arcade game we received.

Here they are—the winners of the Second BYTE Games Contest. The good news is that all the games are outstanding. The bad news is that almost all of them were written in assembly-language code, which means their listings are too long to include in BYTE. Fortunately, however, most of the authors are making the games available on disk (see the text box for details). We've compiled a brief dossier on each winner.

by Gregg Williams

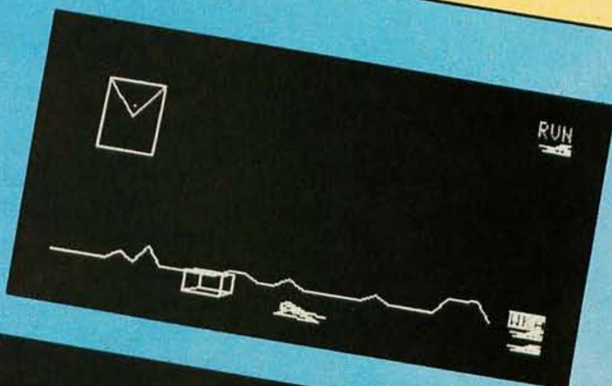
The Second BYTE Games Contest Winners

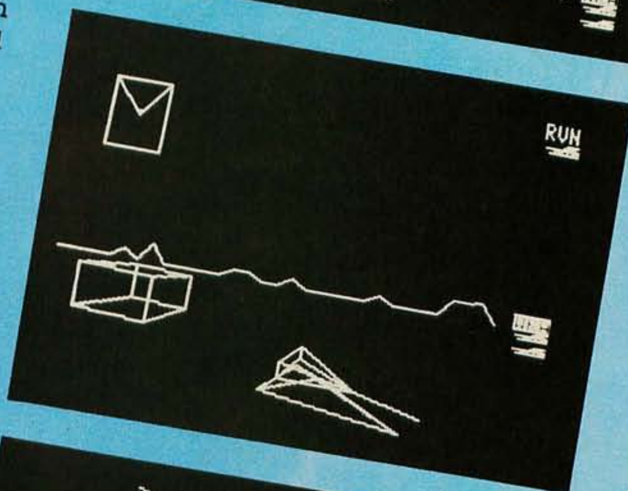
Game: DUAL DUEL (first prize)
Author: Aaron Pratt, Ypsilanti, MI

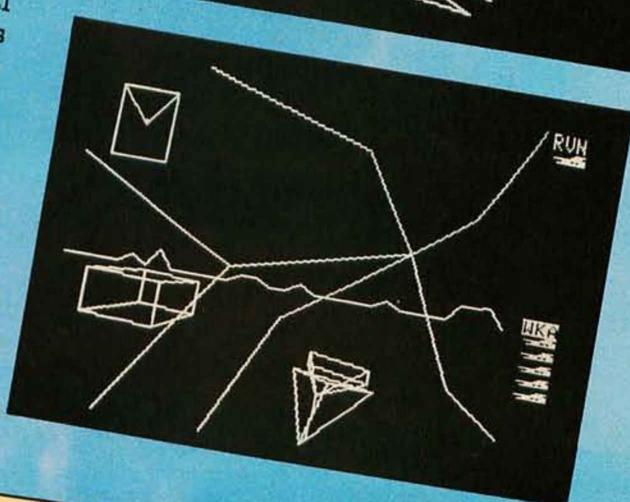
BYTE
The Small Systems Journal

Judges' comments: When they heard he'd won our contest, Aaron Pratt's friends said, "Of course you won," and if you could see this game, you'd be just as sure. In Dual Duel, two human players slug it out in a tank-vs-tank battle via two Apple computers connected through a game paddle. Each player can turn left or right, move forward or back, and fire a missile. The small square in the upper half of the screen is a sort of "radar" that shows you the position of the enemy tank relative to you. As you can see from the first two photos, a player's view changes as his tank moves (the animation is as smooth as you would find on any commercial game). The third photo shows what happens when your tank gets shot.

A tribute to both the ingenuity of microcomputer programmers and the versatility of the machines themselves, Dual Duel compares favorably to arcade games that have far more computational resources than the Apple II. Author Pratt wrote the game in RGL (Real-time Graphics Language), a compiled C-like language optimized for three-dimensional graphics.



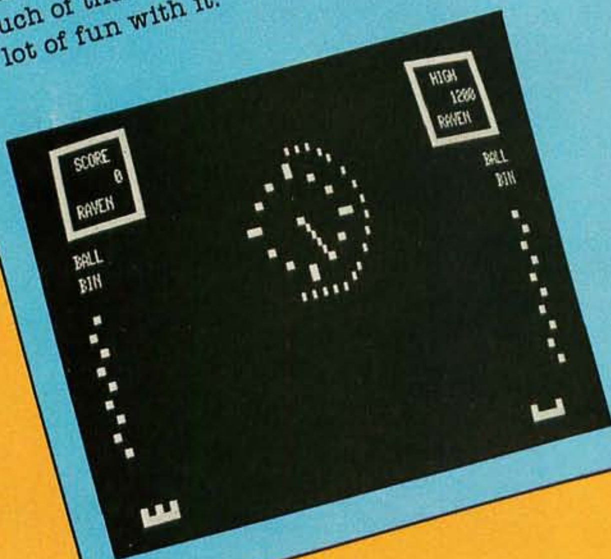




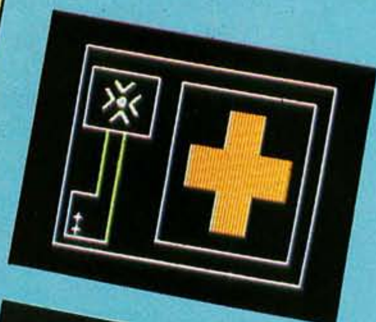
Game: JUGGLE (third prize)
Author: William P. Porter, Coral Springs, FL

Judges' comments: Juggle is actually a simulation of juggling as many objects as you dare. Each ball can be thrown high or low on the screen and has a realistic trajectory. The integration of music with realistic, real-time movement of multiple objects is a real programming feat for which author William Porter deserves credit.

In Juggle, you are working against a clock, and you get points for keeping objects in the air and for putting additional objects in motion. Low tosses get you more points than high tosses. Juggle is a game in the sense that you can compete against another player or against yourself for the higher score, but it is primarily a simulation that has much of the feel of juggling actual objects. We had a lot of fun with it.



Judges' comments: Tony Ray distinguished himself last year with an abstract target game called Charge. This year, he's given us a maze-and-dots game, but with a twist—maze walls are replaced by radioactive pits into which you fall if you don't move your player (called a Grimpet) just right. You can also lose your player if a Wirlybird picks it up. As in most games, however, you



Game: IT'S THE PITS (fourth prize)
Author: C. Anthony Ray, Urbana, IL

are not totally defenseless—if you pick up the hat in the maze and get through the maze successfully, you'll get a candle in the next one. The candle, which goes on top of the hat, spells instant death to any Wirlybird that tries to pick up your player.

It's the Pits is maddeningly frustrating (although in video games, that's not necessarily bad) and demands unwavering attention. One of the judges found that it became tedious because of its lack of variety. Nevertheless, the game is a professional one, and its animation is superior to this year's other game winners.

Game: RESCUE (fifth prize)
Author: William Hubbard, Tucson, AZ

Judges' comments: This game marks the second occasion that William Hubbard has won a contest; the first time, he won first place in a Halloween costume contest—dressed as a computer. Rescue is the only game winner written in BASIC, but we chose it because its original idea put it ahead of some less original (but technically more professional) games. The object of the game is to find and rescue stranded survivors of an ocean liner crash. You start by helicopter from your island Coast Guard base (top photo) and search until you find an inhabited island (bottom photo), which contains trees, pit traps, cannibals, lions, and (invisible) quicksand and headhunters.

We liked the basic idea of Rescue and its combination of strategy (luring lions into pits, for example) and luck as the key to success. The game is slow only when drawing a new island; fortunately, that doesn't happen too often. We also liked Rescue because it was written in BASIC, which makes it easy to modify.

Games for Sale

Four of the winning games are for sale. All inquiries for further information must be accompanied by a stamped, self-addressed envelope.

Dual Duel (for Apple II, Atari 800/1200XL, Commodore 64; both the game and the development language used, RGL, are available): Microcraft Systems Inc., POB 1109, Ann Arbor, MI 48106.

Juggle (for Radio Shack TRS-80 Models I and III only, "Big Board" CP/M system): William P. Porter, 1364 NW 82nd Ave., Coral Springs, FL 33065.

It's the Pits (for Apple II): C. Anthony Ray, 39 Carriage Pl., Urbana, IL 61801.

Rescue (for Apple II): William Hubbard, Re: Apple game, 3415 Calle del Prado, Tucson, AZ 85716

Photo 1: *The Akihabara quarter in Tokyo.*

Update on Personal Computing in Japan

Battery-powered systems, optional communications, and attractive packaging highlighted the Japan Microcomputer Show '83

by Phil Lemmons

The Japan Microcomputer Show '83, held May 25-28 at Ryutsu Center in Tokyo, showed more low-end home computers, notebook-sized and hand-held computers than the more expensive desktop machines. All but a few of the machines at the show were on display and on sale in Akihabara—Tokyo's electronics quarter—before the show opened. Nevertheless, the thousands of Japanese who packed Ryutsu Center each day were just as intensely interested as those who attended the larger Japan Data Show last October.

New Personal Computers

The most striking new machine, the Canon X-07 Handy Personal Computer, combines battery power, attractive packaging, and intermachine communication through inexpensive optical couplers (see photo 2). For a base price of $445 (104,800 yen at 235 yen per dollar, but prices in the United States are generally higher than the exchange-rate equivalent), Canon provides a Z80-compatible NSC800 CMOS (complementary metal-oxide semiconductor) microprocessor, 20K bytes of ROM (read-only memory) containing an interpretive BASIC, and a 4-line by 20-character display. A compact dot-matrix printer costs about $192. The X-07's RAM (random-access read/write memory) is expandable to 24K bytes and ROM to 42K bytes. Further memory expansion comes in the form of "memory cards," which resemble credit cards and fit into a slot in the bottom of the computer. These cards contain ROM, battery-backed CMOS RAM, or a combination of the two. A 4K-byte RAM card costs about $42, while a card containing 8K bytes of software in ROM and 4K bytes of RAM costs about $64. The keyboard is not quite large enough for adult touch-typists. Indeed, the X-07 measures only about 8 by 5 by 1 inch and weighs just over 1 pound.

The X-721 optical coupler plugs into the machine at left rear and costs $42.

Photo 2: *The Canon X-07.*

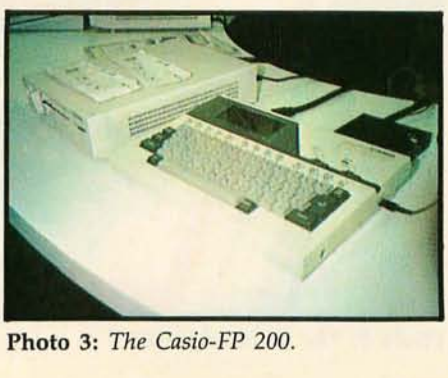


Photo 3: *The Casio-FP 200.*

Machines using the optical (infrared) couplers can communicate directly through the air, using BASIC statements to send data between machines. A printer attached to one machine prints data transmitted from another. One exhibit at the show depicted students in a classroom transmitting answers during an exam to a teacher's X-07. Indeed, the classroom seems to be one of the major targets of this machine. Shared software cards would reduce the cost per user to reasonable levels, perhaps making a room full of X-07s the least expensive intercomputer communications system available.

Usually, software availability is a problem for new computers, but a software house called dB-SOFT was promoting a series of five cassettes of business programs for the X-07 and another five of games. The business cassettes covered credit calculations, other financial calculations, sales management, inventory management, and marketing management. The business cassettes cost about $16 each, while the game cassettes cost about $12.

Two other attention grabbers are the Casio-FP 200 (see photo 3) and the National (Panasonic) JR-800. With a few changes, the FP-200 could challenge the NEC PC-8201 among Japan's full-keyboard, battery-powered portables. The FP-200 keyboard is large enough for touch-typing but seems to have a rollover problem. The 8-line by 20-character dis-

Photo 4: *The National JR-800.*

play is only half as large as the PC-8201's but much larger than the Epson HC-20's display.

When introduced, the FP-200 had only two pieces of software, a BASIC in ROM and another programming language called CETL (Casio Easy Table Language). CETL seems more like Visicalc than a traditional programming language.

Although an FP-200 with 8K bytes of RAM and 32K bytes of ROM costs only about \$300 (as against the PC-8201's \$590), without additional software, specifically a text editor, the FP-200 cannot offer serious competition for the PC-8201 or the Radio Shack Model 100 as an electronic notebook. The omission of a text editor and the presence of a keyboard rollover problem are hard for some visitors to Japan to understand because they frustrate a major application of the machine (namely, text editing), but an American computer scientist living in Tokyo was not surprised. He pointed out that most Japanese have never used a typewriter. Most business correspondence in Japan is still handwritten. The Japanese are moving directly from handwriting to computing, and their language's large character set has prevented the emergence of a standard keyboard. A typewriter keyboard, for the present, may not sell any more machines in Japan than the smaller keyboards on hand-held machines.

Another interesting battery-powered machine present both at the show and in Akihabara is the National JR-800 (see photo 4), called the Panasonic JR-800U in English promotional literature. At a list price of 128,000 yen (roughly \$550), the JR-800 is an impressive concentration of computing power. The processor is a 63A01V, an 8-bit CMOS microprocessor compatible with the Motorola 6801. The system has a full QWERTY keyboard, a numeric pad, and 10 programmable function keys. Each programmable key can hold two values; the second set is accessed with the shift key. Unfortunately, you must also use the shift key to move the cursor left or down because the keyboard has only two cursor control keys. The keyboard is a little too small for touch-typing and has only a tiny space bar, which is placed awkwardly at the lower right where a second shift key might be expected.

The JR-800's liquid-crystal display (LCD) can show 8 lines by 32 columns. While a little smaller than the PC-8201's display, the JR-800's is almost as easy to read and ranks among the largest hand-held-computer displays. The JR-800's other features include a built-in calendar/clock, 16K bytes of user RAM expandable to 24K, 20K bytes of ROM containing BASIC, 1552 bytes of video RAM, and a five-octave music function with a dynamic speaker. The JR-800 will run for 25 hours on batteries, weighs only $1\frac{5}{8}$ pounds, and measures $10\frac{1}{4}$ by $5\frac{5}{8}$ by $1\frac{3}{8}$ inches. Options include a graphics printer, an I/O (input/output) interface unit, and expansion cartridges. The only software on view at the show or in Akihabara was the built-in BASIC language. The BASIC does calculations up to 20 digits with an exponent of ± 153. The optional printer costs about \$150 and weighs a little over 1 pound.

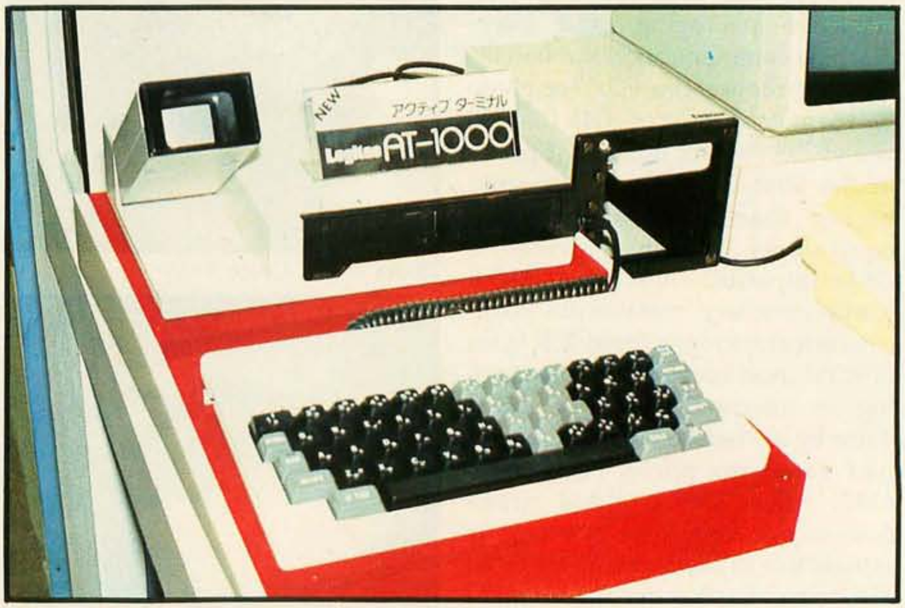


Photo 5: *The Logitec AT-1000.*

Photo 6: *The Seikomap.*

A Portable Network?

A unique portable was introduced by a smaller Japanese firm named Logitec, which is related to Kanto Denshi, a trading company. Called the AT-1000 (see photo 5), the machine uses the 6301, a CMOS 6801 microprocessor, and has 32K bytes of ROM and 32K bytes of CMOS RAM expandable to 576K bytes. The AT in AT-1000 stands for "active terminal," but the system really differs from both computers and terminals as we know them. Although it contains its own microprocessor, the AT-1000 cannot do any processing until you insert an AT-100, a hand-held terminal with 32K to 64K bytes of CMOS RAM. The AT-1000 can hold six of these. The AT-100 includes a 2-line by 16-character LCD and from 32 to 64K bytes of CMOS RAM. AT-100s can be inserted into one of the two slots in the front of the AT-1000 or one of the four slots in back. Once the AT-100s are inserted, the host machine can function as a multitasking, multiprocessing portable under the control of the AT-100 processor located in its first slot of the AT-1000. AT-100s can serve as microprocessors or simply pass data to the AT-1000 for transmission through its RS-232C serial port. An AT-1000 packed with AT-100s is like a local area network in a lunch pail. Logitec promotional literature uses the metaphor of the kangaroo and its young to explain the physical relationships among the parts of the system. Because there is no such thing as an applied kangaroo, however, the metaphor does not enlighten us about the intended applications of the AT-1000. Kanto Denshi spokesmen mentioned insurance as a possibility.

While the current AT-100 is based on the 6301 microprocessor (CMOS 6801), future models may be based on CMOS versions of the Z80 or the 6502. That opens the possibility of turning the AT-1000 into a CP/M or Apple-compatible machine.

Unlike most of today's battery-powered portables, the AT-1000 uses a cathode-ray-tube display rather than an LCD. As a result, the AT-1000 runs for just three hours on a single charge. The display measures only 1½ inches (diagonally) but tilts up and is legible through its viewing glass. Amazingly enough, the tiny screen will display 20 lines of 64 columns or 10 lines of 32 columns. The system has video output to drive a larger monitor when AC power is available.

The ROM contains an interpretive BASIC that resembles Microsoft BASIC.

Some of the AT-1000's features seem well designed for American use. The detached keyboard has a coiled connector that permits a wide range of motion, a full QWERTY set of keys, plus six programmable keys, four cursor keys, and Menu, Insert, Delete, and Break keys. The Logitec machine has interesting possibilities but needs a microprocessor capable of running existing American software if the machine is to sell in the United States.

Home and School Computers

Several new computers targeted for home or school use drew crowds at the show. Seiko showed its Seikomap (see photo 6), which would look equally at home in the classroom or the living room. The basis of the system is the MAP-1010, a Z80A computer with 24K bytes of ROM containing BASIC and 32K bytes of RAM. TV interface and color graphics are standard, as is a built-in cassette drive for mass storage. The keyboard has four programmable function keys, four cursor keys, and a numeric pad. The system unit has a switch to select between two monitors and a knob to set the volume of the speaker. Disk drives, a printer, a graphics tablet, and a joy-

Photo 7: *Toshiba's Pasopia 5 and Pasopia 7.*

Photo 8: *The Fijitsu FM-7.*

stick are available. The Seikomap-1030 I/O unit provides interfaces for all these devices.

Six CAI (computer-aided instruction) cassette packages for elementary school children were prominently displayed in the Seiko booth. The price of the system unit and keyboard, about $417, seems appropriate for both home and school. The industrial design, much like that of stereo components, would look good alongside the family television.

NEC displayed its new PC-8000 Mark II, its recently introduced portable PC-8200, and the rest of its line—from the PC-2000 hand-held computer to the PC-9800 and N5200 16-bit machines. In the United States, the N5200 is called the Advanced Personal Computer. There has been speculation that NEC would either sell both the APC and the 9800 in the United States or replace the APC with the 9800. Shunzo Hamada, assistant general manager of NEC's EDP Small Systems Division, dismissed those rumors in an interview at NEC headquarters in Morinaga Plaza, Tokyo. "We will not sell the PC-9800 in the West," he said. "The next 16-bit computer that we introduce in the United States will be an entirely new machine that responds to the challenge of the IBM PC recently introduced here in Japan." That version of the IBM PC, the 5550, has very high resolution graphics and greater mass storage than its American cousin.

Toshiba showed its new Pasopia 5 and Pasopia 7 (see photo 7), both Z80A-based machines that support color graphics. The main difference between the two systems is that the Pasopia 7 also generates music over a range of six octaves. The Pasopia 7 has 64K bytes of user RAM, 56K bytes of video RAM, 16K bytes of operating system in ROM, and another 32K bytes of ROM containing T-BASIC 7. The system can display 25 lines by 80 columns or 20 lines by 40 columns. The highest graphics resolution is 640 by 200 pixels. With two disk drives and a monochrome monitor, the Pasopia 7 costs about $1350 in Japan. A 14-inch color monitor adds about $300 to the cost.

Fujitsu's major entrant in the low end of the market is the FM-7 (see photo 8). According to some sources in Japan, this machine is already the second-best-selling system in the domestic market. Fujitsu is fond of the 6809, the 8-bit processor with internal operations done in 16 bits. Like most Fujitsu microcomputers, this one contains a 68B09, but it also has a Z80A processor. A 44K-byte ROM contains BASIC. The FM-7 has lots of RAM—117K bytes plus 64K for BASIC and 64K for video. The base price is about $540. A 640- by 200-pixel color monitor costs $430. A floppy-disk drive adds another $420. For about $1800, you come away with a powerful two-drive system, color graphics, and ample memory.

Fujitsu also displayed the impressive FM-11 (see photo 9), with a 2-MHz 68B09E, an 8-MHz 8088, and a 4-MHz Z80A as microprocessors. The FM-11 also has 128K bytes of RAM expandable to 1 megabyte, 76K bytes of RAM set aside for BASIC, and 192K bytes of video RAM. When the 8088 is playing central processing unit, the 6809 manages the graphics. That and the abundance of memory

Photo 9: *The Fijitsu FM-11.*

make the color graphics run like lightning, even at a resolution of 640 by 400 pixels. Fujitsu sells MS-DOS and CP/M-86 for the 8088, CP/M for the Z80, and three operating systems for the 6809: OS-9 (a multitasking system with window management) and the more familiar FLEX and UCSD Pascal. Prices are attractive, but Fujitsu probably will not sell the FM-11 in the United States.

The Japan Microcomputer Club

With its Information Center on the top floor of the 10-story Omron personal computer store in Tokyo's Ginza, the Japan Microcomputer Club has 28 branches in Japan and a membership of 8000. The Information Center has meeting rooms, seminar classrooms, and a library of software, books, manuals, and magazines. The club has 11 different microcomputers.

Its avowed goals are promoting popularization of microcomputers and technical advancement among members. The method of achieving technical advancement is somewhat more formal than American practice. The Japan Microcomputer Club gives a qualification test, issues licenses, and assigns members to one of four grades. Grade 1 is top level and requires more than five years of experience. Grade 4 is the lowest, and it requires "efficient manipulation of a personal computer." Grade 3 requires "highly experienced operating and programming," and grade 2 requires "wider and higher experience in hardware and software."

Photo 10: *The Sharp PC-5000.*

The club's sixth annual "Micro-Contest" had the theme "Intelligent Micro-Robot and Microcomputer Art" and awarded 13 prizes. The technical prizes were for a color- and sound-sensing robot made by Naotaka Yokoyama and a shape-selecting robot made by Tadashi Hino. Yokoyama's robot, NAOTA 3, can recognize, interpret, and act upon traffic signals—red, yellow, and green.

Market Trends

In general, the emphasis continues to be on more functional battery-powered machines, greater integration with video and home-entertainment equipment, attractive consumer packaging of systems and accessories, and a surprising degree of interest in optical communications.

The allocation of the crowded shelf-space in Akihabara's personal computer stores suggests that NEC is still leading the sales race. The most popular 16-bit personal computer, the PC-9801, seems to be the focal point

Photo 11: *The Sharp X1 in a store display.*

Photo 12: *The Sanyo MBC-55.*

of domestic 16-bit software development. Photo 1 on page 250 shows a stack of boxed PC-9801s waiting for customers on a street in Akihabara. NEC's PC-8201 dominates the portable market, attracting much more attention than the pioneering Epson HC-20. Tomihiro Matsumura, associate senior vice-president of NEC, said the company will develop smaller and more powerful battery-powered portables and may market those models, rather than the 8200, in the United States. Asked whether these would have microfloppy-disk drives, Matsumura said that NEC's advanced CMOS technology would render that unnecessary. But he added, "Compactness is very important in home computers." The PC-8000 Mark II and PC-8801 8-bit systems are seen everywhere.

Sharp's position appears to have improved over the past six months. Its battery-powered portable, the PC-5000, with 8-line by 80-character LCD and bubble-memory cartridges appeared at the Microcomputer Show '83 (see photo 10) and enhanced Sharp's position in the office market. The Sharp X1, introduced last October and seen in photo 11 in an Akihabara store display, enjoys great popularity among 8-bit customers. Expect to see further integration of video and home computing equipment with slick consumer packaging. Making a color television that turns into an RGB (red-green-blue) monitor at the flick of a switch gives Sharp a clever way to let its home computer marketing benefit from existing channels for consumer electronics. The idea also saves consumers the expense of buying a redundant color CRT. Sony's SMC-70, also an impressive machine, could challenge the Sharp X 1 by reducing its price and widening its marketing to include the home as well as the office.

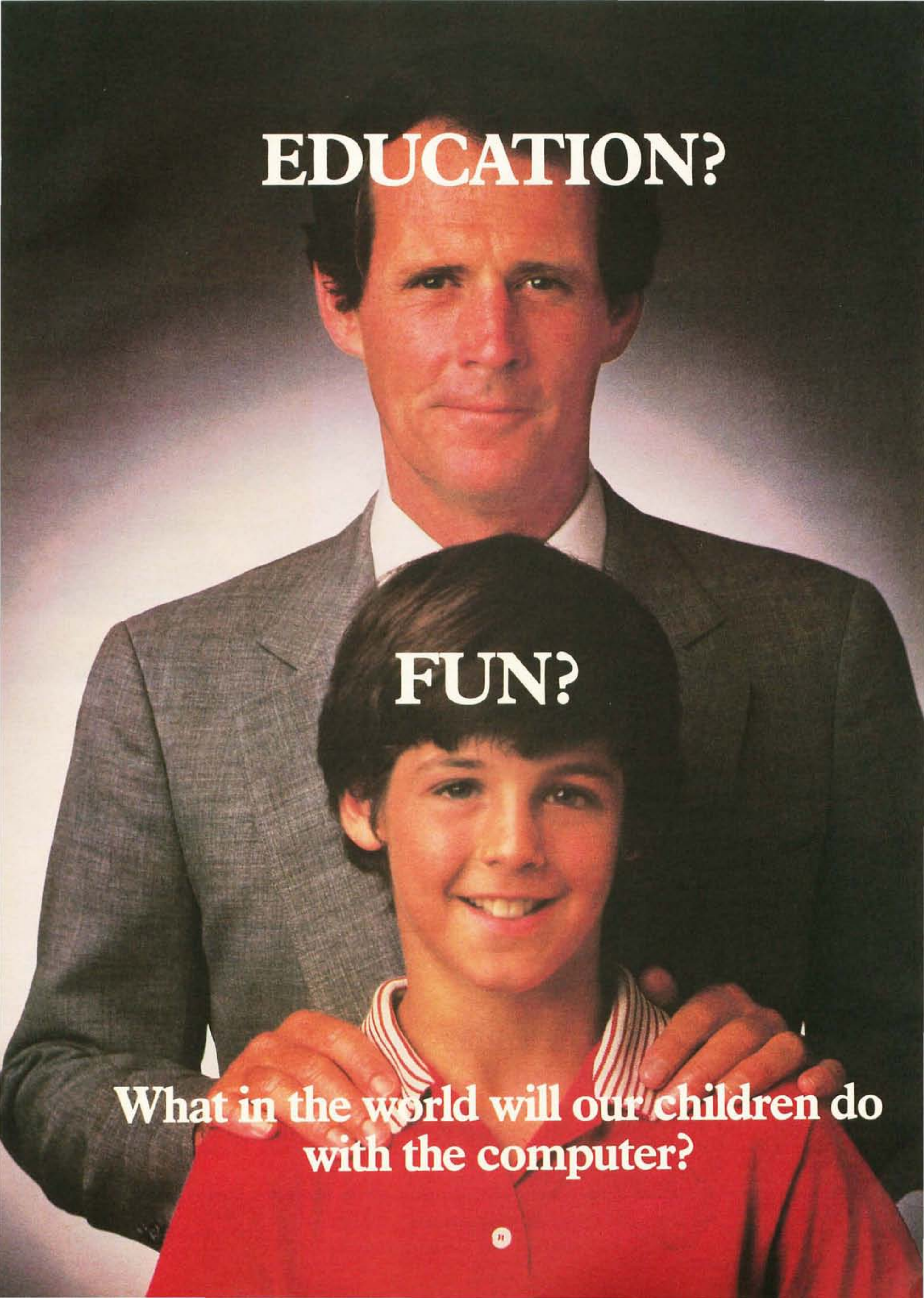
The Sanyo MBC-55, an 8088-based machine with attractive consumer-electronics styling (see photo 12) does not appear to have been widely distributed since its introduction in October. The Toshiba Pasopia 16, the Hitachi Basic Master 16000, and the National Mybrain 3000—three attractive 16-bit systems introduced in October—appear in many stores in Akihabara but not in numbers to rival the NEC PC-9801. The Mitsubishi Multi-16 seems to be somewhat popular.

Published survey results confirm the apparent trends in Akihabara. The Nihon Keizai Shimbun Market Share Survey for 1982 shows NEC's share of the personal computer market growing to 45%. Sharp ranks second with 17%, and Fujitsu finishes third with 12%, almost double its 1981 percentage. (These figures are in terms of production from April 1981 through March 1982).

Nikkei Personal Computing (April/May 1983) reports that as of December 1982, NEC had 34.3% of the market for business microcomputers, followed by Fujitsu's 11.8%, Sord's 9.6%, and Sharp's 7.8%. (These percentages reflect installed systems rather than annual production). The NEC PC-8001 and PC-8801 were by far the most popular machines in December 1982.

The magazine also explains that the most commonly reported operational and organizational problems with microcomputers in Japan were the time-consuming nature of input (reported by 42.2% of those surveyed), difficulty in programming (also 42.2%), and insufficient corporate understanding of microcomputers (37%). While the problem of input may be worse in Japan because of the size and complexity of the character set, the latter two problems are probably just as common in the United States.■

Phil Lemmons, West Coast Bureau Chief of BYTE, can be reached at BYTE/McGraw-Hill, 4th Floor, 425 Battery St., San Francisco, CA 94111.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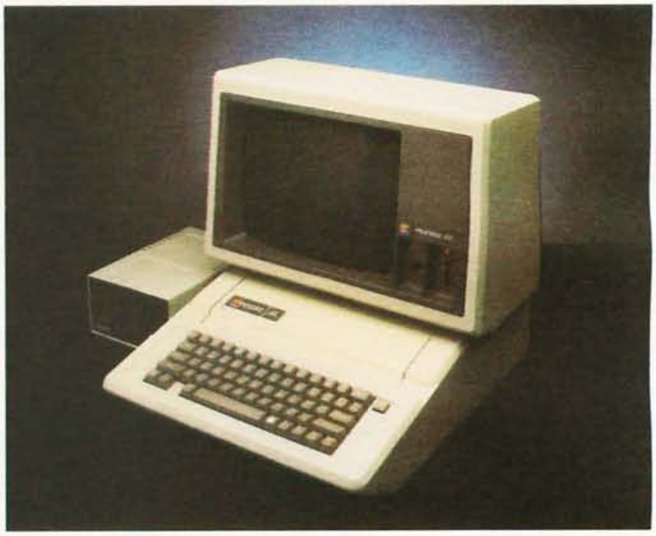

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The Unix Tutorial

Part 2: Unix as an Applications-Programs Base

A look at the availability of applications programs for the Unix operating system and customizing Unix for individual users

by David Fiedler

Last month, we examined the birth and growth of the Unix operating system from Bell Laboratories and looked at some Unix commands and how they fit together in simple and consistent ways. This article presents commercially available applications programs for Unix systems and illustrates some ways to make Unix more useful to you from both a user-interface and an applications perspective.

Almost as soon as Unix started becoming popular, people lined up on either side—for it or against it. Many self-proclaimed authorities felt that Unix would never make it in the commercial marketplace because it was unfriendly, too slow, lacked commercial features, and had no applications software.

In many respects, they were right, although perhaps they had their own reasons for implying these conditions would always hold. The people who have been around Unix for years know that besides being an ideal program development environment for computer professionals, it is also a powerful and flexible operating system for using applications programs.

Unix offers multiuser and multitasking capabilities, a hierarchical file system, I/O (input/output) redirection, and hundreds of utilities, such as electronic mail and typesetting. The appearance of Unix to the user and the structure of its commands can be customized to suit the sophistication of each user. The availability of Unix on microcomputers like the Apple Lisa, IBM Personal Computer, and TRS-80 Model 16 is directly related to its portability. This is due in large part to the C programming language used to write the Unix operating system. Most applications programs and utilities for Unix also tend to be written in C.

The Change in Languages

Some of us remember when advocating structured programming, writing readable documentation, and using a computer terminal instead of a card punch were considered revolutionary or at least seditious acts. Then a few years ago, almost every software engineer was frantically studying Pascal, which was then clearly the wave of the future, or so it seemed. Pascal would be the universal structured language, suitable for any project; school children would learn it instead of BASIC; Pascal programs would be the same everywhere; be able to write Pascal and you would always have a programming job. If I didn't know that the same had been claimed for PL/I, I might have been fooled. Today, of course, we know "better": we have Ada. But I digress.

Pascal does have its virtues, but not enough of them. The C programming language, however, has just the right extra features needed to make it a viable candidate for widespread acceptance: the ability to manipulate pointers to information, the de facto standard system interface provided with Unix, and fast-running and compact code. The biggest plus for C is the instant portability of programs not only between separate Unix systems running on different processors, but also between other operating systems and Unix. Admittedly, the expectation of a huge market for Unix applications is the biggest push behind C. In contrast, the chief operating system associated with Pascal has been the UCSD p-Sys-

tem, with no special attributes other than portability and a lackluster history in the commercial market.

I don't claim that C will be the universal language. C is too cryptic for many people, too close to assembly language for others. It's not as terse as APL, but it's not the gothic novel that COBOL is, either. C is just a very good language for what it was designed for, namely, systems programming—writing operating systems, device drivers, compilers, high-speed utility programs, and the like. For writing quick and easy general-purpose programs, BASIC is the popular choice. Engineers and scientists will continue to crunch numbers with FORTRAN, and Big Business will probably use COBOL until the end of the century. For those are the *stated purposes* of these languages; like an athlete, each excels in its own special area.

Assembly language will continue to be necessary for those things that cannot be done in C, which raises the question, why doesn't someone just make a computer that uses C as its assembly language? In 1981, BBN Computer Company did just that. The BBN C Machine was billed as "the first computer optimized to execute the C language." It uses 17 addressing modes while implementing often-used C constructs in microcode. An implementation of a similar machine as a *single* silicon integrated circuit is not far off; possibly the Bellmac-32 processor from Western Electric will be the closest to this. In fact, now that AT&T has announced that the central kernel of Unix will not be changed, Unix on a chip is not far off, either.

With the Unix kernel on a chip, a reasonable implementation of Unix could be built with about two dozen main integrated circuits, such as eighteen 256K-byte RAM chips giving a full half-megabyte of parity-protected memory, a microprocessor, a memory-management device (if not included on the microprocessor), the kernel chip, a Winchester disk controller, and serial port controller. Bearing in mind the dropping prices of Winchester disks, this could mean an end-user price of $2500 to $5000 for Unix-based computers—just about the range I've predicted for AT&T's systems.

Where Are the Programs?

Some industry watchers are still leery of Unix, waiting for the promised applications programs, friendlier and more capable than those available on current 8-bit computer systems.

Patience, say I. We have to remember the classic sequence of events that goes along with any major new phenomenon in the computer field.

First, *the hard-core computer people discover the product.* From 1975 to 1979, Unix and C were known to comparatively few students, computer scientists, and advanced users.

Next, *a few entrepreneurs notice the product's potential.* Between 1979 and 1982, firms such as Whitesmiths Ltd., Interactive Systems, and Onyx Systems began selling Unix-related hardware and software. The computer press started to print articles discussing Unix and why pro-

grammers liked to use it.

Then, *marketing panic develops around the product as it gains mass appeal.* The market begins to be saturated with similar products whose differences can hardly be distinguished by the untrained observer. Beginning in 1982, dozens of companies, ranging in size from one-man firms to the IBM Corporation, have offered Unix, Unix-based computers, Unix look-alike software, and a smattering of applications.

Finally, *the shakeout occurs.* By this time, the largest companies have split up the lion's share of the hardware market by dint of service, advertising, and cut-throat competition. The best software has emerged from rough beginnings or has been written recently in response to the cries of the end users. For Unix, this period is only now beginning and will most likely continue for a number of years.

As I've said, this series of actions is not new. It happened in the S-100 industry a few years ago, it is happening in the portable computer market now, and it happened in the mainframe and minicomputer business a decade or so ago. Notice how stable the applications software market is in the minicomputer and mainframe industry and how few different operating systems are widely used on the 8080/Z80 class of processors. These markets have now settled down, and the needs and wants of hobbyists have been superseded by those of the folks in three-piece suits. This is generally better for the average businessperson wanting to use computers.

Unix, however, is still basically in the stage of market panic. Until software firms with a great deal of capital invest their people's time in creating the kind of software the market desires, the only software available will be that which programmers want to write. Because many C programmers— typically systems programmers by nature—often feel that applications code is beneath their dignity, they will not write it willingly; they have no personal interest in it. And frankly, C *is* a lousy language

For Unix, the shakeout period is only now beginning and will most likely continue for a few years.

for writing accounts-receivable programs. Therein lies the reason for the general lack of applications software in C, and therefore for Unix. But good old portability, along with AT&T, saves the day again.

I mention AT&T because it has planted a small army of programmers (2500 or so) in and around Lisle, Illinois, for the express purpose of creating supportable, marketable programs for use on Unix machines. Expect a small mountain of code from that source! Generally, however, many of the classic applications programs now available on Unix systems are written in classic applications languages: COBOL and BASIC. Companies such as Ryan-McFarland, Silicon Valley Software, and Science Management Corporation have simply ported compilers

Company	Price	Language	Operating System; Processor	Description
American Business Systems Inc. 3 Littleton Rd. Westford, MA 01886 (617) 692-2600	$1000 to $1500 each	RM/COBOL	Xenix, Unix; Z80, Z8000, 68000, TI990	Business Accounting Control System: accounts payable, accounts receivable, general ledger, payroll, order and inventory management, financial modeling program, report writer
BIS Software Ltd. York House 199 Westminster Bridge Rd. London, SE1 7JT England (01) 928-3551	$20,000	RM/COBOL, C	Unix System III; Onyx, 68000, Plexus, Perkin-Elmer	BONDAID: written for international bond market, gives information on history, parity, floaters, yields position and pricing in international bond market
Computer Masters 25 West 39 St. New York, NY 10018 (212) 221-3016	$8000	RM/COBOL	Unix, Oasis, CP/M, MP/M	Marker: garment industry vertical market package: accounting and inventory programs
Cyma Corp. 2160 East Brown Rd. Mesa, AZ 85203 (602) 835-8880	$1095 to $2795	C-BASIC	Cromix, Unix	general ledger, accounts payable, accounts receivable, payroll, inventory, Time Billing for Professionals, other vertical market packages
IRIS Systems Inc. 225 West 30th St. National City, CA 92050 (619) 474-2010	$500 to $650 each	COBOL	Uniplus+, Unix V7; 68000, PDP-11, VAX	ACUITY: general ledger, payroll, accounts payble, accounts receivable, order entry, inventory management, customer order processing, fixed assets
Lime Tree Computer Systems 1 Penn Plaza New York, NY 10001 (212) 594-6172	$700		RSTS, RSX-11, RT-11, Unix, PDP-11	labor and job tracking for manufacturing support
MBSI Dover Rd. Willow Hill Building Chichester, NH 03263 (603) 798-5700	$1000 each	RM/COBOL	CP/M, MS/DOS, Unix; 68000, 8080, Z80, 8088	accounts payable, accounts receivable, general ledger, payroll, sales analysis, order entry/inventory
Open Systems Inc. 430 Oak Grove Minneapolis, MN 55403 (612) 870-3515	$595 each	COBOL, BASIC	Xenix for Lisa or Altos, CP/M, MP/M, MS-DOS, RMCOS, Oasis; 8080, 8086, 68000	accounts payable, accounts receivable, general ledger, sales order processing, payroll, inventory, job cost control, global report writer
Quadratron Systems 14542 Venture Blvd. Suite 205 Sherman Oaks, CA 91430 (213) 789-8588	$295 to $495	C	Unix; 68000	Vertical Market Packages for Ad Agencies: estimating, cost tracking, billing, bookkeeping. Electronic Calendar emulates Day-Timer scheduling reminder
Scientia Computer Applications 5001 Beach Rd. -06-25 Golden Mile Complex Singapore 0719	not available	C	Unix	shareholder register, accounting, DBMS with report generator, mailing list/membership program
Unisoft Inc. 303 West 42nd St. New York, NY 10036 (212) 327-6800	$400 to $800		Unix, Venix, Xenix; PDP-11, VAX, Z8000, 68000, 8086	Viewcomp: spreadsheet designed specifically for Unix, has macros, bar graphs, choice of absolute, relative, or computed coordinates.
Urban Software Corp. 330 West 42 St. New York, NY 10036 (212) 736-4030	$385	C	Unix, Xenix; PDP-11, 68000, Z8000, 8086, VAX	Leverage: mailing list/information manager, can print letters or labels, on-screen search capability

Table 1: *A sample of business applications programs available for the Unix operating system.*

for their languages (RM/COBOL, SVS Basic-Plus, and SMC BASIC) to Unix-based computers. Then, programs that have been available on various minicomputers for several years are moved to the new machine and recompiled—and almost magically, you can buy applications on Unix.

Tables 1, 2, and 3 show some of these programs and their sources. Keep in mind that, in the rush to be the

Text continued on page 267

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Company	Price	Operating System; Processor	Description
Touchstone Software Corp. 909 Electric Ave., Suite 308 Seal Beach, CA 90742 (213) 594-9266	$495	Unix; 8086, VAX, PDP-11, Z8000, 68000	MIMIX: lets you run CP/M operating system with special help for new users
Virtual Microsystems Inc. 2150 Shattuck Ave., Suite 720 Berkeley, CA 94704 (415) 841-9594	$3500	Unix, RT-11, IAS, RSX-11, RSTS, VMS, AOS, RDOS	The Bridge: lets you run CP/M binary code

Table 2: *Operating-system emulators for Unix.*

Company	Price	Operating System; Processor	Description
Applied Technology Ventures Inc. 610 National City—E 6th Bldg. Cleveland, OH 44114 (216) 589-0525	$500	Unix; 68000, PDP-11	Uniword: spelling, global substitutions, customized form letters, Undo key, menu driven
Computer Methods Ltd. POB 709 Chatsworth, CA 91311 (213) 998-7979	$2000 to $7500	Unix V7, System III or V, Berkeley 4.2, Xenix, Uniplus+; VAX, PDP-11, 68000, Z8000, 8086	XED: has spelling checker, math, spreadsheet and mailing list capabilities, works over 1200 bps modem XPR: formatter processes output of XED for precision line printers
Handle Corp. 140 Mackinaw Rd. POB 7018 Tahoe City, CA 95730 (916) 583-7283	$200 to $500 each	Unix, Xenix; Hewlett-Packard, 68000 (8086 underway)	Handle Writer: with modules for word processing, mail merge, spelling checker, graphics capability, document writer, table of contents and indexing, calculations, document management, security function key driver
HCR 10 St. Mary St. Toronto, ON M4Y 1P9 Canada (416) 922-1937	$750	Unix V7 or System III; PDP-11	HCR/EDIT: upwards compatible with ed (the standard Unix editor), uses standard control keys, termcap library
Horizon Software Systems 185 Barry St., Suite 4821 San Francisco, CA 94107 (415) 543-1199	$750	Unix System III and look-alikes	Horizon Word Processor: editor, formatter, document manager, embedded format commands including: headers and footers, pagination, super- and subscripts, typesetting, menus, window into file for text editing, report, document, cut and paste, English language commands.
Information Nexus Ltd. 6272 West North Ave. Chicago, IL 60639 (312) 637-7995	$450 to $750	Unix; PDP-11, 68000	NEX: horizontal scroll, dynamic window size changing, error recovery
Info Sciences Dept. The Rand Corp. 1700 Main St. Santa Monica, CA 90406 (213) 393-0411	$200	Unix V6, V7, and 32V; PDP-11, VAX	"e": enhancement of ned (new Unix editor), can edit multiple files at once, recovery from system crashes, on-screen justify, fill. Can manipulate files while in editor
The Santa Cruz Operation 500 Chestnut St. Santa Cruz, CA 95060 (408) 425-7222	$750	Unix, Xenix; Z8000, Altos, PDP-11, Lisa	Uniplex: menu driven, cut and paste, file locking, user-configurable
Softest Inc. 555 Goffle Rd. Ridgewood, NJ 07450 (201) 447-3901	$500 to $750	Uniplus+, Xenix, MS-DOS; 68000, 8086/8088	LEX: menu-driven, proportional spacing, mass mailing document merge, calculator, spelling dictionary

Table 3: *Word processors and full-screen text editors.*

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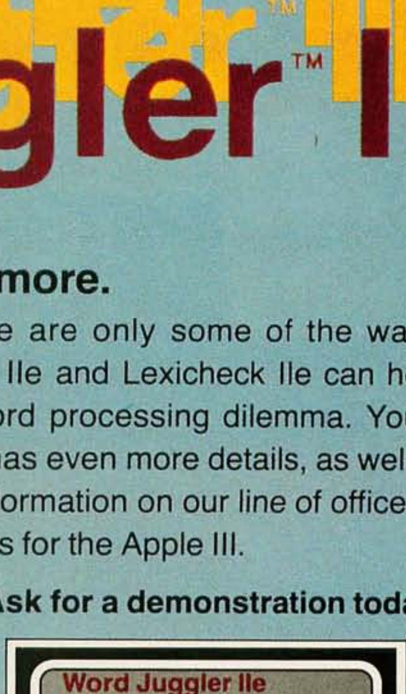

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Company	Price	Operating System; Processor	Description
Computer Software Design Inc. 1911 Wright Circle Anaheim, CA 92806 (714) 634-9012	$850 to $2500	Xenix; TRS-80 Model 16	Data Ace: relational database, English query commands, demonstration disk $20
International Software Enterprises 85 West Algonquin Rd., Suite 400 Arlington Heights, IL 60005 (800) 323-3629	$2200 to $20,000	Unix, Xenix; PDP-11, 8086, Z8000	MDBS: English-language queries, report writer can physically cluster related records, encryption capabilities, password access code facilities, data validation, written in C
Logical Software Inc. 1218 Massachusetts Ave. Cambridge, MA 02138 (617) 864-0137	$5000	Unix, Xenix, UNOS	Logix: interactive programming, database management, report and form generation, educational license available, database for engineering
Rod Manis 1300A Space Park Way Mountain View, CA 94043 (415) 967-7778	$250	Unix, Uniplus+; 68000	/rdb: uses Unix utilities; accounting and manufacturing packages available, written with the database
Pacific Software Mfg. Co. 2608 Eighth St. Berkeley, CA 92710 (415) 540-0616	$1395 to $12,000	Unix System III, CP/M, CDOS, Isis, North Star DOS	Sequitur: relational DBMS, integrated word processing, can recover earlier versions of changed records, report generator, built-in screen editor, written in C
PHACT Associates Ltd. 231 East 11th St. New York, NY 10003 (212) 420-1512	$250 to $950	Unix and look-alikes, Idris, MS-DOS; 68000, Z8000, 8086, VAX, PDP-11, Perkin-Elmer	PHACT-dbrms: relational database manager, data dictionary, ISAM and relative record access, written in C
Relational Database Systems Inc. 1208 Apollo Way, Suite 503 Sunnyvale, CA 94086 (408) 746-0982	$4000	Unix and look-alikes	Informix: relational database, audit trail and recovery, report writer, other packages to go with it
RHODNIUS Inc. POB 1, Station D Scarborough, Ontario Canada M1R 4Y7 (416) 922-1743	$5000	Unix V6, V7, and 32V, PWB, Zeus, Xenix; VAX, Onyx, ZILOG System 8000, Perkin-Elmer	Mistress: educational license, relational database, with report generator, user-friendly query language, Unix shell interface, two C language interfaces, report writer, interactive interface, small-to-medium database
Science Management Corp. Proprietary Systems Div. POB 6800 Bridgewater, NJ 08807 (201) 685-9000 / (800) 526-3968	$595	Unix; Onyx, IBD Series/1, TI9900, Mercator 8086, Basic 4, Rexon Pertec	Idol: interactive, menu driven, can have passwords, audits, documentation control, statistics report
Unify Corporation 9570 Southwest Barbur Blvd. Portland, OR 97219 (503) 245-6585	$3000	Unix; VAX, PDP-11, 68000, 8086	Unify: menu-driven, interactive, applications and development tools include menu handler, automatic data entry, query by forms, report generator, and SQL—a structured query language based on IBM's Sequel 2 relational language.
A.I. Wasserman Room A16 University of California Medical Info Science San Francisco, CA 94134 (415) 666-2951	$200 (educational licensees of Unix only)	Unix; VAX, PDP-11	Troll: relational DBMS with screen editor

Table 4: *Database management systems for the Unix operating system.*

first with Unix-based applications, some of the software brought from larger and faster computers may not have been redone so as to make the best use of Unix features, or it may tend to use system resources more heavily on a smaller system. As always, it pays to investigate software carefully before betting your business on it.

The tables should not be viewed as all-encompassing but rather as a guide to general availability.

Database Management Systems

Except for ported applications, the first business programs to appear on a new system such as Unix are

AGS Computers Inc.
111 Broadway
New York, NY 10006
(212) 962-4646

American Institute for Professional Education
Carnegie Bldg.
100 Kings Rd.
Madison, NJ 07940
(201) 377-7400

Computer Technology Group Inc.
Telemedia Inc.
310 S Michigan Ave.
Chicago, IL 60604
(312) 987-4000 / (800) 621-3155

Institute for Advanced Professional Studies
55 Wheeler St.
Cambridge, MA 02138
(617) 497-2075

Integrated Computer Systems
3304 Pico Blvd.
POB 5339
Santa Monica, CA 90405
(213) 450-2060 / (800) 352-8251

International Technical Seminars
520 Waller St.
San Francisco, CA 94117
(415) 621-6415

RLG Corp.
1760 Reston Ave., Suite 508
Reston, VA 22090
(703) 471-6860

Structured Methods Inc.
7 West 18th St.
New York, NY 10011
(212) 741-7720

Technical Education Research Centers
8 Eliot St.
Cambridge, MA 02138
(617) 547-3890

User Training Corp.
POB 970
Soquel, CA 95073
(408) 354-6433 / (415) 321-0889

Table 5: *Companies that give training or courses on Unix, its utilities, and applications programs.*

generally database management systems (DBMSs). This is partly because they are more interesting to write than accounting packages and partly because they are used as building blocks for general applications. A DBMS is a system of programs that can be thought of as a high-speed interface between data stored on a computer system and applications code. With a DBMS, a skilled programmer can create, fairly quickly, a set of applications programs in a *fraction* of the time it would take to write them otherwise. The programmer is freed from the necessity of maintaining the data files and just has to worry about the relationships among the data items themselves. The true DBMS is not a predefined program for managing data, therefore, but a base for creating applications.

While a complete guide to selecting a DBMS would be out of place here, your first step should be to decide how much programming you wish to do and how flexible your needs are. A simpler data management system, often implemented as a mailing list package, may be all you require. This type of application may be found in table 1, while table 4 summarizes information about some of the true DBMS systems available for Unix-based computers.

Using Applications on the Unix System

If you're the type of person who learns to use a new computer by plugging it in and trying it out, you probably don't have to enroll in any sort of formal training course to use Unix. Many other people will be exposed to Unix in the next few years who have never used a computer before. This fact is responsible for the sudden appearance of quite a few organizations that will teach you or your staff how to use Unix more effectively (see table 5). Most of these firms do their instruction in seminars and will do in-house courses; a few, such as International Technical Seminars, the Institute for Advanced Professional Studies, and Structured Methods Inc., specialize in actual hands-on work with a Unix-based computer. User Training Corporation's courses are self-taught using audiodigital technology, which combines an instructor's voice with an actual session shown on your display screen, while the Computer Technology Group features video-tape-based training.

My experience in training people with a wide range of expertise how to administer Unix systems, however, leads me to point out the following: It is *not* always a good idea to teach *everyone* how to use the system all at once.

Many businesses that will be buying Unix computers, especially small businesses, will have little or no experience with multiuser systems. With single-user microcomputers such as Apple or CP/M systems, it is fairly easy to control system use. Just limit computer access to those who must perform the work. When you begin putting terminals around the office connected to a central Unix facility, more people will get a chance to use the new machine, passwords will be passed around, and some people will experiment more than others. At this point, those who have some knowledge of the system are the most dangerous in terms of system integrity and security (i.e. not having your sensitive files looked at, changed subtly, or even removed). Deliberate malicious acts are not the worry here—it's mistakes made while experimenting that can be dangerous (naturally, this doesn't apply to software development environments where the highest priority is that your programmers learn the system). We have found that in many organizations this is also the critical time when backup procedures are still not totally worked out.

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CB-80 $459
Link-80 $90
FOX & GELLER
Quickscreen $135
Quickcode $265
$65 DUtil
DGraph $265
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Quadratron Systems Inc. 14542 Ventura Blvd. Sherman Oaks, CA 91403 (213) 789-8588	$295 to $495	Unix; 68000	Configurable Menu System: screen development package; can act like Fortune menu system with window extensions
Schmidt Associates 7 Mt. Lasser Dr. San Rafael, CA 94903 (415) 499-8001	$400	Unix; 68000	/menus: configurable menu system, to make Unix easier for novice; good for administration and maintenance
Softest Inc. 555 Goffle Rod. Ridgewood, NJ 07450 (201) 447-3901	$250	Unix; PDP-11, 68000, Perkin-Elmer	Menu Creation/Interpretation System (MCIS): error recovery, user profiles, inter-menu linking; easy to reconfigure

Table 6: *Menu systems or Unix Shell replacements that present a simple view of Unix for the novice user.*

dinary people away from the all-powerful computer? Hardly; just a cautionary note to those who are just beginning to administer a system of their own. Skeptics would do well to note that there are various ways of totally incapacitating a Unix system by a *single command line*. The point is that people who only have to do word processing might be better served, especially at the beginning, by a system set up so they can only do word processing.

This is fairly easy to do. On any standard Unix or look-alike system, it is possible to force a particular person's log-in account to execute a given program rather than the Unix Shell program itself, as is normal. Thus, secretaries could be restricted to a word processor and data-entry personnel to an appropriate portion of the database system. Or users could be given an account that lets them choose among several different applications programs by means of a Shell program that they cannot exit without logging off the system. Users of Unix System III and later versions can also be assigned a restricted Shell, known as rsh, which prevents them from using someone else's directory, redirecting output of commands, or using commands other than those permitted by the system administrator.

As people learn more about the system, their access to other commands can be expanded as necessary. Properly handled, this expanding access technique is useful in exposing people gradually to the power of Unix, without overwhelming them with the sheer number of commands and options or opening the system to many novice users all at once. Some Unix-based systems are using this technique already; for example, the Fortune 32:16 computer implements the entire user interface as one large menu system that allows even a novice to follow logical steps in performing tasks previously reserved for "experts," such as adding new users, backing up the system, and installing new software. Meanwhile, expert users can bypass the menu entirely.

This type of menu facility can be created on any Unix machine by a competent programmer, but it may be easier to start from an established base. Table 6 lists a number of commercially available menu systems for a range of computers. While these are most useful to an OEM (original equipment manufacturer) or system house wishing to create a better working environment for clients, they might well come in handy for end-user organizations as well.

Aside from adding menus, you can customize your Unix environment in many different ways. For instance, one of the biggest complaints some people make about Unix is the way the commands are named. The terseness that characterizes Unix is certainly most apparent in command names like cp, mv, cat, and lpr. If you don't like them, it's perfectly possible to change them. By becoming a super-user, you can just go into the /bin directory where most commands reside:

```
$ su
Password:
# cd /bin
# mv cp copy
# mv mv rename
# mv cat type
mv: not found                (you forgot that you renamed the mv command)
# rename cat type
# rename lpr print
#
```

This will work, but imagine the confusion that would result when someone else attempted to use the normal terse command names. A more reasonable solution is to create new links to the command names, which essentially allows the same file (a command is, after all, just an executable file) to be called by more than one name.

Text continued on page 274

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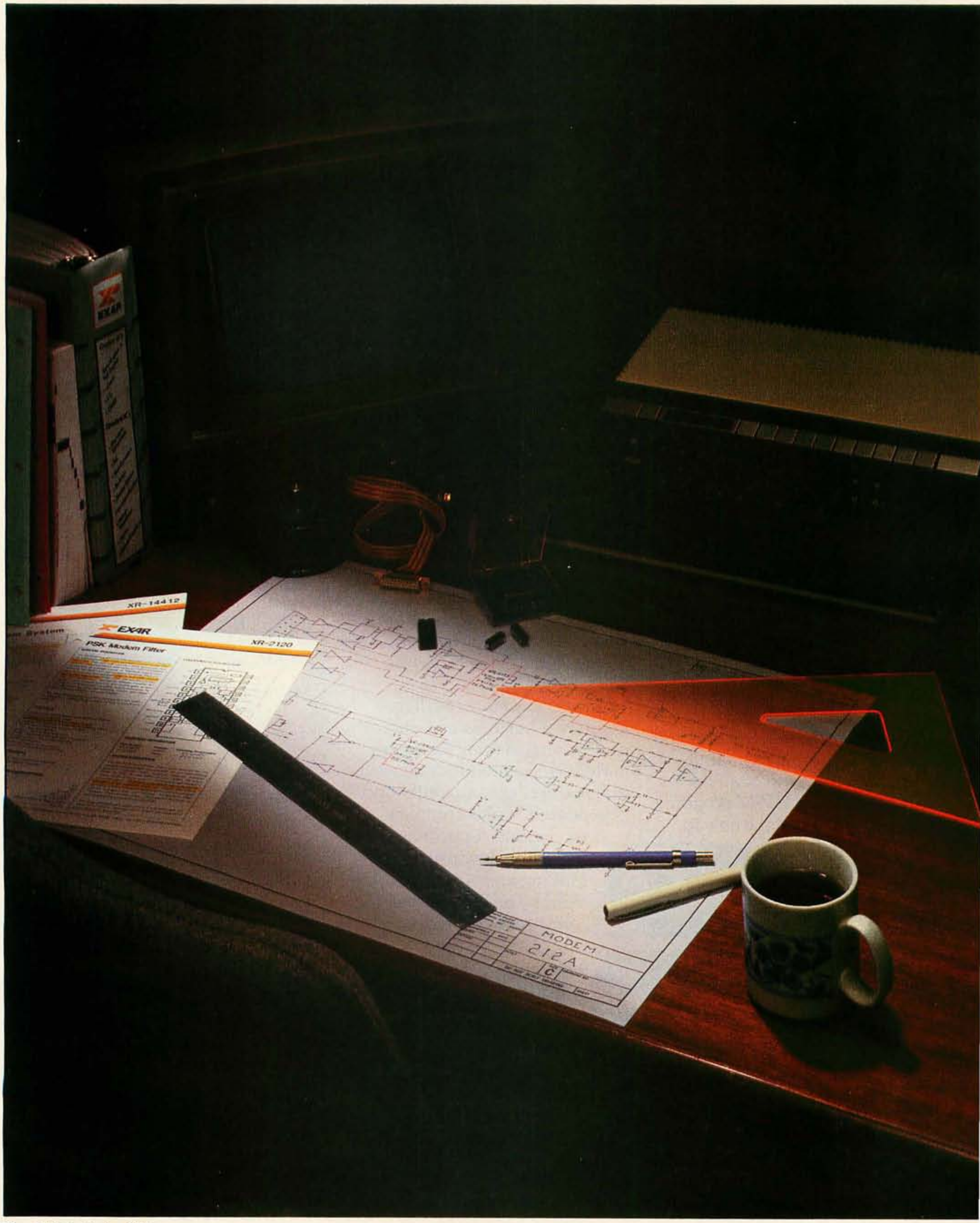

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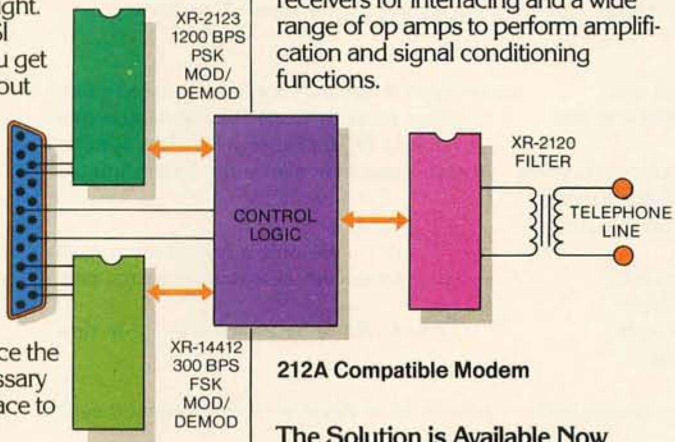

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The difference between an extra link and a copy of a file is that creating a link creates a new directory entry that points to an existing file and doesn't take up extra space in the file system. This is especially handy when creating links to large files like multimegabyte databases.

However, this prevents ordinary users from creating their own programs with these names. So the easiest way is to change the order in which the Shell searches directories for your commands. This affects no one else, requires no special permissions, and can be changed at any time, but you must set up a new directory:

```
# mkdir /alias              (create special directory for links to system files)
# chmod +rwx /alias             (allow users to create their own alias files)
                                 (chmod 777 for those with older systems)
# ln /bin/mv /alias/rename  (create some new names for system utilities)
# ln /bin/cp /alias/copy
# ln /bin/ed /alias/edit
$                                             (become a regular user again)
$ echo $PATH                         (show current execution search path)
:/bin:/usr/bin
$ ed .profile                       (create file to be executed at log-in time)
?.profile
a
PATH=:/alias:/bin:/usr/bin  (search /alias directory before system default)
.
w
27
q
$
```

Why must you be a super-user to do this? The /bin directory is generally on a different logical file system than the users' personal directories. Due to the way the link command works, you can't link across different file systems, so it is impossible for a regular user to create a set of links under that user's home directory to system files.

What about the $PATH we used? Like the other variables beginning with a dollar sign ($), this is interpreted by the Shell. The $PATH may be shown (with the echo command) or changed at any time, much like an ordinary variable in C or BASIC. And .profile is simply a file that the Shell executes if the file is found in your home directory when you log in; it's expected to hold a number of Shell commands and is typically used to set up your terminal characteristics and default execution path. It can be changed easily and so is ideal for starting novice users off with certain programs. Another popular Shell variable to modify is the prompt, which you can change to whatever you want in the following manner:

```
$ PS1="Yes, master: "
Yes, master:
```

The .profile is called .login on systems using code developed at the University of California at Berkeley (UCB) or derivations from that code. UCB systems will also have a Shell command called alias that performs the same function as this $PATH modification. Otherwise, if you wish to accomplish aliasing (rename commands) on an individual basis without being the super-user, it is necessary instead to make each new command simply a one-line shell program:

```
$ cd                                        (go to your home directory)
$ mkdir bin                        (create a personal command directory)
$ cd bin                                                    (go to it!)
$ echo 'mv $*' > rename   (put the system commands in your selected
                                                            file names)
$ echo 'cat $*' > type
$ echo 'grep $*' > search
$ echo 'pr -w132 $* |lpr &' >lp          (refer to last month's article)
$ chmod +x *                (make these files executable, or chmod 744)
$ cd ..                     (go back "up" one level to home directory)
$ ed .profile           (modify your .profile to include the new directory)
27
c
PATH=:$HOME/bin:/alias:/bin:/usr/bin
.
w
38
q
$
```

Because this is something any user can do, variations of this technique are usually discovered eventually by anyone who wishes a customized environment. Naturally, these short shell programs can be made longer; perhaps setting up particular files or directories to be used,

Ishell: A Unix Information-Retrieval System

Ishell is a simple data-retrieval system comprising a data file of logical records and the associated Unix Shell command files that process the data file and produce a formatted report. Implemented with selected system utilities found on Unix, Ishell may be used to keep track of almost any kind of data, from a project development team's ideas-and-documents file to a writer's drafts of different articles and their reference documents.

Each record in the data file consists of a series of physical records. The first physical record contains up to four fields: the logical record identification number, a capital N *(standing for name or title), the record title, and an optional locator field. Subsequent physical records contain three fields: the logical record ID, a capital* K *(for keyword), and a freeform content line. For example:*

```
000199:N:Spectragraphics: work file cabinet
000199:K:System 1250—a 16-color raster or graphics display
000199:K:system that emulates the IBM 3250 graphics display
000199:K:system. Local or remote configuration, supports
000199:K:up to 4 workstations per controller or up to 64
000199:K:workstations per channel controller.
```

*The logical record ID—*000199, *in the example—is a sequentially assigned number that links together the physical records into one logical record. It has meaning only to the Shell programs and never appears in the output. The record title and locator field—*Spectragraphics *and* work file cabinet *in the example—are context dependent and may be used to describe the data entry and a particular physical (i.e., noncomputer) location where the source data may be found. The locator field, in particular, permits anyone who may access the data file to find further information on the data.*

Using Ishell

The data file is called ishell.data, *and it may be edited with any standard text editor available. You must assign a new logical record number for each product or project to be entered into the system. Following the format of the previous example, a short article may be entered, and keywords may be input on lines of their own. This will facilitate later retrieval by use of the dictionary file* ishell.dict, *which may be created by running the program* create.dict.

You search the data file by following three steps. First, find the appropriate terms to search for by looking in the dictionary file. Next, edit the file awk.search *to contain the string to look for by using a proper Boolean equation. Then run the* ishell *program, which will automatically display the information thus found. The output file* ishell.out *contains this information and may be printed or edited further.*

Program Logic Flow

The commands used in the Ishell information and retrieval system are shown in listing 1. The ishell *file contains all the commands necessary to perform the search. The* awk.long *program creates one long physical record for each set of logical records with the same record ID in the data file. The output is directed both to the* ishell.long *file and to the search program* awk.search. *This program creates a sorted list of record ID numbers matching the search criteria called* ishell.list, *which is then joined to the* ishell.long *file and piped to* sort *to create the* ishell.sort *file. Finally, the* awk.short *and* awk.out *programs are used to format the selected output file* ishell.out *and direct it to the terminal.*

Improvements

Ishell is not a fast or particularly user-friendly system, but it does illustrate the concept of developing a useful tool with Unix utilities. Much faster searches, if quality of output is not important, may of course be done by searching the data file for a particular keyword using grep, *finding the matching record ID numbers, and using* grep *again for those ID numbers, thereby finding all associated entries.*

A Shell or C program could easily be constructed to accept and prompt for user input, automatically assigning record ID numbers and adding the N *and* K *fields. Menus and prompts for keywords to search on could be added. But as it stands, Ishell will run on virtually any Unix or Unix-like system as is; just type in the programs given in listing 1 and your data.*

or sending a series of control sequences to a terminal or printer. Once you learn how easy it is to set up things the way you want, you are likely to be more interested in creating your own small applications programs.

Some Real Examples

The classic example of a "home-built" application on Unix is that of the personal phone directory. I'll show you how this can be done and suggest some methods of improving it as we go along. Then we'll explore some more elaborate applications that can be constructed using standard Unix utilities.

A phone directory can be as complex or as simple as you wish. I've seen some people go to the trouble of writing a program that would format names, addresses, and phone numbers and provide menus for selection by category. Most people will just want something simple to understand and use. The simplest directory is merely a file of names and phone numbers:

```
Joe Blow    (201) 666-1913
Ella Fitz    (415) 339-9001
Ada Lovelace    (800) 543-7895
Rosanne Rosannadanna    (212) 986-1717
Anna Stasia    (201) 310-4697
Tricia McMillan    44(01) 276-709
```

After creating your file, which I'll assume is named phonelist or something similar, the simplest way to retrieve data from it is to use the string-and-pattern finding pro-

Listing 1: *Command files for Ishell, a simple data retrieval system. Programs copyright © 1983 Access Technology Inc.*

```
Ishell:

rm ishell.list ishell.long ishell.out ishell.sort
awk -f awk.long ishell.data | tee ishell.long | awk -f awk.search > ishell.list
join -j1 1 -j2 1 -t: ishell.list ishell.long | sort -ft: +2 -3 >ishell.sort
awk -f awk.short ishell.sort | awk -f awk.out | tee ishell.out | cat

create.dict:

awk -f awk.dcreate ishell.data | sort -u >dict.tmp
cat ishell.name dict.tmp > ishell.dict
rm dict.tmp

awk.dcreate:

BEGIN (FS = ":")
(if ($2 == "N")
    (print $3 > "ishell.name"
     next
    )
    (print $3
    )
)

awk.long:

BEGIN (FS = ":" ; OFS = ":" )
(if (NR == 1)
    (printf ("%s:" "%s:" "%s:" "%s:", $1, $2, $3, $4)
     prev = $1
     next
    )
else (while ($1 != prev)
        (printf ("\n")
         printf ("%s:" "%s:" "%s:" "%s:", $1, $2, $3, $4)
         prev = $1
         next
        )
    )
        (printf ("%s:", $3 )
        )
)

awk.out:

BEGIN (
    FS = ":"
    OFS = ":"
    print "ISHELL Data File Selections"
    printf ("\n")
    printf ("\n")
    prev = 0000)
(if ($1 != prev)
    (printf ("\n")
        print $2
                prev = $1)
else print $2)

awk.short:

BEGIN (FS = ":" ; OFS = ":")
(i=3
record = $1
while   (i <= NF)
        (printf ("\n")
         printf ("%s:" "%s:", record, $i)
         ++i
        )
)

awk.search:

BEGIN (FS = ":" ; OFS = ":" ; print "0000:")
(if ($0 ~ /[Gg]raphic/)
    (printf ("%s:\n", $1))
)
```

gram, grep:

```
$ grep Joe phonelist
Joe Blow      (201) 666-1913
$
```

You can find all the New Jersey listings just as easily:

```
$ grep 201 phonelist
Joe Blow      (201) 666-1913
Anna Stasia   (201) 310-4697
$
```

The first improvement to be made is to make a command that knows the name of the phone number file:

```
$ echo 'grep $1 phonelist' > phone          (create a Shell program)
$ chmod +x phone         (make it executable (or use chmod 744))
$ phone Anna                                 (and try it out)
Anna Stasia     (201) 310-4697
$
```

This is easier to type, and you don't have to remember the name of the phone file. But suppose you're in a different directory when you want to look up someone's number? We have to build the fully qualified name of the file into the phone command, so that it should now read:

```
grep $1 $HOME/phonelist
```

Using the Shell variable $HOME (which is equivalent to spelling out the entire name of your actual home directory) not only saves typing but lets the system do the thinking, keeping the program as general as possible. You *can* substitute your home directory for the $HOME used here, but that's not recommended because system administrators have been known to move things around over the weekend. Besides, this keeps even your Shell programs portable: you can use them as is on another system or allow your friends to copy them without having to do a lot of editing. Speaking of your friends, maybe you don't want anyone else to see your personal phone list:

```
$ chmod go= phonelist                 (or chmod 600 phonelist)
$ ls -l phonelist
-rw------- 1 dave      184 Apr 14 16:25 phonelist
$
```

Now nobody but you (and the super-user) can read your phonelist. But the super-user can't read what he doesn't know about! Renaming your file to .phonelist will work on most systems so that listing your files won't reveal it exists (don't forget to change your phone program too) because files and directories whose names begin with a period are not shown by ls unless a special option is used.

It must be noted at this point that the grep program is sensitive to upper- and lowercase; in particular, you can't type phone anna and expect to get Ms. Stasia. Care must therefore be taken when entering the command line. If you don't want to continually press the shift key, you can convert the entire phonelist file to lowercase:

```
$ tr "[A-Z]" "[a-z]" < .phonelist>temp     (translate all letters found,
                                             in order)
$ mv temp .phonelist
$ phone joe
joe blow     (201) 666-1913
$ phone anna
rosanne rosannadanna     (212) 986-1717
anna stasia     (201) 310-4697
$
```

The second example above shows that this conversion also means less precision in interpreting your requests. But sometimes "too much" output can be helpful. If you add the name of each person's company or job title to their entry in your "phone book," you can search by this information as well as name. Or adding the address (make sure you keep one entry to a line) allows you to search by city or state. This extra information comes in handy when you forget the exact name of the person you were looking for but know some other information about her or him:

joe blow	(201) 666-1913	kokomo travel agency
ella fitz	(415) 339-9001	audiotape testing
ada lovelace	(800) 543-7895	structured programming group
rosanne rosannadanna	(212) 986-1717	snl newsbreak
anna stasia	(201) 310-4697	salty czardine company
tricia mcmillan	44(01) 276-709	mouse computer inc.

If you wish to develop this idea further, look at the options available to you using some more Unix utilities, such as awk, sort, cut, and paste. These, along with the programming constructs available as part of the Shell, can provide you with all sorts of fancy formatting fun. Data entry may be controlled by another Shell program or a C program especially written for this purpose.

Such usefulness has not gone totally unnoticed by the commercial community. For instance, a mailing list/form letter package called Leverage (see table 1) implements data entry and screen formatting with C programs and uses grep for searches, nroff for creating form letters, and awk programs for printing formatted lists and labels. Other firms have similar products, some of which use fewer system utilities and more proprietary programs; these tend to be more expensive but have better performance. If you don't mind a bit of typing, a simple yet complete data retrieval system can be built using standard Unix utilities (see the text box "Ishell: A Unix Information Retrieval System").

A Few More Programs

A word or two should be written about awk. This is a C-like string-handling language that is used for manipulation of data files; in particular, it is good for writing quick programs that scan for strings, rearrange data fields, and take action based on the contents of a file. Again, see the Ishell text box for some examples of awk programs.

Mentioned earlier, the programs developed at Berkeley (usually referred to as UCB) have been a major addition to the world of Unix software. One of the most useful UCB programs is the screen editor vi, which has spread throughout the Unix community so quickly that AT&T is now distributing it with Unix System V. The UCB C-Shell was created as an alternative to the standard Unix Bourne Shell developed by Steve Bourne at Bell Labs. The C-Shell has several unique features, such as the ability to repeat or edit previous commands, the aliasing mechanism described before, and expansion of various special characters to save typing. Other UCB programs include more, which lets you read a file a screenful at a time; finger, which displays detailed information about each user on the system; and apropos, which helps you search the online programming manuals for information by keyword. Most UCB programs have been created specifically for the purpose of making people's work with Unix easier.

We've examined some more Unix commands and facilities and some of the diverse applications available on Unix-based machines, seen how to customize the environment, and tasted the flavor of home-built applications. Next month's article will examine some of the currently available computers running Unix, the different software implementations of Unix, and what can be expected in the next few years.■

Thanks to Rosemary Simpson, director of educational systems at Access Technology Inc. for the ISHELL material, to Rob Coben at Polymorphic Systems Inc. for the use of its Pixel computer, and to my wife Susan for digging through back issues of Unique *and compiling the tables.*

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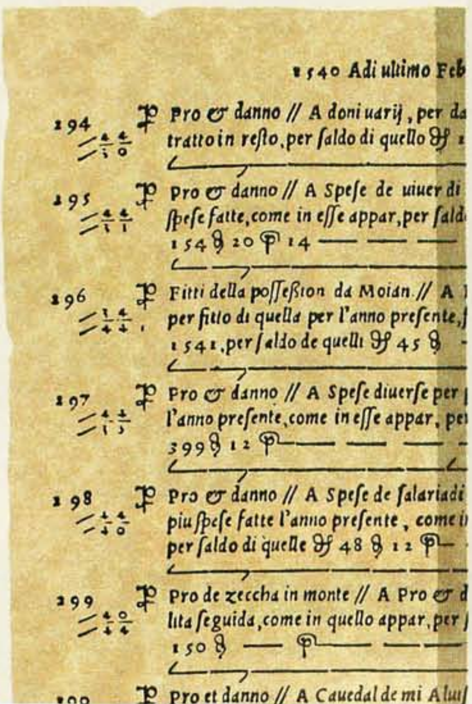
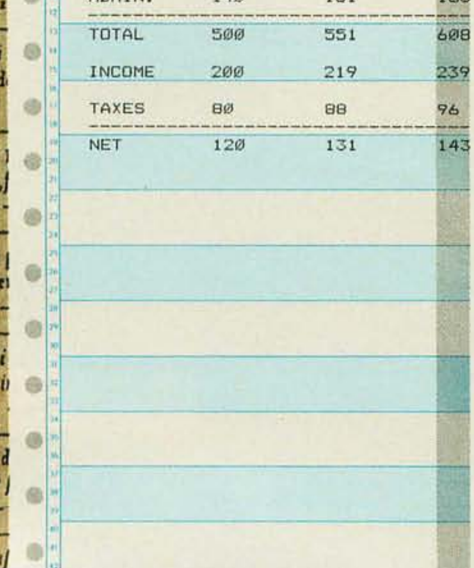
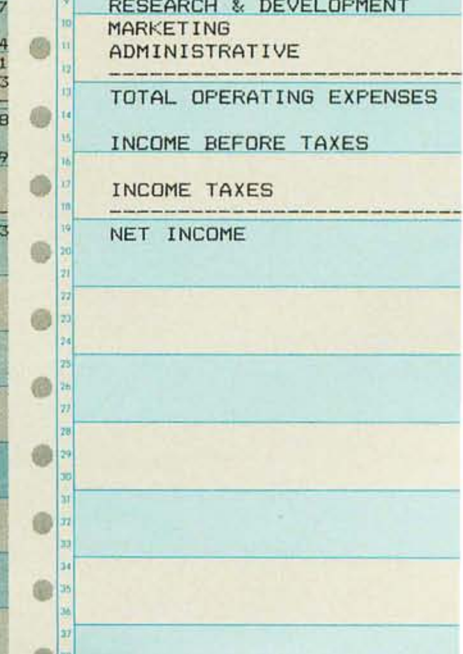


1979



	STATEMENT		
	JAN	FEB	MAR
SALES	1000	1100	121
COST	300	330	363
GROSS	700	770	847
R & D	160	176	194
MARKETING	200	224	251
ADMIN.	140	151	163
TOTAL	500	551	608
INCOME	200	219	239
TAXES	80	88	96
NET	120	131	143

1981



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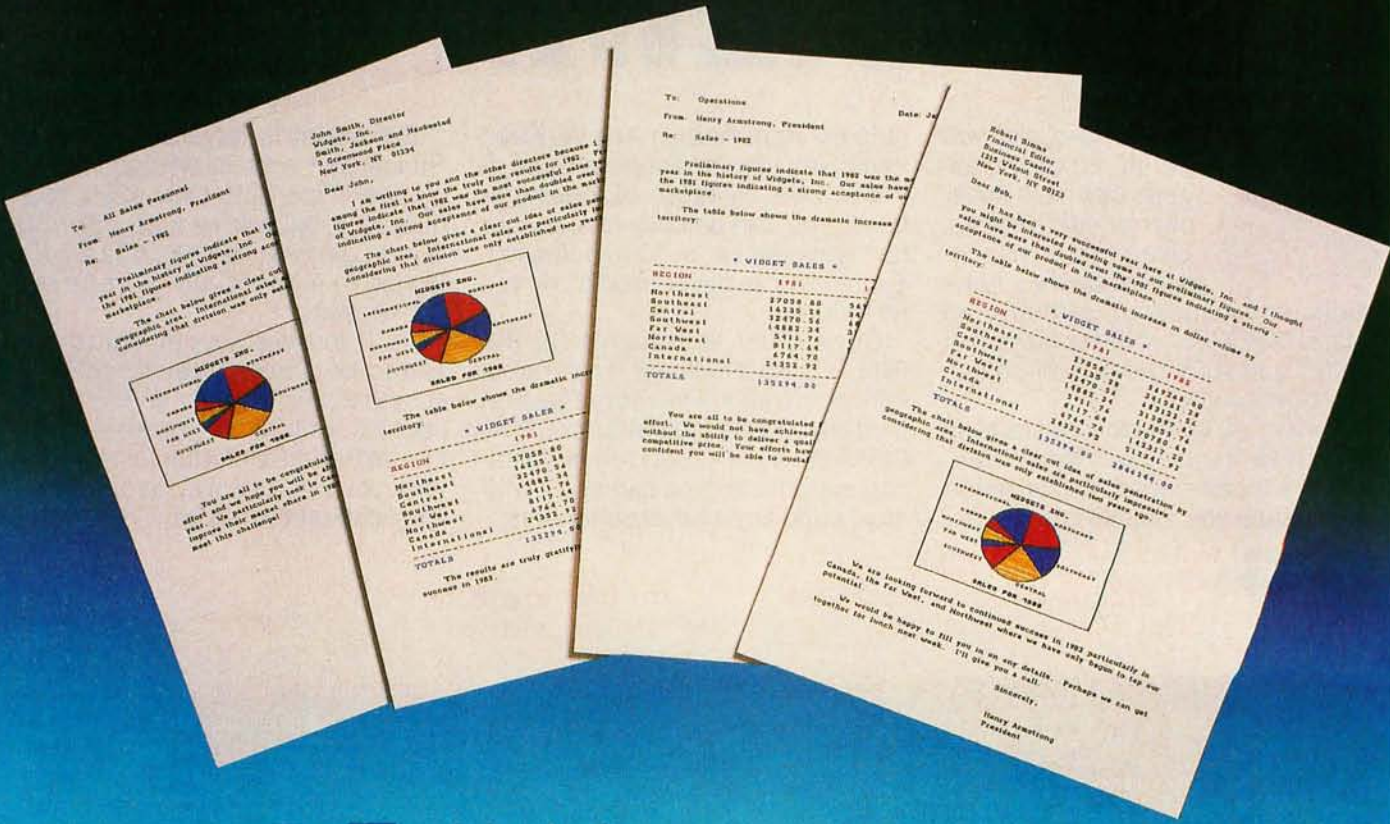

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Just Rewards for Programmers

In the microcomputer industry, it's not always obvious how to divide up the profits

by Barbara Robertson

To paraphrase Gilbert and Sullivan, the programmer's lot is not a simple one. Some have superstar status, and others crank out code for a weekly paycheck. Some work for equity, others earn royalties based on retail prices that range from a few dollars to hundreds of dollars. Dividing up the profits is done in many ways. But the issues that burn in programmers' and publishers' minds are the same: who gets the money, and who handles pricing, distribution, and marketing?

The corollary, "Who *ought* to get the money?" depends on the originality of the idea, who developed it and whether it changed, the difficulty of the coding and who did it, and the breadth of distribution and marketing and who manages and funds it. Arrangements vary enormously within the industry. Let's look at a few examples drawn from actual events.

CASE #1

Eagles Nevelstorm shut down the computer and began locking up. Once again, he was the last one to leave the office. The company had sure changed since he and a few others put old Dynamodata on the market a couple of years before. Some things were good—for one, the company's newly hired product manager seemed to like the idea the design team had conceived. A fully integrated multiwindow, artificially-intelligent, mouse/touch-pad/voice-driven, omnitasking, full-color graphic videotext communications program was finished. That should satisfy the marketing guys, thought Eagles. And it looked as if the team could actually produce the product, what with all the money available for people and machines from Dynamodata's profits. Of course, the programming team wouldn't be seeing any royalties on this one, but the programmers' salaries and benefits were good, and the product's success might mean the company would go public. Eagles wondered if the new programmers had been offered stock options when they were hired. He'd heard they had to work a year first, but there didn't seem to be any hard-and-fast rules yet.

In this case, the idea is a marketing department decision that has been refined by a design team and product manager and will be programmed, documented, marketed, and distributed by other members of the company. The product clearly belongs to the company. The programmer can negotiate for rewards within the range of traditional corporate benefits: salary and stock options. Here the programmers are not stars but part of a team. In this environment, programmers and designers are in the same position as most inventors working for large corporations. The corporation owns the copyrights.

CASE #2

Inside an ivy-covered garage in East Suburbia, California, Joe Machinecode debugs the last routine for Superprogram. Superprogram Manuals line the hallways of his house, proof sheets for the first ad are on the bulletin board, and a carton of blank disks sits in the corner ready for the orders to start rolling in. It's been a long, hard year. The house is mortgaged to the hilt, but the program is done, and it's all his—every last dollar that rolls in. That is, if anyone sees the little ads he has placed in the back pages of several magazines.

Joe Machinecode's case is easy. The program is his idea, and as long as he does all the work and invests only his own money, he determines the price and reaps 100 percent of the profits. While this may seem an ideal arrangement, it's becoming more difficult for such "garage" software producers to compete, and Joe may find that he doesn't have the same talent for business, marketing, and customer service that he does for programming. Let's look at two ways Joe might get help and what will happen to his 100 percent in each case.

First, let's assume that Joe decides the documentation needs to be improved, so he hires Chris, a writer. Chris makes suggestions about the user interface that Joe incorporates into the program and also introduces Joe to a product manager at the General Enormous Software house. General Enormous Software decides to buy exclusive rights to the products. Joe pays Chris a flat fee, takes the rest of the money, and moves to a tropical island.

Meanwhile, General Enormous Software does market research studies, modifies the program to meet those studies and fit in its product line, mounts a massive advertising campaign, puts the product and

its documentation in a box, and ships it to distributors who have no trouble putting it into shelf space already set aside for General Enormous in the retail stores. The product, which sells for twice the price Joe had in mind, is a great success. It's named Program of the Year in *Computer Trade Weekly,* and after two years its gross sales reach several million dollars. The software house makes a profit of 40 percent.

Would Joe have been better off on his own? How much more would he have made if he had negotiated for a share of royalties or kept some distribution rights rather than agreeing to sell the exclusive rights to his program? And what about the writer who improved the user interface and introduced Joe to General Enormous? Did she deserve a share in the profits, too? Or did the contributions made by General Enormous far exceed those of Joe and Chris?

Let's forget about General Enormous for a moment and follow Joe on an alternate route as he decides to sell his program to a software publisher. After making a number of phone calls, Joe learns that before publishers will consider buying his product, they want a one-page proposal that describes the product, outlines the market for it, details what compensation Joe expects to receive, and gives his background and qualifications. The publisher notes that only one out of every 200 programs submitted is usually accepted. Joe's proposal makes it through the first round at a publisher. He submits the documentation for the second round, and finally he gets to show his program. On acceptance, the publisher draws up a contract for exclusive rights that entitles Joe to a 10 percent royalty based on wholesale revenue.

Next, the publisher's documentation department rewrites and packages the manuals, the marketing department makes design changes that Joe implements with the help of the in-house programming staff, and Joe adds several changes of his own with the consent of the marketing department. The publisher signs an OEM (original equipment manufacturer) agreement with a major hardware vendor, giving the vendor exclusive rights. The product's success seems guaranteed. The hardware vendor determines a retail price that is considerably higher than the publisher's wholesale cost.

Did Joe get his fair share? What if his royalty had been based on the retail price? Could he have retained some rights? After all, the product was his original idea, and he did most of the programming. The software publisher, on the other hand, contributed to the design, and the company's marketing expertise resulted in the OEM contract that ensured a large sales volume.

CASE #3

Mary came up with the idea for Spelldata Dumptruck in the middle of rush-hour traffic on the way to work one morning. Because she didn't know the first thing about programming, she talked the idea over with Rob, and he agreed to write the code in his spare time. As soon as Rob had a good working demo of the program, he and Mary realized they had some decisions to make. It looked as if it might take years to complete the program on a spare-time schedule.

Starting a company didn't sound like much fun. Neither Rob nor Mary knew the first thing about marketing, distribution, or attracting venture capital, but they knew that they wanted to continue working on the product. They decided that even a modest royalty on a lot of sales would be preferable to 100 percent of a few sales and a lot of headaches. So they took their demo to a publisher. The publisher, well-funded and full of sparkling show-business ideas, agreed to give them an advance against royalties to complete Spelldata Dumptruck and introduced them to a programmer who could help them get it finished quickly. The publisher agreed to give Rob and Mary full credit, use their names in the promotion, package the product, determine pricing and marketing strategies, and provide distribution.

How are the profits divided in this case? The idea is Mary's, but without Rob's programming expertise, it would never have become a reality. And because the code is the product, Rob might argue that he deserves

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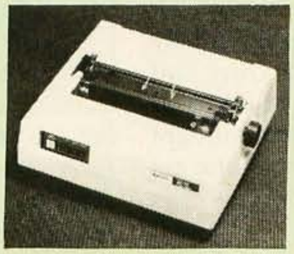

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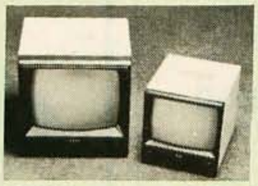

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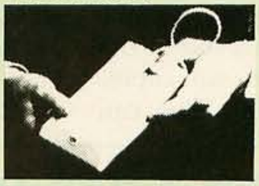

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half or more of the royalty money. Some people argue, however, that unless the programming is especially creative, Rob occupies essentially the same role as a ghostwriter and deserves pay but no royalties. And what about the programmer brought in by the publisher—should she get credit in the promotion? Who pays for her time?

Rob and Mary have further complicated the question of how to apportion profits (and perhaps increased their potential profits at the same time) by taking the product to a software publisher interested in promoting the product beyond the traditional marketing channels. Rob and Mary's names are used in the promotions, and if the product is a success they'll soon see Spelldata T-shirts and little stuffed Dumptrucks in the stores. How much of the profits do they deserve for each T-shirt and stuffed Dumptruck that's sold? And if Rob and Mary's names become household words as a result of the product promotion, how will superstardom affect the royalties they can demand on their next product?

CASE #4

Walt Wizard, masterful money handler, and Tom Brightman, well-known program designer, met at one of those cocktail parties that make big computer shows almost worth attending. It didn't take them long to realize that they had the same idea in mind for a new product and that they were a potentially great team. The Wizard knew what had to be on the screen and in the reports, and Tom could write the system design specs. The Wizard would attract the financiers, and together they could build a company that would skyrocket if they could move fast enough. They knew the product's success depended largely on getting it into the market very quickly, and the one person who could do the job was Sam Supercoder, a programming genius at implementing complex ideas in assembly language. Sam looked at Tom's design specs, suggested some improvements to which Tom and the Wizard agreed, and finished coding in three days, which gave them the edge they needed. The Wizard took the finished product to a group of venture capitalists who gave the threesome start-up money in return for 49 percent of the company.

In this case, all three will share in the profits and help determine pricing by virtue of their equity ownership in the company they're building. But how should the 51 percent share be split among them? The original idea came from Tom and the Wizard. Tom wrote the design specs, but all of them contributed to the design. How much is the Supercoder's contribution worth? After all, he got the product to market within the time frame.

CASE #5

Susan Smart had been working as a computer programmer and systems analyst for a management consulting firm during the day and spending all her spare time designing a microcomputer software system. When she had a reasonably good plan down on paper, she approached Clyde Dealmaker with her idea. Clyde convinced a management team to invest its time and enough money for Susan's salary and start-up costs on his

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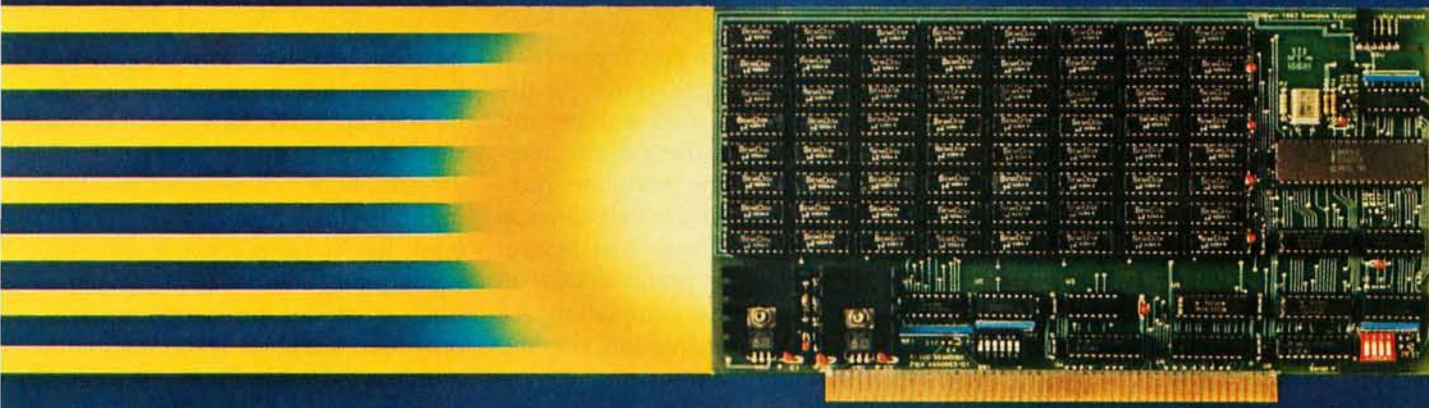

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assurance that the venture capitalists would soon be eating out of their hands. The management team liked Susan's concept but soon came up with an entirely new user interface for the program that they felt had a better chance of success. Susan improved the design and began writing code.

As it turned out, Clyde was wrong about the venture capitalists. The management team, desperate to recoup its investment of time and money, sold the program idea to a hardware vendor, who would use an in-house software team to develop it.

In this case, the idea for the program was Susan's, but the program changed considerably after she brought it to Clyde. No coding was done beyond what was needed for a demo, and because Susan was paid a salary, she assumed little risk. Clyde invested time, but no money. The management team, which contributed to the design, invested its own money and time without compensation. Was the vendor's decision to buy the program based on the management team's interface design or Susan's original concept? Who should profit from the sale?

Alternate Arrangements

There are probably as many stories as there are programs. Programmers are faced with several complex alternatives from which to choose, and they *don't* have much help in choosing. Going to work for a major software house for a salary and stock options is one. This option means a lower risk for the programmer and potentially lower gain. Working for a start-up company for a salary and equity usually translates to higher risk and potentially greater gain. Employment agents may be able to offer some help in negotiations.

If, however, a programmer decides to develop a product, the issues get muddy. How much is the idea worth? How much are the coding, documentation, marketing, and distribution worth? George Tate of Ashton-Tate, a software publisher that also develops in-house software, notes that advertising and marketing are now by far the biggest costs in bringing a product to market, exceeding the costs of research and development. This factor is bound to have some effect on the price.

Traditional software publishers such as Ashton-Tate, Digital Marketing, Software Publishing, and Information Unlimited Software offer independent software vendors a variety of choices, among them buy-out agreements, licensing agreements, stock offerings, and royalty arrangements. The amount of money publishers are willing to pay depends on the amount of work done by the author, anticipated market share, and pricing. However, there is no clear-cut formula. Some software publishers may be willing to help develop a program if the idea has market potential, but most prefer to take on a product that's near completion. All will assume documentation, marketing, distribution, and pricing responsibilities.

New software producers like Electronic Arts and International Microcomputer Software Inc. offer programmers another choice. Some will promote the authors and give them status and possibly even some control. Electronic Arts calls itself an "association of electronic artists" and puts the software authors' names on the cover of the software package. IMSI, for example, lets authors hire and fire their product managers.

Software producers tend to pay higher royalties than software publishers, but the amount of royalties and advances varies widely. It might seem that with a software producer the programmer can become a superstar. But what happens when a producer comes up with the idea or if he asks a famous mystery writer, sports car driver, or tax analyst to design a product? Will the programmer share equally in the royalties and fame?

Changing Rules

Clearly, it's not always obvious how to divide up the dollars. In the complex, undefined microcomputer software industry, the rules change as fast as the technology. Both the amount of the royalty and the basis on which royalties are paid vary from one publisher to another. Royalties can be based on wholesale revenues, gross profits, or retail prices, and it takes an expert to assess the best arrangement. Unfortunately, however, a programmer whose expertise lies in software development cannot become an overnight expert in contract law, marketing research, and distribution.

Peter Sinclair of Software Publishing, a company that develops in-house software and markets software from independent vendors, says that the independent software producers he sees are often naive not because they haven't done enough background work but because no clearinghouse for information exists. The book hasn't been written yet. And while many standards of excellence exist as guides for programmers—proposed graphics standards, communications standards, and even operating system standards—there are no established algorithms for the business and marketing sides that will guarantee programmers a fair share of the profits. Many programmers learn the hard way that it's not unusual for someone else to make a fortune from their genius.

The book publishing, recording, and movie industries have agents and standard contracts. Now agents are emerging for software authors, but standards for determining the value of ideas and programming remain undefined. Programmers as a group need to exchange information, perhaps through electronic bulletin boards and networks as a means of establishing those standards. It might be worth some programmer's time to set up a database and begin collecting information.

Until programmers themselves begin to address these issues, they can never be sure of getting just rewards for their work. But programmers would not be the only ones to benefit from standard business practices. Software houses would have a more stable basis for determining prices, and greater price stability would benefit consumers.■

Barbara Robertson is a technical editor in BYTE's West Coast Bureau (BYTE/McGraw-Hill, 4th Floor, 425 Battery St., San Francisco, CA 94111).

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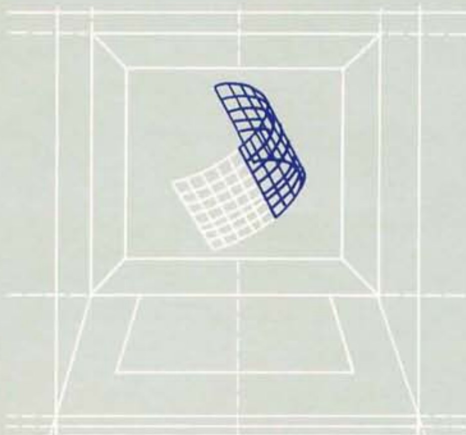

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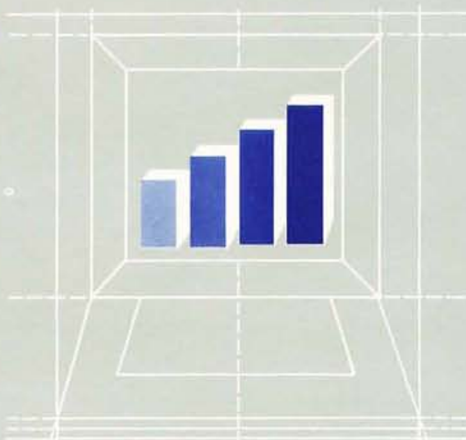

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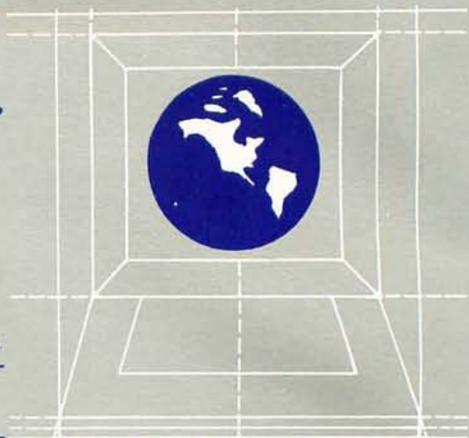

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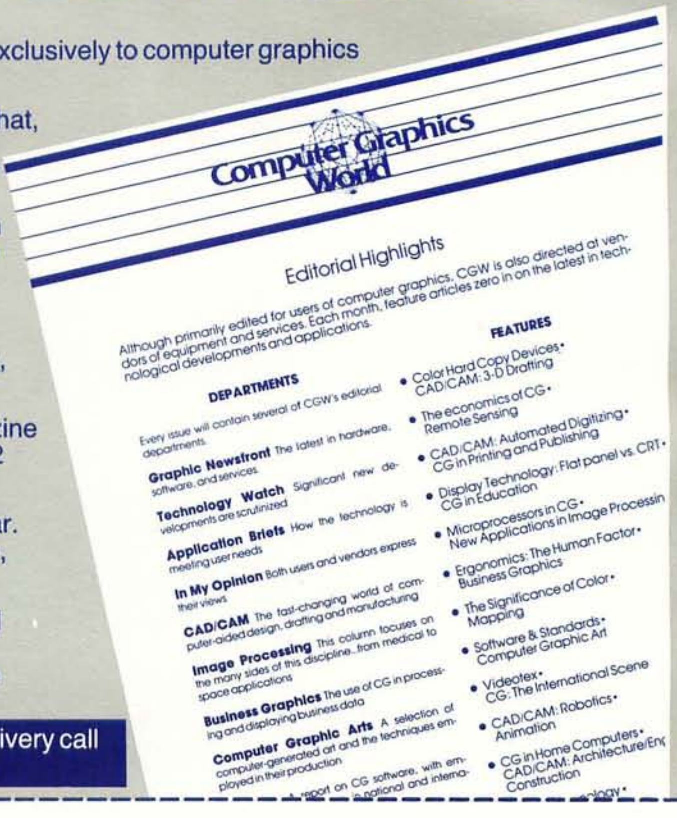

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A C Language Primer

Part 2: Tool Building in C

by James Joyce

It is difficult to say whether C has become so popular because it is the major language Unix is written in or because it is in its own right a clean, small, highly expressive language. C allows programmers to write programs that package assignment expressions inside a logical test, as in this example:

```
/*--- copy.c  Use preprocessor variable for EOF ---*/
#define EOF -1
main ()
{
    int byte;
    while ( (byte = getchar() ) != EOF)
        putchar (byte);
}
```

In this case the while statement makes the program one executable statement in length. It copies characters until EOF (end of file) is reached. Such economy does have its disadvantages in that obscure C code is fairly easy to write. A programming language purist can rightly accuse C of inviting side effects in coding. But to the C language veteran, the side effects are desirable and should be treated with proper respect.

The proper C program is organized into functions, one of which must be named main. When a C program executes, control is given to main first. As we saw in Part 1, it is common practice in C to organize particular aspects of processing into functions called by main.

In this second and final part, we shift our emphasis from language fundamentals to the important concept of tool building in C. As we write programs we will be alert to code that could be packaged into a general-purpose function and employed in solving more than one problem.

Arrays of Characters

Because C contains no built-in function to read an entire line of input, it could be called a rather primitive language. Yet part of C's elegance and appeal is due to its encouragement of tool building. You can build a routine to read a line of input and package it as a function named getline that you can then use whenever the need arises. The next two examples develop a slightly modified version of the getline function found on page 26 of Kernighan and Ritchie's book *The C Programming Language* (Prentice-Hall, 1978). The first example focuses on character arrays, and the important work is done in main.

```
/*--- getline.c  To illustrate character arrays ---*/
#define EOF   -1
#define NL    '\n'
#define EOS   '\0'                                          /* A */
#define LIMIT 1024

main ()
{
    int byte, index;
    char line[LIMIT];                                       /* B */

    for ( ;; ) {                                            /* C */
        for (index = 0; index < LIMIT - 1; index++) {       /* D */
            if ((byte = getchar()) == EOF) break;           /* E */
            else if (byte == NL) break;
                else line[index] = byte;
        }
        if (byte == EOF) break;
        else if (byte == NL) line[index++] = byte;
        line[index] = EOS;                                  /* F */
        printf("%s", line);
    }
}
```

This example begins by defining several preprocessor variables; the backslash-zero combination inside single

quotes in line A is C notation for a byte of all zeros, by convention the end-of-string maker in C. In C, any single byte of data inside single quotes tells the compiler to use the value of the byte as an integer. Character strings are enclosed in double quotes, as they are in the printf statements used in earlier examples.

In line F the end-of-string marker is assigned following the last character in the array just before it is printed. The %s format code indicates that the line is a character string. To verify that the zero byte is needed, run this example without lines A and F. Be sure to enter more than one line in assessing the effect of not having the end-of-string marker.

Line B shows how arrays are declared in C. The brackets distinguish arrays from functions. As mentioned in Part 1, a preprocessor variable is used to specify the array bounds; thus you can easily change the value throughout the program simply by changing the preprocessor command.

Line C shows a for loop that, undisturbed, will run forever. You can exit the loop using the break command if the end-of-file character is reached. Note that break on end-of-file occurs twice here, once to exit the for loop in line D, and once to exit the for loop in line C.

The for loop beginning with line D gets one character at a time and puts it into the array. The value of index starts at zero because arrays in C start at zero. The limit of the array must be adjusted down by one to compensate. The expression LIMIT-1 is calculated only once, at compile time.

There are three conditions for exiting this inner loop: if the array is full, as tested for in line D; upon reaching end-of-file, as in line E; and upon reading a newline character. If these conditions do not exist, the byte is added to the array.

The next example illustrates the use of arrays as function arguments. The code in the inner loop of the previous example is the heart of the next version of getline. Preprocessor variables are defined in getline because they are used there, although they could have been defined with the others at the beginning of the code for main.

```
/*--- getline2.c  To package getline as a function ---*/

#define ALLDONE 0
#define LIMIT 1024

main( )
{
    char string[LIMIT];

    while (getline(string, LIMIT) != ALLDONE)
        printf("%s", string);
}

getline(line, toobig) /*--- To read a line into an array ---*/

#define NL   '\n'
```

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```
#define EOS '\0'
#define EOF -1

char line[ ];                                   /* G */
int toobig;

{
    int byte, i;

    for (toobig-- , i=0;                        /* H */
        i < toobig &&
        (byte = getchar( )) != EOF &&
        (byte != NL);
            ++i ) {
            line[ i ] = byte;
    }
    if (byte == NL) line[ i++ ] = byte;
    line[ i ] = EOS;
    return( i );                                /* I */
}
```

The parameters of getline are defined in line G and the subsequent line. Note that these declarations are made before the brace that contains the body of the function. The declaration for line as a character array lacks a number in the brackets because the true array will be handed to getline, and its length will have been determined in main.

Parameters in C are passed not as addresses of locations in the calling routine, as in many languages, but as their values. Consequently, values given to getline may be changed by code in getline without affecting their counterparts in main. If we pass simple arguments, such as the constant 1024 or a variable such as byte, a copy of the value is given to the function. If we pass an array, however, the address of the array is passed to the function rather than the contents of the array.

One consequence of this approach is that we can write getline as we did, but if we wrote a similar function—say, getbyte(byte)—we would hand the function the current value of byte as a parameter and, upon return, the value would be unchanged. To programmers this means that functions return only one value, and that is through the return statement. All values passed as parameters become copied into areas local to the function. If you pass an array as a parameter, you will actually be passing a pointer to the array (that is, its address). We'll return to this in the section introducing pointers in C.

Now let's look at what the user would see as the program code is being compiled.

```
$ cc -v -o getline getline2.c
getline 2.c;
    Preprocessing
    Compiling
    Assembling
Loading
$
```

The first line asks that cc (the C Compiler) be run, with the option -v indicating that each stage of the compilation process is to be reported as it is entered. The -o option tells cc that the executable version of the program is to be stored in a file named getline. When the processing is complete, the shell returns with its prompt: $.

To execute the program you need only type its name and press the Return key. Then give it some data:

```
$ getline
This is some normal data.
This is some normal data.
$
```

Here a line of data was typed, followed by a Return and then the end-of-file signal Control-D. Two lines appear because the first line is the Unix shell's transcript of what you typed and the second line is getline's output.

In the example that follows, a line is typed, but instead of pressing Return, Control-D is typed at the end of the line:

```
$ getline

Here I type Control-D>Here I type Control-D>$
```

Everything seems run together, but that is because we typed Control-D instead of Return. The shell's transcript of what you typed runs on the first >, getline's output continues on the same line until the second >, and the shell's prompt appears at the end of the line. On a video terminal, the cursor would be waiting at the end of the line for you to type another command line.

The Switch and System Statements

The last control structure we'll discuss is switch, which allows a multi-way decision via an elegant construct. We introduce switch with the system statement, which enables you to issue commands to the host operating system from your C program. Our example issues Unix commands, but that's because the system on which the program runs is Unix. Properly implemented, the system function simply hands the host operating system a pointer to a character string containing a command, then returns control to the user's program. The example that follows is a simple but suggestive help program for C programmers.

```
/*--- switch.c   Demonstrate switch command and system call ---*/

#define BLANK ' '
#define EOF    -1
#define NL     '\n'
#define TAB    '\t'

main()
```

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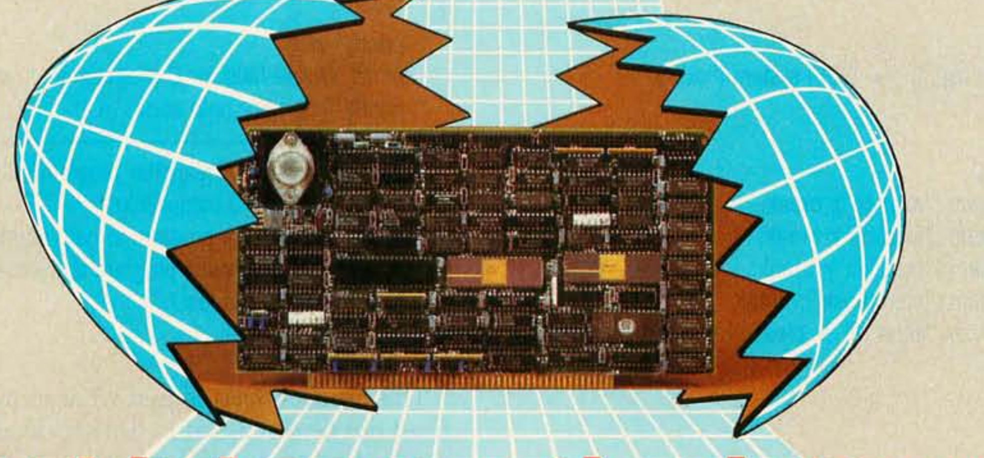

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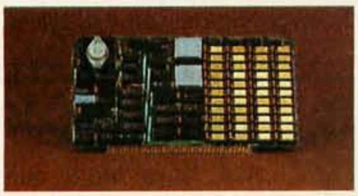

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```
{
    int byte = 0;

    greet( );
    if ((byte = getresp( )) == EOF) system ("exit");

    printf(" \ n");
    switch (byte) {
    case ' c ': system ("man cc"); break;
    case ' b ': system ("man cb"); break;
    case ' l ': system ("man lint"); break;
    case ' m ':system ("man make"); break;
    default:   system ("echo Uh — please rerun the program");
    break
    }
}

getresp ( ) /*--- Get nonwhite character from input ---*/
{
    int byte;

    for (;;) {
        if ((byte = getchar( )) == EOF) break;
        else if ((byte != BLANK) &&
            (byte != TAB) &&
            (byte != NL) ) break;
    }
    return (byte);
}
```

```
greet( )

{
    printf(" \n");
    printf("Online help for C programmers: \n \n");
    printf("Type   For help about \n");
    printf(" ------------------------------------------------------------ \n");
    printf("  b   the C beautifier program \n");
    printf("  c   the C compiler \n");
    printf("  l   the lint program to help portability \n");
    printf("  m   the make program to maintain code \n");
    printf(" \n Your request? ");
}
```

The function greet is just what its name implies and need not be discussed in further detail here. The packaging of getresp into a function may seem unnecessary, but it was done primarily to make a point about the human engineering of software. Some users of interactive programs type a space or even press Return before entering a response, just as someone about to give a talk in front of a group may blow into the microphone before speaking. Good human engineering of software allows for such responses. While we're on the subject of human engineering of software, note, too, the space after the question mark inviting a request. The space not only makes the message more readable but makes it more inviting to answer than if the space were not there.

Upon return from getresp the value of byte is tested and,

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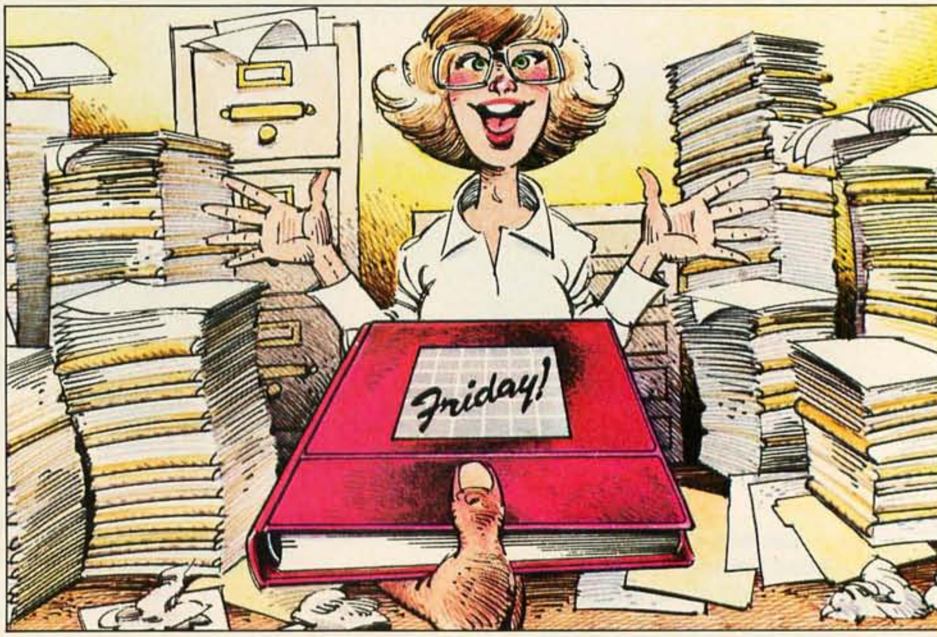

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if it is an end-of-file character, the function system executes the Unix command, given as a character string, "exit". The exit system call to Unix is the usual way of terminating a process. The other system calls are to print pages from the *Unix Programmer's Manual* or to use echo to print a message to the user. Though printf could have been used instead of a system call to echo, the point was to illustrate system. Of particular note is that the shell scans the command it is given for metacharacters, except character-delete and line-kill, just as if the command had been keyed at your terminal.

The switch statement evaluates the expression in parentheses—which must evaluate to an int—and transfers control to the case matching the value, resuming execution with the statement following the case keyword. For example, if byte contains a c, it will match the first case, and the system call will be to print the manual pages for cc, the C compiler. The break statement afterwards keeps execution from continuing with the next system call to print the pages for cb, the C beautifier program.

You might think of switch as switching you to a matching case, where execution resumes. The case values mark places in the code, like labels, to which control is transferred. By pairing a break with each case, you isolate each case's treatment. The default keyword in a switch catches all other instances beyond the ones matched earlier. If default is not in the switch, unmatched cases cause no action, as if the switch were not there. As Kernighan and Ritchie note in their discussion of switch, it is best always to put a break after the last case, so that if a new case is added later execution will not accidentally "fall through" to the newly added case.

Pointers

To some people, an aura of mystery surrounds pointers, as though there were some trick to them. Pointers are variables that have addresses as their values, just as an integer variable has integers as its legal values or a character variable has characters as its legal values. The following example is a version of hello.c that has been rewritten to introduce pointers.

```
/*--- point.c   To introduce pointer variables ---*/

main()
{
    char *message;                                    /* A */

    message = "Hello, world! \n";                      /* B */
    printf(message);                                  /* C */
}
```

The declaration in line A places an asterisk before message, indicating that message is a pointer to a character variable. In line B, what looks to be the assignment of a character string to message is the assignment of the address of the literal "Hello, world! \n" to message. There are no operations on entire arrays or strings in C. In line C the only argument is message, indicating the address of the message to be printed.

Line C gives us some insight into how printf works as a function. The control string we give to printf is stored away by the C compiler, and its address is given as the first argument to printf. As a result, printf sees just what any function in C sees—a list of values; here, the list contains a pointer to character string. We can take this point one step further:

```
/*--- point2.c   More on pointer variables ---*/

#define NL '\n'

main()
{
    char *message;

    message = "Hello, world!%c";                       /* D */
    printf(message, NL);                              /* E */
}
```

In this example, we use the control string pointed to by message to print the newline character. The %c is replaced by '\n', just as if the character string had appeared in the call to printf. So you've already seen pointers in C several times so far without knowing it!

Pointers are common in C programs that manipulate strings or arrays. Here is an adaptation of the function that copies a string, from Kernighan and Ritchie's book.

```
/*--- strcopy.c   Pointers used to copy a string ---*/

#define BIG 1024

main()
{
    char *original, copy[BIG];                        /*A*/

    original = "This will repeat once. \n";
    strcopy(copy, original);
    printf(original);
    printf(copy);
}

strcopy(tostr, fromstr)          /* use: fromstr is copied to tostr */

char *tostr, *fromstr;
{
    while ( *tostr++ = *fromstr++)
    ;
}
```

Line A draws attention to the close relationship between arrays and pointers. Here original is a pointer to a character string and copy is a declared array. Yet in the call to strcopy the names appear side by side, and in the definition of strcopy both are declared as pointers to characters. Array references in C translate to pointers to the array plus the appropriate offset.

The work in strcopy is done in the condition for the while—yet another instance of the terse code often found in C programs. We will read it from the inside outward. The character pointed to by fromstr (think of the asterisk as representing the phrase "pointed to by") is copied to a location pointed to by tostr. After this copy is done, the two pointers, tostr and fromstr, are incremented. The value assigned also becomes the value of the expression in parentheses. When the end-of-string marker is copied to tostr, its value, 0, becomes the value of the expression for the while. In C this means "false," and the while loop ends. The semicolon marking the body of the while is lined up under the w to tell a human reader that the body of the while is empty.

You might want to alter this program to see what happens when both copy and original are declared as pointers. The run-time errors are amusing enough to encourage several tries. If copy is declared as a pointer rather than as an array, the value it contains is undefined; where it will store the characters assigned in the function is anyone's guess. You might run this version through lint, which checks the style of programs, to see what it thinks of the code.

Next, let's look at how a function can return a pointer to a character string. The function in the next example is a model for functions that, given an integer, might return the corresponding month or part-name or job title—the uses are many, and the present example is perhaps one of the simplest. As indicated in line A, the function's type must be declared in main if it returns non-integer values.

```
/*--- weekday.c  Introduce static variables and ? : construct ---*/

main()

{
    char *weekday();                                    /* A */

    printf("I was born on a %s \n", weekday(4));
}

char *weekday(number) /*--- return pointer to name of weekday ---*/

int number;
{
    static char *day[] = {                              /* B */
        "Oopsday",
        "Monday",
        "Tuesday",
        "Wednesday",
        "Thursday",
        "Friday",
        "Saturday",
        "Sunday",
    };
    return( (number < 1 || number > 7) ? day[0] : day[number]);
}
```

The function weekday returns a pointer to character data, and it must be declared as such. Until now, our functions that returned anything returned integers, the default in C. The strategy behind weekday is that the integer will be the index into an array of pointers pointing to character strings containing the names of weekdays. That is, the value of day[4] is the *address* of the character string Thursday.

The declaration of day as an array of pointers to character data has several aspects worth noting. First is the word static, which refers to the storage class for the array of pointers. Normally in C, local variables in functions are allocated each time the function is called and deallocated when the function is exited. These are *automatic* variables. If you want the variables in a function to remain allocated after the function is exited, you must specify that the variables be *static*.

We certainly want the names of the weekdays and their pointers to stay around. If they disappeared after the return from the first call, subsequent calls would not have them or would have to reinitialize the array. C circumvents this by prohibiting aggregate initialization of automatic variables. If you omit the static declaration, the C compiler will complain, and compilation will not be successful.

The number of elements in the array is not specified *within* the brackets. Because the array is initialized in its declaration, the compiler will count the number of elements and allocate that much space. Again, you should note that *pointers to the names* are the values being stored in the array day rather than the *names* themselves.

The return statement contains a rarity in programming languages, a ternary (three-item) operation. Parts one and two are separated by a question mark, and parts two and three by a colon. The expression in parentheses is evaluated, and if its value is true, part two is executed. If the expression is not true, part three is executed. This is similar to an if-else construct, but it is working at the level of an expression rather than as a full-fledged control structure. The condition tests whether number is outside the range of a valid weekday number (between 1 and 7), and, if so, returns a pointer to the string Oopsday. Otherwise it returns a pointer to the name of the weekday. The ? : construct is both powerful and compact. You might rewrite weekday without it to see how much less readable the code becomes.

Structures

Structures did not enter the language until 1973, but they cap the major developments of C. A structure is like a record in Pascal or levels in COBOL Data Division entries. These next examples show a transcript of part of a Unix session using Mark Horton's script utility to record what appeared on the video display. Here a program using structures is listed using the cat command (think of cat as being short for "copy all text"), then compiled, and finally run to produce the output of three names and telephone numbers.

```
/* struct.c  Show an array of structures ---*/

main()
{
    static struct list {                              /*A*/
        char *name;
        char *number;
    } phones[3] = {                                   /*B*/
        "Jim Joyce" , "415-621-6415",
        "Time"      , "415-767-2676",
        "Story"     , "415-626-6516"
    };
    int i;

    for (i=0; i<3; i++)
        printf("%12s %12s \n",
            phones[ i ].name, phones[ i ].number);
}
```

The program listing starts with the by-now-familiar comment line having as its first word the name of the file—the absolute minimum that good documentation practice requires. Line A begins the structure's definition. The keyword struct announces that a structure is being defined. It is a static variable, and the structure will be initialized at compile time. We recently saw a variable declared static; now we can state a generality about initializing arrays and structures: automatic structures and arrays cannot be initialized. If you try to compile this example without the keyword static, the C compiler will complain:

```
"struct.c", line 9: no automatic aggregate initialization
```

The name list at first looks like a variable but is really a structure tag. Using a structure tag, you can declare other variables as being a structure having the form described in the structure tagged list, without having to enumerate the members. The structure has two members, both pointers to characters: name and number. Line B names the structure as phones, and we note that phones is an array. What we have created is an array of structures. Others might simply call phones a table.

The assignment operator here, as in the previous example, indicates that the variable phones is to be initialized. The three lines following are pairs of strings; the C compiler will store them somewhere safe and then put their addresses in the structure members, the first corresponding to name and the second to number. The elements are separated by commas, with each "line" of the structure on its own line; this format helps readability.

In the printf statement we see how to access the members of the structure. The name of the structure is given first, then a period to separate the two tokens, and then the member name. This example is admittedly contrived to show a simple example of a structure and how

to access members. We could have written the printf as

```
printf("%12s, %12s \n", phones[i]);
```

with the same result.

Quite apart from the topic of structures is the control string for the printf. The %12s specifies that the output string is to be 12 characters long. Surprisingly, the strings are justified at the right margin in the field, as we see in the resulting output:

```
$ cc -o struct struct.c
$ struct
    Jim Joyce 415-621-6415
         Time 415-767-2676
        Story 415-626-6516
$
```

This format conversion is simply part of printf. To have the string output justified at the left margin, we would write %–12s. Page 147 of Kernighan and Ritchie's book details the options.

Going Further in C

By now you have seen quite a bit of the programming language C, but not all of it by any means. As you may have noticed, the examples have gradually increased in complexity and sophistication. By now you should have enough experience with the language to write useful programs and to learn more of the language from Kernighan and Ritchie. Among the topics you will want to read more about are preprocessor facilities, structures, and the Unix system interface. You might consider adopting the approach that has guided the examples you have seen here; that is, write programs for yourself that focus on the language feature you are learning. Then, once your example is working, modify it to introduce deliberate errors so you will recognize them later.

Another valuable tool for learning C is Alan Feuer's *The C Puzzle Book: Puzzles for the C Programming Language* (Prentice-Hall, 1982). When you get a copy, be sure to add the missing right brace at the end of the program on page 53. Then key in each example and run it, taking care to include spaces, tabs, and blank lines where Feuer puts them.

The puzzles in Feuer's book are working programs that illustrate the major aspects of the language: operators, basic types, included files, control flow, programming style, storage classes, pointers and arrays, structures, and the preprocessor. The second half of the book offers a step-by-step discussion of just what the programs do, with helpful diagrams for the puzzles about pointers. Do let me know about other simple examples of C constructs that should be shared, and there may be a follow-up article in the future.■

James Joyce is president of International Technical Seminars Inc. (520 Waller St., San Francisco, CA 94117) and founder of the Unix Bookstore.

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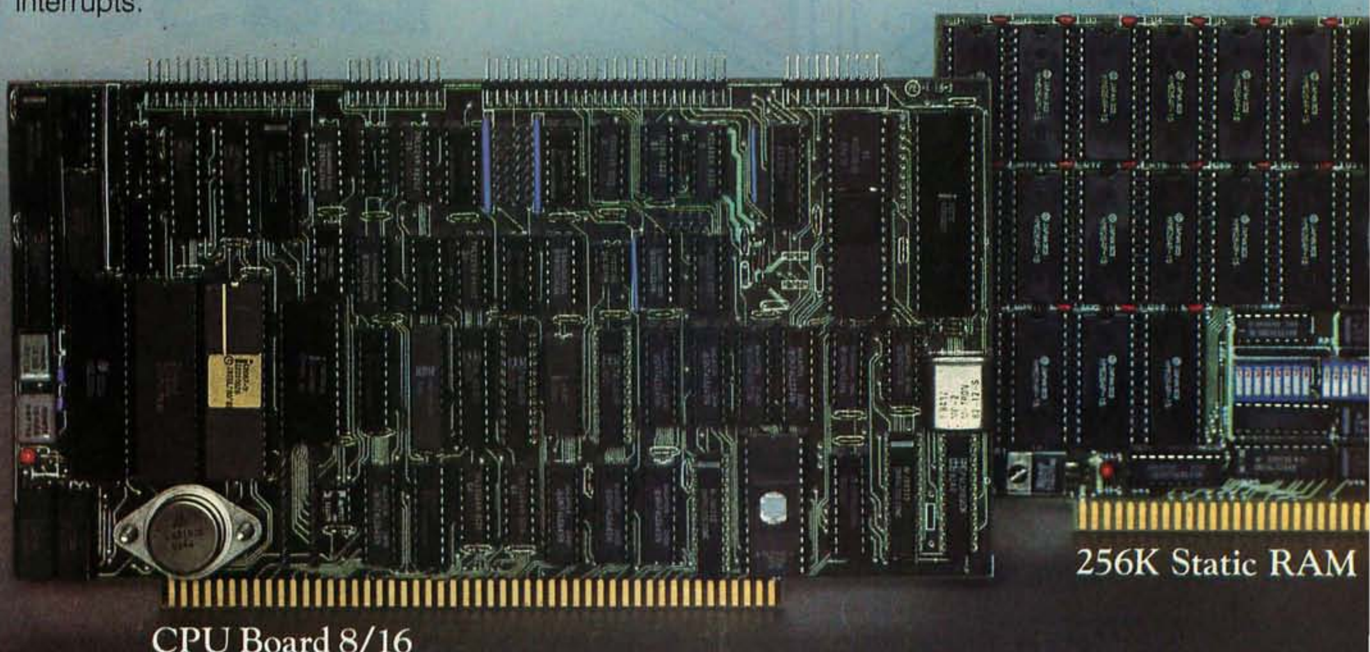

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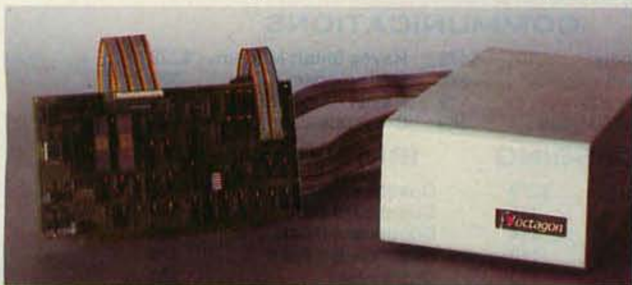

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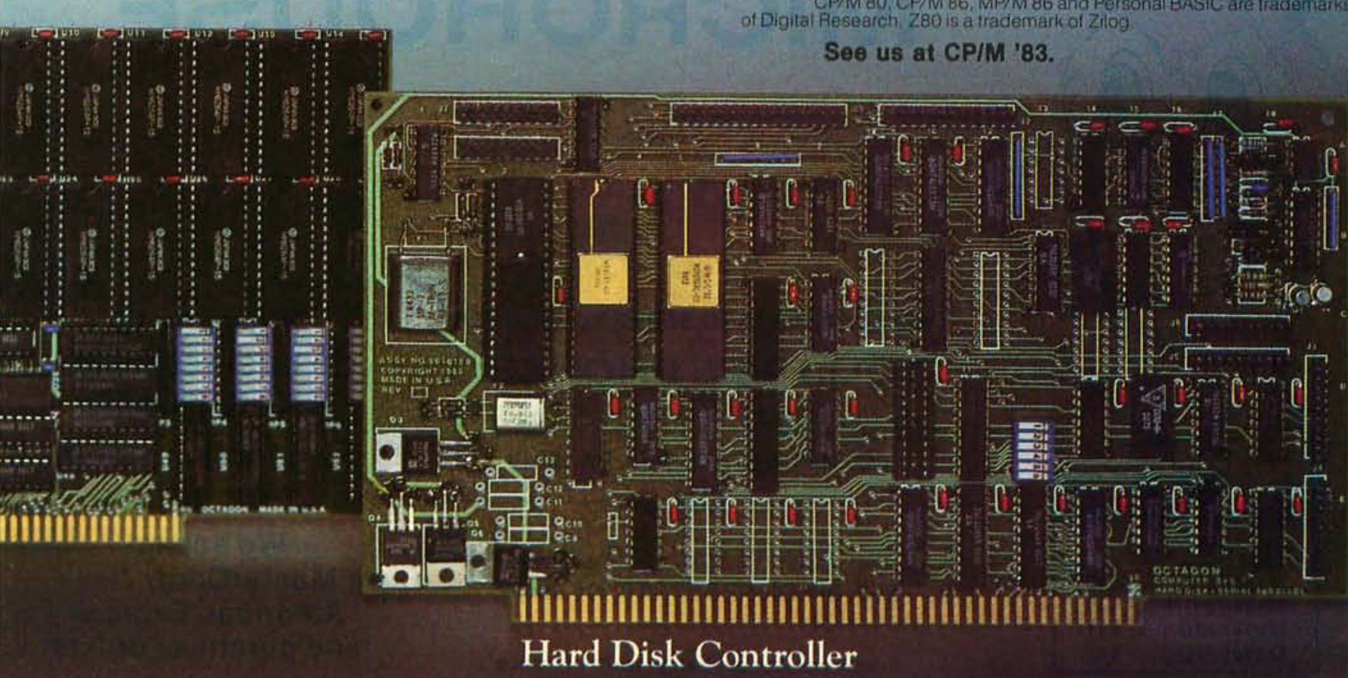

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Eagles, Text Editors, New Compilers, and Much More

Important items of information from our ingenious insider

by Jerry Pournelle

I surrender. Next week I'm going out to buy an IBM Personal Computer, rotten keyboard and all. (Of course I'll use Jim Baen's Magic Keyboard on it; I haven't gone completely mad.)

Obviously there's a reason: software compatibility. Over in one corner there's four cubic feet of unevaluated software, much of which won't run on anything but an IBM PC.

Although a lot of machines claim to be 100 percent IBM PC compatible, I've yet to have one arrive at Chaos Manor. Now true: some of the machines we have, such as the Eagle 1600 with hard disk and the Eagle PC, have some awfully strong points compared to the genuine IBM. In fact, compared a feature at a time, I think I'd prefer the Eagle, which is faster and has a much nicer keyboard. A lot of our PC-type software runs quite well with the Eagle.

There's the Compupro 10-MHz 8086; Tony Pietsch has just dreamed up a new method whereby we can boot PC-DOS (the disk operating system for the IBM PC) off 5¼-inch disks even though the primary disk system for the Compupro machines is 8-inch. A fair amount of PC software will run with that machine, as well as, naturally, our Compupro 8085/8088 dual processor.

We also have the Zenith Z-100, which has a number of features in common with the PC. Some PC-type software runs fine with the Z-100.

Alas, a lot of stuff doesn't run with Eagle, Z-100, Compupro, or anything else we have around here. Some of that software looks pretty nifty. Then too, my contract for the Inferno game based on *Inferno* (Larry Niven and Jerry Pournelle, Pocket Books) calls for it to run on an IBM PC. Finally, I keep getting letters from readers concerning the genuine IBM PC: "Try it, you'll like it."

So I'm going to try it. While I'm at it, I'll try to buy the absolute minimum from IBM itself and get my disks and memory and such like from less expensive sources; that should give me something to write about and justify the expense.

The Eagle 1600

We've had the Eagle 1600 for about a month and it runs fine. Eagle justifiably brags about how easy it is to get this machine out of the box and up and running. It took us about 5 minutes.

The 1600 has a 20-megabyte hard disk that contains all the operating system and applications programs: the machine boots off that disk. When it comes up, you have a choice of Eaglewriter, which is Lexisoft's Spellbinder text editor; Eaglecalc, which is a general-purpose spreadsheet; backing up the hard disk; exiting to the PC-DOS operating system; or shutting down the system.

Incidentally, that last choice retracts the hard-disk head and protects the system. The Eagle documents insist that you use that method whenever you turn off the system, and they warn you that if you shut down without going through the regular shutdown command sequence, you can damage things. The documents don't say what will happen if you have a power failure and *can't* use Eagle's orderly procedure. In my case what happened was nothing; the system worked fine after two blackouts.

Spellbinder is a more than adequate text editor with all the usual text-editing commands. I have friends who work for the U.S. Congress; they've been using Lexisoft's Spellbinder editor for a couple of years and are well pleased with it. A lot of special-function keys are on the Eagle's keyboard, and this version of

Spellbinder has been tailored to use them, making Eagle with Eaglewriter at least as easy to use as most dedicated word processors. I still prefer Zeke II and WRITE, but I'm pretty set in my ways.

I can recommend the Eagle 1600—with reservations.

On the positive side, the Eagle's keyboard is much nicer than the IBM PC keyboard. It has a better feel, and the key layout is standard Selectric. It's also capable of doing everything the PC keyboard can do. Alas, Logitech's IBM PC Mouse won't work with the Eagle; I understand that both Eagle and Logitech are working on that problem.

Also very much to the Eagle's credit, it's *fast*, much faster than the IBM PC, and that makes up for a lot. Sorts and spreadsheet recalculations take about half as much time. If you're looking for a PC-like machine that runs much (but alas not, by a long shot, all) of the IBM PC software, check out the Eagles. They're well made, quiet, and likable machines, and they sure are fast.

There are a couple of drawbacks. First, the Eagle 1600 is *big*, I mean really massive; the machine itself, without keyboard, measures 19 by 19 by 6 inches. The detached keyboard is also large, 19 by 9 inches, so that the Eagle plus keyboard barely sits on a desk 28 inches deep, and even then things are jammed together. You'll want to think about where to put the Eagle before you buy one; ideally, you'd want one of those workstation tables that has a separate (and lower) shelf for the keyboard. Given that, the Eagle's size won't matter.

Second, the screen's scrolling is not very pretty. When you scroll text, it sort of ripples up and down on the screen. Once it has scrolled, it's rock steady, and the character set is attractive enough. It all depends on what you're used to: some won't find this a problem at all. I do, but recall that my primary machine uses memory-mapped video for superfast scrolling and text movement.

Now to my reservations.

First: there's a fatal error in the Eaglewriter I have. The hard disk is disk A:, and a single floppy disk is designated C:. Disk B: does not exist. However, you can, from within Eaglewriter, try to access all kinds of nonexistent disks. With most, such as E: or M:, nothing happens. However, if you try to access B: for reading or writing, the machine hangs, and you must reset to get back in control. Any text you had in the text editor is *lost*. Text editors that lose text are not acceptable.

Second, PC-DOS 1.0 and 1.1 have no provision for user numbers or any other kind of structured directory; neither does the Eagle 1600. This means that the hard disk soon fills with programs, directories take a long time to list out, and finding anything becomes impossible.

Third, a lot of programs will run with the Eagle. You can boot Lotus 1-2-3, for example: you hold down the F key while the 1600 is booting up, and it will boot from a floppy disk rather than from the hard disk.

Once you have Lotus 1-2-3 running, the program complains that the Numlock key is depressed and urges you to fix that condition. There is no Numlock key. However, Control-Shift-N will have the same effect

as the Numlock key on the IBM PC.

Alas, those latter two features (how to boot from a floppy and how to numlock) are not documented; indeed, while the documents for Eaglewriter and Eaglecalc are really very nice, the system documentation for the machine itself is plain lousy.

Finally, I can't get Concurrent CP/M-86 to run on the Eagle 1600. That can be serious: see below.

I've told the Eagle people all this, and they claim that by the time you read this all will be fixed, with the possible exception of running Concurrent CP/M-86, and they'll work on that.

Certainly the fatal text-losing error will be fixed now that they're aware of it.

PC-DOS 2.0 has a structured directory system, and one assumes that by the time you read this the Eagle 1600 will have DOS 2.0 or later, making it a lot easier to find files.

Finally, it can't be that hard to write adequate documents for the machine, and they swear they're working on them.

Before you buy an Eagle 1600, check the above points. Otherwise, I can recommend this machine.

Recommended Editors

Ian Morton of St. Paul writes, "As respects CP/M, consider ED. No, don't consider it—*wipe it out. Bury it in the Love Canal.*

"Surely ED is the most preposterous piece of software ever written."

He's very nearly right. ED is the text editor you get free with CP/M. It's overpriced. No one could do any serious writing, whether creative text writing or programming, with ED.

Mr. Morton asks what editors I recommend.

I have a lot of text editors and have used most of them. The following are my personal preferences.

For text creation, we continue to use WRITE, which is for 8080, 8085, and Z80 machines only. Its strong points are that it is transparent to the point of invisibility and it's very flexible. I can write a lot of words in a big hurry with WRITE.

For programming, I continue to use Wordmaster, but that's in large part due to sloth; it's not really the best programming editor available.

Two very good programming editors are Superwriter, by Sorcim, and Vedit, by Compuview. Vedit is by all odds the most flexible programming editor I've ever seen. It is also one of the most complex. The version I've got isn't easy to install, and the instructions for learning to use it aren't at all clear. Ted Green of Compuview swears he's fixing all those problems as a result of my grouches. A lot of good programmers swear by Vedit; one of its best features is multiple buffers; that is, you can store chunks of programs in various places and pull them out into your main file when needed.

Vedit also has excellent macro capabilities; that is, you can go through a long program and make complicated changes with conditions: such things as "If a GOTO statement is

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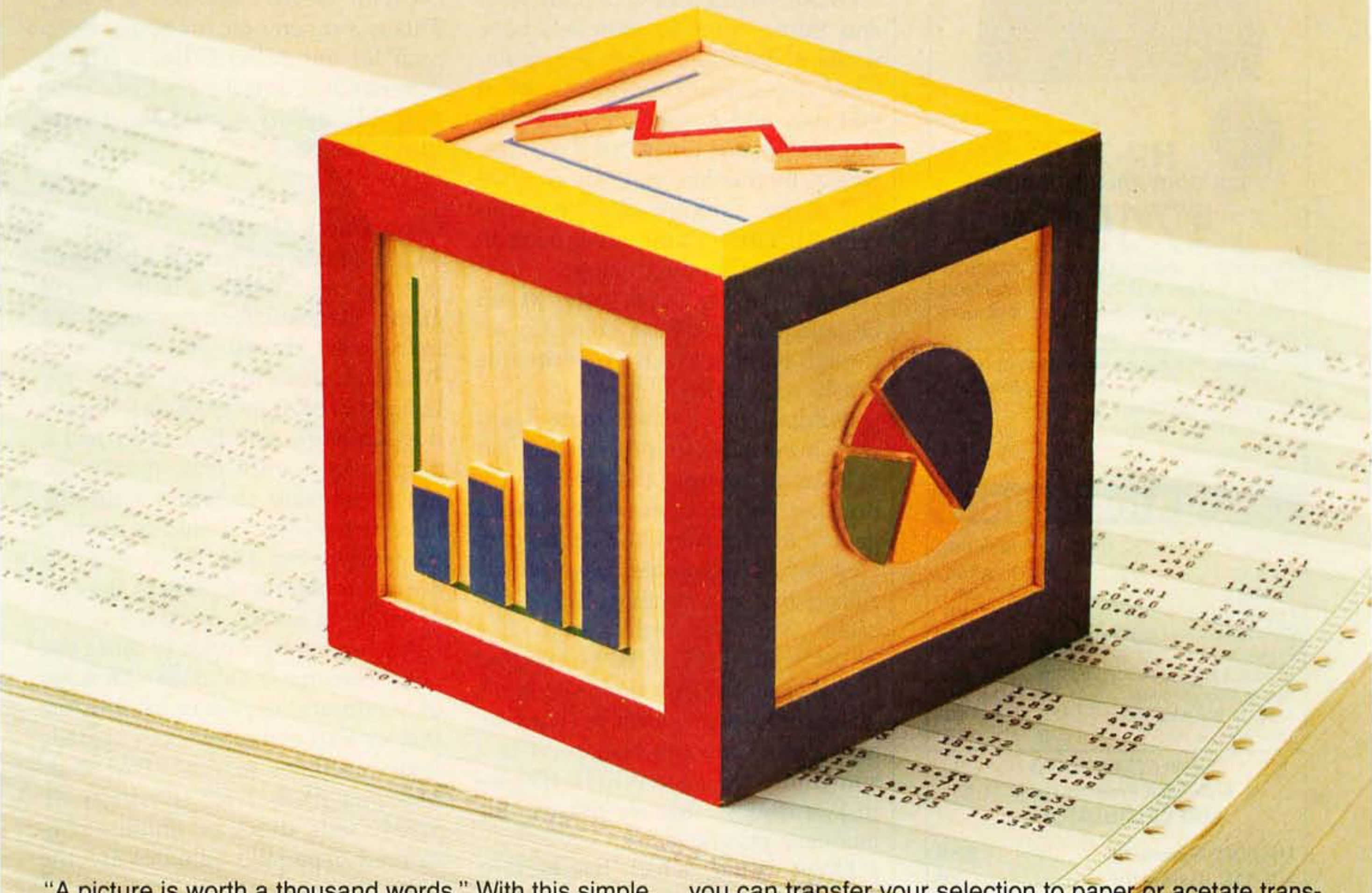

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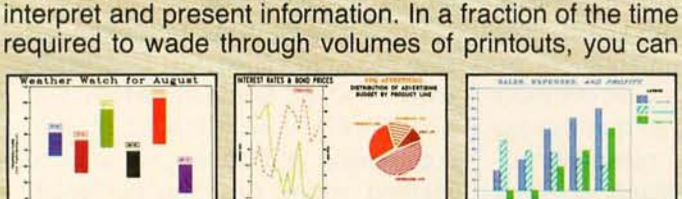

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followed by 456 then change it to GOSUB, and at the end of the line add the following REMARK."

Superwriter, though not as flexible, is much better documented and a lot easier to get running. It too has many positive features and a number of passionate supporters.

I intend a full review of both Vedit and Superwriter as soon as I have stable installations: both are somewhat dependent on what terminal you use, and around here that has changed several times in the past few weeks. By the time you read this, we will almost undoubtedly have converted to either Superwriter or Vedit as our programming editor.

Either Vedit or Superwriter would be adequate for text creation, although I'd hate to have to write this article with either.

Wordstar remains adequate. Used with a machine that's been tailored to it—as an example, the special-function keys for the Otrona have been geared to Wordstar—the editor goes well beyond adequate. Used with a silicon disk, or something like Microcache, Wordstar really wails. If I didn't prefer WRITE, I'd be tempted by Wordstar because there's so much auxiliary software, such as Footnote, and Index, and the like. As it is, I sometimes translate WRITE files into Wordstar so that we can use the auxiliary programs.

Magic Wand, which has become Peachwriter now that it's owned by Peachtree, and Palantir, which was written by the author of Magic Wand, are also more than adequate. Both have very good documentation, including tutorials. They have extensive "auto typer" features, so that you can use them to send "personalized" computer-generated letters to a large mailing list. Each also has "features" I find annoying.

As mentioned above, Spellbinder is much above the average, and a lot of professionals swear by it. You want to get a version configured for the terminal you like, because a good part of Spellbinder's convenience comes from special-function keys; given that, it's quite a good editor, and very possibly what I'd adopt if I didn't have WRITE.

Mark of the Unicorn's MINCE and Final Word editors are quite nice if you're used to MIT's EMACS; if you're not, you might not like them. The commands tend to be complicated, and I don't care for the "philosophy"; that is, Control-f means "forward a space" while Escape-f means "forward a word." This is a mnemonic for some, but a pain for me. MINCE has a million commands; Control-meta-CokeBottle probably means something. Everything else does.

Lobo Users Group

Carl Rankin of Chelsea, Michigan, informs me there's a Lobo users group, Maximul, for those interested in the Lobo Max-80 computer. Barry Workman tends to rely on Ralph, his Lobo Max-80, for a great deal of production work, and he's never had a glitch. As I write this, there's not much software included with the Lobo; otherwise, it would be a strong contender for the best deal in microcomputerland. As it is, it's a lot of machine for the money.

A users group ought to make the Lobo even more valuable. An issue of Maximul's newsletter informs me that for $30 Lobo owners can upgrade their machines to run CP/M Plus. Maximul (POB 19525, Orlando, FL 32814) sells disks of utilities considered especially valuable for the Lobo.

CP/M Source Code

The darndest thing I ever did see is a program called M/PC. Distributed by C. C. Software, M/PC will disassemble your CP/M 2.2*x*, add comments, and give you a commented source file. You no longer need MOVCPM to change your system, because you can reassemble the source code after making any changes (such as system size) that you like.

Naturally this is mostly useful to the hackers among my readership. For those who can use it, however, it's really neat.

The version I got was sold as an .INT file for CBASIC, along with a whole raft of data files that contain

the comments. M/PC disassembles the CCP (console command processor) and the BDOS (basic disk operating system) of your CP/M. It doesn't attempt to disassemble the CBIOS (customized basic input/output system). However, if you have your BIOS source—and you should—you now have everything you need to really customize heck out of your system.

Clark Calkins of C. C. Software says this is a goofy way to distribute a disassembly of CP/M, but he has no choice; else he'd be violating Digital Research's copyright.

You must run the program; it took about an hour with a 2.5-MHz Z80 and regular disks. With a 5-MHz 8085 and M-Drive pseudo disks (memory that your computer thinks is a disk drive; *it's wonderful*) the disassembly is a lot faster. I found this sufficiently interesting that I was willing to help Mr. Calkins and compiled his program with CB-80; it now runs in about 11 minutes on his system. I presume it would go in half that time on mine. I presume he now supplies the compiled .COM file as well as the .INT file.

M/PC sells for $35, and if you're at all interested in what's going on in your system, it's worth it.

Hacking Up Your Kaypro

If you like customizing your keyboard, it turns out to be simple with the Kaypro II. Daniel Wiener of Simi Valley, California, writes:

> *The Kaypro allows you to redefine the cursor (arrow) keys and the 14-key numeric pad by assigning any hexadecimal codes you want to them. . . .*
>
> *I took advantage of this by simply setting the eighth bit: the keypad 0 was changed from 30 to B0; Enter was changed from 0D to 8D; etc. Normal operation is not affected, since the eighth bit is usually ignored. But now the Enter key is potentially distinguishable from the Return key.*
>
> *Next I bought a neat little program called Smartkey ($60 from Heritage Software Inc.). It intercepts keyboard calls to the CP/M BIOS, and allows you to redefine any key as a string of commands and/or characters.*

He uses this to redefine various keys for use with text editors. I'm trying to see if we can do that to redefine escape sequences sent by terminals like the Telewidget; that would really be useful. So far we haven't been able to do it. Even so, Smartkey is a good value for those who like customizing their systems.

Appli-card for Apple

The PCPI 6-MHz Appli-card is a one-card solution to running CP/M on the Apple. Being very fast, you notice the speed improvement over the Microsoft Softcard. The Appli-card has a one-disk copier program, letting you copy any CP/M Apple disk. My boys installed it, and they use it a lot.

The Appli-card converts the Apple to 70-column video, with uppercase and lowercase. (These work only when the Apple is under CP/M.) Running it is simple: put in the CP/M master disk, and it boots as CP/M; put in any other disk, and it boots as

Circle 326 on inquiry card.

an Apple. Because the Appli-card has its own onboard memory, you can have up to a 64K-byte CP/M system.

In fact, this is in essence a one-card computer that turns your regular Apple into a kind of terminal. You can think of it as a computer that happens to use parts of the Apple.

Incidentally, when running under Appli-card, Reset forces a CP/M cold boot, giving you a way out of some programs. Under regular Apple DOS, Reset may not do anything at all, and sometimes the only escape is to turn the machine off . . .

Epyx's New World

Reviewed by Richard Pournelle, age 12, a user.

"New World is about the conquest and colonization of the New World. There are three countries: Spain, France, and England. You may play a one-, two-, or three-person game.

"The main flaw is that Spain is the weakest country, but when you play a one-player game you always get Spain. The computer gets France and starts with 16 colonists, while Spain has only 2.

"The game is rather slow. Sometimes if you hit Return when you are not supposed to, it stops the game and you cannot restart it. Also, at one time, for no reason at all, it took away my chance to go on an expedition.

"The graphics are very nice, also the way the letters are written is very nice. I don't like it much when you have to play against the computer, but if you play a three-person game it is fun. It is sort of a family-type game. On a rating of 1 to 10 I would give it a 5."

Book Learning

When I first got involved with microcomputers, there weren't a lot of choices about programming languages; you used BASIC, which was cumbersome and slow, or you used assembly language, which was fast but hard to learn.

Assembly language is one (fairly large) step up from what the computer itself knows. That is: in BASIC if you want to add two variables, you say something like

LET A = A + B

while in assembly language you must find the address of A, move the number into the accumulator, find the address of B, add what's at that address into the accumulator, then take the result and store it where you found A. Of course that's what the BASIC statement did, but higher-level languages spare you the gory details.

It's now possible for computer users to get along without ever learning assembly language, which is just as well, because assembly-language programs are by definition not transportable. (In the example above we assume there *is* an accumulator, which isn't true of all systems; even where the instructions are similar, an assembly program written for one kind of machine is highly unlikely to run on another.)

However: if you're after fast and efficient programs that don't waste memory, there's nothing like assembly language. Fortunately, some fairly good books on the different assembly languages are available. I'm not competent to judge the merits of most of them. However, I have done some 8080 and Z80 assembly-language programming, and for those I found the best reference works to be the Osborne/McGraw-Hill books by Lance Leventhal.

Leventhal's books have an introductory section explaining what assembly languages are and why they're important. Even so, they wouldn't be my first choice as elementary texts—but I would be sure to get the proper Leventhal book at the same time I bought the elementary textbook, because his examples are clear and his books are very complete.

Leventhal has written a whole series of these works covering just about every microcomputer chip. As it happens, I've known Lance Leventhal since I served as his unofficial high school adviser in Seattle in the early 60s. I therefore have some confidence that all his books will be as good as the ones I can read.

He has also produced a book of Z80 assembly-language subroutines. These can be copied out of the book and used as part of larger programs. They all look useful. For some strange reason, the subroutines given in the book aren't listed until page 163. The listing there is complete enough, once you find it.

There's a good section on programming practices and another on common errors. Both would be better for an analytical table of contents. The other books in the series have excellent analytical contents tables; I can't think why this one doesn't.

Don't let that stop you from getting the book, though; if you're writing in Z80 assembler, it's just about guaranteed to save time and frustration.

Floods of Programs

We get a lot of programs. For some reason, a lot of them come packaged in a rather odd way.

Typically, in these cases, the documents are printed on cheap paper offset from a Spinwriter. We read the documents two or three times, and sometimes we figure out what the program does. Sometimes, though, we're just out of luck. We're fairly sure it does *something*, but we can't quite puzzle out what.

The documents are generally written by a programmer. Typically they say, "Here's this program. I use it a *lot, so it's easy* to use. I like it, and you will too. It's set up to run on a TzQ-820 terminal running off the Z-79 chip; it might not run on your system, but just use DDT to patch it in the usual way, and I'm sure you'll love it."

Needless to say, every office has suitable receptacles for stuff like that . . .

More Licensing Agreements

Ralph McElroy of ZXY Controls sends his candidate for the Most Absurd Licensing Agreement of 1983. It looks to be a leading contender.

It's from Avocet Systems Inc., apparently for an 8048 cross-assembler. Under this agreement, you promise to destroy all the software within five days if Avocet cancels your license.

Avocet explicitly warrants absolutely nothing if you use its program with *any* non-Avocet software (such as CP/M). If the disk is no good and you respond quickly enough, Avocet might replace it, although it doesn't have to.

The agreement also incorporates a "Statute of Limitations" as follows: "7.6 Statute of Limitations. No suit shall be brought on an alleged breach of this Avocet Warranty more than Twelve (12) months following delivery of the SOFTWARE to LICENSEE."

Apparently, no one has told its lawyer that a statute is an act of a legislature, not a term in a contract. Ah, well.

It also says that if you open the package and don't sign, you'll be deemed to have signed the warranty anyway. If you do sign, you're to send the company the make, model, and serial number of your computer; naturally you've agreed to use its product on one and only one machine. The agreement doesn't say you can take the output of the cross-assembler and use it on another machine; one presumes Avocet will allow this because otherwise the product is useless.

There's enough of this sort of thing that I'm contemplating an award each year in the April issue of BYTE for

Most Absurd Licensing Agreement
Silliest Documentation
Most Obscure Document

Readers are encouraged to send me candidates. The award is guaranteed to be valueless and in bad taste. It should be much coveted.

Happy Endings

Some time ago I got a copy of a letter to Bill Godbout from an information systems company in Quebec. It was written in much better English than my French.

The problem was that the company had bought a Compupro system and it wouldn't boot. The Canadian company it had bought the system through was either unwilling or unable to help. Godbout's people tried, but over the phone they couldn't figure out what was wrong (I don't know if Chris or Peggy speaks French; if not, they must have *really* had a time of it) . . .

The company sent another letter to Godbout. "Because we found it so difficult to proceed only by phone and mail, we decided to find somebody who wanted to receive us. We contacted Micro-Computer Technology Corp. in Florida and they accepted."

The consultants soon discovered that the ROM (read-only memory) chip sent with the Disk 1 controller was for software version E, while the CP/M system received was version F.

The letter continues, "As our system was now working, we bought an M-20 hard disk from Pragmatic Design with a Disk 2 controller and an extra RAM16 board. . . . it is important to have centers that are responsible and friendly like Micro-Computer Technology.

"We are now running our system with CP/M-86 and Pascal MT+86 for nearly one month and we are very happy. The system is the fastest microcomputer we ever saw. I want to let you know how happy we are to arrive at the end of problems with our system."

When ordering equipment across international boundaries it's especially important to work with systems integration people who know what they're doing. Many of the problem stories I hear—and all of those concerning Compupro equipment—involve international transactions. If you intend to mix equipment, be especially careful you're dealing with people who know what they're doing.

Not long ago I read in *Infoworld* the sad story of a lawyer who decided what equipment she wanted (it wasn't what I'd have recommended) and proceeded to purchase it by ordering parts from three different places, each of which had a special price. She saved a few hundred dollars that way, but the result was horrible.

What did she expect? As someone later commented about her case, if you decided you wanted a Harvester engine, Fisher body, Bendix brake

system, Saginaw steering, and shopped by mail for all these by price alone—would you expect to have a working car when you got done?

S-100 bus systems have nearly become standardized; but it's just not true that randomly selected S-100 systems are certain to work together, unless they're really and truly IEEE-696 standard (and not just "696 compatible"). Even then you want to know what you're doing.

Know what you're doing, or deal with those who do, and you can assure yourself of a happy ending, at ultimately lower costs.

Zenith Z-100/IBM PC Compatible

This is going to get a little technical. Sorry, it's important.

Victor Wright of Louisville, Kentucky, has a Zenith Z-100 and has done considerable research on which IBM PC programs will run on it.

In CP/M and Zenith ZDOS, the BIOS is a program on the so-called system tracks of your master disk. It is read into the machine when you first turn it on (or reset). The 8088 chip allows a total of 256 different interrupts. ZDOS uses interrupt 21 to make BIOS calls: such things as "Read a character from the keyboard," or "Close file," or "Rename file," or "Print a character to the console," etc. This is all explained in some detail in the BIOS source code, which is furnished with ZDOS.

Alas, IBM built the CBIOS for the IBM PC into ROMs. That has its good points, but it also causes some problems because you can't make changes.

Here's where the incompatibilities come in: although PC-DOS uses interrupt 21 just as ZDOS does, it also uses a number of other interrupts that call the BIOS directly—and those are not implemented in the Z-100. The result is that programs for the IBM PC that use interrupts below 20 hexadecimal will blow the Z-100 sky-high.

The upshot, according to Mr. Wright, is that if you're contemplating PC software for the Z-100, test it before you buy it or else be certain that it doesn't use interrupts below 20 hexadecimal. I'm not en-

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There's an acceptance letter inside. And a check that could have your name on it. (If we select your program, that is.)

But remember.

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Because the software we publish for the IBM Personal Computer has to be good enough to complement IBM Personal Computer hardware. (See the box at right.)

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Microprocessor
16-bit, 8088

Auxiliary Memory
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83 keys, 6 ft. cord attaches to system unit
10 function keys
10-key numeric pad

Diagnostics
Power-on self testing
Parity checking

Display Screens
Color or monochrome
High-resolution
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Upper and lower case

Operating Systems
DOS, UCSD p-System, CP/M-86†

Languages
BASIC, Pascal, FORTRAN, MACRO Assembler, COBOL

Printer
All-points-addressable graphics capability
Bidirectional
80 characters/second
18 character styles
9 x 9 character matrix

Permanent Memory
(ROM) 40K bytes

Color/Graphics
Text mode:
16 colors
256 characters and symbols in ROM
Graphics mode:
4-color resolution: 320h x 200v
Black & white resolution: 640h x 200v
Simultaneous graphics & text capability

Communications
RS-232-C interface
SDLC, Asynchronous, Bisynchronous protocols
Up to 9600 bits per second

are high-quality, full-function tools that were submitted by authors like you and subsequently published by us.

Now you might have the chance to win.

Who knows? You could open the mailbox and find one of the envelopes shown here.

For information on how to submit your program, if completed and running, write: IBM Personal Computer External Submissions, Dept. 765 PC, Armonk, New York 10504.

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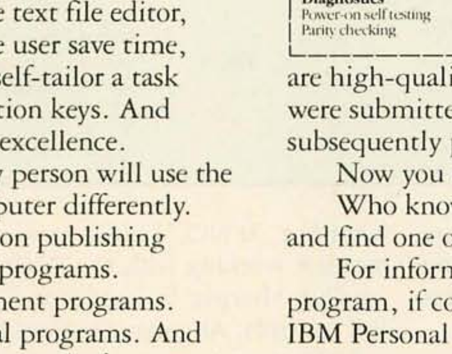

The IBM Personal Computer
A tool for modern times

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For more information on where to buy the IBM Personal Computer, call 800-447-4700. In Alaska or Hawaii, 800-447-0890.

Items Reviewed

Appli-card $295
Personal Computer Products Inc.
16776 Bernardo Center Dr.
San Diego, CA 92128
(619) 485-8411

CB-86 $600
Digital Research
POB 579
Pacific Grove, CA 93950
(408) 649-3896

Compilable Business BASIC $600
Microsoft Corporation
10700 Northup Way
Bellevue, WA 98004
(206) 828-8080

Critical Connection $175
USS Enterprises
6708 Landerwood Lane
San Jose, CA 95120
(408) 997-0264

Eagle 1620 $4495, 1630 $6995, 1640 $8995
Eagle Computers
983 University Ave.
Los Gatos, CA 95030
(408) 395-5005

M/PC $35
C. C. Software
2564 Walnut Blvd. #106
Walnut Creek, CA 94598

New World $29.95
Epyx Automated Simulations Inc.
1043 Kiel Court
Sunnyvale, CA 94086
(408) 745-0700

Smartkey $60
Heritage Software Inc.
2130 South Vermont Ave.
Los Angeles, CA 90007
(213) 737-7252

Superwriter $295
Sorcim
2310 Lundy Ave.
San Jose, CA 95131
(408) 942-1727

Vedit $150
Compuview Products Inc.
Suite 200
1955 Pauline Blvd.
Ann Arbor, MI 48103
(313) 996-1299

WRITE $395
Workman and Associates
112 Marion St.
Pasadena, CA 91106
(213) 796-4401

Zenith Z-100 Computer $2899
Zenith Data Systems
1000 Milwaukee Ave.
Glenview, IL 60025
(312) 391-8865

Books Reviewed

Lance Leventhal series on assembly language. For further information, contact Osborne/McGraw-Hill, 2600 Tenth St., Berkeley, CA 94710, (415) 548-2805.

tirely certain how you can make sure it doesn't use those, short of asking the program's author; few dealers would know.

We've found that some PC programs run on the Z-100 and some don't. Lotus 1-2-3 doesn't, although by the time you read this there may be a Z-100 version of it. IBM PC Pascal runs fine. CBASIC and CB-86 for the PC work.

A sufficiently clever programmer could probably rewrite the ZDOS BIOS to make the machine entirely compatible. I've heard rumors of a ROM for the Z-100 that would do the same job, but I don't yet know where to get one. Incidentally, Mr. Wright concludes, "I certainly won't trade my Z-100 for any other computer."

While we're on the subject of the Z-100, one of my major complaints about it is that the big color monitor is both too big and has no controls whatever. At NCC I saw a new color monitor working with the Z-100. It's smaller, sharper in image, and has full controls. Anyone contemplating a Z-100 ought to insist on seeing the new screen.

There's also a persistent rumor that next year Zenith will bring out a version of the Z-100 with a detachable keyboard. I sure hope so; the Z-100 keyboard is *much* nicer than the IBM PC keyboard, but it's attached to that really *big* machine; it would be a lot easier to use if the keyboard were detachable.

One Way to Tame a Telewidget

I've made no secret of my difficulties with the Back Tab key on my Televideo 950; because it is placed outboard of the Shift key and just below Control, it's very easy to hit by mistake.

Several readers took pity on me and sent little plastic gizmos called "keylocks." They look like little plastic horseshoes. It's not at all obvious how they go on—one must have faith that they will go on before you can put them on—but they sure do the job. It's now impossible to depress the Back Tab key on both our Telewidgets. This greatly improves my temperament.

Incidentally, we're probably going to abandon the Televideo for the Zenith Z-29 terminal. I'd probably have done that already except that NCC and other stuff interfered with getting my favorite text editor installed on it properly. We like the Z-29 a lot, and anyone contemplating purchase of a terminal really ought to look at one.

Creeb File

I like the new manual sizes used by IBM and Digital Research, really I

SuperSoft BASIC Compiler

for CP/M-86,® MS DOS, and PC DOS

Compatible with Microsoft BASIC

The SuperSoft BASIC compiler, available under CP/M-86 and MS DOS, is compatible with Microsoft* BASIC and follows the ANSII standard. If you want to compile BASIC programs under CP/M-86, PC DOS, and MS DOS, SuperSoft's BASIC compiler is the answer.

Greater accuracy with BCD math routines

If you have used other languages without BCD math, you know how disconcerting decimal round off errors can be. For example:

With IBM PC* BASIC	With SuperSoft BASIC with BCD math
10 A=.99 20 PRINT A 30 END	10 A=.99 20 PRINT A 30 END
Output: .9899999	Output: .99

As you can see, SuperSoft BASIC with BCD provides greater assurance in applications where accuracy is critical.

SuperSoft's BASIC is a true native code compiler, not an intermediate code interpreter. It is a superset of standard BASIC, supporting numerous extensions to the language. Important features include:

- Four variable types: Integer, String, and Single and Double Precision Floating Point (13 digit)
- Full PRINT USING for formatted output
- Long variable names
- Error trapping
- Matrices with up to 32 dimensions
- Boolean operators OR, AND, NOT, XOR, EQV, IMP
- Supports random and sequential disk files with a complete set of file manipulation statements
- IEEE floating point available soon as an option

In addition, SuperSoft BASIC has no run time license fee. SuperSoft's line of fine language compilers includes FORTRAN, BASIC, C, and Ada.

Requires: 128K memory
BASIC compiler: $300.00

SUPERSOFT LANGUAGES: THE STANDARD OF EXCELLENCE.

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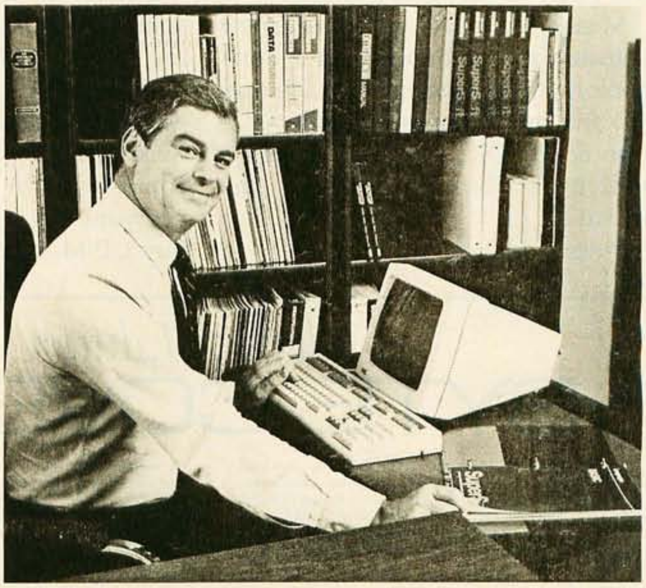

SuperSoft BASIC lets me run compiled BASIC programs under either CP/M-86 or MS DOS.

*SuperSoft BASIC is compatible with Microsoft BASIC interpreter and IBM PC BASIC. Due to version differences and inherent differences in compilers and interpreters some minor variations may be found. Machine dependent commands may not be supported. The vast majority of programs will run with no changes.

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do—but why couldn't they have given us some blank paper properly punched? I have discovered that stationery stores have several not-quite 8½ by 11 sizes of notebook paper, and only one is the proper size for adding to the new manuals. Alas, whichever one I buy is not the right one.

Meanwhile, I have got some review software that is bundled in a notebook that is *yet another* size, neither full 8½ by 11 nor the smaller size favored by DR, nor even 9½ by 6 which I brought home by mistake . . .

Please, fellows?

Language War

The war between Digital Research and Microsoft is heating up, now that Digital Research is heavily into languages and Microsoft is marketing the MS-DOS operating system. It's hard to say who's winning, although it is clear that Digital Research made some terrible mistakes in the marketing of its CP/M-86.

The IBM PC can run the Microsoft MS-DOS (called PC-DOS) or Digital Research's CP/M-86. Neither actually comes with the machine, but nearly everyone buys PC-DOS. You could buy CP/M-86 at extra cost, but that cost was high; consequently, fewer than 5 percent of PCs were sold with CP/M-86, and Digital Research found itself squeezed out of the fastest-growing microcomputer market.

Like The Empire, DR has struck back: first, it's dropped the price of CP/M-86 for the PC to something less unreasonable. Second, it put out CB-86, its CBASIC Compiler, to run with MS-DOS. Third, it developed Concurrent CP/M-86, which is the most exciting new operating system I've yet seen. Note: I've recently learned that all DR languages will now run with PC-DOS.

Concurrent CP/M-86 is a way of making your IBM PC get instant schizophrenia: you can make it run up to four jobs at once. As an example, you can write a text file and start it printing; then, leaving that run, you can bring back the editor and edit another file. Unlike "spooler" programs, this method works without distracting you.

You can compile a long program while simultaneously editing another; look up data in one file while editing something else entirely; and in general be up to four separate users without having separate terminals or equipment. I expect Concurrent CP/M-86 to become very popular with PC users.

That was Digital Research's move. Microsoft, meanwhile, has challenged DR's popular CB-86 CBASIC Compiler: it's brought out Microsoft Business BASIC.

Business BASIC is a recognizable outgrowth of regular Microsoft BASIC, but it has a number of features obviously derived from CBASIC. It even comes with a program suggestively named CTOMB that will convert CBASIC source files into MS Business BASIC.

Business BASIC is both interpretive and compilable. Like CBASIC, it requires no line numbers; referenced lines must be identified, but that can be by a label rather than a number. However, that's for the *compiled* program only; if you want to run the program interpretively, you still must use numerical line numbers for every line.

A number of features formerly in

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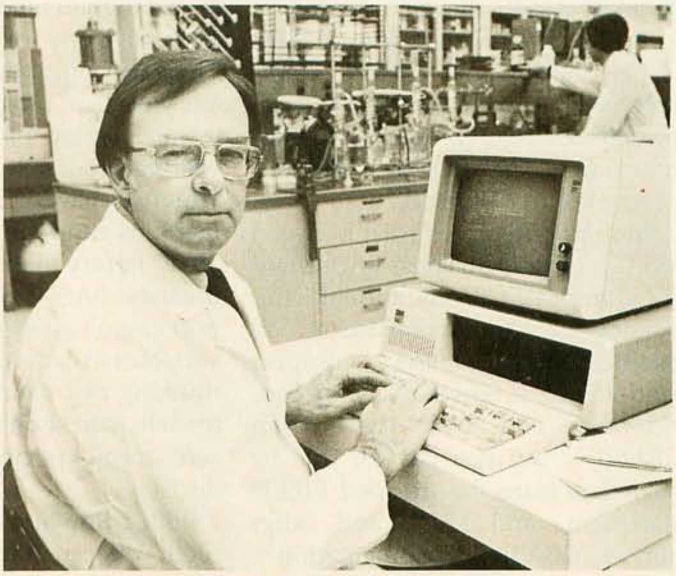

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CBASIC have been added to the Compilable version of Business BASIC. The language has been made modular, meaning that you can compile chunks of it and link them together at a later time; this is a great boon for developing large programs. Business BASIC allows multiple-line functions. Another new feature is external subroutines called "subprograms"; they're similar to Pascal procedures. Both functions and subprograms can be called by name; you don't have to "GOSUB."

Enough differences exist between MS Compilable Business BASIC and DR Compiled CBASIC to make impossible any simple comparison. MS Business BASIC allows compact random-access files that take up considerably less disk space than CBASIC's; but you pay for that by having to learn the dreaded FIELD statement, and LSET, and other horrors. CBASIC's documentation is much better than Microsoft's for Business BASIC; Digital Research has made enormous improvements in its documentation.

Neither language has a noticeable speed advantage. The Microsoft system has some advantages: you can test out various tricks in the interpretive mode, thus finding out quickly whether or not something will work. On the other hand, to do that you have to use line numbers, and some of the tests you want to perform won't work in the interpretive mode, which can be confusing. Both compilers allow separate compilation and modular program construction.

I have a mild preference for Compiled CBASIC's method of libraries from program modules, and CBASIC does have one very large advantage. The new Compilable Business BASIC lets you chain programs together and create overlay programs. If you're writing programs for sale, however, you must pay Microsoft a royalty for using its run-time library. There is a "free" library module for Compilable Business BASIC, but it does *not* support chaining programs and putting variables in common. Thus, if you're thinking of creating large programs for sale, you should look into Microsoft's royalty pricing before making a decision.

Both compilers are priced far too high. We can hope that continued competition will remedy this situation: in fact, next month I hope to report on a BASIC compiler that will sell for less than $100.

The Atari Connection

Vincent Cate continues to improve his Critical Connection. This gadget makes an Atari think a CP/M computer system is a set of disks. The only requirement is that your CP/M system have an RS-232C serial port operating at 19,200 bps. Given that, you needn't buy disks for an Atari; by using the Critical Connection, you can make the Atari believe you have *four* disks. The really nice part is that you can use 8-inch as well as 5¼-inch disks.

Cate's new software package has automatic installation for a number of CP/M systems, including Kaypro, North Star, Sanyo, CCS, Heath/Zenith, and Morrow. He also explains how to use DDT to install it for other systems; you'd need to know something of what you're doing to do that. Cate's documentation is improved, but it's not what I'd call good. Still, you can puzzle it out, and if you don't want to invest a lot in an Atari system but still want to use disks with it, Cate's Critical Connection is the way to go.■

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed stamped envelope to Jerry Pournelle, c/o BYTE Publications, POB 372, Hancock, NH 03449. 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.

Jerry Pournelle is a former aerospace engineer and current science-fiction writer who loves to play with computers.


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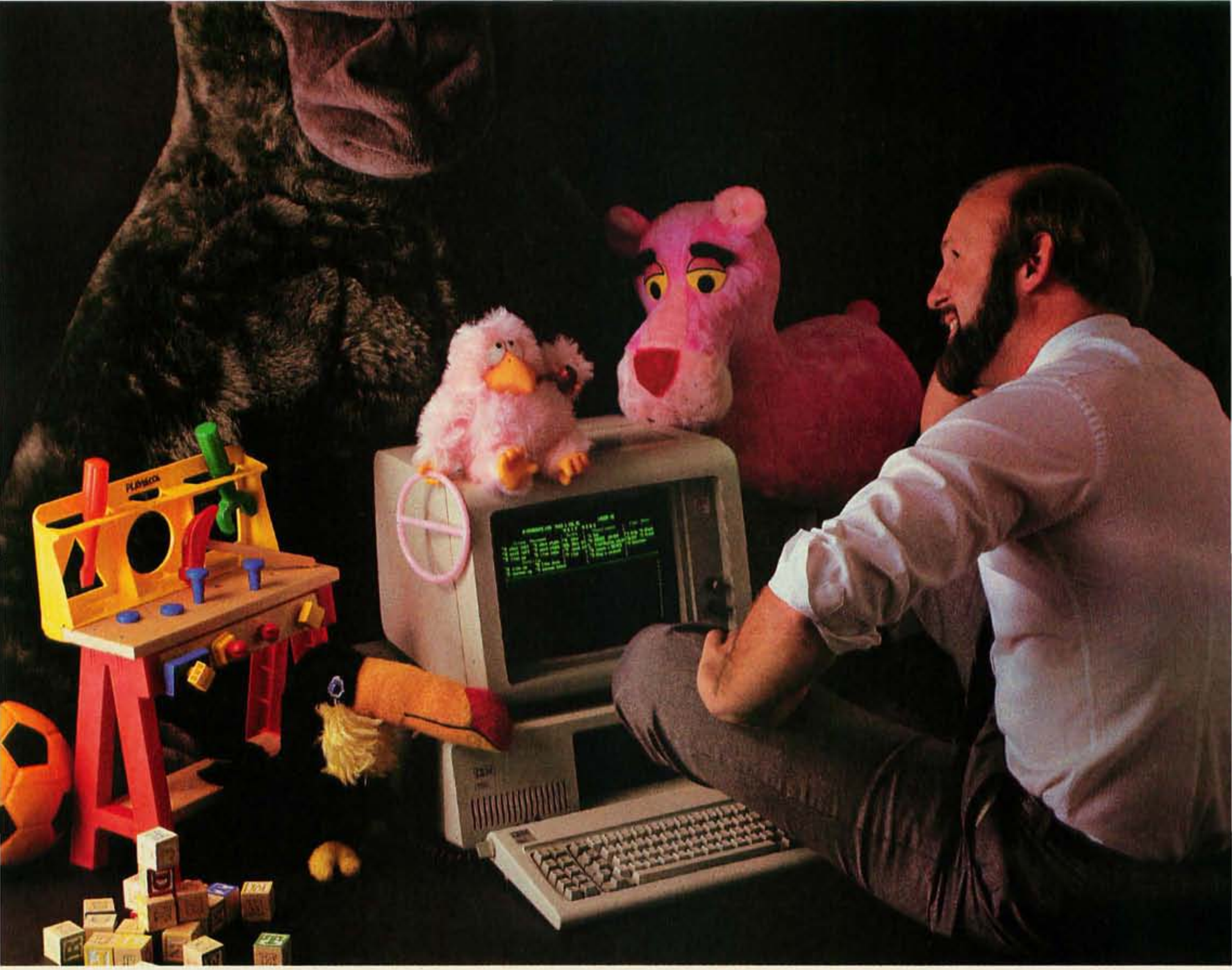

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The IBM PC and the Intel 8087 Coprocessor

Part 2: Interfacing to IBM Pascal

Using the 8087, you can speed up most Pascal programs by at least a factor of three

by Tim Field

Last month we looked at the Intel 8087 Numeric Data Processor (NDP) and saw how to provide software support (M8087.MAC) for the assembly-language programmer using the IBM Macro Assembler. This month we build on the support provided by M8087 to develop a higher level of support for the Pascal programmer using the IBM Pascal Compiler.

This software support package consists of two basic components: PAS87 (listing 1) and P87_INT (listing 2). PAS87 is an assembly-language file that, through the extensive use of the macro-processing capability of the IBM Macro Assembler, builds a set of assembly-language subroutines that are Pascal-callable as standard procedures and functions and provide complete access to the full 8087 NDP instruction set.

P87_INT is a file of Pascal procedure declarations that define all routines found in PAS87 in such a manner that the Pascal compiler can readily access those routines. The P87_INT file is to be included in any Pascal program that uses a PAS87 operation.

PAS87 Overview

The best method of providing Pascal support for the 8087 would be to make that support invisible to the programmer. In this approach, if the program executed a "$y := x + z$" instruction, the concern whether this was executed using software routines or the 8087 would be immaterial to the user—the compiler would automatically emit the code for the 8087 use. Under this scheme, any standard Pascal program would show some level of performance improvement by a simple recompilation of the program using a revised compiler. The problem with this approach is that it requires rewriting portions of the compiler. This nontrivial task is beyond the scope of this article.

The PAS87 software support lets you execute 129 individual 8087 instructions.

The PAS87 software support presented here does *not* provide this "invisible" support. Rather, it lets you execute 129 individual 8087 instructions, each of which is callable as an external Pascal procedure. Because individual 8087 instructions are fairly powerful, you can get a lot of work done with only a few 8087 calls—the biggest drawback is that the user must be conscious of the inner workings and current state of the 8087. As a bonus, direct use of the 8087 lets the Pascal programmer "cheat" the Pascal type-checking mechanism by manipulating data types that the IBM Pascal Compiler does not allow.

The Pascal Frame

When a Pascal procedure or function is compiled, the code produced

is a typical machine-language subroutine. A standard mechanism (defined in the *IBM Pascal User's Manual*) specifies how parameters are passed to the procedure or function and how, in the case of a function, a result is returned to the caller. Any time the compiler finds an invocation of a procedure or function, it emits the machine-language code that causes the parameters to be set up properly, calls the subroutine for the procedure or function, and handles the result returned by a function.

The IBM Pascal Compiler provides the means by which we can write our own procedures or functions in assembly language. As long as we meet the parameter-passing requirements established by the compiler, our routine can find and use the parameters passed to it by Pascal; if necessary, it can also return results to Pascal.

A knowledge of frames is needed to modify but not to use the PAS87 file in Pascal programs. If you want to know more about frames, look at the "Internal Calling Conventions" section of the *IBM Pascal User's Manual*.

PAS87–8087 Support for the Pascal Programmer

The most important initial question in deciding how to support the Pascal compiler to access the 8087 is "How do we want to trade off performance versus code size?" The constant battle in software development is deciding whether to sacrifice some performance to gain in the compactness of the resulting code or to instead sacrifice the code length for maximum speed of execution. The final verdict almost always lies at some happy medium within the boundaries of the two extremes.

For PAS87 the two extremes were these: first, we could develop a single assembly-language subroutine that would receive as parameters the 8087 operation to be performed and any parameters needed for that operation; second, we could develop a separate subroutine for each and every 8087 operation. In the former case, we would have no repetition of

Listing 1: *The PAS87 assembly-language file, when compiled and linked to a Pascal program object file, lets the program use the 8087 Numeric Data Processor through procedure calls. To save space, the functions CHK87, EXAM87, GETST, and STATUS have been omitted. Their full definitions, starting with the word PUBLIC and ending with the word ENDP, should be copied into this file from listing 3 of last month's article.*

```
PAGE 64,132
TITLE LISTING 1 - PAS87 Pascal support for 8087

;*************************************************************************;
;                                                                         ;
;       PAS87 - This is an assembly language file that produces the      ;
;               full library of routines callable from IBM Pascal to      ;
;               implement every 8087 NDP operation.  This file, once      ;
;               it is assembled, can be linked with any Pascal program    ;
;               which contains the command ( $INCLUDE P87_INT ).          ;
;                                                                         ;
;*************************************************************************;


;
; MEMOP - Macro to emit code for memory based operands in 8087 operations.
;       The address to the operand is expected to be a pass-by-reference
;       parameter from Pascal.
;
MEMOP MACRO P1,P2

        PUSH  BP
        MOV   BP,SP
        MOV   BP,[BP+6]
        P1 P2 [BP]
        POP   BP
        RET   2
ENDM


;
; PASSTACK - Macro that emits code to use pass-by-value parameter
;       as register (value 0 to 7) value for 8087 register operation
;       (Uses self-modifying code to work).
;
PASSTACK MACRO R1,R2,R3
        LOCAL   FLAG

        PUSH    BP
        MOV     BP,SP
        MOV     BX,OFFSET FLAG+2
        MOV     AL,CS:[BX]
        AND     AL,0F8h
        OR      AL,[BP+6]
        MOV     CS:[BX],AL
        JMP     FLAG
FLAG:
        R1 R2 R3
        POP     BP
        RET     2
ENDM

PAGE    ; move to next page on listing
;
; PAS87 - Macro to produce code for all of the 8087 operations.  Each
;       call to PAS87 sets up a separate subroutine which is callable
;       from Pascal.
;
PAS87 MACRO P1,P2,P3
  IFB <P2>       ; IF P2 BLANK, MEANS NO PARAMETERS FOR PROC CALL
    PUBLIC F_&P1
    F_&P1 PROC FAR
    P1
    RET
    F_&P1 ENDP
  ELSE
    IFIDN <P2>,<SHORT>
      PUBLIC FSHORT_&P1
      FSHORT_&P1 PROC FAR
      MEMOP P1 P2
      FSHORT_&P1 ENDP
```

Listing 1 continued on page 334

various sections of code, but the code would be complex and would require numerous tests to determine the operation being requested. In the latter case, we would be able to maximize the performance of each interface to the 8087, but the large number of definitions would add to the length of the PAS87 file.

After realizing that the main reason for using an 8087 chip is to decrease program execution time, I found that I could follow the latter objective without prohibitively adding to the size of the program that uses PAS87. The PAS87 package we are about to look at in detail increases the size of a compiled Pascal program by some 5000 bytes, which will increase the size of the "average" Pascal program by about 12 percent. At the same time, execution speed of a Pascal program making heavy use of the 8087 via PAS87 can be cut by 67 percent or more. This is, in my opinion, an acceptable trade-off.

Dividing the Tasks

At first glance, it appears that we will have to individually write every one of the 129 routines to be included in PAS87. This would be a repetitive and error-prone job, definitely not a task to look forward to. For example, 11 different 8087 operations use a short-real memory operand. Each requires identical manipulation of the operand and will differ only on the actual 8087 instruction escape (ESC) sequence.

Because PAS87 is written entirely in assembly language, the power provided by the IBM Macro Assembler as discussed last month indicates that repetitive functions can be handled easily and automatically through the use of macro definitions. This approach works beautifully and greatly simplifies the building of PAS87.

Upon examination, the 8087 operations fall into two basic categories: those that don't require parameters and those that do. For example, the classical stack operation FADD doesn't require parameters. It always operates on two values already in the 8087 system stack. On the other hand, the 8087 operation FADD

Listing 1 continued:

```
                    ELSE
                      IFIDN <P2>,<LONG>
                        PUBLIC FLONG_&P1
                        FLONG_&P1 PROC FAR
                        MEMOP P1 P2
                        FLONG_&P1 ENDP
                      ELSE
                        IFIDN <P2>,<TEMP>
                          PUBLIC FTEMP_&P1
                          FTEMP_&P1 PROC FAR
                          MEMOP P1 P2
                          FTEMP_&P1 ENDP
                        ELSE
                          IFIDN <P2>,<WORD>
                            PUBLIC FWORD_&P1
                            FWORD_&P1 PROC FAR
                            MEMOP P1 P2
                            FWORD_&P1 ENDP
                          ELSE
                            IFIDN <P2>,<ST>
                              PUBLIC FST_&P1
                              FST_&P1 PROC FAR
                              PASSTACK P1 P2 P3
                              FST_&P1 ENDP
                            ELSE
                              IFIDN <P2>,<SPECIAL>
                                PUBLIC FSPEC_&P1
                                FSPEC_&P1 PROC FAR
                                MEMOP P1
                                FSPEC_&P1 ENDP
                              ELSE
                                PUBLIC FSTI_&P1
                                FSTI_&P1 PROC FAR
                                PASSTACK P1 P2 P3
                                FSTI_&P1 ENDP
                              ENDIF
                            ENDIF
                          ENDIF
                        ENDIF
                      ENDIF
                    ENDIF
                  ENDIF
                ENDM


                ; Now, lets pull in the 8087 software support macros

                ENDIF

                ASSUME CS:CODE, DS:CODE

0000            CODE SEGMENT

                .SALL

                ;
                ; DEFINE PASCAL-8087 INTERFACE ROUTINES
                ;
                        PAS87   FABS
                        PAS87   FADD
                        PAS87   FADD    ST,ST(i)
                        PAS87   FADD    ST(i),ST
                        PAS87   FADD    SHORT
                        PAS87   FADD    LONG
                        PAS87   FADDP
                        PAS87   FADDP   ST(i),ST
                        PAS87   FBLD    SPECIAL
                        PAS87   FBSTP   SPECIAL
                        PAS87   FCHS
                        PAS87   FCLEX
                        PAS87   FCOM
                        PAS87   FCOM    ST(i)
                        PAS87   FCOM    SHORT
                        PAS87   FCOM    LONG
                        PAS87   FCOMP
```

Listing 1 continued on page 336

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SHORT R_ VALUE requires a parameter (R_ VALUE in this case) that specifies the real number to be added from memory to the top element on the 8087 stack.

Of the 129 operation types that PAS87 supports, 44 don't require parameters. We can make these operations accessible from Pascal through a procedure call that passes no parameters. We can divide the 85 remaining PAS87 operations, all requiring parameters, into four subgroups: 24 operations requiring a real-memory operand, 24 requiring an integer-memory operand, 24 needing register numbers (specifying the "*i*" in ST(*i*)), and the remaining 13 that can be grouped as needing a special-memory operand type (operations that use operands of 2, 14, and 94 bytes, as well as packed-decimal).

The real-memory, integer-memory, and special-memory operands are passed to and from the 8087 as part of the operation. Because they come in different sizes (including 16-, 32-, and 64-bit integers; 32-, 64-, and 80-bit real numbers; and from 16- to 80-bit special values), it at first appears that PAS87 will have to handle each case in a separate manner. However, if we treat all memory operands as pass-by-reference parameters (where operands, regardless of length, are specified by their 16-bit addresses), the routines in PAS87 do not have to differentiate between the various operand sizes.

The remaining type of parameter to be considered is the register-operation type. We would like to let the user specify some register operation (such as the 8087 FADD ST,ST(*i*) instruction) in the Pascal program and pass as a parameter the register number *i* to be used. The PAS87 operations supporting this type of call would need to look at the register specified and invoke the appropriate 8087 operation.

Because all 8087 register operations are one-way (that is, they leave their results on the 8087 stack and do not return a result), we need not specify the parameter passed to the PAS87 routines as pass-by-reference. Furthermore, because all register opera-

Listing 1 continued:

```
PAS87   FCOMP   ST(i)
PAS87   FCOMP   SHORT
PAS87   FCOMP   LONG
PAS87   FCOMPP
PAS87   FDECSTP
PAS87   FDISI
PAS87   FDIV
PAS87   FDIV    ST(i),ST
PAS87   FDIV    SHORT
PAS87   FDIV    LONG
PAS87   FDIVP   ST(i),ST
PAS87   FDIVR
PAS87   FDIVR   ST,ST(i)
PAS87   FDIVR   ST(i),ST
PAS87   FDIVR   SHORT
PAS87   FDIVR   LONG
PAS87   FDIVRP  ST(i),ST
PAS87   FENI
PAS87   FFREE   ST(i)
PAS87   FIADD   WORD
PAS87   FIADD   SHORT
PAS87   FICOM   WORD
PAS87   FICOM   SHORT
PAS87   FICOMP  WORD
PAS87   FICOMP  SHORT
PAS87   FIDIV   WORD
PAS87   FIDIV   SHORT
PAS87   FIDIVR  WORD
PAS87   FIDIVR  SHORT
PAS87   FILD    WORD
PAS87   FILD    SHORT
PAS87   FILD    LONG
PAS87   FIMUL   WORD
PAS87   FIMUL   SHORT
PAS87   FINCSTP
PAS87   FINIT
PAS87   FIST    WORD
PAS87   FIST    SHORT
PAS87   FISTP   WORD
PAS87   FISTP   SHORT
PAS87   FISTP   LONG
PAS87   FISUB   WORD
PAS87   FISUB   SHORT
PAS87   FISUBR  WORD
PAS87   FISUBR  SHORT
PAS87   FLD     ST(i)
PAS87   FLD     SHORT
PAS87   FLD     LONG
PAS87   FLD     TEMP
PAS87   FLDCW   SPECIAL
PAS87   FLDENV  SPECIAL
PAS87   FLDLG2
PAS87   FLDLN2
PAS87   FLDL2E
PAS87   FLDL2T
PAS87   FLDPI
PAS87   FLDZ
PAS87   FLD1
PAS87   FMUL
PAS87   FMUL    ST(i),ST
PAS87   FMUL    ST,ST(i)
PAS87   FMUL    SHORT
PAS87   FMUL    LONG
PAS87   FMULP   ST(i),ST
PAS87   FNCLEX
PAS87   FNDISI
PAS87   FNENI
PAS87   FNINIT
PAS87   FNOP
PAS87   FNSAVE  SPECIAL
PAS87   FNSTCW  SPECIAL
PAS87   FNSTENV SPECIAL
PAS87   FNSTSW  SPECIAL
PAS87   FPATAN
PAS87   FPREM
PAS87   FPTAN
```

Listing 1 continued:

```
                    PAS87   FRNDINT
                    PAS87   FRSTOR  SPECIAL
                    PAS87   FSAVE   SPECIAL
                    PAS87   FSCALE
                    PAS87   FSQRT
                    PAS87   FST     ST(i)
                    PAS87   FST     SHORT
                    PAS87   FST     LONG
                    PAS87   FSTCW   SPECIAL
                    PAS87   FSTENV  SPECIAL
                    PAS87   FSTP    ST(i)
                    PAS87   FSTP    SHORT
                    PAS87   FSTP    LONG
                    PAS87   FSTP    TEMP
                    PAS87   FSTSW   SPECIAL
                    PAS87   FSUB
                    PAS87   FSUB    ST,ST(i)
                    PAS87   FSUB    ST(i),ST
                    PAS87   FSUB    SHORT
                    PAS87   FSUB    LONG
                    PAS87   FSUBP   ST(i),ST
                    PAS87   FSUBR
                    PAS87   FSUBR   ST,ST(i)
                    PAS87   FSUBR   ST(i),ST
                    PAS87   FSUBR   SHORT
                    PAS87   FSUBR   LONG
                    PAS87   FSUBRP  ST(i),ST
                    PAS87   FTST
                    PAS87   FWAIT
                    PAS87   FXAM
                    PAS87   FXCH
                    PAS87   FXCH    ST(i)
                    PAS87   FXTRACT
                    PAS87   FYL2X
                    PAS87   FYL2XP1
                    PAS87   F2XM1

                ;*********************************************************************;
                ;                                                                     ;
                ;       Define some special purpose routines here.  All must be       ;
                ;       callable by Pascal.                                           ;
                ;                                                                     ;
                ;*********************************************************************;

                PAGE
                ;
                ; Procedure C_IBM_8087(VAR X : REAL);
                ;
                ;       This routine converts a real number from IBM format to 8087 format
                ;
                PUBLIC C_IBM_8087

0688            C_IBM_8087      PROC    FAR
0688  55                PUSH    BP              ;
0689  8B EC             MOV     BP,SP           ;
068B  8B 6E 06          MOV     BP,[BP+6]       ;
068E  8B 46 02          MOV     AX,[BP+2]       ;
0691  3D 0000           CMP     AX,0            ; No difference between IBM & 8087 "zero"
0694  75 06             JNE     CONTIBM         ; Skip if not zero
0696  83 7E 00 00       CMP     WORD PTR [BP],0 ; Check second word
069A  74 0D             JE      EXITIBM         ; If zero, exit
069C            CONTIBM:
069C  FE CC             DEC     AH              ;
069E  FE CC             DEC     AH              ;
06A0  D0 D0             RCL     AL,1            ;
06A2  D0 DC             RCR     AH,1            ;
06A4  D0 D8             RCR     AL,1            ;
06A6  89 46 02          MOV     [BP+2],AX       ;
06A9            EXITIBM:
06A9  5D                POP     BP              ;
06AA  CA 0002           RET     2               ;
06AD            C_IBM_8087      ENDP

                ;
                ; PROCEDURE C_8087_IBM(VAR X : REAL);
```

Listing 1 continued on page 340

tions restrict the register to a value between 0 and 7, we know in advance that the pass-by-value parameter of any register operation can be contained within a single word (the smallest parameter passed by Pascal).

To summarize, we have divided the PAS87 operations into three main types: those without parameters, those with memory operands, and those with register specifications. We can thus handle all PAS87 operations in one of three ways. This provides a uniform approach that we will take advantage of in developing the macros used to generate the PAS87 code.

PAS87 Macro Generator

Take a moment to look at listing 1—the assembly-language code that produces the PAS87 operations. It consists of three macros (PASSTACK, MEMOP, and PAS87) followed by 129 macro calls to PAS87 (with various parameters, of course). Following these are some assorted utility routines (to be discussed later).

Now look at listing 2, the P87_INT file. This is a file that any Pascal program wishing to access PAS87 operations will use $INCLUDE to incorporate it into the program (see the *IBM Pascal User's Manual* for instructions on $INCLUDE). This listing defines all EXTERN procedures that access PAS87 routines and thus use the 8087 from Pascal. P87_INT establishes the interface to each PAS87 routine for the Pascal compiler.

A side-by-side comparison of the PAS87 macro calls in listing 1 and the procedure declarations in listing 2 may help in your initial understanding of how the PAS87 macro will work. There is a one-to-one correspondence between the two listings. The macro expansion of the calls in listing 1 builds subroutines that meet the Pascal internal calling conventions. Let's now look at the PAS87 macro and see what happens at assembly time.

The PAS87 macro builds complete subroutines. Each of the 129 PAS87 macro calls in listing 1 results in a full subroutine specification. Notice that each macro call has from one to three parameters. The first parameter is


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always the basic 8087 operation that the subroutine is to invoke. These are the same 77 basic operations defined last month in the M8087.MAC assembler software support. In fact, each PAS87 macro expansion will in turn invoke the M8087 macro specified by the first parameter. This means that the PAS87 file in listing 1 requires the M8087.MAC program from last month.

An assembly-language subroutine has three parts: the initial declaration of the routine (consisting of two parts, a PUBLIC ROUTINE_ NAME command that specifies the routine to be made public to external modules and a line of the format ROUTINE_NAME PROC FAR to signify a subroutine of type FAR with the name ROUTINE_NAME), the code that makes up the subroutine, and the closing or delimiting portion of the routine (which has the syntax ROUTINE_NAME ENDP).

PAS87 Naming Conventions

If PAS87 is to produce 129 separate subroutines, we have to come up with 129 unique routine names. The syntax that I use in PAS87 is the following: all PAS87 routine names begin with an F, followed by the type of operation to be performed, an underscore _, and end with the 8087 mnemonic operation name.

The possible types of operations include SHORT, LONG, WORD, TEMP, SPECIAL, ST, STI, and "no op." The first four types refer to the memory operand type used in the operation (for example, the FSHORT_ FADD operation in PAS87 uses a short-real memory operand to execute the 8087 FADD operation). The SPECIAL operation type handles such special operands as the 94-byte control-word operand used in the FLDCW operation.

The ST and STI operation types refer to the register operations. Any register operation of the type f-op ST, ST(i) is considered to be of the ST type. The f-op ST(i),ST and f-op ST(i) 8087 operations fall under the STI classification. Thus, an FST_ FSUB procedure executes an 8087 FSUB ST,ST(i) instruction. An FSTI_FSUB procedure does the FSUB ST(i),ST

Listing 1 continued:

```
                                ;
                                ;       Convert real from 8087 to IBM format
                                ;
                                PUBLIC C_8087_IBM

06AD                            C_8087_IBM      PROC    FAR
06AD  55                                PUSH    BP              ;
06AE  8B EC                             MOV     BP,SP           ;
06B0  8B 6E 06                          MOV     BP,[BP+6]       ;
06B3  8B 46 02                          MOV     AX,[BP+2]       ;
06B6  3D 0000                           CMP     AX,0            ; No difference between IBM & 8087 "zero"
06B9  75 06                             JNE     CONT8087        ; Skip if not zero
06BB  83 7E 00 00                       CMP     WORD PTR [BP],0 ; Check second word
06BF  74 0D                             JE      EXIT8087        ; If zero, exit
06C1                            CONT8087:
06C1  D0 D0                             RCL     AL,1            ;
06C3  D0 D4                             RCL     AH,1            ;
06C5  D0 D8                             RCR     AL,1            ;
06C7  FE C4                             INC     AH              ;
06C9  FE C4                             INC     AH              ;
06CB  89 46 02                          MOV     [BP+2],AX       ;
06CE                            EXIT8087:
06CE  5D                                POP     BP              ;
06CF  CA 0002                           RET     2               ;
06D2                            C_8087_IBM      ENDP
                                                                ;
                                                                ; FUNCTION CHK87 : INTEGER;
                                                                ; FUNCTION EXAM87 : INTEGER;
                                                                ; FUNCTION GETST : INTEGER;
                                                                ; FUNCTION STATUS : INTEGER;
                                                                ;
                                                                ; These functions are not listed here but should
                                                                ; be included in the PAS87 file.  Copy their
                                                                ; definitions, starting with "PUBLIC..." and
                                                                ; ending with "...ENDP", from listing 3 of
                                                                ; last month's article.
                                                                ;

                                0734                                    CODE ENDS
                                                                        END
```

Listing 2: *The P87_INT file. Any Pascal program wishing to use the 8087 should include the statement { $INCLUDE P87_INT } and should also be linked to the object code version of PAS87 in listing 1.*

```
{ $LIST- }

{ P87_INT - This file interfaces any IBM-Pascal program to the 8087
            software support library (PAS87) of routines.  All 129
            8087 routines in PAS87 are declared here as external
            procedures.  By "$INCLUDE"ing this file with a Pascal
            program, the user may access the 8087 from Pascal.
            Following the PAS87 procedure declarations below are
            six utility declarations for utilities also defined in
            PAS87.  (See PAS87 listing for full explanation of these
            utilities).
}

procedure F_FABS;                                       EXTERN;
procedure F_FADD;                                       EXTERN;
procedure FST_FADD(reg : integer);                      EXTERN;
procedure FSTI_FADD(reg : integer);                     EXTERN;
procedure FSHORT_FADD(var r : real);                    EXTERN;
procedure FLONG_FADD(var r : real);                     EXTERN;
procedure F_FADDP;                                      EXTERN;
procedure FSTI_FADDP(reg : integer);                    EXTERN;
procedure FSPEC_FBLD(var special : real);               EXTERN;
procedure FSPEC_FBSTP(var special : real);              EXTERN;
procedure F_FCHS;                                       EXTERN;
procedure F_FCLEX;                                      EXTERN;
procedure F_FCOM;                                       EXTERN;
procedure FSTI_FCOM(reg : integer);                     EXTERN;
procedure FSHORT_FCOM(var r : real);                    EXTERN;
procedure FLONG_FCOM(var r : real);                     EXTERN;
procedure F_FCOMP;                                      EXTERN;
procedure FSTI_FCOMP(reg : integer);                    EXTERN;
procedure FSHORT_FCOMP(var r : real);                   EXTERN;
procedure FLONG FCOMP(var r : real);                    EXTERN;
```

Listing 2 continued on page 342

operation. (Note the distinction between FST__FSB and FSTI__FSUB. The results of these two procedures are different. See last month's discussion for clarification.)

The "no op" type of operation refers to all 8087 instructions that don't have operands. These instructions are characterized by a name of the syntax F__ followed by the 8087 mnemonic command. For example, the F__FLDPI procedure executes the 8087 FLDPI operation to load PI onto the 8087 stack.

Given this naming scheme for the PAS87 operations, we can use the MACRO ability to manipulate macro parameter strings to build the name of each procedure from the parameters passed in the PAS87 macro call. In each PAS87 macro call, the first parameter, P1, specifies the 8087 instruction to be executed and the second parameter (if there is one), P2, specifies the "type" of that operation.

The MEMOP Macro

Examining the PAS87 macro now, we see that the macro expansion immediately tests the second parameter of the macro call. If there is no second parameter, then the 8087 needs no operands and we simply establish the procedure entry and exit and issue a call to the M8087.MAC routine.

If P2 equals SHORT, LONG, TEMP, WORD, or SPECIAL, then PAS87 invokes the MEMOP macro. MEMOP inserts the assembly-language code needed to properly pass the address of the operand to the procedure. Listing 3 shows an example of this, the code generated by the expansion of the macro call PAS87 FADD SHORT (here, P1 = FADD and P2 = SHORT).

The PASSTACK Submacro

The three types of 8087 register operations (f-op ST(*i*), f-op ST,ST(*i*), and f-op ST(*i*),ST) cause PAS87 to invoke the PASSTACK macro. For these register operations, we expect to receive a call-by-value parameter that specifies the register number (0 to 7) to be used for the operation. As a result of this parameter, the proper 8087 ESC sequence must be executed

Listing 2 continued:

```
procedure F_FCOMPP;                                          EXTERN;
procedure F_FDECSTP;                                         EXTERN;
procedure F_FDISI;                                           EXTERN;
procedure F_FDIV;                                            EXTERN;
procedure FSTI_FDIV(reg : integer);                          EXTERN;
procedure FSHORT_FDIV(var r : real);                         EXTERN;
procedure FLONG_FDIV(var r : real);                          EXTERN;
procedure FSTI_FDIVP(reg : integer);                         EXTERN;
procedure F_FDIVR;                                           EXTERN;
procedure FST_FDIVR(reg : integer);                          EXTERN;
procedure FSTI_FDIVR(reg : integer);                         EXTERN;
procedure FSHORT_FDIVR(var r : real);                        EXTERN;
procedure FLONG_FDIVR(var r : real);                         EXTERN;
procedure FSTI_FDIVRP(reg : integer);                        EXTERN;
procedure F_FENI;                                            EXTERN;
procedure FSTI_FFREE(reg : integer);                         EXTERN;
procedure FWORD_FIADD(var i : integer);                      EXTERN;
procedure FSHORT_FIADD(var i : integer);                     EXTERN;
procedure FWORD_FICOM(var i : integer);                      EXTERN;
procedure FSHORT_FICOM(var i : integer);                     EXTERN;
procedure FWORD_FICOMP(var i : integer);                     EXTERN;
procedure FSHORT_FICOMP(var i : integer);                    EXTERN;
procedure FWORD_FIDIV(var i : integer);                      EXTERN;
procedure FSHORT_FIDIV(var i : integer);                     EXTERN;
procedure FWORD_FIDIVR(var i : integer);                     EXTERN;
procedure FSHORT_FIDIVR(var i : integer);                    EXTERN;
procedure FWORD_FILD(var i : integer);                       EXTERN;
procedure FSHORT_FILD(var i : integer);                      EXTERN;
procedure FLONG_FILD(var i : integer);                       EXTERN;
procedure FWORD_FIMUL(var i : integer);                      EXTERN;
procedure FSHORT_FIMUL(var i : integer);                     EXTERN;
procedure F_FINCSTP;                                         EXTERN;
procedure F_FINIT;                                           EXTERN;
procedure FWORD_FIST(var i : integer);                       EXTERN;
procedure FSHORT_FIST(var i : integer);                      EXTERN;
procedure FWORD_FISTP(var i : integer);                      EXTERN;
procedure FSHORT_FISTP(var i : integer);                     EXTERN;
procedure FLONG_FISTP(var i : integer);                      EXTERN;
procedure FWORD_FISUB(var i : integer);                      EXTERN;
procedure FSHORT_FISUB(var i : integer);                     EXTERN;
procedure FWORD_FISUBR(var i : integer);                     EXTERN;
procedure FSHORT_FISUBR(var i : integer);                    EXTERN;
procedure FSTI_FLD(reg : integer);                           EXTERN;
procedure FSHORT_FLD(var r : real);                          EXTERN;
procedure FLONG_FLD(var r : real);                           EXTERN;
procedure FTEMP_FLD(var r : real);                           EXTERN;
procedure FSPEC_FLDCW(var special : real);                   EXTERN;
procedure FSPEC_FLDENV(var special : real);                  EXTERN;
procedure F_FLDLG2;                                          EXTERN;
procedure F_FLDLN2;                                          EXTERN;
procedure F_FLDL2E;                                          EXTERN;
procedure F_FLDL2T;                                          EXTERN;
procedure F_FLDPI;                                           EXTERN;
procedure F_FLDZ;                                            EXTERN;
procedure F_FLD1;                                            EXTERN;
procedure F_FMUL;                                            EXTERN;
procedure FSTI_FMUL(reg : integer);                          EXTERN;
procedure FST_FMUL(reg : integer);                           EXTERN;
procedure FSHORT_FMUL(var r : real);                         EXTERN;
procedure FLONG_FMUL(var r : real);                          EXTERN;
procedure FSTI_FMULP(reg : integer);                         EXTERN;
procedure F_FNCLEX;                                          EXTERN;
procedure F_FNDISI;                                          EXTERN;
procedure F_FNENI;                                           EXTERN;
procedure F_FNINIT;                                          EXTERN;
procedure F_FNOP;                                            EXTERN;
procedure FSPEC_FNSAVE(var special : real);                  EXTERN;
procedure FSPEC_FNSTCW(var special : real);                  EXTERN;
procedure FSPEC_FNSTENV(var special : real);                 EXTERN;
procedure FSPEC_FNSTSW(var special : real);                  EXTERN;
procedure F_FPATAN;                                          EXTERN;
procedure F_FPREM;                                           EXTERN;
procedure F_FPTAN;                                           EXTERN;
procedure F_FRNDINT;                                         EXTERN;
procedure FSPEC_FRSTOR(var special : real);                  EXTERN;
procedure FSPEC_FSAVE(var special : real);                   EXTERN;
procedure F_FSCALE;                                          EXTERN;
procedure F_FSQRT;                                           EXTERN;
procedure FSTI_FST(reg : integer);                           EXTERN;
procedure FSHORT_FST(var r : real);                          EXTERN;
procedure FLONG_FST(var r : real);                           EXTERN;
procedure FSPEC_FSTCW(var special : real);                   EXTERN;
procedure FSPEC_FSTENV(var special : real);                  EXTERN;
procedure FSTI_FSTP(reg : integer);                          EXTERN;
procedure FSHORT_FSTP(var r : real);                         EXTERN;
procedure FLONG_FSTP(var r : real);                          EXTERN;
procedure FTEMP FSTP(var r : real);                          EXTERN;
```

Listing 2 continued on page 347


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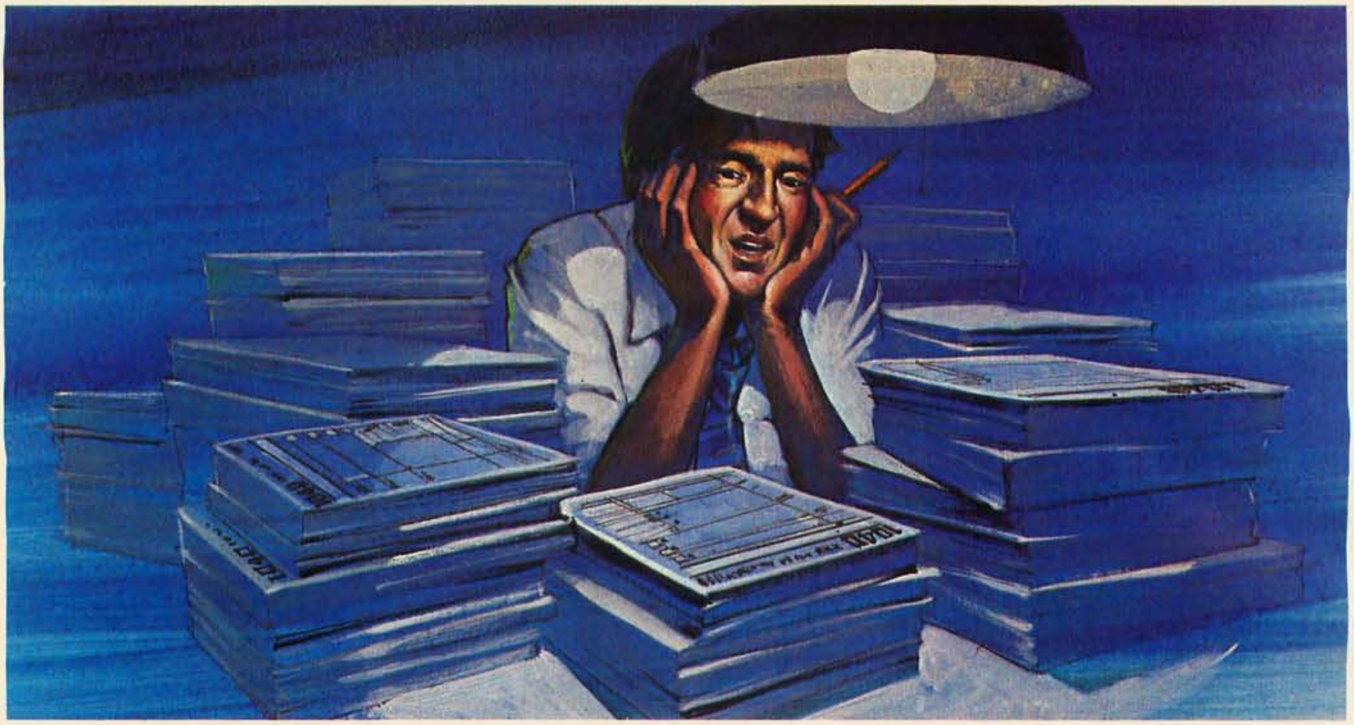

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to accomplish the register operation. Therefore, we can have any one of eight variations to the register operation executed.

The obvious method of approaching this would be to compare the register parameter *i* with each possible value from 0 to 7 and execute the appropriate 8087 command when a match is found (i.e., "IF REG=0 THEN XXXX ELSE IF REG=1 THEN YYYY . . ."). But this requires up to seven run-time comparisons for each call. Because these comparisons slow down the actual execution of register-based PAS87 procedures, I looked for another way around the problem.

Looking at the structure of the 8087 register operations, I made two observations:

1. All register-operation op codes require exactly 2 bytes.
2. The register selection for each of these op codes is encoded in the same manner for all such operations. The low 3 bits of the second byte store the register number (thus allowing for the eight registers that the 8087 contains).

Because *all* 8087 register operations use the same 3 bits to specify the register in the ESC command, we can do a naughty thing and set up some self-modifying code. Self-modifying code is tricky and somewhat risky because it relies on changing the machine-language code during run time for correct operation. This is dangerous for numerous reasons, not the least of which is that this code must *never* be put into read-only memory because it could not modify itself and thus would not work correctly.

Let's look at PASSTACK as found in listing 1 and see how it works. The first six instructions make the actual code modification. The line immediately following the FLAG: label (containing R1 R2 R3) is the line of code to be modified. Upon macro expansion of PASSTACK, R1 through R3 will be replaced by the parameters passed, which will in turn cause some M8087 macro to be invoked, resulting in a 2-byte ESC 8087 instruction.

As an example, look at the macro expansion of the PAS87 FADD ST,ST(*i*) macro call. PAS87 receives P1=FADD, P2=ST, and P3=ST(*i*). Checking P2, it matches ST and invokes PASSTACK, passing to it P1, P2, and P3. PASSTACK then has R1=P1=FADD, R2=P2=ST, and R3=P3=ST(*i*). The result of this expansion is given in listing 4. Notice that the line after FLAG: is now FADD ST,ST(*i*). This invokes the M8087 FADD macro and results in the 8087 ESC 00H,AX command (equivalent to FADD ST,ST(0)) being assembled. This is then assembled into the machine-language instruction D8 C0 (hexadecimal). The lowest 3 bits of the C0 byte specify the

Listing 2 continued:

```
procedure FSPEC_FSTSW(var special : real);        EXTERN;
procedure F_FSUB;                                 EXTERN;
procedure FST_FSUB(reg : integer);                EXTERN;
procedure FSTI_FSUB(reg : integer);               EXTERN;
procedure FSHORT_FSUB  (var r : real);            EXTERN;
procedure FLONG_FSUB(var r : real);               EXTERN;
procedure FSTI_FSUBP(reg : integer);              EXTERN;
procedure F_FSUBR;                                EXTERN;
procedure FST_FSUBR(reg : integer);               EXTERN;
procedure FSTI_FSUBR(reg : integer);              EXTERN;
procedure FSHORT_FSUBR(var r : real);             EXTERN;
procedure FLONG_FSUBR(var r : real);              EXTERN;
procedure FSTI_FSUBRP(reg : integer);             EXTERN;
procedure F_FTST;                                 EXTERN;
procedure F_FWAIT;                                EXTERN;
procedure F_FXAM;                                 EXTERN;
procedure F_FXCH;                                 EXTERN;
procedure FSTI_FXCH(reg : integer);               EXTERN;
procedure F_FXTRACT;                              EXTERN;
procedure F_FYL2X;                                EXTERN;
procedure F_FYL2XP1;                              EXTERN;
procedure F_F2XM1;                                EXTERN;

procedure F_FSTP;                                 EXTERN;
procedure C_IBM_8087(var x : real);               EXTERN;
procedure C_8087_IBM(var x : real);               EXTERN;
function  CHK87  : integer;                       EXTERN;
function  EXAM87 : integer;                       EXTERN;
function  GETST  : integer;                       EXTERN;
function  STATUS : integer;                       EXTERN;

{ $LIST+ }
```

Listing 3: *The expanded assembly-language code resulting from the expansion of the macro call PAS87 FADD SHORT.*

```
PUBLIC FSHORT_FADD          ; Begin subroutine FSHORT_FADD
FSHORT_FADD PROC FAR        ;
PUSH BP                     ; Save caller's frame pointer
MOV  BP,SP                  ; Set up own frame pointer
MOV  BP,[BP+6]              ; Move addr to parameter into BP
FADD SHORT [BP]             ; Add short-real memory op to 8087
POP  BP                     ; Restore callers frame pointer
RET  2                      ; Return, discard VAR parameter
FSHORT_FADD ENDP            ; End subroutine FSHORT_FADD
```

Listing 4: *The expanded assembly-language code resulting from the expansion of the macro call PAS87 FADD ST,ST(i).*

```
     PUBLIC FST_FADD               ; Begin subroutine
     FST_FADD PROC FAR
     PUSH BP                       ; Save caller's frame
     MOV  BP,SP                    ; Access own frame
     MOV  BX,OFFSET FLAG+2         ; Get address to second byte of op
     MOV  AL,CS:[BX]               ; Get byte to be changed
     AND  AL,0F8h                  ; Clear out lowest three bits
     OR   AL,[BP+6]                ; Access parameter, set register
     MOV  CS:[BX],AL               ; Save new operation, modify code
     JMP  FLAG                     ; Clear 8088 internal fetch queue
FLAG:
     FADD ST,ST(i)                 ; Execute 8087 operation
     POP  BP                       ; Restore caller's frame
     RET  2                        ; Return, discard parameter
     FST_FADD ENDP                 ; End subroutine
```

register to be used. Thus, by changing the lower 3 bits of the second byte before executing any register operation, we will change the register used.

The code preceding the FLAG label accesses the second byte of the 8087 operation, adds in the register value passed as the parameter from Pascal (using a logical OR operation), and stores the byte back in memory before executing it. This results in the proper register value being used.

If the use of the JMP FLAG instruction in listing 4 puzzles you (the JMP simply moves to the next instruction because FLAG is immediately after the JMP), look at it as the penalty for using self-modifying code. I spent several long and frustrating days trying to figure out why the PAS87 register operations were not working quite right before I determined the cause of my problem and its solution.

The problem, to make a long story short, is that the 8088 CPU is too efficient. The Intel 8088 and 8086 CPUs have internal instruction prefetch queues that are used to fetch instructions for the CPU before they are actually needed. This greatly improves the speed with which the CPU can execute instructions.

The 8088's internal queue is 4 bytes long—that is, the CPU loads the 4 bytes into the prefetch queue immediately following the one being executed. Look at the code expanded in our example and mentally remove the JMP operation momentarily. The MOV CS:[BX],AL instruction modifies the 8087 register operation (in the example of listing 4, the instruction FADD ST,ST(i)) and immediately executes that operation. However, this MOV instruction modifies the FADD instruction in program memory—an *unmodified* copy of this instruction is already in the prefetch queue, and it is this copy that is about to be executed. Result: things don't work as expected (a true understatement).

The solution to the problem is the JMP instruction. The CPU will always discard its internal queue and reload it starting with the destination of the jump instruction. Even though the JMP in PASSTACK does not really change the flow of the program, it fools the CPU into flushing its internal queue. The CPU then fetches the next instruction after the JMP, which happens to be the correctly modified 8087 register operation.

This problem was almost enough to convince me to change PAS87 to the more straightforward approach of comparing the parameter received from the Pascal caller with the values 0 to 7 and executing the appropriate 8087 instruction. But this would increase the execution time of the register-based procedures, so I stuck with the self-modifying approach. If you would rather not use self-modifying code, simply rewrite the PASSTACK macro and reassemble PAS87.

PAS87 Design Conclusions

We have now looked at the methods I used to construct the PAS87 file shown in listing 1. When assembled using the IBM Macro Assembler, this produces a library of Pascal-callable procedures that access the 8087 NDP. Listing 2 (P87_INT) lists the corresponding Pascal procedure declarations for each PAS87 routine.

PAS87 is assembled one time by the user, and the resulting object file is linked with any compiled Pascal object files that need these routines. To access any PAS87 routine, the Pascal program need simply include the statement { $INCLUDE P87_ INT }.

At this point, we have finished the discussion of how PAS87 works. When listing 1 is assembled, all 129 operations for the 8087 are set up as callable procedures from Pascal. To assemble PAS87, you need to have the M8087.MAC file examined last month on the disk. Due to the heavy use of

Listing 5: *An IBM Pascal program to repeatedly perform a complicated arithmetic calculation described in the listing. The text describes the results of comparing this program with a similar one that does not use the 8087 for its calculations.*

```
JG IC  Line#  Source Line        IBM Personal Computer Pascal Compiler V1.00
  00      1   { $TITLE:'Figure 3 : Sample application of PAS87' }
          2   { $PAGESIZE:64 $LINESIZE:132 $SYMTAB- $DEBUG- }
          3
  20      4   PROGRAM FIGURE3(INPUT, OUTPUT);
          5
          6   { $INCLUDE : 'A:P87_INT' }
  10    152   { $LIST+ }
          7   { NOTE : The above command causes the Pascal compiler to look out to the  }
          8   {        A: disk drive for a file named P87_INT.  This file contains      }
          9   {        all of the PAS87 procedure declarations                          }
         10
  10     11   const
  10     12          arrsize = 5000;
         13
  10     14   var
  10     15          x,y       : array [1..arrsize] of real;
  10     16          loop,size : integer;
  10     17          result    : real;
         18
         19   { OBJECT OF THIS PROGRAM : to find the sum of ((pi * x^^2) + (e^^x))^^0.5);
         20          over all of the arrays x and y  }
         21
         22
  10     23   begin
  11     24     repeat
         25
  12     26          write('Enter array size : ');
  12     27          readln(size);
         28
         29          { Initialize the x and y arrays with anything.  These values have no
         30          { special meaning to them.  Simply test values.                    }
  12     31          for loop := 1 to size do begin
```

Listing 5 continued on page 350

nested macros in PAS87, its assembly takes more than 25 minutes. But this is a one-time cost. After the initial assembly, you simply keep the resulting object file around to be linked with any Pascal program that needs it.

The compilation time of a Pascal program using PAS87 via the P87_INT declaration file is not visibly affected. Listing 5 contains an imaginary Pascal application program that uses the PAS87 package. This program takes two large arrays of real numbers (x and y) and calculates

$$\sum_i \pi(x[i]^2 + e^{y[i]})^{0.5}$$

Pascal Type Extensions via PAS87

I need to comment briefly on using PAS87 and the 8087 capabilities to support numeric data types *not* supported by IBM Pascal. PAS87 provides a way for Pascal programs to bypass the type-checking protection features of the Pascal compiler and perform numeric calculations with a higher degree of accuracy. For example, Pascal does not handle double-precision real numbers (64 bits long). If you want to use numbers of this precision, you can do so as long as you are very careful.

Perhaps you have an application that requires greater accuracy than that offered by the IBM Pascal's single-precision real numbers. You would thus like to do all your numeric calculations in double-precision arithmetic. Of course, the 8087 stack mechanism lets intermediate results be left on the stack as 80-bit temporary values. But if you have hundreds or thousands of intermediate double-precision results, you might want to keep them in a standard Pascal array or some other data structure. You can sneak around the Pascal single-precision limitation as long as all input and output operations (using READ and WRITE) occur using standard single-precision Pascal numbers.

For example, suppose you want to set up an array of 100 double-precision real numbers in your Pascal program. You cannot declare in

Listing 5 continued:

```
13                  x[loop] := float(loop);
13                  y[loop] := 1/float(loop);
12          end;

12          writeln('Done with initialization');

            { Now, convert whole array from IBM to 8087 format }
12          for loop := 1 to size do begin
13                  C_IBM_8087(x[loop]);
13                  C_IBM_8087(y[loop]);
12          end;

12          writeln('Done with numeric conversion');

            { Using the 8087, find sum from 1 to 1000((pi * x^^2 + e^^y)^^0.5); }

12          F_FINIT;        { Initialize the 8087 }
12          F_FLDZ;         { Initialize running sum of calculation }
12          for loop := 1 to size do begin
13                  F_FLDPI;        { Move pi onto top of 8087 stack }
13                  FSHORT_FLD(x[loop]); { Move next value of x onto stack }

                    { Now, we would like to square the current value of x (which
                            is on the stack).  We can do this via an 8087
                            "FMUL ST,ST(0)" operation (tells 8087 to multiply
                            the top of stack by itself and leave result on TOS) }
13                  FST_FMUL(0);

                    { At this point, the top of 8087 stack contains x^^2 and
                      second slot contains pi.  We want to multiply the two so
                      execute a simple "classical stack" multiply which multiplies
                      the top two elements and leaves only result on stack top }
13                  F_FMUL;

                    (Now, lets find ln(y).  Since the 8087 has no operation to
                            calculate this directly, we must use the formula
                            "ln(y) = log(y)/log(e)" with log in base 2.  }

13                  F_FLDL2E; { Load log e (base 2) onto TOS }
13                  F_FLD1;   { Let's calculate 1/(log e) }
13                  F_FDIV;   { ST(1) = TOS/ST(1) followed by POP }

13                  FSHORT_FLD(y[loop]); { Get y on TOS }
13                  F_FYL2X;        { Find TOS=ST(1) * LOG(ST(0)) }

                    { At this point, the 8087 stack contains three values. The
                            TOS contains the result of ln(y) while the second
                            element contains pi * x^^2.  Let's add these together
                            and find square root.  Then add result to current
                            running sum which is the third element on the stack }

13                  F_FADD;  { Classical stack add }
13                  F_FSQRT; { Take square root of result }
13                  F_FADD;  { Update running sum using classical stack add }

12          end; { repeat loop }

            { Now, convert result to IBM number format }
12          FSHORT_FSTP(result);
12          C_8087_IBM(result);
12          writeln('Final value is ',result);
11      until false;
00  end.


        Errors  Warns  In Pass One
            0      0
```

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Pascal DBL : array[1. .100] of double_reals;. You can, however, declare DBL : array [1. .200] of real;. This tells Pascal to set aside room for 200 32-bit single-precision real numbers. You can then turn around and use this structure to store 100 64-bit numbers on a temporary basis.

You begin to trick Pascal when you call a PAS87 procedure such as FLONG_FST(DBL[0]). This operation will move a long-real value from the top of the 8087 stack into the address that points to the zeroth slot in DBL. The 8087 takes over, moves 64 bits of data from the stack to that address, and returns; note that it moves 64 bits of data, not the 32 bits that Pascal itself associates with DBL(0). Pascal has no idea that anything out of the ordinary has happened. Of course, what did happen is that slots 0 *and* 1 of DBL have been filled to store the 64-bit value.

As long as you, the programmer, are aware of what has occurred, everything is okay. You simply have to remember that the first long-real will be found at DBL[0], the second at DBL[2], the third at DBL[6], and so on. This technique can be expanded and refined as long as you are very careful. Remember, you are defeating the type-checking mechanisms that make Pascal so nice to use, so beware.

PAS87 Utility Routines

We will now look at the supporting procedures and functions in listing 1 starting with procedure C_IBM_8087. They should look familiar because we used them last month. (Actually, the last four, functions CHK87, EXAM87, GETST, and STATUS, are listed only as comment lines. Their full definitions, starting with the word PUBLIC and ending with the word ENDP, should be copied into this file from listing 3 of last month's article.) PAS87 users need these routines to use the 8087 from Pascal.

Recall from last month the different storage formats used to define IBM-format real numbers versus 8087-format real numbers. In IBM Pascal, any real number that is defined as a constant or is input (using a READ) or output (using a WRITE) must be in the IBM real-number format. On the other hand, all real numbers sent to and received from the 8087 must be in 8087 format. The C_IBM_8087 and C_8087_IBM procedures convert short-real numbers from IBM format to 8087 format and vice versa. These routines convert the short-real number found at the memory location specified—that is, they convert the value "in place," destroying the number in its original format.

It is up to the user to ensure that the values being used in a program are always in the appropriate format. If you move an IBM-format real number into the 8087 or print an 8087-format real number, you will be working with or printing incorrect numbers; to make things worse, you may not get any indications that you are in error. As a general approach to handling the format problem, you can try to convert all IBM-format values into 8087 format as early as possible and leave them in the 8087 format until it is absolutely necessary to convert them back to IBM format.

It is up to the user to ensure that the values being used in a program are always in the appropriate format.

In several programs I have written using PAS87, I was able to make a single conversion from IBM format for all my variables at the beginning of the program and use a special CONV_WRITELN procedure that would automatically convert 8087 numbers into IBM format, print them to the screen, and convert them right back to 8087 format for additional computation. The conversion routines are very efficient, but it is best to avoid too many unnecessary conversions.

(Note that this number-format problem does not affect the use of integer values. The 8087 word-integer format is the same as the IBM integer format.)

The last four functions perform needed tests on the internal state of the 8087. These are CHK87 (which returns the results of an 8087 compare or test operation), EXAM87 (which determines the validity of the number currently on top of the 8087 stack), GETST (which returns the current stack-top pointer value), and STATUS (which returns the value of the 8087 status word). These were explained in greater detail in last month's article.

Performance of PAS87

The big question is "How much does my application benefit by using PAS87?" In other words, will extensive use of the 8087 from Pascal really be worth the trouble? If you are interested in high performance and you have a number-crunching application, the answer is yes.

As a very simple test, I implemented the program of listing 5, adding some additional commands that let me accurately measure the time needed to execute the program for various sizes of arrays. I then rewrote the program to accomplish the same thing from standard Pascal. Testing the running time (excluding the time to initialize the arrays) for arrays from 500 to 5000 real numbers in size gave an average execution time for the PAS87 implementation that was 65 times faster than the straight Pascal execution time. For example, with 5000 elements the PAS87 implementation took less than 4 seconds to run; the standard Pascal version, however, required more than 265 seconds.

Now this is an impressive improvement. But it is misleading, too, because it emphasizes the very operations that show the 8087 to its best advantage. To be fair, I also tested a long and fairly complex general linear-equation solver library in IBM Pascal, a program with an instruction mix much closer to an average Pascal program you might write.

It is beyond the scope of this article to go into much detail about this program except to say that it uses Gaussian elimination with partial pivoting to factor and solve a set of linear equations. The linear equations

are entered in matrix form, factored into their lower- and upper-triangular matrix (LU) components, and then solved.

The 8087-Pascal and Pascal-only implementations of the program were designed to record the times required to factor and solve matrices from 5 by 5 up to 120 by 120 (an upper limit dictated by the 64K-byte data area allotted by IBM Pascal). The 8087 version of the program was written directly from the straight Pascal version so that they are as close to identical in structure as possible.

After timing the programs and analyzing the results, I came to the following conclusions: the use of the 8087 consistently sped up the factorization of the different-sized matrices by a factor of three, and the 8087-based program solved the factored matrix twice as fast as the Pascal-only program. (It took the IBM PC 461.9 seconds to factor a 120 by 120 matrix and another 10.5 seconds to solve the LU matrix. The 8087 cut this time to 154.5 seconds to factor and 5.2 seconds to solve the same matrix.)

This program shows the 8087 contributing a less spectacular but still significant improvement to the execution speed of Pascal programs. The 8087 caused a smaller improvement in this case for two reasons: first, the general-purpose overhead in this program (similar to the overhead in most Pascal programs) does not involve the kinds of functions the 8087 contributes; second, the standard IBM Pascal is already able to do some of the arithmetic in this program (addition and subtraction, for example) quite competitively. As a general rule, computation-intensive programs can expect an improvement of 3 to 10 times through the use of the 8087.

Conclusions

The Pascal support package for the 8087 (PAS87) discussed in this article provides access for the user to the full 8087 instruction set. The negative side of PAS87 is that it does require you to fully know the inner workings of the 8087. Because you must understand and manipulate the current state of the 8087, you will be working at a programming level that is about the same level as assembly-language programming. The unarguable positive side of using PAS87, though, is that it provides a remarkable improvement in execution speed to the Pascal programmer. Thus, PAS87 brings the power of the 8087 to both the experimenter and the programmer who needs extra performance in Pascal programs.■

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Software on Disk

Disks containing PAS87/P87_INT (this month) and M8087 (last month) are available on standard IBM single-density format 5¼-inch floppy disks. For more pricing and 8087 information, contact

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Echonet

Part 1: A Flexible Programming System

This interactive system combines natural language and machine-native code to revolutionize the way we solve problems with computers.

by C. Bradford Barber

Echonet is an interactive system that lets you manage and create programs in much the same way that we manage and expand our natural language. To do this, Echonet has a dictionary of entries (useful functions) that perform specific tasks. Instead of one programming instruction for a thousand different uses, Echonet has a thousand entries, one for each different use. Echonet entries are defined by other entries and compiled, from those entries, into complete, executable programs. (Note: Last year's version of Echonet used 8080 instructions to define some of the entries. The next version will define all entries in terms of entries. I'll explain the process in part 2.)

Perhaps the most important concept employed by Echonet, though, is the separation of an entry's meaning from its definition: the meaning of an entry is what we understand it to do and what the computer does when it executes the entry; an entry's definition is how

Next month's article and glossary will define in detail the following terms as they apply to Echonet:

compile	*data*	*Echonet dictionary*
entry	*entry definition*	*entry name*
indented program	*indicate*	*instruction*
object	*object name*	*relocatable code*

Blackboard	go to **blackboard** entry
Commands	go to **commands** entry
Compile	compile relocatable code for the entry
Do	compile and execute the current instruction
Entries	go to . . . **entries** entry
Get	get the contents of **stored text**
Go To	go to the entry indicated by the current instruction
Help	go to . . . **help** entry
Next	go to the next entry (usually the working entry)
Previous	go to the previous entry
Steno	insert the matching word
Stop	stop execution
Test	go to test text for the entry
Text	store an entry definition into **stored text**
Work	define the current entry as the working entry

Table 1: *The function keys available on the author's Echonet system and used in this article.*

the entry is described in terms of other entries.

To introduce the system, let us follow Carl, a hypothetical Echonet user, as he develops a program for controlling a robot vacuum cleaner. Then I'll show how Carl creates an *instruction* (part of an entry) by adding an entry to the Echonet dictionary. Through these examples, you will see that writing entries takes the place of writing and maintaining programs. (Next month I'll describe entry compiling and define how Echonet works.)

The examples are based on an Echonet system that runs on a Z80 microcomputer with 8-inch floppy disks. The computer's terminal is a Heath WH19 with labeled function keys (see table 1). All keys, except for Compile, complete their operation almost immediately.

A Scenario

Carl returns to his computer lab after a week's vacation in the mountains. He turns on his computer and it starts humming. Text appears on the screen. "Oh yes," Carl remembers, "I was finishing my robot vacuum-cleaner program. Let's see how far I've gotten." Carl presses Compile, but the compiler reports an unknown instruction in his program. Carl presses Entries to find the correct wording for the unknown instruction, edits his program, and again presses Compile.

Let's go over Carl's actions in detail. Here is what he saw after he turned on his computer:

```
Vacuum one room
  repeat for 15 minutes
    adjust floor brushes for Vacuum
    check Vacuum nozzle
    while Vacuum..isStopped do
      rotate Vacuum by 90 degrees
    move Vacuum forward for 3 seconds
```

This block of information displays an entry in an Echonet dictionary. It shows an entry name (**"Vacuum one room"**) and an entry definition: ("repeat for 15 minutes," etc.). The entry name lets you indicate the entry with an instruction. For example, if an instruction (one line of text) was "Vacuum one room," Carl could position the cursor to that instruction and press the Go To key. The display would then show the entry **Vacuum one room.**

The entry definition contains six instructions, one instruction per line. The second, third, fourth, and sixth instructions form a sequence by starting at the same column. They also form a subprogram, or *indented program,* of the first instruction. The indented program repeats for 15 minutes. First, it directs the robot vacuum cleaner to adjust the floor brushes for carpets or hard floor. Second, it checks the vacuum to see if the nozzle is blocked. Third, it rotates the vacuum if the vacuum is stopped by an obstruction. Fourth, it moves the vacuum forward for three seconds.

When Carl pressed the Compile key, he could hear whirring and clicking from the disk drive as Echonet read entries from a floppy disk. In about 20 seconds, a message appeared on the screen: "unknown instruction: rotate Vacuum by Number degrees." Carl remembered an entry for rotating the vacuum cleaner, so he positioned the cursor to the word "Vacuum" and pressed the Entries key. Almost immediately, the entry **Vacuum one room** moved to the bottom of the screen and the following entry appeared at the top:

```
Vacuum entries
  adjust floor brushes for Vacuum
  check Vacuum nozzle
  display room with Vacuum
  display Vacuum statistics
  lower floor brushes for Vacuum
  move Vacuum backward for Number seconds
  move Vacuum forward for Number seconds
  raise floor brushes for Vacuum
  rotate Vacuum clockwise by Number degrees
  turn off Vacuum
  turn on Vacuum
  turn Vacuum left
  Vacuum one room
```

Echonet took the word "Vacuum" and appended "entries" to get "Vacuum entries." Then it found the entry with a matching name in its dictionary. This entry lists other entries that use the **Vacuum** object. In Echonet, *objects* serve the same role that variables, arrays, data types, and data structures serve in a programming language. Object names always start with a capital letter.

Entry Names

An entry definition contains instructions that indicate entries with entry names. An entry name describes what an entry does. This is important. It means you can read

```
add TowerRing to HanoiTower
allocate Reference to Integer bytes of MemoryArray
clear the Console screen
clear Number bytes of Buffer
declare type ObjectName of Integer bytes
declare ObjectName a local TypeName
display Entry
for each Entry on EchoDisk do IndentedProgram
if ConditionalClause then IndentedProgram
load frequently used code
optimize CodeElementArray
wait for Number milliseconds
print EchoDisk
select RamBank
verify EchoDisk and check all TextEntry's
wait until User reads the Console
```

Table 2: *A few of the more than 800 entries from the Echonet dictionary circa October 1982, listed in alphabetical order.*

and understand an instruction without reading the corresponding entry definition. Table 2 shows a list of entry names as examples.

If you cannot figure out an entry from its name, you have several options. First of all, many words and objects have Help entries that you can find by moving the cursor to the word or object and pressing the Help key. Here is the Help entry for **HanoiTower** (which will be discussed further next month):

HanoiTower help

A HanoiTower is one of three towers for displaying the solution of a Hanoi tower puzzle.

The rings on a HanoiTower are called TowerRings.

The first HanoiTower is number 0.

With many keywords and objects you can press the Entries key and see a list of related entries. Carl did this when he wanted to look at the **Vacuum** entries. You can also read the entry's definition by pressing Go To, or write an instruction and press Do to see what it does.

Let's get back to Carl. His screen showed a list of entry names that use the **Vacuum** object. Carl scanned down the list to find an entry that would rotate a **Vacuum.** He found:

```
rotate Vacuum clockwise by Number degrees
```

He realized that in his robot program he had forgotten the word "clockwise," so he pressed the key labeled Previous and the entry **Vacuum one room** (the previous entry) reappeared on his display.

With Echonet, you always work with a screen editor on the current entry, so Carl could quickly change "rotate Vacuum by 90 degrees" to "rotate Vacuum clockwise by 90 degrees." Carl pressed Compile and the compiler successfully generated relocatable code.

The Scenario Continued

Carl presses Test and finds the tests he developed a month ago while working on an earlier version of the vacuum-cleaner program. Now he presses Do. A top-view diagram of a room appears on his screen with boxes showing furniture and a circle showing his robot vacuum cleaner. As the circle moves, it leaves behind a crosshatched pattern. Carl observes that the robot keeps following the same path. He thinks, "Must be something wrong. It keeps turning at right angles. Let me check my program." Carl presses Stop and then Previous. His program reappears. "Oh yes, it shouldn't turn 90 degrees each time. Let me try a prime number." Carl picks 73 degrees; he then presses Compile, Test, and Do. The display fills up with cross-hatching.

When Carl pressed Test, the entry **Vacuum one room** moved to the bottom of the screen and new text appeared at the top. Carl then saw the following:

```
test  Vacuum one room
  show Vacuum on Console during
    display room with Vacuum
    Vacuum one room
  display Vacuum statistics
```

The test screen is another page of text associated with an entry. In this case, it consists of instructions for testing **Vacuum one room.** The first three instructions model the vacuum cleaner using graphics. The last instruction, "display Vacuum statistics," displays statistics collected while running the model.

Carl positioned the cursor to the instruction "show Vacuum on Console during" and pressed Do. Echonet compiled, loaded, and executed relocatable code for this instruction. A diagram then appeared at the bottom of the screen, showing the position of the robot vacuum cleaner (marked by a circle) in relation to existing pieces of furniture (shown by boxes).

As Carl watched the display, the circle started moving, leaving a trail of cross-hatching behind it. Carl pressed Stop. The cursor returned to the test text at the top of the screen. After pressing Previous, Carl saw:

```
Vacuum one room     (compiled)

repeat for 15 minutes
  adjust floor brushes for Vacuum
  check Vacuum nozzle
  while Vacuum..isStopped do
    rotate Vacuum clockwise by 90 degrees
  move Vacuum forward for 3 seconds
```

Carl reduced the amount of rotation to 73 degrees and retested the entry.

Commands

Its last test completed successfully, Carl's robot vacuum cleaner appears to work. Carl presses Previous and then Commands, finds the instruction "store code for Previous_Entry into PROM," *loads a PROM into the PROM slot, and presses Do. Carl moves the new PROM to his robot and starts the robot vacuuming. Finally, he has a clean room.*

Carl pressed Previous to return to **Vacuum one room**; then he pressed Commands, and a new entry appeared at the top of the screen:

```
commands

  edit backup text for Previous_Entry
  edit archive text for Previous_Entry

  list code for Previous_Entry
  print text for Previous_Entry
  store code for Previous_Entry into PROM

  load code optimizer
```

The entry **commands** is a list of useful instructions that act on the previous entry. The third instruction lists relocatable code for the previous entry; a listing helps you fine-tune short entries. The last instruction loads a code optimizer for generating more efficient code.

The entry **commands** is similar to a menu: You can position the cursor to any instruction and press the Do key. But unlike most menus, you can edit **commands**

any way you want to. If you find that you seldom need to list relocatable code, you can move the instruction "list code for Previous_Entry" to a different entry. Similarly, if there is an instruction that you frequently execute, you can add it to **commands**. Smalltalk provides a similar facility (see the August 1981 BYTE for information about the Smalltalk language).

Carl wanted the fifth instruction, "store code for Previous_Entry into PROM." He positioned the cursor to that instruction and pressed Do. Echonet displayed the following message:

place PROM in PROM slot and press any key

Carl did this; he put the new PROM into his robot and started the robot vacuuming. Everything worked fine.

Creating an Entry

Working the Echonet involves writing and modifying entries. To demonstrate this, I'll describe how Carl would write an entry for "while . . . do" instructions. This entry repeats an indented program as long as a conditional clause remains true.

The "while" entry already occurs in the Echonet dictionary, but let us suppose that Carl wants to create it. To do so, Carl first presses the Blackboard key, moves the cursor to the bottom of the **blackboard** entry, and types "while." He then sees the following on the display:

blackboard

today is 10,18,82
Echonet message0310

benchmark
display solution for 5 TowerRings

while

This entry acts as a scratch pad for new and current work. For example, the second instruction "Echonet message0310" indicates an entry containing messages displayed by Echonet.

Carl next presses the New key and the Go To key. A new, empty entry appears at the top of his screen:

while

Carl presses Work to make this his working entry. Carl decides that **while** will use an indented program, so he types "IndentedProgram" and presses Entries. The entry **while** then moves to the bottom of his screen and another entry appears on top:

IndentedProgram entries

do IndentedProgram
if ConditionalClause then IndentedProgram
if ConditionalClause then IndentedProgramA else IndentedProgramB
for Integer from IntegerA to IntegerB do IndentedProgram
program IndentedProgram
repeat IndentedProgram
repeat Integer times IndentedProgram

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Because the "while" instruction is similar to "repeat," Carl moves the cursor to "repeat IndentedProgram" and presses Text. This key stores the entry definition of **repeat IndentedProgram** into an entry named **stored text.** Carl presses Next to return to **while,** deletes a line, and presses Get to recover the contents of **stored text.** He then sees:

```
while
  label Loop
  do IndentedProgram
  go to Loop
```

The **while** entry now has the same definition as **repeat IndentedProgram.** Carl returns to **IndentedProgram entries** by pressing Previous. He positions the cursor to "if ConditionalClause then IndentedProgram" and presses Text and then Next. He deletes the line reading "do IndentedProgram" and presses Get. Now he sees:

```
while
  label loop
  if not ConditionalClause goto Exit
  do IndentedProgram
  label Exit
  go to Loop
```

When Carl pressed Get he inserted the entry definition for **if ConditionalClause then IndentedProgram** between the first and last line. Carl reverses the instructions "label Exit" and "go to Loop." He positions the cursor one space after the **while** and types "C." Then he presses the Steno key. This key searches for a word in the entry with the same prefix (in this case, "C") and inserts the rest of that word. Carl types "do I" and again presses the Steno key. Now he sees:

```
while ConditionalClause do IndentedProgram
  label Loop
  if not ConditionalClause goto Exit
  do IndentedProgram
  goto Loop
  label Exit
```

He presses Compile. Echonet renames the **while** entry to **while ConditionalClause do IndentedProgram** and compiles the entry. The display now shows:

```
while ConditionalClause do IndentedProgram      (compiled)
  label loop
  if not ConditionalClause goto Exit
  do IndentedProgram
  goto Loop
  label Exit
```

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Language	Execution Time (seconds)	Size (bytes)	Total Run-Time Size (bytes)	Compile and Load Time (seconds)
Echonet	13.0	243	763	22.0 (3.7)
Echonet (optimized)	11.4	216	544	29.0 (4.1)
Digital Research PL/I-80	14.0	242	5977*	112
BD Software C (version 1.46)	15.2	240	3664*	20.7
TSW RATFOR	16.5	203	2370*	103
Digital Research Pascal/MT+ (v 5.5)	22.7	344	3816	50.8
Coral	13.8	n/a	n/a*	n/a
Interactive Systems ZC	18.5	292	897*	n/a
UCSD Pascal	239.0	282	8282	14

Table 3: *Comparison of the Gilbreaths' prime-number benchmark as performed under Echonet versus other languages. The languages selected had the best times or sizes running on 4-MHz Z80 systems. The Echonet compile and load times in parentheses are for entries that have been recently compiled and so are still in memory, rather than on disk. The run-time sizes marked with an asterisk (*) indicate that CP/M must be present, which adds 3580 bytes to the run-time size.*

Carl tests the new entry by pressing Test and typing a small test program:

```
test while ConditionalClause do IndentedProgram

  program
    clear Count
    while Count < 10 do
      display Count
      increment Count
```

Carl now positions the cursor to "program" and presses Do. Echonet displays a line of numbers, one number for each repetition of the "while" instruction: 0 1 2 3 4 5 6 7 8 9. Carl replaces the 10 with 1 and presses Do, and Echonet displays a single number: 0. Carl replaces the 1 with 0, presses Do, and Echonet displays nothing. The "while" instruction works well. Carl is finished.

Benchmark of Echonet

Echonet outperforms programming systems currently in use: its programs execute faster, its code requires less space, and its entries compile faster. I compared Echonet to other programming systems with the benchmark program published by Jim and Gary Gilbreath in "Eratosthenes Revisited: Once More through the Sieve" (January 1983 BYTE, page 283).

Text continued on page 372

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Listing 1: *The prime-number sieve entry used for benchmark comparisons. Listing 1a is the Echonet entry itself, while listing 1b shows the disassembled relocatable code produced by Echonet.*

(1a)

benchmark

```
  uses {{False True}}
  Console line <- "10 iterations.", ConsoleBell

  repeat 10 times
    clear Count
    PrimeSieveFlags_size bytes of PrimeSieveFlags <- True

    for PrimeSieveFlags_size Index's starting at 0 do

       if PrimeSieveFlags [Index]. true then
         Prime <- Index + Index + 3
         SieveIndex <- Prime + Index

         while SieveIndex < PrimeSieveFlags_size do
           PrimeSieveFlags [SieveIndex] <- False
           bump SieveIndex by Prime

         bump Count
         ;;Console line <- Prime " is a prime."

   Console line <- Count " primes.", ConsoleBell
```

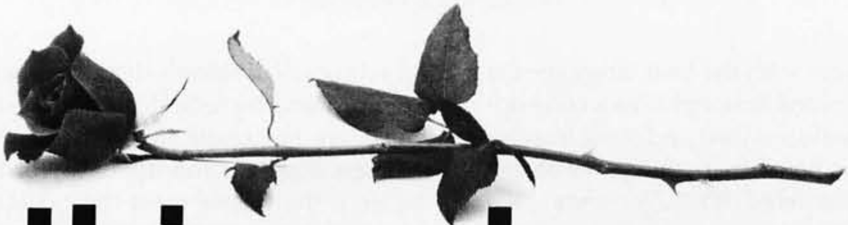
(1b)

```
;;Listing for benchmark

                              ;;
                              ;;uses {{False True}}
0000    11  lxi   d,"001      ;;Console line <- "10 iterations.",ConsoleBell
0003    CD  call  id- 0696
0006    11  lxi   d,"000D
0009    CD  call  id- 0696
                              ;;
000C    21  lxi   h,000A      ;;repeat 10 times
       '000F:
000F    7C  mov a,h
0010    B5  ora  l
0011    CA  jz    '0097
0014    E5  pushh
0015    21  lxi   h,0000      ;;/clear Count
0018    22  shld  *0000
001B    3E  mvi a,FF          ;;/PrimeSieveFlags_size bytes of PrimeSieveFlags <- True
001D    01  lxi   b,1FFF
0020    11  lxi   d,*0002
0023    12  stax d
0024    62  mov h,d
0025    6B  mov l,e
0026    13  inx  d
0027    0B  dcx  b
0028    ED  z80  ldir
0029    B0
                              ;;/
002A    21  lxi   h,0000      ;;/for PrimeSieveFlags_size Index's starting at 0 do
002D    22  shld  *2001
0030    21  lxi   h,1FFF
       '0033:
0033    7C  mov a,h
0034    B5  ora  l
0035    CA  jz    '0092
0038    E5  pushh
```


Listing 1b continued on page 370

Listing 1b continued:

```
                           ;;//
0039  2A  lhld *2001       ;;//if PrimeSieveFlags [Index]. true then
003C  11  lxi  d,*0002
003F  19  dad d
0040  7E  mov a,m
0041  B7  ora a
0042  CA  jz  '0086
0045  2A  lhld *2001       ;;///Prime <- Index + Index + 3
0048  EB  xchg
0049  2A  lhld *2001
004C  19  dad d
004D  11  lxi  d,0003
0050  19  dad d
0051  22  shld *2004
0054  EB  xchg             ;;///SieveIndex <- Prime + Index
0055  2A  lhld *2001
0058  19  dad d
0059  22  shld *200A
                           ;;///
      '005C:               ;;///while SieveIndex < PrimeSieveFlags__size do
005C  11  lxi  d,1FFF
005F  2A  lhld *200A
0062  CD  call id- 0DB3
0065  D2  jnc '007F
0068  2A  lhld *200A       ;;////PrimeSieveFlags [SieveIndex] <- False
006B  11  lxi  d,*0002
006E  19  dad d
006F  36  mvi m,00
0071  2A  lhld *2004       ;;////bump SieveIndex by Prime
0074  EB  xchg
0075  2A  lhld *200A
0078  19  dad d
0079  22  shld *200A
007C  C3  jmp '005C
      '007F:
                           ;;///
007F  2A  lhld *0000       ;;///bump Count
0082  23  inx h
0083  22  shld *0000
      '0086:               ;;///;;Console line <- Prime " is a prime."
0086  2A  lhld *2001
0089  23  inx h
008A  22  shld *2001
008D  E1  pop h
008E  2B  dcx h
008F  C3  jmp '0033
      '0092:
0092  E1  pop h            ;;/
0093  2B  dcx h
0094  C3  jmp '000F
      '0097:
0097  2A  lhld *0000       ;;Console line <- Count " primes.",ConsoleBell
009A  CD  call id- 0E87
009D  11  lxi  d, "0003
00A0  CD  call id- 0696
00A3  11  lxi  d,"0000
00A6  CD  call id- 0696

literals for code
0000 0D 0A 96 20 70 72 69 6D 65 73 2E 07 96 0D 0A 96 --- primes.-----
0010 31 30 20 69 74 65 72 61 74 69 6F 6E 73 2E 07 96 10 iterations.--
```



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Text continued from page 366:

Table 3 compares Echonet with the best language for each measurement. Optimized Echonet uses a code optimizer that removes superfluous load and store instructions. Listing 1a shows the benchmark entry, while listing 1b shows the disassembled 8080/Z80 code produced by the Echonet lister.

As of October 1982, the Echonet dictionary contained 870 compiled entries, 324 text-only entries, and 347 objects. Its capacity is 2000 entries and objects. Its compiled entries include programs that can do the following:

- display solution for Towers of Hanoi puzzle
- generate prime numbers using Eratosthenes sieve
- optimize register usage for compiled code
- print the Echonet dictionary
- sort entry names using a bank of memory
- verify the Echonet dictionary for internal consistency

The benchmark and implemented programs confirm that Echonet is a practical system. The scenarios for **Vacuum one room** and **while ConditionalClause do IndentedProgram** show Echonet's flexibility, ease of use, and quick interaction with the user.

Natural System

Underlying Echonet is a natural system, i.e., a system that *evolves*. For example, the English language forms a natural system, as does the common law—neither was created as a complete unit. English uses many words evolved from a variety of sources, while the common law uses many "judicial decisions based on custom and precedent" (*Webster's New Collegiate Dictionary*, 8th edition. Springfield, MA: G. & C. Merriam Co., 1981).

Let's look at English as represented by *Webster's New Collegiate Dictionary*. The 8th edition was published in 1981. It replaced the 7th edition that appeared in 1963. The 8th edition has already sold over 12 million copies. It contains 150,000 words and 191,000 definitions. Of these, 22,000 words and definitions are new; that's over 10 percent more than the 7th edition.

In English, words are made up by users and then come into common use. If a word becomes widely used, the editors of *Webster's* dictionary will probably notice the word and include it in their next edition. The new words are not made up by *Webster's* editors; English-speakers make up and use new words. Then the editors decide if the words meet their criterion of usefulness.

In Echonet, entries are like words in a dictionary. Echonet evolves as users write and modify entries; it can evolve in any direction.

Separating Definition from Meaning

Echonet does not use a created language such as BASIC or Pascal. Instead it builds entries out of entries. This is possible because Echonet separates the definitions of entries from their meanings.

English dictionaries also separate *definition* from *meaning*. Let's look at one definition of "entry" in *Webster's New Collegiate Dictionary:* "a headword with its definition or identification."

If definition and meaning were the same for English, then substituting definitions for words should not destroy the meaning of a sentence. This is not the case; substitution produces gibberish. To illustrate that point, here are two definitions of the word "entry." The second definition is made from the first by substituting a definition (from *Webster's New Collegiate Dictionary*, 8th edition) for each word of the first:

> **entry:** a headword with its definition or identification.
>
> **entry:** used as a function word before singular nouns when the referent is unspecified a word or term placed at the beginning [as of an entry in an encyclopedia] used as a function word to indicate combination, accompaniment, presence, or addition of or relating to it or itself a statement of the meaning of a word or word group or a sign or symbol a function word to indicate an alternative evidence of identity.

In natural language, the meaning of a word determines its definition. Behind every definition in a dictionary there is a set of sentences collected from books, magazines, and newspapers. These sentences illustrate the actual uses of words, and hence their meanings.

In Echonet, the reverse is true: the *definition* of an Echonet entry determines the entry's *meaning*. Its meaning is relocatable code that the computer can execute along with data that the computer can access. This relocatable code was compiled from text that defines the entry.

FORTH and Macroinstructions

On first sight, Echonet looks like either FORTH or a macroprocessor. Both define names in terms of other names, but the system underlying each is different from Echonet. In particular, FORTH and macroprocessors equate meaning with definition.

The August 1980 BYTE covered the FORTH language. A FORTH program consists of words in a dictionary. Each word is defined by other words or by some combination of about one hundred primitive words. The computer executes a FORTH word by executing its component words. The *meaning* of a word—the code that is executed—is the group of words that define a word.

Macroprocessors are available with most assemblers and as preprocessors to many compilers. A macroinstruction's definition consists of a name and text. When an assembler or compiler sees a macroinstruction's name, it replaces the name with the macroinstruction's text. Instead of writing the same text over and over again, the programmer just writes the name of a macroinstruction. The meaning of a macroinstruction—the code that is assembled or compiled—is the text that defines the macroinstruction.

The separation of definition and meaning in Echonet may appear to be insignificant, but its consequences are far-reaching. The separation allows every entry to be defined with entries and objects. This makes Echonet a visible system; i.e., every part of Echonet is defined in the Echonet system.

By separating definition from meaning, the Echonet dictionary can contain many entries without affecting performance. This is not true of FORTH and macroprocessors; as the number of FORTH words or macrodefinitions increases, performance slows down. In Echonet, another entry only takes disk storage, so increasing the number of entries does not decrease the performance of Echonet, even if Echonet contains hundreds of thousands of entries. This allows many people to add entries to Echonet over many years.

Summary

I've demonstrated Echonet's operation with scenarios and a benchmark. The key ideas I've tried to convey are (1) that Echonet is an interactive system for managing and creating programs with a dictionary of entries and objects, (2) that every entry in Echonet is defined by entries and objects in Echonet, (3) that the name of an entry is a phrase that describes the entry, and (4) that Echonet is a natural system that separates entry definition from entry meaning.

In your mind, an entry's name should become a symbol for the entry's meaning. Programming becomes a process of design in a symbolic language instead of encoding into a programming language. By separating definition from meaning, Echonet lets you work with symbolic text while the computer works with numeric data.

Echonet is a programming system that responds to the creativity and ingenuity of its users and user groups. Like a natural language, Echonet can grow in elegance and usefulness as the needs of its users develop and change.■

Brad Barber runs Echo Systems Company (POB 5192, Westport, CT 06881), a one-person research firm. He recently joined ITT Programming as part of a research group that works on coordination systems.

Echonet is a research project of Echo Systems Company. To receive the next EchoNet Newsletter, *please send a stamped, self-addressed envelope to Newsletter, Echo Systems Company, POB 5192. Westport, CT 06881.*

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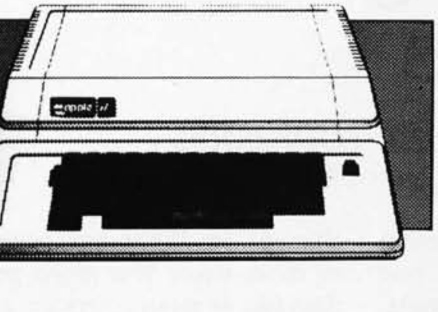

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Data File Management Methods

Organize your files to eliminate confusion

by Robert B. Johnson

Recently, after spending days straightening out the disk files for my personal computing system, I realized the results of improper data file management. At first, managing files for two operating systems, two versions of Visicalc, two versions of a word-processing program, three language packages, and a few applications packages didn't seem difficult. But with the passage of a year, I no longer knew what data files went with what programs, what versions of programs were the most current, or what modifications were installed on what disks. I desperately needed a simple system of data file management that would provide program and data security, continuity of work flow, maximum standardization and software compatibility, and minimal maintenance. To meet these objectives, I designed the following system, which can also successfully handle the needs of a small business. The system described can expand and grow to meet the changing needs of the organization.

Objectives

There are two aspects to the first objective. Providing for program and data security means that a workable system must have backup copies of critical programs and data files so that a minimum amount of time is lost when the inevitable data loss occurs. Security also refers to the need to restrict the dissemination of sensitive or confidential information to only those users who require access to this information to perform their jobs.

The second objective, continuity of work flow, is the ability of the system to allow easy assimilation of one employee's duties by another. Illness, vacations, promotions, and terminations all require that employees be trained to perform new duties. When all employees are familiar with and use a common system, this continuity of work flow is more easily realized.

The third objective, standardization and software compatibility, is required because of the enormous costs associated with software development. To achieve the greatest degree of compatibility, the data file management system must provide a means of assuring that all programs developed by one user are compatible with the rest of the system. Also, the system must provide a means to evaluate the total impact of contemplated changes before they are made.

To meet the fourth objective the ideal system will provide an efficient way to make changes. All changes, record keeping, and educational or other activities associated with a program or data file that is accessed by more than one user should be performed by a single person (or group of persons) who has been given that responsibility.

System Overview

The system is based on the concept of control services residing at discrete control levels. Each level has its own standards of control that specify such parameters as software and data change restrictions, required password protection, file backup requirements, testing required to verify changes, etc. Whenever there are two or more users of a given program, data file, or related service, a control entity is established at the next higher level of control to provide and coordinate the required services. Whenever there is a single user of a program or data file, control services for that program or data file are the responsibility of that user.

Figure 1 shows a block diagram of a generalized system with five levels of control. The highest level is the computer network, essentially a communication system linking a number of computer systems. The next level down is the computer system, which is defined as a particular hardware configuration. For data file management in an organization, all computers of the same make and model are considered part of the same computer system. The next level contains the operating system. For our purposes, an operating system is defined as any control program that has more than one application program dependent on it for proper operation of the computer system. The next lower level is for application programs. A typical small business would have application programs to perform functions such as payroll, accounts receivable, accounts payable, word processing, etc. The lowest level is the user level. When there is more than one user on any level, control resides at the next higher level. Programs and data files that have only one user have the least number of controls placed against them in terms of change restrictions. There are procedures that require backup protection for files at the user level.

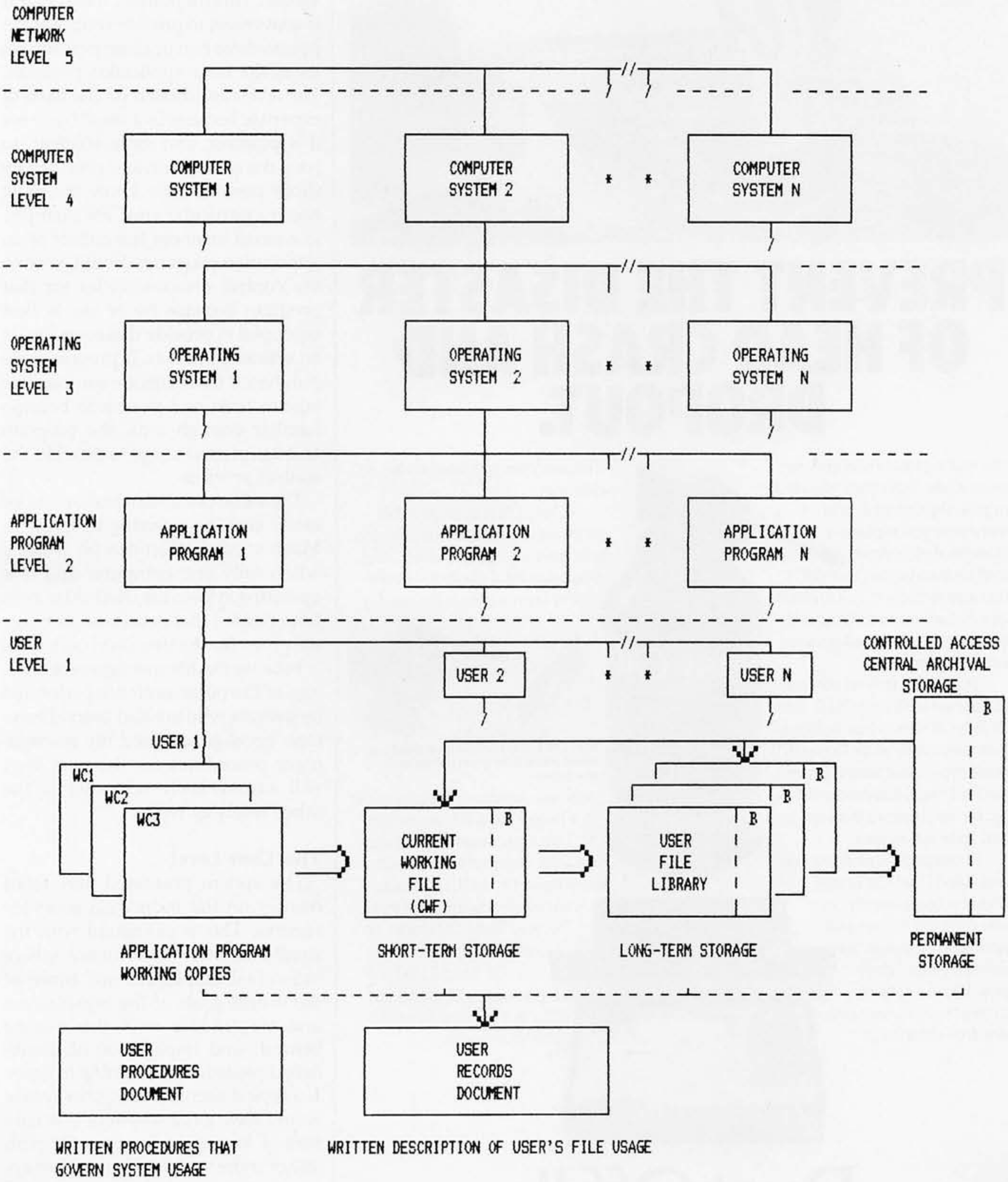

Figure 1: *Data file management system block diagram. The system is divided into five levels, each with its own procedures for control. You must design your own specific and detailed procedures for maintaining the security of your data files and application programs.*

It is important to mention that the upper levels were not selected on the basis of stringency of control but to provide convenient control points based on areas of expertise. By convenient control points I mean that it is convenient to provide control at the point where two or more persons are using the same application program. The levels are chosen on the basis of expertise because in a small business it is possible, and more efficient, to have the control services provided by those persons who know the most about a particular area. For example, in a small business the author of an application program should assume the control responsibilities for that program because he or she is best equipped to provide these services in an efficient manner. If programs are purchased from outside sources, it is best to train one person to become familiar enough with the program and its internal usage to provide the control services.

The value of standardization can be easily seen by referring to figure 1. Much control effort can be avoided when only one computer and one operating system are used. Also note from figure 1 that details on file usage are given for the user level only. This is because the file management activities of the other levels are performed by persons who are also users. Therefore, good generalized file management procedures for the user level will automatically take care of the other levels as well.

The User Level

The system presented here relies heavily on the individual users for success. This is consistent with the small-business environment where individual employees are aware of the overall goals of the organization and are familiar with the reasons behind, and importance of, established procedures. Referring to figure 1, a typical user of a computer system would have a filing system that consists of four major parts: a file with one or more working copies of an application program, a current working file, a user file library, and controlled access to a permanent filing system that is shared among all users.

1.0 SCOPE
2.0 REFERENCED DOCUMENTS
3.0 DEFINITION OF TERMS
4.0 SYSTEM CONFIGURATION
5.0 CONTROL MATRIX
5.1 Control Matrix Code Definitions
6.0 RESPONSIBILITIES
6.1 Control Coordinator Job Description
7.0 USER RECORDS DOCUMENT
7.1 Format
7.2 Update Procedures
8.0 CENTRAL ARCHIVAL STORAGE

Table 1: *An outline of the user procedures. This outlines specific topics and should describe your computer, the various levels of control, who is responsible for each level, how to access user records documents, and how and where material is stored in the central archival storage.*

The working copies of an application program are files that contain day-to-day copies of programs used in the performance of the user's job. A typical user might have working copies of Visicalc, Pascal, and a word-processing program, for example. There is no need for the user to maintain backup copies of these files because they are available from the person designated control coordinator for each application program.

The current working file is a small file that can contain any program or data file that the user is currently using or developing. It is periodically backed up (approximately once a day) by the user to assure against data loss. About once a week, the current working files are transferred to a user file library for more permanent storage.

The user file library is a collection of files maintained by the user and intended for long-term data storage. The files in this library are arranged in a logical sequence determined by the user and designed to facilitate retrieval of programs and data. The file-naming conventions and volume names used are to be documented in a user records document. Backup copies of the contents of the user file library are maintained by the user.

The controlled access central archival storage is a permanent storage area where critical files, backup copies, and related documentation are permanently stored. Files are stored and removed from central storage in accordance with estab-

lished procedures defined in a user procedures document.

The user procedures document is used to communicate to all users the procedures that govern usage of the computer system. The document contains standard operating procedures and methods, definitions required to promote common understanding of the procedures, listings of those persons responsible for the various control activities, and all other information required to enhance the orderly functioning of the system. The user procedure document is maintained at a central location within the organization and is used to communicate information of a general nature to all system users.

The user records document is maintained by the user and communicates, in standard format, critical information regarding the user's files. This document contains file names and descriptions, program names and usage, storage volume directories, naming conventions, storage locations, and other pertinent data related to the user's employment of the system. The user records document is maintained by the user as a general index to his or her filing system; it is also used by persons who may need to access this information in the absence of the user.

1.0 USER IDENTIFICATION
2.0 USER RESPONSIBILITY
2.1 Listing of Level 5 Files Under User Control
2.2 Listing of Level 4 Files Under User Control
2.3 Listing of Level 3 Files Under User Control
2.4 Listing of Level 2 Files Under User Control
3.0 USER VOLUME AND FILE-NAMING CONVENTIONS
3.1 Volume-Naming Conventions
3.2 File-Naming Conventions
3.3 File Extension-Naming Conventions
4.0 WORKING COPY VOLUME INDEX
4.1 Volume Names and Descriptions
4.2 Important File Names and Descriptions
4.3 Backup Copy Volume Names
4.4 Storage Locations
5.0 CURRENT WORKING FILE INDEX
5.1 Volume Names and Descriptions
5.2 Important File Names and Descriptions
5.3 Backup Copy Volume Names
5.4 Storage Locations
6.0 USER LIBRARY FILE INDEX
6.1 Volume Names and Descriptions
6.2 Important File Names and Descriptions
6.3 Backup Copy Volume Names
6.4 Storage Locations
7.0 PERMANENT STORAGE FILE INDEX
7.1 Volume Names and Descriptions
7.2 Important File Names and Descriptions
7.3 Backup Copy Volume Names
7.4 Storage Locations

Table 2: *This outline of the user records document lists the records an employee or another person needs to maintain an orderly set of programs and files for current use.*

The User Procedures Document

The user procedures document communicates procedures required to meet management's goals regarding the use of the computing facilities. It is a working document that should be updated frequently and used as a helpful source of information. The contents of this document depend to a large extent on the nature of the organization, but they can be generalized.

Table 1 is an outline of the contents of a generalized user procedures document. Many of the topics outlined are self-explanatory, while others require additional explanation. Paragraph 4.0, system configuration, should be a block diagram, similar to figure 1, that shows the details of the specific computing facility. It should clearly show the specific control levels that will be used in the organization as well as all computer systems, operating systems, application programs, and other pertinent features that require control. Include on the diagram the names of the people who will act as control coordinators for each control point. The user procedures document is the place to define responsibilities crucial to the success of the system.

Paragraph 5, control matrix, defines specific procedures that govern control at each level. For example, your procedures may require that each user's current working file be backed up once a week if it contains level 1 files and once a day if it contains level 2, or higher, files. Procedures should be included here to govern such things as: file backup frequency; file backup methods; change restrictions, including approval levels; password protection for files; and verification tests that must be performed after changes or revisions. Procedures for each of these and other relevant control areas must be specified for each controlled area and control level. A matrix of control procedures should result. If the control procedures appear in coded form on a diagram, the codes should be defined in this paragraph.

Paragraph 6 is a listing of those persons responsible for each control point with a description of the duties to be performed by them.

Paragraph 7 contains the format, update requirements, and other procedures that govern the user records document to assure that all employees are familiar with the document and can use it effectively when needed.

Paragraph 8 contains the procedures that are associated with the storage and retrieval of files from central archival storage.

The User Records Document

The user records document has a general format specified in the user procedures document; it is maintained by the computer system user. This document serves as an index to the user's files and is helpful to both the user and to other persons who may need to access the files. Table 2 is an outline of the essential contents of a user records document. Again, the specifics of the document are dependent on the particular organization.

Paragraph 2, user responsibility, contains specific information on files the user is control coordinator for. This section should contain volume names, file names, backup volume and file names, storage locations, and the names and locations of historical documents associated with the files under his control.

Paragraph 3 contains the user's volume and file-naming conventions. This section is particularly useful in assisting those unfamiliar with the user's files in locating a particular file or determining file usage. This section should, at minimum, contain: volume-naming conventions, file-naming conventions, and file extension-naming conventions.

Paragraphs 4 through 7 contain the indexes to the user's working copy files, current working files, user library files, and permanent storage files. These indexes contain volume names, important file names, and storage location information.

Conclusion

This outline for the data file management system is adaptable to almost any small business environment. However, the only way to ensure that this system works is to carefully record the procedures that your company's computer users must follow. By clearly recording and presenting these procedures to your employees, you will eliminate many potential problems that could plague your computer. You and your employees will be happier with a computer system that clearly defines the lines of information access.■

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Readers who wish to obtain outline copies of the user procedures document and the user records document should send a check for $15 and a self-addressed, stamped envelope to:
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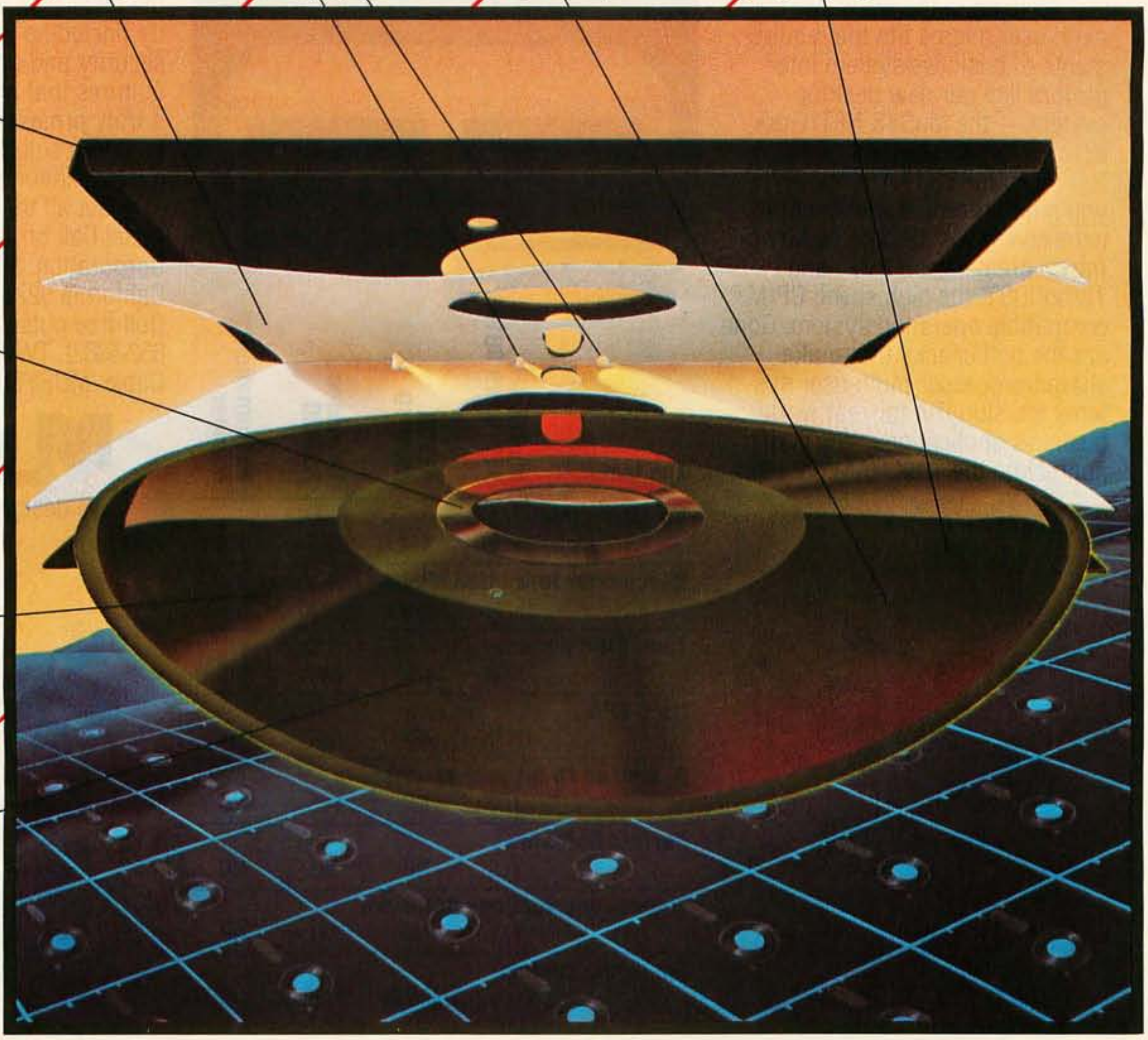

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An Introduction to Layered Protocols

Understanding layered protocols can help you evaluate network architectures of data-communications products

by Michael Witt

Product announcements for computers and peripherals increasingly include claims of some sort of networking capability. To understand the network architectures of these products, it is essential to understand the concept of layered protocols. In this article, I'll discuss a reference architecture based on the International Standards Organization's (ISO) model for open-systems interconnection. This architecture provides a framework within which protocol layering can be explained. I will also briefly investigate protocol design issues within the different layers.

The Reference Architecture

Several years ago, the ISO, which is made up of national standards organizations from various countries, recognized the need for a basic framework in which computer networking standards could evolve. A subcommittee (SC16) was appointed to develop a model for "open systems interconnection." The resulting model is called the "ISO OSI model."

The ISO model is intended to be a vehicle for the development of specific standard protocols, but I use it here for its value as an architectural reference model. A reference architecture sets forth a general framework and principles by which a system is designed to operate. The model is presented here in a very simplified form, and I have taken some liberties with it to increase its value in this particular discussion. References 1 and 2 provide a precise, detailed description of the ISO model.

The physical link resides at the lowest protocol layer.

Layering, Protocols and Interfaces

Figure 1 shows a layered network in two computers (hosts) connected by a physical communications channel.

At a given layer (layer n), a program communicates with the corresponding layer in another host. This is peer communication. Because communication in a computer network is based on formalized communication protocols, *peer protocol* is used to describe the interaction of the corresponding layers in a communications network. Logically, these two layers communicate directly with one another (the dotted line), but in reality all communication must take place at the lowest layer because the only actual physical link is there (the solid line).

Communication between hosts takes place when layer n on the transmitting host formats a message and passes it down to its layer $n-1$. (Communication between two layers in one host is called an interface.) The message continues to be transmitted down until it reaches the bottom layer. It is then sent over the physical link to the receiving host. After being accepted by the lowest layer, the message works its way up to layer n in the receiving host.

An analogy can be made here to the type of communication that goes on in an office environment. For example, suppose the president of ABC Company decides that his softball team should play a series of games against the team sponsored by XYZ Corporation. He calls the captain of the softball team into his office and asks her to find out how XYZ Corporation feels about this plan. The softball team captain asks her

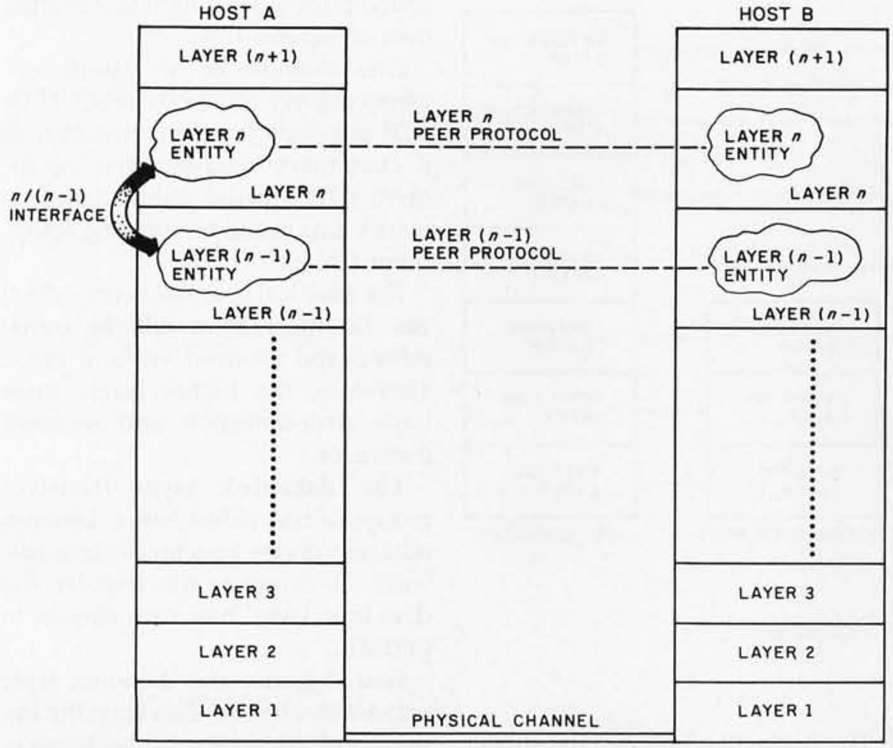

Figure 1: *A layered networking implementation of two interconnected host computers. Although a given layer (layer n) in one computer should communicate with the corresponding layer in the other computer, all communication actually takes place through the physical channel, which employs layer-1 protocol.*

secretary to deliver the message to the captain of the softball team at XYZ Corporation to find out where XYZ Corporation would prefer to play if a series of games is scheduled.

The ABC secretary calls XYZ Corporation, relays the message and adds some information regarding the team's schedule.

When XYZ's softball team captain arrives at the office, his secretary informs him of the challenge from ABC Company, and he checks with the president of XYZ to find out if he may schedule the games. After receiving permission he asks his secretary to tell ABC Company that the challenge is accepted and that the games should take place in the park. The two secretaries talk again, and then ABC's softball captain reports to her president that the offer has been accepted and all arrangements have been made.

In this example, the only physical communication took place when the secretaries talked on the phone. However, there was a logical, or *virtual,* communication between the two company presidents (advancing and accepting the challenge) and between the two softball team captains (arranging the details of the game).

All of the network architectures currently being proposed as standards are based on the layered-design approach

The communication between the layer *n*s in figure 1 is the same as the communication between the company presidents in the example.

Peer protocols must follow the specifications of the network architecture precisely if information exchange is to be successful, but the interface between layers may be implemented in any way because it does not affect communication between the two hosts.

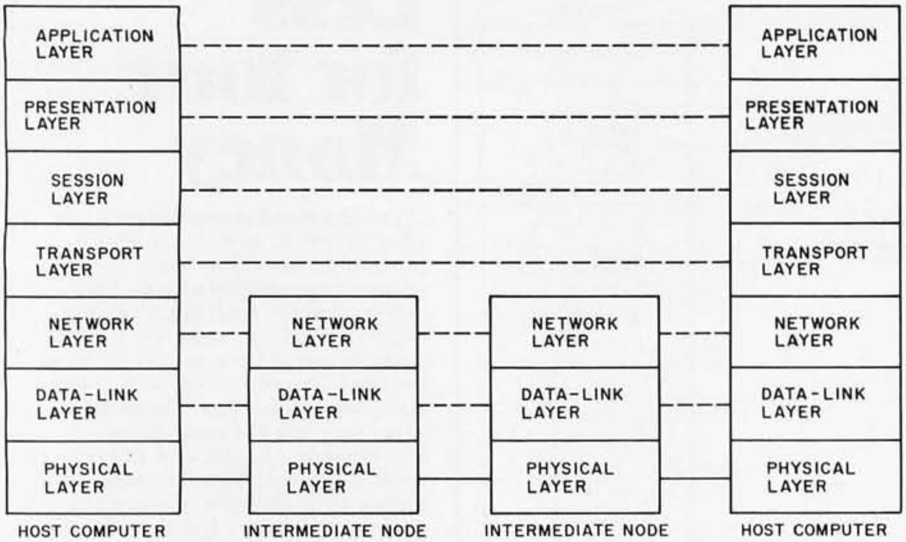

Figure 2: *The seven layers of the ISO reference architecture.*

Using a layered approach to design computer networks is advantageous because the layers are relatively independent of one another and can be replaced without affecting the entire design. For example, if you have a layered network based on an underlying communication facility consisting of numerous point-to-point data links and if a new local networking technology is developed to allow the network to be intraconnected via one high-speed, coaxial cable bus, you only have to redesign the lower, transmission-oriented layers, which deal directly with the specific transmission media and topology. All of the network architectures currently being proposed by various standards organizations and designed by commercial vendors are based on the layered-design approach.

The Layers

The ISO reference architecture (see figure 2) contains seven layers: the physical, data-link, network, transport, session, presentation, and applications layer.

The lower three layers form the *subnet*. These layers route data through the network from one host to another. The higher layers are concerned only with the dialogue between the communicating hosts (end-to-end communication).

The distinction between the subnet protocols and the higher-level protocols is particularly important when public data networks are involved because it is this subnet that is supplied to the customer by the public data network.

The layered approach is advantageous because the layers are relatively independent and can be replaced without changing the entire design.

The physical layer resides at the level of the transmission medium (referred to also as the link or channel) over which information is sent between two or more nodes in a network.

The basic unit of information sent and received at this level is the "bit" (one binary digit). Bits can be encoded in a variety of ways depending on the transmission medium employed. Transmission mediums include: a particular voltage signal on a wire for a given time period (baseband signaling), a carrier signal modulated at a certain frequency (frequency-shift keying or FSK), phase changes in a modulated carrier (phase-shift keying or PSK), and coded pulsations of light transmitted over an optical fiber.

One example of an established physical-layer protocol is CCITT's X.21 standard for the connection of a customer's data-terminal equipment (DTE) to the public data network's data circuit-terminating equipment (DCE).

The physical channel is imperfect; not all information will be transmitted and received without error. Therefore, the higher layers must have error-detection and recovery measures.

The data-link layer transfers groups of bits, called *frames*, between adjacent nodes (machines) in a network. To complete this transfer, the data-link layer has two checks to perform.

First, because the data-link layer may receive invalid data from the imperfect physical layer, a checksum (a single calculated value based on a numerical operation involving each information unit in the frame) is usually affixed to each frame as it is sent by the data-link layer in the transmitting node. When the frame arrives at the receiving node, the appended checksum is compared with a checksum generated locally, and if the two don't match, the receiving data-link layer knows that a transmission error has occurred.

Second, because not all nodes in the network can send and receive data at the same rate, the data-link layer must take charge of flow control. Many different data-link-level protocols allow reliable transmission and balanced flow control.

Two popular flow-control link protocols are "stop-and-wait" and "sliding window" protocols. The stop-and-wait protocol uses the positive acknowledgment method to control data flow, in which an acknowledgment (Ack) signal sent back from the receiving node to the transmitting node indicates that the transmission was successfully received and that the receiver is ready for more data. Sliding-window protocols assign each frame a sequence number, and both the sender and receiver maintain a "window" of valid sequence numbers. This method is dependent

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on the receiver's ability to process received data while receiving still more data; thus, the transmitter may send several frames (determined by the window size and other factors) without stopping to wait for an acknowledgment. Transmission of data is held up only when the receiver is incapable of further processing. This method is suitable for full-duplex situations (in contrast to the stop-and-wait method, which is suitable for half duplex).

In other schemes separate credit frames are sent to the transmitter when the receiver is ready to process more data.

The network layer (the last layer of the subnet) handles routing; it determines what path a message, or *packet*, will take through the network to get from the transmitting host to the receiving host.

In a network environment, two host computers generally are separated by an arbitrary number of other nodes not directly involved in that particular communication. Any given node in the network layer must have some way of determining which way to forward data so that it reaches its intended destination.

There are four states of routing protocols: centralized versus distributed and static versus adaptive.

The network becomes congested when the hosts pump data into the network faster than it can be absorbed and delivered.

A centralized routing protocol stores information regarding network topology at one site. Information on how to route packets resides in each node. This routing protocol has the advantage of centralized control and ease of implementation, but it has two disadvantages: the central site becomes vulnerable because the network cannot function if the routing capability is lost, and the higher level of communications activity around the routing center can present a throughput problem.

In distributed routing, much depends on the sophistication of the network nodes. Simple nodes *can* only be supplied with a routing table or an algorithm such as *flooding*. If the nodes are more sophisticated, an adaptive technique can be used.

With a static routing protocol the routing tables are calculated in advance and no changes can be made in network topology without bringing the network down; in adaptive routing there is some provision for recognizing topology changes and incorporating this information into future routine decisions. Reference 8 provides more information on routing protocols.

The network layer must also deal with congestion. The network becomes congested when the hosts pump data into the network faster than it can be absorbed and delivered. Congestion is similar in some respects to the problem of flow control in the data-link layer, and some methods of dealing with it are the same (the issuing of credits, for example). For a discussion of network congestion and techniques for dealing with it, see reference 4 (pages 215-225).

Because few network architectures have implemented the higher-level protocols, explanations tend to get more abstract once you leave the subnet.

The transport layer ensures an error-free end-to-end connection between two or more communicating hosts. This layer, and all of the higher layers, need to exist only on network hosts (machines that take part in end-to-end communications over the network).

Although the data-link layer ensures reliable communication over the separate data links, it does not guarantee reliable exchange of data between hosts. Consider the network depicted in figure 3. Hosts A and B are engaged in an exchange of information over the shortest available path (in this case, the solid line through nodes 1 and 2). In the middle of the dialogue, node 2 becomes

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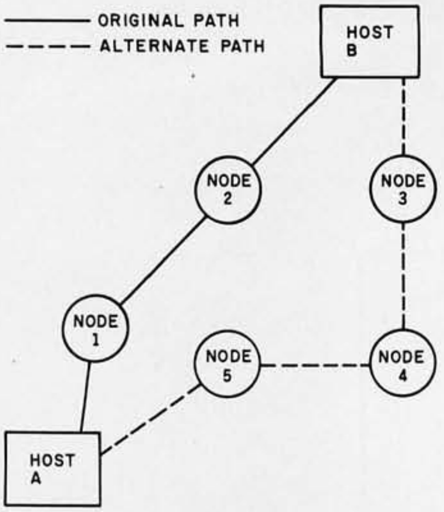

Figure 3: *A network that could employ adaptive routing to ensure continuing host-to-host communication in the event of a node failure.*

inoperable because of hardware difficulties. There are two ways to ensure the connection: the network layer can incorporate some form of adaptive routing and the connection can be rerouted, or the conversation can be restarted.

In either case, the hosts have a problem. If the entire exchange is started over, what does host B do with the packets already received from host A? According to the link-level protocol the packets are valid, but if they are accepted by host B, there will be duplication when the same data arrives again over the new path, resulting in an incorrect message.

The situation is as bad if an alternate path (the dotted line through nodes 5, 4, and 3) is established. How does host A know which packet to begin sending over the new path? Host A knows only that the last packet sent reached node 1 without error. There is no way for host A to determine if the packet was received by node 2 before it crashed, much less if it was successfully forwarded to host B.

The transport layer also must concern itself with end-to-end flow control. Many of the flow-control measures in this layer are similar to those in the data-link layer.

In some networks, the subnet provides a virtual-circuit service. This means that when host A wishes to communicate with host B, host A requests that a connection be set up to host B. This connection is called a virtual circuit because once set up, it can be used in much the same manner as a circuit on a circuit-switched network.

In other networks, the subnet provides only a datagram service. Each packet is considered a separate datagram, and each packet must contain the entire destination address (instead of just a virtual-circuit number). When using the datagram service the subnet does not guarantee the order in which datagrams will be delivered. The transport layer must sequence the data flow.

The session layer sets up, maintains, and closes down sessions (specific periods of communication) between specific layers on different host computers.

The most important responsibility of this level is that of remote log-on, in which a user on one host logs on to a second; that way, it appears to the second host as if the user is local.

Another session-layer activity is bracketing, which prevents execution of a critical database update until all information needed for that update is received, eliminating the chance of a partial update when transmission is interrrupted. An opening bracket indicates to the session-layer protocol that a critical transaction is starting. When the closing bracket appears, it is safe to allow the transaction to be recorded. If the network should crash before the closing bracket is received, no update takes place.

Current networking architectures do not provide a good example of a distinct session layer. In most of the networks that implement the functions described here, those session-layer functions are subsumed in the transport and/or presentation layers.

The presentation layer formats the information being delivered. Some presentation activities are data com-

pression and compaction, data encryption, file translation, and virtual-terminal protocols.

Data compression eliminates repeated characters, such as blanks at the end of a line. This is usually done by specifying what character is to be compressed and inserting a count to indicate how many repetitions occur at a particular place in the text. Compaction removes data redundancy by encoding the data in an alternate form.

Data encryption is important because information traveling through the public data networks (as a result of satellite broadcasting, microwave links, etc.) is so accessible (see text box below).

Two types of encryption (which

Encryption and Decryption Procedures

In traditional cryptography, plain text (symbolized by the letter P) is passed through an encryption process (E) to produce cypher text *(C). To recover the original plain text, it is necessary to pass the cypher text through a decryption process (D). This procedure is illustrated in figure 4.*

Encryption and decryption procedures are generally parameterized with a key (K). Two correspondents wishing to engage in a secret communication agree on a key. Their dialogue will be secure (even when encryption and decryption procedures are public knowledge) because no one else knows the key.

The functional notation generally used to describe the encryption process is $C=E_k(P)$, which means that the cypher text C is produced by applying the encryption procedure E, parameterized by the key K, to the plain text P. The decryption process is notated as $P=D_k(C)$. For two correspondents to be able to read each other's messages, it must be true that $P=D_k(E_k(P))$.

An encryption method is considered symmetric if $P=E_k(E_k(P))$, meaning that the encryption process and the decryption process are equivalent. One example of such a process is the exclusive OR of the key value with that of the plain text.

There have been schemes proposed that differ from traditional cryptography; the most prominent of these is public-key encryption. Public-key encryption constructs the encryption and decryption procedures so that it is possible to choose a pair of keys K1 and K2 for which $P=D_{k2}(E_{k1}(P))$ holds true, but $P=D_{k1}(E_{k1}(P))$ does not. In other words, text encrypted with K1 must be decrypted with K2. K1 can then become the public key, accessible to anyone who wishes to send a private message to the owner of K2.

Public-key encryption yields a promising method of obtaining digital signatures. Digital signatures will become important as more and more business is transacted via company networks. They can be implemented as follows: K1 and K2 are again used, however; this time K2 is in a public file while K1 is a user's private key. If the user wants to send a digital signature to his bank, for instance, he encrypts his name (or some other predetermined text) using his private key K1. In other words, he performs $C=E_{k1}$ (signature). Upon receiving the message, the bank performs the decryption signature$=D_{k2}(C)$. If the decrypted signature matches the expected one, the message must have been sent by the authorized user.

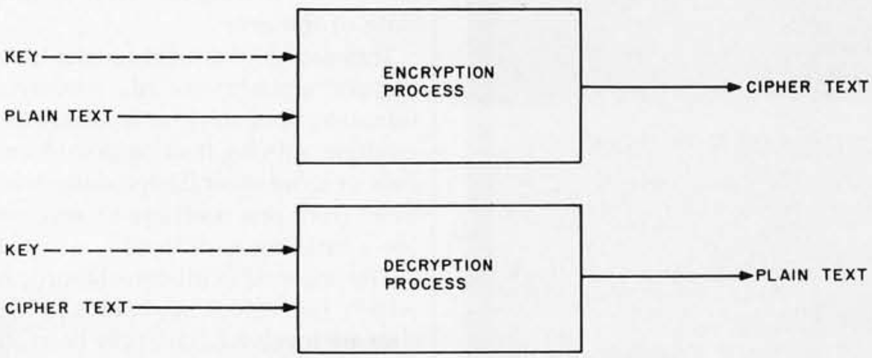

Figure 4: *An illustration of the encryption and decryption process.*

might be placed in a layer other than the presentation layer) may be necessary in a computer network. One is *link encryption*, in which data is encrypted by the link (or physical) layer as it flows between two network nodes. The other is *end-to-end encryption*, in which the encryption and decryption take place between the hosts involved and are performed at the transport layer or above.

Link encryption is valuable as a means of thwarting traffic-flow analysis, where an eavesdropper on the network attempts to gain information by reading the source and destination addresses in the packets to find out who is talking to whom, even though he may not be able to determine exactly what they are saying. If the link layer is to encrypt the packet headers to prevent traffic-flow analysis, each node in the network must know the key to decrypt the headers to determine the route of the packet.

It is unlikely that many users would trust their keys to every network node. Therefore, all networks will probably support some form of end-to-end encryption, and networks in which traffic-flow analysis is an issue will also use link encryption.

For an introduction to cryptology as it applies to information systems, see reference 9; also, see reference 10 for an up-to-date look at security measures in a layered-network environment.

The presentation layer must also be able to translate files from the format of one machine to another so that network users may take advantage of files that exist on the various hosts. Possible kinds of translations range from easy to beyond what is now state of the art.

Translation of a print format is relatively straightforward. However, translations of a syntactic nature (for example, moving floating-point numbers or more complicated data structures from one machine to another) are a little more difficult.

The most difficult translations, in which the actual semantics of the data are involved, have only been addressed in limited research settings. One example of this kind of transla-

tion would be to send an actual applications program from one computer host to another.

The presentation layer is also responsible for virtual terminal protocols. These protocols eliminate the problem that occurs when some terminals in a computer center are unable to accept a program because they use a different sequence of control characters than the others do to position the cursor.

The virtual-terminal protocols define a hypothetical terminal (the network virtual terminal). Mappings are then established between the virtual terminal's defined functions and the real terminal's functions. If the programmer follows the rules established by the virtual-terminal protocols, his program will run on all of the supported network terminals.

See reference 11 for a summary of virtual-terminal protocols currently in use.

The applications layer is responsible for network-wide program applications. No currently existing network has a truly integrated applications layer, but the most important research topics with regard to the applications layer are distributed databases, distributed computational models, and distributed operating systems. Designers of network-wide applications must determine how to distribute functions that traditionally existed within a single computer to two or more network hosts (distributed control).

There are several motivations for having distributed databases. If different subsets of the database are accessed more frequently in different geographic areas, a distributed database will help keep telecommunications costs down. Also, local control of data may sometimes be appropriate for political or business reasons.

There are two basic models for distributed databases: the replicated database, in which all information is duplicated at each site, and a partitioned database, in which the information is divided up among the various sites. Figure 5 shows how a relational database might be distributed among three different sites using these two methods. A parti-

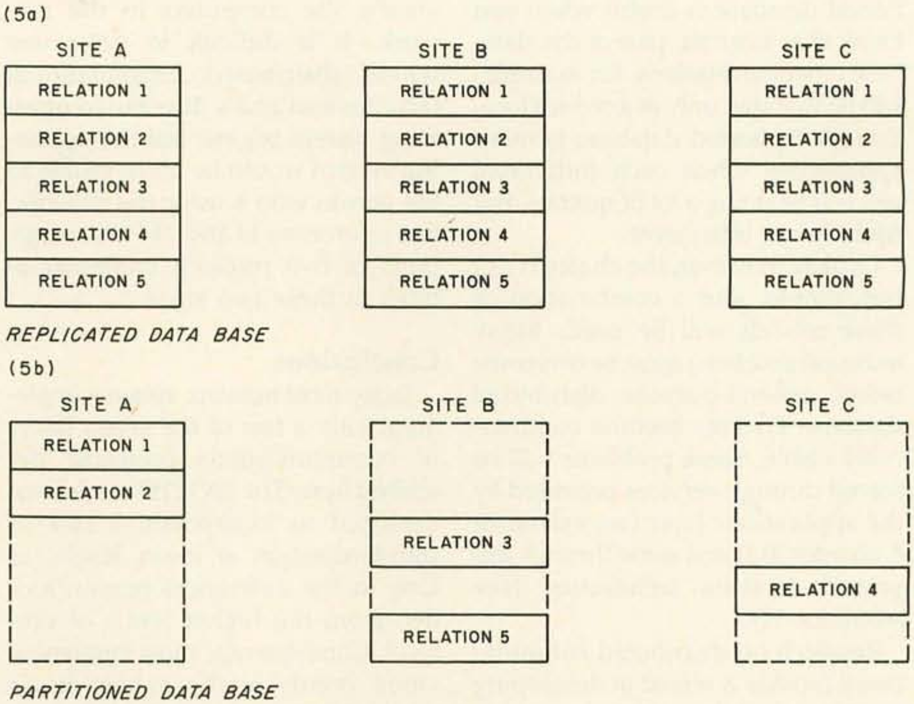

Figure 5: *Two methods of distributing a database among three sites. In a replicated database, all information is duplicated at each site; in a partitioned database, the information is divided among the three sites.*

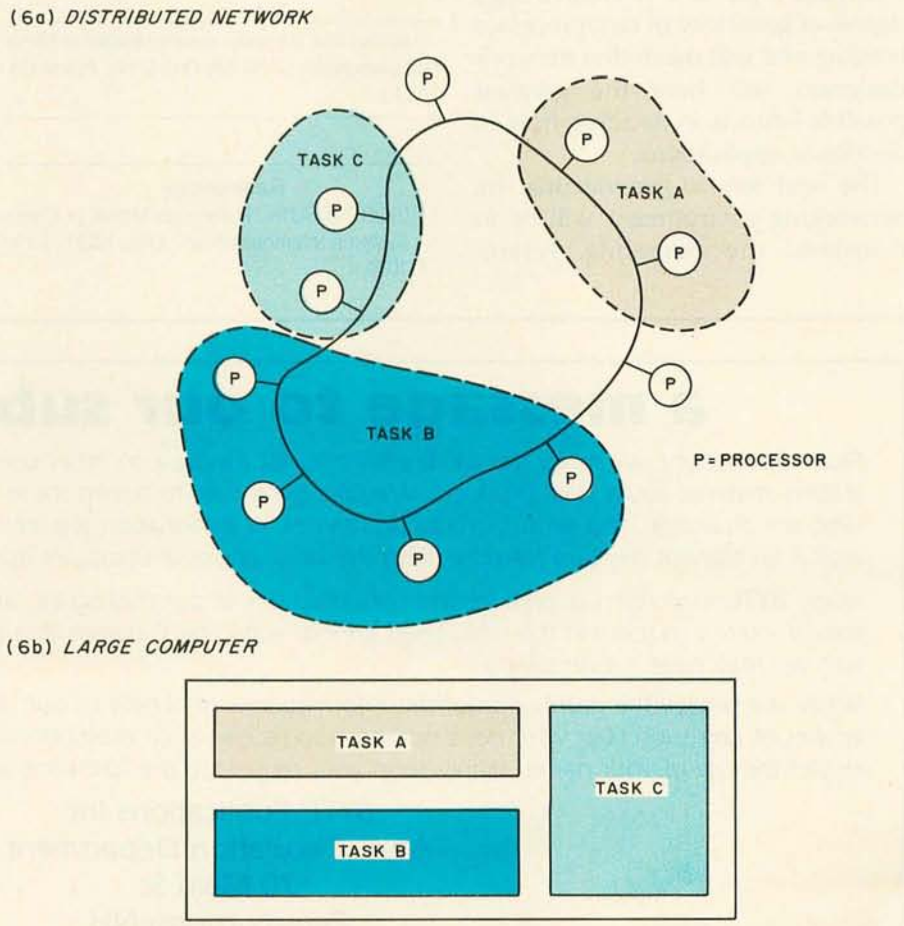

Figure 6: *A distributed computational model (a) acting as a mainframe as it shares more than one processor per task. Compare this to a single mainframe handling multiple tasks (b).*

tioned database is useful when you know that a certain part of the database (specific relations, for example) will be updated only at a certain location. A replicated database is more appropriate when each individual site will be doing a lot of queries, but updates are infrequent.

Usually, however, the choice is not this simple, and a combination of these models will be used. Many technical problems must be overcome before general-purpose distributed database systems become commercially viable. Some problems will be solved through services provided by the applications layer (see reference 4, chapter 10.1) and some through improved database architecture (see reference 12).

Research on distributed computational models is aimed at developing a way to schedule more than one processor per task in the distributed network, just as more than one task per processor can be scheduled in the central mainframe (see figure 6). This will make it possible to attain a high degree of generality in task/processor binding and will mean that network designers will have the greatest possible latitude in deciding how to distribute applications.

The next step in generalizing the networking environment will be to distribute the operating system among the computers in the network. It is difficult to determine where distributed computational facilities end and a distributed operating system begins, but the operating system would be more visible to the person who is using the network. See references 13 and 14 for descriptions of two research implementations in these two areas.

Conclusions

Today most network systems implement only a few of the seven layers of communications protocols described here. The ISO OSI model was designed to incorporate a lack of standardization at lower levels, as long as the differences remain hidden from the higher levels of protocol. Consequently, most implementation occurs at the subnet levels where this variation is allowed. And, until more work is done to establish compatible higher-level protocols, the use of networks will remain limited.■

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Programming Quickies

Cipher via Computer

The One-Time Pad

by Theodore Hines, Lois Winkel, Rosann W. Collins, and Francis A. Harvey

Much has been written about codes and ciphers and their many computer applications. Obviously computers can be used to decode messages and to create code books. They can also encipher and decipher messages by means of a previously agreed upon algorithm. In a sense, algorithms are what computing is all about.

A code is a system of symbols or words with meanings previously determined by those exchanging messages. For instance, a set of five-letter groups such as "ASDMN HCTWL DZCHW" might mean "sell our current gold holdings today," with each group standing for a word or phrase in the appropriate code book. A cipher, on the other hand, consists of transforming the original text in accordance with an algorithm previously agreed upon by the message exchangers.

Perhaps one of the most secure enciphering methods of all is the *one-time pad system*. In this system, sender and receiver have identical note pads, each page of which lists a series of random numbers. The person sending the message sequentially transforms the characters in accordance with the random numbers on the pad's top sheet. The person receiving the message uses the duplicate of that sheet for deciphering the message. The sheets are then destroyed. Because the same random-number sequence is never used twice, and because each character is encoded randomly (making character-frequency analysis impossible), the system is quite secure.

The enciphering/deciphering program given in listing 1 uses a similar system. The message is encoded via a set of random numbers derived by the programming language's (here, Microsoft's MBASIC) random-number generator. In this case, the random numbers are generated in a manner that uses the ASCII (American National Standard Code for Information Interchange) character set above decimal 32 as cipher characters.

Use of the random-number set for encoding prevents decipherment by frequency analysis. But what about the possibility of repeating the same number set used to encode a series of messages? The program presented here uses a keyword or phrase to determine a number to be used for "seeding" the random-number generator. In this

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Listing 1: *Enciphering/deciphering program for Microsoft BASIC. The program uses a keyword or phrase as the seed for generating a random-number series; the series is then used as the basis for encoding (or decoding) a message.*

```
0 '                     CIPHER PROGRAM
20 '
30 '      Copyright (c) 1981 by Theodore C. Hines
40 '
50 '  This program uses an enciphering algorithm which
60 ' fairly closely approximates the one-time pad technique.
70 ' It can be made more secure by using a personal
80 ' randomizing function.
90 '  However, even if the keyword and the randomizer
100 ' are known, the algorithm for determining the
110 ' randomizer number must be figured out.  Users may
120 ' devise their own algorithm for this purpose.
130 '
140 '
150 INPUT "DO YOU WANT TO ENCODE OR DECODE? (E OR D),A$
160 IF LEFT$(A$,1)="D" THEN 410
165 IF LEFT$(A$,1)<>"E" THEN 150
170 INPUT "FILE TO READ FROM? ",A$
180 OPEN "I",1,A$
190 INPUT "FILE TO WRITE TO? ",A$
200 OPEN "O",2,A$
210 GOSUB 620
220 RANDOMIZE C
230 IF EOF(1) THEN 400
240 LINE INPUT#1, A$
250 PRINT A$
260 IF A$="" THEN GOTO 360
270 FOR I=1 TO LEN(A$)
280 C=INT(RND(.5)*95)+1
290 B=ASC(MID$(A$,I,1))
300 B=B-32
310 D=B+C
320 IF D>95 THEN D=D-95
330 D=D+32
340 B$=B$+CHR$(D)
350 NEXT I
360 PRINT #2,B$
370 PRINT B$
380 B$=""
390 GOTO 230
400 CLOSE: PRINT "CLOSED!": END
410 'DECYPHER
420 INPUT "FILE TO READ FROM? ",A$
430 OPEN "I",1,A$
440 INPUT "FILE TO WRITE TO? ",A$
450 IF A$<>"" THEN OPEN "O",2,A$: S=1
460 GOSUB 620
470 RANDOMIZE C
480 IF EOF(1) THEN 610
490 LINE INPUT#1,A$
500 FOR I=1 TO LEN(A$)
510 C =INT(RND(.5)*95)+1
520 A=ASC(MID$(A$,I,1))
530 D=A-C
540 IF D<32 THEN D=D+95
550 D$=D$+CHR$(D)
560 NEXT I
570 PRINT D$
580 IF S=1 THEN PRINT#2, D$
590 D$=""
600 GOTO 480
610 CLOSE: PRINT "CLOSED!": END
620 'KEYWORD SUBROUTINE
630 LINE INPUT "KEYWORD? ",A$
640 FOR I=1 TO LEN(A$)
650 A=ASC(MID$(A$,I,1))
660 C=C+A
670 NEXT I
690 RETURN
```

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program, the seed is very simply derived by adding together the ASCII values of the characters in the keyword. Much more complex algorithms could be used. The keyword could be varied with each message, or a number from some predetermined sequence (such as pi) could be added to the keyword figure to form the seed. Other bewildering elements might be included, such as starting with an agreed upon *n*th number in the random series, omitting every *n*th number, or skipping *n* random numbers in the table. You could insert a personal randomizing algorithm rather than use the one built into BASIC. Most users could easily adapt the BASIC code given here to their particular machines and applications. Note that TRS-80 Level II BASIC's randomizer can be given a known seed by poking the seed in the bytes located at 16554 through 16556 (decimal).

Some versions of BASIC (Applesoft and TRS-80 Level II, for example) do not have a LINE INPUT function. This means that either you may not be able to key in commas or colons in the data to be coded or that you'll need to write a new input loop using the INKEY$ or GET functions for inclusion of these punctuation marks in your input string. Similarly, input from a file in these versions of BASIC may ignore information in a sequential-file record that follows a colon or comma. In this case, you'd need to convert these characters to the ASCII value of some character not in the data or use some other method. The encoding routine must not generate a comma or a colon. (If this puzzles you, drop us a query.)

In a way, the program given here is just a sample of what could be done. Those who have to send their code on paper (instead of in machine-readable form) to the receiver might want to restrict the cipher alphabet to capital letters and to print out the cipher text in five-letter (or so) groups. The computer could simply produce a pair of one-time pads, or the cipher as sent might consist only of numbers—random plus ASCII—rather than being translated into ASCII as is done here.

The enormous effort of trying to crack such a cipher would hardly be repaid by finding out from the local CBBS (computer bulletin board system) or electronic mail that George wants Matilda to meet him at Leon's Lounge at 12:30 or that Al won't go any higher than $250 for the S-100 board in question. On the other hand, the program is easy to implement, reasonably secure, fun to play with, and will cost you considerably less than commercial cipher programs.

As noted earlier, codes, ciphers, and computers seem to go together. If you like this program, you may want to get a copy of David Kahn's *The Codebreakers* (Macmillan, 1967), an enormously entertaining and informative history. It will also give you lots of ideas for programs. ■

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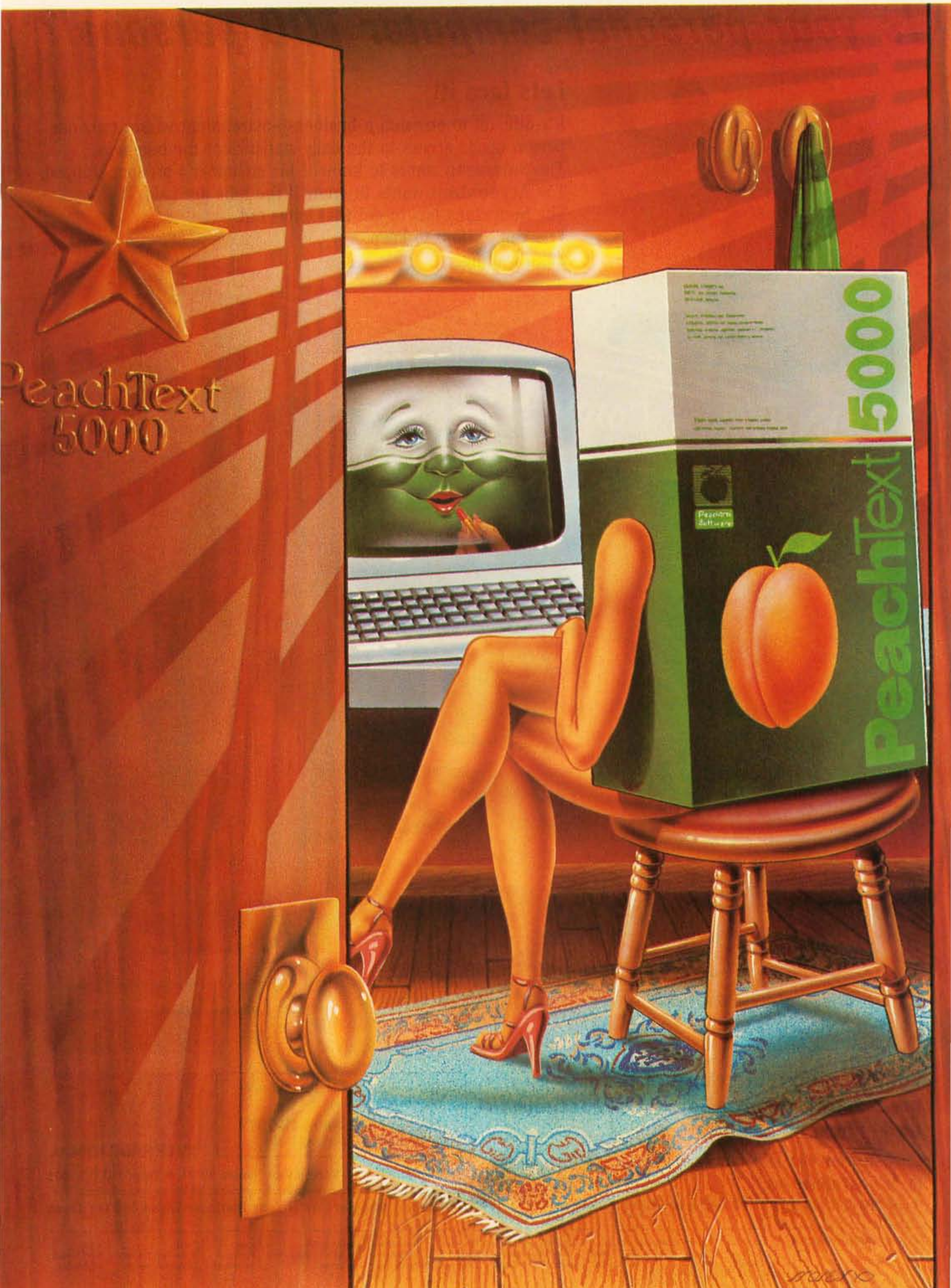
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Does Your Printer Work with Wordstar?

Overcome compatibility problems between Wordstar and your printer

by Charles Stevenson

You might think it's reasonable to assume that getting a popular word-processing program, an equally popular personal computer, and a printer to work together would be a breeze—just plug everything in and go.

Nothing is ever that simple.

Even with such widely used products as IBM's Personal Computer and Micropro International's Wordstar program, compatibility can be a problem. In this article, I will point out some of the troubles you may face when trying to combine these two with a printer, and I will describe ways to get around these problems.

Printer Pointers

First, you must make sure your printer will work with Wordstar. Unfortunately, there is little standardization in the printer industry, which means that not all printers will work with all word-processing programs.

When you have determined that your printer is compatible with Wordstar, your next step is to connect the printer to the computer. This task will be easier if you break it into three parts: get your computer system to work, get it to work right, and get it to work at its best.

To get your system to work, first make sure the printer itself works. Many new printers have a self-test mode. Use this to find out if the printer has survived its trip from the factory to your computer. Be sure that the ribbon and print wheel are properly installed and that other adjustments required prior to first use have been made.

Even slight variations from printer standards can wreak havoc with software.

Next, check that the cable between the printer and computer will work. The IBM Personal Computer usually accepts printers with parallel interfaces. If the printer has a Centronics-type 36-pin male connector, it should mate with the parallel printer cable sold by IBM, but there are exceptions. There is at least one printer on the market with a Centronics connector that requires a special cable because the electrical signals are not on the same pins. A connector with the wrong gender (the Centronics connector on the end of the IBM-supplied parallel printer cable is female) will require a gender-changer cable.

Serially interfaced printers may cause different problems. The asynchronous port on the IBM Personal Computer is defined as a modem port, rather than a printer port. A modem port puts the remote computer in charge while the IBM Personal Computer acts as a terminal, but a printer port assumes that the Personal Computer is running the show. To put your Personal Computer back "in charge," a number of wires must be interchanged through a special cable, not usually supplied by either the printer manufacturer or IBM. To wire your own cable, interchange pins as shown in figure 1.

If the cable still doesn't work during the testing (described in a moment), consult the appropriate manuals to determine what signals are required at each end of the cable. You may need to experiment a bit before you get it right, but your

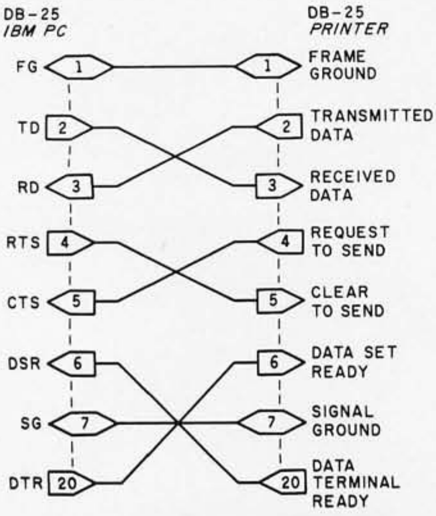


Figure 1: *A cable must be specially wired to connect the IBM Personal Computer to a printer through an RS-232C serial link. Because both the computer and the printer are set up as data-terminal equipment (DTE), connections must be crossed so that each communicates with data circuit-terminating equipment (DCE).*

dealer or the printer manufacturer should be able to help you if you can't figure it out. (See reference 3.)

When the cable is wired and installed, check to make sure the printer will work with it. You also must make sure that all options that can be selected with switches on the printer are set according to the documentation. Make note of the settings as you may need this information later.

Trying It Out

The first test you should try with your computer and printer is to print a directory. Obviously, if what shows up on the paper doesn't match what shows up on the screen, something is wrong, and you should not proceed until you can print a directory listing. If your printer is connected through the parallel port, typing a Control-P or Control-PrtSc will establish a logical link to the printer so that anything going to the screen will also be printed. A serially connected printer must be activated by two MODE commands from PC-DOS. The first is

MODE COM1:12,8,N,1,P

This means that the printer is set up to run at 1200 bps (bits per second), with 8 data bits, no parity, 1 stop bit, and the printer option. The second:

MODE LPT1:=COM1

switches the output from the parallel port to the serial port. See the PC-DOS manual for further details.

If the printed directory is unrecognizable or if nothing prints, then the data rate is probably incorrect. If you get gaps, misalignment of columns, or other printing that is almost right, there is probably a problem with handshaking on the serial port, causing characters to be lost because of buffer overflow. If this has happened, check your cabling. If the cabling seems all right, contact the printer manufacturer or your dealer for help.

Note: printers that are connected through the parallel port can also fail to handshake properly if they are not set to respond to the $\overline{\text{STROBE}}$ line correctly. (This is a control line that signals when data is valid.) The IBM Personal Computer expects the printer to accept data when $\overline{\text{STROBE}}$ is low. In some cases, the printer's strobe input may accept data when high. There may be a switch somewhere inside the printer to invert this signal. If you suspect this to be the problem, change the switch position and try again.

At this point, your system is working and may be working correctly. Next test: find (or create) a text file that will fill at least two pages. After turning the printer on with Control-P (or Control-PrtSc), use the TYPE command from PC-DOS to print the text file. Examine the printout carefully. If you find no errors, such as missing characters or lines, you can be sure the connection is correct.

Run one more test to make sure your system is working right. Using the Install program that comes with Wordstar, select the nonspecific (fixed-escapement) serial printer option for your first attempt at Wordstar (this will appear as the "Teletype-like printer" or "standard printer" option; specify the backspacing capability that is appropriate for your printer.) Run Wordstar and print the test file on the Wordstar distribution disk (EXAMPLE.TXT or PRINT.TST, depending on the version of Wordstar you have). If this output looks acceptable (don't worry about vertical positioning of subscripts and superscripts or about the lines in the test output that mention character width and line height), run Install once again. This time, select the option appropriate for your printer by name. Then, reenter Wordstar and print the same text file. If your printer can handle all the Wordstar output commands, you will see a remarkable transformation in the printout. Subscripts and superscripts will be in the right places (a little below or above the printing line rather than a whole line space apart). Boldface type will look bold. The lines in the test files that show the effects of changing character width and line height will do so.

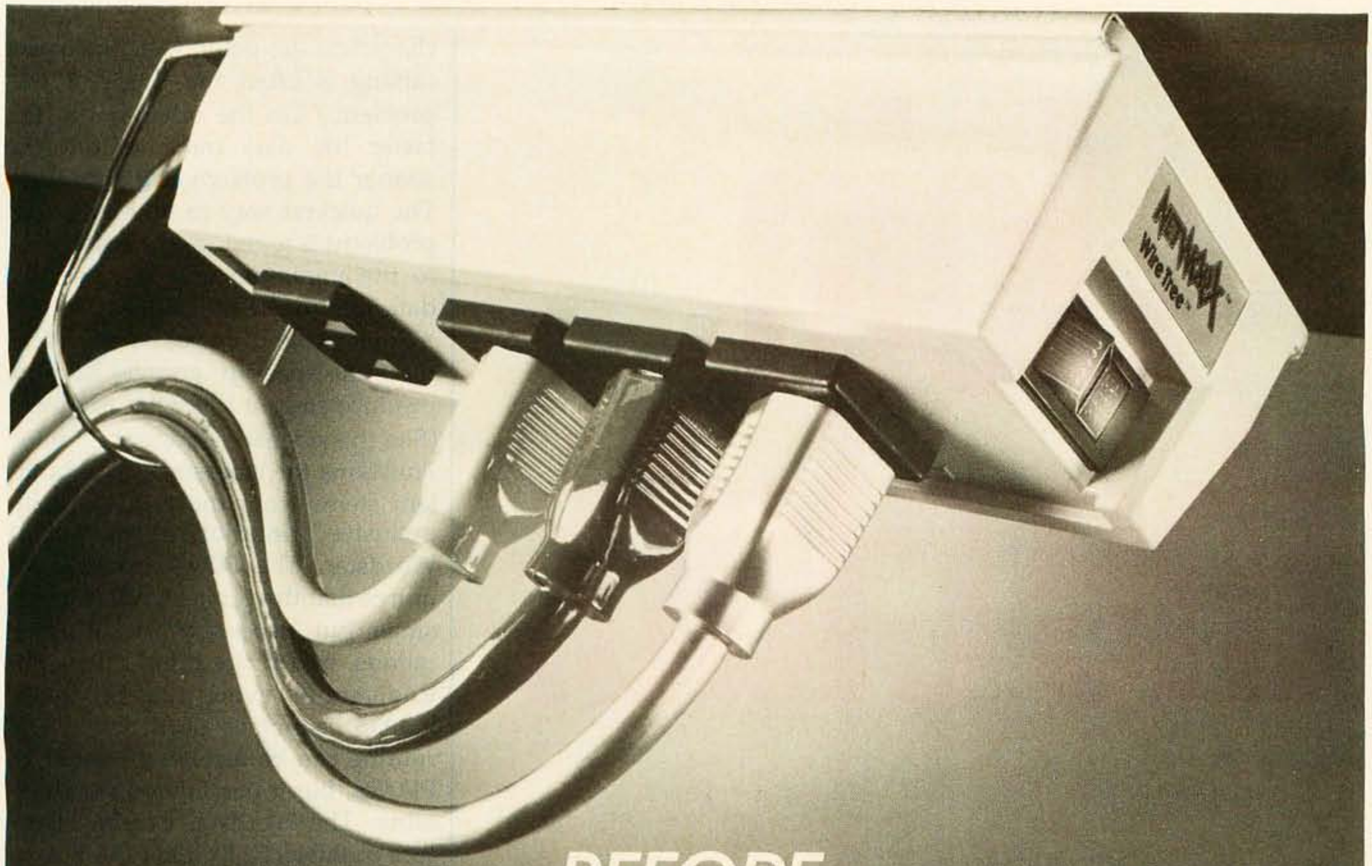
If this happens, and if nothing was misprinted or lost, your system is working at its best. If the printout doesn't look right, you may still have a handshaking problem that can only be resolved by the printer manufacturer or computer dealer.

Teletype versus Microspaced Printing

You may wonder why Wordstar prints the file correctly when the printer operates as a Teletype-like device but loses characters when the printer is formatting output for a microspaced specialty printer like a Diablo, Qume, or NEC Spinwriter.

This happens because specialty printers are sent a large number of extra characters to tell it to set the width of individual characters to justify the text. The extra characters cause the buffer in the printer to fill much more quickly with formatted output (occasionally causing the loss of some characters) than it does when the printer output is in the nonspecific (Teletype) mode.

The problem of lost characters may not be discovered when there are only a few pages of text because there may not be enough text to fill the buffer. The larger the buffer, the longer it takes to find out that some



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characters are being lost. (Incorrect cabling is often the cause of this problem.) On the other hand, the faster the data transmission, the sooner the problem will show up. The quickest way to find buffering problems is to reduce the buffer size to the minimum and increase the data rate to the maximum.

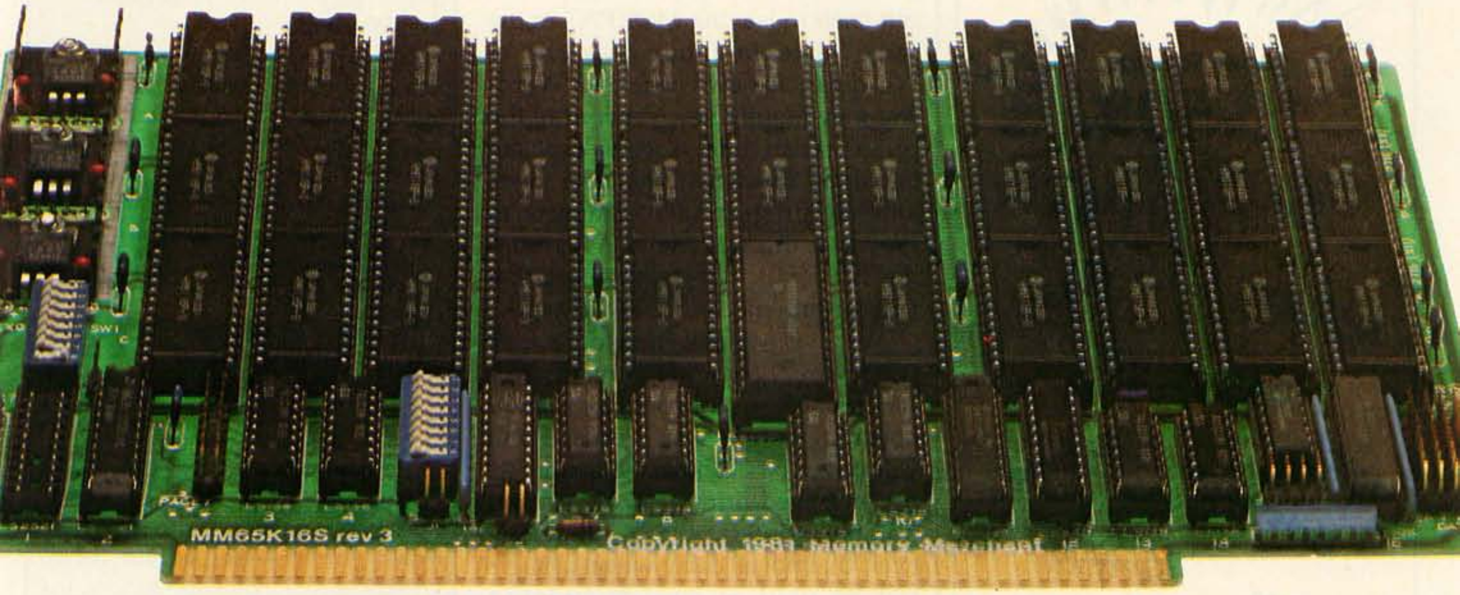
Some printers do not have the features the specialty printers have to produce elegant Wordstar printing. (See the sidebar "Necessary Printer Functions for Wordstar.") The problem stems from the two mutually exclusive printer-driver routines in Wordstar. The PDAIS routine requires that the printer understand a small but necessary set of commands, and if the printer does not understand even one of them, PDAIS cannot be used. The PTTY routine can be activated instead of PDAIS, but it has limited expandability. The Wordstar overlay structure prohibits PTTY and PDAIS from being stored in memory at the same time.

Patching Wordstar

Dot-matrix printing technology has produced a great variety of relatively low-cost printers suitable for IBM's Personal Computer. Each of these printers has a number of enhanced printing modes that people would like to use, but there has been little consistency in the implementation of these features. Also, very few of these printers can do all the things required by PDAIS.

Some users have sent program patches (modifications) to Micropro that open up many of these printing modes for Wordstar use, and some patching packages are being marketed by firms other than Micropro. These patching techniques take one of the user-print functions, such as Control-PQ, and extend it to a three-letter control sequence. Doing this requires that every character be intercepted as it is being sent to the printer driver to see if it is, in this case, Control-P. If so, the patch must divert the next character to a new piece of code that checks it for extended capability. These operations make use of a memory area called

64K STATIC RAM MEMORY



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MORPAT, and code placed in that area is not supported by Micropro. Furthermore, Micropro cannot commit itself to leaving MORPAT in the same place in future versions of Wordstar, so new versions of Wordstar may require new versions of the printer patch code. A worse problem could be created if the user buys another program that connects to Wordstar through MORPAT, resulting in a conflict that might mean that neither enhancement would work.

Wordstar was designed for specialty printers. Low-cost matrix printers can provide an inexpensive way of obtaining output from Wordstar, but will never be of the same quality as the engraved-print daisy-wheel and thimble printers. (Be aware, however, that not all daisy-wheel printers can be used as specialty printers under Wordstar. If in doubt, ask your dealer.)

Future Compatibility

Many printer manufacturers are now conferring with software manufacturers before their printers hit the market. Software designers can often detect and report hardware problems, incompatibilities, and design errors in printers in time to get them fixed before distribution. Printer manufacturers who disregard these offers of cooperative assistance run the risk of producing products that never perform satisfactorily in their intended roles.

Cooperative assistance between printer and software manufacturers should help alleviate future compatibility problems among programs, printers, and computers.■

References

1. Ciarcia, Steve. "Build an RS-232C Breakout Box." BYTE, April 1983, page 28.
2. Leibson, Steve. "The Input/Output Primer, Part 4: The BCD and Serial Interfaces." BYTE, May 1982, page 202.
3. Witten, Ian H. "Welcome to the Standards Jungle." BYTE, February 1983, page 146.

Charles Stevenson is chief programmer at Micropro International Corporation (33 San Pablo Ave., San Rafael, CA 94903).

Necessary Printer Functions for Wordstar

In order to use all the features of Wordstar, your printer must accept all the commands Wordstar uses to position the platen. If any one of them is missing, your printer will operate correctly in Teletype mode only, a nonspecific mode that does not include advanced features, such as proportional spacing and subscripts. The user's manual for your printer should tell if the following commands are available:

Set Horizontal Motion Index (HMI)
Set Vertical Motion Index (VMI)

These commands set the character width and line height without causing direct motion. HMI is given in 120ths of an inch, VMI is given in 48ths of an inch. An increment of 1/60 inch is also allowed, but results are not as satisfactory. The printer must also have minimum and maximum values for these commands. The command must take effect immediately with no restrictions on setting or resetting within a line. For example:

Print left to right (LTR)
Print right to left (RTL)

There should be explicit commands for each direction. Bidirectional printers without these options may work, but you should check with Micropro. Explicit commands include:

Space
Backspace
Carriage Return

These must operate in conjunction with printing direction and the setting of HMI. If RTL printing is in effect, a carriage return should set the printing mode to LTR. Some printing directions are:

Linefeed
Reverse linefeed
Reset printer

If a software Reset is not available, a command that returns the printer to the power-on state must be supplied. Such a command string must not exceed 16 bytes.

Your printer may recognize other commands, such as for shifting between ribbon colors or changing fonts, but these must not conflict with the required commands.

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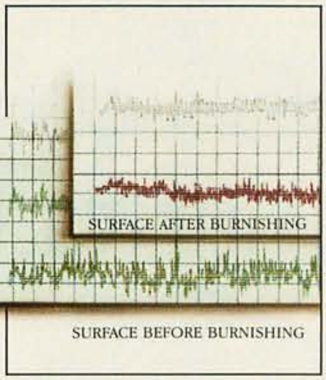

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In-Circuit Emulation for the Apple II Computer

You can convert your Apple into a host for testing a target system's hardware and software

by John D. Ferguson

Without doubt, the easiest method of debugging any microprocessor-based computer system is to access that system through its processor socket. Using in-circuit-emulation (ICE) techniques, the most powerful diagnostic aids currently available, the processor of the unit under test (the target) is removed, and a second microcomputer system (the host) is linked to the target through the target's processor socket.

Emulators are usually associated with expensive microprocessor development systems or equally expensive troubleshooting tools such as the Fluke 9010A (manufactured by the John Fluke Company of Everett, Washington). However, with one simple circuit you can turn your Apple II into a host computer for emulation purposes. This allows it to test hardware and evaluate software in a target system based on a 6502 microprocessor (or one compatible with the 6502).

The Apple II in-circuit emulator is carried on one Apple card. A 40-conductor ribbon cable, terminated in a dual-inline plug, connects the ICE to the target microcomputer (see figure 1). The ICE card gives the Apple limited emulation capability, allowing it to relocate any 2K-byte block of address space in the target system into the normally free memory area at locations C800 through CFFF hexadecimal in the Apple (see figure 2). The memory region observed in the target system is software selected by writing to an address-select latch. Because this selection is under program control, you can write routines in the host system to test the target system's entire memory map.

With one simple circuit you can turn the Apple II into a host computer for emulation purposes.

Test software can be written in either a high-level language, such as BASIC, or in machine code, and it can be directed at the main functional blocks within the target system: system buses, RAM (random-access read/write memory), ROM (read-only memory), and I/O (input/output) devices.

Routines written in BASIC tend to be inconveniently slow for even the simplest tests. The more effective approach is to write standard test modules in machine code and use a BASIC program to form an overall test strategy that sequences the tests and guides the user with recommendations if a fault is detected.

In this article I'll describe test modules for exercising the system buses and testing RAM and ROM. I'll conclude with a case study that illustrates how the Apple ICE can be used to test Rockwell International's AIM-65 single-board computer.

ICE Hardware

Figure 3 on page 422 shows a circuit diagram of the ICE card. Address lines A0 to A10 together with control lines R/$\overline{W}$, ϕ_0, and $\overline{RES}$ pass directly from the Apple to the target system via octal driver chips IC4 and IC5. However, address lines A11 to A15 in the target system are not obtained from their Apple equivalents but are instead generated by the block-select latch IC3. For selection of the five most significant lines in the target system, a control word is first written to this latch, which is clocked by the Apple I/O SELECT line. Hence, if the ICE was in slot 5, the following short program would set A11 to A15 in the target system to zero:

```
LDA #$00  \ sets A11 to A15 to zero
STA C500  \ activates the I/O SELECT
            line in slot 5.
```

After the block-select latch is con-

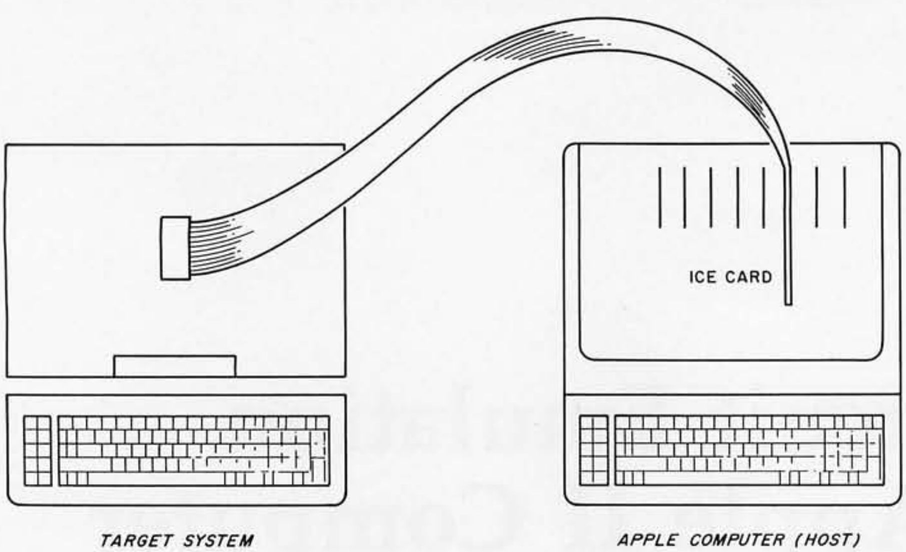


Figure 1: *The processor is removed from the target system, which is then connected to the host via a 40-conductor ribbon cable.*

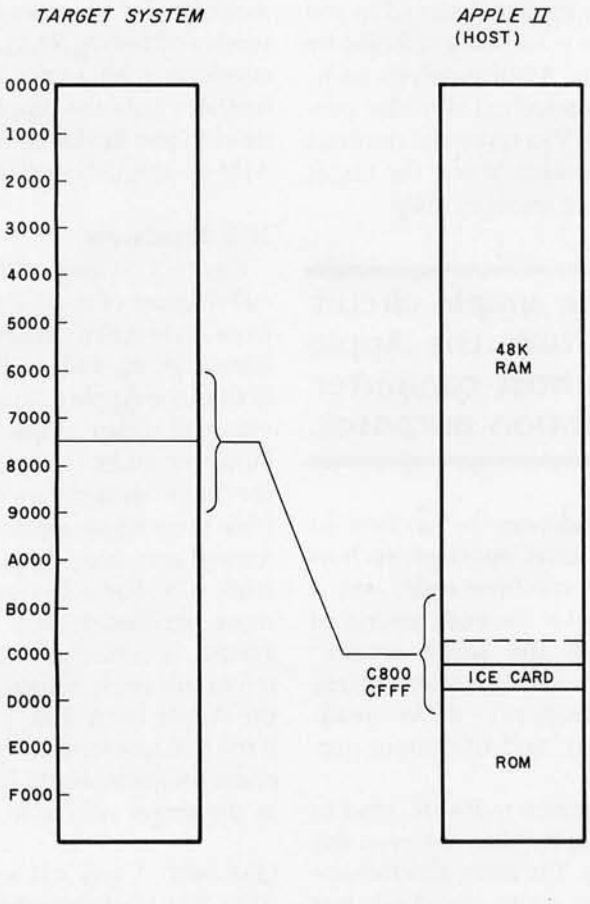


Figure 2: *Any 2K-byte block of memory space in the target system can be mapped into the normally empty memory slot from location C800 to CFFF hexadecimal in the Apple.*

figured, any read or write operations to memory locations between C800 and CFFF hexadecimal in the Apple activate the address decoder chip IC1 and enable the output of latch IC3, establishing corresponding addresses between 0000 and 07FF hexadecimal in the target system.

The address decoder (IC1) also enables the octal transceiver (IC2), allowing data to be either written to or received from the target system. The decoder IC1 might seem unnecessary because $\overline{\text{I/O STROBE}}$ is active low for addresses between C800 and CFFF hexadecimal. However, close examination of $\overline{\text{I/O STROBE}}$'s timing shows that its low state appears too late in the timing cycle to enable slow memory or I/O devices in the target system (see figure 4 on page 427).

Test Software

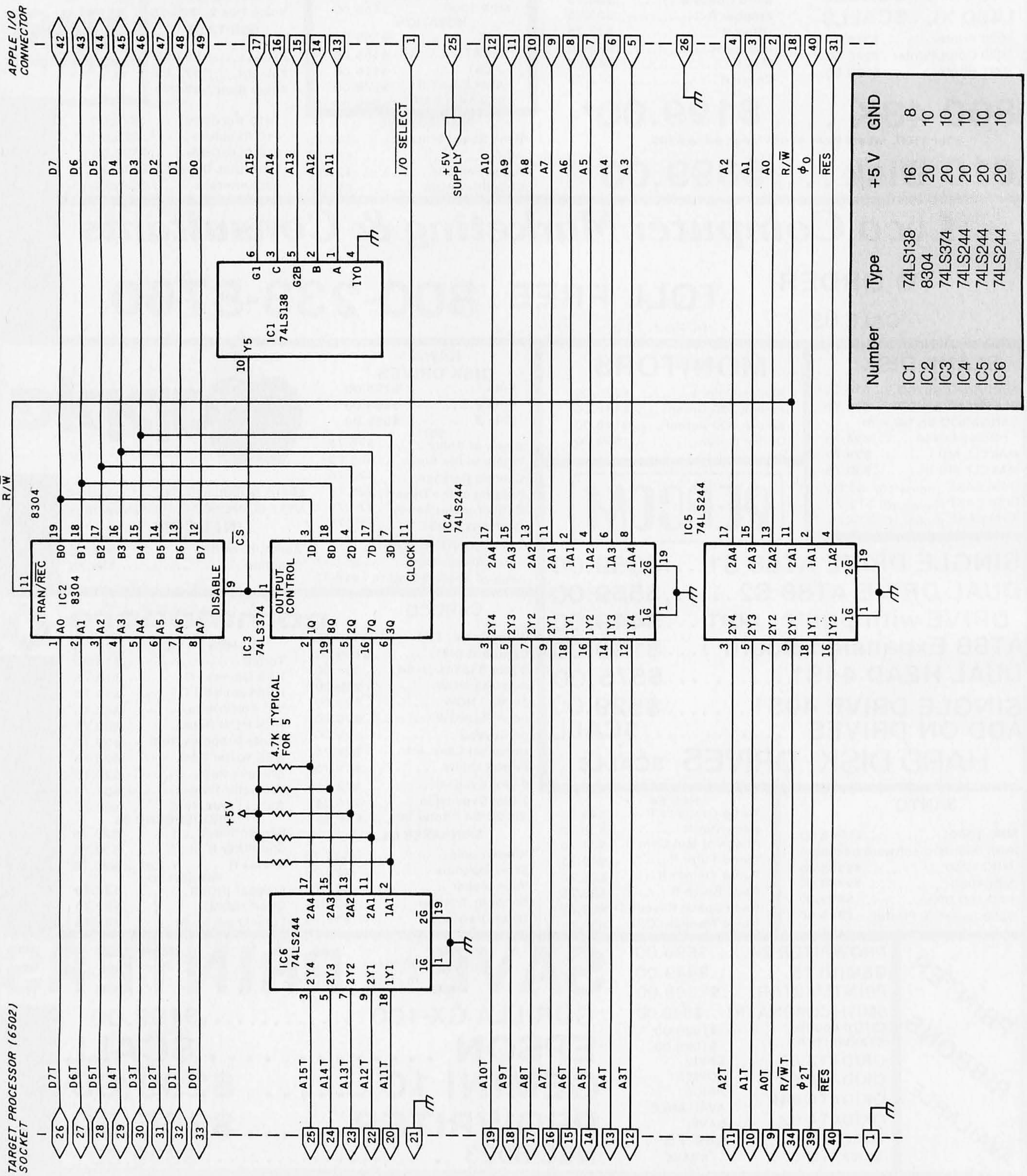
The software required for testing falls into two categories: (1) routines that exercise and test the various functional areas of the target microcomputer—its system buses, RAM, ROM, and I/O devices—and (2) the overall test program, which guides you through the test sequence, calling the functional tests and performing the tasks normally performed by a fault-finding tree (i.e., pinpointing the source of the fault and suggesting a remedy—for instance, "replace IC28"—or initiating a new test to gather more information).

The following section describes the functional tests, providing three routines written in 6502 assembly language. Each program operates on the memory window at locations C800 to CFFF hexadecimal between the Apple and the target system.

Address and Data-Bus Toggle Test

Before launching into complex tests of the system's ICs, test the integrity of the system buses. With a toggle test you can exercise the address and data-bus lines by alternately driving them high and low. Listing 1 on page 427 shows such a test program, which starts by selecting addresses in the binary pattern 10101 . . . in the target system. A dummy read is then made to address AAAA hexadeci-

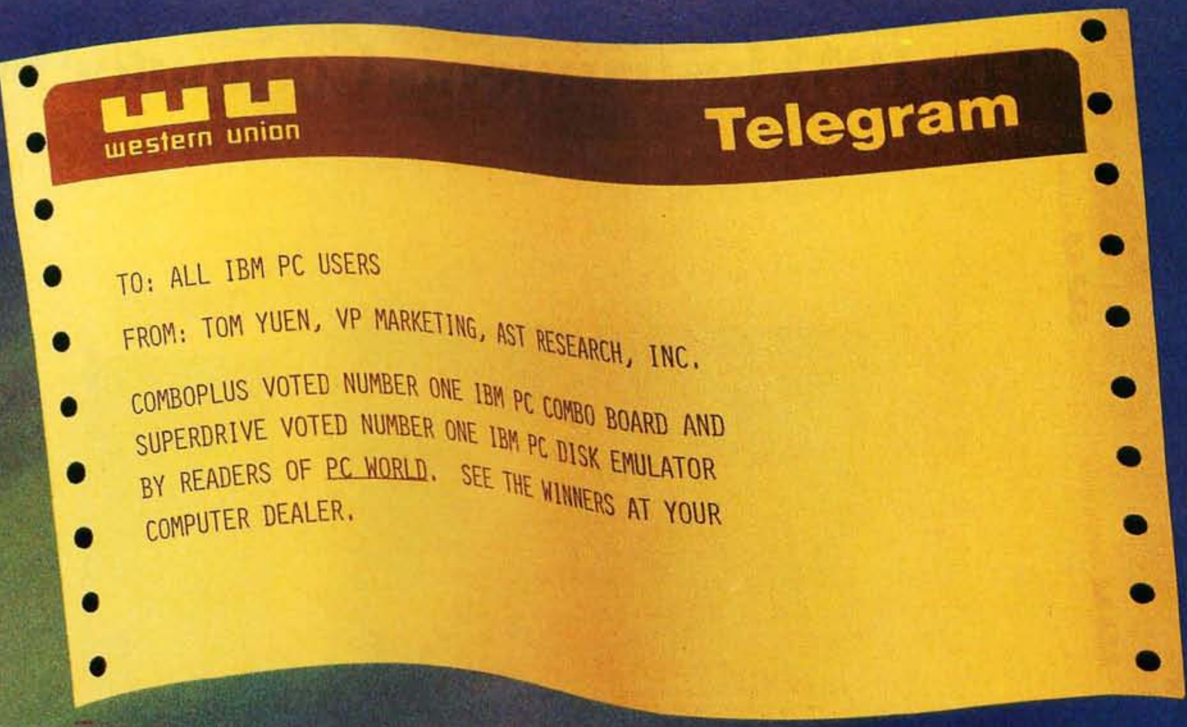
Text continued on page 427



Number	Type	+5 V	GND
IC1	74LS138	16	8
IC2	8304	20	10
IC3	74LS374	20	10
IC4	74LS244	20	10
IC5	74LS244	20	10
IC6	74LS244	20	10

Figure 3: *A circuit diagram of the Apple ICE card.*

Circle 5 on inquiry card. →



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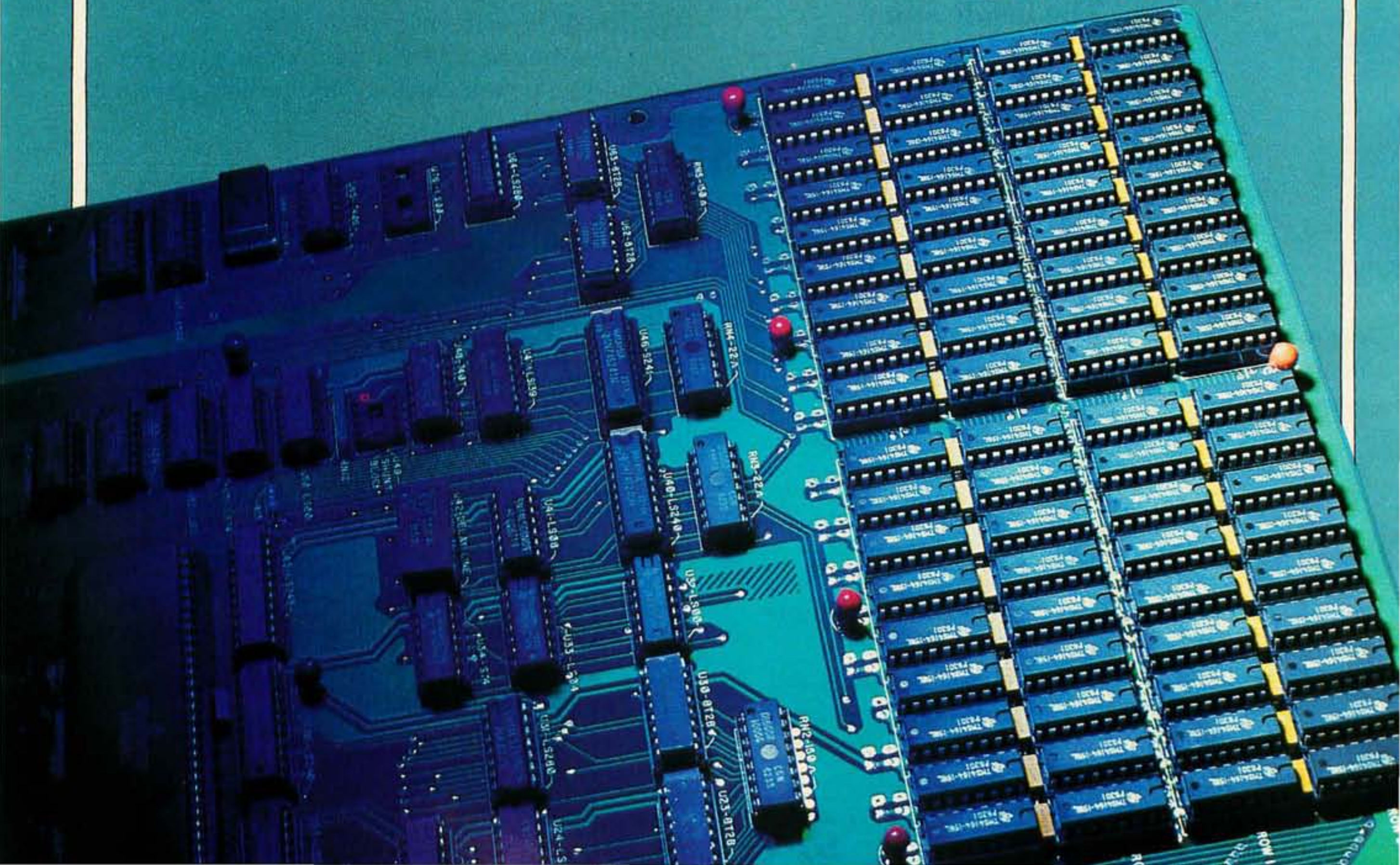

Text continued from page 420

mal, placing the high, low, high, low pattern on the target-system bus. The select latch is again accessed and addresses in the binary pattern 01010 . . . are selected, followed by a dummy read to location 5555 hexadecimal, thus complementing the previous address-bus pattern. This procedure is repeated 256 times before a similar test pattern is started on the target system's data bus.

Exercising the system buses with this pattern allows the operator to determine, using an oscilloscope or logic probe, whether each line in the target system is drivable (i.e., no lines are stuck high or low) and whether each line is continuous from its source (the processor socket) to its destination on each chip.

A more complex test could also check for shorts between lines by injecting a characteristic frequency or pattern onto each line. You could then use a frequency meter or oscilloscope to check for corruption between lines.

Toggling the system buses 256 times does not allow enough time for checking even one circuit node. The short routine below illustrates how the bus test (BTEST) is used in the test sequencing program:

```
180 PRINT "BUS TESTING—
    PROBE TARGET SYSTEM
    BUSES"
190 PRINT "(PRESS SPACE FOR
    NEXT TEST)"
200 CALL BTEST
210 IF PEEK (-16384)<=127
    THEN 200
```

By placing the test within a loop that also checks the keyboard, the test repeats until you press the space bar, signaling that further testing isn't needed.

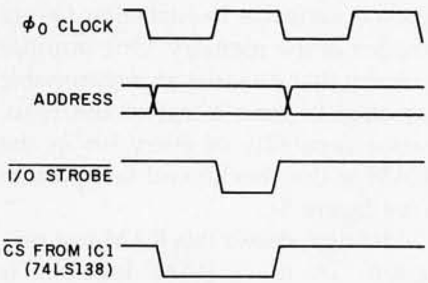

Figure 4: *Relative timing of the Apple slot signal $\overline{I/O\ STROBE}$ and the $\overline{CS}$ signal from IC1. Note that the $\overline{I/O\ STROBE}$ signal occurs too late for use in selecting the target address bus.*

Listing 1: *Toggling all address and data-bus lines.*

```
SOURCE FILE: APPTOG
0000:         ;***********************************************************
0000:         ;ADDRESS AND DATA BUS TEST
0000:         ; TOGGLE ADDRESS BUS AAAA-5555
0000:         ; 256 TIMES
0000:         ; TOGGLE DATA BUS AA-55
0000:         ; 256 TIMES
0000:         ;***********************************************************
0000:         ;
C500:         SELECT    EQU   $C500     ;2K SELECT LATCH
——— NEXT OBJECT FILE NAME IS APPTOG.OBJ0
2100:                   ORG   $2100
2100:A2 00              LDX   #00       ;SET COUNTER TO ZERO
2102:         ;EXERCISE ADDRESS BUS
2102:A9 AA    ABUS      LDA   #$AA      ;SELECT ADDRESSES 10101XXX
2104:8D 00 C5           STA   SELECT
2107:AD AA CA           LDA   $CAAA     ;IE AAAA ON TARGET BUS
210A:A9 55              LDA   #$55      ;SELECT ADDRESSES 01010XXX
210C:8D 00 C5           STA   SELECT
210F:AD 55 CD           LDA   $CD55     ;IE 5555 ON TARGET BUS
2112:CA                 DEX
2113:D0 ED              BNE   ABUS      ;REPEAT 256 TIMES
2115:         ;EXERCISE DATA BUS
2115:A9 00    DBUS      LDA   #$00      ;SELECT ADDRESSES 00000XXX
2117:8D 00 C5           STA   SELECT
211A:A9 55              LDA   #$55      ;01010101 ON DATA BUS
211C:8D 00 C9           STA   $C900     ;0100 IN TARGET SYSTEM
211F:A9 AA              LDA   #$AA      ;10101010 ON DATA BUS
2121:8D 00 C9           STA   $C900     ;0100 IN TARGET SYSTEM
2124:CA                 DEX
2125:D0 EE              BNE   DBUS      ;REPEAT 256 TIMES
2127:60                 RTS             ;TOGGLING COMPLETE

*** SUCCESSFUL ASSEMBLY: NO ERRORS

2102 ABUS           2115 DBUS           C500 SELECT           2102 ABUS
2115 DBUS           C500 SELECT
```

RAM Checkerboard Test

The basic strategy for testing RAM requires writing a test pattern into memory, reading it back, and checking that both the write and read operations were successful. Many different test patterns can be used; each is *sensitive* to particular failure modes of the memory. One popular pattern that provides in a reasonable amount of time a test of the read/write capability of every bit in the RAM is the checkboard test pattern (see figure 5).

Listing 2 shows this RAM test program. In it, a RAM location is selected and 55 hexadecimal (01010101 binary) is stored in the location and then read back and compared. If the comparison fails, the test terminates with the Apple displaying a RAM failure message. If the comparison passes, the location is then tested with the complementary pattern AA hexadecimal (10101010 binary). The test then moves on to the next location and continues until all locations within the window (C800 to CFFF hexadecimal) have been exercised and tested.

	00	01	10	11
00	0	1	0	1
01	1	0	1	0
10	x	x	x	x
11	x	x	x	x

Figure 5: *Checkerboard-testing RAM. Alternate bits are set to 1 and 0 and checked. The pattern is then reversed and checked before moving off to the next row of cells.*

Before the RAM test in the main test program is called, the memory-select latch should be written to, moving the RAM to be exercised into the ICE test window. For example, the following program would test RAM from 0800 to 0FFF hexadecimal in the target system:

```
250 PRINT "RAM TESTING
    0800—0FFF"
260 POKE SELECT, 08:CALL
    RAMTEST
```

ROM Signatures

The usual method for testing ROMs involves forming a checksum byte based on a sum of all the data within the ROM. However, faults could be concealed by several errors that cancel each other out. A technique that is more sensitive and less likely to mask errors involves performing a cyclic redundancy check (CRC) on the ROM contents. It originated in data communications, but more recently it's been used in signature analysis, a relatively new troubleshooting tool pioneered by Hewlett-Packard. Like most jobs in computing, the cyclic redundancy check can be evaluated by either hardware or software. The hardware model proves the simplest to illustrate.

Figure 6 on page 435 shows a typical CRC evaluation circuit using a 16-bit linear shift register with feedback. Each bit of data is fed serially into the register. When the data stream ends, the final binary pattern remaining in the register forms the 4-digit cyclic redundancy check. The feedback paths effectively form a sum to the base 2 between the data fed back and the new data entering and ensure that every bit entering the register contributes toward the final CRC or signature.

An equivalent software routine is presented in listing 3. In this scheme, each byte from the ROM under test is fed serially (bit 0 to bit 7) to the subroutine FEEDBACK, which performs a sum to the base 2 of bits 15, 11, 8, and 6 within the register and the incoming bit. When 16,384 (2K × 8) bits of data have entered the feedback algorithm, the pattern remaining in locations SIGH and SIGL forms the final signature.

To enable checks to be made on ROMs containing more than 2K

Text continued on page 435

Listing 2: *A program to checkerboard-test RAM.*

```
SOURCE FILE: APPRAM
0000:                ;*****************************************************************
0000:                ;PROGRAM TO CHECKERBOARD TEST RAM
0000:                ; (C800-CFFF)
0000:                ;*****************************************************************
0000:                ;
FDED:                COUT     EQU    $FDED      ;CHARACTER TO SCREEN
FD8E:                CROUT    EQU    $FD8E      ;C-RETURN TO SCREEN
FDE3:                PRHEX    EQU    $FDE3      ;OUTPUT HEX DIGIT
0008:                POINT    EQU    08         ;POINTER
0000:                ;
----- NEXT OBJECT FILE NAME IS APPRAM.OBJ0
2090:                         ORG    $2090
2090:                ;
2090:A9 00                    LDA    #00        ;POINT TO C800
2092:85 08                    STA    POINT
2094:A8                       TAY
2095:A9 C8                    LDA    #$C8
2097:85 09                    STA    POINT+1
2099:A9 55           START    LDA    #$55       ;START TEST WITH 55
209B:91 08                    STA    (POINT),Y  ;STORE
209D:D1 08                    CMP    (POINT),Y  ;READ BACK AND COMPARE
209F:F0 03                    BEQ    OK
20A1:4C BC 20                 JMP    ERROR      ;DISPLAY ERROR MESSAGE AND END
20A4:A9 AA           OK       LDA    #$AA       ;NOW TRY AA
20A6:91 08                    STA    (POINT),Y  ;STORE
20A8:D1 08                    CMP    (POINT),Y  ;READ BACK AND COMPARE
20AA:F0 03                    BEQ    OK1
20AC:4C BC 20                 JMP    ERROR      ;DISPLAY ERROR MESSAGE AND END
20AF:E6 08           OK1      INC    POINT      ;NEXT LOCATION
20B1:D0 E6                    BNE    START
20B3:E6 09                    INC    POINT+1
20B5:A5 09                    LDA    POINT+1
20B7:C9 D0                    CMP    #$D0
20B9:D0 DE                    BNE    START      ;END OF BLOCK?(CFFF)
20BB:60                       RTS               ;TEST COMPLETE
20BC:                ;
20BC:                ;ERROR DISPLAY ROUTINE
20BC:                ;
20BC:A2 00           ERROR    LDX    #00        ;POINTER FOR MESSAGE
20BE:BD D5 20        NEXT1    LDA    MESS,X
20C1:20 ED FD                 JSR    COUT       ;MESSAGE TO SCREEN
20C4:E8                       INX               ;NEXT CHARACTER
20C5:E0 0F                    CPX    #$0F       ;MESSAGE COMPLETE?
20C7:D0 F5                    BNE    NEXT1
20C9:A5 09                    LDA    09         ;FAIL ADDRESS TO SCREEN
20CB:38                       SEC
20CC:E9 C8                    SBC    #$C8
20CE:20 E3 FD                 JSR    PRHEX
20D1:20 8E FD                 JSR    CROUT      ;C-RETURN TO SCREEN
20D4:60                       RTS               ;  AND FINISHED
20D5:                ;ERROR MESSAGE
20D5:A0 C5 D2        MESS     ASC    "          ERROR ON PAGE "
20D8:D2 CF D2
20DB:A0 CF CE
20DE:A0 D0 C1
20E1:C7 C5 A0

*** SUCCESSFUL ASSEMBLY: NO ERRORS
```

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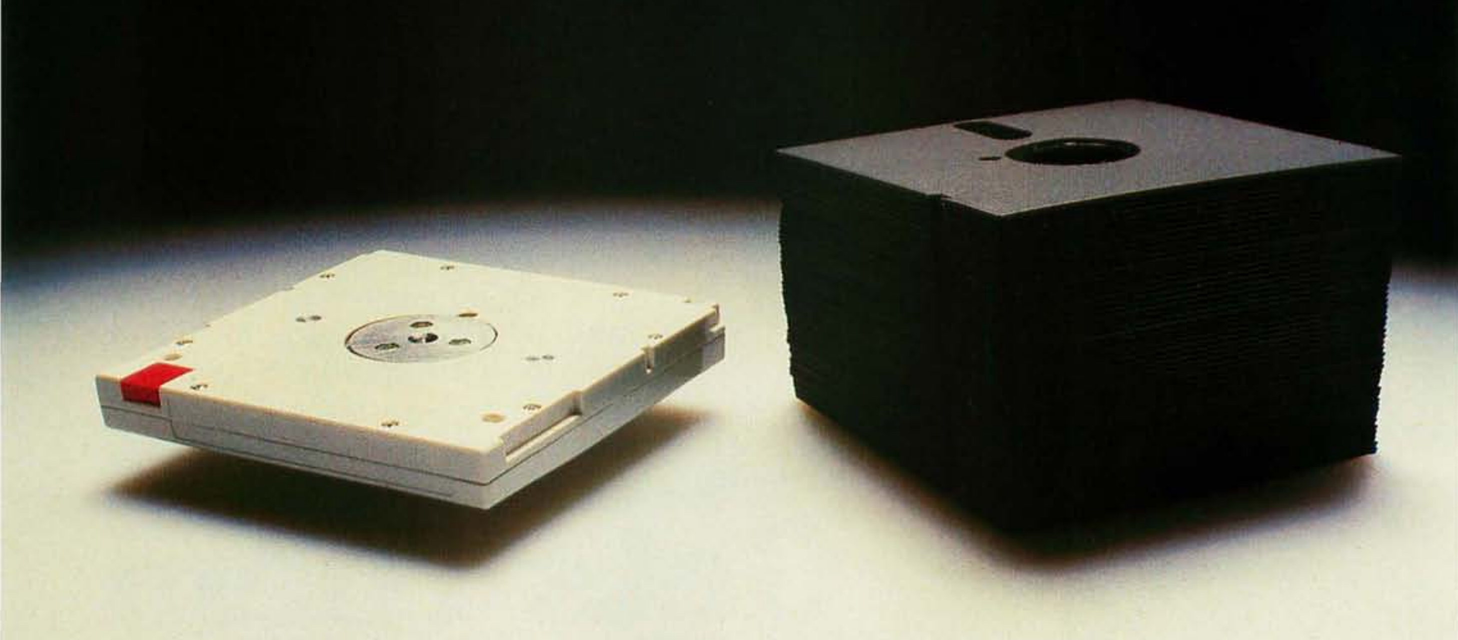

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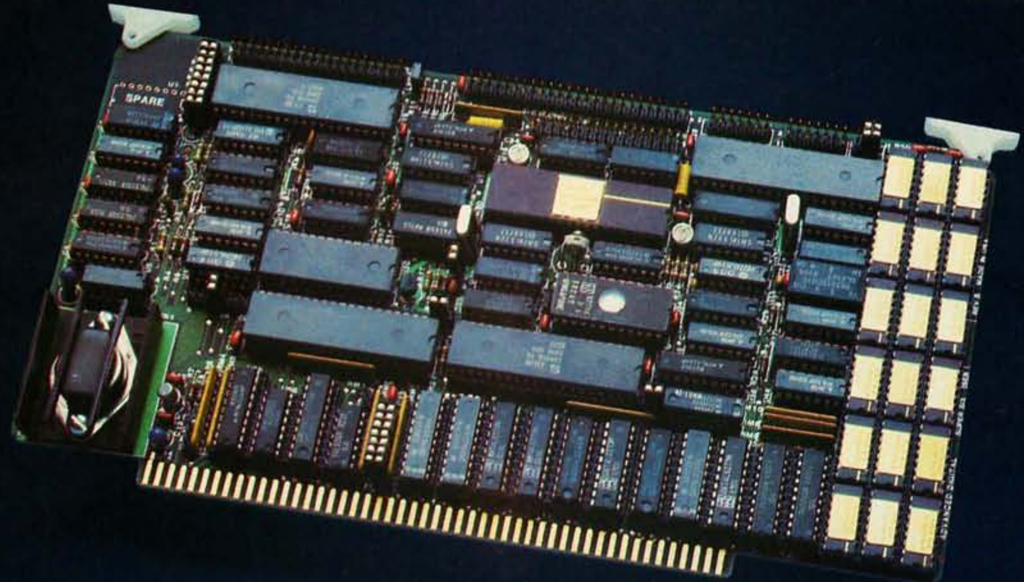

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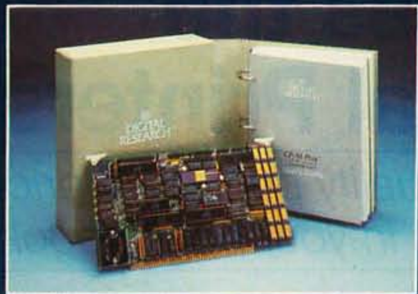

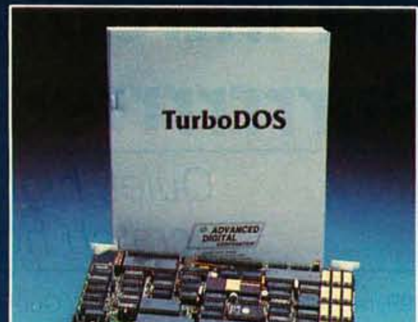

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Text continued from page 428

bytes, three routines are used. The NSIG (new signature) routine resets the shift register pair SIGH, SIGL to zero and forms a signature on 2K bytes of ROM. In CSIG (continue signature), the shift register is *not* reset to zero at the start, thus allowing a continuation of a signature for ROMs greater than 2K bytes. The DISPLAY routine shows the contents of the shift register pair SIGH, SIGL in hexadecimal form.

The following listing shows how all three routines can be used to evaluate the signature of a 4K-byte ROM located at B000 to BFFF hexadecimal in the target system:

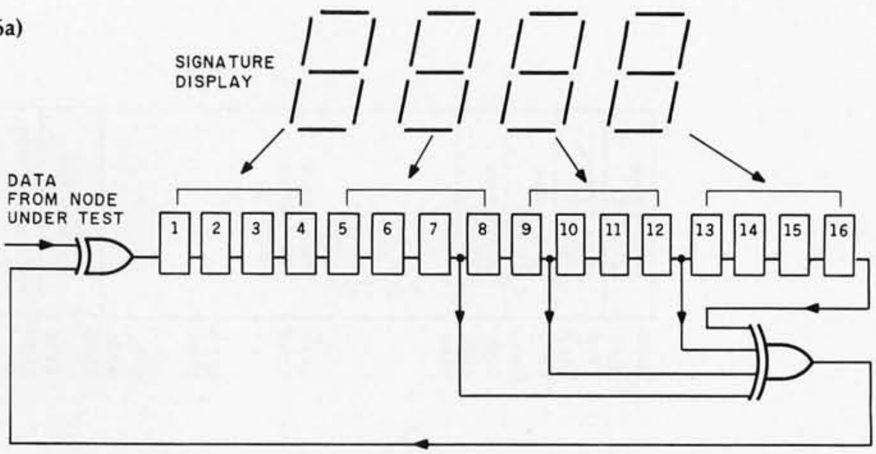
```
320 REM B0 HEX IS 176
      DECIMAL
330 POKE SELECT,176
340 CALL NSIG:REM FIRST 2K
      BYTES
350 REM B8 HEX IS 184
      DECIMAL
360 POKE SELECT,184
370 CALL CSIG:REM CONTINUE
      WITH NEXT 2 BYTES
380 CALL DISPLAY:REM
      DISPLAY FINAL SIGNATURE
```

Implementing a Test Program

The Apple ICE described here can be used with a wide range of 6500 microcomputers designed to run at 1 MHz if all the onboard circuitry is controlled by the processor's ϕ_2 clock. The AIM-65, for example, provides an ideal target system, containing as much as 4K bytes of RAM, 20K bytes of ROM, and a wide range of I/O devices—two 6522 VIAs (versatile interface adapters), a 6520 PIA (peripheral interface adapter), and a 6532 RIOT (RAM input/output timer). Figure 7 provides an overview and a memory map of the AIM-65, and a test sequence is shown in listing 4 on page 443. The program begins by testing the system buses, followed by a RAM test on the 4K bytes of RAM and a ROM test that forms signatures for each of the five system ROMs. The test sequence concludes with a check on the user 6522 VIA. For this test, the ports are linked together

Text continued on page 444

(6a)



(6b)

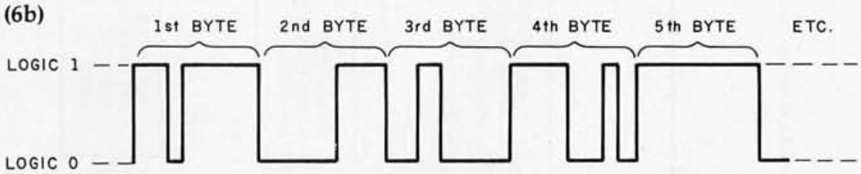


Figure 6: *A feedback shift register can be used to form a cyclic redundancy check of ROM (6a). Data from ROM is fed in bit-serial (bit 0 to bit 7) byte-serial form into the shift register (6b).*

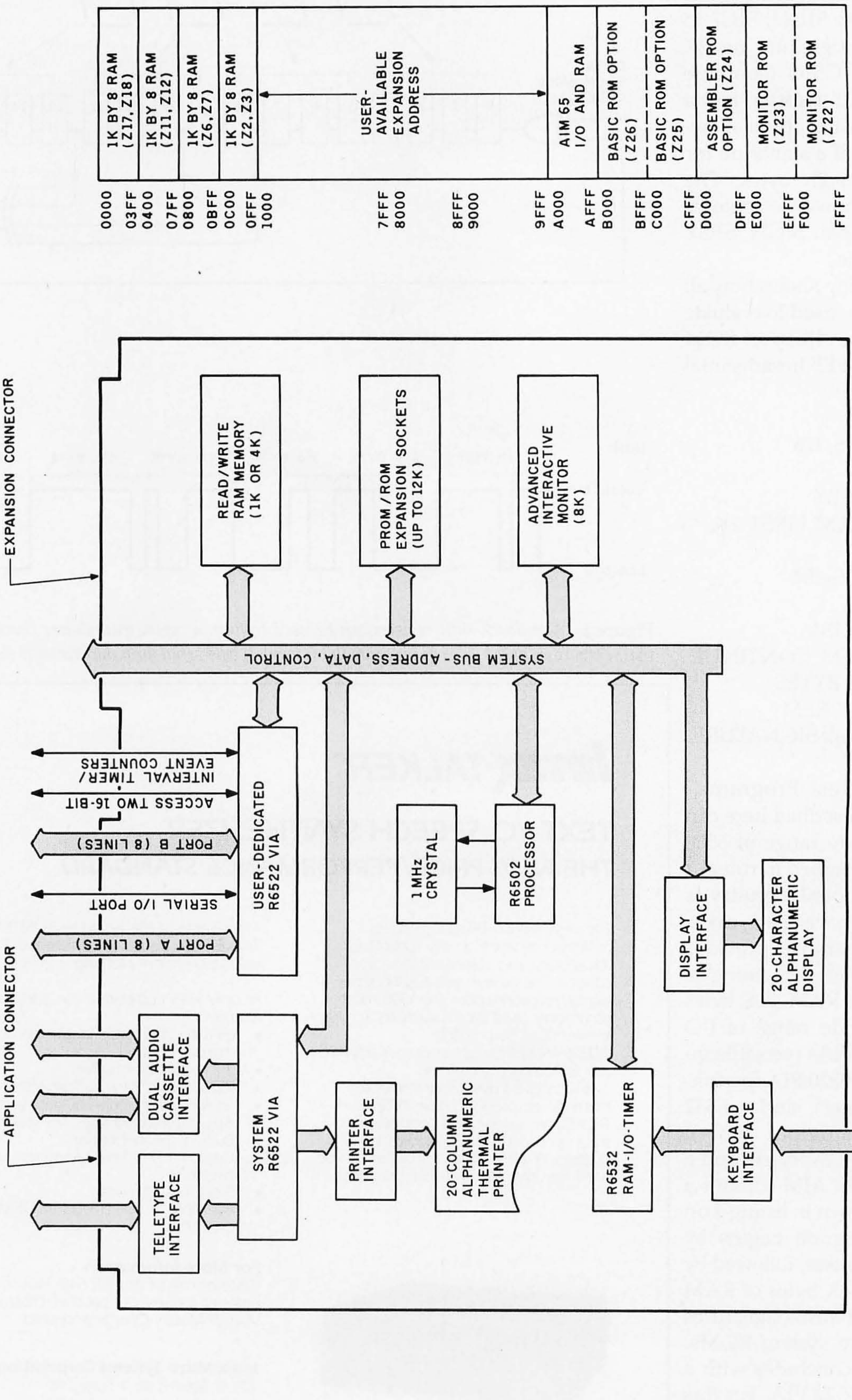


Figure 7: *The layout and memory map of the AIM-65.*

Listing 3: *A program to evaluate ROM signatures.*

```
SOURCE FILE: APPSIG
0000:                ;**********************************************************************
0000:                ; PROGRAM TO EVALUATE SIGNATURE
0000:                ;OF 2KBYTE BLOCK (C800-CFFF)
0000:                ;EACH BYTE IS SERIALIZED BIT0-BIT7
0000:                ;**********************************************************************
0000:                ;
0000:                ;
0000:                ;
——————— NEXT OBJECT FILE NAME IS APPSIG.OBJ0
2000:                              ORG    $2000
1900:                COUNT         EQU    $1900        ;STORE FOR SUM
1901:                SIGL          EQU    $1901        ;CURRENT SIGNATURE LOW BYTE
1902:                SIGH          EQU    $1902        ;CURRENT SIGNATURE HIGH BYTE
0008:                POINT         EQU    $0008        ;BYTE COUNTER
1903:                TEMP          EQU    SIGH+1       ;TEMPORARY STORE
FDDA:                PRBYTE        EQU    $FDDA        ;PRINT A HEX BYTE
FD8E:                CROUT         EQU    $FD8E        ;GENERATE C-RETURN
2000:                ;
2000:A9 00           START         LDA    #00          ;ZERO SHIFT REGISTER
2002:8D 01 19                      STA    SIGL
2005:8D 02 19                      STA    SIGH
2008:A9 00           WSTART        LDA    #00          ;WARM START
200A:85 08                         STA    POINT
200C:A8                            TAY
200D:A9 C8                         LDA    #$C8         ;START OF BLOCK C800
200F:85 09                         STA    POINT+1
2011:B1 08           NBYTE         LDA    (POINT),Y    ;GET BYTE
2013:8D 03 19                      STA    TEMP
2016:A2 08                         LDX    #08          ;FOR 8 BITS
2018:AD 03 19        NBIT          LDA    TEMP
201B:29 01                         AND    #01          ;BIT0 INTO COUNT
2010:8D 00 19                      STA    COUNT
2020:20 36 20                      JSR    FEEDBACK     ;APPLY FEEDBACK
2023:6E 03 19                      ROR    TEMP         ;READY FOR NEXT BIT
2026:CA                            DEX
2027:D0 EF                         BNE    NBIT         ;BACK FOR NEXT BIT
2029:E6 08                         INC    POINT        ;NEXT BYTE
202B:D0 E4                         BNE    NBYTE
2020:E6 09                         INC    POINT+1
202F:A5 09                         LDA    POINT+1
2031:C9 D0                         CMP    #$D0
2033:D0 DC                         BNE    NBYTE        ;END OF BLOCK? CFFF
2035:60                            RTS
2036:                ;
2036:                ;
2036:                ;FEEDBACK ALGORITHM—SUMS BITS
2036:                ;15,11,8 AND 6 WITH INCOMING BIT
2036:                ;ON ENTRY 'COUNT' CONTAINS INPUT BIT
2036:                ;
2036:AD 02 19        FEEDBACK      LDA    SIGH         ;TOP HALF OF SIG
2039:10 03                         BPL    NEX1         ;TEST BIT15
203B:EE 00 19                      INC    COUNT
203E:6A              NEX1          ROR    A
203F:90 03                         BCC    NEX2         ;TEST BIT 8
2041:EE 00 19                      INC    COUNT
2044:6A              NEX2          ROR    A
2045:6A                            ROR    A
2046:6A                            ROR    A
2047:90 03                         BCC    NEX3         ;TEST BIT 11
2049:EE 00 19                      INC    COUNT
204C:AD 01 19        NEX3          LDA    SIGL         ;BOTTOM HALF OF SIG
204F:2A                            ROL    A
2050:2A                            ROL    A
2051:90 03                         BCC    NEX4         ;TEST BIT 6
2053:EE 00 19                      INC    COUNT
2056:6E 00 19        NEX4          ROR    COUNT        ;SUM INTO CARRY
2059:2E 01 19                      ROL    SIGL         ;CARRY INTO BIT0 LBYTE
```

Listing 3 continued on page 443

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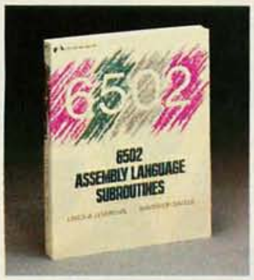

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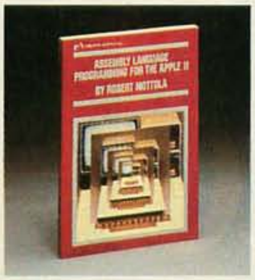

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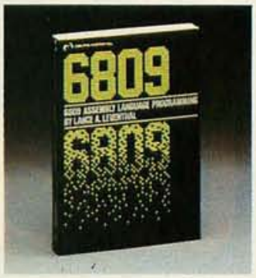

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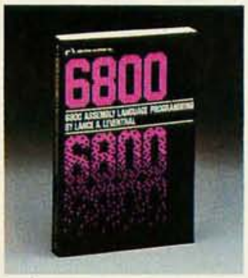

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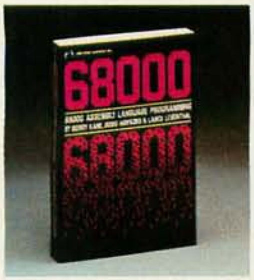

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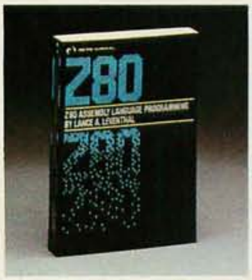

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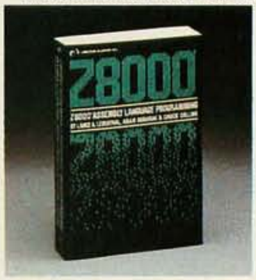

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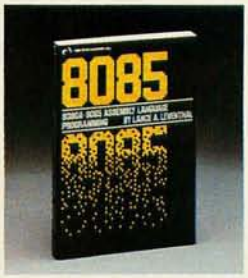

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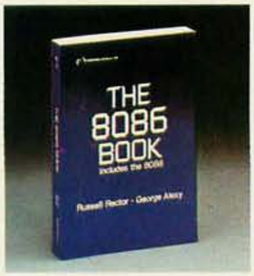

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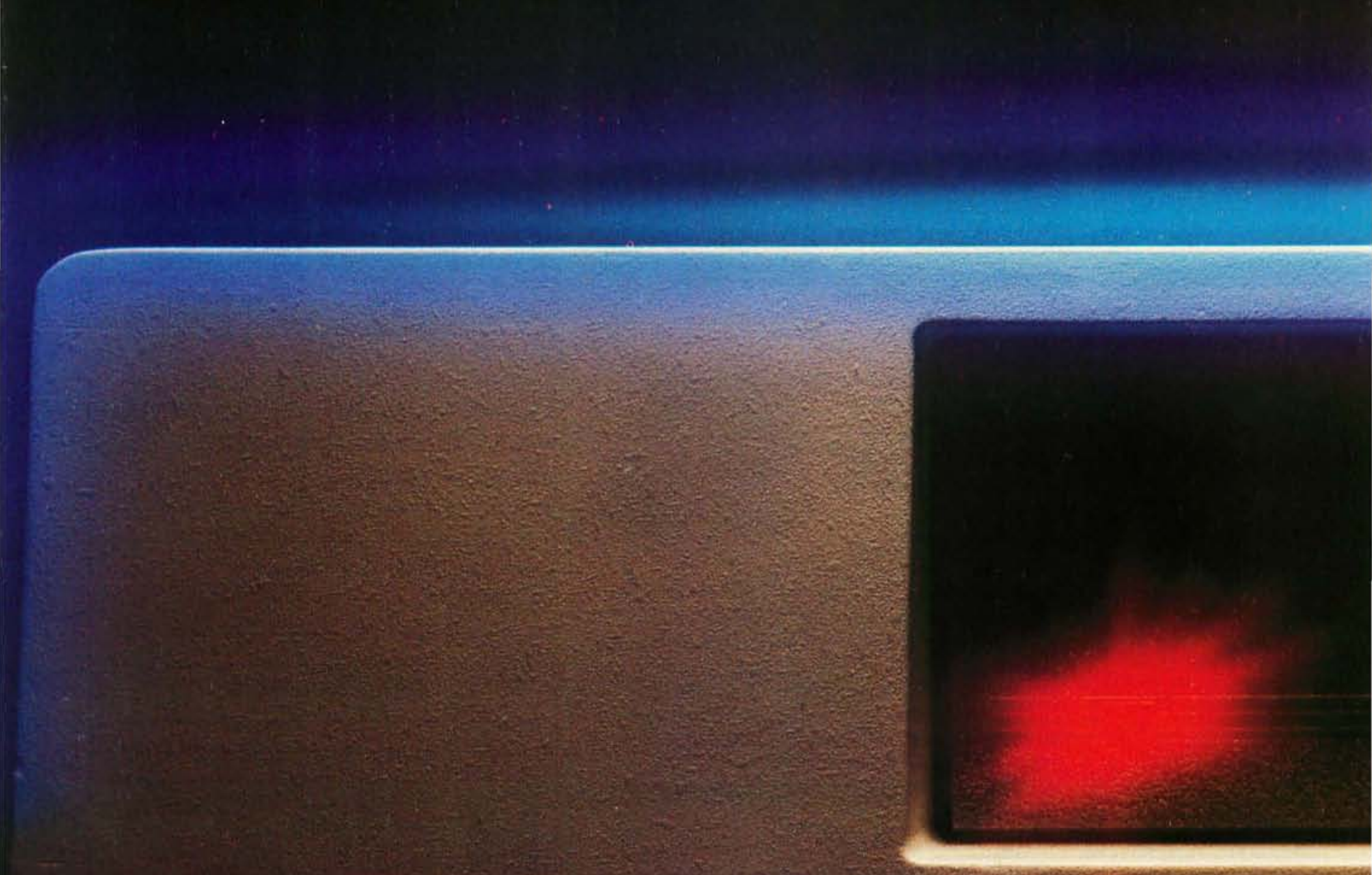

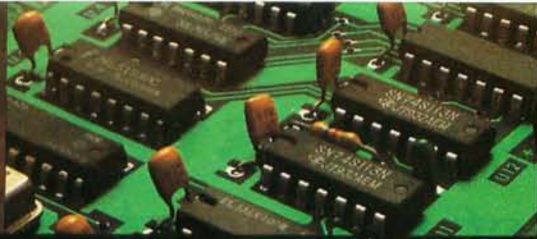

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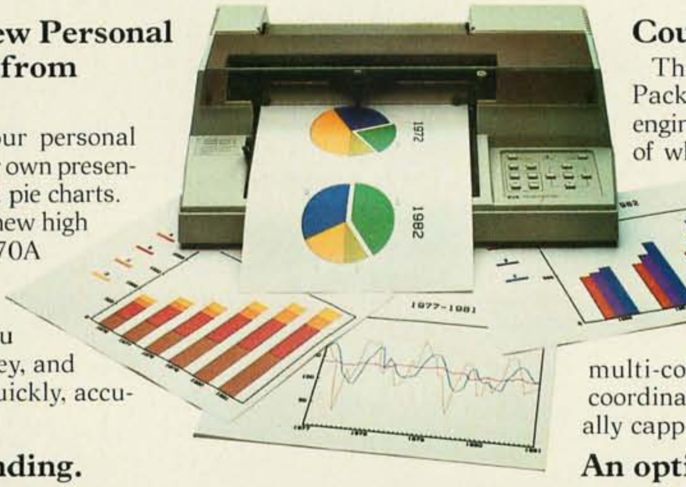

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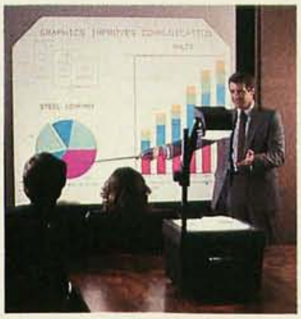

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Listing 3 continued:

```
205C:2E 02 19                ROL    SIGH      ;CARRY INTO BIT0 HBYTE
205F:60                      RTS
2060:AD 02 19      DISPLAY   LDA    SIGH      ;MSB TO DISPLAY
2063:20 DA FD                JSR    PRBYTE    ;ONTO APPLE DISPLAY
2066:AD 01 19                LDA    SIGL      ;LSB TO DISPLAY
2069:20 DA FD                JSR    PRBYTE    ;ONTO APPLE DISPLAY
206C:20 8E FD                JSR    CROUT     ;C-RETURN
206F:60                      RTS

*** SUCCESSFUL ASSEMBLY; NO ERRORS
```

Listing 4: *Applesoft BASIC program sequencing tests.*

```
listing 4

50    REM AIM65 TEST ROUTINE
60    HOME
70    REM DEFINE SYSTEM ADDRESSES
80   SELECT = - 15100
90   DISPLAY = 8288
100   NSIG = 8192
110   CSIG = 8200
120   BTEST = 8448
130   RAMTEST = 8336
140   PRINT " "
150   PRINT "LOADING MACHINE CODE TESTS"
160   PRINT "BLOAD APPTESTS"
170   PRINT " "
180   PRINT "BUS TESTING-PROBE TARGET SYSTEM BUSES"
190   PRINT "(PRESS SPACE FOR NEXT TEST)"
200   CALL BTEST
210   IF PEEK ( - 16384) < = 127 THEN 200
220   PRINT " "
230   PRINT "RAM TESTING 0000-07FF"
240   POKE SELECT,0: CALL RAMTEST
250   PRINT "RAM TESTING 0800-0FFF"
260   POKE SELECT,08: CALL RAMTEST
270   PRINT " ": PRINT " RAM TESTS COMPLETE "
280   PRINT " "
290   PRINT "ROM SIGNATURES BLOCKS B,C,D,E,F "
300   PRINT " "
310   FOR N = 176 TO 240 STEP 16
320   POKE SELECT,N: CALL NSIG
330   POKE SELECT,(N + 8): CALL CSIG
340   CALL DISPLAY
350   NEXT N
360   PRINT " ": PRINT " ROM SIGNATURES COMPLETE"
370   PRINT " "
380   PRINT " VIA TEST"
390   POKE SELECT,160: REM SELECT BLOCK AXXX
400  APRT = 51201:BPRT = 51200
405  ADIR = 51203:BDIR = 51202
410   POKE ADIR,0: POKE BDIR,255
415   REM A INPUT - B OUTPUT
420   FOR N = 0 TO 255
430   POKE BPRT,N
440   IF PEEK(APRT) < > N THEN PRINT "VIA ERROR"
450   NEXT N
460   POKE BDIR,0: POKE ADIR,255
465   REM BINPUT - A OUTPUT
470   FOR N = 0 TO 255
480   POKE APRT,N
490   IF PEEK (BPRT) < > N THEN PRINT "VIA ERROR"
500   NEXT N
510   PRINT " ": PRINT " TEST COMPLETE"
520   END
```

Listing 4 continued on page 444

Listing 4 continued:

```
]RUN

LOADING MACHINE CODE TESTS

BUS TESTING-PROBE TARGET SYSTEM BUSES   (PRESS SPACE FOR NEXT TEST)

RAM TESTING 0000-07FF
RAM TESTING 0800-0FFF

  RAM TESTS COMPLETE

ROM SIGNATURES BLOCKS B,C,D,E,F

B89C
A181
F727
B072
8A9E

  ROM SIGNATURES COMPLETE

  VIA TEST

  TEST COMPLETE

]
```

Text continued from page 435:

with a hard-wired fixture connecting PA0 to PB0, PA1 to PB1, and so on. The routine starts by configuring port A as an input and port B as an output. A test pattern is then written out port B and read and checked at port A. The role of the ports is then reversed, and the test is repeated.

This example illustrates some techniques that can be used with the Apple ICE. A more detailed program for the AIM-65 would test the remaining I/O devices, such as the display, printer and keyboard, and more thoroughly guide the user. However, the ideas presented here illustrate the principles behind the techniques and mirror those found in commercial instruments. The Apple ICE is therefore not only a practical fault-finding tool but also an ideal, low-cost, educational aid.■

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Add Multiple Tasks to Your Communication and Control Program

A special kernel lets your 8080 run multiple tasks concurrently

by Jerry Holter

Robotics, data communications, measurement and control, and computer music are only a few of the microcomputer programming applications that must respond to external real-time stimuli. Handling these stimuli is no problem if only one event occurs at a time and there is enough time between each event to do all the required computing for that task. But real-time problems are seldom so obliging. Often, the computer must handle several events concurrently.

This article describes one way to include concurrency in your programs, so that each simultaneous function can be written as a separate, straightforward task. You achieve concurrency by using a compact set of routines called a multitask kernel, to which each task speaks in a well-defined way. To demonstrate, I will present an 8080 kernel that supports multiple concurrent tasks in programs running under typical single-user operating systems.

A Split-Screen Display

First, let's explore some multitasking concepts by taking a look at an example program. Suppose you would like to use your computer as a smart terminal for a remote system, but you have a tendency to forget the passage of time, thereby running up a gigantic bill for computer and telephone services. A possible solution is to display the current time in a large banner format on the upper one-third of the console screen and show the usual dialogue with the remote system on the lower two-thirds. Because you can assume that the processor and the console screen run much faster than the telephone modem, this goal appears reasonable.

Five tasks are chosen to run at the same time; these tasks send keyboard characters to the modem, receive modem input, periodically get the time of day, and display the two parts of the screen. The keyboard task can be written in pseudocode as:

```
KEYBOARD_TASK:
  begin
    repeat
      while no key hit
        SWAPOUT;
      get character from keyboard;
      while modem not ready for character
        SWAPOUT;
      send character to modem;
    until forever;
  end;
```

The routine that enables you to write this task as though it had exclusive use of the processor is called SWAPOUT. This kernel routine takes control from the calling task and gives it to another task. Thus, one way that the processor can be shared among concurrent tasks is by having them voluntarily relinquish control, with the understanding that they will soon get it back. Of course, the best time for a task to do this is when it is in a waiting mode.

The SWAPOUT routine demonstrates how multiple tasks are made to behave as concurrently executing processes. Each task is assigned its own data area, or *stack frame*. When SWAPOUT is called, the complete state of the calling task is saved; the state of the task includes the condition of its program counter, machine registers and flags, and everything already on its stack. Then, by switching the stack pointer to another stack frame, the next ready task is restored to the state in which it was preserved, and returned to execution.

Unlike the keyboard task, the other sample tasks (modem receive, time, and display) are not truly independent of each other. They need to communicate somehow; in particular, the display task needs to receive characters for display from the remaining two tasks. Moreover, it needs to know when characters are available. The other two tasks need to know when to send characters. I will explore these two closely related issues of *task communication* and *syn-*

chronization further, but, for now, assume the existence of some kind of buffer mechanism between tasks. The remaining four tasks can then be sketched as follows:

```
MODEM_RECEIVE_TASK:
  begin
    repeat
      while the modem has no character
        SWAPOUT;
      get character from modem;
      put character in bottom_buffer;
    until forever;
  end;

TIME_TASK:
  begin
    repeat
      get time in banner form;
      put time string in top_buffer;
      DELAY(one minute);
    until the end of time;
  end;

TOP_DISPLAY_TASK:
  begin
    repeat
      while top_buffer empty
        SWAPOUT;
      get character from top_buffer;
      show character on top screen;
    until forever;
  end;

BOTTOM_DISPLAY_TASK:
  begin
    repeat
      while bottom_buffer empty
        SWAPOUT;
      get character from bottom_buffer;
      show character on bottom screen;
    until forever;
  end;
```

A new kernel routine, DELAY, is introduced in TIME_TASK. This routine allows you to postpone a task for a specified time, giving control of the microprocessor to the remaining tasks. Here, it triggers a new time display about once per minute. To implement the DELAY routine, the existence of some type of real-time clock is assumed, perhaps the same one used to handle the time of day. The clock handler calls the kernel routine TICK each time a tick (cycle) occurs. When the time specified to DELAY has elapsed, the delayed task is readied to continue execution.

The availability of a periodic clock interrupt that cycles every few milliseconds also raises the possibility of calling SWAPOUT from the interrupt

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handler. This technique (called *time-slicing*) would eliminate the need for each task to call SWAPOUT itself. Some new problems would be introduced, however, because the order of task execution is harder to control. What's more, all parts of the system must now be *reentrant*; that is, they must not use memory cells that are accessible to other parts of the system, except explicitly for intertask communication. An important consequence of this situation is that run-time libraries and operating system calls must be reentrant, which they not always are. A more direct way to eliminate multiple calls to SWAPOUT involves the use of semaphores.

Semaphores

You might notice that in the sample keyboard task, the keyboard is checked many times before a character is finally typed. Calling SWAPOUT prevents getting hung up in a loop, but it seems a waste of microprocessor time to keep swapping KEYBOARD_TASK in and out of execution with nothing accomplished. A better method would forgo execution until a certain event occurs (a key is hit). This facility can be provided by a *semaphore*, a simple data structure used to signal the occurrence of events and to wait for them. The event associated with a semaphore is agreed upon by the tasks involved; the routines for using it are provided by the multitask kernel.

A semaphore is based on the idea of using a Boolean variable to communicate an event (for example, the real-time clock flip-flop). A way to suspend a task's execution has been added by the inclusion of a *link field*, which the kernel routines can use to build a list of tasks waiting for the event (see figure 1). This field takes care of one or more tasks that are anticipating an event. But what if lots of events are signaled before they can all be handled? Within reasonable limits, these events can be handled by a *counting semaphore*, a semaphore whose Boolean variable is replaced by a counter. Each time an event is signaled with nothing waiting for it,

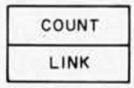


Figure 1: *The semaphore data structure consists of a count of the number of times the semaphore has been signaled with no tasks waiting and a link to a list of tasks waiting for signals.*

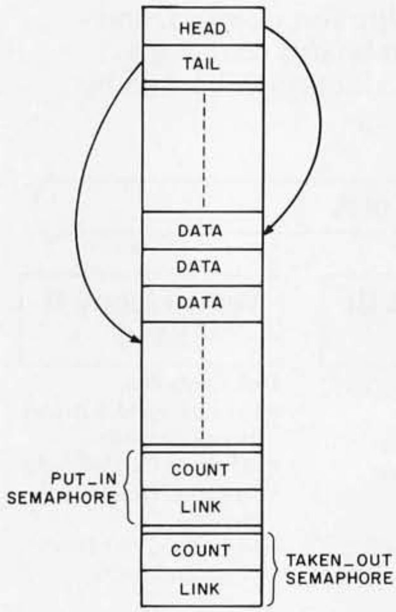


Figure 2: *The FIFO buffer. Characters are put into the buffer where TAIL points and removed at HEAD. After each access, the appropriate pointer is advanced; at the end of the buffer, the pointers are wrapped around to point to the first slot.*

the counter is incremented. When a task finally gets around to checking the semaphore, the counter is decremented, and the task doesn't need to wait at all.

Using the new semaphore structure, you can rewrite the keyboard task:

```
KEYBOARD_TASK:
  begin
    repeat
      WAIT(keyboard_hit);
      get character from keyboard;
      WAIT(modem_out_ready);
      send character to modem;
    until forever;
  end;
```

The modem-receive task could undergo similar changes, with both tasks using the new kernel routine WAIT(*semaphore*). The address of the semaphore is passed to the kernel. If at least one event has occurred, WAIT returns immediately; otherwise, it postpones the task until a routine such as SIGNAL(*semaphore*) is called to signal the event. In the above example, an interrupt handler could do the signaling, or one task could be dedicated to checking all the devices and signaling the appropriate semaphores.

Intertask Communication

Now that you have semaphores to handle the synchronizing of tasks, you can build ways of moving data between tasks as well. Focusing on the passing of a single character, I will use a circular first-in/first-out (FIFO) buffer of the form shown in figure 2; in this buffer, characters are put in at TAIL and removed at HEAD, advancing these pointers with each access. What's needed is a way to indicate when the buffer is full and when it is empty; you will also want to suspend a task that can't access the buffer at these times.

Both of these needs are met by using a pair of counting semaphores, one to guard the input and one to guard the output. The count fields correspond to the count of characters put in and taken out, respectively. Initially, the input count is 0, the output count is set to the buffer size, and the buffer is empty. The following complementary routines can now be written to access the top and bottom screen buffers:

```
GET_ONE(buffer):
  begin
    with the buffer specified, do
      WAIT(PUT_IN);
      get character at HEAD;
      advance HEAD;
      SIGNAL(TAKEN_OUT);
      return character to caller;
    end;
  end;

PUT_ONE(character, buffer):
  begin
    with the buffer specified, do
      WAIT(TAKEN_OUT);
      put character at TAIL;
      advance TAIL;
      SIGNAL(PUT_IN);
    end;
  end;
```

The effect of these routines is to enable tasks to pass characters to other tasks without concern for whether they can be accepted at the moment; likewise, the accepting tasks need not worry about whether characters are available (SWAPOUT is unnecessary). Buffer-space housekeeping is done by the semaphore counts, and through the semaphore links, tasks are postponed if their requests cannot be honored.

Mutual Exclusion

The possibility of tasks interfering with each other may be important not only in conjunction with memory cells used by simultaneous tasks but also with any resource. In fact, the console screen is itself a single resource shared by two display tasks. What makes this condition a problem is that screen operations are divisible; that is, a single console function (such as positioning the cursor) might require several accesses (escape sequences). Each of these accesses might take enough time so that the microprocessor could be executing other tasks while waiting. Thus, the console-screen accesses constitute a critical region of the program—one that needs protection from use by more than one task at a time.

The mutual exclusion of tasks from a critical region can be handily accomplished using a semaphore. The count field of this semaphore takes on only two values: available (1) and reserved (0). A calling task waits at the entrance to the region if it is reserved; upon exit, the region is made available again. The semaphore is initially set to available (1). The following routine is passed either a displayable character or a special code requesting a control function, such as erase line or inverse video on/off:

```
SHOW_CHARACTER(character,subscreen):
  begin
    WAIT(available);
    if necessary, move cursor to new subscreen;
    send character or special sequence to screen;
    record new cursor position;
    SIGNAL(available);
  end;
```

The routine calls WAIT or SWAPOUT between sending characters to the console device. Therefore, other tasks run but cannot enter the critical region until the first calling task is finished.

An 8080 Multitask Kernel

Listing 1 (page 458) shows a set of routines, called MTK80, written in 8080 code for the Digital Research MAC assembler. You can insert the routines into a program along with the included macroinstructions for convenient calling sequences (see listing 2, page 466). Except for the user macroinstructions, all labels include a nonalphanumeric character to reduce conflicts with user symbols. If you use the DELAY call, a real-time (periodic) clock is also required.

If the conditional assembly control symbol INTS? is true, interrupts are disabled on entry and enabled on exit from each kernel routine. This setup ensures that the kernel data structures cannot be accessed by more than one routine at a time (a simple form of mutual exclusion). If STAK?CK is true, the stack pointer is checked to see if it is inside the current frame. If it intrudes upon a neighboring frame at the time it is checked, crucial data has likely been destroyed, so the kernel is abandoned.

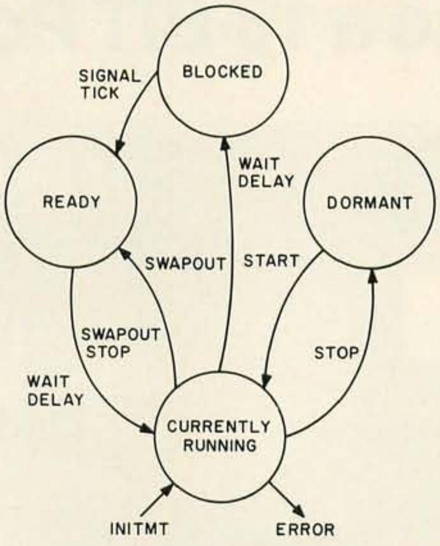


Figure 3: *The MTK80 task state diagram.*

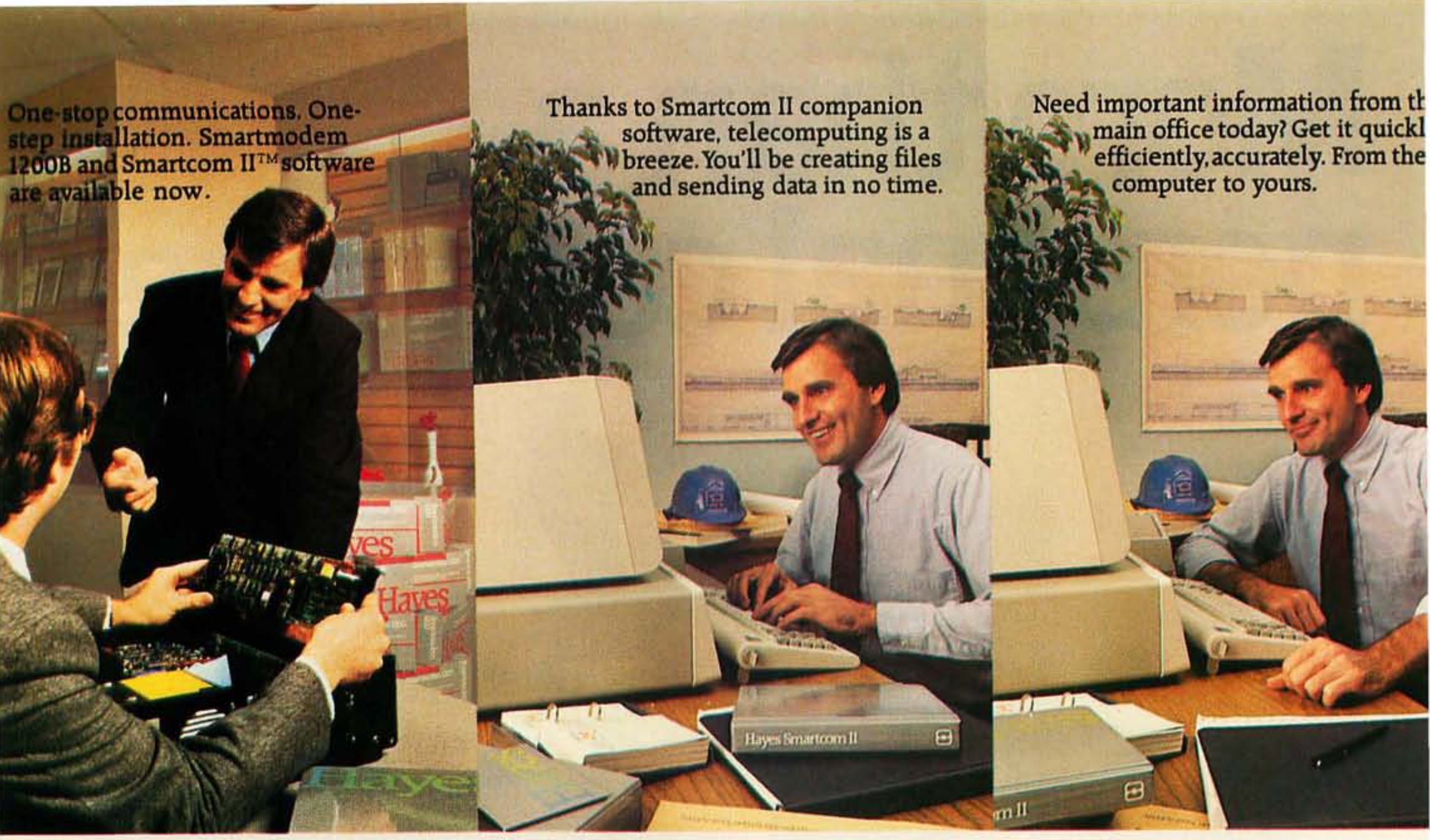
The operation of the MTK80 kernel can be described from three perspectives: the states that tasks enter, the underlying data structure, and the function calls used.

Task States

The state diagram in figure 3 shows the possible states a task can be in (circles) and the routines used to make transitions (arrows) to other states. You would need one such diagram for each task to describe the condition of all tasks in a program. Only one task can be in the *running* state at a time, and, of course, it makes the function calls to change its own state or the state of another task.

The *dormant* state applies to tasks that might be in program memory but have no assigned stack frame. When a task initially starts, it is associated with a frame and given control. As the diagram shows, only a running task can stop its own execution altogether and become dormant again. It is not possible to terminate other tasks directly.

Text continued on page 467



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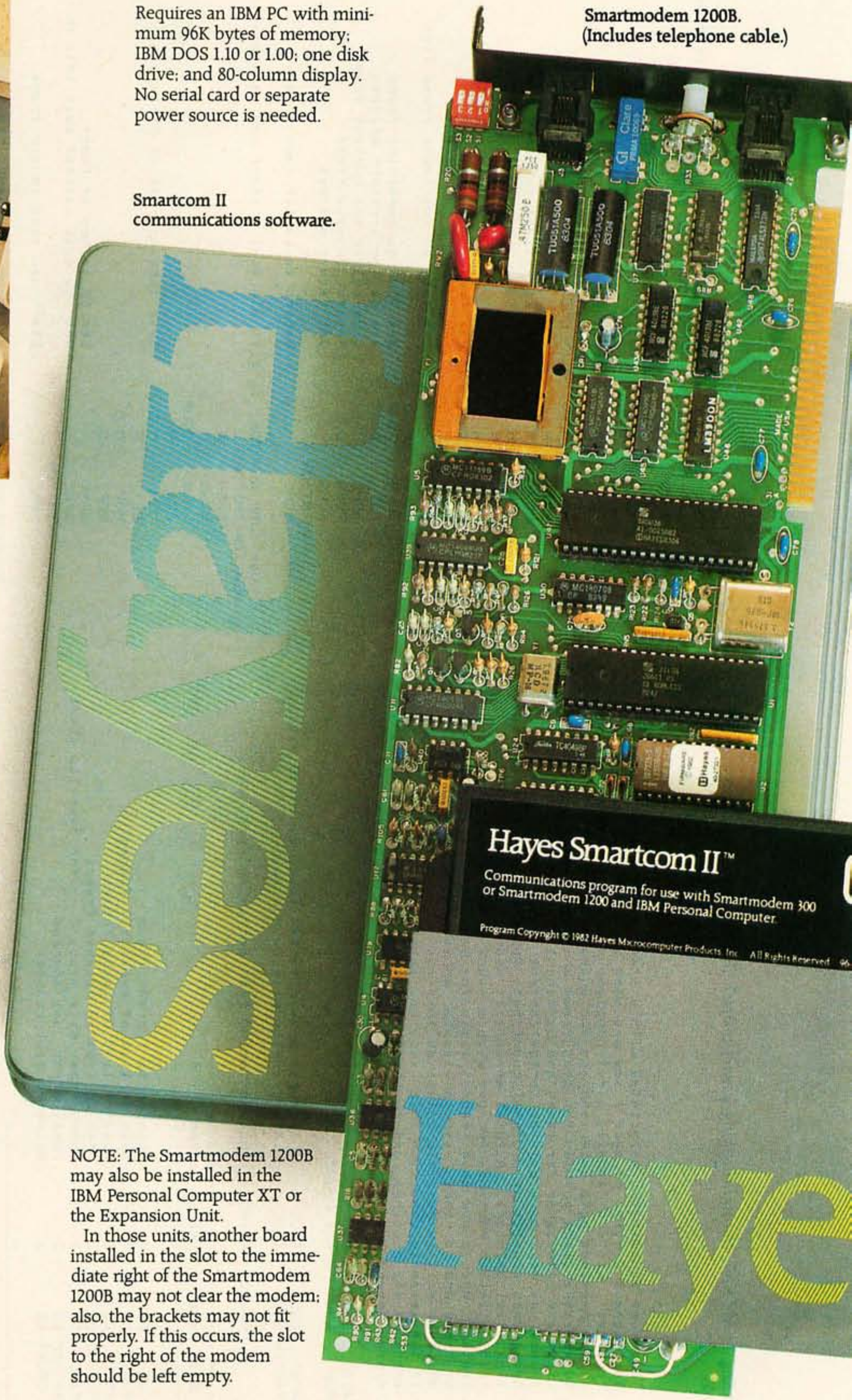

NOTE: The Smartmodem 1200B may also be installed in the IBM Personal Computer XT or the Expansion Unit.

In those units, another board installed in the slot to the immediate right of the Smartmodem 1200B may not clear the modem; also, the brackets may not fit properly. If this occurs, the slot to the right of the modem should be left empty.

Listing 1: *MTK80, the multitasking kernel written in MAC assembly language for the 8080.*

```
; Tasks are dynamically associated with a stack frame when created.
; The highest 2 bytes of each frame are used by the ?DELAY and ?TICK
; routines.  Lists of equally sized contiguous stack frames are linked
; by the previous byte pair, and the two bytes before that are used
; to save the stack pointer for that frame when the task is suspended.
; Lists are maintained for ready and waiting tasks/frames, and available
; frames, as well as a pointer to the current task/frame.
; Semaphores consist of a signal count byte followed by a two-byte queue
; link (list pointer).  A fatal error exit address is passed to the
; initialization routine, for use when a stack frame overflow is de-
; tected.  When a new task request fails for lack of available frames,
; or there are no ready tasks to execute, an idle loop is entered, from
; which no exit is possible unless an interrupt creates the missing frame.
; If the assembly condition INTS? is true, interrupts are disabled upon
; entry to all routines, and re-enabled upon exit and in the idle loop.
; Approx. memory requirements: code 750 bytes, data 14 bytes.
;
FALSE:   EQU     0
TRUE:    EQU     not FALSE
;
INTS?:   EQU     TRUE     ;Interrupts are in system (used by mtk80.lib)
STAK?CK: EQU     TRUE     ;Stack overflow will be checked
;
         MACLIB  mtk80    ;Include "mtk80.lib" macros on first pass
;
;------------------------------
; Data Area -- Must be in RAM
;------------------------------
;
?CUR:    DS      2        ;Pointer to current frame
?AVAIL:  DS      2        ;Head of list of available frames
?RDY:    DS      2        ;Head of list of ready frames
D?LAYED: DS      2        ;Head of list of delayed frames
?SIZE:   DS      2        ;Saved frame size minus 2 -- for overflow check
ERR?JMP: DS      2        ;Fatal error jump address
T?COUNT: DS      2        ;Relative tick counter
;
;----------------------------
; Code area -- may be in ROM
;----------------------------
;
; Initialize Multi-task kernel data structures.  THE STACK POINTER
; IS CHANGED IN THIS ROUTINE.  On return, the caller has a new frame.
; Not a trace remains of the old stack or registers.  Enter with:
;     HL=addr of first byte of stack (lowest),
;     BC=frame size,
;     A=number of frames (must be at least 2),
;     DE=Fatal error jump address.
M?INIT:  INT?OFF
         PUSH    H
         LXI     H,-2
         DAD     B
         SHLD    ?SIZE    ;Save frame size-2
         XCHG
         SHLD    ERR?JMP  ;Set fatal error jump address
         POP     D
         DCX     D
         DCX     D
         DCX     D
         DCX     D        ;Set DE to pt to first link field when BC is added
         LXI     H,0      ;End link will be NIL
         SHLD    ?RDY     ;Init ready queue empty
         SHLD    D?LAYED  ;Init delayed queue empty
         PUSH    H
         XCHG             ;Form linked list backward...
FR?LNK:  POP     D        ;Get ptr to "previous" frame
         DAD     B        ;Advance to next frame
         MOV     M,E
         INX     H
         MOV     M,D      ;Set link field to "previous"
         DCX     H
         PUSH    H
         DCR     A
         JNZ     FR?LNK   ;Last frame?
         XCHG
         SHLD    ?AVAIL   ;Set head of available frame list
         POP     H
         SHLD    ?CUR     ;Set ?CUR to remaining frame
         POP     D        ;Get caller's return address
         SPHL             ;Give caller the current frame
         PUSH    D        ;Reserve SP-save field
         XCHG             ;Get return address
         INT?ON
         PCHL             ;Return to caller (now a task)
;
; Use "JMP NEW?TSK" to kill old task & start new, address passed in HL.
NEW?TSK: INT?OFF
         PUSH    D
         XCHG
         LHLD    ?CUR
         DCX     H
         MOV     M,D      ;Save task address in SP-save slot
         DCX     H
         MOV     M,E
         POP     D
         SPHL             ;Set SP to top of frame
         XTHL             ;Get new task address back into HL
         INT?ON
         PCHL             ;Start new task in old frame.
;
; Suspend old task, get new frame, and start new task.
; Use "CALL ?SPAWN" with new task address in HL.
?SPAWN:  INT?OFF
         PUSH    PSW
         ?SAVE
         CALL    ?SHELVE  ;Save (& check) SP, get ?CUR in BC
         CALL    AP?RDY   ;Add current frame to end of ready list
         NEW?CUR ?AVAIL   ;Get new current frame from top of available list.
         LHLD    ?CUR
         DCX     H
         DCX     H
         DCX     H
         POP     D
         MOV     M,D      ;Place new task address on new stack
         DCX     H
         MOV     M,E
         POP     D        ;Bring all regs but HL along to new task
         POP     B
         POP     PSW
```

Listing 1 continued:

```
        SPHL            ;Set SP to new frame
        INT?ON
        RET
;
; Terminate current task, forget all registers and stack.
; Put stack frame on the available list, go to next ready task.
?TERM:  INT?OFF
        LHLD    ?AVAIL  ;Get ptr to available list
        XCHG
        LHLD    ?CUR    ;Get current frame ptr
        SHLD    ?AVAIL  ;put it at top of available list, for convenience.
        MOV     M,E
        INX     H
        MOV     M,D     ;Link to the rest of the list
        JMP     ?NEXT   ;Get next ready task and resume it
;
; Check for signals at the semaphore pointed to by HL.  If
; signaled, acknowledge and return, else suspend the current
; task on the semaphore's queue and go to the next ready task.
WAIT?S: INT?OFF
        PUSH    PSW
        MOV     A,M
        ORA     A
        JNZ     ?ACK    ;Signaled?
        ?SAVE
        CALL    ?SHELVE ;Save & check SP, get ?CUR in BC
        POP     H       ;Restore semaphore ptr
        PUSH    H
        INX     H       ;Point to queue link
        CALL    A?PEND  ;Add current frame pointer to sem. queue
        JMP     ?NEXT   ;Activate next ready task
;
; Check if a semaphore at HL has been signaled; acknowledge if so.
; Returns non-zero if signaled.
WAIT?C: INT?OFF
        MOV     A,M
        ORA     A       ;Signaled?
        PUSH    PSW     ;(Save status)
        JZ      NO?ACK
?ACK:   DCR     M       ;Yes, acknowledge
NO?ACK: RE?SUME         ;Return to caller
;
;  Suspend current task.   Save regs, find next task, resume it.  If
; there was only one ready task (the active one), it will be continued.
SUS?PND:INT?OFF
        PUSH    PSW
        ?SAVE
        CALL    ?SHELVE ;Save & check SP, get ?CUR in BC
        CALL    AP?RDY  ;Add current task to end of ready list
?NEXT:  NEW?CUR ?RDY    ;Get new frame from top of ready list
        LHLD    ?CUR
        DCX     H
        MOV     A,M
        DCX     H
        MOV     L,M     ;Get saved SP
        MOV     H,A
        SPHL            ;Switch SP to new frame
        RE?STOR         ;Retrieve registers
        RE?SUME         ;Resume previously suspended task
;
; "Flag" a semaphore pointer to by HL.  If its count is non-zero,
; it's been signaled already - return, else signal it normally.
SIG?F:  INT?OFF
        PUSH    PSW
        MOV     A,M
        ORA     A
        JZ      SIG?Q   ;If count=0, signal
        RE?SUME         ;...else return to caller
;
; Signal a semaphore pointed to by HL.  If nothing in queue, increment
; count and return, else activate first task in semaphore queue.
SIG?S:  INT?OFF
        PUSH    PSW
SIG?Q:  INX     H       ;Point to semaphore link field
        MOV     A,M
        INX     H
        ORA     M       ;Queue ptr = NIL?
        DCX     H
        DCX     H       ;(restore HL)
        JNZ     SIG?RDY
        INR     M       ;YES, increment count (no waiters)
        RE?SUME         ;...return to caller.
;
SIG?RDY:?SAVE
        INX     H
        MOV     E,M     ;NO, get first frame ptr in queue
        INX     H
        MOV     D,M
        XCHG
        MOV     C,M     ;Use it to get next ptr in list
        INX     H
        MOV     B,M
        DCX     H
        XCHG
        MOV     M,B     ;Make that new first in queue
        DCX     H
        MOV     M,C
        MOV     C,E     ;Get first waiter in BC
        MOV     B,D
        CALL    AP?RDY  ;Add waiting task to ready queue
        RE?STOR
        RE?SUME         ;Return to caller
;
; Real-time clock handler.  Can be called, or use a jump at end of
; interrupt handler.  Preserves all registers, and enables interrupts
; before returning (if INTS? is TRUE).  Increments the relative tick
; count, and takes tasks off the top of the delayed list when their

; time is up.
?TICK:  INT?OFF
        PUSH    PSW
        ?SAVE
        LHLD    T?COUNT
        INX     H       ;Bump tick count
        SHLD    T?COUNT
        XCHG            ;Get current count in DE
TICK?LP:LHLD    D?LAYED ;Get first in delayed list
        MOV     A,H
        ORA     L       ;Empty list?
        JZ      TICK?X
        PUSH    H       ;No...
        INX     H
        INX     H
        MOV     A,M     ;Get target time for delayed task
```

Listing 1 continued on page 462

International

IBM PC SOFTWARE (PC/MS DOS)

Business

	LIST	SALE
American Training International		
Power for PC DOS	75	56
Aptek		
Rainbow Writer		125
Ashton-Tate		
Financial Planner	700	489
Aspen Software		
Grammatik	75	56
Proofreader 32K	50	38
Proofreader 50K	50	38
Proofreader 80K	50	38
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Personal Accountant	195	160
Beaman Porter		
Powertext	399	369
Best Products		
Personal Financial Pgm.	95	66
Comprehensive Software Support		
PC Tutor	80	60
Comshare		
Financial Modeling	325	264
Continental Software		
FCM (First Class Mail)	125	79
Home Accountant Plus	150	99
Datamost		
Real Estate Inves. Prg.	130	95
Eagle Software Publishing		
Money Decisions Vol. 1	199	129
Money Decisions Vol. 2	230	169
Money Pack Vol. 1 & 2	400	299
Emerging Technology		
Edix	195	149
Edix + Wordix	390	279
Howard Software		
Real Estate Analyzer	250	185
Information Unlimited Software		
AP	595	389
AR	595	389
Easy Planner	250	188
Easy Speller 1.1 (Dead)		
Easy Speller 2	225	135
Easy Speller 2/Legal	350	229
Easy Speller 2/Medical	350	229
Easy Writer II	350	229
Financial Mgmt. (AR/AP/GL)	1495	1019
GL	595	389
INV	595	389
Order Entry	595	389
Payroll	595	389
Intellect Associates		
PC Text	100	73
Window	150	113
Lexisoft		
Spellbinder	495	259
Lifetree		
Volkswriter	195	129
Metasoft		
Benchmark Mail List	250	184
Benchmark Word Processor	500	367
Micro Pro		
Mailmerge	250	165
Spellstar	250	165
Word/Mail	695	426
Word/Spell	695	426
Word/Spell/Mail	845	558
Wordstar	495	327
Microsoft ®		
Multiplan™*	275	189
Oasis		
Punctuation & Style	0	109
The Word Plus	150	112
PBL Corporation		
Personal Investor	145	98
SERIES 4 PAK (GL,AR,AP)	595	349
Pro-Tem		
Notebook	150	
Scripps Data Systems Inc.		
Job Cost System	495	371
Select Information Systems		
Select Word Processor	595	339
Softward		
Wordmate	500	340
Software Arts		
TK!Solver		224
Software Products International		
Logicalc	190	142
Procalc	350	262
Sorcim		
Supercalc	195	129
Supercalc 2	295	185
Superspellguard	195	129
Superwriter	295	179
Supersoft		
Optimizer	200	149
Texasoft		
Thinker (Spreadsheet)	75	56
Versatext	200	172
Visicorp		
Business Forecasting Modl	100	78
Desktop Plan	300	229
Visicalc	250	169
Visispell	225	183
Visiwork	375	298

Database

	LIST	SALE
Alpha Software		
Database Manager	245	169
Mail List	95	67
Applied Software Technology		
QBASE	189	143
Versaform	389	259
Ashton-Tate		
dBASE II	700	398
dBASE II w/user's guide	729	429
Conceptual Instruments		
Desk Organizer		245
Condor Computer Corporation		
Condor 1	295	189
Condor 3	650	398
Fox & Geller		
Quickcode	295	185
dGRAPH	295	195
dUTIL	99	59
Information Unlimited Software		
Easy Filer	400	279
Innovative Software		
TIM III	495	279
Link Systems		
Data Fax	299	224
Micro Pro		
Infostar	495	327
Reportstar	350	231
North American Business Systems		
<<Answer>>	250	159
PC Software		
Createbase	75	67
Software Products International		
Logiquest II	250	188
Logiquest III	550	412
Software Publishers		
PFS: File	140	105
PFS: Report	125	94
Supersoft		
Personal Data Base	125	93
Synapse Video		
File Manager	150	112
Synergistic Software		
Data Reporter	250	169
Visicorp		
Visidex	250	189
Visifile	300	219

Hardware

	LIST	SALE
Hayes Microcomputer Products		
Smartmodem 1200B	599	479
Microsoft ®		
Mouse™	195	149

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Lost Colony	30	22
Aptek		
PC Ticker Tape		22
Automated Simulations/Epyx		
Curse of Ra	20	15
Temple of Apshai	40	30
Upper Reaches of Apshai	20	15
Avalon Hill		
Andromeda Conquest	23	17
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Draw Poker	21	16
Galaxy	25	19
Midway Campaign	21	16
Voyager	25	19
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THE WORD Processor		146
Blue Chip		
Millionaire	100	75
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Datamost		
Pig Pen	30	22
Space Strike	30	22
Friendly Software		
Friendlyware	50	38
Infocom		
Deadline	50	37
Starcross	40	30
Suspended	50	38
Zork I	40	30
Zork II	40	30
Zork III	40	30
Information Solutions, Inc.		
25:01 The 25th Hour	100	74
ISM		
Mathemagic	90	65
Lightning		
Master Type	50	38
Microsoft ®		
Flight Simulator™	50	38
Omric		
Blingsplats	35	26
Championship Draughts	35	26
Space Guardian	30	22
Sierra On Line		
Crossfire	30	22
Frogger	35	26
Ulysses & Golden Fleece	40	29
Sirius		
Conquest (Call To Arms)	30	22
Strategic Simulations		
Warp Factor	40	30

Language

	LIST	SALE
Howard Sams		
Programmer	200	150
Lifeboat		
C-Food Smorgasborg Lattice C Compiler	500	415
Microsoft ®		
C Compiler™	500	400
Mumath/Musimp™	300	225
Pascal™	500	400
muLisp/MuStar™	250	188
Ryan-McFarland		
RM/Cobol Full Dev System	950	713
RM/Cobol Runtime Only	250	188

™ = Manufacturer's trademark

Utility/Comm/Graphics

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Apple-IBM Connection	195	135
Typefaces	125	87
Aptek		
Epson to Prism		38
Byrom Software		
BSTAM	200	149
BSTMS	200	149
Cavalier		
Championship Blackjack	40	30
Central Point		
Copy II PC	40	35
Hayes		
Smartcom 2	119	90
Hercules		
Graphics CARD	499	399
Innovative Software		
Fast Graphs	295	159
Insoft		
Data Design	225	169
ISM		
Graphmagic	90	65
Graphmagic Combo	150	119
Microstuf		
Crosstalk/Smartmodem	195	135
Peter Norton		
Utilities	80	60
Southeastern		
Data Capture	120	90
Versa Computing		
Graphics Hardcopy	25	19
Versawriter Graphics Tabl	299	249
Visicorp		
Visitrend/Plot	300	215
Woolf		
Move It	150	99

IBM PC HARDWARE

Hardware

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5MB Hard Disk	1795	
Corvus		
PC Interface, Cable, Man.	300	239
Kraft		
Joystick	70	52
Microsoft ®		
128K RAM™	525	379
192K RAM Card™	700	499
256 RAM Card™	875	624
64K RAM™	350	249
64K RAM Chip Set™	175	139
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PC-Hayes Cable	35	29
QCS		
Big Blue	595	449
Quadrum		
256K QUADBOARD	595	435
64K Quadboard	395	289
64K RAM Chip Set	95	75
Asynch Adaptor, RS232	110	90
Quadcolor I	295	220
Symtec		
Light Pen	150	126
TG Products		
Joystick	65	49
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Tandon		
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Random House Thesaurus	150	113
Metasoft		
Benchmark Mail List	250	184
Benchmark Word Processor	500	367
Structured Systems		
AP	1250	790
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GL	1250	790
INV	1250	790
Order Entry	1250	790
PR	1250	790

Database

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Ashton-Tate		
dBASE II	700	398
Fox & Geller		
Quickcode	295	195
dGRAPH	295	195
dUTIL	99	59
Organic		
Datebook	395	331

Language

	LIST	SALE
Digital Research		
CB86 (avail soon!)		
CBASIC 86	200	150
CIS COBOL 86	800	600
CP/M-86	60	45
Concurrent CP/M-86	350	264
Level 2 COBOL 86	1600	1200
Pascal MT+ 86	400	300
Pascal MT+86 With SPP-86	600	450
SID 86	150	94
Micro Focus		
CIS Cobol 8086	850	637
Ryan-McFarland		
RM/Cobol Full Dev System	950	713
RM/Cobol Runtime Only	250	188

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Color 11 (R&G)	899	645
Corona Data Systems		
11MB Hard Disk	3295	2695
20MB Hard Disk	4295	3495
6MB Hard Disk	2295	1895
PC Interface,Cable,Man.	300	239
Corvus Systems		
11MB Hard Disk	3295	2695
20MB Hard Disk	4295	3495
6MB Hard Disk	2295	1895
Hayes Microcomputer Products		
Chronograph	249	199
Smartmodem 1200	699	509
Smartmodem 300	279	209
NEC		
Monitor 12" Green Hi-Res	285	167
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Smart Cat 103	259	207
Smart Cat 103/212	595	476
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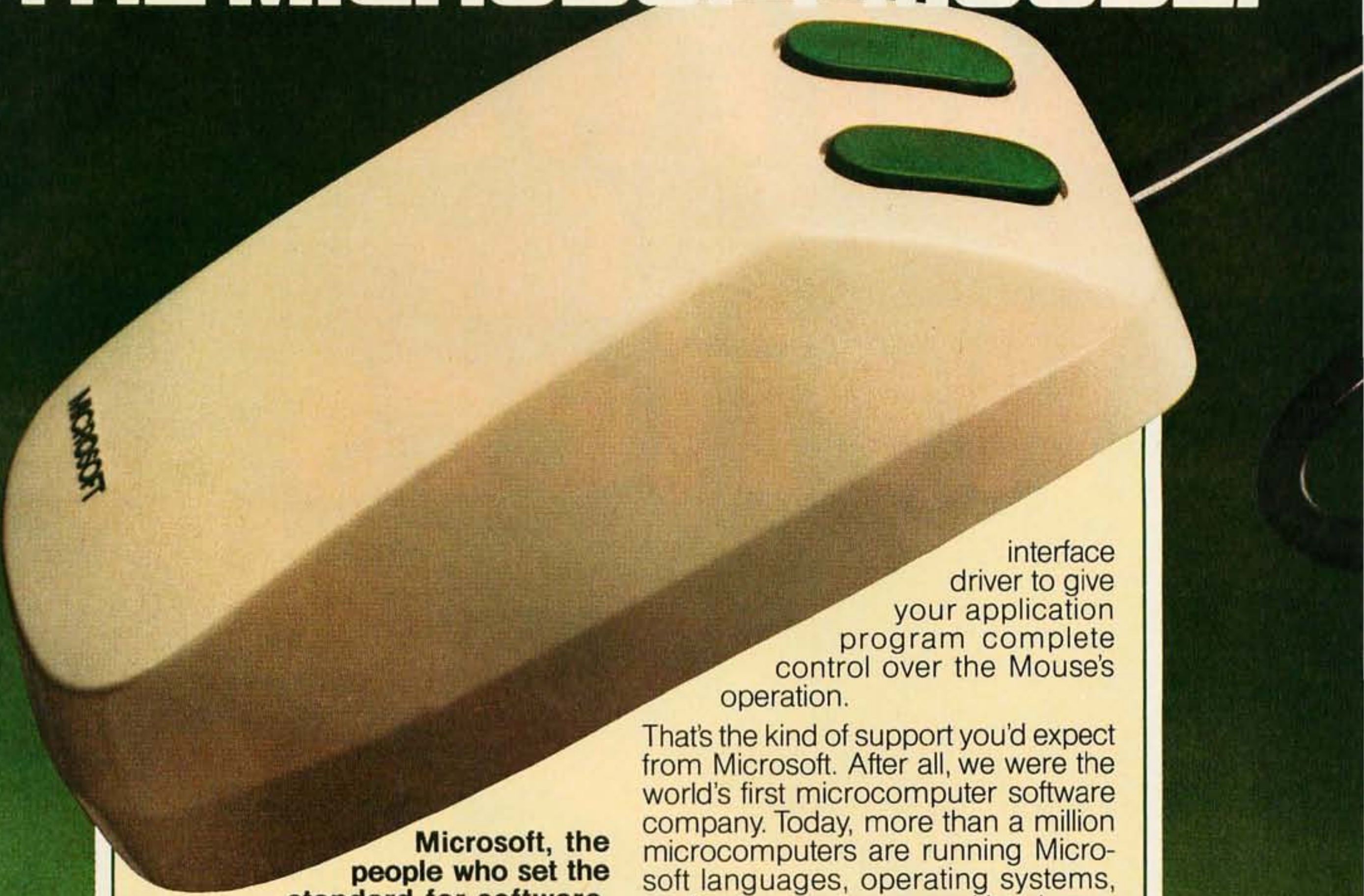
Listing 1 continued:

```
        INX     H
        MOV     H,M
        MOV     L,A
        CALL    DBL?CP  ;time is now?
        POP     H
        JNZ     TICK?X
        PUSH    D       ;(save tick count)
        MOV     E,M     ;Yes, get next in list
        INX     H
        MOV     D,M
        DCX     H
        XCHG
        SHLD    D?LAYED ;Make it first
        MOV     B,D
        MOV     C,E
        CALL    AP?RDY  ;Append ready task to ready queue
        POP     D       ;(restore tick count)
        JMP     TICK?LP ;Check for any more whose time is up
TICK?X: RE?STOR
        RE?SUME
;
; Put caller to sleep for the number of ticks passed in HL, by
; inserting the current frame in the D?LAYED list in order of
; target times.  Maximum delay is 65,536 ticks (when HL=0).
?DELAY: INT?OFF
        PUSH    PSW
        ?SAVE
        CALL    ?SHELVE ;Save & check SP
        POP     D
        PUSH    D       ;Get delay request
        LXI     H,D?LAYED  ;point to delayed list
DELAY?L:PUSH    H       ;Save pointer
        MOV     A,M
        INX     H
        MOV     H,M     ;Get link to next frame in list
        MOV     L,A
        ORA     H
        JZ      DELAY?I ;If none, go insert
        PUSH    H       ;Save link pointer
        INX     H
        INX     H
        MOV     C,M     ;Get delayed task target time
        INX     H
        MOV     B,M
        LHLD    T?COUNT ;Get current tick count
        MOV     A,C
        SUB     L
        MOV     L,A
        MOV     A,B     ;Subtract it from target
        SBB     H
        MOV     H,A
        CALL    DBL?CP  ;If .GT. requested delay, go insert
        POP     H       ;(restore link pointer)
        JC      DELAY?I
        POP     B       ;throw away previous pointer
        JMP     DELAY?L ;Continue down the list
DELAY?I:MOV     B,H
        MOV     C,L     ;Save pointer
        LHLD    T?COUNT
        DAD     D       ;Calculate target tick count
        XTHL            ;Save target, get pointer to previous frame
        XCHG
        LHLD    ?CUR    ;Get pointer to calling frame
        XCHG
        MOV     M,E     ;Set previous link to new frame
        INX     H
        MOV     M,D
        POP     H       ;Get back target
        XCHG
        MOV     M,C     ;Link new frame to next in list
        INX     H
        MOV     M,B
        INX     H
        MOV     M,E     ;Set target time field in current frame
        INX     H
        MOV     M,D
        JMP     ?NEXT   ;Resume execution of next ready task
;
; Initialize semaphore at HL to value in A, and set link to NIL.
; HL destroyed, A preserved.
S?INIT: INT?OFF
        MOV     M,A
        INX     H
        MVI     M,0
        INX     H
        MVI     M,0
        INT?ON
        RET
;
; Save stack pointer, check for overflow, and return with BC=?CUR.
?SHELVE:LXI     H,2
        DAD     SP      ;Get SP (plus 2 for return addr)
        XCHG            ;..into DE
        LHLD    ?CUR    ;Get current frame pointer
        MOV     B,H     ;Save it in BC
        MOV     C,L
        DCX     H
        MOV     M,D     ;Save Stack pointer
        DCX     H
        MOV     M,E
        if      STAK?CK
         LHLD   ?SIZE   ;Get frame size (less 2 for return address)
         DAD    D       ;Calculate saved SP + frame size
         MOV    A,B
         CMP    H
         RC
         JNZ    ?ERROR
         MOV    A,C
         CMP    L
         RC             ;Return if ?CUR is less than SP+frame size
        endif
?ERROR: INT?ON
        LHLD    ERR?JMP
        PCHL
;
; A?PEND an item (frame link) to the end of a list. HL=ptr to the
; head of the list.  BC=item address.  HL, DE and A destroyed.
; AP?LP is entry point if item is also a list.  Call AP?RDY to append
; a frame to the ready list.
AP?RDY: LXI     H,?RDY
A?PEND: XRA     A
        STAX    B
        INX     B
        STAX    B       ;item points to NIL
        DCX     B
AP?LP:  MOV     A,M     ;end of list?
        INX     H
        ORA     M
```

Listing 1 continued on page 466

THE NEW STANDARD. THE MICROSOFT MOUSE.



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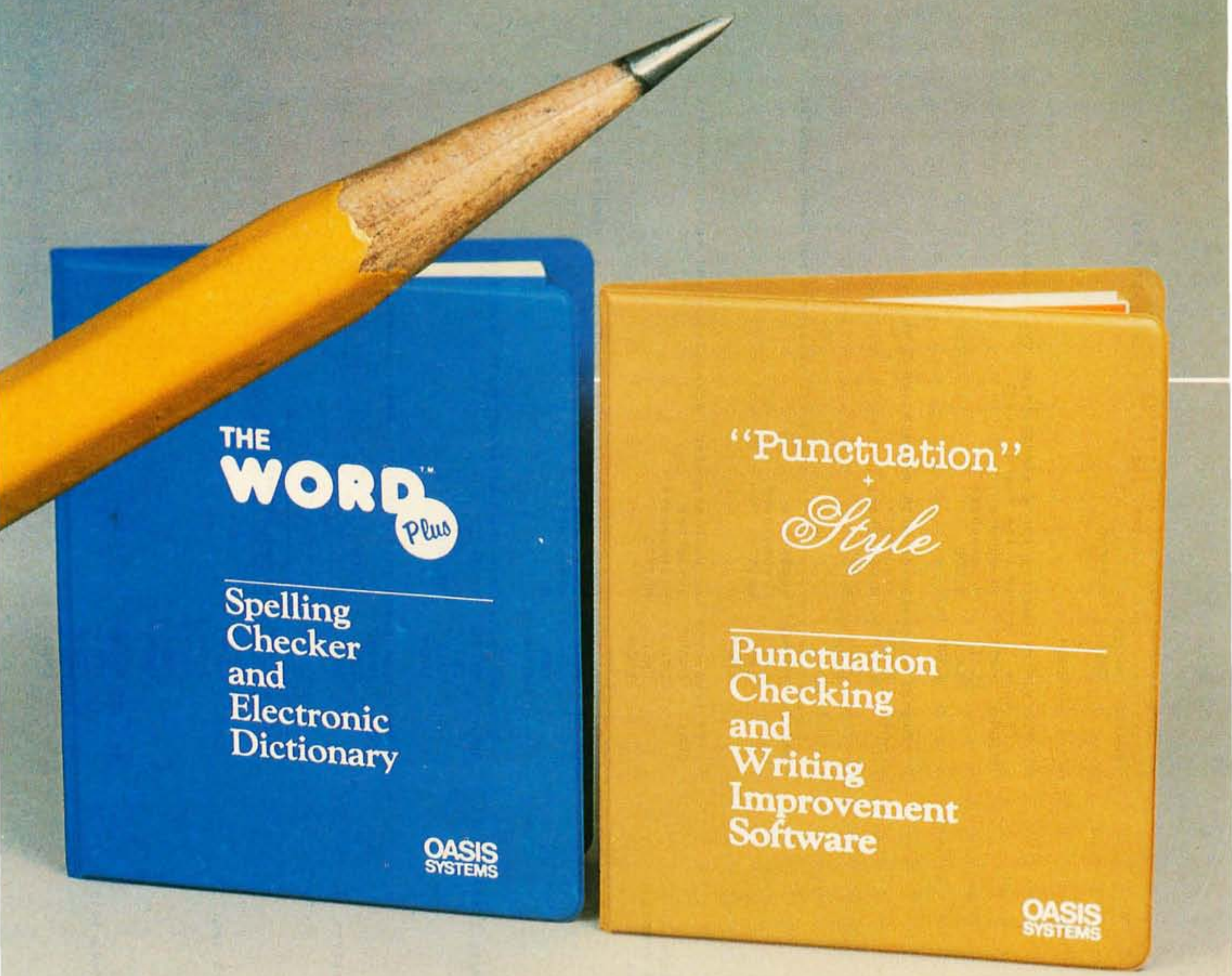

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Listing 1 continued

```
        JZ      AP?X
        MOV     D,M       ;no, get link as new ptr
        DCX     H
        MOV     E,M
        XCHG
        JMP     AP?LP
AP?X:   MOV     M,B       ;yes, set end link to point to item
        DCX     H
        MOV     M,C
        RET
;
; Double precision compare (16-bit unsigned).
; HL compared to DE.  Accumulator destroyed.
; Carry set if HL is greater than DE,   Z set if equal.
DBL?CP: MOV     A,D
        CMP     H
        RC                ;HL .GT. DE
        RNZ               ;HL .LT. DE
        MOV     A,E
        CMP     L
        RET
;
```

Listing 2: *This program sets up initial conditions for multitasking.*

```
; Initialize the multi-task kernel data structures, specifing the
; beginning of the stack area, the number of equal sized stack frames
; to be allocated, their size, and the fatal error jump address.
INITMT: MACRO   stack,frames,frame@size,error@jump
        LXI     H,stack
        LXI     B,frame@size
        MVI     A,frames
        LXI     D,error@jump
        CALL    M?INIT
        ENDM
;
; Initialize  a semaphore's count, and set its link to NIL (empty list).
INITSEM:MACRO   semaphore,value
        LXI     H,semaphore
        MVI     A,value
        CALL    S?INIT
        ENDM
;
; Create a stack frame for a new task, and place it into
; execution.  The new task will get a copy of the current registers
; (except HL).  The current task is placed on the ready list.
START:  MACRO   new@task@addr
        LXI     H,new@task@addr
        CALL    ?SPAWN
        ENDM
;
; Assign the current stack frame to a new task, killing the old task.
; The current registers are preserved (except HL).
TASK:   MACRO   new@task@addr
        LXI     H,new@task@addr
        JMP     NEW?TSK
        ENDM
;
; Kill the current task entirely.  Control goes to the next ready task.
STOP:   MACRO
        JMP     ?TERM
        ENDM
;
; Swap current task out of execution, placing it on
; the ready list.  Control goes to the next ready task.
SWAPOUT:MACRO
        CALL    SUS?PND

        ENDM
;
; Place first waiter for a semaphore on the ready list.
; If none, increment the signal count.
SIGNAL: MACRO   semaphore
        LXI     H,semaphore
        CALL    SIG?S
        ENDM
;
; Signal a semaphore, with maximum count of 1.
FLAG:   MACRO   semaphore
        LXI     H,semaphore
        CALL    SIG?F
        ENDM
;
; Suspend task execution if and until semaphore has been signaled.
WAIT:   MACRO   semaphore
        LXI     H,semaphore
        CALL    WAIT?S
        ENDM
;
; If semaphore has been signaled, acknowledge and return non-zero.
CWAIT:  MACRO   semaphore
        LXI     H,semaphore
        CALL    WAIT?C
        ENDM
;
; Set condition codes to non-zero if semaphore has been signaled.
CKSEM:  MACRO   semaphore
        LDA     semaphore
        ORA     A
        ENDM
;
; Suspend caller for the number of ticks specified.
DELAY:  MACRO   ticks
        LXI     H,ticks
        CALL    ?DELAY
        ENDM
;
; Real-time clock tick handler.  Wake up tasks when it is time.
TICK:   MACRO
        CALL    ?TICK
        ENDM
;
;
;--------------------------------
;  Macros for internal kernel use.
;--------------------------------
;
?SAVE:  MACRO
        PUSH B
        PUSH D
        PUSH H
        ENDM
;
RE?STOR:MACRO
        POP H
        POP D
        POP B
        ENDM
```

Listing 2 continued on page 467

Listing 2 continued:

```
;
INT?OFF: MACRO
         if      INTS?
          DI
         endif
         ENDM
;
INT?ON:  MACRO
         if INTS?
          EI
         endif
         ENDM
;
RE?SUME: MACRO
         POP     PSW
         INT?ON
         RET
         ENDM
;
; Get new CURrent task from the list pointed to.
NEW?CUR: MACRO   pointer
         LOCAL   IDLE,OK
IDLE:    LHLD    pointer ;;Get head of list
         SHLD    ?CUR    ;;Make it new CURrent
         MOV     A,H     ;;Head of list NIL?
         ORA     L
         if      INTS?   ;;If so, wait for interrupt,
          JNZ    OK
          EI
          JMP    IDLE
OK:       DI
         else
          JZ     ?ERROR  ;;...or use fatal error exit.
         endif
         MOV     A,M     ;;Get next in list
         INX     H
         MOV     H,M
         MOV     L,A
         SHLD    pointer ;;...make it new head of list.
         ENDM
```

Text continued from page 454

A task is in the *blocked* state when it is waiting for either a semaphore signal or a delay time-out. Only a running task can become blocked; the task is then out of contention for microprocessor time until the specified event occurs.

Tasks in the *ready* state are in contention for the microprocessor simultaneously (but are not running). Only one task can execute at a time; the remaining tasks are in line to run when given a chance. Tasks are made ready when an event is signaled, a delay times out, or the running task gives up control voluntarily. When more than one task is ready, the task that was presented to the kernel first will be executed.

Data Structure

The 8080 kernel is based on the data structure in figure 4; in this figure the RAM (random-access read/write memory) area pointed to by STACK is divided into frames of equal size. Several bytes in each frame are used to save the stack pointer for that frame (SP), link to other frames to form lists (LINK), and save the start-up time during delays (TIME). The remainder of each frame is used as a stack in the normal 8080 manner.

In figure 4, the queue heads shown are pointers to (possibly empty) lists of frames, strung together by their LINK fields. Lists are maintained of ready, available, and delayed frames (and thus of their associated tasks). There is also a pointer to the current frame (the running task). Frames not presently allocated to tasks are available for use by dormant tasks being initiated. In the ready list, the newest arrival is placed at the end of the list. The frame at the head of the list (the one that has been ready the longest) is the one to go when the microprocessor becomes free. All tasks have equal priority.

A semaphore is a 3-byte structure in memory; 1 byte contains the signal count and the other 2 point to a (possibly empty) list of tasks waiting for signals. Two representative semaphores are shown in figure 4. One of them has no waiters (a nil LINK) but can have a nonzero count; the other has a single frame on its wait list.

Programming

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Payroll		320
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Piewriter/Standard	150	108
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Accounting + II SOE	395	289
Accounting + II POE	395	289
Accounting + II POS	395	289
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Versawriter Exp. Pak 2	40	30
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Visicalc	250	169
Visiplot	200	156

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Data Factory	300	216
Muse		
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Sierra On Line		
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Silicon Valley		
List Handler	90	68
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PFS: Graph	125	94
PFS: Report	125	94
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Utility Pak 2	99	65
Synergistic		
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MODIFIABLE DATABASE	80	59
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Visidex	250	194
Visifile	250	169

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80 Col Preboot Applewrite	19	15
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Algebra 3	40	30
Algebra 4	40	30
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Compu-Spell/ Data Disk 5	20	15
Compu-Spell/ Data Disk 6	20	15
Compu-Spell/ Data Disk 7	20	15
Compu-Spell/ Data Disk 8	20	15
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Accounting + IIE Payroll	395	289
Accounting + IIE SOE	395	289
Accounting + IIE POE	395	289
Accounting + IIE POS	395	289
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Visicalc	250	189

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dBASE II w/user's guide	729	419

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XLT 86	150	132

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Series 8 - PAK (AR,AP,GL)		
Series 80 PAK (GL,AR,AP) †	595	398
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Series 80 AP Videoterm †	400	275
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Select Word Processor	595	356
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Sensible Speller †	125	94
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Accounting + AP	645	398
Accounting + Inventory	645	398
Accounting + Payroll	645	398
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Suspended	50	38
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Zork II	50	38
Zork III	50	38
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Fortran 80 †	195	146
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ACT 68	175	126
ACT 69	175	126
ACT 80	175	126
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Pascal/M-86/88	495	356
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C Compiler	250	188

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Peachtree		
Series 9 - Telecom	375	258
Southwestern		
Z-Term †	100	75
Z-Term Professional †	150	109
Supersoft		
Disk Doctor	100	75
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20MB Hard Disk	4295	3495
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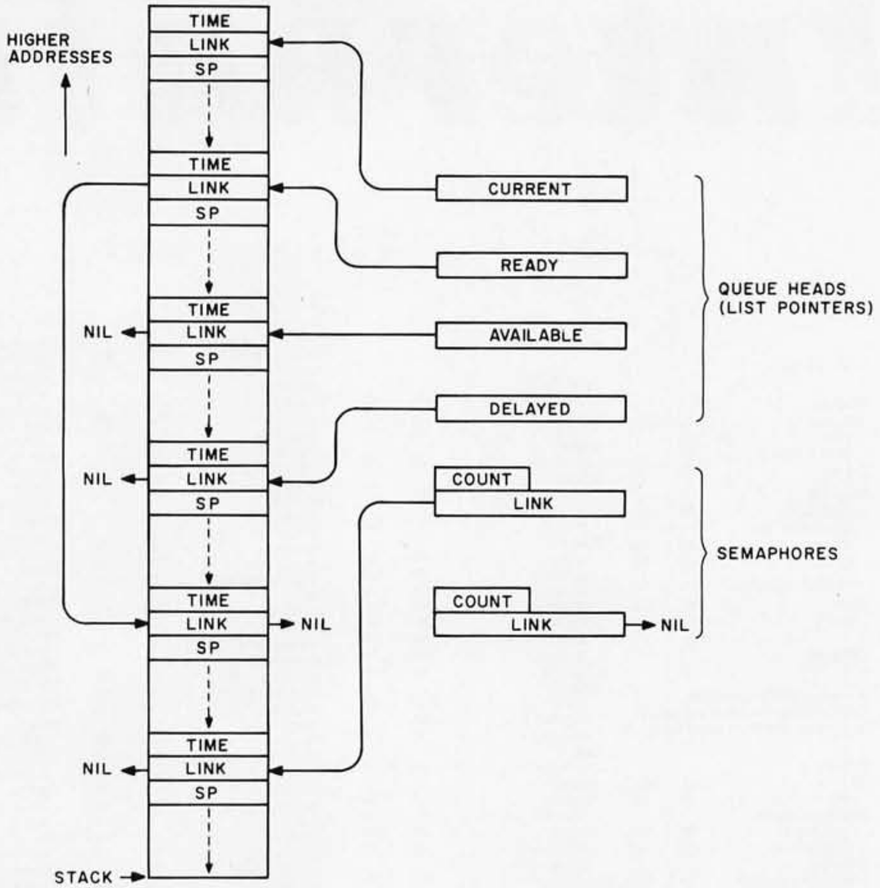


Figure 4: *The MTK80 data structures. A sample state is shown, involving six stack frames and two semaphores. NIL represents the end of a list.*

Function Calls

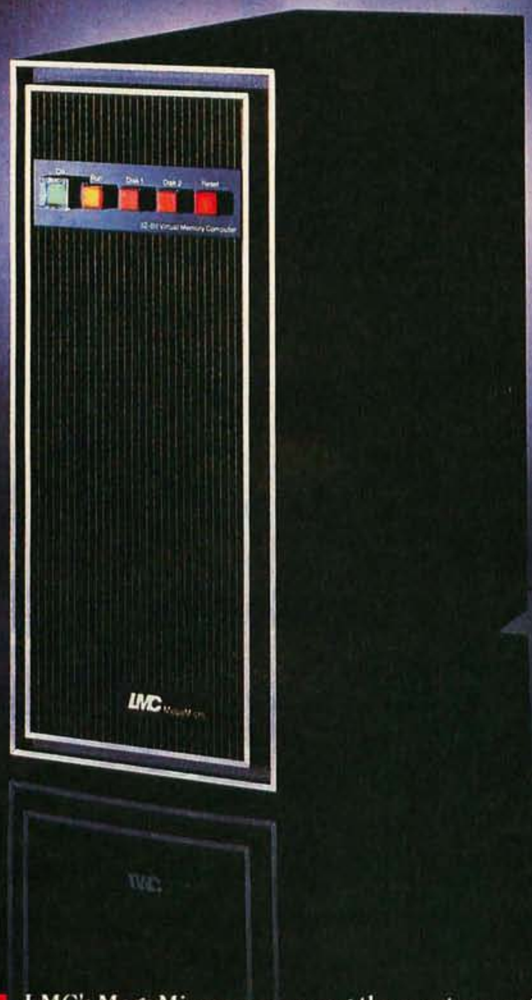
You establish the data structure and error exit by using the macroinstruction INITMT (listing 2). The macroinstruction sets the ready and delayed lists empty, puts all frames but one on the available list, and makes the remaining frame the currently running one. When INITMT is called, the (hardware) stack pointer must be valid. The default operating system stack is valid and can serve as the stack pointer. On the return from INITMT, however, the state of the machine has been completely altered, and the calling task has become a task with a fresh stack.

Semaphores are initialized by the INITSEM macroinstruction, which sets the count field to the specified initial value and sets the wait queue to empty.

The START macroinstruction gets a frame from the available list and makes that frame the new running task, beginning its execution at the address supplied. The calling task is put on the ready list. An interesting result of the dynamic connection between executable code and stack frames is that, as long as there are available frames, the same piece of (reentrant) code can be alive in several incarnations at the same time! Because the task started gets a copy of the creator's registers, it might be handy to have more than one identical task active, each with different initial register contents. In this way, you could pass parameters to new tasks on start-up; you could also use this method in the split-screen example to reduce the two nearly identical subscreen tasks to one routine.

A special case of the START macroinstruction is the TASK macroinstruction, which terminates the calling task and starts the new one. It is equivalent to resetting the stack pointer to the top of the current frame and jumping to the new starting address.

LMC MegaMicro 32-Bit Virtual Memory Microcomputers



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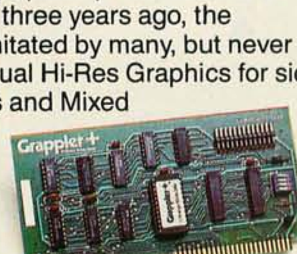

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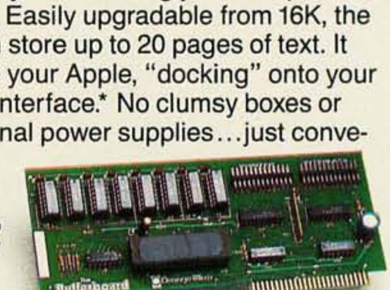

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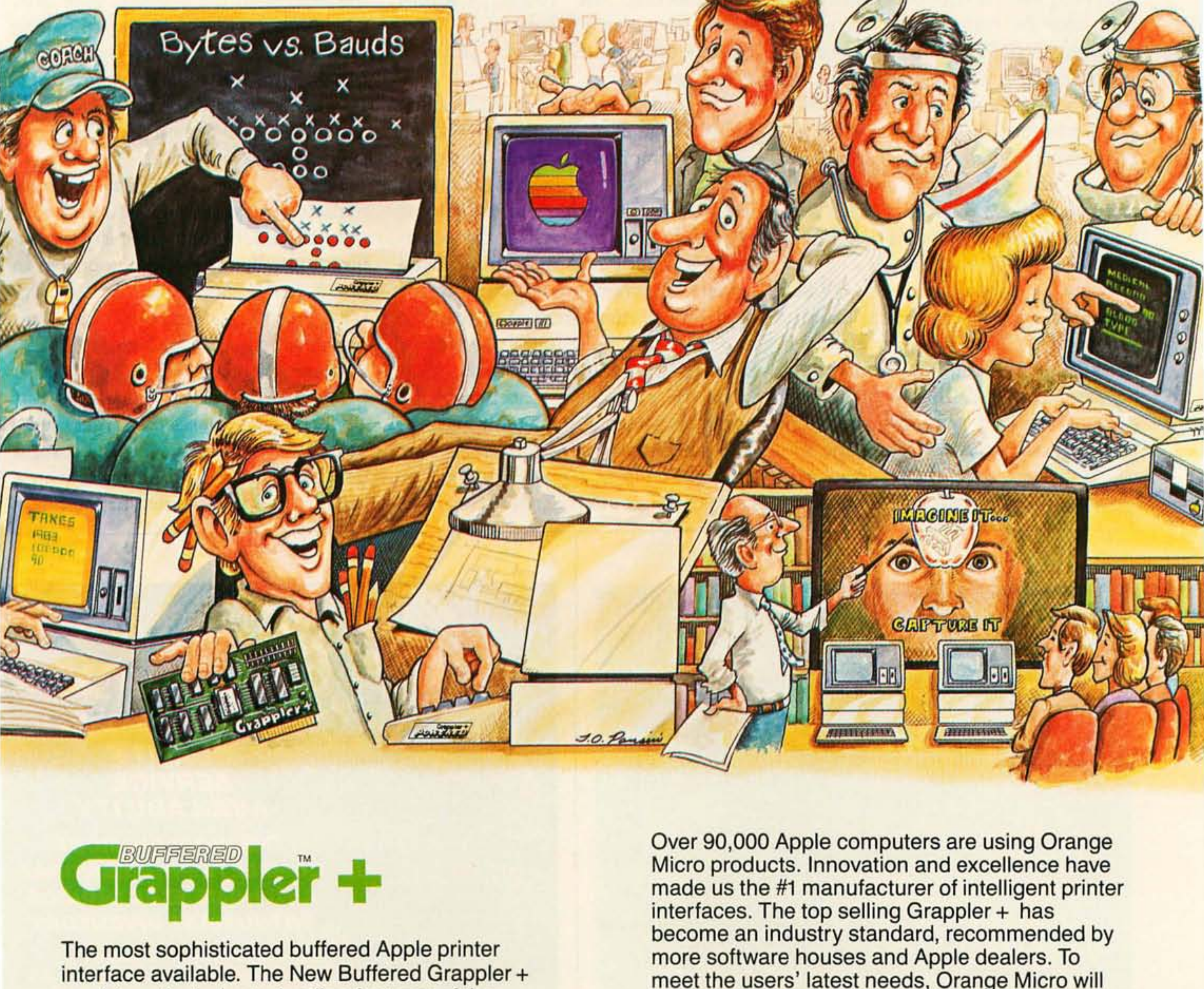

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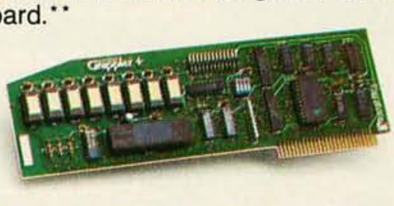

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The STOP macroinstruction terminates a task by returning the task's frame to the available list. The first frame on the ready list is removed and is run.

SWAPOUT puts the currently running task at the end of the ready list, swapping it for the one at the top of the ready list. As with other functions that take the current task out of execution, SWAPOUT first pushes the return address and registers onto the stack, saves the stack pointer (at SP), and performs the optional stack overflow check. When a new current task is selected, its stack pointer is restored, followed by its register contents. It is then allowed to resume execution where it left off.

Using a semaphore, the WAIT macroinstruction enables a task to synchronize itself with an event. If the semaphore count is nonzero, it has been signaled (the event has occurred), and the count is decremented, acknowledging the signal. If the count is 0, the task becomes blocked; the current frame is added to the end of the semaphore queue list using its LINK field, and the next ready task begins execution.

Two special cases of WAIT are CWAIT and CKSEM, both of which return the status of the semaphore in the Z flag (nonzero if signaled). CWAIT acknowledges a signal by decrementing the count; CKSEM leaves the count unchanged. Control returns immediately to the caller in either case.

The complement of WAIT is the SIGNAL macroinstruction, which uses a semaphore to signal an event. If any tasks are waiting for the event, the first one is moved to the end of the ready list. Otherwise, the semaphore's count of unacknowledged signals is incremented. No check for overflow of this count is made (the maximum is 255). Another version of SIGNAL is FLAG, which works in exactly the same way except that it never increments the count past 1. This behavior is appropriate for mutual exclusion semaphores and for preventing count overflow. Neither SIGNAL nor TICK takes the calling task out of execution.

The DELAY macroinstruction puts the calling task on the delayed list, thereby blocking it until the specified number of system clock ticks have passed. The delayed list is ordered according to the length of time requested, with the shortest time first. The proper placement of the calling task in the list is handled by DELAY, because this somewhat complex insertion needs to be done only once. The next ready task is then placed into execution.

DELAY uses a 2-byte counter register. Because this counter rolls over at 65,536, that value is the maximum number of cycles supported in one DELAY call. The register contains only a relative count that is incremented once by each call to TICK. Because the task with the shortest delay is at the top of the delayed list, TICK then compares the target wakeup time of that task with the current tick count. Any and all tasks whose time is up are appended to the ready

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Listing 3: *This program illustrates how you can use MTK80 macroinstruction calls. This example, for use with a North Star Horizon, simply runs four tasks, each of which merely identifies itself when it runs.*

```
        ORG     100H
;
        JMP     MAIN
;
;==================================================
; ]----->>  INSERT THE KERNEL FILE mtk80.asm HERE.
;==================================================
;
;  Kernel stack structure parameters.
FRAMES: EQU     6                       ;Specify the number of stack frames
FRSIZ:  EQU     64                      ;Specify the size of each, in bytes
ERR@JMP:EQU     0EB00H                  ;Choose a place to jump on fatal error
;
; North Star Horizon real-time clock equates.
RST2:   EQU     2*8                     ;Choose clock interrupt at RST vector 2
ARM:    EQU     0C0H                    ;Clock interrupt arm code
DISARM: EQU     40H                     ;Clock interrupt disarm code
CLK$RST:EQU     50H                     ;Clock flip/flop reset code
CLK$PRT:EQU     6                       ;Clock I/O port
;
; CP/M equates.
BDOS:   EQU     5                       ;BDOS call address
CONST:  EQU     11                      ;Keyboard status check code
COUT:   EQU     2                       ;Console output code
EXIT:   EQU     0                       ;CP/M restart address
;
;.Kernel stack and semaphore data area.
STACK:  DS      FRAMES*FRSIZ
SEMA:   DS      3
;
; Example main program.
MAIN:   INITMT  STACK,FRAMES,FRSIZ,ERR@JMP      ;Set up kernel
        MVI     A,JMP
        STA     RST2
        LXI     H,CLK$INT               ;Set clock interrupt handler jump vector
        SHLD    RST2+1
        MVI     A,ARM                   ;Enable clock interrupts
        OUT     CLK$PRT
        INITSEM SEMA,0                  ;Initialize the sample semaphore
        START   TASK1
        START   TASK2                   ;Start the simultaneous tasks
        START   TASK3
        START   TASK4
TASK0:  SWAPOUT                         ;While polling, let other tasks run
        MVI     C,CONST
        CALL    BDOS                    ;Check the console keyboard
        ORA     A
        JZ      TASK0
        SIGNAL  SEMA                    ;When a key is hit, signal TASK4
        STOP                            ;  then quit this task -- the job is done.
;
; This task has nothing to do but wait to die.
TASK4:  WAIT    SEMA                    ;Sleep until signaled
        MVI     A,DISARM
        OUT     CLK$PRT                 ;Disable clock interrupts
        JMP     EXIT                    ;Terminate the program
;
; Tasks 1-3 identify themselves by number at different intervals.
TASK1:  DELAY   700
        MVI     E,'1'
        CALL    CONOUT
        JMP     TASK1
;
TASK2:  DELAY   900                     ;Delay 900 clock ticks
        MVI     E,'2'
        CALL    CONOUT                  ;Send identifing number to screen
        JMP     TASK2                   ;Loop "forever"
;
TASK3:  DELAY   1100
        MVI     E,'3'
        CALL    CONOUT
        JMP     TASK3
;
; Clock interrupt handler.
CLK$INT:PUSH    PSW
        MVI     A,CLK$RST               ;Clear the interrupt
        OUT     CLK$PRT
        POP     PSW
        JMP     ?TICK                   ;Activate delayed tasks whose time is up
;
; Send character in register E to the console screen.
CONOUT: MVI     C,COUT
        JMP     BDOS
;
        END
;
```

list. The current task then resumes execution, whether it called TICK or was interrupted.

Applications

Listing 3 contains a skeletal example of the declaration of data structures and the use of kernel macroinstruction calls. Refer also to the comments in listing 2 for details of ways to use the routines. If you have no macroinstruction facilities, use the macroinstruction definitions as a set of instructions for calling the kernel routines explicitly.

I used a Z80 version of this kernel for more than three years in my ham radio teletype (RTTY) communications program. The kernel made it easier for me to include features such as a split-screen display, continuous time and modem-frequency monitoring, and the reading and writing of a circular disk log file while transmitting and receiving.

I have written a related kernel in BDS C (B.D. Software C) for inclusion in a CP/M RTTY program. Expansion to allow monitoring of multiple communication channels (VHF, HF, telephone, packet radio, and satellite) is a natural application of multiple concurrent tasks. ■

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Jerry Holter (2329-B Hilgard Ave., Berkeley, CA 94709) is a senior engineer at Ampex Corporation in Redwood City, CA. He is involved with real-time microprocessor servomechanism control.

The author would like to thank David Altekruse, Ron Porat, and Robin Gurse for their support and assistance in the preparation of this article.

User to User

Conducted by Jerry Pournelle

Jerry Pournelle's User's Column generates a lot of mail. In this space, Jerry will answer readers' questions on a regular monthly basis.

The MULTICS Operating System

Dear Jerry,

In your March column ("A User's View of Comdex," page 44) you mentioned the concept of an Executive Secretary program that would allow interruption of an editing task in order to run another program without destroying the file being edited.

I, too, have wished for such a facility. Though I have not seen it on a micro, I can vouch for the fact that this facility is every bit the pleasure you anticipate. The Honeywell MULTICS operating system is so designed. In fact, it is possible to interrupt *any* program being run and return to it later (providing, of course, that you have altered none of the files being used by the interrupted program).

The MULTICS solution is quite elegant. When a command is typed into the terminal, it is interpreted by the command processor not as a program to execute but as a call to a (usually PL/I) *procedure*. Using predefined search rules, the procedure is located in the file system hierarchy and then actually called. (The syntax of commands even provides for the interpreter to pass text typed after the "command" or procedure name to be passed to the procedure as actual parameters.) Moreover, the entire system is constructed to allow unlimited recursion. Thus, no matter where you are, the command processor (also a PL/I procedure) may be called—hence, so can any procedure.

This method is not without cost. It is because of this feature that MULTICS is an incredible money and resource sink. Large amounts of virtual memory can be consumed when multiple users have a large call stack. But it is arguably the single best feature of MULTICS. It is interesting to note that although many features of Unix come from MULTICS, this one is not part of the Unix system. It is a shame that a cost-effective way to implement this feature could not have been found during the design of Unix.

James E. Densmore Jr.
503 Timber Lane
Falls Church, VA 22046

Instead of looking to Unix, I predict that concurrent CP/M-86 will enable us to write Executive Secretary for 8086 machines. . . . **Jerry**

Valdocs Revisited

Dear Jerry,

In Response to "Epilogue: A Look at Valdocs" (August, page 442), most of your requests are valid. However, numbers 4, 5, and 7 are already implemented (version 1.16 as of June 1, 1983). In fact, #4 exists in every copy of the editor that you have ever seen, and it is documented. Also, top and bottom margins are changeable and always have been. However, only one set of top and bottom margins may be used in any one document (until version 2.0). If one needs to leave space on page 1 for a company logo, carriage returns work very nicely—after all, the editor is truly what you see. . . .

Most of your other requests will have been implemented by version 2.0 of the editor. Of those listed, numbers 1, 2, and 3 will certainly be included. I'm not at liberty to reveal the release date of this product, but I can say *soon*.

Additionally, as you know, the perceived slowness of the editor is primarily a by-product of using a bit-mapped display. The benefits are obvious—multiple fonts, underlining, and eventually merged graphics and text can only be done bit-mapped. The cost is speed. Compared to Lisa's editor, it's fast. Compared to most editors, it's adequate. Compared to the fastest, it's slow. But we have made some rather interesting breakthroughs that will speed up most of the editor's functions to among the best by version 2.0. I suspect that even you will be pleased.

Chris Rutkowski
President
Rising Star Industries
24050 Madison St., Suite 113
Torrance, CA 90505

Valdocs is the closest thing I've seen to the Executive Secretary program I described in a previous column. Because I like the concept a lot, I wish Valdocs all success, but alas, so far I have no version that my people find acceptable. I first tried the Epson out on John Carr, my long-suffering editorial associate. After he gave up and reclaimed his Selectric, the Epson sat in lonely exile over in one corner of our living room. Finally, Roberta and our son Richard (13) set up the Epson with a new version of Valdocs that fixed some silly bugs in the earlier distribution versions. The new version was a little better, but the Valdocs program is so painfully slow that it will eventually drive you mad. Also, there are ways to lock up the system. I don't know all of them because Roberta didn't keep notes, but it happened to her. The bottom-line result is that she's not interested in returning to the Epson. I've previously concluded that the Epson Valdocs software is a noble try that pushes the Z80 chip beyond its limits. I have no reason to change that view. . . . **Jerry**

JRT Version 3.0

Dear Jerry,

I thought you might be interested in my experience with JRT Pascal. I

had a lot of trouble with version 2.x and was about to give up on the language entirely until I had occasion to use a friend's version 3.0. What a difference! I have no trouble compiling "standard" Pascal programs with the new version.

For example: I compiled and ran your matrix multiplication program flawlessly (it executed in 87 seconds); the same is true with Jim and Gary Gilbreath's Erastosthenes Sieve program (472 seconds) on my Osborne 1. What I am leading up to is this: why don't you and Alex give JRT version 3.0 a shot? I'd really like to see Alex's introductory package come out for JRT Pascal.

Enclosed are the results when running your "Silly" program on version 3.0 (see listing 1). I think the error message in version 3.0 is just as meaningful as those of Pascal/M and Pascal MT/+. And once you get used to it, you know the error occurred on the line after the last one it tried to compile—so it's just as easy to find.

O. H. (Jack) Adams
33 Briarwood Court
Walnut Creek, CA 94596

JRT version 3.0 does seem considerably improved over the earlier version. We'll have to examine it again. However, it is still nothing like standard, so programs written in JRT aren't likely to work with any other compiler. . . . **Jerry**

Listing 1:

```
Program Silly (output):              A>JRTPAS3 B:SILLY1.P
  BEGIN                              JRT Pascal ver 3.0
    Writeln( 'Hello, World' );       Copyright 1983 JRT Systems
    Writeln( 'Foo' );                0000      0001:      Program Silly (output);
    Writeln( foo );                  0000      0002:
    Writeln( 'Hello again!' );       0006      0003:        BEGIN
  END {silly}.                       001A      0004:          Writeln( 'Hello, World' );
                                     0025      0005:          Writeln( 'Foo' );

%Warning: Invalid variable or data type declaration
%Error: Syntax error — unrecoverable
```

Transferring Files to Otrona Disks

Dear Jerry,

In your January column ("Burnouts, Bargains, and Two Sleek Portables," page 438) you state that the "Attache has simple ways for getting stuff to and from your 8-inch disks" and that transferring files is easy, as attested by your column's existence, written on the Attache in Europe (in part) and transferred on your return. In the documentation for my Attache I cannot find a way to transfer files. My dealer says (and one manual confirms) that I must buy Softcom to do this. Personally, I would much prefer to use Modem7 or some other utility, but at the moment I do not have a way to get a public-domain program into the Otrona format.

Is it necessary to have a modem-type utility (or Softcom by Otrona, at $150) to transfer files to Otrona disks?

Tom Flagg
547 Tilden Ave.
Teaneck, NJ 07666

We use the File Transporter from Workman and Associates. Modem7 is in the public domain; Workman has obtained permission to include it with the Transporter.

You could probably get Modem7 for the Otrona from a club or users group, but I don't know of one at the moment. . . . **Jerry**

Toward Computer "Literacy"

Dear Jerry,

I'm considering buying our family's first personal computer, and I want to read about the latest applications and available products.

One question of particular importance concerns my two sons (ages 15 and 13) and their computer "literacy." We have read enough of your articles and other primers (e.g., Adam Osborne and Peter McWilliams) to realize how computer dumb we are. It will take some more research—and budget reviews—to determine what we buy. Before then I'd like my boys to get some "hands-on" education.

The local high school offers computer courses, but there's a catch. I hesitate to have my sons learn some fundamental aspects which, as you quoted Professor Dijkstra, would later have to be painfully "unlearned." Should my sons, for example, learn BASIC and FORTRAN as their first languages? I want to encourage their enthusiasm for hands-on training, but I hesitate about the high school's curriculum. What are your views?

David E. Goode
6454 Dryden Dr.
McLean, VA 22101

I don't see how anyone is harmed by learning BASIC, and your school's courses sound like a very good start. And although limited in scope, a Sinclair is a good machine to begin on. . . . **Jerry**

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed stamped envelope to Jerry Pournelle, c/o BYTE Publications, POB 372, Hancock, NH 03449. 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.

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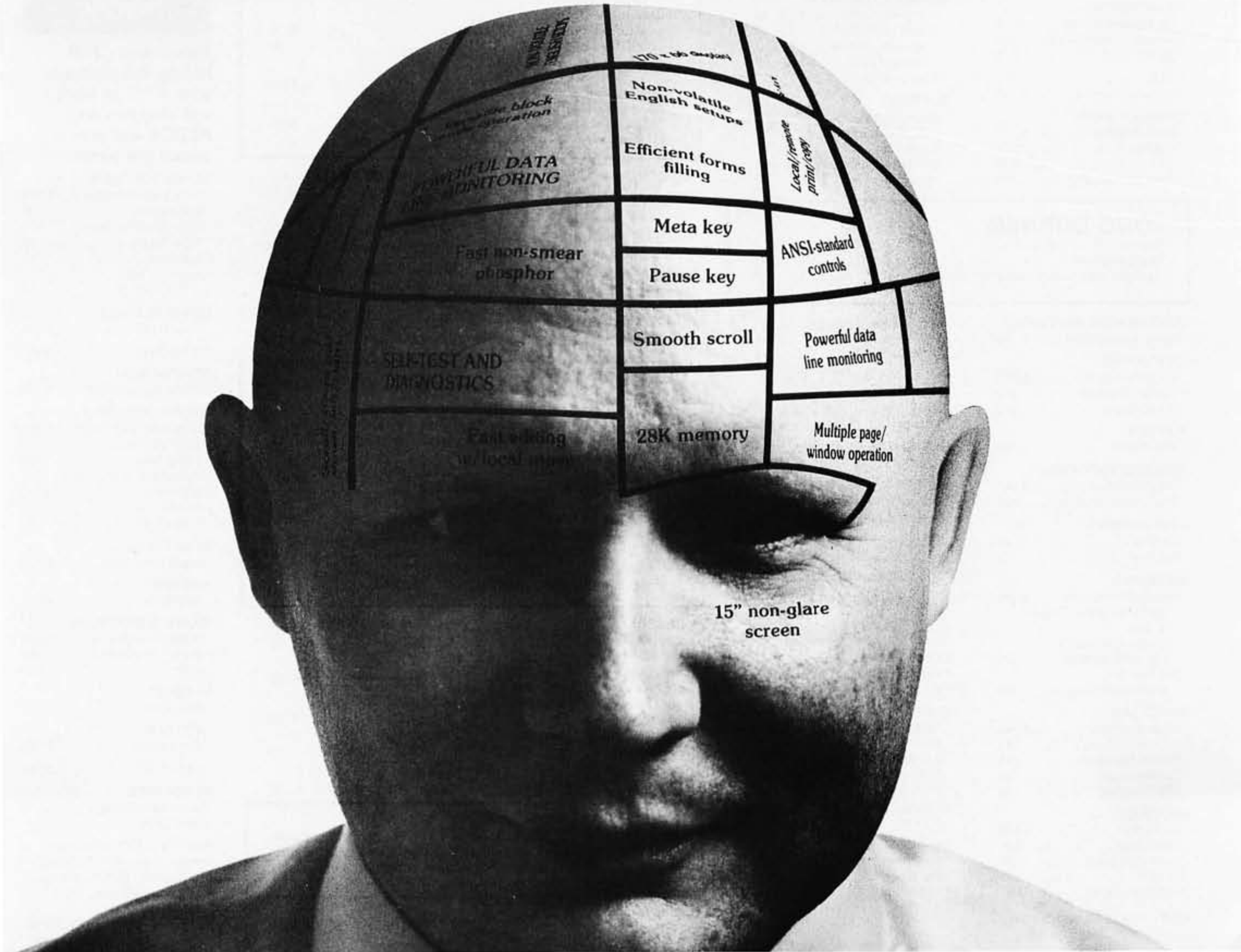

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Book Reviews

The Handbook of Artificial Intelligence, Volume 2

Avron Barr and Edward Feigenbaum, eds.
William Kaufman Inc.
Los Altos, CA, 1982
428 pages, $35

Reviewed by
Henry W. Davis

The Handbook of Artificial Intelligence, a three-volume overview of artificial intelligence (AI), presents basic AI accomplishments and techniques so that people need not be specialists in the field to understand them. Volume 2 (discussed here) covers AI programming languages, AI applications to science, medicine, and education, and automatic programming. (For a review of volume 1, see the July issue, page 450. Volume 3 will be reviewed at a later date.)

Volume 2's extensive bibliography (through early 1981) provides direction to basic material as well as research papers and is useful for novices and experts alike. The articles are carefully edited and work together quite well. Elaborate cross-referencing lets you skip to a specific topic of interest.

Languages

AI programming languages, the first topic in volume 2, have been heavily influenced by LISP, the dominant AI programming language today. It is therefore appropriate that the authors devote considerable effort to explaining the useful features of this language. Other influential languages covered are PLANNER, CONNIVER, QLISP, SAIL, POP-2, and FUZZY. PROLOG and LISP-machines are not discussed.

Early programming languages dealt mainly with useful ways to process numerical data. In contrast, LISP was developed to manipulate symbolic expressions, making it more suitable for the needs of AI programming.

LISP has endured as an important tool over the years for a number of reasons. First, its main data structure consists of multilevel lists, providing LISP with a powerful and flexible way to represent complicated knowledge, and LISP allows lists to change in structure and size during program execution. Furthermore, LISP's emphasis on recursion allows it to simplify the handling of many problems.

The control structure of LISP consists primarily of function composition. One effect is to encourage interactive development of complicated programs. Functions are easily replaced or enhanced on the spot.

LISP programs and data have the same syntax. Programs may pass other programs as data or read programs from a database. Such data may be executed by the receiving program because LISP supports a primitive function that is itself a LISP interpreter. Programs may construct other programs (and run them) and analyze other programs, or themselves.

In PLANNER, a program's statements consist of "theorems" that describe strategies for achieving certain goals given a set of preconditions. Theorems also give contingency plans if specified situations arise. When a program is run, PLANNER searches through its database of assertions and theorems, attempting to solve a user-specified goal.

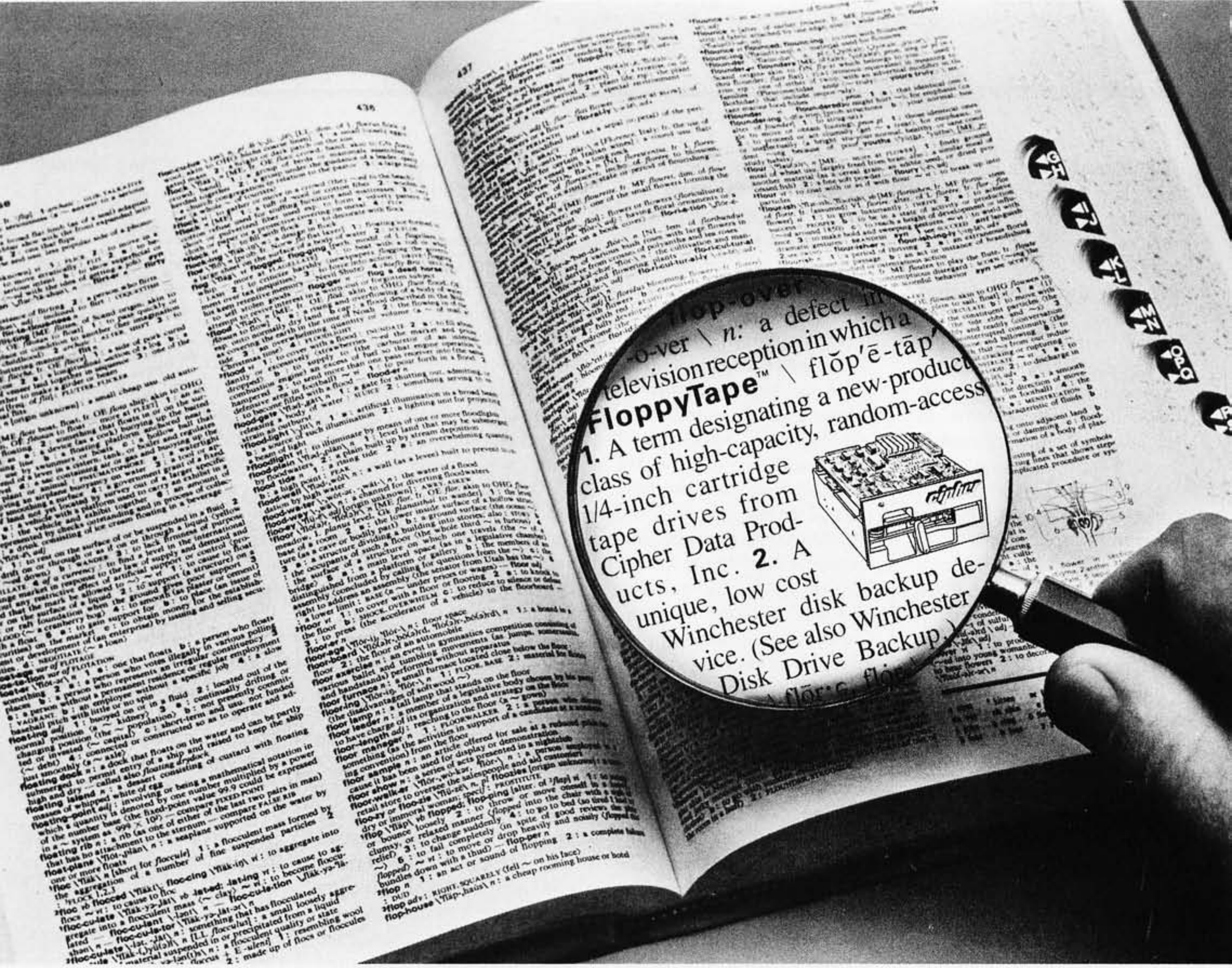
CONNIVER and QLISP extend this to give the user more control over the search process. QLISP's capabilities include resolution-based theorem proving, a powerful inference technique.

FUZZY allows the user to associate certainty values to assertions in the database. These numbers are manipulated as goals are sought from the database. Final conclusions also have measures of certainty associated with them.

Expert Systems

Expert systems (ESs) are programs that help solve complex, real-world problems in such areas as science, engineering, and medicine, thus minimizing the need for expensive human help. They work with large amounts of *domain knowledge* (facts and procedures, gleaned from human experts, that have proved useful in certain specialties) and several of these systems have a level of expertise comparable to or exceeding that of a good human professional.

The *Handbook* devotes a chapter each to ESs in science, medicine, and education. In no other single source can you find such a comprehensive overview of ES technology. Articles in these chapters cover noteworthy systems in each domain. Each article attempts to describe the problem, the knowledge used to solve it, the AI methods that were used to represent and manipulate that knowledge, the level of expertise obtained, and future prospects for the program and those methods. A large variety of systems are described, usually with great clarity. (You may find it help-



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ful to read the material on search and knowledge representation in volume 1 before reading the ES articles.)

Science and Engineering

Science and engineering have historically been a favorite application domain for expert systems. The *Handbook* describes systems in chemistry, geology, mathematics, and database management. To give the flavor of the text, I'll discuss two of the chemical applications.

Current ES technology evolved from the DENDRAL project, started at Stanford University in 1965. The project was intended to show that algorithmic procedures that produce results exhaustively and at enormous expense could be augmented by the heuristic knowledge of experts to produce similar results at a fraction of the cost. From this highly successful project scientists isolated some key questions for what soon became ES technology: How does one obtain from human experts the large amounts of knowledge needed to simulate their expertise? How does one represent this knowledge? What are effective ways to manipulate and control the use of this knowledge?

Input to DENDRAL consists of the atomic constituents of a molecule along with mass spectrometric data. This information describes how molecules of a particular substance fragment when they are subject to intense heat. DENDRAL's output is a ranked list of possible structures for the molecule. Such information is extremely useful in many chemical applications but typically requires many man-hours of effort by experienced chemists.

In DENDRAL, expert knowledge about interpreting mass spectrums is represented in *rules,* which are statements in the form "if *a* is true then take action *b*." Rules are used to build constraints on the set of molecular structures that might have produced the mass spectrum data. After a candidate list of molecular structures is generated, more rules are used to simulate or test the mass spectrum of each candidate so the list may be pruned and properly ranked. Many aspects of the DENDRAL program became common ingredients in later ESs: especially the "generate and test" paradigm and the use of rules to represent sophisticated human knowledge.

Another fascinating program that uses rules to represent complicated knowledge is Gelernter's SYNCHEM, developed at State University of New York at Stony Brook. The input to SYNCHEM is the structure of an organic molecule. The program seeks a sequence of reactions useful to the laboratory or industrial chemist for synthesizing the input molecule. A typical synthesis route consists of a chain of 3 to 20 reactions beginning with readily available compounds. Reactions are represented as rules. Starting with the goal molecule, rules are applied backwards in a heuristic search for shelf compounds. Finding workable synthesis routes is complicated for humans. Gelernter has had some success in automating it and his work looks very promising.

Medicine

Nearly a score of medical AI systems have been built since the mid-1970s; the *Handbook* surveys seven. Most of these systems focus on medical diagnosis. Typically the physician enters a patient's symptoms, laboratory data, and other findings in a dialogue with the computer. The ES infers a likely disease or combination of diseases, often explaining its reasoning. In some cases therapy is recommended. Today's systems operate in narrow areas of medicine such as bacterial infection or aspects of internal medicine. Some of them have received very favorable ratings compared with human experts. In addition to diagnostic systems, ESs have been built for other medical purposes, such as drug-regimen determination.

The design techniques of AI medical systems vary considerably. Most of the knowledge-representation schemes described in volume 1 of the *Handbook* occur in one system or another. Search procedures are exhaustive rather than heuristic because of the small size of the databases and the potentially serious consequences of missing applicable information.

The items of knowledge used in medical reasoning are often, in fact, judgments. There may be competing evidence for and against a certain hypothesis. AI systems deal with this by attaching "weights" or "certainty factors" to information. For example, weights may be numbers between -1 and $+1$ where -1 means "known to be false" and $+1$ means "known to be true." Rules for combining weights are applied when the system must reason with uncertain knowledge. A hypothesis will be viewed as true when its weight exceeds some specified threshold.

Only one AI diagnostic system is reported to be in routine clinical use. However, several appear to be close to this stage. To account for this lack of use, many observers claim that physicians will not use computer diagnostic aids when they feel they are already performing adequately.

Education

Programs that interact directly with students in an effort to promote and control learning in a particular subject are called computer aided instruction (CAI) and have their roots in the 1960s. In the first such programs, the student was typically given some instructional text (possibly on line) and then asked brief questions about it. The student's answers determined what further questions and text would be presented. The courseware author attempted to anticipate all patterns of wrong responses and use them to specify branches to appropriate remedial material. Some very sophisticated systems use this technique.

AI ideas of the 1970s have led to work on much more ambitious systems called knowledge-based or intelligent CAI (ICAI) programs. Such systems have three main components. The *expertise module* generates problems and evaluates the correctness of the student's solutions. In some cases this module reasons much like a conventional noneducational ES. The *student model module* maintains a representation of how well the student understands the skills being taught, plus related information (for example, student goals or what he or she tends to forget). The *tutoring module* integrates information from the other modules with teaching strategies to affect the learning process.

The *Handbook* describes eight ICAI systems in such varied areas as geography, medicine, electronics, programming, arithmetic, and university-level logic. In addition to their potential usefulness, these systems provide striking insight into the

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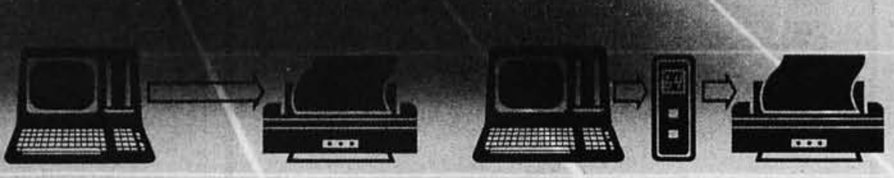

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teaching-learning processes.

Automatic Programming

Automatic programming (AP) refers to a program or system of programs that enable users to specify a programming task to the computer on a very high level. This may mean that only the desired effect of the program is described (or partially described), or the intended effect and some of the methodology is specified. AP aims to allow the programmer to specify the task much the same way a manager specifies a task to a programmer.

At the foundation of AP is the idea that the program should know both the problem domain and the principles of programming so well that it can fill in the details. An ideal AP system should provide an efficient, correct program. Because much of today's software is costly and unreliable, the benefits of such goals are unquestionable.

Some impressive AP systems have been written within restricted problem domains. For example, George Heidorn's NLPQ program determines the specifications for queuing problem simulations via an English dialogue with the user. It outputs programs written in GPSS. Systems with larger problem domains (for example, nonnumeric programming) are much less understood. In today's technology such systems work on only short programs in a few subclasses of their intended domain. We are a long way from being able to write an operating system via AP.

AP research falls into two major areas. One covers the *specification problem*, which is concerned with translating partial or ambiguous user input into complete and unambiguous specifications. A major obstacle to applying AP concepts to complex problems is determining a specification language that is easy to work with but forces users to be complete, consistent, and unambiguous. Such formal methods do not seem to reflect the way humans usually understand and describe programs. Some experimental systems have dealt with this by allowing users to describe their programs via some or all of the following: sample input-output pairs, traces (descriptions of how certain data structures change when certain decisions are made), English, and mixed-initiative English dialogue with the system. These are called informal specification methods. Systems using them must have knowledge of the problem domain and of programming concepts in order to make the transformation into complete specifications.

The other major area of AP research, the *synthesis problem*, is concerned, with generating the target program once a complete and unambiguous description of the specifications has been obtained. Several approaches have been undertaken. One of these is illustrated by the PECOS and LIBRA modules within Cordell Green's PSI system at Stanford University. PECOS contains hundreds of rules that may be applied to a program specification. Each rule alters the program, to varying extents, producing a refinement. Rules applied to refinements produce further refinements. By successive application of rules, PECOS attempts to move the original program specification into a target-language implementation. A rule may be applied only if its "if condition" matches some part of the current refinement. Of course, sometimes several rules apply. This method generates a tree of refinements rooted in the original specifications. PECOS expands leaf nodes in that tree in its searach for an implementation.

LIBRA, whose knowledge is also based on rules, analyzes and guides the development of the refinement tree to achieve an efficient implementation. Plausible implementation rules tell what type of data structures to use. Cost analysis rules estimate (with certainty factors) the expected efficiency of an implementation obtained by successive refinements of a given node. Other rules describe when to shift attention to different nodes in the tree.

The PSI system has been successful with a number of short programs in certain areas of nonnumeric computing.

Conclusion

No book is perfect, and volume 2 of the *Handbook* does have a few problems. Some articles on overlapping topics do not mesh well, and sometimes examples are not clear. I found five references in the text whose entries are missing from the bibliography. (The bibliography contains nearly 400 items.)

Overall, these problems are trivial and may be corrected when the *Handbook* is updated. Like Volume 1, this volume succeeds in explaining AI in a way that is useful to both novice and expert. Doubtless the *Handbook* will become a basic AI reference.■

Henry W. Davis is a professor of computer science at Wright State University, Dayton, OH 45435.

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Book Reviews

Starting FORTH

Leo Brodie
Prentice-Hall Inc.
Englewood Cliffs, NJ,
1981
348 pages
softcover, $17.95
hardcover, $22.95

Reviewed by
Thomas Clune

Any examination of FORTH quickly leads to *Starting FORTH,* written by Leo Brodie, a technical writer for FORTH Inc. (the Poly-FORTH people) and editor of *FORTH Dimensions,* the FORTH Interest Group publication. *Starting FORTH* is the only widely recommended book specifically on the language for two reasons. First, the book is authoritative and comprehensive; second, it has no real competition.

This is a serious and substantial work, but the first thing you notice is Brodie's cartoon illustrations throughout. What are they doing there? Alas, the answer is "Nothing." The line drawings do not help the reader at all. In fact, they are merely distractions. Similarly, Brodie suffers from the apparently universal characteristic of FORTH programmers, a propensity toward obvious puns.

Despite these irritations, the book is impressive. Encyclopedic in scope, it lists and illustrates the use of every standard FORTH word and catalogs differences between FORTH dialects. As you'd expect from the author's background, the unique features of Poly-FORTH are especially well documented. Brodie clearly explains the reasons for deviations from and additions to the FORTH-79 standard. I particularly appreciated this feature; such explanations are unfortunately rare. Further, the book is loaded with excellent hints and advice on working with FORTH. It also includes clear, brief expositions of such key FORTH concepts as factoring.

It includes much more, but that's the problem. By doing a bit of everything, *Starting FORTH* fails to do anything properly. It could be unbundled into two or three very good books on FORTH, but as a combination operator's manual, tutorial introduction, and programmer's handbook, it has no focus. The book's tone is predominantly tutorial, but it is too comprehensive to be a good FORTH tutorial. Yet as a reference book, it suffers from the tutorial motif. And it is indexed in the manner of a FORTH reference manual—by FORTH words only. As a result, if you're trying to track down that handy hint on loading a stubborn block, you won't get any help from the index.

Brodie appears to have tried to fill the void of published material on FORTH with this one book. The result is that the reader is more impressed with Brodie's understanding of FORTH than educated by his book. Not that the book is poorly written—in general, each subject is explained clearly and well. The problem is with the organization of the whole. The book needs a major editing job to give it focus, and it desperately needs a real index. Nonetheless, if you want to learn FORTH, you will need this book. ■

Thomas Clune is physical-chemistry laboratory coordinator for the Chemistry Department of Brandeis University, Waltham, MA 02154.

Books Received

American National Standard Pascal Computer Programming Language. New York: Institute of Electrical and Electronics Engineers Inc., 1983; 128 pages, 18 by 26 cm, hardcover, ISBN 0-471-88944-X, $17.95.

An Apple for the Teacher, Fundamentals of Instructional Computing, George Culp and Herbert Nickles. Monterey, CA: Brooks/Cole Publishing Co., 1983; 256 pages, 18.5 by 23.3 cm, softcover, ISBN 0-534-01378-3, $15.95.

Apple Machine Language, Robert D. Rosen. New York: Holt, Rinehart and Winston, 1983; 256 pages, 18.8 by 23.3 cm, softcover, ISBN 0-03-063336-2, $19.95.

Atari Programming with 55 Programs, Linda M. Schreiber. Blue Ridge Summit, PA: Tab Books, 1982; 254 pages, 19.5 by 23.3 cm, softcover, ISBN 0-8306-1485-0, $13.95.

BASIC for Business for the VAX and the PDP-11, 2nd ed., Val Silbey and Alan J. Parker. Reston, VA: Reston Publishing Co., 1983; 272 pages, 18 by 24 cm, hardcover, ISBN 0-8359-0358-3, $21.95.

BASIC Exercises for the Atari, J. P. Lamoitier. Berkeley, CA: Sybex, 1983; 272 pages, 17.8 by 22.8 cm, softcover, ISBN 0-89588-101-2, $12.95.

BASIC Programming Primer, 2nd ed., Mitchell Waite and Michael Pardee. Indianapolis, IN: Howard W. Sams & Co., 1982; 378 pages, 14.8 by 22.8 cm, spiral-bound, ISBN 0-672-22014-8, $17.95.

Before You Buy a Computer, Dona Z. Meilach. New York: Crown Publishers Inc. (One Park Ave.), 1983; 224 pages, 18.5 by 22.8 cm, softcover, ISBN 0-517-54733-3, $8.95.

CDP Review Manual: Data Processing Handbook, 3rd ed., Kenniston W. Lord Jr. New York: Van Nostrand Reinhold, 1983; 512 pages, 21 by 27.8 cm, softcover, ISBN 0-442-26087-3, $29.95.

Choosing a Word Processor, Phillip I. Good. Reston, VA: Reston Publishing Co., 1982; 209 pages, 15.5 by 23.8 cm, hardcover, ISBN 0-8359-0761-9, $18.95.

COMAL Handbook, Len Lindsay. Reston, VA: Reston Publishing Co., 1983; 336 pages, 17 by 23.5 cm, spiral-bound, ISBN 0-8359-0878-X, $18.95.

Computer Network Architectures, Anton Meijer and Paul Peeters. Rockville, MD: Computer Science Press Inc., 1983; 418 pages, 15 by 23.5 cm, hardcover, ISBN 0-914894-41-2, $27.95.

Concise Encyclopedia of Information Technology, Adrian V. Stokes. Englewood Cliffs, NJ: Prentice-Hall, 1983; 288 pages, 22.8 by 15.3 cm, softcover, ISBN 0-13-167205-3, $9.95.

Design and Analysis of Software Systems, Alan Daniels and Don Yeates, eds. Princeton, NJ: Petrocelli Books, 1983; 270 pages, 13.8 by 21 cm, softcover, ISBN 0-89433-212-0, $15.

Doing Business with Pascal, Richard Hergert and Douglas Hergert. Berkeley, CA: Sybex, 1983; 384 pages, 17.8 by 22.8 cm, softcover, ISBN 0-89588-091-1, $16.95.

The Elements of CAL, David Godfrey and Sharon Sterling. Reston, VA: Reston Publishing Co., 1982; 296 pages, 15.3 by 22.8 cm, softcover, ISBN 0-8359-1700-2, $16.95.

From Baker Street to Binary, Henry Ledgard, E. Patrick McQuaid, and Andrew Singer. New York: McGraw-Hill, 1983; 296 pages, 13.8 by 21.3 cm, softcover, ISBN 0-07-036983-6, $10.95.

Fundamentals of Computers and Data Processing with BASIC, Wilson T. Price. New York: Holt, Rinehart and Winston, 1983; 448 pages, 19 by 22.5 cm, softcover, ISBN 0-03-063231-5, $21.95.

Graphics Referral Catalog, 3rd ed. Engineering Systems Group. Marlboro, MA: Digital Equipment Corp., 1983; 96 pages, softcover, 21 by 27 cm, ISBN-none, $5.

How to Choose Your Small Business Computer, Mark Birnbaum and John Sickman. Reading, MA: Addison-Wesley, 1982; 158 pages, 18.8 by 23.3 cm, softcover, ISBN 0-201-10187-4, $9.95.

How to Select Your Small Computer, Hillel Segal and Jesse Berst. Englewood Cliffs, NJ: Prentice-Hall, 1983; 208 pages, 21.5 by 27.8 cm, softcover, ISBN 0-13-431320-8, $14.95.

The Icon Programming Language, Ralph E. Griswold and Madge T. Griswold. Englewood Cliffs, NJ: Prentice-Hall, 1983; 333 pages, 15.5 by 22.8 cm, softcover, ISBN 0-13-449777-5, $19.95.

The Ins and Outs of the Timex TS 1000 & ZX 81, Don Thomasson. Nashville, TN: Melbourne House Software Inc., 1983; 104 pages, 14 by 21 cm, softcover, ISBN-none, $12.95.

Inside Atari BASIC, Bill Carris. Reston, VA: Reston Publishing Co., 1983; 192 pages, 17.5 by 23.5 cm, softcover, ISBN 0-8359-3082-3, $12.95.

Introduction to Arithmetic for Digital Systems Designers, Shlomo Waser and Michael J. Flynn. New York: Holt, Rinehart and Winston, 1982; 336 pages, 18 by 24 cm, hardcover, ISBN 0-03-060571-7, $35.95.

Introduction to Computers, Elias M. Awad. Englewood Cliffs, NJ: Prentice-Hall, 1983; 512 pages, 17 by 23 cm, softcover, ISBN 0-13-479444-3, $19.95.

Kids and Computers, The Parents' Microcomputer Handbook, Eugene Galanter. New York: Perigee Books, 1983; 192 pages, 17.8 by 23.5 cm, ISBN 0-399-50749-3, $7.95.

Microcomputers in Small Business, Robert D. Randall. Englewood Cliffs, NJ: Prentice-Hall, 1982; 144 pages, 17.3 by 23.3 cm, softcover, ISBN 0-13-580746-8, $8.95.

Microprocessors for Managers, Ronald L. Krutz. Boston, MA: CBI Publishing Co. (286 Congress St.), 1983; 148 pages, 16 by 24 cm, hardcover, ISBN 0-8436-1610-5, $24.95.

Microprocessors: Principles, Programming & Interfacing, Kenneth Muchow and Bill R. Deem. Reston, VA: Reston Publishing Co., 1983; 512 pages, 18 by 24 cm, hardcover, ISBN 0-8359-4383-6, $23.95.

Pascal Under Unix, J.N.P. Hume and R.C. Holt. Reston, VA: Reston Publishing Co., 1983; 402 pages, 18 by 24 cm, hardcover, ISBN 0-8359-5446-3, $22.95.

Pilgrim in the Micro World, David Sudnow. New York: Warner Books, 1983; 239 pages, 14.5 by 22.5 cm, hardcover, ISBN 0-446-51261-3, $15.50.

Problem Solving with BASIC, Richard Dillman. New York: Holt, Rinehart and Winston, 1983; 336 pages, 17.8 by 23.5 cm, softcover, ISBN 0-03-061981-5, $19.95.

Professional Programming Techniques—Starting with the BASICs, Richard Galbraith. Blue Ridge Summit, PA: Tab Books, 1982; 308 pages, 12.8 by 20.8 cm, softcover, ISBN 0-8306-0128-7, $10.95.

Robot Motion: Planning and Control, Michael Brady, John M. Hollerbach, Timothy L. Johnson, Tomas Lozano-Perez, and Matthew T. Mason, eds. Cambridge, MA: MIT Press, 1982; 608 pages, 16 by 24 cm, hardcover, ISBN 0-262-02182-X, $37.50.

Scripsit Made Clear, J. S. Wilson. Felton, CA: Delegate Press (3 Kelldon Dr.), 1982; 96

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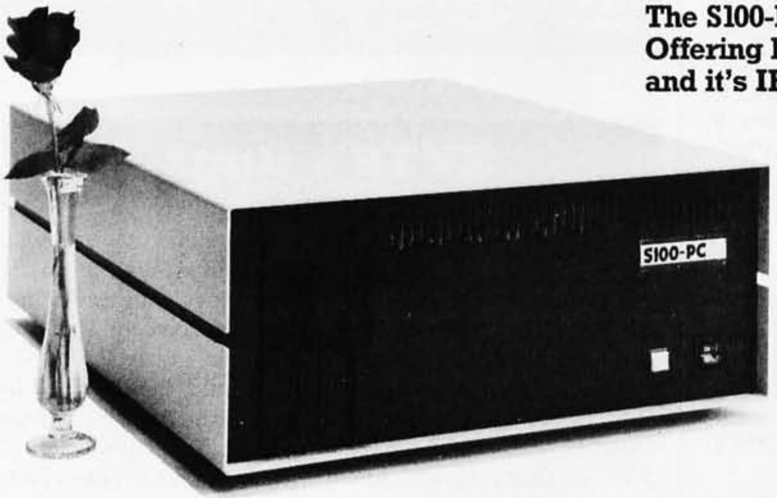

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Books Received

pages with cassette, 21.5 by 28 cm, softcover, ISBN-none, $16.95.

The Software Catalog: Microcomputers, Spring 1983. New York: Elsevier Science Publishing Co. (52 Vanderbilt Ave.), 1983; 808 pages, 21.3 by 27.8 cm, softcover, ISBN 0-444-00745-8, $69.

Standard Pascal User Reference Manual, Doug Cooper. New York: W. W. Norton & Co. Inc., 1983; 192 pages, 19.8 by 23.5 cm, softcover, ISBN 0-393-30121-4, $12.95.

Structured Cobol for Microcomputers, Keith Carver. Monterey, CA: Brooks/Cole Publishing Co., 1983; 424 pages, 21.5 by 27.8 cm, softcover, ISBN 534-01421-6, $17.95.

Structured Problem Solving with Pascal, Lawrence Mazlack. New York: Holt, Rinehart and Winston, 1983; 400 pages, 17.5 by 23.5 cm, softcover, ISBN 0-03-060153-3, $19.95.

Talking Computers and Telecommunications, John A. Kuecken. New York: Van Nostrand Reinhold, 1983; 256 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-442-24721-4, $26.50.

Tutorials in Modern Communications (IEEE Communications Society), Victor B. Lawrence, Joseph L. LoCicero, and Laurence B. Milstein, eds. Rockville, MD: Computer Science Press, 1983; 360 pages, 22 by 28.5 cm, hardcover, ISBN 0-914894-48-X, $33.95.

VAX Basic, David Weinman and Barbara L. Kurshan. Reston, VA: Reston Publishing Co., 1983; 286 pages, 17.8 by 24 cm, hardcover, ISBN 0-8359-8239-4, $21.95.

Vic Revealed, Nick Hampshire. Rochelle Park, NJ: Hayden Book Co., 1981; 284 pages, 14.8 by 20.8 cm, softcover, ISBN-none, $12.95.

Voice Technology, Edward R. Teja and Gary W. Gonnella. Reston, VA: Reston Publishing Co., 1983; 224 pages, 16 by 23.8 cm, hardcover, ISBN 0-8359-8417-6, $19.95.■

This is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.

BYTE's Bugs

A Word of Caution

Word has reached us that a bug may be lurking in listing 1 of James Folts's article "Cross-Reference Utility for IBM PC BASIC Programs" (August 1983 BYTE, page 378). In this program, line numbers are stored in integer variables to speed up processing. This, however, limits the line numbers to values no greater than 32767. To handle larger lines with this utility, drop the percent sign (%) from the variables LINE.NO% and LINE.REF%. In line 6050 on page 382, change SPACE$(5) to SPACE$(6).

Our thanks to James Folts for pointing out this potential problem.■

Clubs and Newsletters

For Occupational Therapists Only

The Occupational Therapy Microcomputer Club is designed for computer users in occupational therapy administration, clinical practice, education, and research to share software and information. Members receive a subscription to the bimonthly *Occupational Therapy Microcomputer Club Journal*. Dues are $5; a sustaining membership is $20. For further information, write to Michael Weber, Occupational Therapy Microcomputer Club, 206 North Green St., Tuckerton, NJ 08087, or call (609) 296-3056.

IBM PC Users in Boca Raton

A computerized bulletin board is available for meetings and business at the College of Boca Raton's South Florida IBM Personal Computer Users Group. Interested parties can contact Wyatt Bell, College of Boca Raton, 3601 North Military Trail, Boca Raton, FL 33431, (305) 994-0770, ext. 83 or ext. 14.

Tidewater of Virginia Beach

The Tidewater Commodore Users Group (TCUG) invites anyone interested in Commodore computers or in computing to inquire further. Contact Tidewater Commodore Users Group, 4917 Westgrove Rd., Virginia Beach, VA 23455.

Indianapolis Group for the IBM PC

The IBM PC Users Group, a nonprofit organization, meets on the fourth Monday of each month at 7 p.m. at the Computerland store in Indianapolis, Indiana. Members have access to a library of disks, books, and magazines as well as the information from monthly newsletters. Individual membership is $15; family memberships are $20. For more information, contact Davie Reed, IBM PC Users Group, POB 68271, Indianapolis, IN 46268.

Computers in the Legal Mode

The Law School Computer Group (LSCG) of Dallas, Texas, keeps members informed about computer usage and advancement in the legal profession through articles in its quarterly newsletter, *Dataline*. A network is supported. All people in the legal community, including students, alumni, and lawyers, are invited to join. Membership costs $5. Contact the Law School Computer Group, Southern Methodist University School of Law, Dallas, TX 75275.

NCR Users Form Global Cooperative

NCR World is an independent cooperative of NCR users. The organization provides such services as technical and software exchanges, product reviews, and a journal called the *NCR Monthly*. Membership is $92 in the U.S.; foreign rates vary. For further details, contact NCR World Inc., POB 399, Cedar Park, TX 78613, or call (512) 250-9023.

Smart Users Group

The Santa Monica Area TRS-80 Users Group (SMARTUG) meets on the third Wednesday of each month at 7 p.m. at the Senior Citizens Center in Santa Monica, California. For further details, contact SMARTUG, 1433 11th St. #3, Santa Monica, CA 90401, or call (213) 394-5997.

Long Live Folklife

The Folklife Terminal Club, a Commodore users group, maintains a software library of more than 5000 public-domain programs. Any interested Commodore owners and users can contact the Folklife Terminal Club by writing to POB 2222, Mount Vernon, NY 10551.

Focus on Basis

A national users group has been formed for the Basis computer. Participants will share knowledge and skills. For information, contact Ms. Barbara Thomas, Suite 320, 100 Almeria Ave., Coconut Grove, FL 33134.

Transportation Communication

Users of Personal Computers in Transportation (UPCIT) is a group that explores the use of computers in analyzing, graphing, or transmitting data related to transportation operations, rates, costs, or markets. For further details, contact Arthur Todd, Lincoln Electric Co., 22801 St. Clair Ave., Cleveland, OH 44117, or call (216) 481-8100.

Midwestern Chronicle

The Greater Cleveland PC Users Group produces a newsletter, *PC Chronicles*, and meets the first Saturday of every month at 2 p.m. at the Beachwood Public Library in Beachwood, Ohio. Anyone interested is invited to attend meetings designed to educate members in the capabilities of the IBM PC and similar microcomputers. Membership dues are $15 a year and include access to a book and magazine library and public-domain software. Newsletter exchanges with other groups are welcome. An online bulletin board is planned. For information, contact Roy McCartney, 30704 Royalview Dr., Willowick, OH 44094, or call (216) 944-5173.

For Users of the TI PPX-59

Users of the Texas Instruments TI-58/59 can join an independent club dedicated to the use of TI-manufactured hand-held computers and calculators. The club produces a newsletter, *TI PPC Notes*, and welcomes all former members of the TI-supported PPX-59 club. Membership is $25 a year and includes the newsletter. Contact PPC Publications, POB 1421, Largo, FL 34294.

North Star Notes Via Polaris

The North Star Computer Society (NSCS) produces a monthly newsletter, *Polaris*, that is dedicated to exchanging information about North Star computers, software, and peripherals. The group of professionals and hobbyists meets on the third Wednesday of each month at 7:30 p.m. Dues are $24 a year. For details, write to NSCS, POB 311, Seattle, WA 98111.

Computers in Schools

The Timex/Sinclair Educators' Users Group of Texas Wesleyan College, in cooperation with Timex Computer

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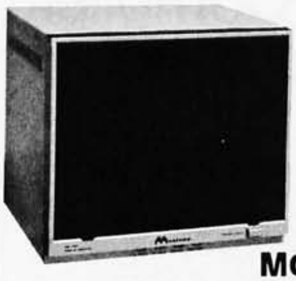

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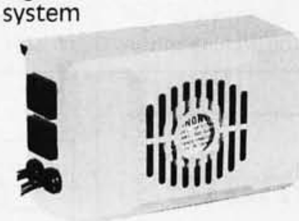

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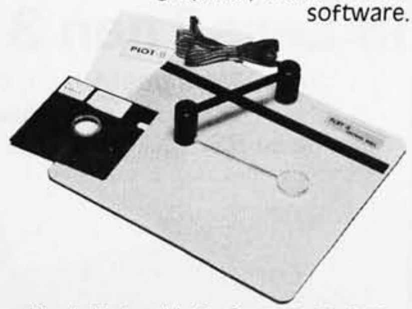

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Corporation, produces a quarterly newsletter, *The TEC News*, dedicated to the application of low-cost computers to educational settings. Each edition will contain a theme section, a teacher-report section, and an applications section that provides lesson plans, programming tips, and ideas. The newsletter is free to educators. For information, write to M. Mark Wasicsko, School of Education, Texas Wesleyan College, Fort Worth, TX 76105.

A Free HUG Membership

The Schenectady HUG (Heath Users Group) meets on the third Wednesday of each month at 7:30 p.m. to promote familiarity with hardware and software relating to the Heath H-89, H-8, HDOS, and the CP/M operating systems. Membership is free as no newsletter is produced, although the group is available via a bulletin-board service, for which there is a $10 user's fee. Further information is available from Walter Whipple at (518) 385-5660, or write to Schenectady HUG, c/o T. Budge, 715 Sanders St., Scotia, NY 12302.

Clubs and News Notes

The Silicon Valley Color Computer Club (SVC³) for users of the TRS-80 Color Computer now meets on the first Tuesday of each month at 7:30 p.m. in the Dysan Auditorium at 5201 Patrick Henry Drive in Santa Clara, California. Write to Silicon Valley Color Computer Club, POB 61593, Sunnyvale, CA 94088. (For the first mention of this club, see February 1983 BYTE, page 444).

Subscribers to *Interactive Video Technology*, a newsletter produced by Heartland Communications (233 Sunrise Dr., Shreve, OH 44676), can now access all back and future issues via Newsnet, an electronic information and retrieval service (March 1983 BYTE, page 491).

Article submissions are welcome to *The I/O Connector*, the newsletter produced by the San Diego Atari Computer Enthusiasts (SD-ACE), 5353 Baltimore Dr. #39, La Mesa, CA 92041 (January 1983 BYTE, page 469).

The Connecticut IBM Personal Computer Users Group meets on the fourth Tuesday of each month at 6 p.m. Contact Davis or Sherry Foulger, POB 291, New Canaan, CT 06840, (203) 744-4002. ■

BYTE's Bugs

Bug In Board

A bug popped up in William Barden's article "A General-Purpose I/O Board for the Color Computer" (June 1982 BYTE, page 260). Substitute pin 32 (CTS⋆) for pin 36 (SCS⋆) on the Color Computer I/O bus. The board is now addressed with hexadecimal C000, 1, 2, and 3 in place of the addresses hexadecimal 3FF0, 1, 2, and 3.

Using the SCS⋆ signal for the device selection does not enable the 8255 at the proper time because the SCS⋆ signal is not developed from the E clock. The E clock should be used together with an I/O device address for proper I/O device operation. ■

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The most comprehensive statistics and graphics ever developed for and sophisticated database workstation the personal computer.

Years of research, development, and field testing have resulted in the most extensive statistics and graphics database program specifically designed for the personal computing environment. STATPRO™ provides the data analysis capabilities and flexibility previously available only on a large computer. Researchers, business professionals, and other data analysts will welcome the breadth yet simplicity of this program! STATPRO requires no previous computer experience, no special command language. Single keystrokes access all of the data manipulation, statistics, and graphics power of STATPRO.

STATPRO allows easy access to its extensive numerical data capabilities.
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Statistics Modules Menu
--------------------------------
   A) DESCRIPTION
   B) REGRESSION
   C) ANOVA
   D) TIME SERIES
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⟨ESC⟩) Exit to Master Menu
Choice – )[    ]
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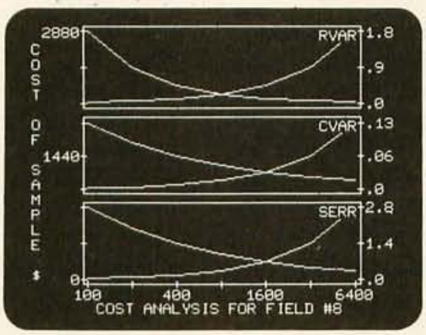
Transformations and over 400 conversions are available. You can place the results of these transformations into the same field or any other field in STATPRO's database.



STATPRO offers a comprehensive collection of statistical procedures.
The statistics component of STATPRO contains a multitude of procedures, grouped into the following modules:

Descriptive: Contingency analysis, cross tabulation, normality tests; descriptive, comparative, range and non-parametric statistics.

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Analysis of Variance: Single and nested classifications, two and three way equal and unequal sample size and non-parametric ANOVA.

Time Series: Moving averages, multi-stage least squares, fitted polynomials and trig functions, additive and multiply forecasting.

Multivariate: Principal components, factor, orthogonal factor, oblique factor, pair-weighted cluster, discriminant function, multiple contingency, and canonical correlation analysis.

STATPRO provides graphic representation of your data in minutes.
STATPRO graphics plot *all* the results of your STATPRO statistical analyses including scatter, triangle regression, and box plots; pie-charts, histograms, and dendograms. Further, with STATPRO you can custom edit with any of four character sets from the keyboard. You can also edit using paddles, joystick or special graphics commands. Mix text with data fields. Place multiple plots on each screen. Define your axis limits.

You can save your graphics on a disk for a multiple color "slide show" presentation, or print them out through a variety of compatible printers.

STATPRO documentation wraps up the package.
Although STATPRO software is essentially self-documenting, complete print documentation is provided. This includes a walk-through Introductory Tutorial, a Menu Chart, and a comprehensive User's Guide for each STATPRO component.

STATPRO currently runs on all versions of the Apple® II personal computers. It will be available for the IBM® PC in September.

To find out more about **Statpro: The Statistics and Graphics Database Workstation,** contact your local dealer, or

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In Massachusetts call (617) 423-0420.

You can also call us toll-free for information on corporate purchase through our National Account Program.

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Software Received

Apple

Accounts Receivable, an open-item, accounts-receivable system for small-business accounting. It includes customer maintenance, transaction processing, reports and printouts, utilities, and end-of-period processing. For the Apple II; floppy disk, $395. Broderbund Software Inc., 1938 Fourth St., San Rafael, CA 94901.

Bop-a-Bet, an educational game for children ages 5 to 8. By moving around a high-resolution maze and selecting letters in sequence, children develop the alphabetizing skills needed in effectively using libraries, dictionaries, and encyclopedias. For the Apple II, II Plus, and IIe; floppy disk, $27.95. Sierra/On-Line Inc., Sierra/On-Line Building, Coarsegold, CA 93614.

Computer SAT, a software/textbook package that leads the student step by step through the complete Scholastic Aptitude Test preparation process. The package pinpoints student strengths and weaknesses, gives immediate feedback, and prepares a study plan to improve scores. No previous computer experience needed. For the Apple II, II Plus, and IIe; floppy disk, $79.95. Harcourt Brace Jovanovich, 1250 Sixth Ave., San Diego, CA 92101.

Crypto-Cube, an educational word puzzle for children ages 8 and up. Spark an interest in spelling and word recognition as players try to identify the missing letters of words in a variety of graphic formats. For the Apple II Plus and IIe; floppy disk, $39.95. Designware Inc., 185 Berry St., San Francisco, CA 94107.

Diskinvoice System, an invoicing/accounts-receivable program that can handle the billing for the small businessperson who sends fewer than 300 invoices per month. It allows easy customizing and back-up; also available in Spanish. For the Apple II, II Plus, and IIe; floppy disk, $55. Broadway Software, Suite 136, 642 Amsterdam Ave., New York, NY 10025.

Disk Protection Program, a locking program for software developers. This inexpensive, easy-to-use program disables list, reset, catalog, and save from pirates. For the Apple II Plus; floppy disk, $45. The Zivv Co., MPO Box #1616, Niagara Falls, NY 14302.

Double Trouble, five arcade-type games. Play two games simultaneously on a split-screen with varying consequences. Requires a joystick. For the Apple II Plus and IIe; floppy disk, $15. BEZ, Suite 108B, 4790 Irvine Blvd., Irvine, CA 92714.

Dragon's Keep, an educational adventure game for children ages 7 and up. Children develop reading comprehension as they rescue 16 animals through reading maps, identifying details, making inferences, and drawing conclusions. For the Apple II, II Plus, and IIe; floppy disk, $29.95. Sierra/On-Line Inc. (see address above).

Early Games for Young Children, nine educational games for children ages 2½ to 6. Children can learn to match numbers and letters, count blocks, add and subtract stacks of blocks, work with the alphabet, type names, compare shapes, and draw pictures in color without supervision. For the Apple II; floppy disk, $29.95. Counterpoint Software Inc., Suite 140, Shelard Plaza North, Minneapolis, MN 55426.

Early Games Music, four educational music games for children ages 4 to 12 that teach basic music skills and music notation in colorful high-resolution displays. For the Apple II Plus and IIe; floppy disk, $29.95. Counterpoint Software Inc. (see address above).

Easel Ease, a full-screen, high-resolution graphics package that lets you create pictures using colors, patterns, and brushstrokes. It includes menu-driven features, save options, and single-keystroke controls. For the Apple II Plus; floppy disk, $24.95. Watermark Inc., Department PC, POB 481, Melbourne Beach, FL 32951.

Fontrix, an extended-screen graphics system. This multipurpose graphics package includes a font editor, graphic writer, character generator, and a graphics dump. You can design, create, typeset, and print in a variety of formats. For the Apple; floppy disk, $75. Data Transforms, Suite 106, 616 Washington St., Denver, CO 80203.

Function Plotter, an educational mathematical tool. This tamper-proof program will graph a user-specified function over any chosen domain. You can change either the domain or the displayed range and overlay any number of functions on the same set of axes. For the Apple II Plus and IIe; floppy disk, $29.95. J.L. Hammett Co. Inc., Microcomputer Division, Hammett Place, Braintree, MA 02184.

Hi-Res Versatile Calculator (HVC), an RPN (reverse Polish notation) calculator that combines the functions of a scientific calculator with a programmer's calculator. It operates in four bases, contains over 50 functions, and features standard ASCII tables. For the Apple II, II Plus, IIe, and III; floppy disk, $59.95. Tackaberry Software, POB 2857, Ormond Beach, FL 32074.

Learning with Leeper, four educational games for preschoolers. Dog Count is a counting game; Balloon Pop is a shape-matching game; Screen Painting is creative play; and Leap Frog develops eye-hand coordination. For the Apple II, II Plus, and IIe; floppy disk, $34.95. Sierra/On-Line Inc. (see address above).

Master Math, an educational math program for high school students that covers algebra, trigonometry, geometry, statistics, and basic accounting. For the Apple II, II Plus, and IIe; six floppy disks at $30 each or the set for $150. PMI Inc., High St., POB 87, Buckfield, ME 04220.

Pascal Source, nine game and utility programs that include Art, Tower, Splitfile, Art 2, Formatter, Graftools, Testgt, Shape, and Trek. Includes all source code. For the Apple II; floppy disk, $15. Mark Watson, 535 Mar Vista Dr., Solana Beach, CA 92075.

Police Artist, a program of three games for children ages 7 and up that draws over 1 million faces. You pick a culprit's face from a police lineup and reconstruct it piece by piece, or create your own faces. For the Apple II, II Plus, and IIe; floppy disk, $34.95. Sir-Tech Software Inc., 6 Main St., Ogdensburg, NY 13669.

Software Received

Professional Unit, a set of utilities for professional Pascal programming that includes Date, Dollar, Phone, Zip-code, Tax Rates, and special facilities for defining fields on the screen. You can double or triple your programming speed. For the Apple II; floppy disk, $39. D & L Computing, 1201 Lincoln Ave., New Castle, IN 47362.

Suspended, an interactive game. After a 500-year sleep, you awake and must strategically manipulate six robots acting as your senses. One even helps you access information from memory banks as you solve an intertwined myriad of graphically realistic and original problems. Several levels of play. For the Apple II; floppy disk, $49.95. Infocom, 55 Wheeler St., Cambridge, MA 02138.

Troll's Tale, an educational adventure game for children ages 8 and up. Children develop reading comprehension as they make maps, identify details, make inferences, predict outcomes, and draw conclusions in order to locate 16 treasures. For the Apple II, II Plus, and IIe; floppy disk, $29.95. Sierra/On-Line Inc. (see address above).

Wizplus, a utility program for the Wizardry adventures that lets you quickly change, restore, add to, modify, recover, edit, or move any of your characters, their equipment, spells, or treasures. No more frustrating games where the wizard always wins. Now you have a chance. For the Apple II Plus; floppy disk, $39.95. Datamost Inc., 8943 Fullbright Ave., Chatsworth, CA 91311.

Atari

Matchboxes, a skill and concentration game. One or two players must match identical squares from a 6 by 6 grid and solve a hidden word puzzle. Each colorful character, creature, or object has *its* own catchy musical signature. For the Atari 400/800/1200; floppy disk, $29.95. Broderbund Software Inc., 1938 Fourth St., San Rafael, CA 94901.

Suspended, an interactive game (see description under Apple). For the Atari 400/800; floppy disk, $49.95. Infocom, 55 Wheeler St., Cambridge, MA 02138.

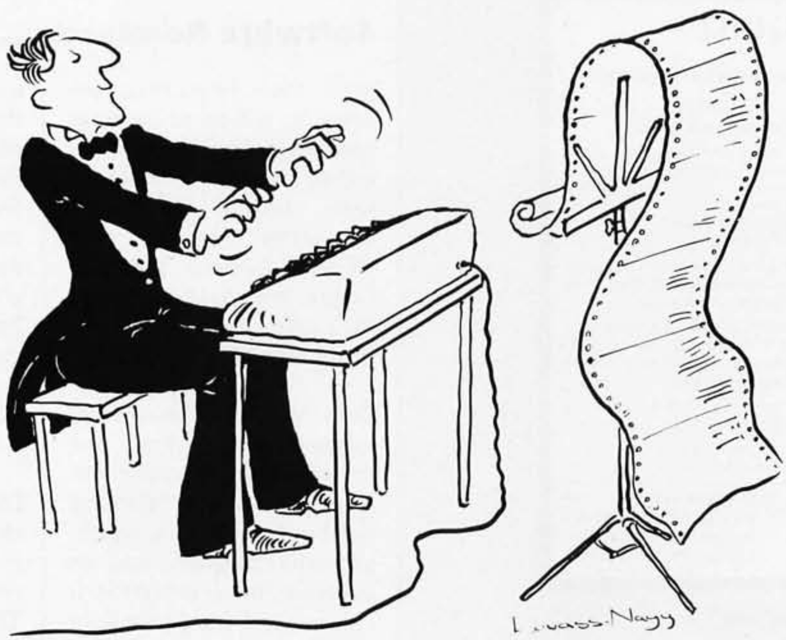
Ultra Disassembler, a utility package that lets you recreate source code. This labeling disassembler handles DOS files and code. Output code may be written to video display, printer, or disk file. For the Atari 400/800/1200; floppy disk, $49.95. Adventure International, POB 3435, Longwood, FL 32750.

CP/M

ACNAP, an AC network-analysis program. This electronic-circuit program can handle circuits as large as 70 components. It is optimized for speed and can analyze a five-node, ten-component circuit in less than one second. For CP/M-based systems; floppy disk, $39.95. BV Engineering, POB 3351, Riverside, CA 92519.

Access Manager, a general-purpose, keyed, file-accessing package designed for programmers creating application programs that must access data records on the basis of identifying such key values as name or number. For CP/M-2.2-based systems; floppy disk, $300. Digital Research, 160 Central Ave., POB 579, Pacific Grove, CA 93950.

CP/M Workshop, a nontechnical CP/M learning pro-



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Circle 281 on inquiry card.

Circle 289 on inquiry card.

Software Received

gram. Your computer can become a self-paced seminar complete with diagrams, exercises, reviews, demonstrations, helpful hints, and evaluation sessions. For CP/M-2.2-based systems; floppy disk, $115. Datascan Inc., 2716 Ocean Park Blvd., Santa Monica, CA 90405.

Data VU, a database-management system. Four features include an automatic form generator, a relational database manager, a report-generator program, and an automatic menu generator. It can be used for personal or small-business purposes. For CP/M-based systems; floppy disk, $149. Thinkers Soft Inc., POB 221, Garden City, NY 11530.

Personal Pearl, an information-management system. This relational database and form/report program generator is designed for the novice end user. Create input and output forms and reports and define simple or complex relationships. For CP/M-based systems, floppy disk, $295. Pearlsoft, POB 13850, Salem, OR 97309.

Suspended, an interactive game (see description under Apple). For CP/M-based systems; floppy disk, $59.95. Infocom, 55 Wheeler St., Cambridge, MA 02138.

XREF, a cross-reference program for Microsoft BASIC that is written in Pascal MT+. You enter certain headings to the command tail. For CP/M-based systems; floppy disk, $50 (preferably converted to South African Rands). Barxact Computer Systems (Pty.) Ltd., POB 785150, Sandton, 2146, South Africa.

Commodore

Check Ease, a professional-quality check-register system that lets you maintain multiple checking accounts with full checkbook *reconciliation* and budget categories. Automatically updates balance figures and can print by check number or category. For the Commodore VIC-20; cassette, $24.95. Talcove & Familian Co., 10902 Riverside Dr., North Hollywood, CA 91602.

Disk Support, a 1K-byte machine-language extension program that adds 12 new commands to the computer. The user can save, save with replace, load, verify, delete, and rename disk files with just two keystrokes. For the Commodore 64 and VIC-20; floppy disk, $14.95. H & H Enterprises, 5056 North 41st St., Milwaukee, WI 53209.

Info-Manager, an information-management system designed to keep records of any nature in the home or small business. You can store and selectively print address lists, expense records, bills due, mailing labels, and many other files. For the Commodore 64; floppy disk, $39.95. Pyramid Software International, Suite A, Department 300, 30 Fairfax St., San Rafael, CA 94901.

Space Sentinel, an arcade-type game. As an orbiting Space Sentinel you must protect Earth from aliens' heat missiles before the polar ice caps melt and cause floods. Joystick required. For the Commodore 64; floppy disk, $29.95. Talcove & Familian Co. (see address above).

Suspended, an interactive game (see description under Apple). For the Commodore 64; floppy disk, $49.95. Infocom, 55 Wheeler St., Cambridge, MA 02138.

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program that calculates, displays, files, and prints a variety of data for designated units in such resources as electric, water, gas, oil and propane. For the Commodore 64 and VIC-20; cassette, $29.95. Fabtronics, 51 Quarry St., Brockport, NY 14420.

The Wizard & The Princess, a graphics adventure game in which you must storm into the evil wizard's castle, defeat the dragon guarding the gate, find your way through the passage, and rescue the princess. On your way out you must slay the troll before your mission is a success. For the Commodore VIC-20; cassette, $14.95. Melbourne House Software Inc., Department CS, 347 Reedwood Dr., Nashville, TN 37217.

IBM Personal Computer

Crypto-Cube, a word-puzzle game (see description under Apple). For the IBM Personal Computer; floppy disk, $39.95. Designware Inc., 185 Berry St., San Francisco, CA 94107.

Financial Management TK Solver Pack. This program includes such topics as compound interest, net present value, level debt service, cost of equity capital, analysis of financial statements, stock-option pricing, bond swaps, convertible debt, and bond-refunding decisions. To be used in conjunction with **TK Solver** ($299). For the IBM Personal Computer; floppy disk, $100. Software Arts Inc., 27 Mica Lane, Wellesley, MA 02181.

Intellicom, an intelligent communications processor. This package provides computer-to-computer communications from terminal-emulation and file-transfer standpoints. It supports several file-transfer protocols that facilitate the transmission of binary and ASCII data. For the IBM Personal Computer; floppy disk, $49.95. Computer Toolbox, 1325 East Main St., Waterbury, CT 06705.

Mailcom, an E-COM mailing program. With a personal computer, modem, and this package, you can send out more than 2000 letters for 26 cents each from home or office via the Postal Service's E-COM System. The Post Office will print, fold, stuff, and seal computer-originated mail and guarantees delivery within 48 hours. For the IBM Personal Computer; floppy disk, $195. Digisoft Computers, 1501 Third Ave., New York, NY 10028.

Media Magician, a disk-editing utility for binary and ASCII codes. You can modify disks by byte, string, or sector. The program brings you to any sector on a disk and displays up to 256 bytes of that sector at a time. It also provides ASCII code and updates representations of each byte. For the IBM Personal Computer; floppy disk, $48.50. Photon Software, 636 120th Ave. NE, Bellevue, WA 98005.

Mystery Message, an interactive-game program. You must guess answers to 500 items as quickly as possible. This program stimulates concentration, recall, and retention skills for all ages. For the IBM Personal Computer; floppy disk, $34.95. Social Systems Corp., Suite 28, 1621 Fulton Ave., Sacramento, CA 95825.

PC-Link, a terminal-emulation package that lets an IBM Personal Computer function like a Digital Equipment Corporation VT100 terminal. It allows transfer of ASCII program and data files between IBM PC and DEC computers. For the IBM Personal Computer; floppy disk, $40. Screenware Corp., POB 3662, Nashua, NH 03061.

Personal Investment Analysis, an investment-decision program. All the information you need to perform accurate analyses for such investments as convertible bonds, mortgage loans, interest rates, retirement funding, and tax-free securities. Requires no prior computing experience. For the IBM Personal Computer; floppy disk, $60. Wiley Professional Software, John Wiley & Sons, 605 Third Ave., New York, NY 10158.

Personal Pearl, an information-management system (see description under CP/M). For the IBM Personal Computer; floppy disk, $295. Pearlsoft, POB 13850, Salem, OR 97309.

Plot, a mathematical-graphing program. You can plot and process data and/or curves described by mathematical functions. This program allows switching back and forth between linear, semi-log, and double-log scales; calculating and plotting inverse relationships, power, and linear functions of data points. Color-graphics adapter required. For the IBM Personal Computer; floppy disk, $29.95. Non-Linear Products, POB 14755, Minneapolis, MN 55414.

SSPLOT, a data-plotting program that generates plots on screen and can print pie charts, bar graphs, histograms, line plots, and scatter plots using files created by Visicalc and saved in DIF (Data Interchange Format). For the IBM Personal Computer; floppy disk, $45. Stanford Software, 585 Singley Dr., Milpitas, CA 95035.

Shoebox, a time- and money-management program with a multiple-user capability. Three basic commodities are offered that assist management: appointments, reminders, and expenses. You can update schedules and record expenses. For the IBM Personal Computer; floppy disk, $195. Techland Systems Inc., 39 Carwall Ave., Mount Vernon, NY 10552.

Suspended, an interactive game (see description under Apple). For the IBM Personal Computer; floppy disk, $49.95. Infocom, 55 Wheeler St., Cambridge, MA 02138.

VIS/Bridge/SORT, a program that lets you sort rows or columns of a Visicalc spreadsheet. Up to five rows or columns may be used as sort keys; they can be sorted alphabetically or numerically in either ascending or descending order. For the IBM Personal Computer; floppy disk, $89. Solutions Inc., POB 989, Montpelier, VT 05602.

Heath/Zenith

Games #1, a collection of five games that includes Gomoku, Concentration, Maze-Dash, Solitary, and Barricade. For the Heath/Zenith Z-89; floppy disk, $19.95. Interactive Micro Systems, POB 21007, Columbus, OH 43221.

Quizzer, an educational program that asks a student a series of practice questions in such formats as true/false, fill in the blank, or multiple choice. It can talk when used with the Votrax Type 'n Talk. For the Heath/Zenith Z-89; floppy disk, $19.95. Interactive Micro Systems (see address above).

TRS-80

ACNAP, an AC network-

Software Received

analysis program (see description under CP/M). For the TRS-80 Models I and III; floppy disk, $39.95. BV Engineering, POB 3351, Riverside, CA 92519.

Cards, an instructional program that enables you to program your own card games and gives hints on the graphics you'll require. For the TRS-80 Color Computer; cassette, $8. William Noggle, 2413 Kenwood Ave., San Jose, CA 95128.

Clean Slate, a word-processing package. This documented software contains a text editor, terminal communications capabilities, a form-letter generator, and handles assembly source code. For the TRS-80 Models I and III; floppy disk, $79.95. Howard W. Sams & Co., 4300 West 62nd St., Indianapolis, IN 46268.

Conquest of Kzirgla, a high-resolution graphics game. As a warrior in the mythical kingdom of Kzirgla, you are faced with the challenge of conquering the evil wizard Kolobarr in his dangerous dungeon. For the TRS-80 Color Computer; cassette, $21.95. Rainbow Connection Software, 3514 6th Place NW, Rochester, MN 55901.

Exams, a word-processing system designed to prepare examinations efficiently. It allows fast creation, modification, and storage of multiple-choice or true/false questions. Neatly formatted tests with answer keys are the final product. For the TRS-80 Model III; floppy disk, $69.95. Microsoftware Services, POB 776, Harrisonburg, VA 22801.

Hidden BASIC 1.0, a utility program designed to protect BASIC programs. Several commands will cease to execute without affecting the speed or ability of your programs. For the TRS-80 Color Computer; cassette, $19.95. Spectrum Projects, 93-15 86 Dr., Woodhaven, NY 11421.

Rainbow-Writer, a general-purpose screen formatter that lets you write text in high-resolution graphics. It also features underline, subscript, superscript, scroll protect, and more. For the TRS-80 Color Computer; cassette, $29.95. Rainbow Connection Software (see address above).

Suspended, an interactive game (see description under Apple). For the TRS-80 Model III; floppy disk, $49.95. Infocom, 55 Wheeler St., Cambridge, MA 02138.

Zaxxon, an arcade-type game. Unique color graphics surround you as you pilot your aircraft through a simulated battlefield with enemy aircraft, fuel tanks, concealed missiles, anti-aircraft tanks, and nerve-shattering sound effects. The final showdown is a confrontation with the deadly robot Zaxxon. For the TRS-80 Color Computer, floppy disk, $39.95. Datasoft Inc., 9421 Winnetka Ave., Chatsworth, CA 91311.

Timex/Sinclair

Arcade Games Package. Two BASIC program listings, Tic Tac Toe and Tank Zap, each with varying levels of difficulty. For the ZX81 and TS1000 computers; two listings, $3. Florida Creations, Department P, POB 16422, Jacksonville, FL 32245.

Music/Sounds Package. Five BASIC program listings and directions for broadcasting music and spaceship noises to a nearby radio. It controls the radio-frequency interference generated by the computer.

Software Received

For the ZX81 and TS1000; five listings, $3. Florida Creations (see address above).

Other Computers

K-Fix v. 2.1, a program that modifies the Kaypro II to shut off the disk drives when not in use, extinguish the drive lights when not being accessed, and allows you to set the default serial data rate. For the Kaypro II CP/M; floppy disk, $29.95. Maplesoft Inc., Suite 100, 49 Ascot Dr., Fredericton, NB E3B 6G1, Canada.

Manykey, a utility package that lets you define 10 control-number keys and CP/M or Wordstar arrow keys for each disk. This package allows each .COM file to define its own arrow and control-number keys. For the Osborne 1; floppy disk, $20. Compumagic Inc., POB 780, Severn, MD 21144.

Swords & Serpents, an arcade-type game. You're the White Knight exploring a maze-like dungeon. Avoid danger and protect a friendly wizard until he can learn the spells to save you both. For the Mattel Intellivision; cartridge, $39.95. Imagic, 981 University Ave., Los Gatos, CA 95030.

Text Formatter, an easy-to-use, plug-in accessory. You can quickly generate memos, form or personal letters, and 10-page reports. Includes keyboard overlay and reference card. For the Hewlett Packard HP-75C Portable Computer; ROM-module cartridge, $95. Hewlett Packard, 1000 Northeast Circle Blvd., Corvallis, OR 97330.■

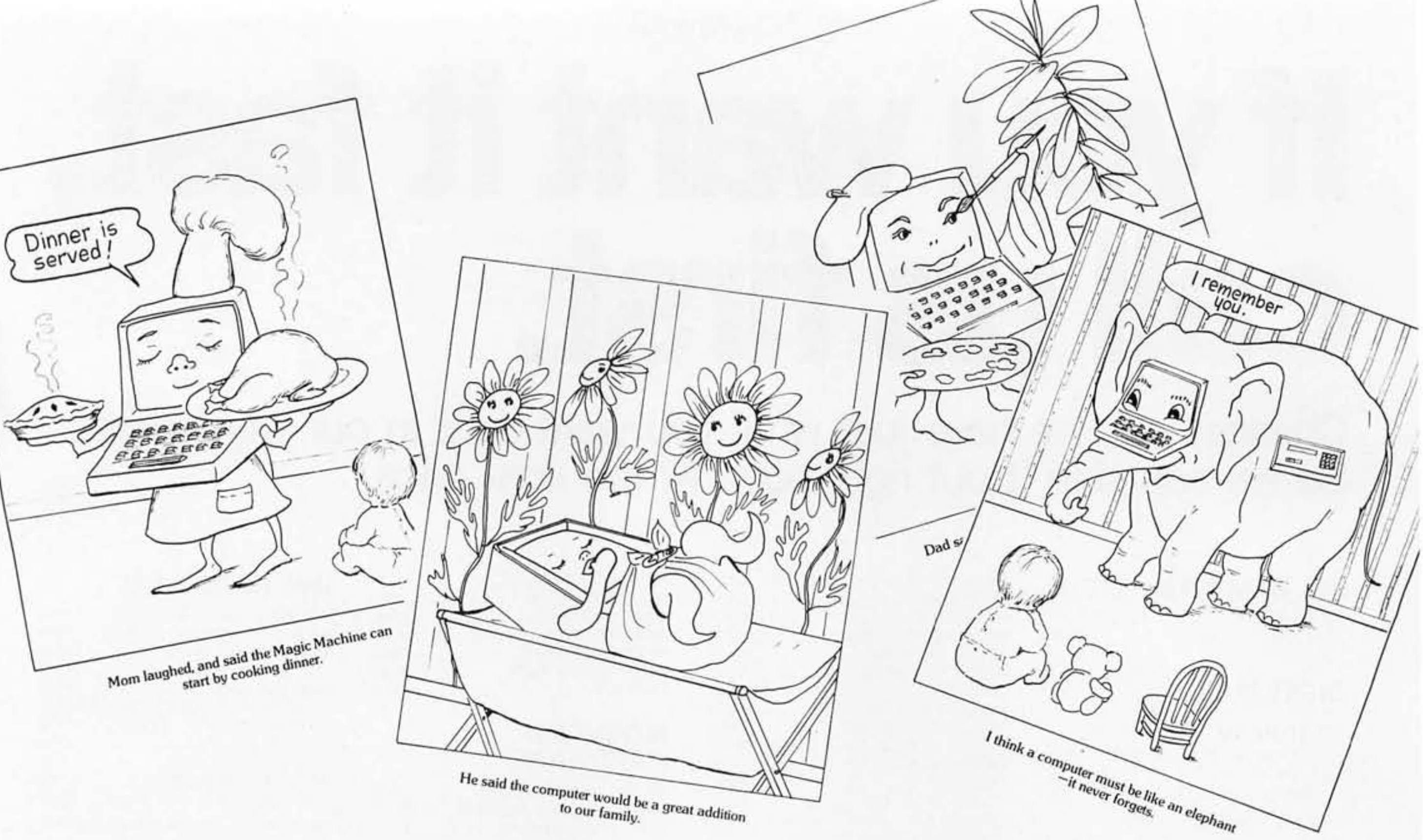
This is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. All software received is considered to be on loan to BYTE and is returned to the manufacturer after a set period of time. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

BYTE's Bits

Software for Schools

Silicon Valley Systems is giving away more than $100,000 worth of its word-processing and educational software to public schools. For further information on how schools can obtain some of this software, contact Peggy Johnson, Assistant to the President, Silicon Valley Systems, 1625 El Camino Real, Belmont, CA 94002.■



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B932

Ask BYTE

Conducted by Steve Ciarcia

Electronically Measuring Fish

Dear Steve,

I have been trying to locate technical information that will assist me in developing some electronic-measuring devices. I am a fisheries biologist and amateur engineer and machinist. I want to design and build equipment that will allow me to measure small fish automatically and record the lengths with my computer. I also want to fit automatic measuring capabilities to some machine tools so that I can have real-time measurements as I work and know precise tool positions. Once I have this capability, I want to move into numerical control and some robotic applications.

I would like to try using magnetic strips coded with distance information attached to the machines' ways, then use a reading head attached to the moving element of the machine. The reading head would feed into a processing unit with a digital readout. I have seen a picture of an electronic vernier caliper that operates on this principle but have not been able to get any details of the actual working elements.

Your assistance in locating technical information or people to contact is greatly appreciated.

Greg L. Young
Juneau, AK

One of the simplest yet most sophisticated techniques devised for electronic measuring is the use of a TV camera. By digitizing a video image of a part or surface, measurements to thousandths of an inch are possible. I have seen units that can inspect complex mechanical parts in seconds, and give a list of all dimensions measured, the allowable range for each dimension, and a flag against any dimension that is not within the spec. Here are some companies that make such products. . . . **Steve**

Interactive Video Systems
358 Baker Ave.
Concord, MA 01742
(617) 371-0104

Stocker & Yale
Rte. 128 and Brimbal Ave.
Beverly, MA 01915
(617) 927-3940

Electro-Optical Information Systems
710 Wilshire Blvd., Suite 501
Santa Monica, CA 90401
(213) 451-8566

EG & G Reticon
345 Potrero Ave.
Sunnyvale, CA 94086
(408) 738-4266

Vestigial-Sideband Filter

Dear Steve,

I am constructing a microcomputer system using Motorola's 6847 VDG (video-display generator) and 1372 TV Modulator. Motorola's documentation on the VDG 6847 interface is quite clear; however, I found the information provided for the 1372 and TV interface is too general. Specifically, the 1372's output is fed into the TV set (probably to the antenna) with a vestigial-sideband filter. Can you tell me what this filter is? I would greatly appreciate it.

Richard F. Man
Medford, MA

A television signal is generated in a manner similar to that of a standard AM (amplitude modulation) sound broadcast, and the video signal consists of two sidebands *and a carrier. To conserve spectrum bandwidth and to reduce the problems associated with wide bandwidth transmissions, one sideband is removed. However, filters to completely remove this sideband (for single-sideband transmission) must have a very sharp cutoff frequency and not change the phase or amplitude of the remaining sideband. Such filters are difficult to construct and expensive. As a compromise, most, but not all, of one sideband is removed. This method is known as* vestigial-sideband *operation.*

A vestigial-sideband filter also removes second harmonic effects and other spurious noise. The output of the MC1372 is essentially a double-sideband signal, and the vestigial filter is used to "trim" the signal to fit the bandwidth of the television receiver. . . . **Steve**

High-Resolution Storage

Dear Steve,

We would like to know if anyone makes a video camera with interface that will let you copy records and files to be recorded on the computer disk for later recall and reproduction through a printer or plotter. We wish to reduce our records to a computer library with indexing capabilities.

Eugene Manzo
Miami, FL

Many video camera systems on the market allow image storage, but it is important to choose one with high resolution in order to store a complete page of text. The higher the resolution, the sharper the image and the greater demands on memory. For example, 1024 by 1024 pixels would be the minimum resolution, and higher values are preferred; but one frame at this size requires 128K bytes.

Some companies making such equipment include

Datacopy
1070 East Meadow Circle
Palo Alto, CA 94303
(415) 493-3420

Imaging Technology Inc.
400 West Cummings Park, Suite 4350
Woburn, MA 01801
(617) 938-8444

Eikonix Corporation
23 Crosby Dr.
Bedford, MA 01730
(617) 275-5070

Quantex Corporation
252 North Wolfe Rd.
Sunnyvale, CA 94086
(408) 733-6730

You might also want to consider using a laser-type videodisc with a personal computer to provide random access. The major problem here is getting the information onto the laser disc. Refer to the June 1982 BYTE for more information. . . . **Steve**

VIC-20 Expansion

Dear Steve,

I have a Commodore VIC-20. Is there a company that manufactures an expansion module that would provide a 40- or 80-column video output?

Robert J. Kakoczki
White Cloud, MI

Quantum Data Inc. makes a series of cartridges for the VIC-20, among which is a card that will display 80 columns of

text. The card optionally features 16K bytes of memory and a programmable ROM socket. It comes set for 40 columns that can be displayed on a TV set. For 80 columns, a change inside the cartridge is made. A video monitor must be used with any 80-column display because the bandwidth of an ordinary TV is not adequate. Contact Quantum Data Inc., 3001 Redhill Bldg., Suite 105, Costa Mesa, CA 92626, (714) 966-6553.

*Data 20 Corporation also makes a set of cards for the VIC that includes a Video Pak 80-column expansion card with additional memory and free word-processing software. Contact Data 20 Corporation, 23011 Moulton Parkway, Suite B10, Laguna Hills, CA 92653, (714) 770-2366. . . .***Steve**

Voiceprints

Dear Steve,

I am writing in reference to your articles in BYTE on voiceprints. I have been thinking along these lines in an attempt to build a system to help deaf people learn to speak. I think if you could display correct voiceprints on a monitor for the deaf person to duplicate, it would facilitate their efforts to speak.

I have an Apple II system and some experience in programming in BASIC. I have heard some rumors about systems that have already been designed, but I have not been able to get any real information. Do you know of anyone I could contact about this subject? Any information or advice on how to proceed would be greatly appreciated. It seems your work with voiceprinting could form the basis of a good system.

Thank you for your consideration.

Dale Sarver
Ridgefield, WA

*Many companies are actively pursuing speech recognition, but I am not sure how many are using the voiceprint concept. Most are concentrating on the recognition of specific words by an unlimited number of users. I am listing below some companies engaged in speech recognition. Write them for further information. . . .***Steve**

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Suite 21
Albuquerque, NM 87104
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Hitachi
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Woodbury, NY 11797
(516) 921-7200

Interstate Electronics
POB 3117
Anaheim, CA 92803
(714) 635-7210

NEC America
532 Broad Hollow Rd.
Melville, NY 11747
(516) 752-9700

Votan
26046 Eden Landing Rd.
Hayward, CA 94545
(415) 785-8060

IMSAI Repair

Dear Steve,

I have an IMSAI VDP-44 in need of repair. To have this done locally, I need schematics and possibly an equipment manual. What is the address of the company that bought out IMSAI?

Is it worth the trouble to fool with this machine? After numerous phone calls, the closest repair available seems to be Computerland in Chicago.
J. R. Weistart
Rochester, IL

Microsystems magazine *features advertisements by a company that has taken over the line of IMSAI computers. Perhaps they have a repair facility to service your unit. Write or call them at*

IMSAI Computer Division
Fischer-Freitas Corporation
910 81st Ave., Bldg. 14
Oakland, CA 94621
(415) 635-7615

As to whether it is worth fixing, that is a question you must answer. Weigh the cost of repair to your total investment. If you were happy with the unit before it malfunctioned, then repair it and keep going. If you were unhappy, here is the excuse that you need to buy a new one.

Good luck. . . . **Steve**

Protecting ZX81 Programs

Dear Steve,

I've had a Sinclair ZX81 computer for about six months and have written a lot of my own programs. Is there any way to prevent someone from being able to display the listing of a program? That is, is there any way you can make a program on tape "run-only"? Any help you can give me on my problem would be greatly appreciated.
Greg E. Sedbrook
Del Rio, TX

The easy way to protect programs from being listed in BASIC is to have the program disable the LIST command. This is easy for computers that have the BASIC in RAM but very difficult if it is in ROM (like your ZX81). I am not aware of a simple way to defeat this command.

Writing your program in machine language will certainly solve the problem. A BASIC program can be written to give title and credits. Then call a USR command to run your machine-language program. This will make it more difficult to copy. . . . **Steve**

Getting Ready for April 15

Dear Steve,

I have a Timex/Sinclair 1000 computer and would like to know if anyone has written a program for it to prepare income tax returns. I know it's been done for other computers.

Also, do you know if anyone has written about converting Sinclair BASIC to BASICs used in computers such as the Atari and Apple II?

Thank you for your help.
Timothy Bartlett
New York, NY

I am not aware of a book written specifically to convert Sinclair BASIC to other BASICs. There is a book to convert between Apple, PET, and Radio Shack; but it does not mention your computer. A general reference for converting between BASIC versions is The BASIC Handbook *by David A. Lien, published by Compusoft Publishing. It describes the similarities and differences between versions of BASIC, gives sample programs, and tells you what to do if your BASIC lacks a particular feature. It should be of great help to you.*

I have not seen an income tax program for the Timex/Sinclair 1000. There have been many articles written for such programs,

(Please turn the page)

so it should be an easy matter to convert one for your computer. One such article appeared in the March 1980 issue of Microcomputing *magazine on pages 42–47. "Income Tax Consultant" by William P. Van Horn describes a tax preparation program that can serve as a model for your computer.* . . . **Steve**

Apple Equipment and the Commodore 64

Dear Steve,

Commodore says that the 6510 processor in its 64 is an improved version of the 6502. If this is true, can I interface the 64 to an Apple II expansion bus? If I do so, can I use Apple-compatible peripheral devices with it? If so, how? Is there any way I could use Apple II software?

Joshua Putnam
Burton, WA

The 6510 microprocessor used in the Commodore 64 is an improved version of the 6502. It features additional input/output lines and shares the same instruction set as the 6502. Apple-compatible peripheral devices, in theory, should work with the Commodore, but some significant differences must be addressed.

1. Many Apple peripheral cards have an onboard ROM that contains software to drive the hardware. These ROMs contain calls to Apple routines in the monitor and other areas not common to the 64. Hence the ROMs may have to be changed.

2. The Apple bus has some built-in decoding known as Device Select signals, which activate the card when a particular area in memory is addressed. No separate address decoding is on the card (usually), and you must add this to work with the 64.

3. Apple uses a different phase of the system clock than the 64 (ϕ 1 instead of ϕ 2). This may create some timing problems on some cards.

Each card must be considered separately for compatibility. It may be possible to create a universal Apple interface for the 64, but an in-depth study of the software and hardware differences is required. . . . **Steve** ■

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:
Ask BYTE
c/o Steve Ciarcia
POB 582
Glastonbury CT 06033

If you are a subscriber to The Source, chat with Steve (TEC317) directly. Due to the high volume of inquiries, personal replies cannot be given. Be sure to include "Ask BYTE" in the address.

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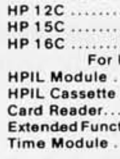

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September

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September-October

Computer-assisted Manual Writing, various sites throughout the U.S. This one-day seminar is designed to teach attendees how to produce good software manuals. The sponsor will demonstrate a software package for automated documentation development called Manual Maker. The fee is $195. For further information, contact Promptdoc, 833 West Colorado Ave., Colorado Springs, CO 80905, (303) 471-9875.

September-November

Computer Showcase Expos, various sites throughout the U.S. This popular show will bring together hardware and software manufacturers, dealers, and consumers of small computer systems. For further details, contact the Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

September-November

Courses from Integrated Computer Systems, various sites throughout the U.S. Course titles include "Hands-On Pascal Workshop," "Structured Design and Programming," "Software Project Management," and "Defining Software Requirements, Specifications, and Tests." Fees range from $695 to $845. For information, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (213) 450-2060.

September-December

Intensive Seminars for Professionals, various sites throughout the U.S. *Electronics* magazine, a McGraw-Hill publication, offers seminars in management and such technical areas as speech recognition and synthesis, controlling electromagnetic interference, fundamentals of computer graphics, and microprocessor interfacing. Inhouse presentations can be arranged. For a descriptive catalog outlining seminars, locations, and fees, contact Irene Parker, McGraw-Hill Seminar Center, Suite 603, 331 Madison Ave., New York, NY 10017, (212) 687-0243.

September-December

James Martin Seminars and **Seminars of Excellence**, various sites throughout the U.S. and Canada. For a brochure describing these data-processing and computer-related seminars, contact Technology Transfer Institute, 741 10th St., Santa Monica, CA 90402, (213) 394-8305.

September-December

Seminars for Professional Development, various sites throughout the U.S. Datapro Research Corporation offers more than 35 professional development seminars in such areas as personal computers, data communications, systems and software, and office automation. Complete outlines and schedules are available from Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075, (800) 257-9406; in New Jersey, (609) 764-0100.

September-December

Software Workshops in MMSFORTH, Boston metropolitan area. These workshops are public versions of the professional training Miller Microcomputer Services (MMS) offers to client companies in support of the MMSFORTH product line. A variety of topics and skill levels are covered. Full details are available from Miller Microcomputer Services, 61 Lake Shore Rd., Natick, MA 01760, (617) 653-6136.

September-January 1984

Technology Opportunity Conference, various sites throughout the U.S. This conference series focuses on the convergence of optical-storage, videodisc, and computer technologies. For full details, contact Technology Opportunity Conference, POB 14817, San Francisco, CA 94114, (415) 626-1133.

September 11-14

The American Data Services (ADS) Users Seminar, Marriott Resort, Lincolnshire, IL. This seminar focuses on the ADS inventory-management system. A procedural cost system for hospital departments will be introduced. Contact Sharon Spencer, American Data Services, Suite 210, 900 North Shore Dr., Lake Bluff, IL 60044, (312) 295-6850.

September 12-14

Discovery '83: Computers for the Disabled, Leamington Hotel, Minneapolis, MN. This conference provides a forum for learning about advances in computer technology that combine special education and vocational rehabilitation. Papers, workshops, demonstrations, and product exhibits will be featured. Further information is available from the Office of Continuing Education, University of Wisconsin-Stout, Menomonie, WI 54751, (715) 232-1167.

September 13-15

AUTOFACT Europe Conference and Exhibition, Palexpo Exhibition Center, Geneva, Switzerland. This conference, cosponsored by the Society of Manufacturing Engineers (SME) and the Institution of Production Engineers of London, England, will focus on the technologies of automated and computer-integrated manufacturing for European production. Technical sessions will explore both theory and applications strategies. A complementary products display will be featured. Contact the Society of Manufacturing Engineers, Public Relations Department, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-0777.

September 13-15

Midcon/83 and **Mini/Micro-Midwest/83**, Chicago, IL. Topics on the professional program include computer simulation, energy management, laser applications, and printed-circuit-board technology. An exhibit area is planned. For further information, contact Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965.

September 13-15

Peripherals '83, Moscone Center, San Francisco, CA. Full details are available from Cahners Exposition Group, Cahners Plaza, 1350 East

Touhy Ave., POB 5060, Des Plaines, IL 60018, (312) 299-9311.

September 13-15

Software/Expo, McCormick Place, Chicago, IL. Contact Professional Exposition Management Co. Inc., Suite 205, 2400 East Devon Ave., Des Plaines, IL 60018, (800) 323-5155; in Illinois, (312) 299-3131.

September 13-16

Understanding Microprocessor-based Equipment and Troubleshooting Seminar, Washington, DC. Topic areas include TTL and CMOS logic devices, architecture of microcomputer systems, test equipment, and digital troubleshooting. Tuition is $595. For more information, contact Micro Systems Institute, Garnett, KS 66032, (913) 898-6152.

September 14-16

Euromicro '83, Madrid, Spain. The ninth annual Euromicro symposium will cover microprocessing and programming. Speeches will address economic and social aspects of microprocessors and trends in VLSI (very-large-scale integration) technology. Tutorials, seminars, and an exhibition are planned. The highlight of this event is the Euromouse contest, in which mechanical mice from around the world race around a maze. A complete program is available from Euromicro, TH Twente, POB 217, Department INF, Room A312, 7500 AE Enschede, The Netherlands; tel: (31) (53) 338799; Telex: 44200 Thes.

September 15-16

Ethernet-type Local Networks, San Francisco, CA. This is the third program in the four-part Architecture Technology Corporation 1983 Forum Series. This program will bring together manufacturers and users of local-network schemes to exchange information in an informal setting. The format includes presentations, panel discussions, and a technological summary. The fee is $395. For further information, contact the Architecture Technology Corp., POB 24344, Minneapolis, MN 55424, (612) 935-2035.

September 15-16

The Second Annual Indiana Computer Expo, Convention Center, Indianapolis, IN. This exposition is designed for business end users interested in mini- and microcomputers, software, word processing, graphics, services, and peripherals. Contact Ernie Kerns & Associates, Trade Show Department, Suite 201, 2555 East 55th Place, Indianapolis, IN 46220, (317) 259-8111.

September 15-18

The Second Annual Twin Cities Computer Show and Software Exposition, Minneapolis Auditorium, Minneapolis, MN. This show features more than 350 displays of microcomputers, accessories, peripherals, publications, services, and software. General admission is $5 for adults and $3 for children. Contact Northeast Expositions, 822 Boylston St., Chestnut Hill, MA 02167, (800) 841-7000; in Massachusetts, (617) 739-2000.

September 16-18

Compufair, Seattle Center Exhibition Hall, Seattle, WA. This show will feature personal computer hardware, software, and services available for a variety of applications. Presentations and seminars on how to buy a personal computer and computers' effectiveness with children will be offered. Contact Tom Ikeda, Compufair Inc., Suite 302, 909 Northeast 43rd St., POB 45218, Seattle, WA 98105, (206) 633-3247.

September 16-18

The First Annual Heart of Texas Computer Show, Convention Center, San Antonio, TX. This show will emphasize small-business systems for financial and inventory control, agri-business, education, and personal computing needs. More than 200 hardware, software, and peripheral vendors will display their wares. Show details are available from Robin G. Mann, Heart of Texas, POB 12094, San Antonio, TX 78212, (512) 226-4636.

September 16-18

Great Southern Computer & Electronics Show '83, Memorial Coliseum, Jacksonville, FL. Computers, electronics, and information services will be featured. Contact Great Southern Computer & Electronics Shows, POB 655, Jacksonville, FL 32201, (904) 384-6440.

September 17-18

Carleton University Computer Fair '83, Carleton University campus, Ottawa, Ontario, Canada. Exhibits, lectures, and an auction of used and hard-to-find electronic materials will be featured. Admission to all events is free. Information is available from the IEEE Student Branch, Faculty of Engineering, Carleton University, Ottawa, Ontario K1S 5B6, Canada.

September 18

Computer Swap Meet, Exhibition Hall, Sarasota, FL. This event is sponsored by the Institute of Computer Management (ICM), a nonprofit corporation designed to enhance the mental skills of the physically disabled. Items relating to computers will be sold. Admission is free. Contact the ICM, 3803 Prairie Dunes Dr., Sarasota, FL 33583, (813) 924-7105.

September 19-21

The Third Annual Videodisc Conference, New York Hilton Hotel, New York, NY. For details, contact Meckler Publishing, 520 Riverside Ave., Westport, CT 06880, (203) 226-6967.

September 19-22

Computer Literacy Week, New York City Hilton. More than 35 sessions on such strategies and techniques as how to help managers grow accustomed to computers and how to use microcomputers as a training medium highlight this conference. Workshops, hands-on seminars, and an exhibition hall will be featured. For a brochure, contact Susan Jones, Conference Management Corp., 17 Washington St., POB 4990, Norwalk, CT 06856, (203) 852-0500.

September 19-23

The Ninth World Computer Congress–IFIP '83, Paris, France. This event, sponsored by the International Federation for Information Processing (IFIP), is held in conjunction with SICOB, the major French computer exposition. Formal papers and panel sessions will cover such areas as computer hardware and software, theoretical foundations of information processing, networks, and communications. For full program details, contact the U.S. Committee for IFIP '83, Dorn Computer Consultants, 25 East 86th St., New York, NY 10028, (212) 427-7460.

September 20-21

Data Storage 83, Marriott Hotel, Santa Clara, CA. This international forum covers industry issues and areas of change in data-storage equipment and applications. The

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fee is $850. Contact Cartlidge & Associates Inc., Suite 205, 4030 Moorpark Ave., San Jose, CA 95117, (408) 554-6644.

September 20-22
Caribbean Informatics '83, San Juan, Puerto Rico. This is the first major international exhibition and conference to be held in the Caribbean area. For further details, contact Informatics '83, Suite 219, 3421 M St. NW, Washington, DC 20007, (703) 920-9595.

September 20-23
Understanding Microcomputer-based Equipment and Troubleshooting Seminar, Boston, MA. For details, see September 13-16.

September 21-22
Business-Expo, Boston, MA. This exposition serves as a showcase for office equipment ranging from computers to coffee machines. More than 20 seminars are planned. Address inquiries to Business-Expo, 702 East Northland Towers, 15565 Northland Dr., Southfield, MI 48075, (313) 569-8280.

September 22-23
Computers in Construction, San Francisco, CA. This seminar is designed to assist construction management firms and contractors in acquiring computer systems. The fee is $425. Contact CIP Information Services Inc., 1105-F Spring St., Silver Spring, MD 20910, (301) 589-7933.

September 22-24
The Second Annual Rocky Mountain Computer Show and Software Exposition, Merchandise Mart, Denver, CO. This show features displays of computers, video games, software, accessories, publications, services, and peripherals. For information, contact Northeast Expositions, 822 Boylston St., Chestnut Hill, MA 02167, (800) 841-7000; in Massachusetts, (617) 739-2000.

September 26-28
Maecon/83, Kansas City, MO. This electronic show and convention explores such topics as aerospace electronics, computer peripherals, laser technology, and personal computing. Contact Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965.

September 26-29
The World of CAD/CAM, Boca Raton Resort Hotel, FL. This seminar provides an overview of how manufacturing will change as the automated factory becomes a reality. It will consist of four one-day presentations in computer-aided engineering, design, manufacturing, and computer-integrated manufacturing. For a brochure, write or call the Center for Manufacturing Technology, 4170 Crossgate Dr., Cincinnati, OH 45236, (513) 791-8801.

September 26-30
Compcon Fall '83, Marriott Crystal Gateway Hotel, Arlington, VA. The theme of this show is "Delivering Computer Power to End Users." It features technical papers and panel sessions that address a variety of computer and computer-network issues. It is sponsored by the Institute of Electrical and Electronics Engineers (IEEE) Computer Society. For more information, contact Compcon Fall '83, POB 639, Silver Spring, MD 20901, (301) 589-8142.

September 26-30
Expo Beirut '83, Beirut, Lebanon. This is Lebanon's first international reconstruction/development exposition and conference after eight years of civil war. Topics to be covered include construction, transportation, communications, agriculture, computer hardware and software, metallurgy, textiles, and automated equipment. Further details are available from Show-Tech International Inc., 950 Third Ave., New York, NY 10022.

September 26-30
International Conference on Networks and Electronic Office Systems, University of Reading, Berkshire, England. The conference program comprises formal lectures and discussions. For additional information, contact the Conference Secretariat, Institution of Electronic and Radio Engineers, 99 Gower St., London WC1E 6AZ, England; tel: 01 388 3071.

September 28-29
Ottawa Computer and Office Automation Show, Civic Centre, Ottawa, Ontario, Canada. For details, contact Industrial Trade Shows of Canada, 20 Butterick Rd., Toronto, Ontario M8W 3Z8, Canada, (416) 252-7791.

September 28-October 2
The Sixth Personal Computer World Show, Barbican Centre, London, England. This show, one of the largest computer shows in Great Britain, is sponsored by *Personal Computer World* magazine. Business, scientific, technical, and educational uses of microcomputing will be featured as well as hobbyist and home-based systems. For information, contact Tim Collins, Montbuild Ltd., 11 Manchester Square, London W1M 5AB, England; tel: 01 486 1951; Telex: 24591.

September 29-October 1
CP/M '83 East, Hynes Auditorium, Boston, MA. For information on this conference and exposition of CP/M-based software, contact Northeast Expositions Inc., 826 Boylston St., Chestnut Hill, MA 02167, (800) 343-2222; in Massachusetts, (617) 739-2000.

September 29-October 2
Computers in Health Care '83: A Symposium and Exhibition, Sacramento, CA. This symposium and exhibition explores the role of computers in hospitals, physician and dental offices, rehabilitation centers, long-term care facilities, home-health agencies, pharmacies, and mental-health settings. Contact Eskaton Health Corp., Community Services Division, 1501 El Camino Ave., Sacramento, CA 95815, (916) 927-5722.

October 1983

October 1
The Third Annual Microcomputers in Education Conference, Dutchess County Community College, Poughkeepsie, NY. Dr. Delores Shanahan, an innovator in the field of special education and computers, will speak at this event sponsored by the Microcomputer Educator Group. Details are available from Dr. Florence Staats, Office of Community Services, Dutchess County Community College, Pendell Rd., Poughkeepsie, NY 12601, (914) 471-4500, ext. 240.

October 2-5
Computer Systems Exposition, MGM Grand Hotel, Las Vegas, NV. This exposition will be held in conjunction with the annual meeting of the National Association of Convenience Stores. Hardware and software will be displayed, and computer consultants will be on hand to

answer questions. For details, contact the National Association of Convenience Stores, Suite 809, 5201 Leesburg Pike, Falls Church, VA 22041, (703) 578-1800.

October 2-6

The Annual Meeting of the American Society for Information Science — ASIS-83, Crystal City Hyatt Regency, Arlington, VA. The theme for this meeting is "Productivity in the Information Age." Papers, special-interest sessions, information briefings, an information-science theater, and demonstrations will be featured. Further information is available from Edmond Sawyer, ASIS Headquarters, 1010 Sixteenth St. NW, Washington, DC 20036, (202) 659-3644.

October 2-7

HP 3000 IUG International Conference, George Hotel, Edinburgh, Scotland. This conference, sponsored by the HP 3000 International Users Group (IUG), is made up of technical sessions and tutorials on data-processing management, data communications, and applications in business, manufacturing, and engineering for users of Hewlett-Packard 3000 business computers. Contact the Conference Manager, HP 3000 IUG, 289 South San Antonio Rd., Los Altos, CA 94022, (415) 941-9960. In Europe, contact The Secretariat, HP 3000 IUG, 10 Rutland Square, Edinburgh EH1 2AE, Scotland; tel: (031) 229-7366; Telex: 727136.

October 3-5

SNA Architecture and Implementation, Holiday Inn, Park Center Plaza, San Jose, CA. This seminar provides the working knowledge needed to design SNA (system-network architecture) networks and evaluate SNA-compatible products. Examples of how various protocols are used to control communications will be provided. Other topics include SNA functional layering and network elements. The fee is $650. Full details are available from Communications Solutions Inc., 992 Saratoga-Sunnyvale Rd., San Jose, CA 95129, (408) 725-1568.

October 4-6

The Southwest Computer Conference, Tulsa, OK. The theme for this conference is "Managing Information Technology in the 80s." Computer hardware and software will be exhibited. Contact the Southwest Computer Conference, POB 950, Norman, OK 73070, (405) 329-3660.

October 5-6

Compusource '83, Red Lion Inn and Convention Center, San Jose, CA. Original equipment manufacturers and sophisticated end users are offered a look at products and technologies reflecting the latest advances in the computer industry. This conference will feature technical sessions and more than 100 exhibits. Details are available from Norm DeNardi Enterprises, Suite 204, 289 South San Antonio Rd., Los Altos, CA 94022, (415) 941-8440.

October 6-7

Computers in Construction, Atlanta, GA. For details, see September 22-23.

October 6-8

The Second New Jersey Business Computer Show, Holiday Inn (North), exit 14 of the New Jersey Turnpike. This business show features small business systems, desktop computers, word processors, software, and accessories. For further information, contact the Kengore Corp., POB 13, Franklin Park, NJ 08823, (201) 297-2526.

October 6-11

Japan Electronics Show '83, Osaka International Trade Fair Grounds, Osaka, Japan. This show will cover a range of consumer and industrial electronic products and components. For information, contact the Japan Electronics Show Association, 24 Mori Building 11F, 3-23-5, Nishi-Shinbashi, Minato-ku, Tokyo 105, Japan; tel: (03) 433-7751.

October 7

Computer Graphic Networks and Standards, Washington, DC. New directions in integrated voice, data, text, graphics, and image networking for information imaging and market trends for the next five years are some of the topics to be explored at this seminar. The fee is $250. Contact Mike Nolan, Computer Technologies Department, Printing Industries of America Inc., 1730 North Lynn St., Arlington, VA 22209.

October 7-9

Great Southern Computer & Electronics Show '83, Centroplex Expo, Orlando, FL. For details, see September 16-18.

October 8-9

The Tidewater Eighth Annual Computer Convention, Hamfest, Electronic Flea Market, Pavilion, Virginia Beach, VA. Dealers, an electronics flea market, displays, and forums highlight this event. Admission is $4 for both days. For tickets and general information, call or write Jim Harrison, 1234 Little Bay, Norfolk, VA 23503, (804) 587-1695.

October 8-10

PC '83, Bayside Exposition Center, Boston, MA. This conference and exposition features IBM Personal Computers and compatible equipment. A seminar program will explore applications, provide technical information, and offer general sessions designed to show users how to get the most from their IBM PC. For details, contact Northeast Expositions, 822 Boylston St., Chestnut Hill, MA 02167, (800) 841-7000; in Massachusetts, (617) 739-2000.

October 10-12

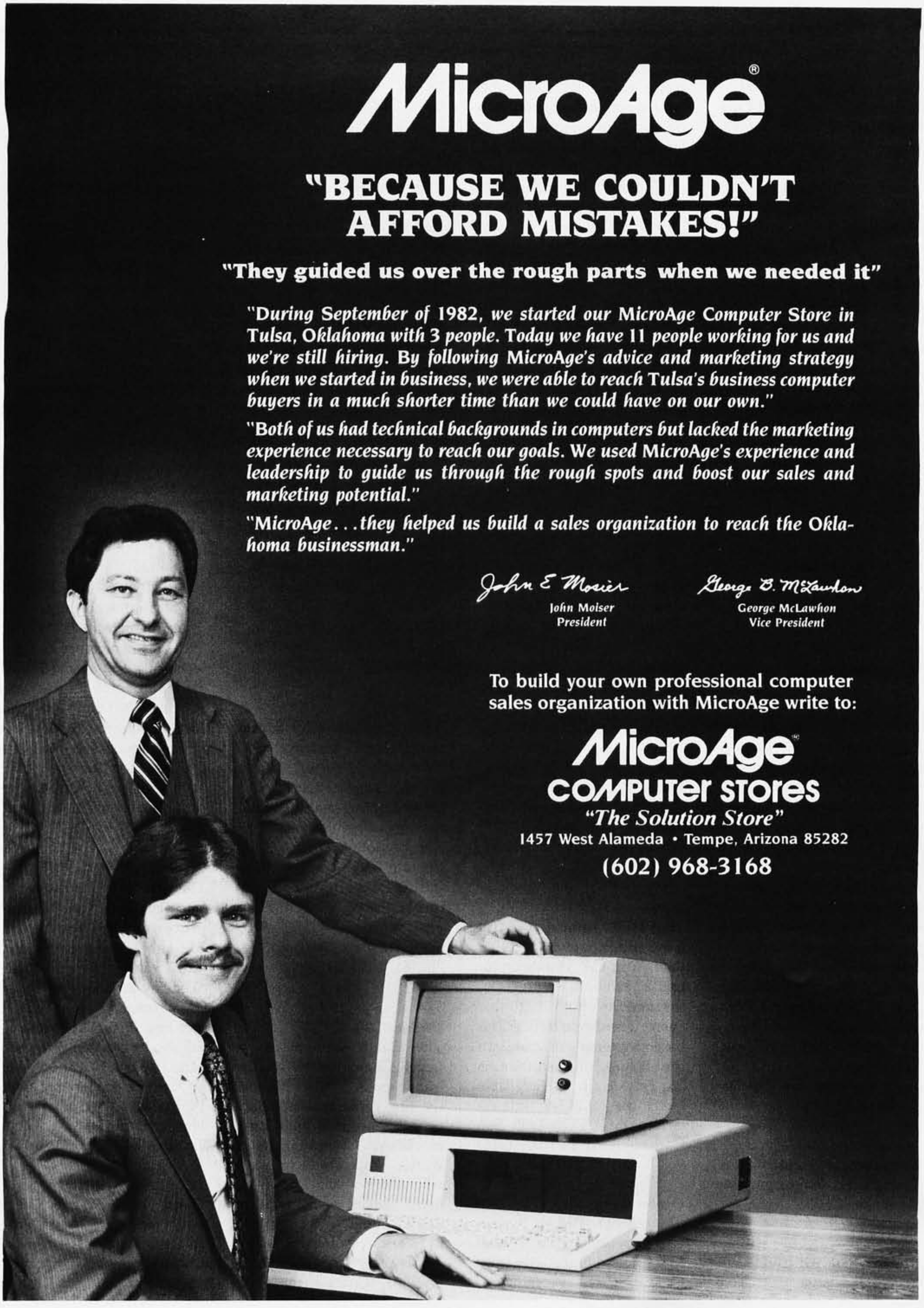
Online '83, Palmer House, Chicago, IL. The fifth annual Online conference and exposition features introductory and advanced technical sessions, panel discussions, workshops, seminars, and addresses. The role of microcomputers and software for database searching, storage, creation, and communications will be emphasized. Registration information is available from Online Inc., 11 Tannery Lane, Weston, CT 06883, (203) 227-8466.

October 10-13

Information Management Exposition and Conference: Info 83, New York City Coliseum. Hardware and software exhibits and conference sessions will revolve around the theme "Tying the Information System to the Business Plan." A number of the conference sessions will deal with decision support systems. For complete details, contact the Marketing Manager, Info 83, 708 Third Ave., New York, NY 10017, (212) 661-8410.

October 10-14

Defense Computers-Graphics-DCG '83, Convention Center, Washington, DC. Sessions and tutorials will complement this conference and exposition about computers and graphics for the defense community. For more information, contact DCG '83, Suite 333, 2033 M St. NW, Washington, DC 20036, (202) 775-9556.



MicroAge franchisees John Moiser and George McLawhon shown with IBM products.

October 11-12

Computer-aided Design Conference—CADCON East '83, Boston, MA. This conference consists of technical programs and exhibitions organized exclusively for computer-aided-design engineering. More information is available from Morgan-Grampian Expositions Group, 2 Park Ave., New York, NY 10016, (212) 340-9780.

October 11-13

Southwest Semiconductor & Electronics Exposition—SSE '83, Civic Plaza Convention Center, Phoenix, AZ. Approximately 200 suppliers of equipment, materials, and services used in the electronics industry will attend this show. A technical conference will be held. Contact Cartlidge & Associates Inc., Suite 205, 4030 Moorpark Ave., San Jose, CA 95117, (408) 554-6644.

October 12-21

The Sixth International Trade Exhibition on Office Organizational Systems, Office Furniture, and Office Aids—Systemotechnika '83, Vassilievsky Ostrov Exhibition Centre, Leningrad, Union of the Soviet Socialist Republics. On display will be communications systems, microfilming equipment and systems, data-processing equipment, and computers. Contact Düsseldorfer Messegesellschaft mbH-NOWEA-Central Division—Foreign Fairs, Düsseldorf Exhibition Centre, 4000 Düsseldorf 30, Federal Republic of Germany; tel: (02 11) 45 60-1.

October 13-14

Computers in Construction, Chicago, IL. For details, see September 22-23.

October 13-15

Edutech/East '83, Civic Center, Philadelphia, PA. Formerly called Ed Com, this conference and exposition is designed for educators at all levels. Presentations will address such topics as computer-aided instruction, administrative uses of computers, classroom management, programming, research applications, authoring languages, and literacy. The format includes workshops, seminars, demonstrations, hands-on sessions, discussions, and micro courses. Hardware, software, and publishing companies will exhibit their wares. Contact Carol Houts, Judco Computer Expos Inc., Suite 201, 2629 North Scottsdale Rd., Scottsdale, AZ 85257, (800) 528-2355; in Arizona, (602) 990-1715.

October 14-15

Computers and Reading/Learning Difficulties, Dallas, TX. Workshops, hands-on exhibits, and speakers will explore such topics as using computers in learning disability classrooms and evaluating software. This program is designed for all education levels. For information, contact Frost Conference Management, Department I, 1070 Crows Nest Way, Richmond, CA 94803, (415) 222-1249.

October 14-15

The Fifth Annual FORTH Convention, Hyatt Hotel, Palo Alto, CA. Hands-on tutorials, exhibits, lectures, and discussions highlight this event. The theme is "FORTH-based Systems—A Look Into the Future." Registration is $5. Full details are available from the FORTH Interest Group (FIG), POB 1105, San Carlos, CA 94070, (415) 962-8653 (FIG hot line).

October 14-16

The UCSD Pascal System Users Society (USUS) Fall Meeting, Hyatt Regency Crystal City, Washington, DC. Contact the Secretary, USUS, POB 1148, La Jolla, CA 92038.

October 15-16

The Seventh New Jersey Microcomputer Show and Flea Market, Meadowlands Hilton Hotel, Secaucus, NJ. Featured will be home, hobby, and small business computers, software, supplies, books, and accessories. Admission is $5 for adults; $2 for children. Contact Kengore Corp., POB 13, Franklin Park, NJ 08823, (201) 297-2526.

October 16-18

The Fifth Annual Hong Kong Consumer Electronics Show, New World Hotel and Regent Hotel, Hong Kong. For details, contact IBS Trade Fair Ltd., 17th Floor, Tung Sun Commercial Centre, 200 Lockhart Rd., Hong Kong; tel: 5-732388-9; Telex: 63037 HKIBS HX.

October 16-18

Texas Association for Educational Data Systems 1983 Convention, Austin Hilton Hotel, Austin, TX. The theme for this year's convention is "Computer Literacy." The keynote speaker will be Captain Grace Hopper of the U.S. Navy. Information may be obtained from Tom Hopper, Northside ISD, 5900 Evers Rd., San Antonio, TX 78238, (512) 618-8330, ext. 212.

October 17-19

The Eighth Conference on Local Computer Networks, Minneapolis, MN. The theme for this conference is "Practical Applications and Issues in Local Computer Networks." Papers and tutorials will address such issues as users' versus manufacturers' needs, public versus private networks, software, and VLSI (very-large-scale integration). Contact the IEEE Computer Society, POB 639, Silver Spring, MD 20901.

October 17-21

Systems 83, Munich, West Germany. Computers, peripherals, and software will be displayed by more than 600 firms from 35 nations. For additional information, contact Kallman Associates, 5 Maple Court, Ridgewood, NJ 07450, (201) 652-7070.

October 18-20

The Fourteenth Annual International Test Conference, Franklin Plaza Hotel, Philadelphia, PA. For information, contact the Conference Registrar, POB 371, Cedar Knolls, NJ 07927, (201) 267-7120.

October 18-21

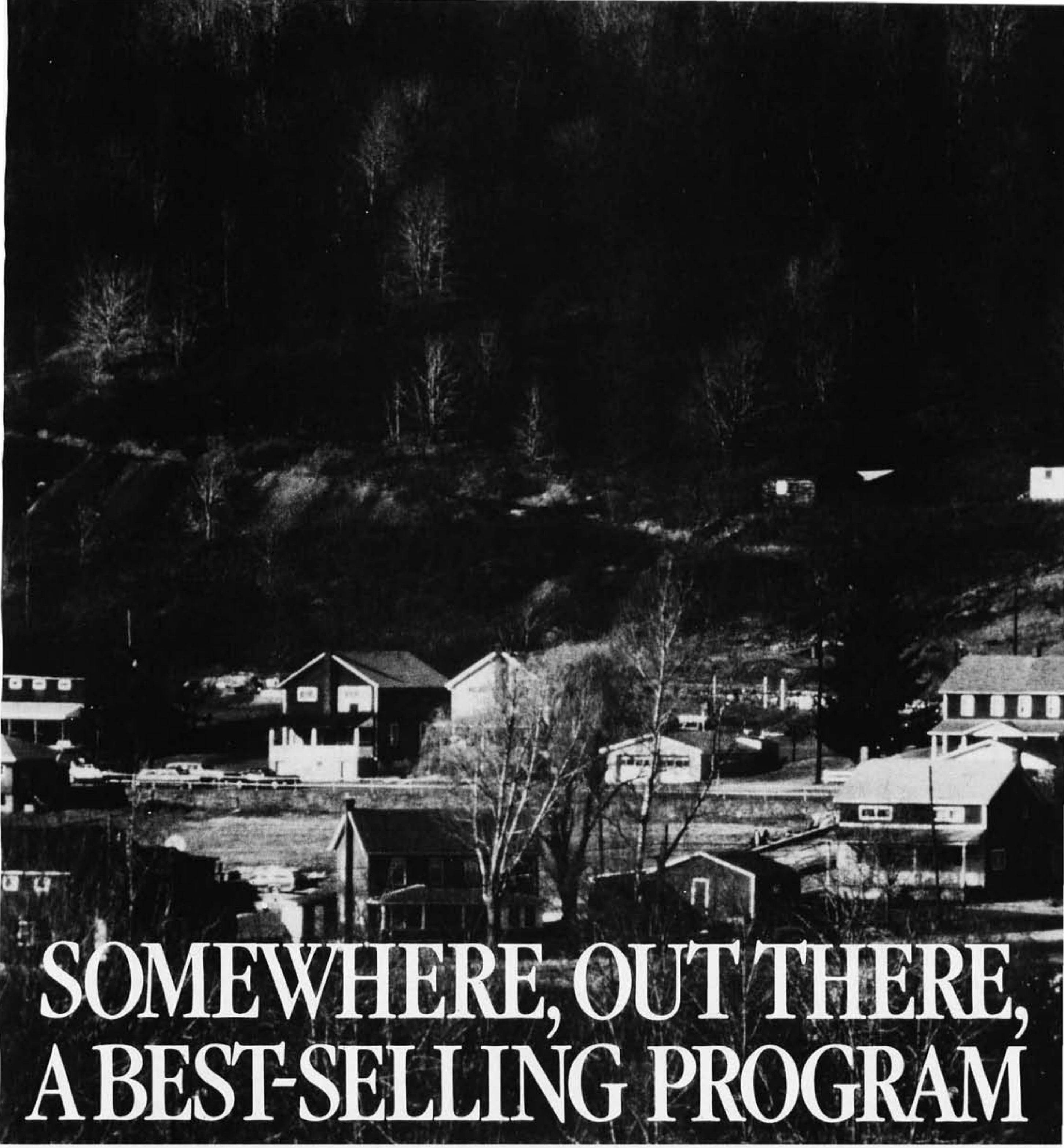
HP 1000 IUG 1983 International Conference, Hyatt Regency Hotel, Fort Worth, TX. This conference features technical sessions and tutorials for users of the Hewlett-Packard 1000 family of real-time engineering and scientific computers. Contact the Conference Manager, HP 1000 IUG, 289 South San Antonio Rd., Los Altos, CA 94022, (415) 941-1943.

October 18-21

The Third Symposium on Microcomputer and Microprocessor Applications-µP '83, Hotel Duna Intercontinental and the Hungarian Academy of Sciences, Budapest, Hungary. The conference language will be English. Full details are available from Mrs. I. Bába, Scientific Society for Telecommunication, POB 451, H-1372 Budapest, Hungary; tel: (36) 1 113-027; Telex: MTESZ 22-5792.

October 19-20

Calgary Computer & Office Automation Show and Conference, Roundup Centre, Calgary, Alberta, Canada. For details, contact Industrial



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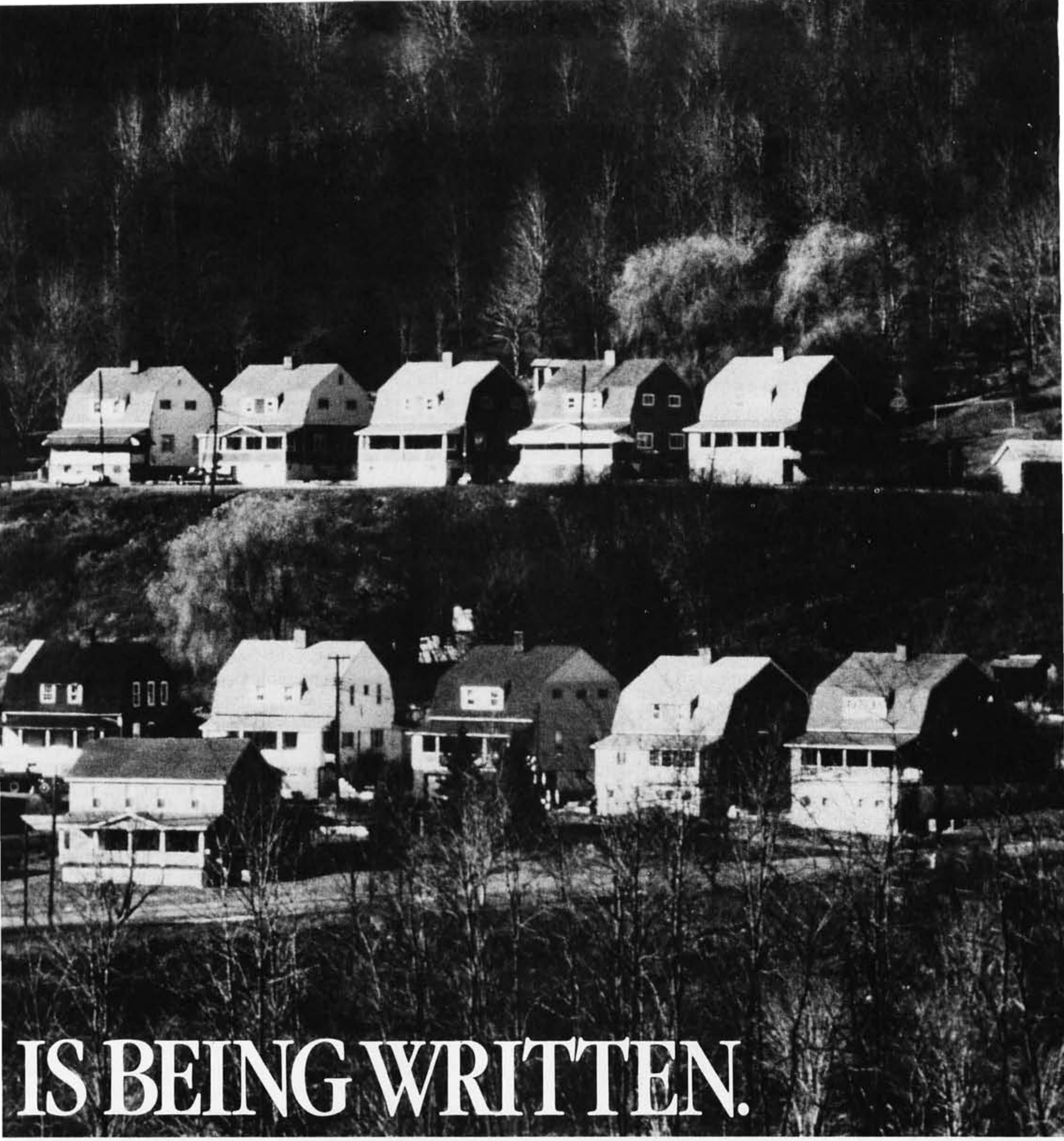

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Trade Shows of Canada, 20 Butterick Rd., Toronto, Ontario M8W 3Z8, Canada, (416) 252-7791.

October 19-21

The Fourth Canadian Symposium on Instructional Technology, Westin Hotel, Winnipeg, Manitoba, Canada. This symposium, designed for education and training professionals and those interested in computer-aided learning, will explore the theme "Computer Technologies for Productive Learning." Topics on the agenda include computer awareness and literacy in schools and society, systems technology, and computer-aided training and retraining for business, industry, and government. A products exhibition will be held. Contact Ken Charbonneau, Conference Services Office, National Research Council of Canada, Ottawa, Ontario K1A 0R6, Canada, (613) 993-9009; Telex: 053-3145.

October 19-21

IDATE–The Fifth International Conference, Montpellier, France. The theme for this conference, sponsored by the International Telecommunication Union, is "Picture Networks." Topics of interest include network functioning and areas of applications, economics and law relating to the visual media, network languages, and languages on the networks. The conference language is French. For further details, contact Francois Rabaté, Responsable Scientifique, Journées Internationales 1983, IDATE–Bureaux du Polygone, 34000 Montpellier, France; tel: (33–67) 65 48 48; Telex: IDATE 490 290.

October 19-21

The National Software Show, Trade Show Center, San Francisco, CA. Full details are available from Raging Bear Productions Inc., Suite 175, 21 Tamal Vista Dr., Corte Madera, CA 94925, (800) 732-2300; in California, (415) 924-1194.

October 19-21

SIBEC – Info Expo, Palais des Congres, Montreal, Canada. Exhibits related to the computer and office automation industries will be held. An international lineup of speakers has been invited. Contact Informatique Québec (Info Expo) Ltée, 1057 Avenue Laurier Ouest, Outremont, Québec H2V 2L2, Canada, (514) 270-5481; in the Toronto area, call (416) 281-3459.

October 19-22

Management Executives Conference, The Breakers, Palm Beach, FL. The "Third Industrial Revolution" is the theme for this conference sponsored by the American Society of Mechanical Engineers (ASME). Management experts will speak on such topics as executive effectiveness and management for international competition. Complete conference details are available from Wendy Morris, ASME, 345 East 47th St., New York, NY 10017, (212) 705-7788.

October 19-22

Percompasia 83–The Second South East Asian Personal Computer Hardware & Software Show & Conference, World Trade Centre, Singapore, Republic of Singapore. This show is devoted to all aspects of personal computing. Further details are available from Overseas Exhibition Services Ltd., 11 Manchester Square, London W1M 5AB, England; tel: 01 486 1951; Telex: 24591.

October 23-26

The Seventh Annual Symposium on Computer Appli-

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cations in Medical Care (SCAMC), Baltimore Convention Center, Baltimore, MD. Some of the topics to be covered include medical applications and solutions to problems of computers and technology in health care. For details, contact SCAMC, George Washington University Medical Center, Office of Continuing Medical Education, 2300 K St. NW, Washington, DC 20037, (202) 676-8928.

October 24-26

The Annual Conference of the Association for Computing Machinery–ACM '83, Sheraton Centre Hotel, New York, NY. Exhibits of computer hardware and software and paper sessions will focus on the conference theme, "Extending the Human Resource." The emphasis will be on theory and practices of personal computing. Highlighting the conference will be the Fourth International Computer Chess Championships. For details, contact Thomas A. D'Auria, Assistant Commissioner, City of New York, Computer Service Center, 11th Floor, 111 8th Ave., New York, NY 10011, (212) 620-5055.

October 25-27

Andean Informatics '83, Bogota, Colombia, South America. This is the first major international exhibition and conference to be held in the Andean region. For details, contact Informatics '83, Suite 219, 3421 M St. NW, Washington, DC 20007, (703) 920-9595.

October 25-28

Working Conference on Prototyping, Brussels, Belgium. This conference will focus on the user-oriented development of information systems supported by prototyping. Research and technical papers will be presented. The sponsor is the Commission of the European Communities. For information, contact Reinhard Budde or Heinz Zuellighoven, GMD-IST Postfach 1240, Schloss Birlinghoven, D-5205, St. Augustin 1, West Germany; tel: 02241/14-2440; Telex: 8 89 469 gmd d.

October 26-28

Developing Long-Range Systems Strategies, Sheraton Hotel, Washington, DC. This is part of the George Washington University Executive Systems Forum series. Contact the Conference Manager, U.S. Professional Development Institute, 1805 Powder Mill Dr., Silver Spring, MD 20903, (301) 445-4400.

October 27-28

Computers in Construction, Washington, DC. For details, see September 22-23.

October 28-30

Applefest, Moscone Center, San Francisco, CA. More than 300 displays and booths of Apple computer equipment and accessories will be featured. Seminars, panel discussions, conferences, and workshops will be held. Details are available from Northeast Expositions Inc., 822 Boylston St., Chestnut Hill, MA 02167, (800) 343-2222; in Massachusetts, (617) 739-2000.

October 30-November 2

DPMA Baltimore '83, Convention Center and Hyatt Regency Hotel, Baltimore, MD. The theme for this conference, sponsored by the Data Processing Management Association (DPMA), is "Information on the Firing Line." Seminars, workshops, general sessions, and product displays will be featured. For details, contact Jim Osowski, DPMA International Headquarters, 505 Busse Highway, Park Ridge, IL 60068, (312) 825-8124.

October 31-November 2

The Ninth International Conference on Very Large Databases, Palazzo dei Congressi, Florence, Italy. This conference seeks to identify and encourage the research, development, and applications of database technology. Subjects of interest include database control, modeling and managing unformatted data, and novel environments and applications of database technology. Contact Mario Schkolnick, K 55-281, IBM Research Labs, 5600 Cottle Rd., San Jose, CA 95193, (408) 256-1648. In Italy, Renzo Pinzani, Istituto di Matematica U. Dini, Viale Morgagni, 67/A, 50134 Florence, Italy.

October 31-November 3

International Conference on Computer Design–VLSI in Computers, Rye Town Hil-

ton, Port Chester, NY. This conference will cover the VLSI (very-large-scale integration) aspects of the interaction between fabricators and systems designers in hardware, software, and reliability in computers. Contact the IEEE Computer Society, POB 639, Silver Spring, MD 20901.

October 31-November 4

Welcome to the World of Personal Computing, Washington, DC. This is a comprehensive introduction on how to use microcomputer technology in business, industry, and government. The workshop agenda offers six modules ranging from user productivity to software reliability. For details, contact Keston Associates, 11317 Old Club Rd., Rockville, MD 20852, (301) 881-7666.

November 1983

November 1-2

The Annual Fall Conference of the Iowa Association for Educational Data Systems, Des Moines, IA. "Quality Software for the 80s: Development, Selection, and Usage" will be the focus of more than 40 sessions presented during this conference. Three preconference workshops will be held on October 31. For details, contact Phillip J. Berrie, Educational Services Division, Heartland AEA 11, 1932 Southwest Third St., Ankeny, IA 50021.

November 1-3

INTECH '83—The Integrated Office Technology Conference and Exposition, McCormick Place, Chicago, IL. This conference and exposition is designed to provide top management with high-level seminars, workshops, and equipment demonstrations that address the integration of information technologies and applications. Contact Mary Beth Gouled, National Trade Productions Inc., 9418 Annapolis Rd., Lanham, MD 20706, (800) 638-8510; in Maryland, (301) 459-8383.

November 1-3

The 1983 Federal Office Automation Conference, Convention Center, Washington, DC. The theme for this conference and exposition is "Making It Work." The conference program will consist of seminars, workshops, technology briefings, and major addresses. The exposition segment will provide displays of the latest office automation equipment, systems, and services. Further details are available from the National Council for Education on Information Strategies, POB N, Wayland, MA 01778, (800) 343-6944; in Massachusetts, call (617) 358-5356, collect.

November 1-3

Western Design Engineering Conference, Convention Center, Los Angeles, CA. Short courses on the agenda include "Principles of Robotics for Engineers," "Effective Project Management," and "Programming Personal Computers." Many of the 12 short courses will provide hands-on experience. An exhibition area will be featured. Contact the Marketing Director, Western Design Engineering Show, 708 Third Ave., New York, NY 10017, (212) 661-8410.

November 2-4

Edmonton Computer and Office Automation Show, Convention Centre, Edmonton, Alberta, Canada. For full details, contact Industrial Trade Shows of Canada, 20 Butterick Rd., Toronto, Ontario M8W 3Z8, Canada, (416) 252-7791.

November 2-4

The First Annual Computer Vertical Market Conference, Meadowlands Hilton, East Rutherford, NJ. This conference, sponsored by Frost and Sullivan, will explore the impact of the new integrated software approaches and the importance of maintenance and support functions. Speakers will address vertical marketing issues from the perspective of the user, vendor, and industry analyst. Full particulars are available from Carol Sapchin, Frost and Sullivan Inc., 106 Fulton St., New York, NY 10038, (212) 233-1080.

November 3-4

Computers in Construction, Scottsdale, AZ. For details, see September 22-23.

November 3-6

The 1983 National Home Electronics Show, Arlington Park Exposition Hall, Arlington Heights, IL. This show covers electronic equipment and technology ranging from home computers to telecommunications security systems. It's produced by Lincoln Merchandising Co. Inc., 1417 Milwaukee Ave., Chicago, IL 60622, (312) 276-2819.

November 5-6

The Fourth Annual San Diego Computer Fair, Scottish Rite Center, San Diego, CA. This fair features short technical sessions, programming and computer games contests, commercial displays, and user group displays. For additional information, contact the San Diego Computer Society, POB 81537, San Diego, CA 92138, (619) 565-8720.

November 5-7

Midwestern Educational Computer & Technology Conference, McCormick Inn, Chicago, IL. Exhibits, software demonstrations, seminars, and workshops will explore the theme "Higher Instructional Techniques in Education." For more information, contact the National Educational Computer Library, POB 293, New Milford, CT 06776, (203) 354-7760.

November 7-11

International Conference on Industrial Electronics—IECON '83, Hyatt Regency Hotel, San Francisco, CA. For information, contact Frank A. Jur, Bechtel Corp., 45 Fremont St., MS-45/17A26, San Francisco, CA 94109.

November 8-10

The Third Annual Software/Expo, Wembley Conference Centre, London, England. Conference topics range from computer-aided design to database management. Contact Software/Expo, Suite 400, 222 West Adams St., Chicago, IL 60606, (312) 263-3131.

November 8-11

Wescon and **Mini/Micro-West 83**, San Francisco, CA. A conference and exposition, Wescon covers a broad range of topics, including artificial intelligence, computer peripherals and simulation, and robotics. Mini/Micro serves the original equipment manufacturer community by exploring peripherals, processors, data communications, and software. Contact Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965.

November 9-10

Business-Expo, Philadelphia, PA. For details, see September 21-22.

November 9-15

Interkama 83, Düsseldorf West Germany. This exhibition is designed for the instrumentation and automation industries. It's expected to attract more than 1000 exhibi-

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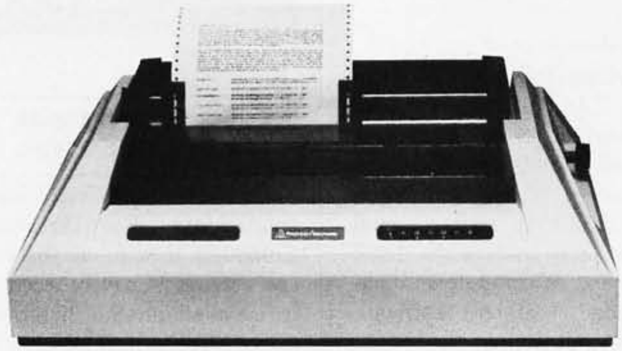

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tors from over 25 countries. For complete details, contact Düsseldorf Trade Shows, 500 Fifth Ave., New York, NY 10110, (212) 840-7744.

November 14-17
AUTOFACT 5 Conference and Exposition, Cobo Hall, Detroit, MI. The focus of this event will be on CAD/CAM (computer-aided design/manufacturing) and the expanding technologies of computer-integrated manufacturing and the automated factory. More than 90 companies will exhibit CAD/CAM systems, computer graphics, software, industrial robots, and computer-based test and measurement systems. Concurrent technical sessions and tutorials will be held. Contact Gregg Balko, Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-1080.

November 14-17
Canadian Computer Show & Conference, International Centre, Toronto, Ontario, Canada. Further information is available from Industrial Trade Shows of Canada, 20 Butterick Rd., Toronto, Ontario M8W 3Z8, Canada, (416) 252-7791.

November 15-17
SNA Architecture and Implementation, Sheraton Rolling Green Inn and Conference Center, Boston, MA. For details, see October 3-5.

November 17-19
Ed-Com/Fall '83, Los Angeles, CA. This conference and exposition offers demonstrations, seminars, hands-on sessions, panels, and micro courses that address, evaluate, and analyze the development of computers in education. Hardware, software, and publishing companies will display items of interest. Contact Carol Houts, Judco Computer Expos Inc., Suite 201, 2629 North Scottsdale Rd., Scottsdale, AZ 85257, (800) 528-2355; in Arizona, (602) 990-1715.

November 17-19
The Fifth Annual Northeast Computer Show and Software Exposition, Hynes Auditorium, Boston, MA. This end user computer show offers nearly 500 displays of computers, peripherals, accessories, and software. More information is available from Northeast Expositions, 822 Boylston St., Chestnut Hill, MA 02167, (800) 841-7000; in Massachusetts, (617) 739-2000.

November 28-December 2
Welcome to the World of Personal Computing, Fort Lauderdale, FL. For details, see October 31-November 4. ■

BYTE's Bits

Coast Guard Finds IBM PC Shipshape

The U.S. Coast Guard has enlisted the IBM Personal Computer in a move to cut costs. Three PCs were recently installed on the 378-foot cutter Rush, which makes its home port in Alameda, California. Many of the 378-foot class of cutters are outfitted with Convergent Technologies' C3 Data Systems, but these machines are high-priced and require a great deal of training. The IBM PC was selected as an inexpensive alternative to the C3.

"At many units, there is a need for small computers but not necessarily with as much power as the C3. After looking at a number of small computer systems, we decided that the IBM PC was the best choice," a Coast Guard spokesman said. ■

In order to gain optimal coverage of your organization's computer conferences, seminars, workshops, courses, etc, notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, POB 372, Hancock NH 03449. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.

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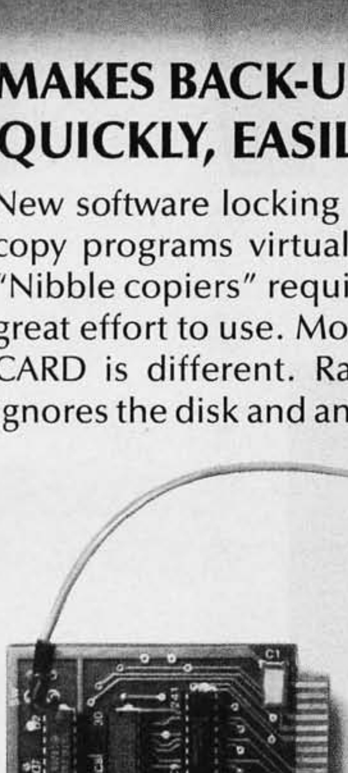

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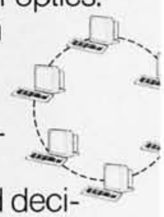

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An Operations Research Scheduling Program

A microcomputer-based scheduling algorithm can be an aid in managerial decision making

by Walter A. Stark Jr. and Richard A. Reid

In the field of operations research (OR), practitioners develop analytical procedures that can help managers improve their decision-making *capabilities.* Many OR techniques provide assistance in solving day-to-day operational problems, such as establishing collection routes, designing nutritional menus, scheduling aircraft and crews, locating offshore oil-drilling platforms, and determining the number of toll operators needed. Some of the more common OR models that have been recently discussed in the microcomputer trade press include linear programming, network analysis, queuing, and routing solutions (see references 1, 4, 8, and 9).

Sequencing and scheduling problems illustrate the short-term planning concerns for which OR techniques have been developed. These techniques have been used for a variety of scheduling problems, including the determination of the processing order for jobs by various machines in a facility and the resultant schedule for each machine, the sequence by which customer orders are picked in an electronics distribution center, and the establishment of a sequence by which customer audits are completed in an accounting firm.

Many of these OR methods contain recipes, or algorithms, for solving problems. Although not difficult conceptually, these algorithms often require extensive calculations that, when performed manually, are tedious and subject to error. However, these algorithms appeared to be well within the capabilities of a modest-sized microcomputer, and we were intrigued by the challenge of executing and applying some of these algorithms using an Apple computer. Various job-sequence algorithms or heuristics have been implemented on large computer systems (see reference 5). However, it seemed appropriate to consider implementing a flow-shop scheduling problem on a microcomputer for two main reasons. First, a microprocessing system at the scene of management action is more likely to be used than a terminal connected to a firm's mainframe because the practice-oriented manager feels less threatened and more in control relative to the smaller system. Second, the total investment in a microcomputer system is commensurate with the job required; extensive number-crunching, graphical displays (such as that required in PERT charting), and database management should be left to the larger centralized systems.

In this article, we will describe and illustrate an efficient method for determining a good sequence for processing a set of jobs or customers, each of which has different characteristics or makes different demands on the various organizational resources.

The Problem

At this point, a simple example will clarify terminology to be introduced later and show how proper scheduling can save time and, presumably, money. Suppose you operate a successful specialty car-painting shop whose reputation for attention to detail and superb paint jobs is spreading. The following are general operations in the normal sequence of your special paint job: removal of

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Job	Major Body Work	Trim Removal	Paint Strip	Body Finish	Paint	Reassembly
		Process-Time Estimates (in hours) for Specialty Paint Shop				
Corvette	0	4	6	12	2	2
Daytona	0	3	4	20	4	2
Turbo-ZX	16	2	2	10	3	2
Rabbit	0	1	0	6	1	1
Cobra	0	1	5	16	4	1

Table 1: *As an example of how a scheduling algorithm works, we'll use a specialty car-painting shop where five cars have to be painted. An entire paint job is made up of six processes. Here are estimates of how long each process will take for each car.*

trim parts, stripping (to the bare metal) of all paint, finishing body work, painting and buffing, and final reassembly after touch-up operations. Normally, your shop does no major body work, although occasionally such work is done for special customers. There are thus six possible operations including major body work. The elapsed time, in hours, for completion of each of these operations is the *process time*. What's more, zero process time is allowable; for example, most jobs require no major body work. Also, on occasion, a low-budget job comes through in which the paint is not stripped. In this case, the sanding is done during the body-finishing operation.

Now, imagine that five cars arrive for painting. Each is a job. Based on years of experience, the shop foreman estimates the times for each job, as shown in table 1. Given these times and a desire to complete all jobs in the shortest possible time, the objective is to determine the best sequence in which to complete all the jobs.

At first glance, it is not immediately obvious that any job sequence is the most efficient. In order to manage this situation, you need to present a schedule that shows the start and finish times for each job at each work station. Such a schedule is shown in table 2 for the sequence of jobs given in table 1.

The cumulative elapsed time for all five jobs is 79 hours. Because we assume you don't fire workers in between operations, the total number of hours paid equals the number of workers (at all operations) multiplied by the total elapsed time. For one worker per operation, you pay for 6 × 79 = 474 hours total operations time. Summing the actual hours worked (16 in major body work, 11 in trim removal, 17 in stripping, 64 in finishing, 14 in painting, and 8 in reassembly) yields a total of 130 hours. Thus, the idle time of workers (and/or machines) is 474 − 130 = 344 hours. Indeed, most of the time the workers are idle! This situation assumes that an idle worker at one operation cannot be used to reduce the time required on another operation; that is, you have a union shop. Moreover, technological specifications require that each job have the same sequence of machine operations.

Using techniques that are described later, a suitable reordering of the jobs reduces the total elapsed time by 54 hours, or 6 × (79 − 70), for a new total operations time of 420 hours; idle time now becomes 420 − 130 = 290 hours. Not only are labor costs reduced by 11 percent, but also the overall fraction of idle time is lowered. Furthermore, in searching for a better sequence, you have identified two sequences having the same low total operations time. Having two or more good job sequences allows the foreman some discretion in granting job priorities, arranging machine maintenance, or workers' vacations, and the like, while at the same time maintaining the best possible schedule.

How do you begin to approach the search for an optimum job sequence? Considerable effort has been expend-

Schedule of Operations

Job	Major Body Work		Trim Removal		Paint Strip		Body Finish		Paint		Reassembly	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Corvette	0	0	0	4	4	10	10	22	22	24	24	26
Daytona	0	0	4	7	10	14	22	42	42	46	46	48
Turbo-ZX	0	16	16	18	18	20	42	52	52	55	55	57
Rabbit	16	16	18	19	20	20	52	58	58	59	59	60
Cobra	16	16	19	20	20	25	58	74	74	78	78	79

Table 2: *A sample schedule of operations. The numbers listed show at which hours a given car enters or leaves a particular process. First, the Corvette enters the trim-removal process and the Turbo-ZX enters the major body work process. After four hours, the Corvette leaves trim removal and enters the paint strip process while the Daytona enters trim removal. The process continues until after 79 hours the last car, the Cobra, leaves the reassembly process.*

ed to develop an understanding of the scheduling problem, which is at best frustrating and at worst totally intractable. Under certain conditions, however, the problem can be solved, or at least a nearly optimal solution can be obtained. It is noteworthy that these special solutions can be implemented on a microcomputer (in this case, a 48K-byte Apple II Plus).

Some Definitions

To understand the problem and the programmatic approach to the solution more clearly, a few definitions are helpful (see also reference 6):

Sequencing is the order in which objects are placed for processing by an organization. Job sequencing involves the time ordering of jobs through one or more processing centers so that specific performance measures, such as minimal idle times or timely deliveries, are achieved. Variation in job sequence can produce significant differences in costs and productivity. The sequential arrangement of start and finish times of various jobs on machines is termed a machine loading *schedule*. A schedule can be generated for a given machine only after the job processing sequence has been determined. In preparing the schedule, note that a machine cannot be used until it is free and that a given operation of some job cannot be started until the prior operation for that job is completed.

Jobs represent customer orders, and machines involve processes that must be performed on customer orders. In other words, a job represents a total effort, the result of which is used to satisfy a customer's need. A *machine* provides processing capability for the job effort and can perform one or more *operations*, but only one at a time. Acts performed by machines are needed to complete the job. In this sense, machines are not necessarily always mechanical devices; they can be human beings performing a strictly manual operation such as visual inspection. The order in which a job must proceed through various machines is referred to as *technological ordering*. And, as mentioned previously, the time spent on a machine to perform a given operation is called the *process time* for that operation.

In the most general case, without any job technological order specified, for N jobs and M machines, there are $(M!)^N$ possible sequences. (For a given job with M machines, there are M ways to choose the first machine operation, $M-1$ ways to choose the second, etc., so that the total number

of possible sequences for machine ordering is $M(M-1)(M-2) \ldots = M!$. The combination of job sequences is an exponential function resulting in $(M!)^N$ possible job-machine sequences.) The number of possible job sequences, therefore, quickly becomes very large. For example, if $M = N = 4$, the number of possibilities is about 3.3×10^5; for $M = N = 5$, the possible sequences total nearly 2.5×10^{10}. Thus, complete enumeration and evaluation of all job sequences becomes impractical for most real problems, and operations researchers seek cost-effective limits in searching for good job ordering.

Although the general problem remains intractable, operations researchers have developed efficient procedures for certain special cases, which result from adding simplifying assumptions to the general problem in order to create a more limited perspective. You can then solve the subproblem mathematically. For the special problem treated here, the crucial assumption made is that the technological ordering for all jobs considered is the same. In other words, each job goes through exactly the same ordered sequence of machine operations (remember that some operations can have zero process time). This enabling assumption results in what is known as the *flow-shop* scheduling problem in contrast to *job-shop* scheduling, in which each job might have different technological ordering (see reference 6). With the same sequence of operations for each of N jobs, the number of possible orderings of jobs becomes $N!$. Now, if N = 5, for example, 120 (or $5 \times 4 \times 3 \times 2 \times 1$) job sequences have to be examined to find the optimum sequence.

Method

The flow-shop scheduling problem assumes that you know or can determine processing times for each of N jobs on M machines (these times could represent average values). Moreover, the best job sequence is assumed to require the least total facility processing time to complete all jobs. By definition, total facility processing time is equal to total machine-operating time plus total machine-idle time. Because total machine-operating time is fixed for a given set of jobs, minimizing total facility processing time also minimizes total machine-idle time.

The approach for solving this problem was first developed by S. M. Johnson (reference 7), extensively explored by R. A. Dudek and R. M. Ghare (reference 3), and popularized by R. E. D. Woolsey and H. S. Swanson (reference 10). The procedure coded here is based on the heuristic presented by R. Hesse and R. E. D. Woolsey (reference 5).

Simply described, for N jobs processed first on Machine A and then on Machine B, the Johnson algorithm requires finding the shortest processing time in the set of times for both machines. If that time is for Machine A, then that associated job is scheduled first; if for machine B, the associated job is processed last. The associated job is then removed from consideration. Next, the selection process is repeated, but this time the algorithm schedules the job having the next-shortest time either as early as possible or as late as possible according to the next-shortest time on Machine A or Machine B, respectively. This job is then removed from consideration, and the process is continued for the remaining jobs until all jobs are scheduled.

To illustrate, suppose we have five jobs with the following process times (in hours):

Job Name	Machine A	Machine B
Job 1	2	5
Job 2	6	1
Job 3	3	6
Job 4	5	2
Job 5	7	4

The optimal sequence is Job 1-3-5-4-2. The shortest time on any machine is 1 hour (Job 2, Machine B). Hence, according to the algorithm, Job 2 is scheduled last. Job 2 is then eliminated from further consideration. The next-shortest time is 2 hours for both Jobs 1 and 4. Job 1 is scheduled

as the first job (the 2-hour time is on Machine A); Job 4 is scheduled next to last because its 2-hour time is on Machine B. After removal of these two jobs from consideration, Jobs 3 and 5 remain to be scheduled. The next-shortest time is 3 hours (Job 3, Machine A). Thus, Job 3 is scheduled as early as possible, after Job 1. Job 5 remains to be scheduled between Job 3 and Job 4.

This algorithm forms the heart of the machine-scheduling program presented in listing 1. A formal proof of the algorithm can be found in S. M. Johnson's original paper (see reference 7). However, intuitively, you can see that the last job (N) cannot be finished earlier than the time required to process each job on Machine A, plus the time necessary to complete the second operation of the last job. Similarly, the last job cannot be completed sooner than the time to process each job on Machine B, plus any time delay before Machine B can begin processing. Moreover, the minimum delay is just the time required to process the first job (1) on Machine A. The minimum total time, T_{min}, is thus bounded by the larger of the following two inequalities:

$$T_{min} \geq \sum_{jobs} t_{Aj} + t_{BN}$$

or

$$T_{min} \geq t_{A1} + \sum_{jobs} t_{Bj}$$

where t_{Aj} and t_{Bj} are the process times on Machine A and Machine B, respectively, for job j; t_{BN} thus represents the operation time on Machine B for the last job N, and t_{A1} represents the operation time on Machine A for the first job.

The sums are fixed values, independent of job sequence; therefore, the only way to influence the overall time is by choosing t_{A1} or t_{BN} to be as small as possible. Thus, the job with the smallest t_{Aj} is scheduled first, and the job with the smallest t_{Bj} is scheduled last. The remaining jobs are scheduled by extending the application of this logic.

The rationale underlying this procedure is to place jobs having short

Listing 1: *An Applesoft BASIC program using a scheduling algorithm. The program can be used for an operation using any number M of processes or machines.*

```
1000  REM     MACHINE SCHEDULE
1010  REM  COPYRIGHT 1981, W A STARK
1020  REM
1030  REM     M-MACHINE SCHEDULING
1040  REM    USING QUICK & CLEAN JOHNSON
1050  REM    ALGORITHM
1060  REM
1070  DIM M(20,20),J$(20),M$(20)
1080  DIM A(20),B(20),C(20)
1090  DIM S(20,20),SEQ(20,20),MT(20)
1100  DIM T1(20,20),T2(20,20)
1110  DIM S1(20),S2(20),IT(20)
1120  DIM KL(20)
1130  REM
1140  GOTO 1730
1150  REM   ********************
1160  REM     SUBROUTINE PAUSE
1170  REM
1180  PRINT : PRINT "HIT SPACE BAR TO CONTINUE"
1190 CV =  PEEK (37)
1200  GET W$
1210  VTAB (CV)
1220  PRINT  SPC( 38);""
1230  RETURN
1240  REM   ********************
1250  REM  SUBROUTINE ENABLE PRINTER
1260  REM
1270  REM       USES DRIVER IN
1280  REM       SUBROUTINE AT 7150
1290  REM
1300  CALL (768)
1310  PRINT  CHR$ (17)
1320  REM
1330  REM  DEFEAT 40 COLUMN WINDOW
1340  POKE 33,33
1350  RETURN
1360  REM   ********************
1370  REM  SUBROUTINE TO END PRINTING
1380  REM  DISABLES THE AIO BOARD,SLOT 2
1390  REM
1400  PR# 0
1410  REM  RESTORE 40 COL TV WINDOW
1420  POKE 33,40
1430  RETURN
1440  REM   ********************
1450  REM   SUBROUTINE SCHEDULE
1460  REM
1470  REM        CALCULATES IN / OUT
1480  REM        SCHEDULES FOR MACHINES
1490  REM
1500 T1(1,1) = 0.0
1510  FOR M = 1 TO NM
1520 T2(1,M) = T1(1,M) + M(C(1),M)
1530  IF M = NM GOTO 1550
1540 T1(1,M + 1) = T2(1,M)
1550  NEXT M
1560 TI = T2(1,1)
1570  FOR J = 2 TO NJ
1580 T1(J,1) = T2(J - 1,1)
1590 T2(J,1) = T1(J,1) + M(C(J),1)
1600  NEXT J
1610  REM
1620  FOR J = 2 TO NJ
1630  FOR M = 2 TO NM
1640 T1(J,M) = T2(J,M - 1)
1650  IF T2(J - 1,M) > T2(J,M - 1) THEN T1(J,M) = T2(J - 1,M)
1660 T2(J,M) = T1(J,M) + M(C(J),M)
1670  NEXT M
1680  NEXT J
1690  RETURN
1700  REM   ********************
1710  REM   ******  MAIN  ******
1720  REM   ********************
1730  HOME : PRINT : PRINT
1740  REM
```

Listing 1 continued on page 558

processing times on the first machine early in the sequence so that the second machine can be put to use as soon as possible. At the end of the sequence, the situation is reversed. In particular, those jobs with short processing times on later machines are placed at the end of the sequence so that all machines finish all job processing at approximately the same time.

The Johnson algorithm provides an optimum schedule for the two-machine problem and for special three-machine situations. Extending the algorithm to M-machine situations produces a good, but not necessarily optimal, solution. However, experience shows that of the $N!$ possible job sequences, some of the $M-1$ sequences uncovered using the extended algorithm are optimal or near optimal.

You extend the algorithm to M machines by first applying the Johnson two-machine algorithm to the first (1) and last (M) machine operations in order to obtain a feasible job sequence. Next, by using the sum of the job processing times for the first two $(1 + 2)$ and the last two $[(M - 1) + M]$ machine operations, you can determine another sequence. The process is continued $M - 1$ times, applying the Johnson algorithm successively to the sum of the first j processing times and to the sum of the last j processing times, where j runs from 1 to $M - 1$.

This procedure yields $M - 1$ job-order sequences. The sequence having the least total facility processing time may be selected as best. An advantage of the Johnson algorithm over other flow-shop techniques, such as the Gupta algorithm (see reference 5), is that several sequences are determined for consideration. Having these alternative sequences allows the scheduling manager some viable options if such factors as priority jobs, machine maintenance, or workers' vacations need to be considered.

The Program

Listing 1 shows the implementation of the Johnson scheduling algorithm on an Apple II Plus 48K-

Text continued on page 574

Listing 1 continued:

```
1750  PRINT  TAB( 10);"MACHINE SCHEDULE"
1760  PRINT  TAB( 7);"COPYRIGHT 1981, W A STARK"
1770  FOR T = 1 TO 2000
1780  NEXT T
1790 PASS = 0
1800  HOME : PRINT : PRINT
1810  REM
1820  REM : DESCRIPTION
1830  PRINT "M-MACHINE SCHEDULING "
1840  PRINT "USING THE JOHNSON QUICK &"
1850  PRINT "CLEAN ALGORITHM.": PRINT
1860  PRINT "PROGRAM CAN BE USED FOR"
1870  PRINT "UP TO 15 JOBS AND 20"
1880  PRINT "MACHINE OPERATIONS.": PRINT
1890  PRINT : FLASH : PRINT "NOTE!": NORMAL
1900  PRINT "**************************"
1910  PRINT "COMPLETE ALL DATA ENTRIES"
1920  PRINT "BY HITTING THE RETURN KEY"
1930  PRINT "**************************"
1940  GOSUB 1960: REM  - PRINT CHOICE
1950  GOTO 2070
1960  PRINT : PRINT : PRINT
1970  PRINT "FOR HARDCOPY OUTPUT, TYPE P;"
1980  PRINT "(BE SURE PRINTER IS READY)"
1990  PRINT "OTHERWISE, TYPE AN N"
2000  INPUT TT$
2010  IF TT$ = "N" THEN TTY = 0: RETURN
2020  IF TT$ = "P" THEN TTY = 1: GOTO 2050
2030  PRINT : PRINT "TYPE P OR N, PLEASE"
2040  PRINT : GOTO 2000
2050  GOSUB 7150: REM  - PRINTER DRIVER
2060  RETURN
2070  HOME : VTAB 5
2080 DISPLAY = 0
2090  INPUT "TYPE NUMBER OF JOBS   ";NJ
2100  VTAB 10
2110  INPUT "TYPE NUMBER OF MACHINES ";NM
2120  REM
2130  REM  INPUT JOB DESCRIPTIONS AND
2140  REM  MACHINE OPERATIONS
2150  HOME
2160  PRINT "BEGIN BY DESCRIBING MACHINE"
2170  PRINT "OPERATIONS.  THESE OPERATIONS ARE "
2180  PRINT "ASSUMED TO BE SEQUENTIAL."
2190  PRINT
2200  FOR M = 1 TO NM
2210  PRINT : PRINT
2220  PRINT "TYPE A DESCRIPTION OF OPERATION # ";M
2230  PRINT "(USE UP TO 7 CHARACTERS)"
2240  INPUT M$(M)
2250  IF  LEN (M$(M)) <  = 7 GOTO 2290
2260  PRINT
2270  PRINT "USE ONLY 7 CHARACTERS, PLEASE"
2280  PRINT : GOTO 2220
2290  NEXT M
2300  HOME
2310  PRINT "NOW BRIEFLY (6 CHARACTERS OR LESS)"
2320  PRINT "DESCRIBE EACH JOB, AND THE TIME"
2330  PRINT "IN EACH OPERATION FOR THAT JOB."
2340  PRINT
2350  FOR J = 1 TO NJ
2360  PRINT "TYPE A DESCRIPTION OF JOB # ";J
2370  INPUT J$
2380 J$(J) =  LEFT$ (J$,6)
2390  PRINT
2400  PRINT "FOR THIS JOB, ENTER THE TIME"
2410  PRINT "(TO THE NEAREST TENTH UNIT)"
2420  PRINT "REQ'D FOR EACH OF THE "
2430  PRINT "OPERATIONS LISTED BELOW."
2440  PRINT
2450  PRINT "(USE THE SAME TIME UNITS"
2460  PRINT "FOR ALL OPERATIONS.)"
2470  PRINT
2480  FOR M = 1 TO NM
2490 GAP = 8 -  LEN (M$(M))
2500 CV =  PEEK (37) + 1
2510  IF CV =  > 23 THEN CV = CV - 1
```

Listing 1 continued on page 560

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Power Version 2.55

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Error Handling	☐	☐	☐	☑

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Listing 1 continued:

```
2520  PRINT "TIME IN OPERATION"; SPC( GAP);M$(M);" ="
2530  VTAB (CV): HTAB (28)
2540  INPUT " ";M(J,M)
2550  PRINT
2560  REM -LIMIT DATA TO 1 DECIMAL
2570 P = 10:Q = 0.5
2580 M(J,M) =  INT (M(J,M) * P + Q) / P
2590  NEXT M
2600  PRINT : PRINT : HOME
2610  NEXT J
2620  REM  INPUT COMPLETE
2630  PRINT "INPUT COMPLETE"
2640  PRINT : PRINT
2650  PRINT "TYPE IN THE UNITS OF TIME"
2660  PRINT "(E.G., MINUTES,HOURS,ETC.)"
2670  INPUT UNIT$
2680  REM  OUTPUT THE INPUT
2690  REM
2700  REM  DETERMINE # COLS.
2710 SP =  INT (18 / NM)
2720  IF NM > 3 THEN SP = 4
2730  IF NM > 4 THEN  GOSUB 7730
2740 NS = 1
2750 NF = NS + 3
2760  IF NF > NM THEN NF = NM
2770  REM  OUTPUT FOR APPLE II
2780  HOME : PRINT
2790  IF NS = 1 GOTO 2820
2800  PRINT  TAB( 11);"MACHINE OPERATIONS (CONT.)"
2810  GOTO 2840
2820  PRINT  TAB( 15);"MACHINE OPERATIONS"
2830  REM  GET TIME UNITS
2840  PRINT  TAB( 2);"JOB"; TAB( 15);"(TIMES IN ";UNIT$;" )"
2850  GOSUB 5130: REM  - DASHLINE
2860  VTAB 5: HTAB 1: PRINT "#"
2870  FOR M = NS TO NF
2880 CH = 4 + (1 + 2 * (M - NS)) * SP +  INT ((7 -  LEN (M$(M))) / 2)
2890  VTAB 5: HTAB CH
2900  PRINT M$(M)
2910  NEXT M
2920  GOSUB 5130: REM  - DASHLINE
2930  FOR J = 1 TO NJ
2940 K2 = 5:K3 = 2
2950  IF NJ > 6 THEN K2 = 6:K3 = 1
2960  FOR M = NS TO NF
2970 K = K2 + K3 * J
2980  VTAB K
2990  PRINT J;"."; TAB( 4);J$(J)
3000 L = 9 + (1 + 2 * (M - NS)) * SP -  LEN ( STR$ ( INT (M(J,M))))
3010  VTAB K: HTAB L
3020  PRINT M(J,M)
3030  NEXT M
3040  NEXT J
3050  VTAB 23
3060  PRINT "DO YOU WANT TO CHANGE ANY DATA?"
3070  PRINT " Y=YES,  N=NO": GOTO 3090
3080  PRINT : PRINT "Y=YES, N=NO ,PLEASE": PRINT
3090  INPUT AN$
3100  IF  LEFT$ (AN$,1) = "Y" THEN  GOSUB 5180
3110  IF  LEFT$ (AN$,1) = "Y" GOTO 2770
3120  IF  LEFT$ (AN$,1) <  > "N" GOTO 3080
3130  IF NF = NM GOTO 3160
3140 NS = NF + 1
3150  GOTO 2750
3160  FOR J = 1 TO NJ:C(J) = J: NEXT J
3170  GOSUB 5710: REM  - CALCULATES MACHINE TIME
3180  GOSUB 1450: REM  - CALCULATE SCHEDULE
3190  HOME
3200  IF TTY = 1 THEN  GOSUB 1250: REM  - PRINT ENABLE
3210  PRINT : PRINT "INITIAL SEQUENCE"
3220  PRINT : PRINT "ORDER   JOB NAME   FINISH TIME"
3230  PRINT
3240  FOR J = 1 TO NJ
3250 GAP = 3
3260  IF J > 9 THEN GAP = 2
3270 L1 =  LEN (J$(J))
3280 L2 = 18 - L1 -  LEN ( STR$ ( INT (T2(J,NM))))
```

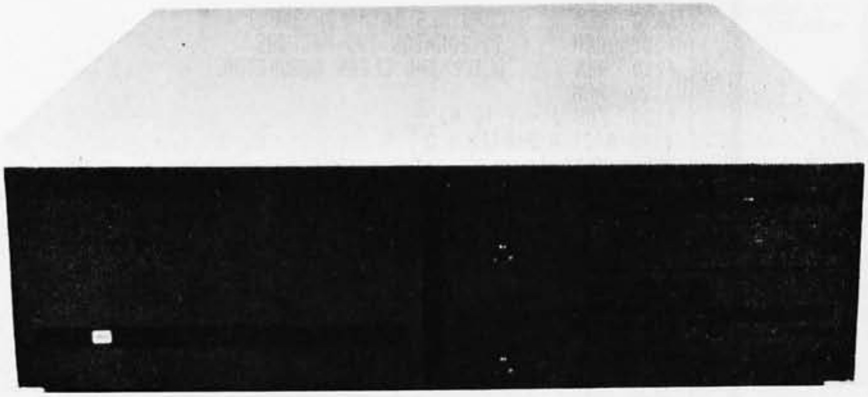
Listing 1 continued on page 562

Listing 1 continued:

```
3290  PRINT  TAB( GAP);J; SPC( 6);J$(J); SPC( L2);T2(J,NM)
3300  NEXT J
3310  IF TTY = 1 THEN  GOSUB 1370: REM  - PRINT INHIBIT
3320  PRINT : PRINT : GOSUB 1160: REM  -PAUSE
3330  HOME : PRINT  TAB( 17);"INITIAL":KK = 0
3340  GOSUB 5880: REM   - PRINT SCHEDULE
3350  HOME : PRINT : PRINT
3360 BT = NM * T2(NJ,NM)
3370 DISPLAY = 0
3380 FLAG = 1
3390  GOSUB 6510: REM   - IDLE TIME CALC
3400  GOSUB 1160: REM   - PAUSE
3410  IF NM = 2 GOTO 3580
3420  HOME : PRINT : PRINT
3430  IF NM = 2 GOTO 3580
3440  PRINT "TO VIEW ALL LOADING SCHEDULES AS"
3450  PRINT "SEQUENCES ARE DETERMINED,"
3460  PRINT "TYPE AN A;"
3470  PRINT "TO VIEW ONLY THE BEST SCHEDULE(S),"
3480  PRINT "TYPE A  B."
3490  PRINT "(ONE MAY RETURN LATER TO REVIEW "
3500  PRINT "ALL SCHEDULES)"
3510  PRINT : PRINT "A OR B?"
3520  INPUT DS$
3530  IF DS$ = "B" THEN DISPLAY = 1: GOTO 3580
3540  IF DS$ = "A" GOTO 3580
3550  PRINT : PRINT "TYPE A OR B, PLEASE!"
3560  INPUT " ";DS$
3570  GOTO 3530
3580  FOR KK = 1 TO NM - 1
3590 RPT = 0
3600  GOSUB 4070: REM  - SET UP FOR 2-MACHINE
3610  GOSUB 4240: REM  - 2 MACHINE ORDERING
3620  IF RPT <  > 1 THEN  GOSUB 4910: REM  - FILTER
3630  GOSUB 1450: REM  -CALCULATE SCHEDULE
3640  IF FLAG = 0 GOTO 3720
3650  IF NM <  > 2 GOTO 3700
3660  IF TTY = 0 GOTO 3700
3670  GOSUB 1250: REM   -PRINT ENABLE
3680  GOSUB 5130: GOSUB 5130: REM  DASHLINE
3690  GOSUB 1370: REM  -PRINT INHIBIT
3700  GOSUB 4670: REM  -PRINT OPTIMAL ORDER
3710  GOSUB 5880: REM  - PRINT SCHEDULE
3720  GOSUB 6510: REM  - IDLE TIME CALC
3730  IF FLAG = 0 GOTO 3760
3740  GOSUB 1160: REM  - PAUSE ROUTINE
3750  IF RPT = 1 GOTO 3960
3760  NEXT KK
3770  IF NM = 2 GOTO 3970
3780  GOSUB 6900: REM  - FIND SMALL IDLE TIME
3790  IF TTY = 0 GOTO 3840
3800  GOSUB 1250: REM  -PRINT ENABLE
3810  GOSUB 5130: GOSUB 5130: REM  -DASHLINE
3820  PRINT
3830  GOSUB 1370: REM  -PRINT INHIBIT
3840  FOR LL = 0 TO LM
3850 KK = KL(LL)
3860 DISPLAY = 0
3870  IF TTY = 1 THEN  GOSUB 1250
3880  IF TTY = 1 THEN  POKE 33,40: HOME : POKE 33,33
3890  HOME : PRINT : PRINT
3900  PRINT "A GOOD JOB SEQUENCE IS:"
3910  PRINT
3920  PRINT "ORDER   JOB NAME   FINISH TIME"
3930  PRINT
3940  IF NM = 2 THEN  RETURN
3950 RPT = 1: GOTO 3600
3960  NEXT LL
3970  GOSUB 5490: REM  - REPEAT?
3980  ON FLAG GOTO 4010,4030
3990  PRINT : PRINT "THEN GOODBYE!": PRINT
4000  GOTO 4050
4010 FLAG = 0: HOME
4020  GOSUB 1960: GOTO 2680
4030 FLAG = 0: HOME
4040  GOTO 1940
4050  END
```

Listing 1 continued on page 564

LSI 11/23 PLUS COMPUTERS WITH UP TO 4 MEGABYTES RAM MEMORY



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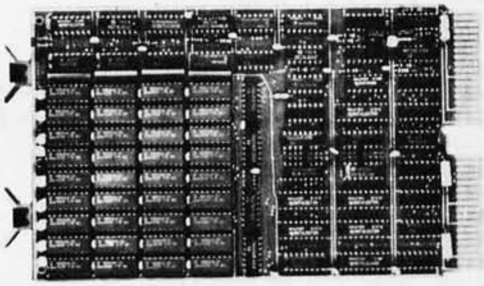

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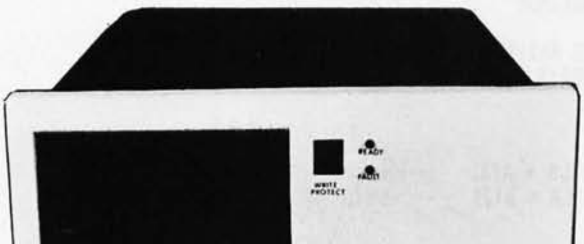

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Circle 69 on inquiry card.

Listing 1 continued:

```
4060  REM   ******************
4070  REM   SUBROUTINE COMBINE
4080  REM
4090  REM       COMBINES DATA FOR INPUT
4100  REM       TO JOHNSON TWO-MACHINE
4110  REM       QUICK AND CLEAN ALGORITHM
4120  REM
4130  FOR J = 1 TO NJ
4140 A(J) = 0:B(J) = 0
4150  NEXT J
4160  FOR M = 1 TO KK
4170  FOR J = 1 TO NJ
4180 A(J) = A(J) + M(J,M)
4190 B(J) = B(J) + M(J,NM - M + 1)
4200  NEXT J
4210  NEXT M
4220  RETURN
4230  REM   ********************
4240  REM   SUBROUTINE FOR JOHNSON
4250  REM   TWO MACHINE QUICK & CLEAN
4260  REM
4270 NF = 0:NL = NJ:L = 0
4280  GOSUB 4550: REM   -FIND MAX ELEMENT
4290  FOR J = 1 TO NJ
4300 C(J) = NJ + 1
4310  NEXT J
4320 SM = LA
4330  FOR J = 1 TO NJ
4340 FL = 0
4350  REM : ELIMINATE DONE JOBS
4360  FOR J1 = 1 TO NJ
4370  IF J = C(J1) THEN FL = 1
4380  NEXT J1
4390  IF FL = 1 GOTO 4420
4400  IF B(J) <  = SM THEN SM = B(J):IL = J:L = 2
4410  IF A(J) <  = SM THEN SM = A(J):IL = J:L = 0
4420  NEXT J
4430  IF L = 2 GOTO 4460
4440 C(NF) = IL
4450 NF = NF + 1: GOTO 4480
4460 C(NL) = IL
4470 NL = NL - 1
4480  IF NL >  = NF GOTO 4320
4490  REM GENERATE ARRAY FOR FILTER
4500  FOR J = 1 TO NJ
4510 SEQ(KK,J) = C(J)
4520  NEXT J
4530  RETURN
4540  REM   ******************
4550  REM    SUBROUTINE MAXIMUM
4560  REM
4570  REM        DETERMINES MAXIMUM ELEMENT
4580  REM        OF TWO ARRAYS A,B
4590  REM
4600 LA = A(1)
4610  FOR J = 1 TO NJ
4620  IF (A(J) > LA) THEN LA = A(J)
4630  IF (B(J) > LA) THEN LA = B(J)
4640  NEXT J
4650  RETURN
4660  REM   ******************
4670  REM   SUBROUTINE OUTPUT ORDER
4680  REM
4690  REM        PRINTS JOB SEQUENCE
4700  REM
4710  IF TTY = 1 THEN  GOSUB 1250
4720  IF RPT = 1 GOTO 4800
4730  HOME : PRINT : PRINT
4740  IF NM <  > 2 GOTO 4760
4750  PRINT "AN OPTIMAL SEQUENCE IS:": GOTO 4770
4760  PRINT "A POSSIBLE SEQUENCE IS:"
4770  PRINT
4780  PRINT "ORDER   JOB NAME   FINISH TIME"
4790  PRINT
4800  FOR J = 1 TO NJ
4810 GAP = 3
4820  IF J > 9 THEN GAP = 2
```

Listing 1 continued on page 566

Listing 1 continued:

```
4830 L1 =  LEN (J$(C(J)))
4840 L2 = 18 - L1 -  LEN ( STR$ ( INT (T2(J,NM))))
4850  PRINT  TAB( GAP);J; SPC( 6);J$(C(J)); SPC( L2);T2(J,NM)
4860  NEXT J
4870  IF TTY = 1 THEN  GOSUB 1370: REM   END PRINT
4880  PRINT : GOSUB 1160: REM  - PAUSE
4890  RETURN
4900  REM   ********************
4910  REM   SUBROUTINE FILTER
4920  REM
4930  REM        CHECKS FOR DUPLICATE
4940  REM        POSSIBLE SEQUENCES
4950  REM
4960 FLAG = 1
4970  IF NM = 2 THEN  RETURN
4980  IF KK < 2 THEN  RETURN
4990  FOR K = 1 TO KK - 1
5000  IF NFLAG = 0 GOTO 5070
5010 NF = 0
5020  FOR J = 1 TO NJ
5030  IF NF = 1 GOTO 5050
5040  IF C(J) <  > SEQ(K,J) THEN NF = 1
5050  NEXT J
5060  IF NF = 0 THEN FLAG = 0
5070  NEXT K
5080  REM   FLAG=1 IF SEQUENCE
5090  REM    DIFFERS FROM PREVIOUS SEQUENCES
5100  REM
5110  RETURN
5120  REM   ********************
5130  REM : SUBROUTINE DASHLINE
5140  REM
5150  PRINT "--------------------------------------"
5160  RETURN
5170  REM   ********************
5180  REM : SUBROUTINE CORRECT
5190  REM
5200  REM       PROVIDES FOR CORRECTIONS
5210  REM       TO INPUT DATA
5220  REM
5230  PRINT
5240  PRINT "ENTER JOB #": INPUT J
5250  PRINT
5260  PRINT "NOW ENTER NEW JOB DESCRIPTION AND"
5270  PRINT "TIMES FOR ALL MACHINE OPERATIONS."
5280  PRINT "SEPARATE NAME AND TIMES WITH SLASHES"
5290  PRINT "(/)"
5300  PRINT
5310  INPUT W$
5320 I = 1
5330  IF  MID$ (W$,I,1) <  > "/" THEN I = I + 1: GOTO 5330
5340 IL = I - 1: IF IL > 6 THEN IL = 6
5350 J$(J) =  LEFT$ (W$,IL)
5360 W$ =  MID$ (W$,I + 1)
5370 M = NS
5380 I = 1
5390  IF  MID$ (W$,I,1) = "" GOTO 5450
5400  IF  MID$ (W$,I,1) <  > "/" THEN I = I + 1: GOTO 5390
5410 M(J,M) =  VAL ( LEFT$ (W$,I - 1))
5420 W$ =  MID$ (W$,I + 1)
5430 M = M + 1
5440  GOTO 5380
5450  IF  LEN ( LEFT$ (W$,I - 1)) = 0 GOTO 5470
5460 M(J,M) =  VAL ( LEFT$ (W$,I - 1))
5470  RETURN
5480  REM   ********************
5490  REM   SUBROUTINE REPEAT
5500  REM
5510 FLAG = 0
5520  PRINT
5530  PRINT "DO YOU WISH TO SCHEDULE MORE?"
5540  PRINT "Y OR N": GOTO 5560
5550  PRINT "Y OR N, PLEASE"
5560  INPUT AN$
5570  IF AN$ = "N" THEN  RETURN
5580  IF AN$ <  > "Y" THEN  GOTO 5550
5590  PRINT : PRINT : PRINT "DO YOU WISH TO MODIFY EXISTING DATA?"
```

Listing 1 continued on page 568

Listing 1 continued:

```
5600  PRINT "Y OR N"
5610  INPUT AN$
5620  IF AN$ = "Y" THEN FLAG = 1: RETURN
5630  IF AN$ = "N" GOTO 5660
5640  PRINT "Y OR N, PLEASE!"
5650  GOTO 5610
5660  PRINT : PRINT : PRINT "THEN, A NEW PROBLEM IS ASSUMED"
5670  FOR T = 1 TO 2500: NEXT T
5680 FLAG = 2
5690  RETURN
5700  REM   *********************
5710  REM   SUBROUTINE MACHINE TIME
5720  REM
5730  REM        CALCULATES CUMULATIVE
5740  REM        TIME ON EACH MACHINE
5750  REM        AS WELL AS TOTAL MACHINE

5760  REM        TIME.
5770  REM
5780  FOR N = 0 TO NM + 1
5790 MT(N) = 0: NEXT N
5800  FOR M = 1 TO NM
5810  FOR J = 1 TO NJ
5820 MT(M) = MT(M) + M(J,M)
5830  NEXT J
5840 MT(NM + 1) = MT(NM + 1) + MT(M)
5850  NEXT M
5860  RETURN
5870  REM   *********************
5880  REM : SUBROUTINE SCHEDULE  OUTPUT
5890  REM
5900  REM        ARRANGES DISPLAY OF
5910  REM        MACHINE SCHEDULE
5920  REM
5930  IF DISPLAY = 1 THEN  RETURN
5940 NS = 1
5950  IF KK < > 0 THEN  HOME
5960  IF NS = 1 GOTO 6000
5970  HOME
5980  PRINT  TAB( 12);"SCHEDULE(CONT.)"
5990  GOTO 6010
6000  PRINT  TAB( 16);"SCHEDULE"
6010  GOSUB 5130
6020 CV =  PEEK (37) + 1
6030 CS = CV
6040  VTAB CV: PRINT "JOB"
6050 NF = NS + 3
6060  IF NF > NM THEN NF = NM
6070  FOR N = NS TO NF
6080  VTAB CV
6090 CH = 3 + (1 + 2 * (N - NS)) * SP +  INT ((7 -  LEN (M$(N))) / 2)
6100  HTAB CH: PRINT M$(N)
6110  NEXT N
6120 CV = CV + 2: VTAB CV: PRINT " *"
6130  FOR N = NS TO NF
6140  VTAB CV
6150 CH = 3 + (2 * (N - NS) + 1) * SP: HTAB CH
6160 GAP = SP - 3
6170  IF NM > = 5 THEN GAP = SP - 2
6180  PRINT "IN"; SPC( GAP);"OUT"
6190  NEXT N
6200  VTAB (CV + 1)
6210  GOSUB 5130: REM   -DASHLINE
6220  FOR N = CS TO CV
6230  HTAB 5: VTAB N
6240  PRINT "*"
6250  NEXT N
6260  VTAB (CV + 2)
6270  FOR J = 1 TO NJ
6280  FOR N = NS TO NF
6290 S1(N) = SP -  LEN ( STR$ ( INT (T1(J,N))))
6300 S2(N) = SP -  LEN ( STR$ ( INT (T2(J,N))))
6310  NEXT N
6320 H = 1
6330 K2 = 4: IF NJ > 6 THEN K2 = 2
6340  IF C(J) < 10 THEN H = 2
6350 CV =  PEEK (37)
```

Listing 1 continued on page 570

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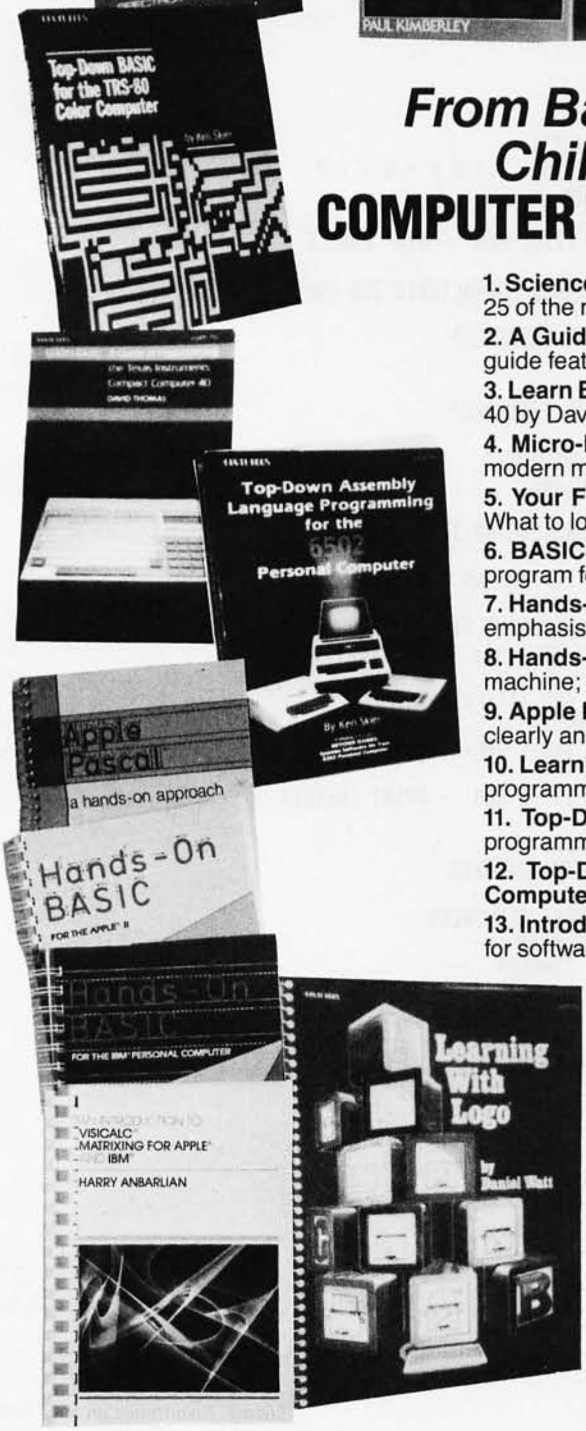

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Listing 1 continued:

```
6360  PRINT  TAB( H);C(J)
6370  FOR N = NS TO NF
6380  VTAB (CV + 1)
6390 CH = 5 + 2 * (N - NS) * SP
6400  HTAB CH
6410  PRINT  SPC( S1(N)); INT (T1(J,N) + 0.5); SPC( S2(N)); INT (T2(J,N) + 0.5)
6420  NEXT N
6430 CV = CV + K2: VTAB CV
6440  NEXT J
6450  GOSUB 1160: REM  - PAUSE ROUTINE
6460  IF NF = NM GOTO 6490
6470 NS = NF + 1
6480  GOTO 5950
6490  RETURN
6500  REM   ********************
6510  REM   SUBROUTINE IDLE TIME
6520  REM
6530  REM        CALCULATES CUMULATIVE
6540  REM        TOTAL OF TIME MACHINES
6550  REM        ARE IDLE.
6560  REM
6570 P = 10.:Q = 0.5
6580 OT = NM * T2(NJ,NM)
6590  IF OT > BT THEN BT = OT
6600 TL =  LEN ( STR$ ( INT (OT)))
6610 IT(KK) = ( INT ((OT - MT(NM + 1)) * P + Q)) / P
6620  IF FLAG = 0 THEN  RETURN
6630  HOME
6640  IF TTY = 1 THEN  GOSUB 1250: REM  -PRINT ENABLE
6650  PRINT
6660  PRINT  TAB( 3);"PERFORMANCE CHARACTERISTICS FOR"
6670  IF KK <  > 0 GOTO 6700
6680  PRINT  TAB( 10);"INITIAL SEQUENCE"
6690  GOTO 6740
6700  IF NM <  > 2 GOTO 6730
6710  PRINT  TAB( 10);"OPTIMAL SEQUENCE"
6720  GOTO 6740
6730  PRINT  TAB( 12);"THIS SEQUENCE"
6740  GOSUB 5130: REM  - DASHLINE
6750  PRINT : PRINT
6760  PRINT "TOTAL FACILITY PROCESSING TIME "
6770  PRINT "= ";OT;" ";UNIT$
6780 S1 = TL -  LEN ( STR$ ( INT (MT(NM + 1))))
6790  PRINT
6800  PRINT "TOTAL MACHINE PROCESSING TIME "
6810  PRINT "= "; SPC( S1);MT(NM + 1); SPC( 1);UNIT$
6820  PRINT
6830 S1 = TL -  LEN ( STR$ ( INT (IT(KK))))
6840  PRINT "IDLE MACHINE TIME "
6850  PRINT "= "; SPC( S1);IT(KK); SPC( 1);UNIT$
6860  PRINT
6870  IF TTY = 1 THEN  GOSUB 1370: REM  - PRINT INHIBIT
6880  RETURN
6890  REM   ********************
6900  REM   SUBROUTINE SHORTEST SEQUENCE
6910  REM
6920  REM        SELECTS SHORTEST SEQUENCES
6930  REM        OF THOSE SEQUENCES
6940  REM        SUGGESTED BY JOHNSON
6950  REM        ALGORITHM.
6960  REM
6970  FOR N = 0 TO NM - 1
6980  IF IT(N) < BT THEN BT = IT(N)
6990  NEXT N
7000 IS =  - 1
7010 KK = 0
7020  IF IT(KK) = BT THEN IS = KK
7030  IF KK >  = (NM - 1) GOTO 7050
7040 KK = KK + 1: GOTO 7020
7050 KL(0) = IS
7060 L = 1
7070  FOR N = 0 TO IS - 1
7080  IF IT(N) <  > BT GOTO 7110
7090 KL(L) = N
7100 L = L + 1
7110  NEXT N
7120 LM = L - 1
```

Listing 1 continued on page 572

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Listing 1 continued:

```
7130  RETURN
7140  REM   ########################
7150  REM   PARALLEL DRIVER ROUTINE
7160  REM
7170  REM   FOR USE WITH EPSON PRINTER,
7180  REM   AND SSM/AIO BOARD INSTALLED
7190  REM   IN APPLE SLOT #2.
7200  REM
7210  REM    TO INITIALIZE THE DRIVER,
7220  REM    RUN THIS SUBROUTINE:
7230  REM       CALL(768)
7240  REM
7250  REM   TO ENABLE THE PRINTER:
7260  REM      PRINT CHR$(17)
7270  REM      POKE 33,33
7280  REM
7290  REM   THE POKE COMMAND ALLOWS LINE
7300  REM   LENGTHS GREATER THAN 40.  IT
7310  REM   IS NOT REQUIRED FOR SHORTER
7320  REM   LINES.
7330  REM
7340  REM   TO DISABLE THE PRINTER:
7350  REM      PRINT CHR$(19)
7360  REM      POKE 33,40
7370  REM
7380  REM   THE POKE RETURNS THE APPLE
7390  REM   TO A FULL SCREEN.
7400  REM
7410  REM   TO EXIT THE PRINTER DRIVER:
7420  REM      PR#0
7430  REM
7440  RESTORE
7450  FOR N = 0 TO 89
7460 NP = 768 + N
7470  READ P
7480  POKE NP,P
7490  NEXT N
7500  DATA  169,255,141,162,192,169
7510  DATA  128,141,160,192,169, 60
7520  DATA  141,161,192,141,163,192
7530  DATA  169, 27,133, 54,169,  3
7540  DATA  133, 55, 96,141, 88,  3
7550  DATA   32,240,253,173, 88,  3
7560  DATA  201,141,208, 12,173, 87
7570  DATA    3,141, 89,  3,169, 13
7580  DATA   32, 61,  3, 96, 32, 61
7590  DATA    3,206, 89,  3,240,236
7600  DATA   96, 73,  0,141,162,192
7610  DATA  169, 60,141,163,192, 73
7620  DATA    8,141,163,192,173,163
7630  DATA  192, 41,128,240,249,173
7640  DATA  162,192, 96,132,141,  8
7650  REM
7660  REM   DRIVER IS SET UP FOR A
7670  REM   132 CHARACTER LINE.
7680  REM   FOR A DIFFERENT LENGTH LINE
7690  REM   POKE 855,NL WHERE NL IS
7700  REM   IS THE DESIRED LINE LENGTH.
7710  RETURN
7720  REM     ####################
7730  REM     SUBROUTINE DISPLAY
7740  REM
7750  HOME : PRINT : PRINT
7760  PRINT  TAB( 3);"BECAUSE THERE ARE MORE THAN"
7770  PRINT  TAB( 3);"FOUR MACHINES,SEVERAL SCREENS"
7780  PRINT  TAB( 3);"OF INFORMATION WILL BE PRESENTED"
7790  PRINT  TAB( 3);"FOR EACH OF THE VARIOUS DISPLAYS."
7800  PRINT  TAB( 3);"PLEASE FOLLOW THE DIRECTIONS"
7810  PRINT  TAB( 3);"AT THE BOTTOM OF EACH DISPLAY"
7820  PRINT  TAB( 3);"TO GET SUBSEQUENT SCREENS"
7830  IF PASS = 1 GOTO 7870
7840 PASS = 1
7850  GOSUB 1160: REM  - PAUSE
7860  RETURN
7870  FOR T = 1 TO 2500
7880  NEXT T
7890  RETURN
```

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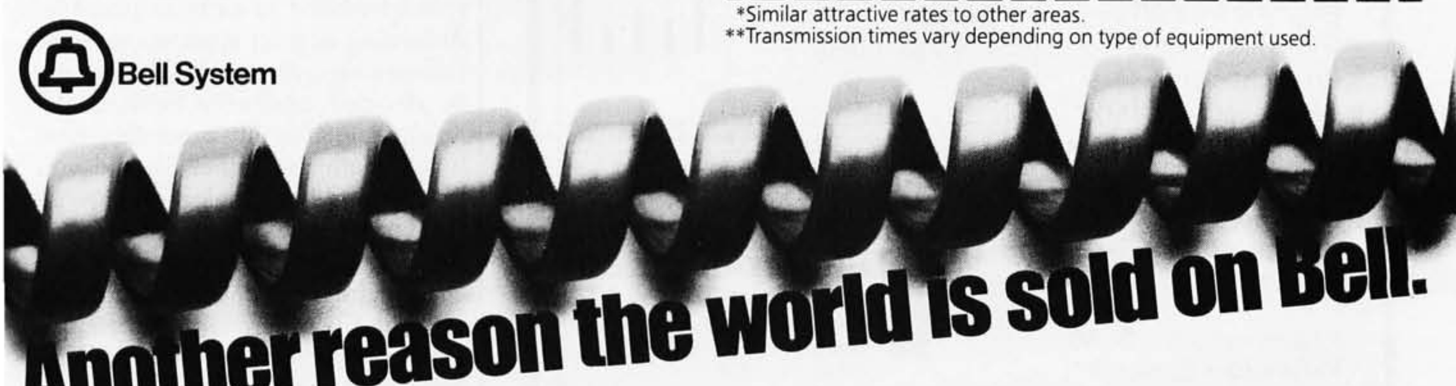

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Text continued from page 558:

byte system (cassette). It is worthwhile to make a few comments regarding program flow, limitations, and operations.

We set up the conversational, interactive program for as many as 15 jobs with as many as 20 machine operations. In principle, more machine operations could be used, and, indeed, more jobs could be added if the DIM statements were changed. However, due to the Apple's vertical display limitation, the various schedules would be confusing in these instances.

We marked the program subroutines with asterisks in listing 1 and included a brief description of subroutine operation at the beginning of each subroutine listing. Also, within the listing, each call to a subroutine indicates, by a following REM statement, what the called subroutine does.

Basically, the program flow consists of data input (beginning at line 2090) with a following sequence for correcting errors (line 5120). Performance characteristics including total facility processing time, total actual machine time, and idle time are calculated for the initial job order before the program begins the search for better sequences.

The subroutine at line 4180 is the Johnson Two-Machine Quick and Clean Algorithm. (A "clean" algorithm is guaranteed to generate an optimal solution; see reference 10.) The algorithm as coded has a slight bias: In case of a tie between jobs for the smallest operations time, the job later in the initial order is the one assigned first. Similarly, if a job that is ready for assignment has equal times on Machine A and Machine B, it is scheduled as early as possible. According to strict application of the Johnson algorithm, equal times may be decided arbitrarily because the resulting total facility processing time will remain the same. Should you care to modify the selection criteria, you must manipulate lines 4340 through 4350. Alternatively, if you change the input data by a fractional amount, the program might produce a different schedule that presents an option to the programmed tie-

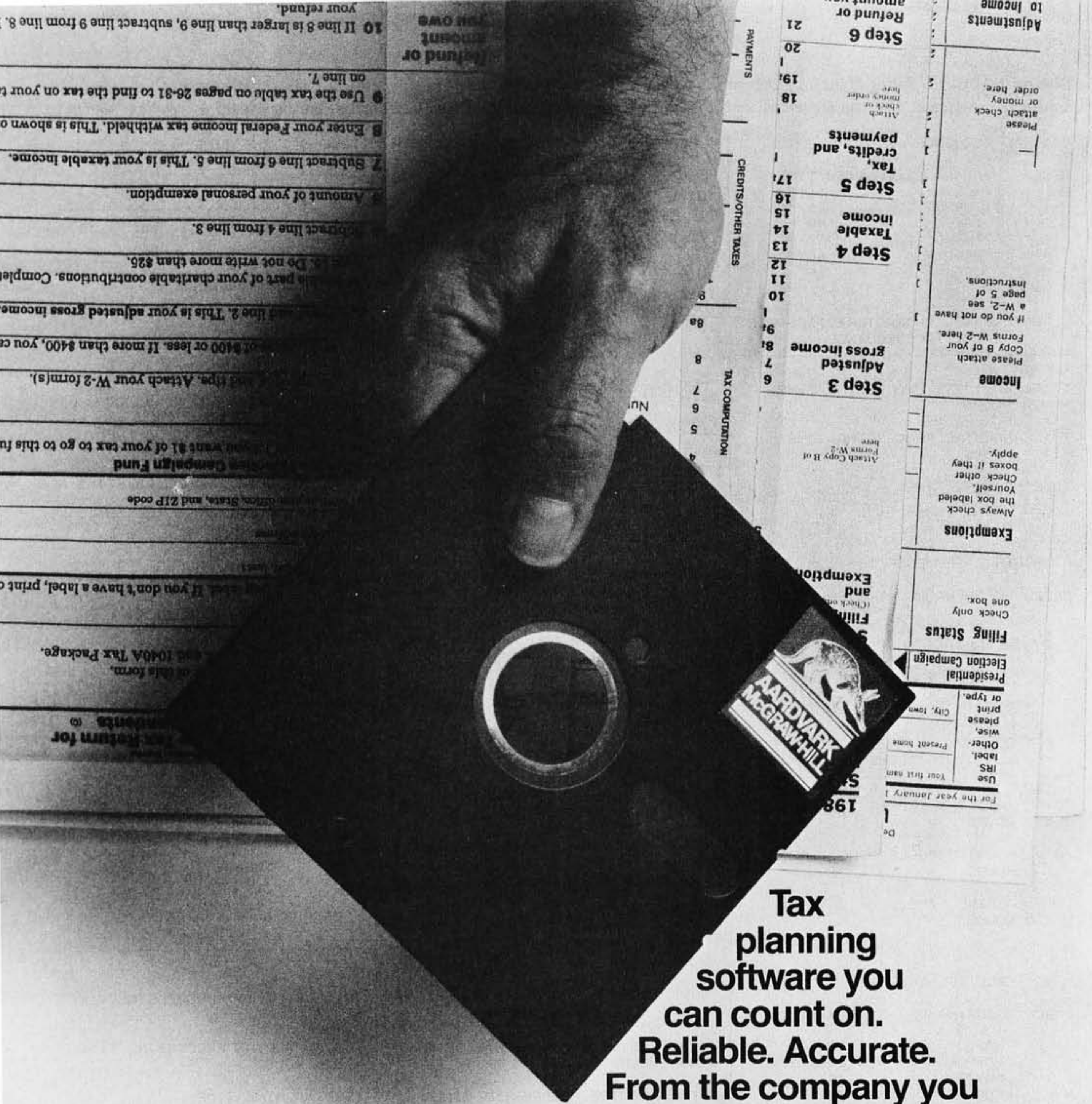
breaking rules.

If there are only two machines, the program exercises the Johnson algorithm, determines the optimum sequence, prepares the machine loading schedule, and calculates the performance characteristics of the optimum sequence. If there are more than two machines, the program searches through the $M - 1$ two-machine problems according to the procedures outlined in the Method section (page 555).

When the search is completed, you are presented the best (i.e., having the shortest total facility processing time) sequence (or sequences) for consideration. Again, performance characteristics are computed, and the machine loading schedule (to the nearest whole time unit) is available for examination and rumination. At this point, the manager can either work on a new series of jobs or return to modify the data of the original set of jobs. The latter permits the manager to test the sensitivity of the recommended job sequence to small changes in expected process times for various jobs. An examination of alternative job sequences with similar performance characteristics provides an opportunity for the manager to explicitly consider other factors, such as priority jobs or machine maintenance requirements.

Note that the program has an optional print capability. In particular, it is set up to allow printed output using an Epson printer and an SSM AIO board. Obviously, modifications to the printer driver at lines 7060 through 7620 are necessary for other printers and interfaces.

Partial output for the paint shop example is shown in listing 2. Two job sequences (Rabbit, Cobra, Corvette, Daytona, then Turbo-ZX; Rabbit, Cobra, Daytona, Corvette, then Turbo-ZX) have the minimum idle time (290 hours) of those sequences that were examined. Both represent equally good job process sequences, and the corresponding loading schedules are determined by the program. Although the machine loading schedules are presented only as video output, the output for the two good sequences is shown in tables 3



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Listing 2: *A partial listing of the output from the program in listing 1 using the paint shop example. The initial sequence and four possible sequences are shown. The two sequences with the least amount of idle machine time (290 hours) are then listed as good job sequences.*

```
INITIAL SEQUENCE

ORDER    JOB NAME    FINISH TIME

  1       CORVET          26
  2       DAYTON          48
  3       TURBOZ          57
  4       RABBIT          60
  5       COBRA           79

  PERFORMANCE CHARACTERISTICS FOR
         INITIAL SEQUENCE
-----------------------------------

TOTAL FACILITY PROCESSING TIME
= 474 HOURS

TOTAL MACHINE PROCESSING TIME
= 130 HOURS

IDLE MACHINE TIME
= 344 HOURS


A POSSIBLE SEQUENCE IS:

ORDER    JOB NAME    FINISH TIME

  1       COBRA           27
  2       RABBIT          30
  3       DAYTON          54
  4       CORVET          64
  5       TURBOZ          75

  PERFORMANCE CHARACTERISTICS FOR
           THIS SEQUENCE
-----------------------------------

TOTAL FACILITY PROCESSING TIME
= 450 HOURS

TOTAL MACHINE PROCESSING TIME
= 130 HOURS

IDLE MACHINE TIME
= 320 HOURS


A POSSIBLE SEQUENCE IS:

ORDER    JOB NAME    FINISH TIME

1       RABBIT            9
2       COBRA            28
3       DAYTON           49
4       CORVET           59
5       TURBOZ           70

  PERFORMANCE CHARACTERISTICS FOR
           THIS SEQUENCE
-----------------------------------

TOTAL FACILITY PROCESSING TIME
= 420 HOURS

TOTAL MACHINE PROCESSING TIME
= 130 HOURS

IDLE MACHINE TIME
= 290 HOURS


A POSSIBLE SEQUENCE IS:

ORDER    JOB NAME    FINISH TIME

  1       RABBIT           9
  2       COBRA           28
  3       CORVET          39
  4       DAYTON          61
  5       TURBOZ          70

  PERFORMANCE CHARACTERISTICS FOR
           THIS SEQUENCE
-----------------------------------


TOTAL FACILITY PROCESSING TIME
= 420 HOURS

TOTAL MACHINE PROCESSING TIME
= 130 HOURS

IDLE MACHINE TIME
= 290 HOURS

A POSSIBLE SEQUENCE IS:

ORDER    JOB NAME    FINISH TIME

  1       RABBIT           9
  2       CORVET          27
  3       COBRA           44
  4       DAYTON          65
  5       TURBOZ          74

  PERFORMANCE CHARACTERISTICS FOR
           THIS SEQUENCE
-----------------------------------

TOTAL FACILITY PROCESSING TIME
= 444 HOURS

TOTAL MACHINE PROCESSING TIME
= 130 HOURS

IDLE MACHINE TIME
= 314 HOURS


-----------------------------------
-----------------------------------


A GOOD JOB SEQUENCE IS:

ORDER    JOB NAME    FINISH TIME


  1       RABBIT           9
  2       COBRA           28
  3       CORVET          39
  4       DAYTON          61
  5       TURBOZ          70

  PERFORMANCE CHARACTERISTICS FOR
           THIS SEQUENCE
-----------------------------------


TOTAL FACILITY PROCESSING TIME
= 420 HOURS

TOTAL MACHINE PROCESSING TIME
= 130 HOURS

IDLE MACHINE TIME
= 290 HOURS

A GOOD JOB SEQUENCE IS:

ORDER    JOB NAME    FINISH TIME

  1       RABBIT           9
  2       COBRA           28
  3       DAYTON          49
  4       CORVET          59
  5       TURBOZ          70

  PERFORMANCE CHARACTERISTICS FOR
           THIS SEQUENCE
-----------------------------------

TOTAL FACILITY PROCESSING TIME
= 420 HOURS

TOTAL MACHINE PROCESSING TIME
= 130 HOURS

IDLE MACHINE TIME
= 290 HOURS
```

First Alternative Sequence for Schedule of Operations

Job	Major Body Work		Trim Removal		Paint Strip		Body Finish		Paint		Reassembly	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Rabbit	0	0	0	1	1	1	1	7	7	8	8	9
Cobra	0	0	1	2	2	7	7	23	23	27	27	28
Corvette	0	0	2	6	7	13	23	35	35	37	37	39
Daytona	0	0	6	9	13	17	35	55	55	59	59	61
Turbo-ZX	0	16	16	18	18	20	55	65	65	68	68	70

Table 3: *A schedule for the first good job sequence in listing 2. Note that the Rabbit is finished by the ninth hour, and all cars are finished after 70 hours.*

Second Alternative Sequence for Schedule of Operations

Job	Major Body Work		Trim Removal		Paint Strip		Body Finish		Paint		Reassembly	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Rabbit	0	0	0	1	1	1	1	7	7	8	8	9
Cobra	0	0	1	2	2	7	7	23	23	27	27	28
Daytona	0	0	2	5	7	11	23	43	43	47	47	49
Corvette	0	0	5	9	11	17	43	55	55	57	57	59
Turbo-ZX	0	16	16	18	18	20	55	65	65	68	68	70

Table 4: *A schedule for the second good job sequence in listing 2. Here the Daytona and the Corvette have switched places, but again all cars are finished after 70 hours. This schedule could be used if the Daytona had a higher priority than the Corvette.*

and 4. You can use the start and finish times for each job at the machine stations to identify idle times. You can plan the reassigning of idle employees and the scheduling of equipment maintenance during idle periods.

Now you can use other criteria to distinguish between the two sequences. For example, suppose the owner of the Ferrari Daytona was a valued customer and required the finished car as soon as possible. The Daytona could be delivered 12 hours earlier using the second good sequence. The Corvette job then suffers a 20-hour delay, but the total processing time remains at 420 hours.

Conclusions

We have presented a microcomputer-based scheduling algorithm that can be helpful in identifying job sequences that minimize total facility processing times. Analyses to determine the effects on schedules and performance characteristics of changes in the machine operations time are easily obtained. In taking this approach to the flow-shop problem, we assumed that processing sequences were identical for all jobs, process times for each job on each machine were able to be determined, and all jobs arrived simultaneously. We developed this approach as an aid in managerial decision making, which is the goal of applied operations researchers.■

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Walter A. Stark Jr. (275 Kimberly, White Rock, Los Alamos, NM 87544) currently manages the isotope heat source research and development at a Los Alamos National Laboratory nuclear-processing facility. Richard A. Reid (The University of New Mexico, Robert O. Anderson Schools of Management, Albuquerque, NM 87131) teaches operations management and quantitative analysis.

What's New?

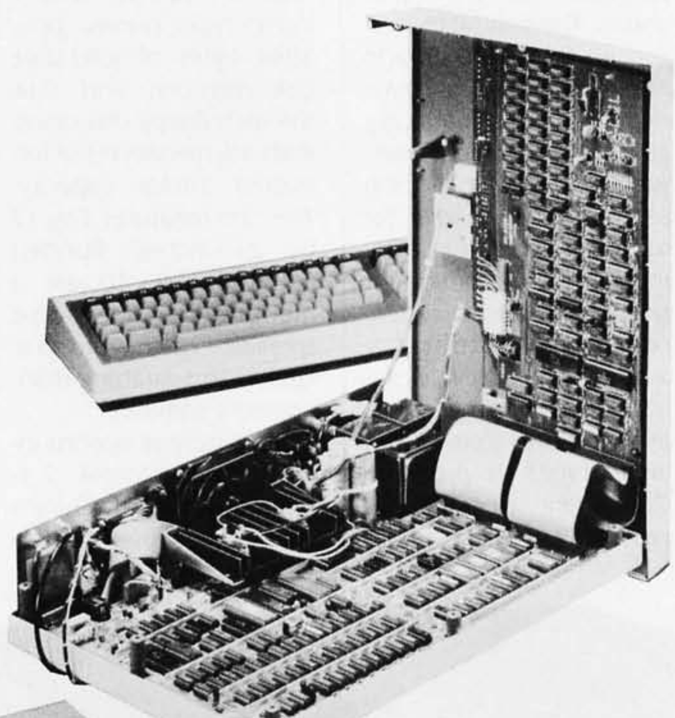
Always a Trainer, ET-100 Has Design/Test Capability

Heathkit/Zenith Educational Systems' 16-bit ET-100 Learning Computer can be upgraded to a full, 192K-byte disk-based computer, yet it's always capable of functioning as a trainer. This multipurpose computer can serve as an electronic base for designing and testing prototype circuits because it has a unique, top-mounted solderless breadboard for unlimited experimentation. Together with its companion advanced microprocessor course, the ET-100 is quite probably the first complete 16-bit microprocessor training system produced for mass distribution.

ET-100's breadboard has solderless connector blocks that provide easy and direct access to address, control, data, and I/O lines. Four voltage supplies for powering experiments and a parallel port are also provided. It can be used for conducting experiments, building and testing circuits, and tinkering with the computer's internal functions. A dust cover protects the breadboard when it's not in use and serves as a convenient video-display platform. Even when it's fully upgraded, you can return the ET-100 to the training mode by removing the dust cover and entering a simple keyboard command.

An 8088-based computer, the basic ET-100 has 16K bytes of RAM, cassette and RS-232C ports, composite video output, and 30K bytes of ROM containing a CP/M-86 assembler, screen editor, and a graphics debugger. A detached, 95-key keyboard generates the 96-character ASCII set. ASCII characters can be displayed in 24 by 80 format on a high-resolution monitor or in a 20 by 40 format on a standard home television. Sixteen function keys and a numeric keypad are provided.

The ET-100 advanced microprocessor training course is designed to teach the fundamentals of 16-bit microprocessor technology to both beginners and veteran 8-bit programmers. It treats 16-bit technology as a standard for today's microprocessors rather than as an extension of 8-bit computing. The course proceeds step by step from the basics of 16-bit technology to such advanced topics as data handling, interfacing, and software programming. A variety of experiments and self-tests are provided. It's available in versions for classrooms and self-instruction. Successful completion of the home-study course entitles you to eight Continuing Education Units.



An upgrade package converts the ET-100 into a complete disk-based computer capable of running 16-bit software under such Z-100 operating systems as Z-DOS. The pack-

age contains 128K bytes of RAM, a floppy-disk controller, a 48-tpi double-sided double-density 320K-byte floppy-disk drive, two RS-232 ports, a programmable timer, a Centronics parallel port, and a 64K-byte video board with bit-mapped graphics. Color graphics, a second disk dive, and 64K bytes of RAM are also available. Nine other courses are planned.

The only peripherals required are a video monitor and a cassette tape recorder. In kit form, the ET-100 costs $999.95. Factory-assembled and tested, it's $1499.95. The complete self-instruction course is $99.95 The upgrade kit is priced at $1299.95 or $1999.95, assembled and tested. For full information, write to Heathkit/Zenith Educational Systems, Heath Co., Department 150-125, Benton Harbor, MI 49022.

Circle 650 on inquiry card.

Dual-Processor Multiuser System Eyes Business Market

At CP/M '83 East in Boston later this month, Compupro will unveil the Multipro Model MP 10, a four-user microcomputer capable of simultaneous 8/16-bit program execution yet priced at less than $1800 per workstation. The Model MP 10 is aimed at businesses seeking to run their databases on a system more powerful than a personal computer network. It supports communications and word and data processing through a shared database, which, in turn, provides access to information more rapidly than through a network.

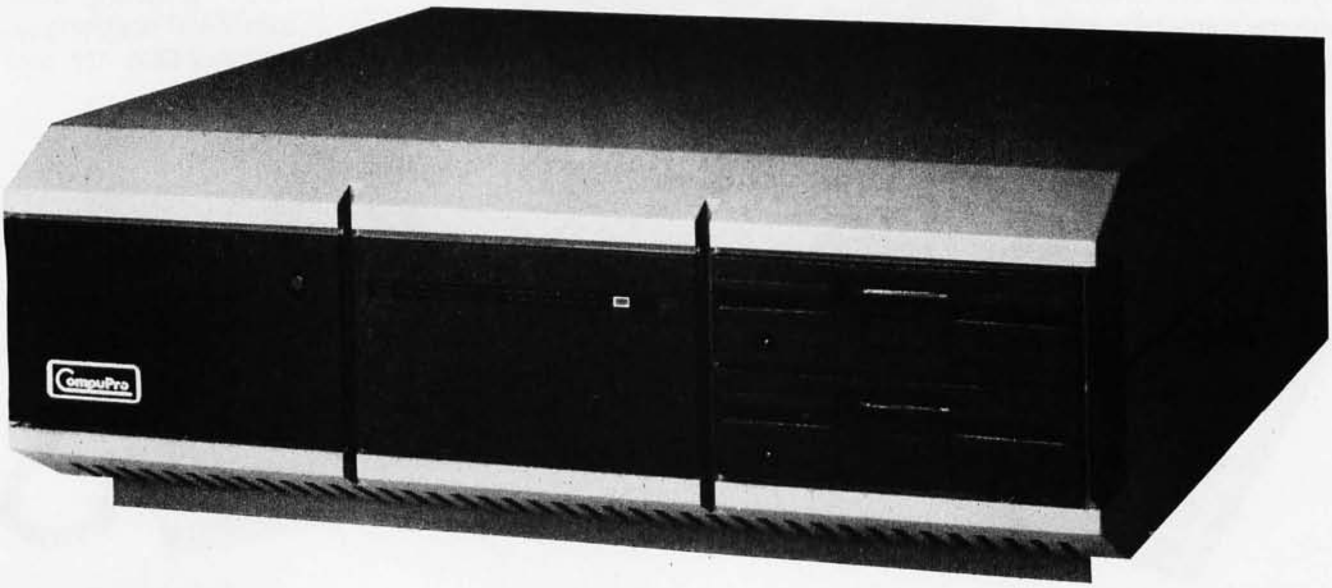
In a standard MP 10 configuration, each workstation has access to a dedicated 64K-byte Z80B processor for 8-bit programs. The central processor, an 8-MHz 8088, and its 1 megabyte of main memory are dynamically allocated to each user, with the Z80B functioning as a terminal handler for running 16-bit tasks. The multiprocessor design is said to make all system resources potentially available to each workstation at any time while allowing operators to run an 8- or 16-bit program. Concurrent operation is provided under a Compupro-enhanced MP/M operating system.

Key hardware features include five serial ports, a modem connector, a Centronics-type printer port, 384K bytes of solid-state disk memory, and dual 5¼-inch floppy-disk drives with 1.6 megabytes of formatted storage capacity. The case measures 7 by 17 by 21 inches. Bundled with the MP 10 are a menu-driven electronic spreadsheet, a word processor, and database-management software.

Mass storage options include an external 2.4-megabyte dual 8-inch floppy-disk drive subsystem and an internal 5¼-inch Winchester hard-disk drive with 40 megabytes of storage. Other options include an 8-MHz 8087 coprocessor, up to 4 megabytes of solid-state disk emulator, and a network interface.

The MP 10 is the first in a series of high-performance business computers departing from Compupro's traditional S-100 bus architecture. Its base price is $4995, excluding terminals. For full details, contact Compupro, 3506 Breakwater Court, Hayward, CA 94545, (415) 786-0909.

Circle 651 on inquiry card.



What's New?

PORTABLE COMPUTERS

Nicad Batteries Power Portable for Half a Day

Self-contained rechargeable nicad batteries power the UDI-500 portable computer for up to 12 hours. Mass storage is provided by dual 3½-inch 322K-byte micro disks that feature DMA data transfer and automatic power down to conserve power. The UDI-500 comes with two CMOS central processors and two DOSes: the Z80 with CP/M 2.2 and the RCA 1805 with MicroDOS. Standard features include 64K byes of RAM, 2K bytes of video RAM, an accessory slot for a 300-bit-per-second (bps) modem, an 8-line by 40-character LCD display, a 59-key keyboard with 6 soft function keys, a Centronics-type parallel connector, and an RS-232C serial port with data rates ranging from 50 to 19,200 bps. The UDI-500 measures 11 by 13 by 3⅛ inches and weighs 12⅖ pounds.

Some of the software packages available for the UDI-500 are BASIC-80, CBASIC, a spreadsheet, and a text processor. Hardware options include double-sided 737K-byte disk drives, a 1200-bps modem, up to 256K bytes of RAM, and an internal AC power supply. For more information, contact Universal Data Inc., M-15, 3960 Ortonville Rd., Clarkston, MI 48016, (800) 521-1056; in Michigan, (313) 625-0158.

Circle 652 on inquiry card.

Notebook Computer

Casio has introduced the Model FP-200 notebook computer. Containing 8K bytes of RAM and 32K bytes of ROM, the FP-200 offers a 20-column by 8-line display that can handle both data and graphic information. It has a full-sized QWERTY keyboard with an integral keypad and an RS-232C port for communications. A Centronics parallel port lets you use the FP-200 with a printer or plotter, and its I/O port provides for future expansion. A cassette port allows you to load and store programs. RAM memory is expandable to 32K bytes.

The retail price of the FP-200 is $499. Contact Casio Inc., 15 Gardner Rd., Fairfield, NJ 07006, (201) 575-7400.

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16-Bit Portable Bundled with Software

The 16-bit 8088-based portable Columbia VP is bundled with 15 business and professional applications packages, including MS-DOS, MS-BASIC, communications, accounting, and the Perfect Writer and Perfect Filer. This 128K-byte IBM PC-compatible weighs 30 pounds and comes with two 5¼-inch half-height floppy-disk drives handling 320K bytes of data. Its green-phosphor, 9-inch display offers full graphics capabilities: 640 by 200 or 320 by 200 pixels in an 80- or 40-column by 25-line format. The VP's 83-key keyboard is IBM-standard. Interfaces include parallel and serial ports, eight-level priority interrupt and DMA controllers, and an IBM PC-compatible expansion slot. RAM memory is expandable to 256K bytes, and a socket for an 8087 coprocessor is provided.

The Columbia VP costs $2995. For additional information, contact Columbia Data Products Inc., 9150 Rumsey Rd., Columbia, MD 21045, (301) 992-3400.

Circle 654 on inquiry card.

Your Passport to Portable Computing

The Anderson Jacobson Passport comes with 256K bytes of RAM, two 320K-byte disk drives, and a 7-inch amber screen. The IBM PC-compatible Passport uses an Intel 8088 microprocessor operating at 4.77 MHz. It offers 20K bytes of display RAM and 8K bytes of ROM for diagnostics and general I/O routines. The 84-key detachable keyboard has 10 function keys and a numeric pad. The alphanumeric screen format is 25 by 80. Greek, foreign language, mathematics, and line-drawing symbols are among the 256 characters available. Display attributes include underline, blink, intensify, reverse video, subscript, and superscript. A parallel printer port is provided, and the Passport's RS-232C port offers programmable asynchronous data rates ranging from

110 to 19,200 bps and synchronous bysnc and bit-oriented protocols (100,000 bps maximum). A built-in, 300-bps Bell 103J-compatible modem with auto-answer capabilities is standard. The 20-pound Passport is supplied with MS-DOS, Multiplan, text editing, communications, relational database, and executive desk software.

Two versions are available. The first, which costs approximately $4500, has two disk drives, parallel and serial ports, battery-backed time and date clock, the modem, and software. The second version is a single-disk model with dual I/O ports and operating system software. It's priced in the low-$3000 range. For complete particulars, contact Anderson Jacobson Inc., 521 Charot Ave., San Jose, CA 95131, (408) 286-7960.

Circle 655 on inquiry card.

Portable Computer with Network Capabilities

The Teletote I may be the first portable computer with network capabilities. An optional RS-422A network port is all that's needed to link the Teletote I with a Televideo network for access to shared files, printers, and electronic mail.

The basic Teletote has a 9-inch video display with 640 by 240 high-quality graphics resolution and 24-line by 80-character format. Mass storage is in the form of a single 368.6K-byte (formatted) 5¼-inch floppy-disk drive. Additional hardware includes a Zilog Z80A, 64K bytes of RAM, a mouse port for quick cursor manipulation, two RS-232C printer/modem ports, and telephone connections. Supplied software is made up of the CP/M operating system, the GSX-80 graphics extension, and word processing, spreadsheet, and graphics packages. The 25-pound Teletote is software- and media-compatible with the 8-bit Televideo TS803 desktop computer.

Teletote's RAM memory is expandable to 128K bytes and a second floppy-disk unit is available for $449. The network option costs $495. A mouse costs $99. The Teletote I costs $1499. A two-drive version is priced at $1899. Contact Televideo Systems Inc., 1170 Morse Ave., Sunnyvale, CA 94086, (408) 745-7760.

Circle 656 on inquiry card.

Desktop Performance in Portable

The Jonos C2100 portable computer is said to offer the performance characteristics typically associated with desktop computers. This 25-pound machine, built around a Z80A central processor, comes with 64K bytes of dual-ported RAM, two RS-232C ports, and a pair of 3½-inch 322K-byte (formatted) Sony micro-floppy-disk drives. Its 92-key detachable keyboard features an IBM Selectric-style layout and a full numeric cluster as well as an entry key and 10 function keys. A 9-inch P-31 phosphor screen provides a 25-line by 80-character format. For expansion, an integral compartment for a third disk drive and five STD bus card slots are available. The basic unit comes with such software as CP/M, Spellbinder, Multiplan, and BASIC-80. It costs $3995 from Jonos Ltd., 920-C East Orangethorpe, Anaheim, CA 92801, (714) 999-6661.

Circle 657 on inquiry card.

PC-5000 Runs on Batteries or AC Power

Sharp Electronics' PC-5000 portable computer operates from a rechargeable built-in battery or from an AC adapter. The basic 11-pound PC-5000 comes with 128K bytes of RAM, a typewriter-style keyboard, 128K bytes of bubble-memory storage, and an 8-line by 80-character LCD display with a bit-mapped graphics capacity of 640 by 80 dots. A character set containing 256 characters and symbols is provided. The unit is programmed in BASIC.

A wide assortment of options are available, including a high-density dot-matrix thermal impact printer, a 10-key modem/auto-dialer, disk drives, and three-octave sound capabilities. Initial software offerings on bubble-memory software cartridges include a word processor, spreadsheets, a database manager, and an executive planner. The basic PC-5000 costs $2500. For full details, contact Sharp Electronics Corp., Systems Division, 10 Sharp Plaza, POB 588, Paramus, NJ 07652.

Circle 658 on inquiry card.

What's New?

20 Megabytes of Hard-Disk Storage in Portable

The Star-Lite HD20 is an S-100 bus portable computer with a built-in 20-megabyte hard-disk drive. A Z80A computer running CP/M 2.2, the HD20 has 64K bytes of RAM, 183K bytes of floppy-disk storage, a 9-inch 24 by 80 green screen, and a detached keyboard with 26 user-programmable function keys. Display attributes include half-intensity, underlining, blinking, and reverse video. Single serial and Centronics-type parallel ports are provided. Three S-100 bus slots are opened for expansion. Bundled with the HD20 is word processing, spreadsheet, modem, and accounting software. It weighs 34 pounds and measures 7⅝ by 16⅜ by 16½ inches.

The suggested retail price for the HD20 is $4995. Further information is available from Computershop Inc., 139 First St., Cambridge, MA 02141, (617) 661-3723.

Circle 659 on inquiry card.

Computer with Bubble Memory

The Teleram 3000 portable computer weighs 9 pounds and is small enough to rest comfortably in your lap. Principal specifications are 64K bytes of RAM, 4K bytes of ROM, 128K or 256K bytes of nonvolatile bubble memory, an RS-232C interface, and a flat-panel LCD display with a 4-line by 80-character format. The 3000 has a typewriter-style keyboard with numeric and cursor keypad and 16 software programmable function keys. The CP/M 2.2 operating system is standard. It's powered by internal rechargeable batteries.

Options include floppy-disk drives, a text/graphics display, networking, and communication interfaces. The basic Teleram costs $2495. With 256K bytes of bubble memory, it's $2995. For details, contact Teleram Communications Corp., 2 Corporate Park Dr., White Plains, NY 10604, (914) 694-9270.

Circle 660 on inquiry card.

SKS Unveils Line of 8/16-Bit Portables

SKS Computers has introduced a modularized 8/16-bit line of portable microcomputers. In an 8-bit Z80A configuration, the desktop-compatible SKS 2502 Nano comes with dual 400K-byte 5¼-inch floppy-disk drives, 80K bytes of RAM, a keyboard controller, two RS-232C serial ports, and CP/M. Its display is a 9-inch green screen with a 16 or 24 by 80 format with reverse video/magnified character attributes. Priced at $2495, Nano is supplied with such software as interpreted CBASIC and Perfect Writer. With the addition of a 16-bit 80186 processor, a parallel port, or a 5¼-inch Winchester hard-disk drive, the Nano becomes a dual-processor 8/16 portable computer with 128K bytes of RAM. This version costs $3295, including MS-DOS.

The SKS 252 Pico is also available. This portable incorporates the same features as the Nano, except that it carries two 3½-inch 200K-byte micro-floppy-disk drives. The 8-bit version costs $2595; the 8/16-bit version is $3395. Contact SKS Computers Inc., 4091 Leap Rd., Hilliard, OH 43026, (614) 876-8668.

Circle 661 on inquiry card.

Large Memory, Math Processor in Portable

The Sord M23P portable computer weighs 19 pounds and can be tucked into carry-on luggage. A Z80A-based computer, the M23P has an Am9511 arithmetic processor, 128K bytes of RAM, and two 3½-inch 290K-byte micro-floppy-disk drives. Two 75- to 19,200-bps RS-232C serial ports, a Centronics-compatible parallel port, and three bus slots compose the M23P's I/O section. With the addition of an acoustic coupler, the M23P can send or retrieve data. Featured software includes Sord's Pan Information Processing System (PIPS), which has simplified commands for making tables, classifying data, searching, arranging information, performing calculations, and creating graphs. BASIC, UCSD Pascal, FORTRAN, a word processor, and an assembly-language debugger are standard. When equipped with a 12-inch green or a 14-inch color monitor, the M23P offers a 25 by 80 display format. Color capacities include 640- by 256-dot graphics and 8 colors.

Options include the SB-80 operating system and a dot-matrix or daisy-wheel printer. The list price is $2185. Add $195 for the

green monitor and $795 for the color monitor. Contact Sord Computer of America Inc., c/o Mitsui (U.S.A) Inc., 200 Park Ave., New York, NY 10166, (212) 878-4403.
Circle 662 on inquiry card.

PORTABLE PC-RELATED PRODUCTS

Check and Budget Program for HX-20

Data-Check, a check and budget program for the Epson HX-20, has been announced by Dataccount. This program maintains a checking account with budgets and reconciliation and allows up to 20 user-defined categories. Budget reports include analysis of month- and year-to-date performance. Transactions can be summarized by category, and Data-Check can print balances and outstanding transactions. When used with the HX-20's microcassette drive, this program also provides extensive file-handling abilities. It can accommodate 125 transactions with the 16K-byte HX-20 and 1000 transactions with the 32K-byte version. Data-Check resides in RAM, so you can access its features at any time.

This program is also available for the Radio Shack Model 100 and the NEC 8201. For full details, contact Dataccount Inc., Suite 820, 516 Southeast Morrison St., POB 14706, Portland, OR 97214, (503) 232-0490.
Circle 663 on inquiry card.

Magazine for Kaypro Users

Pro = Files is a bimonthly magazine for users of Kaypro computers. Written for both the novice and the experienced Kaypro user, **Pro = Files** has a full range of departments, features, and news on Kaypro-related and industry topics. Regular departments include letters to the editor, a question-and-answer column, technical tips, and short summaries of new products and applications.

Pro = Files will be distributed free of charge for one year to new Kaypro owners. Subscriptions for current owners began with the premiere issue, June 1983. Details are available from Kaypro Corp., 533 Stevens Ave., Solana Beach, CA 92075, (619) 481-3424.
Circle 664 on inquiry card.

Stand for Portables

A stand from Icarus Systems lets you adjust the viewing angle of your portable computer console up to 25 degrees. The stand is constructed of heavy-gauge aluminum alloy and is painted with a scratch-resistant, baked urethane enamel. Currently, versions are available for the Compaq, Kaypro II, Osborne Executive, and Zorba. The retail price is $69.95, plus shipping. Dealer inquiries are invited. Contact Icarus Systems, Suite 14-325, 2303 North 44th St., Phoenix, AZ 85008, (602) 945-3993.
Circle 665 on inquiry card.

Software and EPROM Programmer for HHC

Quasar has announced snap-in software capsules and an EPROM programmer for its HHC (hand-held computer). The software capsules include a programmer's aid, statistics and budget programs, and a poker/blackjack game. Prices range from $25 to $80. The EPROM programmer can be used to custom program capsules for the system. It costs $295. For full details, contact Quasar Co., 9401 West Grand Ave., Franklin Park, IL 60131, (312) 625-0020.
Circle 666 on inquiry card.

Computer Backpack

The Compupak backpack makes it possible to transport portable computers on foot for blocks or miles. The water-proof nylon pack is similar to the type used by cross-country backpackers. Its frame is made of welded aluminum with crossbar reinforcing and padded shoulder straps and waist belt.

Compupak will accommodate most portable computers. It costs $139, plus $10 shipping. It's available from Sage Designs, 6035 Ocean View Dr., Oakland, CA 94618, (415) 654-1619.
Circle 667 on inquiry card.

PRINTERS

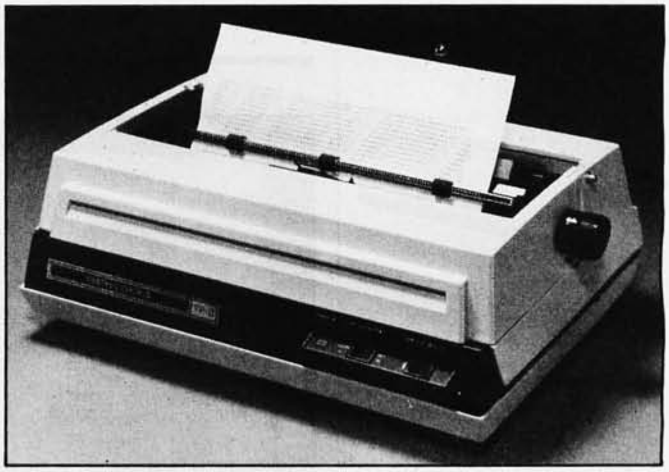
Wide-Carriage Printers

Two versions of the MT 180 wide-carriage printer are available from Mannesmann Tally. The MT 180I features high-speed 132-column printing for accounting, report, or spreadsheet preparation. The MT 180L has letter-quality capabilities. When in the letter-quality mode, these dot-matrix printers operate at 40 cps. For report preparation, they run at 160 cps.

Both versions feature a 15-inch carriage and 132-character print line. A user-selectable compressed print option provides up to 264 columns of data on a single line. Output formats, such as right-margin justification, automatic centering, print pitch, and proportional spacing, can be set directly from front-panel controls or through the computer. These printers come with internal software that integrates text with graphics printing in the same document. A single lever controls switching from single cut-sheet to tractor feed. Both serial and parallel in-

terfaces are standard.

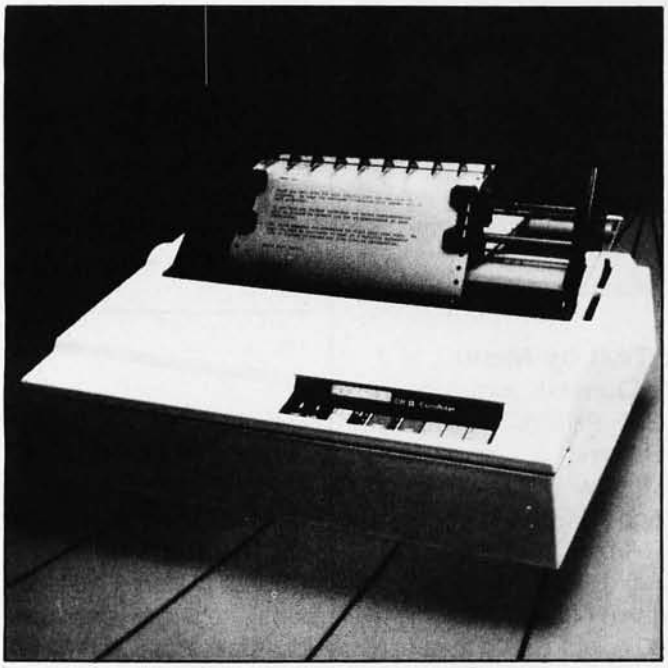
The MT 180I and the 180L will work with such 16-bit computers as the IBM Personal Computer and the DEC Rainbow and with 8-bit computers, including the Apple II and Osborne. The MT 180I costs $998, and the 180L is priced at $1098. For more information, contact Mannesmann Tally Corp., 8301 South 180th St., Kent, WA 98032, (206) 251-5503.
Circle 668 on inquiry card.



Dual-Interface Letter-Quality Printer

The TP-II, a letter-quality, dual-interface printer has been introduced by Smith-Corona. The TP-II daisywheel printer has a 10/12 pitch 93-character ASCII print wheel with reverse slash, brackets, approximate sign, vertical line, uparrow, and greater- and less-than symbols. TP-II can accommodate X/On, X/Off, ETX/ACK, and hardware handshake protocols. A self-test switch, automatic underscore, programmable margins and tabs, and a 256-character buffer are standard. It uses ribbon cassettes, and RS-232C and Centronics ports are built in.

A tractor feed attachment is available for $149. The TP-II costs $895. For details, contact Smith-Corona, 65 Locust Ave., New Canaan, CT 06840, (203) 972-1471.
Circle 670 on inquiry card.



Under-$700 Daisy-Wheel

Comrex International has announced an under-$700 daisy-wheel printer capable of producing letter-quality copy. The Comriter CR-II features such word-processing functions as superscript, subscript, backspace, underline, boldface, double strike, and proportional spacing. Its 5K-byte buffer, capable of storing up to three pages of data, lets you reproduce original and multiple copies of a document stored in it. The average print speed is 12 cps (approximately 140 words per minute). Print motion is bidirectional and logic seeking. The print wheel is ASCII-standard with 96 petals. The ribbon is a Brother-compatible cassette-type. Centronics and RS-232C interfaces are available.

Options include tractor feed, color print ribbons, a cut-sheet feeder, and interchangeable print wheels compatible with the Comriter CR-I. For more information, contact Comrex International Inc., 3701 Skypark Dr., Torrance, CA 90505, (213) 373-0280.
Circle 669 on inquiry card.

Petite Alphanumeric Printer

Syntest Corporation's SP-400 alphanumeric matrix printer measures a mere 8 by 4.45 by 2.7 inches. Capable of producing high-quality 40-column printouts on thermal paper, the SP-400 has switch-selectable data rates from 50 to 9600 bps and selectable stop bits and parity. Input is RS-232C or 20-mA loop. A 40-character buffer and a LED for low paper indication are standard. Printing speed is 1 line per second.

The SP-400 is $285 in quantity. The single-unit price is $365. Both prices include power supply. Contact Syntest Corp., 169 Millham St., Marlboro, MA 01752, (617) 481-7827.
Circle 671 on inquiry card.

What's New?

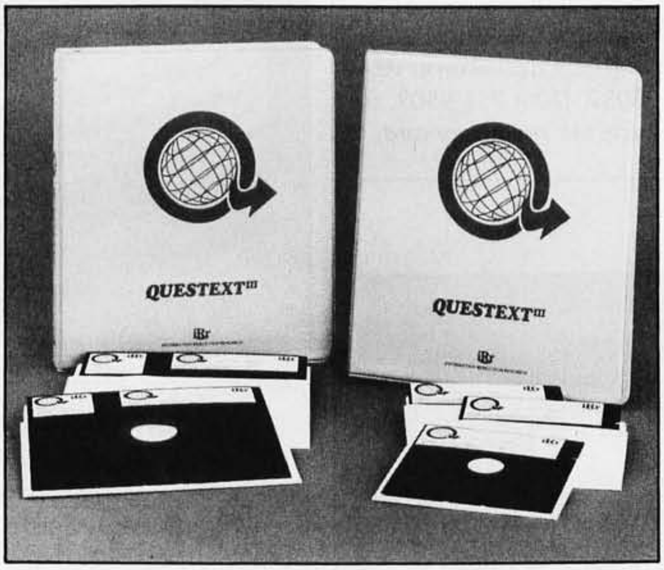
High-Speed Electrosensitive Printer

Axiom Corporation's Model EX1620 is an electrosensitive printer capable of 960-cps operation. This speed is made possible by a "Quick-print" mode that prints two characters with a single pass of the print head. In its normal mode, the EX1620 produces near letter-quality characters at 240 cps. When used with a microcomputer, the contents of a large program, such as Visicalc, can be dumped into the printer's 8K-byte buffer, freeing the computer for other tasks. The EX1620 can operate as a high-speed, high-resolution graphics printer with a density of 144 dots per inch (both horizontal and vertical). In addition to an optional 64 extra characters and special symbols, the full 96-character ASCII set can be printed on 8½-inch-wide paper. Standard interfaces include parallel, RS-232C, and 20-mA serial with busy and X/On X/Off protocols.

The EX1620 costs $795. Quantity discounts are available. Contact Axiom Corp., 1014 Griswold Ave., San Fernando, CA 91340, (213) 365-9521.

Circle 672 on inquiry card.

SOFTWARE



Organize and Store Text by Menu

Questext III version 3.5 is a general-purpose system for organizing, communicating, and storing textual information by menu. Produced by Information Reduction Research, Questext is suitable for such applications as computer-aided instruction, electronic publishing, executive scheduling, and classroom blackboarding. It's entirely menu-driven and said to be learnable in one session.

Questext organizes text into tree-like menu structures and executes machine code. Standard features include easy updating, cursor editing, error trapping, simple English-language commands, Help and Show facilities, and file controls. Print capabilities include screen, text, and outline dumping, continuous or page formats, and variable indentation. Questext can read and write text compatible with Wordstar.

Questext runs on the IBM Personal Computer, Osborne 1, Xerox 820, Morrow Micro Decision, Apple II CP/M, Kaypro, and 56K-byte CP/M systems. An 8-inch single-density disk is offered. A 24-line by 80-column ASCII terminal is required. A full system capable of accommodating 99 lines per menu, up to 6000 screens, and 32,700 records costs $299.95, including a self-teaching disk with sample applications. A mini version with 6 lines per menu, up to 40 screens, and 500 records is available for $49.95. The manual alone is $29.95. Original equipment manufacturer and dealer inquiries are welcome. For further information, contact Information Reduction Research, 1538 Main St., Concord, MA 01742, (617) 369-5719.

Circle 673 on inquiry card.

Arcade Game for Apple IIe

Mission: Escape! is an arcade-type game for 64K-byte Apple II/IIe computers from Micro-Sparc. Volcanic eruptions have blasted asteroids into orbit around the 12 planets in the Appel galaxy. You must pilot your shuttlecraft through the asteroids to save the inhabitants from certain destruction. Mission: Escape! offers 12 levels of difficulty. It costs $29.95 and is available from Micro-Sparc Inc., 10 Lewis St., Lincoln, MA 01773, (617) 259-9710.

Circle 674 on inquiry card.

Educational Software Available

Edusoft offers 17 educational software packages for Apple, Atari, and Radio Shack TRS-80 users. For young children, Alphabet Song and Count provide practice in learning the ABCs and numbers. Elementary school students can gain mathematics mastery with Addition, Multiplication, and Division Drills, and older students can explore computer programming through the Simulated Computer program. For teachers, Edusoft offers Gradebook.

Most Edusoft programs cost $24.95. For a free catalog, contact Edusoft, POB 2560, Berkeley, CA 94702, (800) 227-2778; in California, (415) 548-2304.

Circle 675 on inquiry card.

What's New?

Get the Draw on Graphics

Micro-Labs' Draw is a graphics and text-editing package for creating pictures or designing graphics screens on Radio Shack TRS-80 Model IIIs equipped with the Grafyx Solution Board. Containing nearly 10,000 instructions, this machine-language program lets you set, clear, or complement points, lines, circles, or boxes. Point sizes can be changed at any time, the entire screen can be reversed or shifted in any direction, and sections of the screen can be filled in with patterns. When a picture is completed, it can be saved on disk or tape or printed. Draw uses single-letter commands.

Draw costs $39.95, which includes 12 high-resolution pictures and a manual. Contact Micro-Labs Inc., 902 Pinecrest, Richardson, TX 75080, (214) 235-0915.

Circle 676 on inquiry card.

Modula-2 Compiler for CP/M

A Modula-2 compiler for 60K-byte CP/M systems will be available from JRT Systems on October 1. Derived from Pascal, Modula-2 lets you develop large programs made up of small modules that are kept in a program library. You can modify any module without affecting its relationship to the rest of the program because each module is divided into a definition part and an implementation part. Modula-2 features type checking between separately compiled program segments and low-level facilities for direct access to hardware and for circumventing strong type checking. It has multiprogramming abilities and procedure variables for program control.

Modula-2 was designed by Niklaus Wirth, creator of the Pascal language. Its suggested retail price is $100. An IBM Personal Computer version is in development. Contact JRT Systems Inc., 45 Camino Alto, Mill Valley, CA 94941, (415) 388-9670.

Circle 677 on inquiry card.

Project Grapher Without Additional Hardware

The Harvard Project Manager lets IBM PC users develop project plans graphically without requiring special graphics hardware. HPM, based on CPM (Critical Path Method) and PERT (Program Evaluation and Review Technique), employs the PC character set to construct the graphical elements for project management. It takes user-specified tasks, subprojects, and job milestones and draws a project "roadmap" on the PC's video display. Projects can be depicted as a bar chart showing when each task begins and ends. Task duration units can range from minutes or years. Costs are user-specified. As the project definition is refined, HPM continually recalculates and displays total project costs and duration. The project's critical path is displayed at all times. Other features include dynamic partitioning of the display screen into several functional windows, temporary displays of information, two-dimensional scrolling, and the ability to produce high-resolution hard copy.

HPM will also run on such IBM PC-compatible machines as the Compaq and Hyperion. The suggested price is $395. Contact Harvard Software Inc., Harvard, MA 01451, (617) 456-3400.

Circle 678 on inquiry card.

Keyboard Programmer

AS-Key is a keyboard software package that lets you program special keys on the North Star Advantage. With AS-Key, you can define the 107 special-key combinations on the Advantage as any standard ASCII character or sequence of characters. Eight local functions are provided, including the ability to send keyboard messages to a printer for the setting of special modes.

What's New?

AS-Key, which costs \$250, works with CP/M 2.2 or MS-DOS. It's distributed to North Star dealers through Northern Lights Computers, 1832 2nd St., Berkeley, CA 94710, (415) 540-6162.
Circle 679 on inquiry card.

Utilities for IBM PC Programmers

Power Pac I, the first in a series of IBM PC utility packages from Monument Computer Service, contains three programs: Formatted Lister, Diskmod, and BASIC Variable Cross-Reference. Formatted Lister lets you define headings, page numbers, margins, and line spacing for BASIC source-code listings. Diskmod provides a means for reading and inspecting disk sectors and has a full-screen editor that allows you to modify disk data in either hexadecimal or ASCII code. With BASIC Variable Cross-Reference, you can prepare listings of line-jump references and lists of variables and their use within programs. Also, it can analyze up to 10 programs simultaneously and prepare documented listings and internal programming references.

Minimum requirements are 64K bytes of memory and a printer. Power Pac I costs \$79.95. For details, contact Monument Computer Service, Village Data Center, POB 603, Joshua Tree, CA 92252, (619) 365-6668.
Circle 680 on inquiry card.

PERIPHERALS

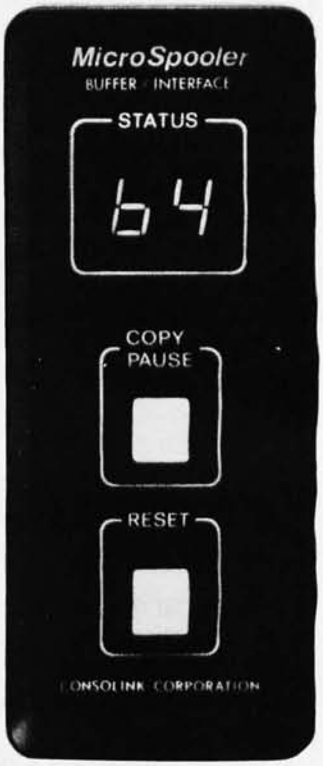
Micrigrids Offer High Resolution

Microgrid digitizer systems are plug and I/O compatible with other Summagraphics digitizers, including ID, Supergrid, and Summagrid. Six tablets, ranging in size from 12 by 12 inches to 42 by 60 inches, compose this series. Each features resolution of up to 1000 points per inch, ±0.010-inch accuracy, a single controller/interface board, a single-board printed-circuit grid, dual RS-232C interfaces, and an 8-bit parallel interface. A choice of transducers is offered so that the Microgrid can be tailored to meet specific applications needs. Transparent self-test and interactive terminal diagnostics are built in.

Options include a 1-button stylus or 3-, 4-, or 16-button cursors. For price and product information, contact Summagraphics Corp., 35 Brentwood Ave., POB 781, Fairfield, CT 06430, (203) 384-1344.
Circle 681 on inquiry card.

Buffer Gobbles Data as Fast as It Comes

Consolink's Microspooler accepts information as fast as your computer can output and holds it in memory until your printer is ready. With this device, you can store sentences, paragraphs, and data from different programs, compile them, and print a finished document. Microspooler can function as an interface between noncompatible computers and printers because it's available in any combination of parallel and serial I/O ports. Other standard features include multiple-copy functions, and a pause button. Microspooler will also receive data from a telephone modem or a remote input terminal.



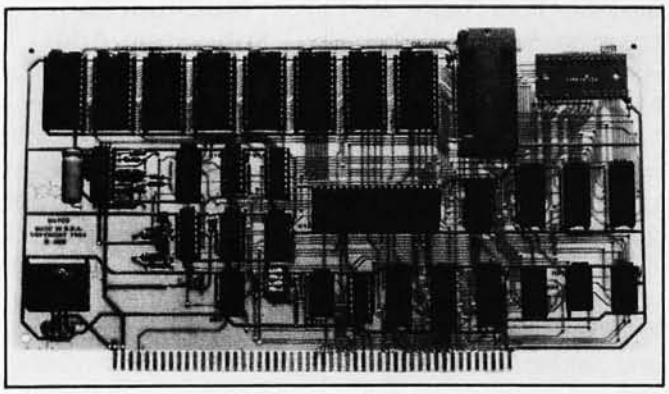
The basic Microspooler contains 16K bytes of memory and an LED display that indicates the amount of memory in use and how much data is yet to be printed. Options include memory expansion of up to 64K bytes and serial interfacing capabilities. The suggested retail price for the parallel-to-parallel interface unit is \$199. For full particulars, contact Consolink, 1840 Industrial Circle, Longmont, CO 80501, (800) 525-6705; in Colorado, (303) 651-2014.
Circle 682 on inquiry card.

What's New?

IEEE-488 Line Output Module

A 64 digital line output module that's IEEE-488 bus-compatible is available from Connecticut Microcomputer. Busster B64 accepts commands and data from any computer with an IEEE-488 interface. This unit processes information through its IEEE port and then activates 1 to 64 digital TTL-level lines, effectively increasing a computer's interfacing capabilities while reducing overhead. Busster can be programmed through BASIC commands from the host computer. Available from stock, Busster B64 costs $495. Contact Connecticut Microcomputer, 36 Del Mar Dr., Brookfield, CT 06084, (203) 775-4595.

Circle 683 on inquiry card.



EPROM Emulator/Programmer

You can program or emulate such chips as the 2758, 2716, 2732, 2732A, 27128, and 68764 with Matco's Emprom-1 EPROM emulator/programmer board. The Emprom-1 does not use system memory space. It uses only eight I/O ports. An 8-inch single-sided single-density disk controls all programming and emulation functions. Programming is accomplished by an onboard or an external zero-insertion force socket. Programming voltages are developed on the card, and personality changes are software-switched. A ribbon cable connects the Emprom-1 and the target processor.

Options include a buffered emulation cable and an adapter module for emulating multiple EPROMs. The software disk will run with CP/M, MP/M, or CDOS. Contact Matco, 427 Perrymont, San Jose, CA 95125, (408) 998-1655.

Circle 684 on inquiry card.

VIC-20 Expansion Device

The RAMmaster 32 for the Commodore VIC-20 has been announced by Mosaic Electronics. RAMmaster expands the VIC's memory to 37K bytes and features a built-in expansion port, pause and write-protect switches, and a relocatable memory block. A disabler switch that permits cartridge removal without turning off the computer is standard.

The suggested retail price for RAMmaster is less than $150. Further information is available from Mosaic Electronics, POB 708, Oregon City, OR 97045, (800) 547-2807; in Oregon, (503) 655-9574.

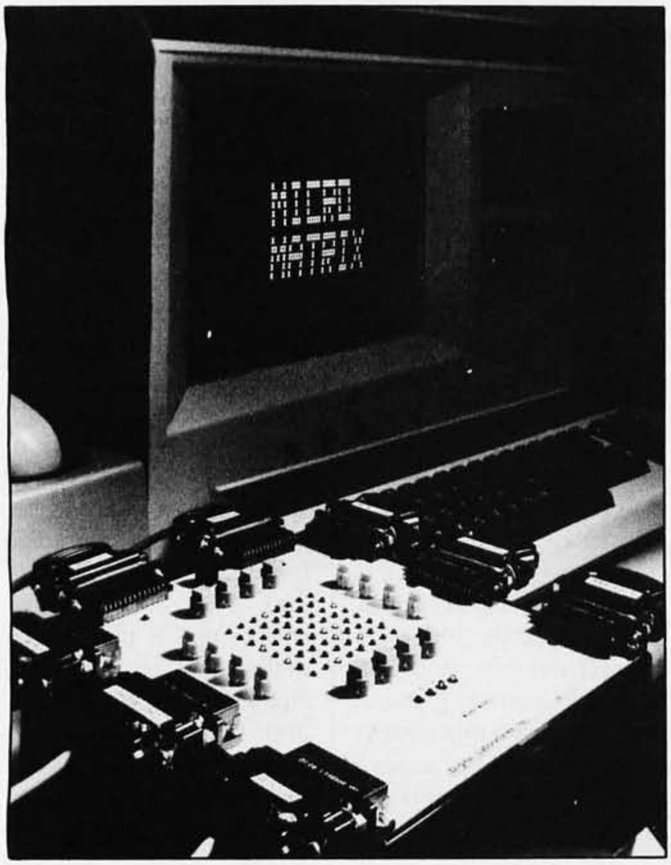
Circle 685 on inquiry card.

Digital Oscilloscope, Data Acquisition for Apple

Applescope from RC Electronics contains all the hardware and software necessary to convert your Apple or Franklin into a multipurpose digital-storage oscilloscope and data-acquisition system. System highlights include the ability to acquire consecutive points on a single sweep, shiftable trigger position within a signal sweep, automatic test and measurement, waveform storage and retrieval on a floppy disk, hard-copy output, real-time voltage measurement, external trigger, 4-channel software support, pretrigger viewing, single sweep or continuous trace, and addition, subtraction, inversion, multiplication, and conversion of input waveforms. It uses the display monitor to graph digitized input signals on a 280- by 160-dot grid. Three lines of text at the bottom of the screen display status. Applescope can acquire and store several screen displays for each sweep (up to 64 in the DMA mode) and permits the screen to be scrolled through the acquired signal trace.

System hardware includes an A/D converter, DMA controller, buffer memory, and programmable timing logic. Two versions are offered: the D2, a two-board, dual-channel 8-bit system, and the HR14, a 14-bit single-channel system with 12-bit absolute accuracy. Options include probes and specialized software packages. The Applescope D2 costs $795. The HR14 begins at $995 per channel. Complete Applescope packages start at $4895, including a computer. For full ordering and product specifications, contact RC Electronics Inc., 5386-D Hollister Ave., Santa Barbara, CA 93111, (805) 964-6708.

Circle 686 on inquiry card.



Switch Lets 8 Units Interact Simultaneously

Digital Laboratories markets a line-controlled general-purpose switch that lets up to 8 nonmedia-compatible modems, printers, monitors, ROM programmers, and computers share resources. The Micro-Matrix II allows multiple conversions and broadcasting between any combination of RS-232C- and 20-mA-compatible devices. This Z80-based unit stores up to 16 frequently used 8 by 8 connection matrices, which can be accessed and routed by simple codes. It can be operated by a standard video terminal or through computer control. Software modification between computers is not required.

The Micro-Matrix II costs $995. For more information, contact Digital Laboratories Inc., 600 Pleasant St., Watertown, MA 02171, (617) 924-1680.

Circle 687 on inquiry card.

Nine Display Formats for the Apple

Videx's Ultraterm video card gives your Apple II Plus, IIe, or III a high-quality 8- by 12-dot character matrix with a flicker-free display. Nine software-selectable formats allow as many as 4096 characters to be displayed. Format modes include 40 by 24, 80 by 24, 80 by 32 with interlacing, 128 by 32 for expanded spreadsheet visuals, and 160 by 24. Video attributes, also software-selectable, include bright, dim, standard or alternate character sets, normal, and inverse.

Ultraterm costs $379. Its interlaced mode requires a monitor with high-persistence phosphor. Contact Videx Inc., 897 Northwest Grant, Corvallis, OR 97330, (503) 758-0521.

Circle 688 on inquiry card.

Voice-Recognition System for Apple

An Apple-compatible voice-recognition board that lets you input commands and repetitive data through a microphone is available from Voice Recognition Systems. When AVIM (Apple Voice Input Module) receives your verbal commands, it responds with any sequence of preprogrammed keystrokes you wish. Its resident 8K bytes of memory can store up to 80 voice-command/keyboard response sets, and additional command sets can be stored on disk. It's supplied with a menu-driven utility for creating commands. The utility disk is also preprogrammed with command vocabularies for Visicalc, Wordstar, List Handler, BASIC, and seven other programs. AVIM connects through any RS-232C port. Among AVIM's pertinent hardware specifications are a Motorola 6803 synthesizer, proprietary analog chips for signal processing, and a 16-channel audio-spectrum analyzer that determines strategies for voice-pattern recognition and storage.

Options include a remote FM microphone for cordless operation, appliance on/off relays, and a number of software packages. The retail price is $950. A $75 adapter is required for the Apple IIe. IBM Personal Computer and S-100 bus versions are in development. For full details, contact Voice Recognition Systems, 550 Battery St., San Francisco, CA 94111, (415) 788-2007.

Circle 689 on inquiry card.

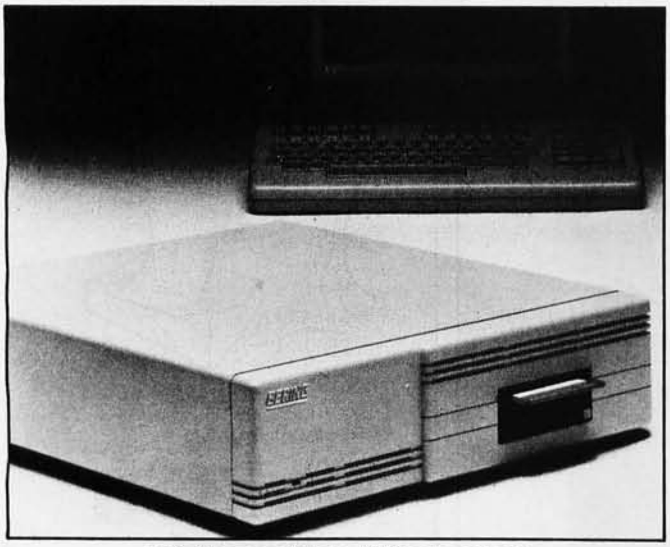
Multifunction Subsystem Adds Speech

The CMJ-IF multifunction subsystem plugs into the cartridge slot on the Radio Shack TRS-80 Color Computer or the TDP-100. Available from Magnum Distributing, the CMJ-IF expands your computer by providing a speech synthesizer accessible from BASIC, two parallel ports, 4K or 8K bytes of EPROM or ROM space, two counter/timers, a serial communications port, and an extender port for accessing a disk controller or ROM pack without disconnecting the subsystem. CMJ-IF is priced at less than $200. For additional information, contact Magnum Distributing Inc., 1000 South Dixie Highway #3, Pompano Beach, FL 33060, (305) 785-2002.

Circle 690 on inquiry card.

What's New?

MASS STORAGE



HP-Compatible Winchesters

The Series 3000 line of Winchester hard-disk subsystems from Bering Industries is designed for Hewlett-Packard computers. This 12-member family offers storage capacities of 5, 10, and 15 megabytes and an average transfer rate of 174,000 bytes per second. The 8085 microprocessor and the 2900 bit-slice chip are integrated with the controller, and a 5-bit error-correction-code circuit is built in for added data integrity. Storage can be partitioned into formatted blocks.

The Series 300 is hardware-, software-, and media-compatible with such HP technical and personal computers as the HP1000, Series 80, and 64000 development systems. Connection is via the HP-IB; no hardware or software modifications are required.

The Series 3000 can be equipped with a variety of options, including integral 3½-, 5¼-, or 8-inch floppy-disk drives. Other options include a multiport feature, an intelligent controller for local backup, and disk-sharing capabilities. Series 3000 prices range from $2860 to $4260. For complete product descriptions, contact Bering Industries Inc., 747 East Brokaw Rd., San Jose, CA 95112, (408) 298-8552.

Circle 691 on inquiry card.

Disk Subsystems for OEM Market

PH-Associates' Mark line of disk subsystems for OEMs have a 30-millisecond average access time. Capacities of 20, 33, and 46 megabytes are available. Said to be identical in size to the standard 5¼-inch floppy-disk drive, these subsystems come with a smart controller featuring intelligent formatting and automatic sectoring. The transfer rate is 5 megabits per second, and the line interfaces to S-100, Z80, Apple, IBM Personal Computer, Radio Shack TRS-80, and many 8-bit parallel computers.

The Mark is available as a complete subsystem assembled into either a standalone or rack-mountable chassis or it can be integrated into an existing chassis. OEM quantity one prices begin at $3000. Contract PH-Associates, 8720 Old Courthouse Rd., Vienna, VA 22180, (703) 281-5762.

Circle 692 on inquiry card.

Dual-Mode Streaming Tape Backup

The 20-megabyte Sysgen Image streaming cassette-tape backup for the IBM PC XT gives you a choice of two backup modes: Preserve and Filesave. Preserve saves a volume of disk data and restores it on another disk. It has a catalog utility that lists all the files by tapefile identification, and size. Filesave allows individual files or groups of files to be saved from hard disk to the tape, and vice versa. Its catalog utility lets you see all the files on tape, a specific range of files, or a particular file.

Image provides complete archival backup of hard-disk information at the rate of 2.5 megabytes per second. Compatible with CP/M-86 and PC-DOS, this subsystem comes with a controller, electronics, and drive mechanics. Word processing, database management, spreadsheet, and other demonstration software are supplied with Image. It costs $995, which includes interface card, cables, and the software. Contact Sysgen, 47853 Warm Springs Blvd., Fremont, CA 94539, (415) 490-6770.

Circle 693 on inquiry card.

Intelligent Drives for Atari 400/800

Trak's single-density AT-D1 and double-density AT-D2 intelligent drive systems work with Atari 400/800 computers. These drives feature an onboard microprocessor, programmed memory, and a digital track counter. Standard controls include a pressure-sensitive control panel that provides information on system activity through read/write indicators, a touch-sensitive write-protect switch for securing data, and an intelligent controller interface for a Centronics-type parallel printer.

These drives have half-height mechanisms with steel-band head positioning and direct-drive beltless DC motors. Track-to-track access time is 5 milliseconds. The AT-D2 costs $499. For full details, contact Trak Microcomputer Corp., 1511 Ogden Ave.,

Downers Grove, IL 60515, (800) 323-4853; in Illinois, (312) 968-1716.

Circle 694 on inquiry card.

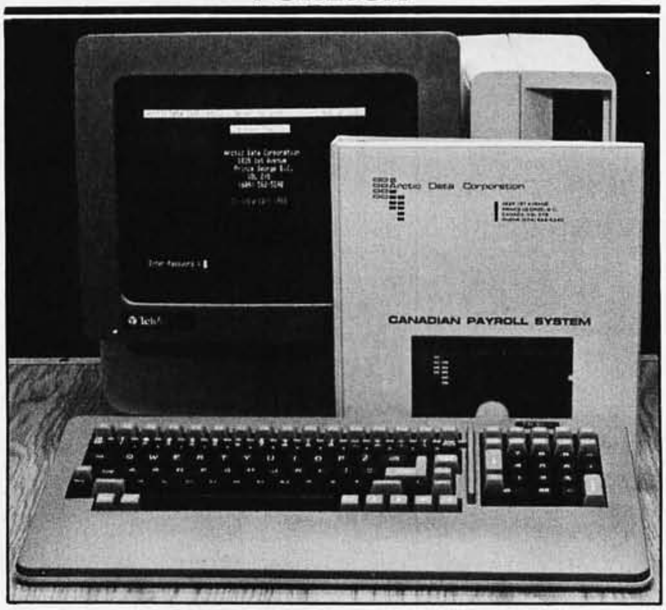
Portable Minicassette for Field Work

The LG-P compact portable minicassette system is manufactured by Analog & Digital Peripherals. This microprocessor-controlled unit is designed for field and factory personnel needing means for loading and storing programs at a remote site. Standard features include 96K bytes of storage per tape, multiple files/tape abilities, switch-selectable data rates of 150 to 9600 bps, double-buffered I/O, terminal and modem ports, and automatic error checking and retry. It has a self-contained operating system, a transparent standby mode between terminal and modem, and the ability to handle ASCII or binary codes. Its manual controls are read and write block or file, stop, skip, and backwards.

The LG-P comes in a shock-mounted briefcase measuring 7¾ by 5 by 9½ inches. Standard RS-232C and 20-mA current loop interfaces are offered. The single-unit price is $639. Quantity discounts are available. Contact Analog & Digital Peripherals Inc., 815 Diana Dr., Tory, OH 45373, (513) 339-2241.

Circle 695 on inquiry card.

FOREIGN



Canadian Payroll System

Arctic Data Corporation's Canadian payroll accounting system works with computers running CP/M and OS65/U operating systems. This package uses menu-driven prompts to guide operators through all phases of installation, operation, and report generation. It can print payroll summaries, input registers, employee lists, and payroll stubs. It supports up to nine user-defined deductions and four rate categories per employee. Payrolls can be calculated concurrently for hourly, salaried, and piecework paid employees. Salaried personnel files can be password protected. Further facilities permit issuing cash advances, bonuses, and lump-sum payments. This system can handle government-supplied forms. Union and job costing versions are available. Dealers and interested end users can receive complete details from Arctic Data Corp., 1839 1st Ave., Prince George, British Columbia, V2L 2Y8, Canada.

Circle 696 on inquiry card.

Remote Line Monitor

The RLM 2000 remote line monitor from RAD Computers Ltd. permits EIA status and line data streams to be transmitted from remote data links to a central site for analysis. This system is made up of a master unit at a central site and a slave unit that can be connected over communication lines and controlled by the master. The slave scans the transmit and receive leads, Tx and Rx clocks, and control signals. It transmits data to the master via low-speed channels using an error-checking algorithm for data integrity. The master unit receives and stores data in its 1K- to 16K-byte memory. Data is then restored and transferred to monitoring equipment for analysis. The slave is programmed through a standard ASCII terminal connected to the master.

Other products from RAD include short-haul modems and automatic cable testers. For more information, contact RAD Computers Ltd., 8 Hanechoshet St., Ramat-Hachayal, Tel Aviv 69710, Israel; tel: (03) 494511; Telex: 35517.

Circle 697 on inquiry card.

Winchesters and Floppies Standard

The Orion VI series of microcomputers from Dy-4 Systems offers two types of Winchester hard-disk drives combined with an 8-inch double-sided double-density floppy-disk drive. The Orion VI-A comes with a 35.6-megabyte (formatted) 8-inch Winchester, and the Orion VI-B is equipped with a 5-, 10-, or 20.8-megabyte 5¼-inch Winchester. Both systems feature STD bus architecture, a Z80A microprocessor, 64K bytes of RAM, 4K bytes of EPROM, and CP/M.

A 12-slot card-cage option for the VI-B allows for up to 9 user card slots. Additional options include RS-232C and parallel ports, color graphics, and floating-point mathematics. Contact Dy-4 Systems Inc., 888 Lady Ellen Place, Ottawa, Ontario K1Z 5M1, Canada, (613) 728-3711.

Circle 698 on inquiry card.

PRINTERS, PRINTERS AND MORE PRINTERS

· See More Specials on Pages 636 & 637

ANADEX

	List	CCU
DP9501	$1725	$1395

BMC

	List	CCU
PB 101, 16 cps, 2K Buffer	$1100	$ 649
PB 104 Silver Reed Copy	849	599

BROTHER

	List	CCU
HR-1A, 17cps	$ 999	$ 675

C. ITOH

	List	CCU
Gorrila-Banana, 50 cps	$ 249	$ 194
Prowriter 8510, 120 cps	495	349
Prowriter II 1550 (15")	995	649
Prowriter I Serial	745	499
Prowtirer II Serial	995	695
Starwriter F-10, 40 pu	1895	1129
8600 BP, 180 cps	1295	999
Printmaster F-10-55	1995	1405

COMREX

	List	CCU
CR-1	$1199	$ 675
CR-11, 12 cps, 5K Buffer	599	499
Tractor, CR-2	129	99

DIABLO

	List	CCU
620	$1195	$ 925
630 R-155	2340	1790
630 KSR	3325	2495

EPSON

	List	CCU
RX-80 (120 cps)	$ 499	Call
MX-80FT (80 cps)	525	Call
FX-80 (160 cps)	699	Call
FX-100 (15" Carriage)	899	Call

IDS

	List	CCU
Microprism 80 w/color	$1048	$ 799

MANESMAN-TALLY

	List	CCU
160L (160 cps)	$1075	$ 615
180L (160 cps)	1495	849

NEC

	List	CCU
PC8023A (100 cps)	$ 619	$ 375
PC8025 (15" Carriage)	975	699

NEC DOT MATRIX

	List	CCU
Nec 8023	$ 619	$ 375
Nec 8025	975	699

NEC 3500 SERIES

	List	CCU
Nec 3510	$1895	$1495
Nec 3515	1890	1490
Nec 3520KSR	2625	1995
Nec 3530	1995	1645
Nec 3550	2295	1850

NEC 7700 SERIES

	List	CCU
Nec 7710	$2595	$1950
Nec 7715	2625	1995
Nec 7720	3258	2550
Nec 7725	3325	2595
Nec 7730	2595	1995

NEW OKIDATA

	List	CCU
Microline 92P (160 cps)	$ 699	$ 499
Microline 92S (160 cps)	799	599
Microline 93P (160 cps, 15")	1249	799
Microline 93S (160 cps, 15")	1349	899

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	List	CCU
Microline 82A (Par. & Serial)	$ 549	$ 379
Microline 83A (15" carriage)	899	629
Microline 84P (200 cps)	1395	929
Microline 84S (200 cps)	1495	999

QUME SPRINT

	List	CCU
1140 +	$1681	$1495

STAR MICRONICS

	List	CCU
Gemini 10X (120 cps)	$ 399	$ 294
Gemini 15 (100 cps)	599	389
Gemini 15X	699	489

TOSHIBA

	List	CCU
P1350	$2195	$1499
Tractor	295	219

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Buffer Board works w/Grappler +	119

FOURTH DIMENSION

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Dumpling GX 16 Interface w/16K of Buf.	149
Additional Buffering 16K	15

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Kaypro to Printer	29
Osborne to Printer	29

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Trade Magazine for Latin American Business

Ejecutivo magazine is designed for Latin American business people who want to know more about computers and information-processing equipment. It offers reports on industry trends, trade happenings, new products and services, and profiles of names in the news. Current circulation of this Spanish-language, four-color journal is 40,000. For information, contact Ms. M. Morelli, Ostwaldstrasse 6, 5300 Bonn 1, West Germany; tel: (228) 612807. In the the U.S., Johnston International, 386 Park Ave. S, New York, NY 10016, (212) 689-0120.

Circle 699 on inquiry card.

K-Fix Patches Kaypro CP/M

Maplesoft's K-Fix version 2.1 is designed to correct several unpopular traits of the Kaypro II. K-Fix alters the Kaypro's CP/M system so that it turns off the drive motors when they are not in use, extinguishes the drive lights except for when a read or write is occurring, and sets the power on/reset default serial data rate to any of the 16 values supported by the Kaypro.

K-Fix is written in assembly language and is recopyable with COPY and SYSGEN utilities. The distribution disk contains KFIX.COM, the source code (KFIX.ASM), and a boot-up message advising users how to proceed. It costs $29.95 (in Canada, $35), which includes a manual containing a fully commented source-code listing. Order K-Fix from Maplesoft Inc., Suite 100, 49 Ascot Dr., Fredericton, New Brunswick, E3B 6G1, Canada.

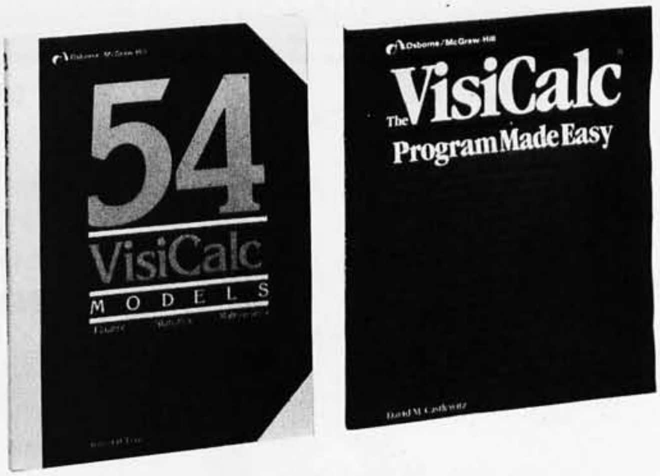
Circle 700 on inquiry card.

Printer Flows at 37 cps

The Flowriter RP1300 operates at 37 cps and offers character pitches of 10, 12, and 15 cpi and proportionally spaced type styles. This bidirectional printer with optimized printhead movement comes with an 8K-byte buffer, graphics capabilities, and such print enhancements as underline and boldface. Standard features include external forms control, multicolor print, self-test, automatic linefeed, paper and ribbon sensors, and a print wheel with the full 96-character ASCII set and 28 special symbols. Flowriter can print an original plus six copies. Interfaces are serial RS-232C, IEEE-488, or Centronics parallel. Options include a variety of typefaces, tractor feed, and a keyboard for communications. A 60-cps version is available. Contact Appropriate Technology Ltd., 2-4 Canfield Place, London NW6 3BT, England; tel: 01-328 7272; Telex: 264538 SSE G.

Circle 701 on inquiry card.

PUBLICATIONS



Visicalc Subject of Two New Works

Two recent releases from Osborne/McGraw-Hill focus on Visicorp's Visicalc spreadsheet program. **54 Visicalc Models: Finance–Statistics–Mathematics** by Robert H. Flast is a collection of ready-to-run Visicalc programs that address common business, mathematics, and statistical problems. It's written for both beginners and seasoned Visicalc users. The price is $15.95.

In **The Visicalc Program Made Easy**, David M. Castlewitz presents a series of hands-on lessons that introduce users to Visicalc's program format and commands. Numerous examples and exercises help even first-time users achieve desired results. It costs $12.95. Contact Osborne/-McGraw-Hill, 2600 Tenth St., Berkeley, CA 94710, (415) 548-2805.

Circle 702 on inquiry card.

Guide to Osborne

Purported to provide all the operational requirements needed to wrest the best from your Osborne 1, **Using the Osborne Personal Computer** is a Van Nostrand Reinhold publication. Author Kenniston W. Lord offers easy-to-use applications that can save business people time and money. Methods of entering, sorting, and presenting information are explained, and graphics techniques for business reports are described. Discussions cover data and programs running under the CP/M operating system and explain how printer graphics are used. Other topics addressed include defining media files and reading and writing to magnetic media. Numerous projects are provided to further refine programming skills.

Using the Osborne Personal Computer contains

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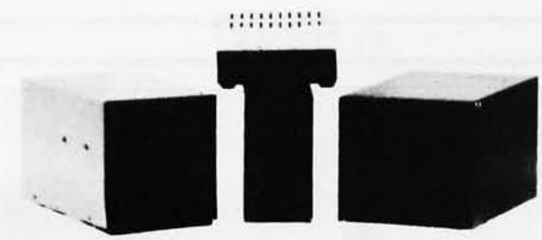

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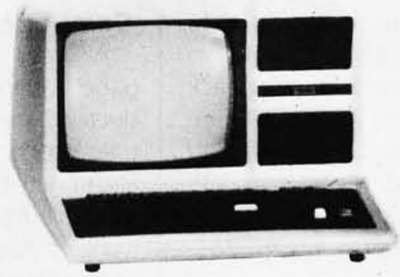

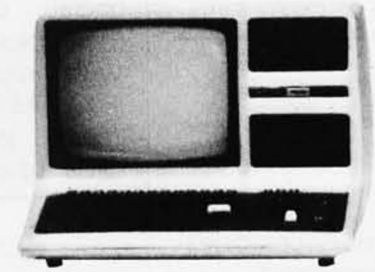

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'TRS-80 is a trademark of the Tandy Corporation   Prices subject to change without notice.

Circle 152 on inquiry card.

15 illustrations and 336 pages. It's available in either cloth or paperback for $20.45 and $13.95, respectively. Contact Van Nostrand Reinhold, 135 West 50th St., New York, NY 10020, (212) 265-8700.

Circle 703 on inquiry card.

Business Accessories Described

Microsoftware Solutions, a free catalog of programs, books, accessories, and games for business computer users, is produced by Career Aids. This catalog describes more than 100 products in such diverse categories as training, word processing, accounting, job scheduling, file management, graphics, and medical/legal office. Product descriptions include information on memory requirements, printer needs and formats, and comparison tables. A glossary of technical terms helps you sort through the jargon.

All the programs listed in **Microsoftware Solutions** are available from and supported by Career Aids. A telephone hotline service provides you with assistance in selecting software for particular applications or with information and advice. For a copy, contact Career Aids/Microsoftware Solutions, 8950 Lurline Ave., Chatsworth, CA 91311, (213) 341-8279.

Circle 704 on inquiry card.

Components Catalog

A free, illustrated 80-page catalog of semiconductors, memories, microprocessors, and passive electronic components is available from Active Electronics. Also covered are computer systems and peripherals. Contact Active Electronics, POB 8000, Westborough, MA 01581, (800) 343-0874; in Massachusetts, (617) 366-0500.

Circle 705 on inquiry card.

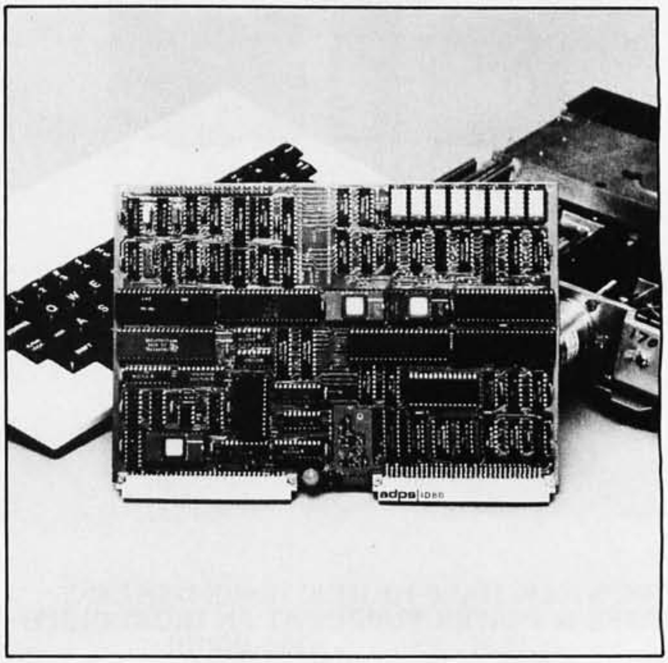
Online Data Directory

Profiles of 291 online services are contained in a 52-page directory produced by Data Decisions. **Online Services** covers databases in 15 categories, such as distribution, education, banking and finance, medical/health, government, and agriculture. Service reports provide information on the primary function of the company, application and industry emphasis, application languages and program development aids supported, and access schemes permitted. Other features include a quick-reference and summary index classifying the listings by industry and a miscellaneous section of databases.

Online Services costs $29.95. Order Report 10-CL from Data Decisions, 20 Brace Rd., Cherry Hill, NJ 08034, (609) 429-7100.

Circle 706 on inquiry card.

SYSTEMS



Single-Board Computer Automatically Boots DOS

The ID-80 from Advanced Data Processing Systems automatically boots a control program or DOS when powered up. This single-board computer comes with a floppy-disk controller, two RS-232C serial ports, three parallel ports, and 64K bytes of dynamic RAM. It features an onboard terminal that uses VT-52 control codes and outputs composite video in an 80-column by 24-row format. Characters are formed in a 9 by 12 matrix, and custom fonts are user-programmable. A semigraphics mode allows the generation of 32 graphics characters. For storage, the ID-80 can handle two single- or double-density, single- or double-sided 5¼-inch floppy-disk drives or up to four single- or double-sided, single-density 8-inch drives. A 2K-byte character generator and 2K bytes of video memory are standard.

In single units, the ID-80 costs $598. For further information, contact Advanced Data Processing Systems, POB 10417, San Jose, CA 95137, (408) 446-9332.

Circle 707 on inquiry card.

Unisystem-PC Is PC-compatible

Compatible with the IBM Personal Computer, the Unisystem-PC is produced by International Systems Marketing. This 16-bit 8088-based machine is outfitted with 256K bytes of memory, dual 720K-byte floppy-disk drives, 8K bytes of EPROM, two RS-232C

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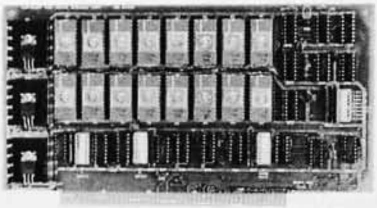
32K S-100 EPROM CARD
PRICE CUT!



$59.95

USES 2716's

Blank PC Board - $34

ASSEMBLED & TESTED ADD $30

SPECIAL: 2716 EPROM's (450 NS) Are $4.95 Ea. With Above Kit.

KIT FEATURES:
1. Uses +5V only 2716 (2Kx8) EPROM's
2. Allows up to 32K of software on line!
3. IEEE S-100 Compatible.
4. Addressable as two independent 16K blocks.
5. Cromemco extended or Northstar bank select.
6. On board wait state circuitry if needed.
7. Any or all EPROM locations can be disabled.
8. Double sided PC board, solder-masked, silk-screened.
9. Gold plated contact fingers.
10. Unselected EPROM's automatically powered down for low power.
11. Fully buffered and bypassed.
12. Easy and quick to assemble.

64K S100 STATIC RAM
$229.00 KIT

NEW!

LOW POWER!

RAM OR EPROM!

BLANK PC BOARD WITH DOCUMENTATION $55

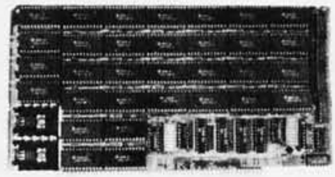
SUPPORT ICs + CAPS $17.50

FULL SOCKET SET $14.50

FULLY SUPPORTS THE NEW IEEE 696 S100 STANDARD (AS PROPOSED)

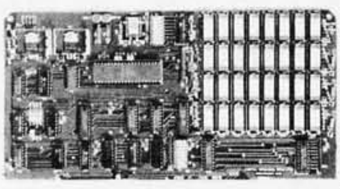
FOR 56K KIT $199

ASSEMBLED AND TESTED ADD $50



FEATURES:
* Uses new 2K x 8 (TMM 2016 or HM 6116) RAMs.
* Fully supports IEEE 696 24 BIT Extended Addressing.
* 64K draws only approximately 500 MA.
* 200 NS RAMs are standard. (TOSHIBA makes TMM 2016s as fast as 100 NS. FOR YOUR HIGH SPEED APPLICATIONS.)
* SUPPORTS PHANTOM (BOTH LOWER 32K AND ENTIRE BOARD).
* 2716 EPROMs may be installed in any of top 48K.
* Any of the top 8K (E000 H AND ABOVE) may be disabled to provide windows to eliminate any possible conflicts with your system monitor, disk controller, etc.
* Perfect for small systems since BOTH RAM and EPROM may co-exist on the same board.
* BOARD may be partially populated as 56K.

256K S-100 SOLID STATE DISK SIMULATOR!
WE CALL THIS BOARD THE "LIGHT-SPEED-100" BECAUSE IT OFFERS AN ASTOUNDING INCREASE IN YOUR COMPUTER'S PERFORMANCE WHEN COMPARED TO A MECHANICAL FLOPPY DISK DRIVE.



FEATURES:
* 256K on board, using + 5V 64K DRAMS.
* Uses new Intel 8203-1 LSI Memory Controller.
* Requires only 4 Dip Switch Selectable I/O Ports.
* Runs on 8080 or Z80 S100 machines.
* Up to 8 LS-100 boards can be run together for 2 Meg. of On Line Solid State Disk Storage.
* Provisions for Battery back-up.
* Software to mate the LS-100 to your CP/M* 2.2 DOS is supplied.
* The LS-100 provides an increase in speed of up to 7 to 10 times on Disk Intensive Software.
* Compare our price! You could pay up to 3 times as much for similar boards.

BLANK PCB (WITH CP/M* 2.2 PATCHES ON DISK) $69.95

$399.00
#LS-100 (FULL 256K KIT)

64K SS-50 STATIC RAM
$179.00 (48K KIT)

NEW!

LOW POWER!

RAM OR EPROM!

BLANK PC BOARD WITH DOCUMENTATION $52

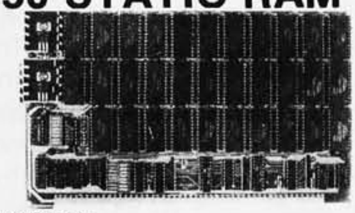
SUPPORT ICs + CAPS $18.00

FULL SOCKET SET $15.00

56K Kit $219

64K Kit $249

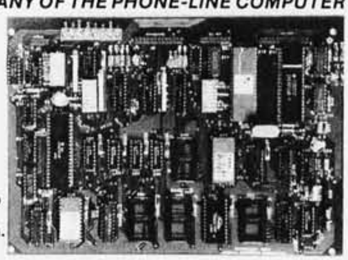
ASSEMBLED AND TESTED ADD $50



FEATURES:
* Uses new 2K x 8 (TMM 2016 or HM 6116) RAMs.
* Fully supports Extended Addressing.
* 64K draws only approximately 500 MA.
* 200 NS RAMs are standard. (TOSHIBA makes TMM 2016s as fast as 100 NS. FOR YOUR HIGH SPEED APPLICATIONS.)
* Board is configured as 3-16K blocks and 8-2K blocks (within any 64K block) for maximum flexibility.
* 2716 EPROMs may be installed anywhere on Board.
* Top 16K may be disabled in 2K blocks to avoid any I/O conflicts.
* One Board supports both RAM and EPROM.
* RAM supports 2MHZ operation at no extra charge!
* Board may be partially populated in 16K increments.

THE NEW ZRT-80
CRT TERMINAL BOARD!
A LOW COST Z-80 BASED SINGLE BOARD THAT ONLY NEEDS AN ASCII KEYBOARD, POWER SUPPLY, AND VIDEO MONITOR TO MAKE A COMPLETE CRT TERMINAL. USE AS A COMPUTER CONSOLE, OR WITH A MODEM FOR USE WITH ANY OF THE PHONE-LINE COMPUTER SERVICES.

FEATURES:
* Uses a Z80A and 6845 CRT Controller for powerful video capabilities.
* RS232 at 16 BAUD Rates from 75 to 19,200.
* 24 x 80 standard format (60 Hz).
* Optional formats from 24 x 80 (50 Hz) to 64 lines x 96 characters (60 Hz).
* Higher density formats require up to 3 additional 2K x 8 6116 RAMS.
* Uses N.S. INS 8250 BAUD Rate Gen. and USART combo IC.
* 3 Terminal Emulation Modes which are Dip Switch selectable. These include the LSI-ADM3A, the Heath H-19, and the Beehive.
* Composite or Split Video.
* Any polarity of video or sync.
* Inverse Video Capability.
* Small Size: 6.5 x 9 inches.



BLANK PCB WITH 2716 CHAR. ROM, 2732 MON. ROM $59.95

SOURCE DISKETTE - ADD $10

SET OF 2 CRYSTALS - ADD $7.50

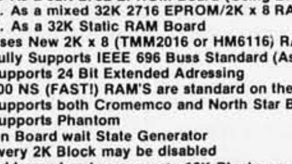
ZRT-80

WITH 8 IN. SOURCE DISK! **$129.95** (COMPLETE KIT, 2K VIDEO RAM)

32K S100 EPROM/STATIC RAM
NEW! FOUR FUNCTION BOARD! **NEW!**

EPROM II FULL EPROM KIT $80.00

A&T EPROM ADD $35.00



BLANK PC BOARD WITH DATA $39.95

SUPPORT IC'S PLUS CAPS $23.00

FULL SOCKET SET $18

We took our very popular 32K S100 EPROM Card and added additional logic to create a more versatile EPROM/RAM Board.

FEATURES:
* This one board can be used in any one of four ways:
  - A. As a 32K 2716 EPROM Board
  - B. As a 32K 2732 EPROM Board (Using Every Other Socket)
  - C. As a mixed 32K 2716 EPROM/2K x 8 RAM Board
  - D. As a 32K Static RAM Board
* Uses New 2K x 8 (TMM2016 or HM6116) RAM's
* Fully Supports IEEE 696 Buss Standard (As Proposed)
* Supports 24 Bit Extended Adressing
* 200 NS (FAST!) RAM'S are standard on the RAM Kit
* Supports both Cromemco and North Star Bank Select
* Supports Phantom
* On Board wait State Generator
* Every 2K Block may be disabled
* Addressed as two separate 16K Blocks on any 64K Boundary
* Perfect for MP/M* Systems
* RAM Kit is very low power (300 MA typical)

32K STATIC RAM KIT — $129.95
For RAM Kit A&T - Add $40

Digital Research Computers
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TERMS: Add $2.00 postage. We pay balance. Orders under $15 add 75¢ handling. No C.O.D. We accept Visa and MasterCharge. Tex. Res. add 5% Tax. Foreign orders (except Canada) add 20% P & H. Orders over $50, add 85¢ for insurance.

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ports, a parallel printer port, and a video monitor with a 25 by 80 format. Video attributes include uppercase and lowercase characters, underline, blink, reverse image, and high-intensity characters. Eight levels of interrupts are provided. Word processing, communications, and electronic spreadsheet software are standard. The operating system is MS-DOS.

Up to 1 megabyte of internal memory, a color graphics monitor, and an 8087 coprocessor are among the options. The Unisystem-PC begins at $2595. Details are available from International Systems Marketing Inc., Jackson Place South, Suite 6, 932 Hungerford Dr., Rockville, MD 20850, (301) 279-5775.

Circle 708 on inquiry card.

Encore 8- or 16-Bit Performance

Ithaca Intersystems' Encore can be configured as either an 8- or 16-bit system with a variety of storage devices. The 8-bit Z80B Encore runs Digital Research's CP/M or MP/M II operating systems, and the 16-bit Z8000 system is provided with Microsoft Xenix. Standard features include a 10-slot motherboard, modified S-100 circuit boards, and two or more mass-storage units. The storage options offered are 5¼- and 8-inch floppy-disk drives and 5¼-inch hard-disk drives with capacities of up to 31 megabytes. Prices for 8-bit Encores begin at $4995. Complete details are available from Ithaca Intersystems Inc., 200 East Buffalo, POB 91, Ithaca, NY 14851, (607) 273-2500.

Circle 709 on inquiry card.

True Three-dimensional Modeling System

The CS-5 three-dimensional, solid-modeling graphics system has been announced by Cubic Systems. Highlighting the CS-5, which can operate as a terminal or as a stand-alone system, are two 512 by 512 by 16 frame buffers with 4096 displayable colors from a palette of 16.8 million. Standard features include true three-dimensional modeling through the application of orthogonal or perspective projections, slipping, antialiasing, and shaded surfaces with smooth shading and hidden line or surface removal. System functions are accessible through self-contained user-friendly menu structures from the keyboard, high-level language programs, or by remote processor control.

A base price of less than $9000 has been set. For ordering information and details on optional equipment, contact Cubic Systems, 2372 Ellsworth St., Berkeley, CA 94704, (415) 540-5733.

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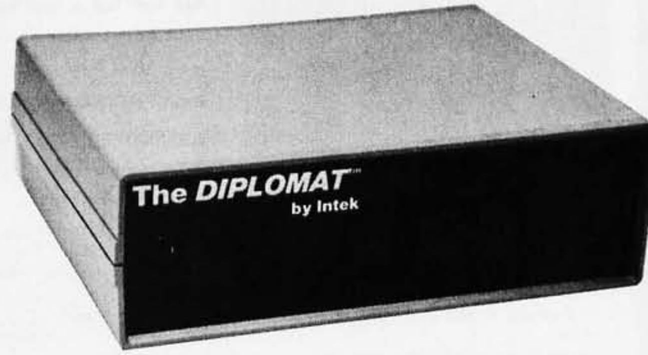
COMMUNICATIONS



Intelligent Communication Controller

Intek's Diplomat is a Z80-based peripheral controller for intelligent communication between microcomputers, peripherals, and printers. A software-controlled switchbox, Diplomat can accommodate a group of devices, regardless of whether serial or parallel, providing that at least one of the units is computer input. Technical features include 16K bytes of RAM, 16 data rates (8 hardware- and 8 software-selectable) from 50 to 19,200 bps, an internal printer driver, automatic bidirectional printing with optimized throughput, sheet-feeder and graphics modes, word-processing features, and RS-232C, Centronics parallel, Qume, and Diablo interfaces. Its switch-selectable protocols are NEC 7710, Diablo 630, IBM PC/Epson, Qume Sprint 5, and Atari. Other specifications include vector plotting, remote diagnostics, reprint of up to 8000 copies, clear error, adjustable tabbing, and an audible alarm.

Options include 64K bytes of memory. Retail prices range from $595 to $895, depending on the amount of memory and desired configuration. Contact Intek, 780 Charcot Ave., San Jose, CA 95131, (408) 946-9041.

Circle 711 on inquiry card.

Interactive Investment Network

ElectroNews Inc. is a computer-accessed interactive news and advisory service. This service produces up-to-the-minute reports on such financial subjects as securities, precious metals, real estate, interest rates, and inflation as well as advice from leading financial and investment experts. Subscribers are able to interact with the system posing questions that help them make personal investment strategies.

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Price-performance leader. Includes Z80A, 8" ds/dd drives, 3 serial + 1 parallel port, winchester port, networking. Prices start below $1500. DEALER / OEM inquiries invited.

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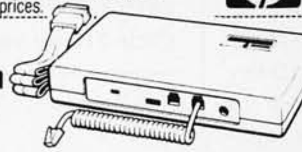
6502A/6512A	8.40	10/ 7.95	50/ 7.35	100/ 6.90
6520 PIA	5.15	10/ 4.90	50/ 4.45	100/ 4.15
6522 VIA	6.45	10/ 6.10	50/ 5.75	100/ 5.45
6532	7.90	10/ 7.40	50/ 7.00	100/ 6.60
2114-L200		2.45	25/ 2.30	100/ 2.15
2716 EPROM		4.90	5/ 4.50	10/ 4.00
2532 EPROM		6.90	5/ 6.75	10/ 6.45
6116 2K×8 CMOS RAM		6.90	5/ 6.75	10/ 6.45
4116 RAM		8 for 14		
Zero Insertion Force 24 pin Socket (Scanbe)				2.00

Hewlett Packard

Write or call for prices.

Anchor Automation Signalman Modems



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All Signalman Modems are Direct Connect, and include cables to connect to your computer and to the telephone. Signalman Modems provide the best price-performance values, and start at less than $100. **Dealer and OEM inquiries invited**

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Mark VI for IBM Personal Computer	(279)	175
Mark VII Auto Dial/Auto Answer	(159)	89
Mark VIII Bell 212 Auto Dial/Answer	(399)	299

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DC Hayes Smartmodem 1200	545

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Apple Emulator for Commodore 64	**89**
Screenmaker 80 COLUMN CARD for C64	**145**
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CARDBOARD/6 Motherboard - VIC	64
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CARDPRINT Printer Interface - C64/VIC	64
CARDBOARD/3s Motherboard - VIC	32
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PETSCAN I — $245 base price

Allows you to connect up to 30 CBM/PET Computers to shared disk drives and printers. Completely transparent to the user. Perfect for schools or multiple word processing configurations. Base configuration supports 2 computers. Additional computer hookups $100 each.

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Intelligent Terminal Package for PET, CBM, C64
Includes ACIA Hardware / STCP Software

VE-2 IEEE to Parallel Interface — 110

Includes case, power supply, full 8-bit transmission, and switch selectable character conversion to ASCII.

VIDEO ENHANCER for Commodore 64 — 89
Realize video quality equal or better than composite monitor using standard color TV.

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Provides big screen capability for business applications.

VIC 20 Products		VIC Sargon II Chess	32
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VIC RAM Cards in stock		Meteor Run (UMI)	39
VIC SuperExpander	52	VIC Radar Ratrace	24
VIC 16K RAM	95	Amok (UMI)	20
Thorn EMI Software		Snakman	15
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Programmers Aid	45	VIC Adventure Series	

VICTORY Software for VIC and C64

Street Sweepers (VIC)	12	Kongo Kong (VIC)	16
Night Rider (VIC)	11	Cosmic Debris (VIC)	12
Annihilator	16	Adventure Pack I	16
Adventure Pack II	16	Metamorphosis	11
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POWER ROM Utilities for PET/CBM	78
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We stock VERBATIM DISKS

Write for Dealer and OEM prices.

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Sentinal 5" ds/dd	10/ 2.55	50/ 2.50	100/ 2.45

We stock Dysan disks

Wabash 5" ss/sd	10/ 1.65	50/ 1.60	100/ 1.55
Wabash 5" ss/dd	10/ 1.95	50/ 1.90	100/ 1.85
Wabash 8" ss/sd	10/ 2.00	50/ 1.95	100/ 1.85

We stock MAXELL DISKS

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Battery back up Uninterruptible Power Supply with surge and noise filtering. The answer to your power problems.

Zenith ZVM-121 Green Phosphor Monitor	98
Zenith new color and monochrome monitors in stock	
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Many printers available (Gemini-Star, Brother, OKI, etc.)	
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ALL BOOK and SOFTWARE PRICES DISCOUNTED

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USI Video Monitors—Green or AMBER 20 MHz hi-res.
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We stock entire Zenith line.

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A B Computers

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Circle 6 on inquiry card.

contact ElectroNews Inc., POB 148, Leesburg, VA 22075, (703) 592-3770.
Circle 712 on inquiry card.

Modem with Processor-Controlled Auto-Dial

Bytcom's Autodial 212AD is a full-featured Bell 212A-compatible modem with a microprocessor-based auto-dial circuit. It provides 0 to 300 bps and 1200 bps full-duplex transmission of data over a switched network. Its nonvolatile memory can store nine 40-digit telephone numbers and names and can be activated by terminal key or computer control. System features include integral voice/data transfer switch; software disconnect; remote boot capabilities; 16-character answer back; redial, linking, and continuous redial until connected; secondary dial-tone detect for PBX dialing; a help menu; and interchangeable Touch-Tone, Pulse, or blind dialing within a stored number sequence to allow pulse-circuit users to dial over MCI and Sprint lines. The terminal interface is RS-232C, and the telephone line interface is RJ11 or RJ45.

The Autodial 212AD modem costs $595. Contact Bytcom, Suite H, 2169 Francisco Blvd., San Rafael, CA 94901, (800) 227-3254; in California, (415) 485-0700.
Circle 713 on inquiry card.

MISCELLANEOUS

Mouse Scampers Across Any Surface

Measurement Systems' Series 122 Mouse for cursor control features optical encoders that operate on any surface. Independently driven X,Y encoders offer low friction and minimal torque requirements, which eases operator control and minimizes the possibility of loose materials interfering with normal operation. Standard counts per inch of motion range from 20 to 200. The Series 122 Mouse is available with quadrature square wave output, scaled pulse output, variable pulse rate, or with coded digital such as RS-232C. Contact Measurement Systems Inc., 121 Water St., Norwalk, CT 06854.
Circle 714 on inquiry card.

Computer Cleaning Aids

A line of computer cleaning products is marketed by Automation Facilities Corporation. The line includes a disk-drive cleaning kit, a compressed-air sprayduster, anti-static sprays, solvents, presaturated cleaning pads, and lint-free wiping materials. For a product catalog, contact Automation Facilities Corp., 3916 State St., Santa Barbara, CA 93105, (805) 687-7040.
Circle 715 on inquiry card.

Microprocessor Handles Keyboard Functions

A single microcomputer controller handles all the functions of the 8000 Series keyboard. This 95-key system offers a standard 53-key typewriter arrangement, a left-hand 10-key function keypad, and 13 numeric keys on the right-hand side. Across its top are 19 special-function keys. All keycaps are nonglare two-shot molded sculptured style. Four versions of the 8000 Series are available, with prices beginning at $170. Contact George Risk Industries Inc., GRI Plaza, Kimball, NE 69145, (308) 235-4645.
Circle 716 on inquiry card.

Card Cage Ready for Projects

The MB6AF-PS6 is an STD bus-compatible modular card-cage assembly from Computer Dynamics. It consists of an integral six-slot motherboard, cage, power supply, and fan. The bottom plate is removable for flat mounting within an enclosure. The connectors feature gold-plated contacts, and the chassis is made of anodized aluminum with nylon card guides spaced at 0.5 inches.

In single units, the MB6AF-PS6 costs $395. Contact Computer Dynamics Inc., 105 South Main St., Greer, SC 29651, (803) 877-7471.
Circle 717 on inquiry card.

Suppressor Responds In Less Than 60 Picoseconds

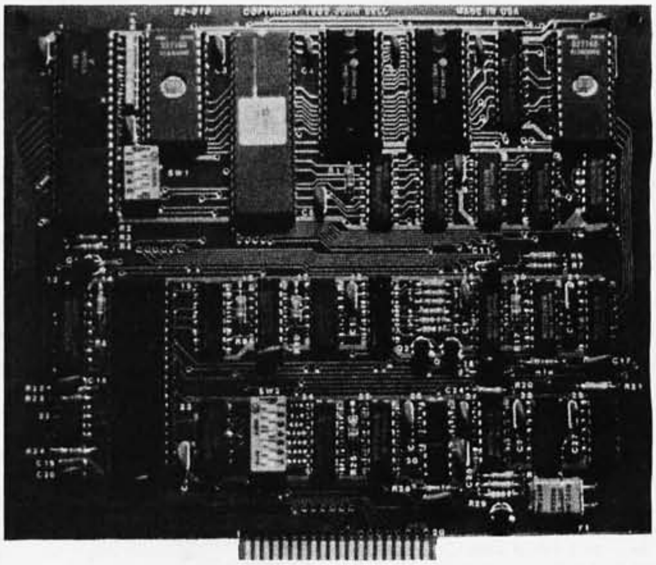
The Power Sentry-2 transient suppressor and line conditioner from Surgeonics responds to voltage transients in less than 60 picoseconds. It comes with a built-in RF filter that's designed to attenuate RF noise and dissipate high-speed, high-energy transients for increased reliability. Key specifications include energy dissipation of more than 1.1 megawatts, 156 V RMS (220 peak) ±10% clamping voltage by means of a two-stage system, and a nominal line voltage of 120 V, single phase at 50 or 60 Hz. Further details are available from Surgeonics Ltd., 155 Kisco Ave., Mount Kisco, NY 10549, (914) 241-3202.
Circle 718 on inquiry card.

Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

VIDEO TERMINAL BOARD 82-018

This is a complete stand alone Video Terminal board. All that is needed besides this board is a parallel ASCII keyboard, standard NTSC monitor, and a power supply. It displays 80 columns by 25 lines of UPPER and lower case characters. Data is transferred by RS232 at rates of 110 baud to 9600 baud — switch selectable. The UART is controlled (parity etc.) by a 5 pos. dip switch.

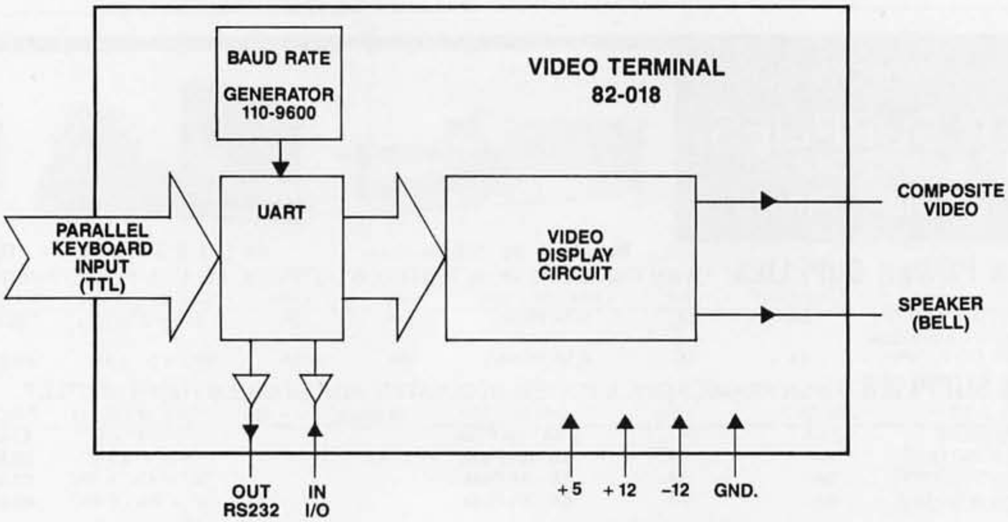


Complete source listing is included in the documentation. Both the character generator and the CRT program are in 2716 EPROMS to allow easy modification to your needs.

This board uses a 6502 Microprocessor and a 6545-1 CRT controller. The 6502 runs during the horz. and vert. blanking (45% of the time). The serial input port is interrupt driven. A 1500 character silo is used to store data until the 6502 can display it.

Features

- **6502 Microprocessor**
- **6545-1 CRT controller**
- **2716 EPROM char. gen.**
- **2716 EPROM program**
- **4K RAM (6116)**
- **2K EPROM 2716**
- **RS232 I/O for direct connection to computer or modem.**
- **80 columns x 25 line display**
- **Size 6.2″ x 7.2″**
- **Output for speaker (bell)**
- **Power +5 700Ma.
+12 50Ma.
–12 50Ma.**



This board is available assembled and tested, or bare board with the two EPROMS and crystal.

Assembled and tested	#82-018A	$199.95
Bare board with EPROMS and crystal	#82-018B	$ 89.95

Both versions come with complete documentation.

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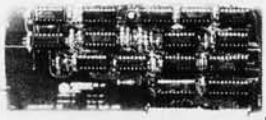
Apple Compatible Products



AFDC-1 Floppy Disk Drive Controller... **$79.95**
Runs DOS 3.3 with any standard Shugart compatible 5¼" Disk Drive. (2 Drives Each Card)

ASCII KEYBOARD A&T............... **$89.00**
Plug in compatible with Apple II, has shiftlock, underscore, [ ] and back slash characters.

Apple Prototype Board.

Double Sided glass with gold plated Apple and General Purpose terminals. Contains matrix of 17 x 63 solder plated donuts on .15" x .1" spacing. Great for 14, 16, and 24 pin IC's.

SUN-722 .... **7.95**
Apprate PROM Blaster **119.00**
"ALS" 80 Column Card **159.00**
"ALS" Z-CARD (Z80 CPU) **149.00**
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General Products

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5¼" Thin DSDD 40 Track................. **310.00**
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General Products- cont.

Video Monitors

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SAMWOO AMBER 9" 18MHz **119.00**
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Assembled Connectors and Cables

Centronics Type Cable Assemblies 36 pin flat cable with male to male or male to female connectors.
4 ft.—**$24.95** 6 ft.—**$27.95**

RS232 Cable Assemblies 25 pin flat cable with male to male or male to female connectors.
5 ft.—**$29.95** 10 ft.—**$35.95**

Assemble Your Own Cables

Cond.	Ribbon Cable Price/ft.	Card Edge Connector Price	IDS Socket Price	Header (w/w) Price
20	$0.50	$2.46	$3.06	$4.24
26	0.65	4.80	3.87	4.68
34	0.83	5.93	6.30	5.25
40	1.00	6.90	7.20	5.95
50	1.30	7.58	7.50	6.20

IDS DB-25P Connector **$5.95**
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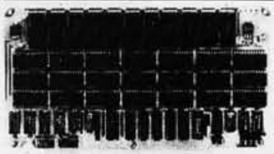
2532 (450nS)	5.95	5.95	4164	Call	Call
2764 (28 pin)	5.95	5.95	Z80A CPU	4.99	4.99

S-100 Products



S-100 MEMORY BOARD

64KSM A&T without RAM.......... **$155.00**
64KSM A&T with 64k RAM (32-6116's) **339.00**
S-100 Board Uses 6MHz 6116's. ½A max. power, Bank Select plus Extended Addressing allow for multi-memory board set-up. 4 independant 16K Blocks make easy use with multi-user systems. Any 2K RAM may be replaced by 2716 EPROM.

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S-100 Prototype Board

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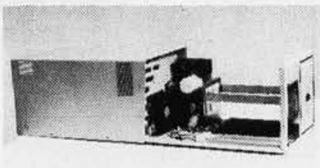
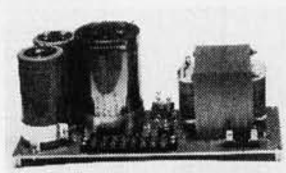
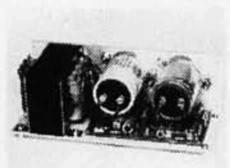


No. 806 & No. 516 Mainframes



Kit 1, 2 & 3 for S-100



R_2, R_3 for 2 Drives (Floppy & Hard)

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ITEM		+5V OVP	−5V	+24V(OR +12V)	+8V	±16V	SIZE W x D x H	PRICE
S_3	12 SLOT & 2 FLOPPY (1 Floppy & 1 Hard Disk)	5A	1A	5-7A PEAK	13A	3A	10" x 6" x 5"	105.95
S_4	6 SLOT & 2 FLOPPY	4A	1A	4-5A PEAK	8A	3A	8⅜" x 5" x 4¾"	95.95

S_3, S_4 for S-100 & 2 Drives

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ITEM	IDEAL FOR	+5V OVP	−5V	+24V (or +12V)	+8V Unreg.	±12V	SIZE W x D x H	PRICE
R_0	2 x 8" SLIMLINE	2.5A		2.5A - 5A Peak			5" x 4" x 4"	51.95
R_1	2 x 8" or 2 x 5¼" DISK	4A	1A	3A - 5A Peak	2A		8" x 4" x 3¾"	56.95
R_2	3 x 8" (or 5¼") FLOPPY	6A	1A	6A - 8A Peak			10" x 4⅞" x 3¾"	71.95
R_3	or 1x Floppy & 1x Hard	6A	1A	6A - 8A Peak		1A	9" x 6¼" x 4⅜"	85.95

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KIT 2	20 CARDS	25A	---	3A	3A	---	12" x 5" x 4⅞"	61.95
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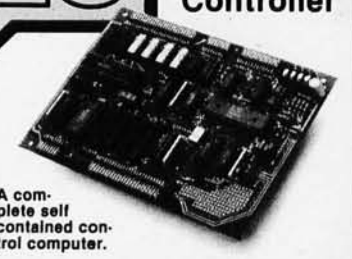

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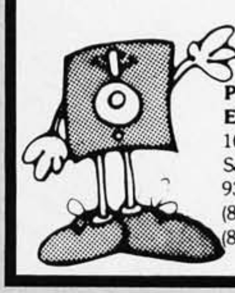

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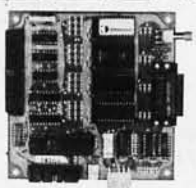

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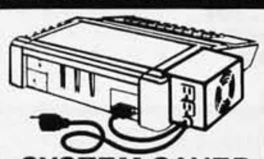

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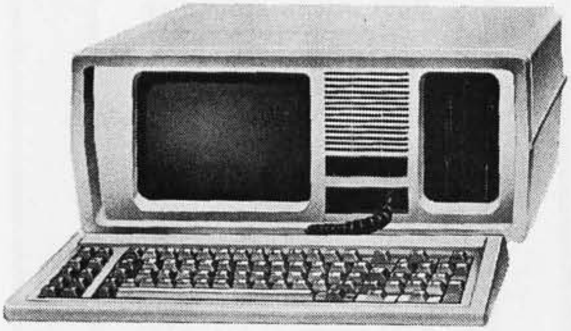

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Designed for large users, complex programmers, and program intensive applications.

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16 Bit • 10 Mmz + • M-Drive/H • I/O mapped on-the-bus terminal • Ultra-fast disk!

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We are the largest in the custom configuration of complete state-of-the-art S-100 systems, at package pricing, with integration, burn-in and programming. We custom build CompuPro systems / hard disk systems for business applications. Call for CompuPro literature, CCT system configuration data and technical information.

COMPUPRO COMPONENTS

LIMITED SPECIALS (A&T): System 816A- $4299 System 816B- $4999 System 816C- $6499 Call for other systems

M-Drive CP/M w/RAM Purch-$49 • Disk 1w/CP/M-$449 • M-Drive/H-512K- $1299
CPU 8085/88-$319 • CPU 8086/87-$579/10Mhz-$659 • CPU 68K-$519/10Mhz-$639 • CPU-Z -$249
Disk 1-$369 • Disk 2-$599 • Disk 2BE-*CALL!* • Disk 3-*SOON!*
RAM 17 (12MHZ)-$359 • RAM 16 (12MHZ)-$399 • RAM 21 (128K)-$849 • RAM 22 (256K)-$1899
Interfacer 1 - $229 • Interfacer 2-$249 • Interfacer 3-5 $439/3-8 $529 • Interfacer 4-$349
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CP/M 80-$99 • CP/M 86-$150 • MP/M 8-16-$769 • CP/M 68K-$279 • Forth 68K-$169

Call for CSC Boards — New Releases — Operating System Mods/Updates

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24 Megabyte hard/floppy

CCT/Fujitsu/Mitsubishi ultra-system: 23 meg. hard disk next to 1.2 meg. 8'' DSDD floppy drive. Includes disk 2 board set, all cabling, A&T, formatting, burn-in. Will stand alone in any CompuPro system.
$3699

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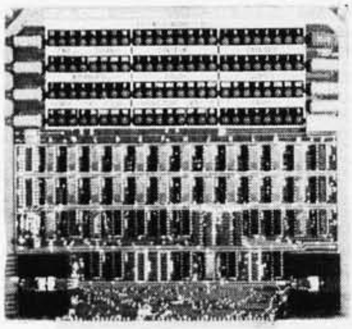
S-100 I/O Boards



The BUS PROBE — Jade

Inexpensive S-100 Diagnostic Analyzer

TSX-200B	*Bare board*	$59.95
TSX-200K	*Kit*	$179.95
TSX-200A	*A & T*	$199.95

I/O-4 — SSM Microcomputer

2 serial I/O ports plus 2 parallel I/O ports

IOI-1010A	*A & T*	$245.00

I/O-5 — SSM Microcomputer

Two serial & 3 parallel ports, 110-19.2K baud

IOI-1015A	*A & T*	$289.00

INTERFACER 4 — CompuPro

3 serial, 1 parallel, 1 Centronics parallel

IOI-1840A	*A & T*	$389.95
IOI-1830C	*CSC*	$495.00

S-100 Memory Boards

64K STATIC RAM - Jade

Uses new 2K x 8 static RAMs, fully supports IEEE 696 24 bit extended addressing, 200ns RAMs, lower 32K or entire board phantomable, 2716 EPROMs may be subbed for RAMs, any 2K segment of upper 8K may be disabled, low power typically less than 500ma.

MEM-99152B	*Bare board*	$49.95
MEM-99152K	*Kit less RAM*	$89.95
MEM-32152K	*32K kit*	$169.00
MEM-56152K	*56K kit*	$225.00
MEM-64152K	*64K kit*	$265.00
Assembled & Tested		add $30.00

EXPANDORAM III

SD Systems new ExpandoRAM III is a high density S-100 memory board utilizing the new 64K x 1 dynamic RAM chips. It allows memory sizes of 64K, 128K or 256K all on a single S-100 board.

MEM-65064A	*64K*	$398.95
MEM-65128A	*128K*	$464.95
MEM-651192A	*192K*	$524.95
MEM-65256A	*256K*	$598.95

S-100 Motherboards

ISO-BUS - Jade

Silent, simple and on sale — a better motherboard

	6 Slot (5¼" x 8⅝")	
MBS-061B	*Bare board*	$22.95
MBS-061K	*Kit*	$39.95
MBS-061A	*A & T*	$49.95
	12 Slot (9¾" x 8⅝")	
MBS-121B	*Bare board*	$34.95
MBS-121K	*Kit*	$69.95
MBS-121A	*A & T*	$89.95
	18 Slot (14½" x 8⅝")	
MBS-181B	*Bare board*	$54.95
MBS-181K	*Kit*	$99.95
MBS-181A	*A & T*	$139.95

S-100 CPU Boards

The BIG Z — Jade

2 or 4 MHz switachable Z-80 CPU board with serial I/O accommodates 2708, 2716, or 2732 EPROM, baud rates from 75 to 9600

CPU-30201B	*Bare board w/manual*	$35.00
CPU-30201K	*Kit w/manual*	$179.00
CPU-30201A	*A & T*	$199.00

SBC-200 - SD Systems

4 MHz Z-80A CPU with serial & parallel I/O, 1K RAM, 8K ROM space, monitor PROM included.

CPU-30200A	*A & T*	$298.95

CPU-Z CompuPro

2 or 4 MHz Z80A CPU, 24 bit addressing

CPU-30500A	*2/4 MHz A & T*	$279.95
CPU-30500C	*3/6 MHz CSC*	$374.95

8085/8088 — CompuPro

Both 8 & 16 bit CPUs, standard 8 bit S-100 bus, up to 8 MHz, accesses 16 Megabytes of memory

CPU-20510A	*6 MHz A T*	$398.95
CPU-20510C	*6/8 MHz CSC*	$497.95

Eprom Erasers

ULTRA-VIOLET EPROM ERASERS

Inexpensive erasers for industry or home.

XME-3100A	*Spectronics w/o timer*	$69.50
XME-3101A	*Spectronics with timer*	$94.95
XME-3200A	*Logical Devices*	$49.95

S-100 Disk Controllers

VERSAFLOPPY II - SD Systems

Double density disk controller for any combination of 5¼" and 8" single or double sided, analog phase-locked loop data seperator, vectored interrupts. CP/M 2.2 & Oasis compatible control/diagnostic software PROM included.

IOD-1160A	*A & T with Prom*	$344.95
SFC-55009047F	*CP/M 3.0 with VF-II*	$128.95

2422 DISK CONTROLLER — C.C.S.

5¼" or 8" double density disk controller with on-board boot loader ROM, free CP/M 2.2 & manual set

IOD-1300A	*A & T with CP/M 2.2*	$338.00

DOUBLE D — Jade

High reliability double density disk controller with on-board Z-80A, auxiliary printer port, IEEE S-100 can function in multi-user interrupt driven bus.

IOD-1200B	*Bare board & hdwr man*	$59.95
IOD-1200K	*Kit w/hdwr & sftwr man*	$299.95
IOD-1200A	*A & T w/hdwr & sftwr man*	$325.00
SFC-59002001F	*CP/M 2.2 with Double D*	$99.95

S-100 Eprom Boards

PROM-100 — SD Systems

2708,2716, 2732 EPROM programmer with software

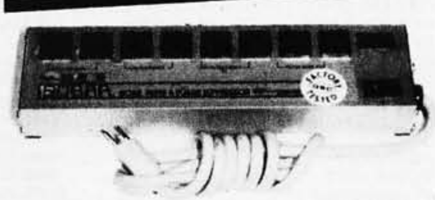
MEM-99520A	*A & T with software*	$248.95

PB-1 — SSM Microcomputer

2708, 2716 EPROM board with on-board programmer

MEM-99510K	*Kit w/manual*	$154.95
MEM-99510A	*A & T w/manual*	$219.00

Surge Protection



ISOBAR

The ISOBAR looks like a standard multi-outlet power strip, but contains surge suppression circuitry and built-in noise filters, plus a 15 amp circuit breaker

EME-115105	*4 receptacle*	$49.95
EME-115100	*8 receptacle*	$69.95

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Computer Products

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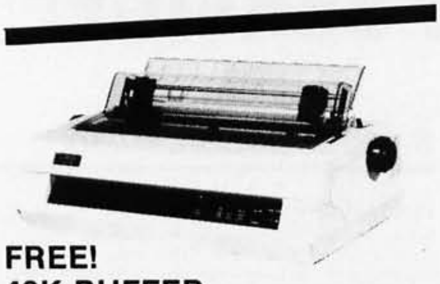

FREE!
48K BUFFER

380Z by D.T.C.

Based on the same quality mechanism as the Comrex printer, the 380Z contains electronic enhancements that allow it to print at speeds up to 32 CPS. Other features include a 48K buffer, proportional spacing, and Diablo 1640/1650/630 compatible protocol. Comes with printwheel, ribbon and users manual. Serial, parallel, and IEEE 488 interfaces standard.

PRD-11300	*380Z printer*	**$1195.00**
PRA-11000	*Tractor option*	**$169.95**
PRA-11200	*Cut sheet feeder*	**$699.95**
Cable	*Please specify*	**$49.95**

LOWEST PRICE! DAISYWHEEL PRINTER - CRII

NEW! from Comrex! Full featured letter quality printer. FREE! 5K buffer. Logic seeking bi-directional printing, boldface, proportional spacing, double-strike, backspace, underlining, true super script and sub script, drop in daisywheel cartridge. The BEST BUY in word processing

PRD-11101	*Comrex CR-II parallel*	**$569.95**
PRD-11102	*Comrex CR-II serial*	**$599.95**
PRA-11100	*Tractor option*	**$119.95**
PRA-11110	*Cut sheet feeder*	**$199.95**

PRINTER PALS — FMJ

Desk top printer stand and paper rack. Fits all printers.

PRA-99080	*10" Printer pal*	**$29.95**
PRA-99100	*15" Printer pal*	**$39.95**
PRA-99700	*for Letter Quality*	**$49.95**

Printers From JADE

OKIDATA 82	*10" 120 cps*	**CALL**
OKIDATA 92	*10" 160 cps with graphics*	**CALL**
OKIDATA 93	*15" 160 cps with graphics*	**CALL**
OKIDATA 83	*15" 120 cps with tractor*	**CALL**
OKIDATA 84	*15" 200 cps with graphics*	**CALL**
OKIDATA 2350	*15" 350 cps*	**CALL**
OKIDATA 2410	*15" 350 cps, two color*	**CALL**
DAISYWRITER 2000	*48K daisywheel*	**$1395.00**
GEMINI 10X	*120 cps 10" with graphics*	**$319.00**
NEW! DELTA 10	*160 cps, full graphics*	**$499.95**
GEMINI 15	*100 cps, 15" with graphics*	**$459.00**
COMREX CR1		**$849.95**
SILVER REED		**$699.95**
STARWRITER F-10		**$1195.00**

NEW! Plug-in ROM Kit To Make OKIDATA 92/93 Fully IBM Compatible

PRA-43086	*For OKIDATA 92*	**$59.95**
PRA-43087	*For OKIDATA 93*	**$59.95**

Compact DAISY WHEEL PRINTER - TTX

The new TTX Daisy wheel printer is compact, versatile and inexpensive—everything you have been waiting for in a letter quality printer

It has a low-profile, contemporary design, and requires 20% to 50% less desk space than most other daisywheel printers. Other features include dual interface (RS232 and centronics parallel), built-in adjustable pinfeed forms guide, and compatibility with Wordstar print control commands, including underline, bold print, super and sub-script, etc

The high quality features and the low price make the TTX a real value leader.

PRD-44010	*TTX 1014*	**$599.95**

Video Monitors

VIDEO MONITOR — Jade

1000 lines ultra-high resolution, 20 MHz ultra-high band width, 9" or 12", Amber or Green phosphor, the finest monitors we sell.

VDM-740920	*9" Green*	**$99.95**
VDM-740910	*9" Amber*	**$129.95**
VDM-751220	*12" Green*	**$129.95**
VDM-751210	*12" Amber*	**$139.95**

12" GREEN SCREEN — Zenith

15MHz, 40 or 80 column

VDM-201201	*12" Green*	**$114.95**

Intelligent Video Terminal

NEW! SMART TERMINAL - TTX

The new TTX 3000 is an intelligent, economical, full-feature terminal designed to be expanded into a full computer. It has more features and is priced lower than similar units from ADDS, LSI, Hazeltime, and Televideo In addition to all the built-in features, there is also space inside the unit for a 6 x 12 inch single board computer, and provisions for mounting two half height 5¼ inch disk drives (and sufficient power supply current to run the add-ins). The detached keyboard features 95 keys, with numeric keypad and 10 function keys. Screen is designed to tilt and swivel for comfortable viewing. Emulate TV 925

VDT-461201	*TTX-3000*	**$469.00**

IBM PC™ Add-ons

QUADLINK Apple emulator for IBM PC

CPX-50500A		**$549.95**

QUADBOARD II 2 serial ports, clock/calendar, memory expansion, and Quadmaster software

MEM-40064A	*Quadboard II, 64K*	**$329.95**
MEX-40256A	*Quadboard II, 256K*	**$499.95**

QUADBOARD parallel port, serial port, clock/calendar, memory expansion, and Quadmaster software

MEX-41064A	*Quadboard, 64K*	**$329.95**
MEX-41256A	*Quadboard, 256K*	**$499.95**

QUAD 512+ up to 512K memory expansion, one serial port, Quadmaster+ software

MEX-42064A	*Quad 512+, 64K*	**$249.95**
MEX-42256A	*Quad 512+, 256K*	**$429.95**
MEX-42512A	*Quad 512+, 512K*	**$649.95**

QUADCHROME High-resolution color monitor for IBM PC

VDC-241301	*Quadchrome RGB*	**$649.95**

DISKETTES Highest quality, certified, double sided, double density, perfect for IBM PC and others

MSM-5220103	*box of 10*	**$29.95**

HAYES 1200B The newest 300/1200 baud modem from Hayes, made to plug into one of PCs expansion slots, complete with software

IOM-5550A	*Hayes 1200B*	**$479.95**

Modems

Smart Buy in MODEMS — Signalman

1200 and/or 300 baud, direct connect, automatic answer or originate selection, auto-answer/auto-dial on deluxe models. 9v battery allows total portability, full one year warranty.

IOM-5600A	*300 baud direct connect*	**$89.95**
IOM-5610A	*300 baud Deluxe*	**$149.95**
IOM-5620A	*1200/300 baud Deluxe*	**$369.95**
IOM-5650A	*300 baud for Osborne*	**$119.95**
IOM-5630A	*300 baud card for IBM*	**$199.95**

SMARTMODEM — Hayes

Sophisticated direct-connect auto-answer/auto-dial modem, touch-tone or pulse dialing. RS-232C interface programmable

IOM-5500A	*Smartmodem 1200*	**$514.00**
IOM-5400A	*Smartmodem 300*	**$229.00**
IOK-1500A	*Hayes Cronograph*	**$199.00**
IOM-1100A	*Micromodem 100*	**$349.00**
IOM-2010A	*Micromodem II*	**$299.00**
IOM-2012A	*Terminal program for MMII*	**$89.95**

1200 BAUD SMART CAT — Novation

103/212 Smart Cat & 103 Smart Cat, 1200 & 300 baud, built-in dialer, auto re-dial if busy, auto answer/disconnect, direct connect, LCD readout displays mode analog/digital loopback self tests, usable with multi-line phones.

IOM-5241A	*300 baud 103 Smart Cat*	**$229.95**
IOM-5251A	*1200 baud 212/103 Smart Cat*	**$549.95**

J-CAT™ MODEM — Novation

1/5 the size of ordinary modems, Bell 103, manual or auto-answer, automatic answer/orginate, direct connect, built-in self-test, two LEDs and audio beeps provide status information.

IOM-5261A	*Novation*	**$149.95**

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7400

**Number of Pins of each I.C. for easy Socket purchase

Part No.	**Pins	Price	Part No.	**Pins	Price	Part No.	**Pins	Price
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SN7401N	14	.19	SN7473N	14	.35	**SN74157N**	**16**	**.59**
SN7402N	14	.25	SN7474N	14	.35	SN74160N	16	.69
SN7403N	14	.25	SN7475N	16	.45	SN74161N	16	.69
SN7404N	14	.25	SN7476N	16	.35	SN74162N	16	.69
SN7405N	14	.25	SN7479N	14	4.95	SN74163N	16	.69
SN7406N	14	.29	SN7480N	14	.69	SN74164N	14	.69
SN7407N	14	.29	SN7482N	14	1.19	SN74165N	16	.69
SN7408N	14	.25	SN7483N	16	.59	SN74166N	16	.89
SN7409N	14	.25	SN7485N	16	.59	SN74167N	16	2.79
SN7410N	14	.25	SN7486N	14	.35	SN74170N	16	1.29
SN7411N	14	.25	SN7489N	16	2.25	SN74172N	24	4.95
SN7412N	14	.35	SN7490N	14	.39	SN74173N	16	.69
SN7413N	14	.35	SN7491N	14	.59	SN74174N	16	.69
SN7414N	14	.49	SN7492N	14	.39	SN74175N	16	.69
SN7416N	14	.25	SN7493N	14	.39	SN74176N	14	.69
SN7417N	14	.25	SN7494N	14	.69	SN74177N	14	.69
SN7420N	14	.19	SN7495N	14	.49	SN74179N	16	1.49
SN7421N	14	.35	SN7496N	16	.49	SN74180N	14	.69
SN7422N	14	.45	SN7497N	16	2.75	SN74181N	24	1.95
SN7423N	16	.59	SN74100N	24	1.49	SN74182N	16	.89
SN7425N	14	.29	SN74104N	14	.89	SN74184N	16	1.95
SN7426N	14	.29	SN74105N	14	.89	SN74185N	16	1.95
SN7427N	14	.25	**SN74107N**	**14**	**.29**	SN74190N	16	.69
SN7428N	14	.49	**SN74109N**	**16**	**.39**	SN74191N	16	.69
SN7430N	14	.25	SN74116N	24	1.49	SN74192N	16	.69
SN7432N	14	.29	SN74121N	14	.39	SN74193N	16	.69
SN7437N	14	.25	SN74122N	14	.55	SN74194N	16	.69
SN7438N	14	.29	SN74123N	16	.49	SN74195N	16	.69
SN7439N	14	.59	SN74125N	14	.45	SN74196N	14	.89
SN7440N	14	.19	SN74126N	14	.45	SN74197N	14	.89
SN7441N	16	.89	SN74132N	14	.49	SN74198N	24	1.19
SN7442N	16	.45	SN74136N	14	.69	SN74199N	24	1.19
SN7443N	16	.99	SN74141N	16	.69	SN74221N	16	1.19
SN7444N	16	.99	SN74142N	16	2.95	SN74251N	16	.79
SN7445N	16	.69	SN74143N	24	2.95	SN74276N	20	1.95
SN7446N	16	.69	SN74144N	24	2.95	SN74279N	16	.79
SN7447N	16	.69	SN74145N	16	.59	SN74283N	16	1.49
SN7448N	16	.69	SN74147N	16	1.49	SN74284N	16	2.95
SN7450N	14	.19	SN74148N	16	1.19	SN74285N	16	2.95
SN7451N	14	.19	SN74150N	24	1.19	SN74365N	16	.55
SN7453N	14	.19	SN74151N	16	.59	SN74366N	16	.55
SN7454N	14	.19	SN74152N	14	.59	SN74367N	16	.55
SN7459A	14	.25	SN74153N	16	.59	SN74368N	16	.55
SN7460N	14	.19	SN74154N	24	1.25	SN74390N	16	1.49
SN7470N	14	.29	SN74155N	16	.59	SN74393N	14	1.49

74LS

74LS00	14	.25	74LS92	14	.55	74LS192	16	.79
74LS01	14	.25	74LS93	14	.55	74LS193	16	.79
74LS02	14	.25	74LS95	14	.79	74LS194	16	.69
74LS03	14	.25	74LS96	16	.89	74LS195	16	.69
74LS04	14	.29	74LS107	14	.39	74LS197	14	.79
74LS05	14	.29	74LS109	16	.39	74LS221	16	.89
74LS08	14	.29	74LS112	16	.39	74LS240	20	1.09
74LS09	14	.29	74LS113	14	.39	74LS241	20	1.09
74LS10	14	.29	74LS114	14	.39	74LS242	14	1.09
74LS11	14	.35	74LS122	14	.49	74LS243	14	1.09
74LS12	14	.35	74LS123	16	.79	74LS244	20	1.09
74LS13	14	.39	74LS125	14	.49	74LS245	20	1.49
74LS14	14	.59	74LS126	14	.49	74LS247	16	1.09
74LS15	14	.35	74LS132	14	.59	74LS248	16	1.09
74LS20	14	.25	74LS133	16	.59	74LS249	16	1.09
74LS21	14	.29	74LS136	14	.39	74LS251	16	.59
74LS22	**14**	**.29**	74LS138	16	.39	74LS253	16	.59
74LS26	14	.29	74LS139	16	.39	74LS257	16	.59
74LS27	14	.29	74LS151	16	.39	74LS258	16	.59
74LS28	14	.35	74LS153	16	.39	74LS260	14	.59
74LS30	14	.25	74LS154	24	.99	74LS266	14	.69
74LS32	14	.35	74LS155	16	.69	74LS273	20	1.49
74LS33	14	.55	74LS156	16	.69	74LS279	16	.49
74LS37	14	.35	74LS157	16	.69	74LS283	16	.69
74LS38	14	.35	74LS158	16	.59	74LS290	14	.89
74LS40	14	.29	74LS160	16	.69	74LS293	14	.79
74LS42	16	.55	74LS161	16	.69	74LS298	16	.89
74LS47	16	.75	74LS162	16	.69	74LS352	16	1.29
74LS48	16	.75	74LS163	16	.69	74LS353	16	1.29
74LS49	16	.75	74LS164	14	.69	74LS365	16	.49
74LS51	14	.25	74LS165	16	1.19	74LS366	16	.49
74LS54	14	.25	74LS166	16	1.19	74LS367	16	.49
74LS55	14	.29	74LS168	16	1.19	74LS368	16	.49
74LS73	14	.39	74LS169	16	1.19	74LS373	20	1.29
74LS74	14	.39	74LS170	16	1.49	74LS374	20	1.29
74LS75	16	.39	74LS173	16	.69	74LS375	16	.69
74LS76	16	.39	74LS174	16	.59	74LS386	14	.45
74LS78	14	.39	74LS175	16	.59	74LS393	14	1.19
74LS83	16	.65	74LS181	24	2.49	74LS399	16	1.49
74LS85	16	.69	74LS190	16	.89	74LS670	16	1.49
74LS86	14	.39	74LS191	16	.89	81LS95	20	1.49
74LS90	14	.55				81LS97	20	1.49

74S/PROMS*

74S00	14	.35	74S124	16	2.95	74S243	14	2.49
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7215EV/Kit*	24	4 Func. Stopwatch Chip, XTL	14.95
7216AIJI	28	8 Digit Univ. Counter C.A.	29.95
7216CIJI	28	8 Digit Freq. Counter C.A.	24.95
7216DIPI	28	8 Digit Freq. Counter C.C.	19.95
7217IJI	28	4 Digit LED Up/Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.	11.95
7224IPL	40	LCD 4½ Digit Up Counter DRI	10.95
7226AIJL	40	8 Digit Univ. Counter	29.95
7226AEV/Kit*	40	5 Function Counter Chip, XTL	74.95

30009 1983 INTERSIL Data Book (1356p.) **$9.95**

NEW PRODUCT! 74HC High Speed CMOS

74HC00	14	.75	74HC139	16	1.49	74HC251	16	1.19
74HC02	14	.75	74HC147	16	1.19	74HC253	16	.99
74HC03	14	.75	74HC151	16	1.19	74HC257	16	1.19
74HC04	14	.69	74HC153	16	.99	74HC259	16	1.49
74HCU04	14	.75	74HC154	24	2.69	74HC266	14	.99
74HC08	14	.75	74HC157	16	1.19	74HC273	20	3.75
74HC10	14	.75	74HC158	16	1.59	74HC280	14	4.95
74HC11	14	.69	74HC160	16	1.79	74HC373	20	3.95
74HC14	14	.85	74HC161	16	1.79	74HC374	20	3.95
74HC20	14	.75	74HC162	16	2.39	74HC390	16	1.49
74HC27	14	.75	74HC163	16	2.39	74HC393	14	1.49
74HC32	14	.75	74HC164	14	1.79	74HC533	20	3.95
74HC42	16	1.39	74HC165	16	2.39	74HC534	20	3.95
74HC51	14	.75	74HC173	16	1.59	74HC595		3.75
74HC58	14	.75	74HC174	16	1.39	74HC688		3.19
74HC73	14	.75	74HC175	16	1.39	74HC4002	14	.79
74HC74	14	.99	74HC192	16	1.39	74HC4017	16	2.19
74HC75	16	.99	74HC193	16	1.39	74HC4020	16	2.19
74HC76	16	.75	74HC194	16	1.59	74HC4024	14	1.59
74HC85	16	2.19	74HC195	16	1.49	74HC4040	16	2.19
74HC86	14	.99	74HC237	16	2.95	74HC4060	16	2.19
74HC107	14	.75	74HC240	20	2.75	74HC4075	14	.75
74HC109	16	1.39	74HC241	20	3.75	74HC4078	14	.69
74HC112	16	.75	74HC242	14	2.79	74HC4511	16	3.29
74HC113	14	.75	74HC243	14	2.79	74HC4514	24	4.79
74HC132	14	.89	74HC244	20	3.75	74HC4538	16	2.95
74HC137	16	2.95				74HC4543	16	4.95
74HC138	16	1.49						

74HCU04 is unbuffered. All others are buffered

NEW Programmable Array Logic (PALS)

Part No.	**Pins	Function	Price
PAL10H8	20	Octal 10-Input AND-OR Gate Array (High Output)	$5.95
PAL12H6	20	Hex 12-Input AND-OR Gate Array (High Output)	5.95
PAL14H4	20	Quad 14-Input AND-OR Gate Array (High Output)	5.95
PAL10L8	20	Octal 10-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL12L6	20	Hex 12-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL14L4	20	Quad 14-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL16L8	20	Octal 16-Input AND-OR-Invert Gate Array (Low Output)	9.95
PAL16R8	20	Octal 16-Input Register AND-OR Gate Array	9.95
PAL16R6	20	Hex 16-Input Register AND-OR Gate Array	9.95
PAL16R4	20	Quad 16-Input Register AND-OR Gate Array	9.95

30012 1982 NATIONAL PAL Data Book (176p.) .. **$5.95**

74C—C/MOS

74C00	14	.35	74C95	14	1.39	74C221	16	1.95
74C02	14	.35	74C107	14	.89	74C240	20	1.95
74C04	14	.29	74C151	16	2.49	74C244	20	1.95
74C08	14	.35	74C154	24	3.49	74C373	20	2.49
74C10	14	.35	74C157	16	2.25	74C374	20	2.49
74C14	14	.59	74C160	16	1.19	74C901	14	.59
74C20	14	.35	74C161	16	1.19	74C903	14	.59
74C30	14	.35	74C162	16	1.19	74C906	14	.59
74C32	14	.39	74C163	16	1.19	74C911	28	8.95
74C42	16	1.39	74C164	14	1.49	74C912	28	8.95
74C48	16	1.95	74C173	16	.79	74C915	18	1.19
74C73	14	.79	74C174	16	1.19	74C917	28	8.95
74C74	14	.69	74C175	16	1.19	74C922	18	4.49
74C85	16	1.95	74C192	16	1.49	74C923	20	4.95
74C86	14	.39	74C193	16	1.69	74C925	16	5.95
74C89	16	5.95	74C195	16	1.39	74C926	18	5.95
74C90	14	1.19				80C95	16	.39
74C93	14	1.19				80C97	16	.39

LINEAR

TL071CP	8	.79	LM340T-5		.79	LM709N	14	.49
TL072CP	8	1.39	LM340T-12		.79	LM710N	14	.69
TL074CN	14	1.95	LM340T-15		.79	LM711N	14	.79
TL081CP	8	.59	LM348N	14	.99	LM723N	14	.55
TL082CP	8	1.19	LM350K		4.95	LM733N	14	1.00
TL084CN	14	1.95	LF355N	8	1.10	LM739N	14	1.95
LM301CN	8	.35	LF356N	8	1.10	LM741CN	8	.35
LM302H		1.95	LM370N	14	4.49	LM747N	14	.69
LM304H		1.95	LM373N	14	3.95	LM748N	8	.59
LM305H		.99	LM377N	14	1.95	LM1310N	14	1.49
LM307CN	8	.45	LM380N	14	.89	LM1458CN	8	.59
LM308CN	8	.69	LM381N	14	1.79	LM1488N	14	.69
LM309K		1.25	LM382N	14	1.39	LM1489N	14	.69
LM310CN	8	1.75	LM384N	14	1.79	LM1496N	14	1.95
LM311CN	8	.69	LM386N-3	8	.89	LM1800N	16	1.49
LM312H		2.49	TL494CN	16	2.95	LM1889N	18	1.95
LM317T		1.19	TL496CP	8	1.19	LM1896N	14	2.95
LM317K		3.95	NE510A	14	4.95	LM2002T		1.49
LM318CN	8	1.95	NE529A	14	2.95	LM3189N	16	1.59
LM319N	14	1.95	NE531V	8	2.95	LM3900N	14	.59
LM320K-5		1.35	NE536H		8.95	LM3905CN	8	1.19
LM320K-12		1.35	NE540H		4.95	LM3909N	8	.99
LM320K-15		1.35	NE544N	14	2.95	LM3914N	18	3.49
LM320T-5		.89	NE550A	14	1.95	LM3915N	18	3.49
LM320T-12		.89	NE555V	8	.35	LM3916N	18	3.49
LM320T-15		.89	LM556N	14	.69	**RC4136N**	**14**	**1.25**
LM323K		5.95	LM565N	14	1.19	RC4151NB	8	1.95
LM324N	14	.59	LM566CN	8	1.49	NE5532	8	2.49
LM337T		1.95	LM567V	8	.89	NE5534	8	1.69
LM338K		6.95	NE570N	16	3.95	ICL8038B	14	3.95
LM339N	14	.69	LM703CN	8	1.19	LM13080N	8	1.19
LM340K-5		1.35				LM13600N	16	1.19
LM340K-12		1.35						
LM340K-15		1.35						

MORE AVAILABLE

30003 1982 Nat. Linear Data Book (1952 pgs.) . **$11.95**

Circle 239 on inquiry card.

COMPUTER-PERIPHERAL SWITCHERS

Connect any number of peripherals to a single I/O port — use a single printer to support several microcomputers — use two or more printers to support a single microcomputer — access a modem from any of several microcomputers — Ideal for demonstrating or comparing equipment. The Selecto-Switches are designed to eliminate the unnecessary plugging & unplugging of cables which connect printers, terminals, or modems to various computers. By using a Selecto-Switch, you achieve more efficient system operation, better utilization of peripherals & computer ports, eliminate redundant hardware & reduce service calls. 5 yr. limited warranty on all Selecto-Switches. No power required. Size (inches): 10L x 7W x 3H. 2½ lbs.

RS232 SERIAL SELECTO-SWITCH

• Switches all lines of asynchronous data • Easy expansion of serial ports • Connectors are female DB25 type

PART NO.	DESCRIPTION	PRICE
GRS232-AB	2-Way Switch	$139.95
GRS232-ABC	3-Way Switch	$179.95

DB25 PARALLEL SELECTO-SWITCH

• TRS-80, Apple, and IBM compatible • Switches 24 lines (line 1 is ground) • Connectors are female DB25 type

PART NO.	DESCRIPTION	PRICE
GP24-AB	2-Way Switch	$139.95
GP24-ABC	3-Way Switch	$179.95

CENTRONICS-STYLE SELECTO-SWITCH

• Switches all 36 lines • Connectors are female Centronics

PART NO.	DESCRIPTION	PRICE
GCENT-AB	2-Way Switch	$199.95
GCENT-ABC	3-Way Switch	$229.95

Micro-Logic Corp. MICRO-CHARTS

• Fully decoded data • Instant access • 2-sided, totally comprehensive • Compact 8½ x 11 in. durable credit card plastic • Perfect for programmers & engineers • Clear & concise tables for: full instruction set, disassembly, ASCII, base conversion, effect of flags, compare vs. jump, interrupt structure, pinout, cycle times, diagrams, bug notes, & much more...

PART NO.	REFERENCE	PRICE
ML-Z80	Z80 CPU	$5.95
ML-8080A	8080A/8085A	$5.95
ML-6502	6502 (65XX)	$5.95
ML-8048	8048, Relatives, Algorithms	$5.95
ML-7400	5400/7400 TTL	$5.95

BOOKS

30001 **National CMOS Data Book (1981)** $6.95
(640 pages) 74C, CD4000, and A/D Converters

30003 **National Linear Data Book (1982)** $11.95
(1376 pages) LM, LF, ADC, DAC, LH Series

30008 **National Memory Data Book (1980)** $6.95
(464 pages) RAMs, ROMs, PROMs, EPROMs Series

30009 **Intersil Data Book (1983)** $9.95
(1356 pages) Complete line.

30010 **National Audio/Radio Handbook (1980)** $5.95
(240 pages) Pre-Amps, AM, FM & FM Stereo, Power Amps

30011 **National Linear Application Handbook (1980)** $15.95
(736 pages) Application Notes, Linear Briefs, etc.

30012 **National PAL Data Book (1982)** $5.95
(176 pages) Application Notes, Linear Briefs, etc.

30013 **Zilog Data Book (1983)** $7.95
(641 pages) Microprocessors and Support Chips

210830 **Intel Memory Components Handbook (1983)** $14.95
(798 pages) Contains all Application Notes, Article Reprints, Data Sheets, and other design information on Intel's RAMs, EPROMs, E²PROMs & Bubble Memories.

210844 **Intel Microprocessor & Peripheral Handbook (1983)** ... $14.95
(1027 pages) Contains Data Sheets on all of Intel's Microprocessors and Peripherals.

ATARI

ATARI PADDLES

JSP (2) .... $2.95 pair

ATARI DRIVER

JSD (1) .... $2.95 ea.

TV GAME SWITCH

Used on Atari. Cosmetically blemished. 100% functional.

TGS-1 ... $1.95 ea.

Jameco Electronics Digital Thermometer Kit

Dual sensors — switch controls for indoor/outdoor or dual monitoring — can be extended to 500 feet. Continuous LED .8" ht. display. Range: -40°F to 199°F, -40°C to 100°C. Accuracy ±1° nominal. Calibrate for Fahrenheit/Celsius. Simulated walnut case. AC wall adapter included. Size: 6⅞"L x 3⅞"H x 1⅞"D.

JE300 ...... $39.95

Universal Computer Keyboard Enclosures

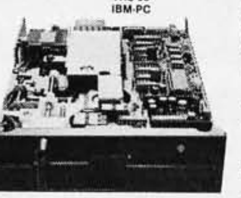
"DTE" Blank Desk-Top Enclosures are designed for easy modification. High strength epoxy molded end pieces in mocha brown finish. Sliding rear/bottom panel for service/component access. Top/bott. panels .080" thick alum. alodine type 1200 finish (gold tint color) for best paint adhesion after modification. Vented top & bottom panels for cooling efficiency. Rigid construction provides unlimited applications. Assembly instructions included.

DTE-8	Panel Width 7.5"	$24.95
DTE-11	Panel Width 10.13"	$27.95
DTE-14	Panel Width 13.5"	$29.95
DTE-20	Panel Width 19.25"	$34.95

5¼" HALF-HEIGHT DISK DRIVES

FIT TWO DRIVES IN THE SAME SPACE AS ONE CONVENTIONAL 5¼" DRIVE

TEAC FD55A — COMPATIBLE WITH TRS-80, IBM-PC — SHUGART SA455



Shugart SA455

TEAC FD55A — SINGLE-SIDED:
- 48 tpi
- 40 Tracks
- 250Kbytes single-sided
- Single/double density
- Brushless DC direct-drive motor
- Low 5W power consumption
- Power req.: +12VDC @ .3A, +5VDC @ .55A
- 6 msec. track to track
- One year warranty
- Size: 5¾"W × 1⅝"H × 8"D
- Weight: 3 lbs. 5 oz.

FD55A $249.95

SHUGART SA455 — DOUBLE-SIDED:
- 48 tpi
- 40 Tracks
- 500Kbytes double-sided
- Single/double density
- Brushless DC direct-drive motor
- Power req.: +12VDC @ .75A, +5VDC @ .7A
- 6 msec. track to track
- Compatible with SA400/450
- One year warranty
- Size: 5.75"W × 1.63"H × 8"D
- Weight: 3.3 lbs.

SA455 .... $259.95

Keyboard Mask for Your ZX81/1000* Computer

BRAND NEW!!

FEATURES:
- Install in seconds. Remove adhesive backing from mask and place over keyboard.
- All characters and symbols reproduced on mask.
- Durable — formed with polycarbonite sheet-satin finish.

JE681 KEYBOARD MASK

The JE681 Keyboard Mask provides users of the ZX81/1000 series computer the individual feel of each keypad on the keyboard. The mask has a raised outline around each keypad allowing the user to feel and correctly position their fingers onto the keyboard.

JE681 KEYBOARD MASK ...... $9.95 each

Jameco Electronics ZX81/1000* Keyboard Conversion Kit

JE682-AK KEYBOARD KIT MOUNTED IN DTE-AK ENCLOSURE. LIGHT TAN PANELS WITH MOLDED DARK BROWN END PIECES. SIZE: 14¼"W x 3½"D x 3½"H

The JE682 Kit provides users of the ZX81/1000 series computers a full-size industrial keyboard hook-up to their computer. The JE682 Kit allows the use of either the full size keyboard or the Sinclair/Timex Keyboard. The Kit also permits the simple disconnection of the Sinclair/Timex Keyboard for portable use. The JE682 Kit consists of a full-size industrial grade keyboard with 62 keys, 2 p.c. boards, 24" ribbon cable, DIP socket and 4 rubber feet. The keyboard conversion kit can easily be mounted into the DTE-AK enclosure. This enclosure is large enough to contain the ZX81/1000 computer and the full-size keyboard together. A handy label representing the ZX81/1000 keyboard layout is placed on the enclosure.

JE682-AK Keyboard Conversion Kit ...... $99.95 ea.
(WITH DTE-AK CASE - AS PICTURED)

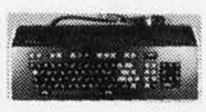
JE682 Keyboard Conversion Kit .... $59.95 ea.
(WITHOUT DTE-AK CASE)

*ZX81/1000 is a trademark of Sinclair/Timex

80-Key Keyboard

CA150C $69.95

95-Key Keyboard



CA154A $79.95

CONTROL DATA KEYBOARDS

Limited Quantities!

- ★ 7-bit Parallel ASCII
- ★ SPST Switching
- ★ FTZ Shielded Base
- ★ N-Key Rollover
- ★ 128 Character ASCII
- ★ Non-Slip, Non-Glare Keycaps
- ★ CDC752 Terminal Keyboards
- ★ Attractive Case

These Control Data Keyboards consist of a base, cover, the keyboard assembly, and an interface cable. Color (case): Harvest gold and black. Color (keycaps): Black, blue, and red. Electrical requirements: +5V @ 600mA, -12V @ 50mA. Size: 21½"W × 9"D × 3½"H. Weight: 6 lbs. All units brand new in original boxes, specifications included.

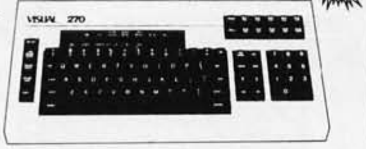
Keytronics 90-Key Soft-Programmable Keyboard

WITH SECURITY KEYLOCK SWITCH

350 Available!

BRAND NEW!!

- RFI shielded
- Cursor controls
- Numeric keyboard
- 8-bit Parallel
- Solid state switches
- 10 user-programmable keys
- Positive TTL Logic
- Size: 17"L × 8¼"W × 2¾"H



Made for Visual Technology, this keyboard features: a security keylock (includes two keys) to guard against unauthorized use; an 11-key numeric keypad; cursor controls; and 10 user-programmable keys. Electrical requirements: +5VDC. Color (case): White. Color (keycaps): Black. Complete with case, keyboard assembly, 40-inch interface cable, and schematics. Weight: 7 lbs.

Part No. KB270 .... $79.95 each

23"L x 5¾"W x 1-3/8"H

MICRO SWITCH 85-KEY KEYBOARD
Word Processing Keyboard, 26 Pin Edge Card Connection. Supply Voltage +5VDC. Main Keyboard is QWERTY. Additional Key Pads for Cursor and word processing functions.
Part No. 85SD18-1 .... $29.95 each

3"L x 3"W x 1½"H

HI-TEK 14-KEY NUMERIC KEYPAD
SPST switching. Charcoal grey keycaps. Mounted on printed circuit board.
Part No. K-14 .... $9.95 each

POWER SUPPLY +5VDC @ 1 AMP REGULATED — *Transaction Tech*
Output +5VDC @ 1A (also +30VDC) reg. Input 115VAC 60Hz. 2-tone (black/beige) self-enclosed case. 6 ft., 3 cond. black power cord. 6½"W x 7"D x 2¾"H. Wt. 3 lbs. Data sheet incl.
Part No. PS51194S .... $14.95 each

POWER SUPPLY +5VDC @ 3 AMP REGULATED — *Deltron*
Input: 115VAC, 47-440Hz. Output: 5VDC Adjustable @ 3 amp, 6VDC @ 2.5 amp. Adjustable current limit, Ripple & Noise: 1MV rms, 5MV p-p — 2 mounting surfaces. UL recognized. Size: 4"W x 4½"L x 2-7/16"H - wt. 2 lbs. Data sheet included.
Part No. OPS-1 .... $29.95 each

POWER SUPPLY +5VDC @ 7.5 AMP, 12VDC @ 1.5 AMP SWITCHING
Input: 115VAC, 50-60Hz @ 3 amp/230VAC, 50Hz @ 1.6 amp. Fan volt./power supply select switches (115/230VAC). Output: 5VDC @ 7.5 amp, 12VDC @ 1.6 amp. 8 ft. blk. pow. cord. 11½"W x 13¼"D x 3¾"H. Wt. 6 lbs.
Part No. PS94VOS .... $39.95 each

POWER SUPPLY 4-Channel Switching - Apple Compatible
FOR USE AS AN EXTERNAL POWER SUPPLY FOR APPLE
Microprocessor, mini-computer, terminal, medical equipment and process control applications. Input: 90-130VAC 47-440Hz. Output: +5VDC @ 5A, -5VDC @ 1A; +12VDC @ 1A, -12VDC @ 1A. Line reg.: ±0.2%. Ripple: 30mV p-p. Load reg.: ±1%. Overcurrent protection. Adj: 5V main output ±10%. 6-3/8"L x 1-7/8"W x 4-15/16"H. Wt. 1½ lbs.
Part No. FCS-604A .... $69.95 each

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6½% Sales Tax
Shipping — Add 5% plus $1.50 Insurance
Send S.A.S.E. for Monthly Sales Flyer!

Spec Sheets — 30¢ each
Send $1.00 Postage for your
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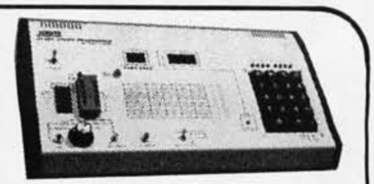


JE664 EPROM PROGRAMMER

8K TO 64K EPROMS — 24 AND 28 PIN PACKAGES

— PROGRAMS 2716's IN 16 SECONDS —
— PROGRAMS 2764's IN 64 SECONDS —

• Programs, validates, and checks for properly erased EPROMs • Emulates PROMs or EPROMs • RS232C Computer Interface for editing / program loading • Loads data into RAM by keyboard • Changes data in RAM by keyboard • Loads RAM from an EPROM • Compares EPROMs for content differences • Copies EPROMs • Power Input: 115VAC, 60Hz., < 10W power consumption • Enclosure: Color-coordinated, light tan panels w/molded mocha brown end pieces • Size: 15-5/8"L × 8¾"D × 3½"H • Weight: 5¾ lbs.

JE664-A EPROM Programmer $995.00
Assembled & Tested (Includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The JE665 RS232C Interface Option implements computer access to the JE664's RAM. Sample software written in BASIC provided for TRS-80® Model I, Level II Computer. Baud rate: 9600. Word lgth: 8 bits - odd parity. Stop bits: 2. Option may be adapted to other computers. The JE665 can be interfaced to any computer with an RS232 port. Information is also provided for interfacing to any CP/M system with an RS232 port.

JE664-ARS EPROM Prog. w/JE665 Option $1195.00
Assembled and Tested (Includes JM16A Module)

EPROM JUMPER MODULES — The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets JE664 for proper programming pulses to the EPROM & configures EPROM socket connections for that particular EPROM.

P/N	EPROM	EPROM MANUFACTURER	PRICE
JM08A	2708	AMD, Motorola, National, Intel, TI	$14.95
JM16A	2716, TMS2516	Intel, Motorola, National, NEC, TI	$14.95
JM16B	TMS2716	Motorola, TI (+5, -12, +12)	$14.95
JM32A	TMS2532	Motorola, TI	$14.95
JM32B	2732	AMD, Fujitsu, NEC, Hitachi, Intel	$14.95
JM32C	2732A (21V)	Fujitsu, Intel	$14.95
JM64A	MCM68764, MCM68L764	Motorola	$14.95
JM64B	2764	Intel	$14.95
JM64C	TMS2564	TI	$14.95
JM64D	HN482764G-4	Hitachi (21V)	$14.95

iii's Black Hole EPROM Eraser

9 Chips — 8 Minutes

The Black Hole EPROM Eraser will completely and safely erase 9 EPROMs in less than 8 minutes. The Black Hole is a fully automatic cassette loading eraser featuring U-shaped 4000 hr. UV lamps mounted in a special ALZAK (UV reflectivity of .9) parabolic light tunnel. In operation, the user slips in an anti-static Bug Box (3 ea. incl.) containing the EPROMs to be erased into the loading slot on the front panel of Black Hole. The rest is fully automatic. The Black Hole latches the Bug Box into place, turns on the UV lamps and starts its fully solid state (CMOS) UV integration dose timer. The percentage erasure time is monitored and displayed on a front panel LED readout. At the end of the erase cycle, the Black Hole ejects the Bug Box containing the 9 erased EPROMs and turns off power.

PART NO.		PRICE
ULV-008	Replacement Lamp for ERS-008	$29.95
ERS-008	Eraser, Auto Eject & LED Readout	$249.95

IBM MEMORY EXPANSION KIT

SAVE HUNDREDS OF $$$ BY UPGRADING MEMORY BOARDS YOURSELF!

Most of the popular memory boards allow you to add an additional 64K, 128K, 192K, or 256K. The IBM64K Kit will populate these boards in 64K byte increments. The kit is simple to install — just insert the nine 64K RAM chips in the provided sockets and set the two groups of switches. Directions are included.

IBM64K (Nine 200ns 64K RAMs) $59.95

EXPAND YOUR MEMORY

TRS-80 to 16K, 32K, or 48K

**Model 1 = From 4K to 16K Requires (1) One Kit
Model 3 = From 4K to 48K Requires (3) Three Kits
Color = From 4K to 16K Requires (1) One Kit

**Model 1 equipped with Expansion Board up to 48K Two Kits Required — One Kit Required for each 16K of Expansion —

TRS-16K3 *200ns	for Color & Model III	$12.95
TRS-16K4 *250ns	for Model I	$10.95

TRS-80 Color 32K or 64K Conversion Kit

Easy to install kit comes complete with 8 ea. 4164-2 (200ns) 64K dynamic RAMs & conversion documentation. Converts TRS-80 color computers with E circuit boards, & all new color computers to 32K. Minor modifications of 32K memory will allow the use of all the 64K of the dynamic RAM providing you have a FLEX DOS operating system.

TRS-64K2 .... $54.95

5¼" Mini-Floppy Disk Drive

Pertec Computer Corp.

FOR TRS-80 MODEL I - COLOR COMPUTER

Features single or double density. Recording mode: FM single, MFM double density. Seek time: 25msec. track to track. Power: +12VDC (±0.6V) 1.6A max., +5VDC (±0.25V) 0.8A max. Unit as pic. at right does not incl. case, power supply, cables). 30-pg. data book incl. Wt. 3½ lbs. Size: 5¾"W x 8"D x 3¼"H.

Part No. — *Limited Quantity!* — Price

FD200 .... $179.95
Single-sided, 40 tracks, 250K bytes capacity

FD250 .... $199.95
Double-sided, 35 tracks, 438K bytes capacity

8" FLOPPY DISK DRIVE

Siemens

- Shugart 801R compatible
- Single-Sided
- 77 Tracks
- 400/800K Bytes Capacity
- Industry Standard

The FDD100-8 8" Floppy Disk Drive (Industry Standard) features single or double density. Recording mode: FM single, MFM double density. Transfer rate: 250K bits/sec. single density; 500K bits/sec. double density. The FDD100-8 is designed to work with the single-sided soft sectored IBM Diskette I, or eq. disk cartridge. Power: 115VAC @ 50-60Hz., +24VDC @ 1.7 amps max., +5VDC @ 1.2 amps max. Unit as pictured above (does not include case, power supply, or cables). Size: 8.55"W x 14"L x 4.5"H. Weighs 12 lbs. Incl. 96-pg. manual.

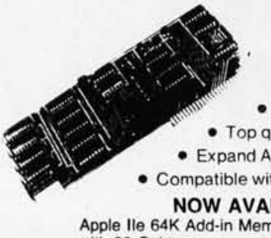
Part No. — Price

FDD100-8 .. $169.95 ea.

ADVANCED COMPUTER PRODUCTS

SEND $2.00 for 1983 CATALOG

16K Apple™ Ramcard



LIST 195
ACP
$59^95

- Full 1 year warranty
- Top quality — gold fingers
- Expand Apple II 48K to 64K
- Compatible with Z-80 Softcard™

NOW AVAILABLE
Apple IIe 64K Add-in Memory with 80 Columns $149^95

32K STATIC RAM

2 or 4 MHz Expandable Uses 2114L's

16K 4 MHz Kit	$159.95
16K 4 MHz A&T	217.95
32K 4 MHz Kit	~~289.95~~ $129.95
32K 4 MHz A&T	339.00
BARE BOARD	39.95
Bare Bd w/all parts less mem.	99.95

64K CMOS RAMCARD

IEEE Compatible
Uses Low Power 6116 IC's
$269^00
5Volt Single Supply
Assm and Tested

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58 Key Unencoded Keyboard

$19^95 ea.

This is a new 58 key terminal Keyboard manufactured by a major manufacturer. It is uncoded with SPST keys unattached to any PC board. Solid molded plastic 11" x 4" base.

INTEL 4K STATIC RAMS

Super Fast! Super Low Power!
Part No. 2147 ...... $1.95 ea.

Unencoded Key Pad

15 key Keypad with 1-10 keys and tab, return, (-), () and ().
Only $9^95 ea.

STEPPER MOTOR

Operates by applying 12VDC in one direction and then reversing polarity (or square wave). Uses 12VDC, Clock Wise Rotation, Rated 3 RPM at 4 P.P.S. with a 5 degree stepping angle.

ACP PRICE $3^95 ea. 10 for $34.95

UV "EPROM" ERASER

Model DE-4
$89.95
Holds 4 EPROM's at a time
Model S-52T $325.00

RS232 SIGNAL TESTER

COEX RS232 Line Tester
(7) LED Indicators
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Other Styles Also Available

16K Memory Expansion Kits for Apple/TRS-80

8 pcs 4116 16K 200/250nS
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For Filter P/N 2912A $4.95 ea.

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6 amps $4^95
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15 Amps 250 Volts transient suppression
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9 pcs 4164 D-RAM

$50^00

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DB25S Female	3.75
Hood	1.25
Set with Hood, Sale	7.50
22/44 S/T, KIM	2.95
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50/100 S-100 Connector W/W	4.95
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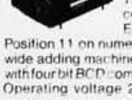
AMD MODEM IC

P/N AM7910
1200Baud
5 Volts
Special ACP Price $99^00

PARALLEL ALPHA NUMERIC PRINTER



19 Column Printer prints 16 numerical columns plus 3 columns which have math, alpha and other notations. Each wheel has 12 positions with position 12 blank. Position 11 on numerical columns have decimal point or #. Utilizes 2.75" wide adding machine tape and a dual color ink ribbon. Input data parallel with four bit BCD comparator circuit. Print rate, 3 lines per second. Operating voltage 22-28VDC with typical cycle time of 140mS. Size 6½"W x 3¾"H x 5¾"Dp. New. $8.95 ea. 3/$25

MICROPROCESSORS

Z8001	$99.00	8008-1	$14.95	6802P	14.95
Z8002	69.00	2901	9.90	8035	14.95
Z80	9.95	2901A	14.95	8039	12.95
Z80A	11.95	9900JL	49.95	8073N	34.95
F-8 (3850)	16.95	6502	9.95	8755	49.95
2650	16.95	6502A	16.95	8748	49.95
1802	9.75	IM6100	29.95	6809	30.00
8080A	4.75	6800	11.75	8086	49.95
8085	14.95	6800B	19.95	68000	129.95

RAMS

CALL FOR QTY PRICING

6116/2016	$7.95	2147	$5.99	5290	$1.99
8264-64K	5.95	411	5.99	5298	1.49
4116-2	1.99	414	4.69	6508	4.50
4116-2	8/12.95	1101	.99	6518	6.79
2101	3.99	1103	.99	6561	3.79
2102	.79	4027	4.69	6604	3.99
21L02-2	1.49	4044	3.99	6605	7.99
21L02-4	1.29	4050	4.69	9130	8.99
2111	3.49	4060	4.69	9140	8.99
2112	3.49	4096	3.99	93415	6.99
2114	1.99	4115	1.49	93425	6.99
2114L-2	3.25	4200	7.95		
2114L-4	2.29	4402	1.99		
2125	6.99	5280	4.60		

64K only $5.95

SUPPORT

8155	$9.95	8259	$8.95	68047	$22.95
8156	9.95	8275	19.95	68488	19.95
8202	29.95	8279	9.50	46505	22.95
8205	2.69	6810	4.75	6520	6.95
8212	2.75	6820	6.50	6522	9.95
8214	4.95	6821	6.50	6530-X	24.95
8216	2.75	6828	10.50	6532	17.95
8224	2.95	6834	16.95	6551	19.95
8226	2.95	6845	22.95	Z80-PIO	6.50
8228	3.95	6847	27.95	Z80A-PIO	9.50
8243	9.50	6850	5.25	Z80-CTC	6.50
8250	14.95	6852	5.25	Z80A-CTC	9.50
8251	6.50	6860	10.95	Z80-DMA	19.95
8253	11.95	6862	10.95	Z80A-DMA	27.95
8255	4.50	6875	5.95	Z80-SIO	24.95
8257	9.50	6880	2.49	Z80A-SIO	29.95

MOS PROMS

2764 (8Kx8) TS	$69.95	2708 (450nS)	$5.75
2732 (4Kx8) TS	12.95	2708 (650nS)	5.25
2716/2516 5V (2Kx8) TS	7.95	1702A	5.75
TMS2716, 5V, 12V	17.95	MM5203AQ	14.50
2758, 5V, (450nS)	3.50	MM5204Q	9.95

HI-TECH

2513-001 (5V) Upper	$9.50	DAC08	$9.95
2513-005 (5V) Lower	10.95	DAC100	9.95
2513-ADM3 (5V) Lower	14.95	8038 Function Generator	4.50
MCM66710 ASCII Shifted	12.95	MC4024 VCO	2.95
MCM66740 Math Symbol	13.95	LM566 VCO	1.95
MCM66750 Alpha Control	13.45	XR2206 Function Generator	5.25
1771-01 8" & Minifloppy	24.95	TR1602B (5V, 12V)	3.95
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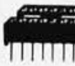
1791-01 Dual Floppy	36.95	AY51014A/1612 (5-14V)	6.95
1791-02 Dual Floppy	44.95	AY51015A/1863 (5V)	6.95
1793 DD, DS Floppy	44.95	IM6402	7.95
1797 DD, DS Floppy	54.95	IM6403	8.95
1691 Data Separator	18.95	2350 USRT	9.95
2143 Clock Generator	18.95	1671B Astron	24.95
8700 8 bit Binary	13.50	MC14411	11.95
8701 10 bit Binary	22.00	4702	14.95
8703 8 bit TS	13.50	WD1941	9.95
9400 Volt to Freq Conv	7.25	COM5016	16.95
8750 3½ Digit BCD	13.95	INS8250	15.95
1408L6 6 bit	3.95	AY5-2376	13.75
1408L8 8 bit	5.95	AY5-3600	13.75
DAC01 D to A	5.95	MM5740AAC	8.95

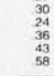
SOCKETS



LOW PROFILE SOCKETS (TIN)

	1-24	25-49	50-100
8 pin LP	.16	.15	.14
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.29	.27	.24
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
40 pin LP	.60	.59	.58

3L WIREWRAP SOCKETS (GOLD)



	1-24	25-49	50-100
8 pin WW	.55	.54	.49
10 pin WW (Tin)	.65	.63	.58
14 pin WW	.75	.73	.67
16 pin WW	.80	.77	.70
18 pin WW	.95	.90	.81
20 pin WW	1.15	1.08	.99
22 pin WW	1.45	1.35	1.23
24 pin WW	1.35	1.26	1.14
28 pin WW	1.60	1.53	1.38
40 pin WW	2.20	2.09	1.89

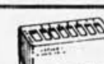
LINEAR

78H05K	$5.95	LM1414N	$1.90
78M06	1.49	LM1458CN/N	.49
78M.G.	1.49	MC1488N	.99
LM108AH	2.95	MC1489N	.99
LM300H	.99	LM1496N	.89
LM301CN	.35	LM1556N	1.50
LM304H	1.98	LM1820N	.95
LM305H	1.89	LM1850N	.95
LM306H	3.25	LM1889N	3.10
LM307CN	.29	LM2111N	1.75
LM308CN	.98	LM2900N	.99
LM309K	1.49	LM2901N	2.50
LM310CN	1.25	LM2917N	2.95
LM311D/CN	.89	CA3013T	2.19
LM312H	1.75	CA3018T	1.99
LM317T	1.70	CA3021T	3.49
LM318CN	1.49	CA3023T	2.99
LM319N/H	1.25	CA3035T	2.75
LM320K-XX*	1.35	CA3039T	1.29
LM320T-XX*	1.39	CA3046N	1.29
LM320H-XX*	1.25	CA3053N	1.49
LM323K	4.95	CA3059N	3.19
LM324N	.95	CA3060N	3.19
LM337K	5.95	CA3062N	4.95
LM338K	6.95	LM3065N	1.49
LM339N	.95	CA3080T	1.29
LM340K-XX*	1.75	CA3081N	1.69
LM340T-XX*	1.25	CA3082N	1.69
LM340H-XX*	1.25	CA3083N	1.55
LM344H	1.95	CA3086N	.80
LM348N	1.20	CA3089N	2.99
LM350K	5.60	CA3096N	3.49
LM358CN	.98	CA3097N	1.99
LM360N	1.49	CA3130T	1.30
LM372N	1.95	CA3140T	1.19
LM376N	3.75	CA3146N	2.49
LM377N	2.75	CA3160T	1.19
LM380CN/N	1.25	CA3190N	1.95
LM381N	1.79	CA3410N	.59
LM383T	1.95	MC3423N	1.49
LM386N	1.25	MC3460N	3.95
LM387N	1.40	SG3524N	3.95
LM390N	1.95	CA3600N	3.39
NE531V/T	3.75	LM3900N	.59
NE555V	.39	LM3905N	1.19
NE556N	.98	LM3909N	.98
NE561T	19.95	LM3914N	3.75
NE565N/H	1.25	LM3915N	3.95
NE566H/V	1.75	LM3916N	3.75
NE567V/H	1.50	RC4131N	2.95
NE592N	2.75	RC4136N	1.10
LM702H	1.99	RC4151N	3.70
LM709N/H	.29	RC4194TK	4.95
LM710N/H	.75	RC4195TK	5.40
LM711N/H	.39	ULN2001	1.25
LM715N	1.95	ULN2003	1.50
LM723N/H	.65	SN75450N	.59
LM733N/H	.98	SN75451N	.35
LM739N	1.15	SN75452N	.49
LM741CN/H	.33	SN75453N	.49
LM741CN-14	.19	SN75454N	.49
LM747N/H	.75	SN75491N	.89
LM748N/H	.39	SN75492N	.89
LM760CN	2.95	SN75493N	.89
LM1310N	1.90	SN75494N	.89
MC1330	1.95	TL494CN	4.20
MC1350	1.95	TL496CP	1.65
MC1358	1.75		

74S00

74S00	$ .39	74S124	3.69	74S244	$2.99
74S02	.43	74S133	.54	74S251	1.35
74S03	.45	74S134	.66	74S253	1.35
74S04	.52	74S135	1.15	74S257	1.29
74S05	.52	74S136	1.69	74S258	1.29
74S08	.49	74S138	1.29	74S260	.75
74S09	.49	74S139	1.29	74S280	2.79
74S10	.42	74S140	.73	74S287	2.99
74S11	.42	74S151	1.29	74S288	2.55
74S15	.42	74S153	1.29	74S373	3.10
74S20	.42	74S157	1.29	74S374	3.10
74S22	.42	74S158	1.29	74S387	2.75
74S30	.42	74S160	2.79	74S471	7.95
74S32	.49	74S174	1.49	74S472	7.95
74S38	1.19	74S175	1.49	74S473	7.95
74S40	.49	74S188	2.69	74S474	9.95
74S51	.42	74S194	1.89	74S475	9.95
74S64	.46	74S195	1.89	74S570	5.75
74S65	.46	74S196	1.89	74S571	5.75
74S74	.69	74S240	2.75	74S572	8.95
74S86	.72	74S241	2.75	74S573	8.95
74S112	.72	74S242	2.99	74S940	2.90
74S113	.72	74S243	2.99	74S941	2.90
74S114	.72				

DIP SWITCHES



2 Position	$ .99	7 Position	$1.39
4 Position	1.19	8 Position	1.49
5 Position	1.29	9 Position	1.65
6 Position	1.35	10 Position	1.69

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- 4.68" sq. x 1.50" deep. Weight - 17 oz.

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NEW! $9.50 ea.

7400

7400	$ .19	7475	$ .38	74161	$ .88
7401	.22	7476	.34	74162	.89
7402	.22	7479	4.60	74163	.87
7403	.22	7480	.49	74164	.87
7404	.22	7482	.95	74165	.87
7405	.23	7483	.55	74166	1.20
7406	.35	7485	.65	74167	1.95
7407	.35	7486	.35	74170	1.69
7408	.26	7489	1.75	74172	4.75
7409	.23	7490	.39	74173	.79
7410	.22	7491	.57	74174	.89
7411	.29	7492	.45	74175	.85
7412	.29	7493	.45	74176	.75
7413	.39	7494	.69	74177	.75
7414	.59	7495	.65	74179	1.34
7416	.29	7496	.69	74180	.75
7417	.29	7497	2.90	74181	1.75
7420	.22	74100	2.90	74182	.75
7421	.35	74107	.32	74184	2.25
7422	.29	74109	.37	74185	2.25
7423	.29	74116	1.95	74186	9.95
7425	.29	74121	.29	74188	3.90
7426	.29	74122	.39	74190	1.15
7427	.25	74123	.59	74191	1.15
7429	.45	74125	.39	74192	.85
7430	.23	74126	.44	74193	.85
7432	.29	74128	.59	74194	.85
7437	.25	74132	.69	74195	.68
7438	.29	74136	.75	74196	.85
7439	.29	74139	.95	74197	.85
7440	.19	74141	.79	74198	1.39
7441	.79	74142	2.95	74199	1.39
7442	.57	74143	2.95	74221	1.19
7443	.95	74144	2.95	74251	.95
7444	.95	74145	.62	74273	1.05
7445	.79	74147	1.95	74276	1.89
7446	.79	74148	1.20	74279	.75
7447	.65	74150	1.09	74283	1.40
7448	.79	74151	.67	74284	3.90
7450	.19	74152	.67	74285	3.90
7451	.19	74153	.67	74290	1.25
7453	.19	74154	1.19	74298	.95
7454	.19	74155	.78	74365	.68
7459	.25	74156	.78	74366	.68
7460	.23	74157	.69	74367	.68
7470	.29	74158	1.65	74368	.68
7472	.29	74159	2.49	74390	1.45
7473	.34	74160	.88	74393	1.90
7474	.34			74490	1.90

74LS00

74LS00	$ .26	74LS113	$ .43	74LS245	$2.20
74LS01	.28	74LS114	.43	74LS247	1.10
74LS02	.28	74LS122	.55	74LS248	1.10
74LS03	.28	74LS123	1.19	74LS249	1.19
74LS04	.35	74LS124	1.35	74LS251	1.40
74LS05	.28	74LS125	.89	74LS253	1.40
74LS08	.28	74LS126	.52	74LS257	.85
74LS09	.35	74LS132	.79	74LS258	.98
74LS10	.28	74LS136	.49	74LS259	2.95
74LS11	.39	74LS138	.85	74LS260	.65
74LS12	.33	74LS139	.85	74LS261	2.49
74LS13	.47	74LS145	1.25	74LS266	.59
74LS14	.95	74LS148	1.49	74LS273	1.75
74LS15	.33	74LS151	.79	74LS275	4.40
74LS20	.26	74LS153	.79	74LS279	.59
74LS21	.33	74LS154	1.70	74LS283	.99
74LS22	.33	74LS155	1.19	74LS290	.99
74LS26	.33	74LS156	.99	74LS293	.99
74LS27	.33	74LS157	.85	74LS295	1.10
74LS28	.33	74LS158	.75	74LS298	1.19
74LS30	.26	74LS160	1.05	74LS324	1.75
74LS32	.33	74LS161	1.15	74LS347	1.95
74LS33	.55	74LS162	1.05	74LS348	1.95
74LS37	.45	74LS163	1.05	74LS352	1.19
74LS38	.39	74LS164	1.19	74LS353	1.19
74LS40	.26	74LS165	.89	74LS363	1.49
74LS42	.79	74LS166	2.48	74LS365	.69
74LS47	.79	74LS168	1.15	74LS366	.69
74LS48	.95	74LS169	1.15	74LS367	.69
74LS51	.26	74LS170	1.99	74LS368	.69
74LS54	.29	74LS173	.89	74LS373	1.89
74LS55	.29	74LS174	.89	74LS374	1.89
74LS73	.45	74LS175	.89	74LS375	.69
74LS74	.42	74LS181	2.20	74LS377	1.95
74LS75	.59	74LS190	1.15	74LS385	1.95
74LS76	.45	74LS191	1.15	74LS386	.65
74LS78	.45	74LS192	.98	74LS390	1.95
74LS83A	.79	74LS193	.98	74LS393	1.95
74LS85	1.19	74LS194	1.15	74LS395	1.70
74LS86	.45	74LS195	.95	74LS399	2.35
74LS90	.57	74LS196	.89	74LS424	2.95
74LS92	.75	74LS197	.89	74LS668	1.75
74LS93	.75	74LS221	1.15	74LS670	2.29
74LS95	.88	74LS240	1.69	81LS95	1.69
74LS96	.98	74LS242	1.69	81LS96	1.69
74LS107	.45	74LS243	1.69	81LS97	1.69
74LS109	.45	74LS244	1.49	81LS98	1.69
74LS112	.43				

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8" Sgl side/dbl den 29.00/10
8" Dbl side/dbl den 39.00/10

MODEMS

Anchor 89.00
Hayes Smart 300 .... 199.00
Hayes Smart 1200 .... 499.00
Multi-Tech MT 212 AD (1200/300) 499.00
Novation J-Cat 300 .... 119.00
Novation Apple Cat 269.00
SSM AMC -300 (For Apple) Auto Dial .. 259.00
U.S. Robotics 212A Auto Dial 469.00

E-PROM ERASERS

QUV-T8/1 (hobby) 49.95
QUV-T8/2 (Industrial version) 68.95
QUV-T8/2 (w/timer & safety switch) 97.50

PARTS

TR1602B	2.50 ea.	TMS2716(5 + 12V)	$3.95 ea.
2114L2	$1.50 ea.	TMS2732	$4.95 ea.
TMS2532	$5.95 ea.	TMS4164(200NS)	$5.95 ea.
2716 (5V)	$3.95 ea.	TMS116-4(200NS)	$4.75 ea.

MANY OTHERS IN STOCK

CONNECTORS

RS232 Connectors
SOLDER TYPE

DB25P 2.50
DB25S 3.00
DB25 Hood 1.00
S-100 Connectors .. 10 for 25.00
DE9P 2.00

FLAT RIBBON TYPE

IDC25P 6.25
IDC25S 6.60
IDC25 Hood 1.60

Socket		QTY 100
IDC10SKT	1 90	1 00
IDC16SKT	2 50	1 20
IDC20SKT	2 75	1 30
IDC26SKT	3 50	1 60
IDC34SKT	4 50	2 20
IDC50SKT	6 50	3 20

8Card Edge		QTY 100
CEC26	5 00	2 70
CEC34	6 00	3 50
CEC50	7 25	4 90

AC SURGE ELIMINATORS

Lemon (6AC outlets-3 prong) ... 44.00
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Orange-Ac surge + EMI filter (6 outlets) 100.00
Peach (6 outlets) 70.00

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S-100 PRODUCTS

GIGANTIC REDUCTIONS IN PRICE!

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IEEE-696-No termination required

Slots	Bare Bd	A + T	w/card cage	bare card cage
4	15.00	40.00	60.00	20.00
6	20.00	48.00	70.00	22.00
8	25.00	69.00	100.00	31.00
12	30.00	99.00	140.00	41.00
18	45.00	150.00	200.00	50.00
22	60.00	185.00	—	75.00

All card cages will accommodate a 4" fan
Add $20.00 for 1 fan-Add $30.00 for 2 fans

MAINFRAMES

For 2 Standard 8" Drives

MF + DD6 (6 slot M/B) 699.00
MF + DD8 (8 slot M/B) 749.00
MF + DD12 (12 slot M/B) 799.00

For 2 Thinline 8" Drives

IMF + DD6C (Cadillac version) 500.00
IMF + DD6F (Ford version) 350.00

For 2-5¼" Disk Drives

MF + MD12 (12 slot M/B) 575.00

Standard Plain Front

MF + 12 (12 slot M/B) 500.00
MF + 22 (22 slot M/B) 600.00

All mainframes except IMF + DD6F have EMI filter, 2 AC outlets, 15 ea. DB25, 2 ea. 50 pin, 2 ea. 34 pin, 1 ea. Centronic cutouts, power supply for 8" MF (−5V1A/ + 5V6A/ + 8V16A/ ± 16V3A/ + 24V6A)

SIERRA DATA

SDS-SBC-100-Z80(4mhz) master 2 serial 2 par/floppy controller/64k ram ... $855.00
SDS-SBC-100S-4mhz slave/2 serial 2 par/64k ram ... $565.00
SDS-ZSIO/4-4 serial port I/O bd ... $235.00
SDS-MUX-RS232 multiplexer bd ... $235.00
SDS-HDI-M-Hard disk bd for micropolis ... $129.00
SDS-CPM/B105-cp/m for SBC 100 w/BIOS ... $150.00
SDS-Turbodos-Multi-user for master & slaves $845.00

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Best Bare Board Set Available
QTC-SBC 2/4 CPU
QTC-EXP + III 256K Memory bd.
QTC-FDC 5/8 Floppy disk controller
Bare Board Set $150.00
1) Includes manuals & assembly instructions
2) Parts available
3) Monitor & BIOS available Add $30.00

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S-100 Clock/Calendar by QT/Computime
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20 Slot MB 210.00
CPU 8085/88 .... 389.00
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QTC-SBC 2/4BB 1 ser 1 par CPU ... $50
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QTC-Z + 80 BB 1 serial ... $28

QTC-EXP + III Bare Bd (dynamic) ... $85
QTC-EXP + III 64K A + T (64K/256K or 1 MEG) ... $450

I/O Tech I/O + 2 Ser 3 Par Bare Bd ... 75
I/O Tech I/O + 2 Ser 3 Par A & T ... 300
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GP100-30CPS-Par	199.00
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View Max 80 Col/64K Mem (III)	149.00
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Rana Controller	85.00
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Inexpensive but powerful, small enough for portability, these mini hard disk systems have a special XOR interface to the S-100 bus that leaves an S-100 slot open for expandability. Choose from 5, 10, and 16 megabyte sizes (6.5, 12, + 20 megabyte unformatted.) Includes CP/M operating system.

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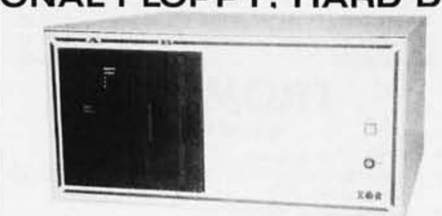

20 Meg Winchester w/2.4 Meg Floppys

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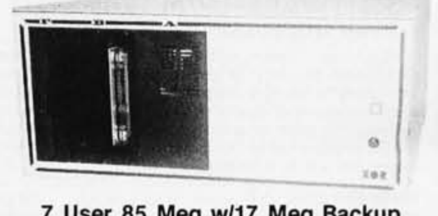

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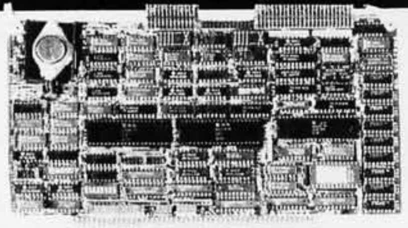

SBC 300
Z-80 Single Board Computer

- Fully complies with IEEE 696 (S100) Bus Standard
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- Polled I/O or Interrupt
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Floppy and Hard Disk Controller

- S-100 (IEEE/696) Compatible
- Supports four 5¼" or 8" floppies
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- Supports three 5¼" Winchester drives
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*CP/M® 3.0 is configured for the SDS SBC300 board.

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- S-100 (IEEE/696) compatible
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- Double density formats
- Separate connectors for 5¼" and 8" drive cables
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- Phased locked loop data separator
- Recommended for operation with the Z80 CPU

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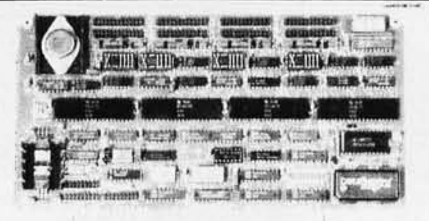
BUSDS38098	Versafloppy II/696 (A&T)	$400.00	$359.89
BUPDBVF239141*	With 5¼" unbanked CP/M®	$520.00	$429.00
BUPDBVF239142*	With 8" unbanked CP/M®	$520.00	$429.00
BUPDBVF239143*	With 5¼" banked CP/M®	$520.00	$429.00
BUPDBVF239144*	With 8" banked CP/M®	$520.00	$429.00

*CP/M® 3.0 configured for the SDS SBC300.

SOFTWARE-CP/M PLUS™ 3.0
SYSTEM REQUIREMENTS AND OS INFORMATION:

CP/M® 3.0 requires a minimum of 112K bytes of system RAM partitioned into two banks (64K each)* for operation. Memory size parameters are communicated to the OS by menu selections in GENCPM. The OS is divided into two modules, the resident portion that resides in the common memory, and the banked portion that occupies the upper area of BNANK 0 (just below the common area). The common area must be from 4K to 16K to be compatible with the distribution configuration.

BUSDS39144	CP/M 3.0 8" banked for SDSSBC300	$315.00
BUSDS39142	CP/M 3.0 8" unbanked for SDSSBC300	$315.00
BUSDS39143	CP/M 3.0 5¼" banked for SDSSBC300	$315.00
BUSDS39141	CP/M 3.0 5¼" unbanked for SDSSBC300	$315.00



I/O-8
8 Port Serial I/O

- S-100 (IEEE/696) compatible
- Synchronous or asynchrous DTE/DCE
- I/O ports are adressable to any 8 byte boundary in 64K
- Software selectable baud rate
- Full duplex, up to 1 Mbit/sec in synchronous mode
- 5, 6, 7, or 8 data bits/character
- Stop bits - 1, 1.5, 2
- Parity - odd, even, or none
- Error detection - parity, overrun, CRC or framing

Interrupts:
- Receiver ready
- All receive characters

Real Time Clock with Battery Backup

Part No.	Description	List Price	Our Price
BUSDS38093	8 Async serial (A&T)	$695.00	$594.00
BUSDS38094	8 Sync serial (A&T)	$795.00	$675.00

Cables: Each port has its own 26 pin header. Order one I/O cable for each port used

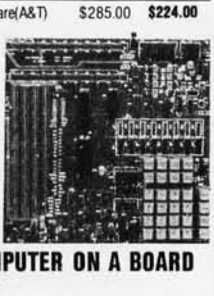
BUPGC26S24DS	26 pin SKT conector to DB25S 24"	$ 14.65
BUPGC26S60DP	26 pin SKT connector to DB25P 5'	$ 15.70
BUPGC26S60DS	26 pin SKT connector to DB255 5'	$ 16.55

PROM 100
Eprom Burner

- S100 (IEEE-696) Compatible
- Programs the Following EPROMs: 2708, Intel 2758, 2716, 2732, and Texas Instruments 2516
- Dip Switch Selection of EPROM type
- 25 VDC Programming Pulse Generated On Board
- Maximum Programming Time: 16,384 Bits in 100 Seconds
- Power Requirement: +8VDC at 300 ma.; +16 VDC at 100 ma.; −VDC at 60 ma.
- TTL compatible
- Software Listing Provides for Reading of Object File from SDOS, CP/M or PROM and Programming into PROM
- Program Verification
- Verification of Erasure
- Zero Insertion Force Socket
- One Year Warranty

BUSDS38076	PROM-100 w/software(A&T)	$285.00	$224.00

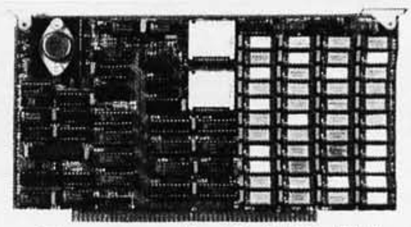
Z80 STARTER SYSTEM



A COMPLETE MICROCOMPUTER ON A BOARD

- Z80 CPU with 158 Instructions
- On-board keyboard and display
- On-board PROM programmer for single voltage PROMs (2716, 2758, TI2516)
- Kansas City standard cassette interface
- Simple key controlled audio cassette load and dump
- Expansion provision for mounting two S-100 connectors (Sockets not included)
- Wire wrap area for custom circuitry
- Single Step through RAM or PROM
- Memory examine and change
- Port examine and change
- Z80 CPU register and change
- 2K Byte ZBUG monitor in ROM
- 1K Bytes of RAM (expandable to 2K Bytes)
- A 4 Channel hardware counter/timer (Z80-CTC)
- Two bi-directional 8-bit I/O ports (Z80-P10)
- Up to 5 programmable breakpoints
- Switch selectable PROM or monitor restart
- Vectored interrupts provided by Z80-CTC and Z80-P10

BUSDS38007	Z80 Starter System (A&T) (Shipping Weight 4 lbs.)	$450.00	$382.00



ExpandoRAM IV
256K Dynamic RAM

- S-100 (IEEE/696) compatible
- 256 K Configuration
- DIP Switch Selectable Addressing
- Board may reside anywhere in the 24 Bit address space of the IEEE-696 Bus
- 8 and 16 Bit data Transfers
- Parity Check
- Optional Error Detection/Correction
- Invisible refresh at end of any OP code fetch forced refresh cycle every 10-16 microseconds
- Error Detection and Correction (Hamming Code) 1 bit correction-optional
- 1 Year Warranty

Part No.	Description	List Price	Our Price
BUSDS38088	ExpandoRAM IV 256K (A&T)	$1145.00	$980.00
BUSDS38089	ExpandoRAM IV 256K w/EDC (A&T)	$1990.00	$980.00

ExpandoRAM III
Random Access Memory Board

- POWER: +7V to +10V @ 400 mA (max)
- 1 year warranty
- Phantom output disable or manual switch selectable outpu disable
- Typical power dissipation of 5 watts
- 4 MHz operation
- Port addressable board select for multi-user system
- POWER: (2 S memory cycle) +7V to +10 V @ 400 mA (max)
- 1 Year Warranty

BUSDS38097	256K ExpandoRAMIII /696 (A&T)	$825.00	$649.0

ROM DISK 128
Program Accellerator

- S-100 (IEEE/696) compatible
- 128K Bytes of storage per board
- Uses 16 user supplied 2764 or 2732 type EPROMs
- Up to four boards per system for a total of 512 K
- Meets all IEEE 696/S-100 specifications
- Serial Port provided (using 8251 UART)
- Dip switch selectable addressing
- Looks like a disk drive to the system
- Eliminates media problems
- CP/M Plus support porvided
- Ideal for environments where mechanical drives are not practica
- CP/M® and MP/M® install programs
- 1 Year Warranty

BUSDS38081	ROM DISC 128K w/o EPROMS (A&T)	$350.00	$296.0
BUSDS61103	ROM DISC Manual		
BUPGC26S24DS	2' Internal Serial I/O cable		

RAM DISK 256
Program Accellerator

- S-100 (IEEE/696) compatible
- 256K bytes of sequentially accessed memory
- On-board transparent refresh (only when the M1 signal i stopped)
- Faster than a floppy disk drive
- Install program included (when configured the RAM DISK-25 looks like a single density 8" disk drive)
- Source code libraries included
- On-board dynamic RAM controller
- Bank addressing allows the use of four boards in the same ad ress to be accessed giving you up to 1 Mbyte of storage
- Asynchronous bus operation and uses the WAIT line only ; needed
- 1 Year Warranty

Part No.	Description	List Price	Our Price
BUSDS38082	Ram Disk 256K (A&T)	$875.00	$715.00
BUSDS61102	Manual		$ 10.00

RETAIL STORE PHONE NUMBERS: (Chatsworth:) (213) 709-5464 - (Irvine:) (714) 660-1411

Circle 365 on inquiry card.

PRIORITY ONE ELECTRONICS

AT LAST! CP/M 68K®!!!

CompuPro

CPU BOARDS

68K - 68000 16 BIT CPU

16 bit 8 or 10 MHz on-board sockets for 2716, 2732, or 2764 EPROMs for up to 8K x 16 of memory

Part No.	Description	List Price	Our Price
BUGBT184A	A&T 8MHz	$695.00	$512.95
BUGBT184C	CSC 10MHz	$850.00	$765.00

CP/M® 68K NOW AVAILABLE!!

FORTH OPERATING SYSTEM INCLUDED

Now CompuPro and Digital Research bring you CP/M for the 68000. Also included is the FORTH Operating System which requires a DISK I, 64K of CompuPro memory and an INTERFACER 3 or 4.

BUGBTCPM68K	68000 CP/M® & FORTH O/S	$350.00

CO-PROCESSOR 8086/8087

16 bit 8 or 10 MHz 8086 CPU with sockets for 8087 and 80136

BUGBT186A	A&T 8MHz 8086 only	$ 750.00	$494.95
BUGBT186C	CSC 10MHz 8086 only	$ 850.00	$784.89
BUGBT186A87	A&T with 8087 option	$1050.00	$939.00
BUGBT186C87	CSC with 8087 option*	$1150.00	$1065.00

*8087 Limits clock speed to 5MHz

DUAL PROCESSOR 8085-8088

6 or 8 MHz provides true 16 Bit Power with a standard 8 bit S-100 bus.

BUGBT1612A	A&T 6MHz	$495.00	$318.97
BUGBT1612C	CSC 6/8 MHz	$595.00	$497.87

CPUZ - Z80B CPU NOW 6MHz!

3/6 MHz Z80B CPU with 24 Bit Addressing.

FASTEST Z80 CPU AVAILABLE!

BUGBT160A	3/6 MHz A&T	$325.00	$228.95
BUGBT160C	3/6 MHz CSC	$425.00	$374.87

DISK CONTROLLERS

DISK 1 DMA FLOPPY CONTROLLER

Fast DMA, Soft Sector, Controls Up to Four 8" or 5¼" Single or Double Density Drives!

BSPDB171ACPM	A&T w/CPM 2.2® & BIOS	$670.00	$489.00
	When purchased w/two 8" disk drives only		$450.00
BUPDB171CCPM	CSC w/CP/M 2.2® & BIOS	$770.00	$595.00
BUGBT171A	Disk 1 Controller A&T	$495.00	$368.95
BUGBT171C	Disk 1 Controller CSC	$595.00	$550.00
BUGBTCPM80	CP/M 2.2® for Z80/8085 w/manual & BIOS 8" S/D disk		$148.95
BUGBTCPM86	CP/M 2.2® for 8086 w/manuals & BIOS 8" S/D disk		$258.95

DISK 2/SELECTOR CHANNEL HARD DISK CONTROLLER

Fast DMA 2 board set controls 4 Shugart 4000 series or Fujitsu 2300 type drives. Includes CP/M 2.2®.

BUGBT177A	Assembled & Tested	$795.00	$568.95
BUGBT177C	CSC	$895.00	$850.00

M-DRIVE/H PROGRAM ACCELERATOR

Interfaces through two I/O ports, and runs at 10MHz IEEE 696 compatible. Requires any CompuPro CPU and a DISK 1. Each board contains 512K of fast, low power (900mA) RAM, with parity checking.

BUGBT197A	M-DRIVE/H w/software, A&T	$1895.00	$1249.00
BUGBT197C	M-DRIVE/H w/software, CSC	$2095.00	$1495.00

STATIC RAM

RAM 17 - 64K CMOS STATIC RAM

12 MHz, RAM 17, 2 Watt, DMA Compatible 24 Bit Addressing

BUGBT175A64	64K A&T 12MHz	$499.00	$460.00
BUGBT175C64	64K CSC 12MHz	$599.00	$550.00

RAM 16 - 32K x 16 BIT CMOS STATIC RAM

8 and/or 16 Bit 12MHz, RAM 16, 32K x 16 or 64K x 8 IEEE/696 16 Bit 2 Watt, 24 Bit Addressing, 12MHz

BUGBT180A	64K A&T 12MHz	$550.00	$510.00
BUGBT180C	64K CSC 12MHz	$650.00	$610.00

RAM 21 - 128K STATIC RAM

816 RAM 21 12MHz, 128K x 8 or 64K x 16 IEEE/696 8 or 16 Bit, 1.2 Amps, 24 Bit Addressing, 12MHz

BUGBT190A	128K A&T	$1095.00	$858.95
BUGBT190C	128K CSC	$1245.00	$1125.00

CompuPro

I/O BOARDS

SYSTEM SUPPORT 1 MULTIFUNCTION BOARD

Serial port (software prog. baud), 4K RAM included, 15 levels of interrupt, real time clock, optional math processor.

Part No.	Description	List Price	Our Price
BUGBT162A	Assembled & Tested	$450.00	$308.95
BUGBT162C	CSC	$550.00	$495.00
BUGBT8231	Math Chip		$195.00
BUGBT8232	Math Chip		$195.00
BUGBT162AM1	A&T w/8231 Math Chip	$645.00	$538.95
BUGBT162CM1	CSC w/8231 Math Chip	$745.00	$670.00
BUGBT162AM2	A&T w/8232 Math Chip	$645.00	$538.95
BUGBT162CM2	CSC w/8232 Math Chip	$745.00	$670.89

S-100 MOTHERBOARDS

Active Termination, 6-12-20 Slot

BUGBT153A	A&T 6 slot (2 lbs.)	$140.00	$125.00
BUGBT153C	CSC 6 slot (2 lbs.)	$190.00	$155.00
BUGBT154A	A&T 12 slot (3 lbs.)	$175.00	$155.00
BUGBT154C	CSC 12 slot (3 lbs.)	$240.00	$220.00
BUGBT155A	A&T 20 slot (4 lbs.)	$265.00	$235.00
BUGBT155C	CSC 20 slot (4 lbs.)	$340.00	$310.00

CompuPro

INTERFACER 1

Two Serial I/O

BUGBT133A	Assembled & Tested	$295.00	$198.95
BUGBT133C	CSC	$370.00	$329.00

INTERFACER 2

Three parallel, one serial I/O board

BUGBT150A	Assembled & Tested	$325.00	$249.00
BUGBT150C	CSC	$399.00	$359.00

INTERFACER 3

Eight-channel multi-user serial I/O board

BUGBT1748A	Assembled & Tested	$699.00	$518.95
BUGBT1748C	CSC 200 hr. 8 port	$849.00	$748.89
BUGBT1745A	Assembled & Tested	$599.00	$448.95
BUGBT1745C	CSC 200 hr. 5 port	$699.00	$628.89

INTERFACER 4

Three Serial, 1 Parallel, 1 Centronics Parallel

BUGBT187A	Assembled & Tested	$450.00	$314.87
BUGBT187C	CSC	$540.00	$414.87

MPX CHANNEL BOARDS

I/O Multiplexer, using 8085A-2 CPU on board w/16K RAM

BUGBT166A16	Assembled & Tested	$649.00	$584.89
BUGBT166C16	CSC	$749.00	$674.89

CompuPro

STATIC RAM SALE!!

256K AND 128K IEEE/696 S-100 - ULTRA LOW POWER!

256K RAM 22

- Fully static design eleiminates timing problems associated with Dynamic RAMs (<4 Watts)
- Guaranteed to work with any IEEE/696 S-100 DMA device
- 24 bit extended addressing
- 8 or 16 bit data
- Single 5V operation
- Assembled and Tested

BUGBT198A

12 MHz

SUPER SALE PRICE:

$1500.00

EACH, WHEN YOU BUY 2 OR MORE

$1595.00 Each

128K RAM 21

- Fully static design uses less power than dynamics (1.2A typical)
- 24 bit extended addressing
- 8 or 16 bit data
- 16K window deselect
- Switch selectable PHANTOM disable
- Fully DMA compatible
- Assembled and Tested

BUGBTRAM21 LIST PRICE: $1295.00

12 MHz

SUPER SALE PRICE:

$650.00

EACH, WHEN YOU BUY TWO OR MORE

$695.00 Each

64K 10MHz LOW POWER S-100 IEE/STATIC RAMS

RAM 17

64K 8 BIT / 24 BIT ADDRESS

BUGBTRAM17 List Price: $499.00

$299.00

RAM 16

64K 8 or 32K 16 BIT / 24 BIT ADDRESS

BUGBTRAM16 List Price: $550.00

$325.00

PRIORITY ONE ELECTRONICS

9161 Deering Ave., Chatsworth, CA 91311

ORDER TOLL FREE (800) 423-5922 - CA, AK, HI CALL (213) 709-5111

Terms: U.S. VISA, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 6½% Sales Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $3.00 for the first 3 lbs. plus 40¢ for each additional pound. Orders over 50 lbs. sent freight collect. Just in case, include your phone number. Prices subject to change without notice. We will do our best to maintain prices through September, 1983. Many quantities are limited. Sorry, no rainchecks, no refunds or exchanges on sale merchandise. Credit Card orders will be charged appropriate freight. Sale prices for prepaid orders only. We are not responsible for typograpical errors.

RETAIL STORE PHONE NUMBERS: (Chatsworth:) (213) 709-5464 - (Irvine:) (714) 660-1411

Circle 365 on inquiry card.

PRIORITY ONE ELECTRONICS

TELETEK

THE SYSTEMASTER Z80 SINGLE BOARD COMPUTER

FEATURES:
• Z8UA 4 MHz CPU with 64K bytes of on-board RAM • RAM is partitioned into two banks. One is always active, and the other deselectable, allowing the use of MP/M • Provisions for and EPROM (2716, 2732, or 2764) • Two RS232 serial I/O ports, 45 to 19,200 baud • Two 8 bit parallel I/O ports • DMA floppy disk controller • Single or double density, single or double sided • Controls up to 4 drives of 5 1/4" or 8" drives • Simultaneous operation of four 8" and 5¼" drives • Real time clock

SysteMaster® For Operation With CP/M®

Part No.	Description	List Price	Our Price
BUTLKA1001	Configured with a 250 nS prewrite comp for use with Sugart and Siemens 8" drives	$895.00	$850.00
BUTLKA1002	Configured with a 0 nS prewrite comp for use with Qume, Tandon, Mitsubishi and MPI8" drives	$895.00	$850.00
	SysteMaster® For Operation with TurboDOS™		
BUTLKA1003	Configured with a 250 nS prewrite comp for use with Shugart and Siemens 8" drives	$895.00	$850.00
BUTLKA1004	Configured with a 0 nS prewrite comp for use with Qume, Tandon, Mitsubishi, and MPI 8" drives	$895.00	$850.00

Shipping weights on above items: 2 lbs. each

SBC-1 Z80A SLAVE PROCESSOR

FEATURES:
• Z80A 4MHz, or Z80B 6MHz CPU • 128K (fully populated) on board RAM • Memory can be partioned onto 4K segments on any 4K boundary • Provisions for one 2716, 2732, or 2764 EPROM • Two RS232 serial ports, 45 to 19,200 baud • Two parallel ports

Part No.	Description	List Price	Our Price
BUTLKA1027	4 MHz SBC-1 w/128K RAM	$ 945.00	$ 895.00
BUTLKA1028	6MHz SBc-1 w/128K RAM	$1145.00	$1050.00

LONG DISTANCE ADAPTOR BOARDS

BUTLKA1200	PSC (RS232) long distance interface up to 50 ft.	$125.00
BUTLKA1202	PSC (RS422) long distance interface up to 4000 ft	$125.00
BUTLKA1220	PPD parallel interface for up to 250 ft.	$ 65.00

Z80A MULTI-FUNCTIONED CPU BOARD

FEATURES:
• Z80 4MHz CPU
• Floppy disk controller: Controlls single/double sided, single/double density, 5 1/4" and 8" disk drives or both at the same time (4 drives maximum) • On board 2716 monitor EPROM • Provisions for two more 2716 EPROMs • Two RS232 serial ports (45 to 9600 baud) • Two parallel ports • Real time clock • PROM programmer for 2716's (requires an external voltage source)

Part No.	Description	List Price	Our Price
BUTLKA1099	FDC-1 0 nS prewrite comp for use with QUME, MITSUBISHI, and MPI	$695.00	$660.00
BUTLKA1105	FDC-1 250 nS prewrite comp for use with SHUGART, and SIEMENS	$695.00	$660.00

256K DYNAMIC MEMORY BOARD

FEATURES:
• Guaranteed to operate at 4 MHz with no wait states • 256K dynamic RAM uses the popular 4164 IC • PHANTOM signal disables output of data from the memory board • On board refresh • Timing changes are done with jumpers to allow operation with 8080, Z80, 8085, or Alpha Micro CPUs • Each of 16 banks are made up of 4K byte segments • Each segment may be individually enabled or disabled

Part No.	Description	List Price	Our Price
BUTLKA1066	Populated to 64K	$550.00	$520.00
BUTLKA1069	Populated to 256K	$995.00	$945.00

HARD DISK/CARTIDGE TAPE CONTROLLER

FEATURES:
• A Z-80A CPU • Support of 5¼" rigid-disk drives (ST506 or equivalent) with • Controller communications with the host processor via 2K • Two 28-pin sockets allowing the use of up to 16K bytes of on-board EPROM and up to 8K bytes of on-board RAM • Cartridge tape drive • Expansion is made possible with an external card.
Available early 4th Quarter of 1983

BUTLKA1130	Hard Disk/Tape controller 4MHz	$795.00	$750.00
BUTLKA1131	Hard Disk/Tape controller 6MHz	$845.00	$795.00

4 SERIAL AND 2 PARALLEL BOARD

FEATURES:
• 2 RS232 serial ports with full handshaking, (45-19,200) baud • Each port is speed independent • The Z80A CTC may be implemented as a real time clock • Two parallel ports with the Z80A PIO IC

Part No.	Description	List Price	Our Price
BUTLKA1175	PSIO 4 serial 2 parallel ports	$325.00	$295.00

Industrial Computer Designs

S-100 TO "REAL WORLD" INTERFACE PRODUCTS

64 INPUT 8 BIT A/D D/A CONVERTERS

Part Number	Description	Price
BUICDAD64100	64 input 8 bit S-100 A/D board	$295.00
BUICDDA64100	64 output 8 bit S-100 D/A board	$395.00
	REMOTE SENSORS, ALARMS, VALVES, AND CONTROLLERS FOR USE WITH ABOVE A/D D/A CONVERTER BOARDS	
BUICDRTS1	remote temperature sensor (1 lb.)	$ 29.95
BUICDRLS1	remote light sensor (1 lb.)	$ 29.95
BUICDRMS1	remote moisture sensor (1 lb.)	$ 59.95
BUICDRSDA1	rewmote smoke detector alarm (2 lbs.)	$129.00
BUICDDNVAC1	in-line remote air-conditioner & heating controller (1 lb.)	$ 94.95
	Air Conditioning & Heating Duct Valves	
BUICDADV07	7" diameter valve (4 lbs.)	$ 74.95
BUICDADV08	8" diameter valve (4 lbs.)	$ 75.95
BUICDADV09	9" diameter valve (5 lbs.)	$ 76.95
BUICDADV10	10" diameter valve (5 lbs.)	$ 79.95
BUICDADV11	11" diameter valve (6 lbs.)	$ 81.95
BUICDADV12	12" diameter valve (6 lbs.)	$ 83.95
BUICDADV13	13" diameter valve (6 lbs.)	$ 84.95
BUICDADV14	14" diameter valve (6 lbs.)	$ 85.95
	64 PIN CABLE ASSEMBLIES	
BUICD464PCA	64 pin single ended 4' long (2 lbs.)	$ 59.25
BUICD1064PCA	64 pin single ended 10' long (3 lbs.)	$ 89.95
BUICD2064PCA	64 pin single ended 20' long (6 lbs.)	$145.00

"HOW TO" APPLICATION NOTES

If you would like to learn more about the ICD Designer Control Series of peripherals, ICD offers a complete collection of "How To" applications notes. See how your computer can control your home or office, or be used as part of an industrial control system.

BUICDAPN	Application notes (1 lb.)	$ 15.00

S-100 CLOCK/CALENDAR BOARDS

BUICDACA100	With alarm circuit	$228.00
BUICDCT100	With timer down to .01 second	$345.00
BUICDCTS	Software for ICDCT100 board on 8" CP/M format	$ 34.95

MICRO
Intercontinental Micro Systems

Z80A DMA SBC & Z80B SLAVES

S-100 IEEE/696 COMPATIBLE - 1 YEAR WARRANTY!

CPZ-48000 FEATURES:
• 4MHz Z80A, 64K RAM
• Floppy disk personality card included for 5¼" or 8" floppy disk drives
• RS232 personality card included
• Two serial - two parallel I/Os

SLAVE PROCESSOR
• Z80 4 or 6MHz CPU (specify at time of order)
• Two serial - two parallel I/Os
• 64K RAM
• TURBODOS compatible

Part Number	Description	List Price	SALE PRICE
BUICMCPZ480008	SBC for 8" floppy	$995.00	$895.00
BUICMCPZ480005	SBC for 5¼" floppy	$995.00	$895.00
BUICM256KMB	256 KByte RAM	$995.00	$895.00
BUICMCPS4A	4MHz slave/asynch. port	$475.00	$439.00
BUICMCPS4S	4MHz slave/synch. port	$485.00	$445.00
BUICMCPS6A	6MHz slave/asynch. port	$550.00	$489.00
BUICMCPS6S	6MHz slave/synch port	$560.00	$499.00
	(Shipping weight: 2 lbs. each)		
BUICMRS232	RS232 Personality Card		$ 25.00
BUICMCENTD	Centronics Parallel Personality Card		$ 28.00
BUICM8FDC	8" Floppy Disk Personality Card		$ 36.00
BUICM5FDC	5¼" Floppy Disk Personality Card		$ 33.00
BUICMCLKCAL	Clock Calendar		$ 48.00

TELETEK SOFTWARE

Software with no prewrite compensation Installed.
CP/M® For SysteMaster®

Part Number	Description	Price
BUTLKB1001	CP/M® on 8" and 5¼" 35 track disks	$135.00
	CP/M® FOR FDC-1	
BUTLKB1031	CP/M® on 8" and 5¼" 35 track disks	$135.00
	TurboDos™ For All TELETEK Floppy Controllers	
BUTLKB1238	V1.22 single user	$300.00
BUTLKB1239	V1.22 single user w/spooling	$350.00
BUTLKB1240	V1.22 multi user, single user, & spooling software	$750.00
	Software with a 250 nS prewrite compensation Installed.	
	CP/M® For The SysteMaster™	
BUTLKB1006	CP/M® on 8" and 5¼" 35 track disks	$135.00
BUTLKB1010	CP/M® on 8" for TANDON TM848 THINLINE	$135.00
	CP/M® For the FDC-1	
BUTLKB1036	CP/M® on 8" and 5¼" 35 track disks	$135.00
BUTLKB1040	CP/M® on 8" for TANDON TM848 THINLINES	$135.00

SSM

IO5

2 Serial, 3 Parallel S-100 Interface

Part No.	Description	List Price	Our Price
BUSSMIO5A	Assembled & Tested	$329.00	$289.95
	IO8 8 Port Serial I/O S-100 Board		
BUSSMIO8A	Assembled & Tested	$550.00	$450.00
	IO4 2 Serial, 2 Parallel I/O S-100 Board		
BUSSMIO4A	Assembled & Tested	$290.00	$245.00
	2708/2716 EPROM PROGRAMMER & EPROM BOARD Programs 2708 and 2716 EPROMs. Holds 4 2708s (4K) or 4 2716s (8K)		
BUSSMMB8A	Assembled & Tested	$265.00	$219.87

DUAL

NON VOLATILE CMOS RAMS

8, 16, or 32K. 8 or 16 Bit Data. Battery Backup On Board 6MHz, Bank Selectable

BUDULCMEM8	8K A&T	$495.00	$450.00
BUDULCMEM16	16K A&T	$595.00	$550.00
BUDULCMEM32	32K A&T	$695.00	$650.00

256K DYNAMIC MEMORY

256K, 230 ns access time, 2 x 128K organization, 24 bit addressing, parity error detection.

BUDULDMEM256K	Assembled & Tested	$1295.00	$1195.00

32/64K EPROM BOARD

8 or 16 bit data, holds 2716s (32K), or 2732s (64K)

BUDULEPROM32	For 2716s A&T	$295.00	$275.00
BUDULEPROM64	For 2732s A&T	$295.00	$275.00

A/D CONVERTER

12 Bit Resolution 16 or 32 Channel Input

BUDULAIM12	Assembled & Tested	$695.00	$625.00
BUDULAIM12B	Without instru. Amp	$645.00	$598.00

D/A CONVERTER

4 Channel, 12 Bit, 3 Output Modes

BUDULAOM12	Assembled & Tested	$695.00	$618.95

SIERRA DATA SCIENCES

S-100 SBC BOARD

Z80A 4MHz, 2 Serial RS232 interfaces, 1 parallel interface, 64K RAM, Floppy Disk Controller, provisions for one 2732 EPROM — ALL ON THIS ONE BOARD!!

BUSDSSBC	Z80A SBC A&T	$895.00	$655.00
BUSDSCPM	CP/M® perating System on 8" disk		$150.00
BUSDSTURBDS	Single User TurboDos™ on 8" disk		$450.00
BUSDSTURBDM	Multi-User TurboDos™ on 8" disk		$750.00
BUMCPI2231	36 MByte Hard Disk(45lbs)	$3695.00	$3250.00

S-100 Z80A SLAVE SBC

Z80A 4MHz, 2 RS232 Serial ports, 4 parallel ports, 64K RAM, EPROM Programmer. Used in multi-user computer system with SDSSBC.

BUSDSSBCSE	Slave Z80 SBC A&T	$825.00	$565.00

California Computer Systems

Z80 CPU 2 or 4MHz

On board RS232 Serial port, On board 2K Monitor, ROM, Power on jump to any location in 64K, LED status indicators for ROM select, halfstate and interrupts.

BUCCS2810A	Z80A 4MHz CPU A&T	$325.00	$258.95
	CCS271901		
BUCCS271901	2 Serial, 2 Parallel, A&T	$360.00	$288.95
	CCS27201		
BUCCS272001	4 Port Parallel, A&T	$275.00	$218.95
	CCS271001		
BUCCS271001	4 Port Serial, A&T	$325.00	$278.95
	CCS2830		
BUCCS283001	Assembled & Tested	$550.00	$428.95
	CCS206601 64K Dynamic S-100 RAM. Cromemco CROMIX™ Compatible.		
BUCCS206601	Assembled & Tested	$450.00	$425.00
	CCS2422A Floppy disk controller w/CP/M 2.2®		
BUCCS2422A	Assembled & Tested	$475.00	$338.95

RETAIL STORE PHONE NUMBERS: (Chatsworth:) (213) 709-5464 - (Irvine:) (714) 660-1411

PRIORITY ONE ELECTRONICS

$4500 CP/M® SYSTEM

DOUBLE-SIDED
DOUBLE DENSITY DRIVES!

FOR ONLY
$1895

MORROW

MD3 Now With:
9 SOFTWARE PROGRAMS!

Since the publication of our last catalog in January, we have sold thousands of the Morrow Micro Decision MD1 and MD2 computers. And now we can offer you the brand new **MD3** which features:

- Double Sided/Double Density Drives — 768 Kbytes of Storage!
- QUEST BOOKKEEPER® Software Package
- PERSONAL PEARL® data base manager
- 2 Serial Ports and 1 Parallel Port — simultaneous connection to terminal, printer and modem

The MD3 is a complete computer system (hardware and software) developed to satisfy the needs of the millions of small, independent businesses with fewer than 50 employees and annual sales under $5 million. These businesses need a computer that is easy to use; provides a wide variety of functions, including word processing, financial planning and forecasting, information management, mailing lists, a good general bookkeeping system, and — most important of all — is affordable! That's the **MD3!**

HARDWARE

The Micro Decision® is a 4 MHz Z80A based computer with 64 K of memory and an on-board disk controller. The two 5¼" **double sided double density** half height floppy disk drives supply an impressive 768K of storage capacity. There are two RS232 serial ports and one Centronics style parallel port for direct connection to a terminal, modem, printer, or just about any other peripheral you may need.

TERMINALS

Choose one of two terminals with the purchase of your MD3. Each is manufactured to Morrow's high quality and engineering standards. Both have full-sized detachable keyboards and the 12" P31 green phosphor screen displays 80 characters by 24 lines — with a 25th status line. Other attributes include reverse video, dim, blink, and underline.

The beige MDT20, manufactured by Lear Siegler, features a keyboard with 92 keys including 14-key numeric keypad and 7 function keys for 7 functions. The black MDT50, manufactured by Liberty Electronics, has a 14-key numeric keypad and 5 function keys for 10 functions.

SOFTWARE

The MD3 comes complete with 9 software packages that would cost as much as the whole system if purchased separately. The highlight of this software package is:

QUEST BOOKKEEPER®

It is a simple, flexible program intended to replace the tedious, manual pegboard or posting machine systems still used by millions of businesses. Quest is designed for users with no computer experience, and offers an instructional mode, a tutorial mode, and on-line help. It provides complete bookkeeping capabilities in three application areas:

ACCOUNTS RECEIVABLE
- Sales Posting and Journal to 11 Different Accounts
- Accounts Receivable Reporting
- Cash Receipts Posting and Journal
- 750 Customer Listings
- 2500 Outstanding Customer Invoices

CASH DISBURSEMENTS
- 750 Cash Disbursements per Month
- Optional Automatic Check Writing
- Cash Disbursements Journal
- 750 Vendor Listings

GENERAL LEDGER SYSTEM
- Monthly Journals for Audit Trials or for Optional Submission to an Accountant
- Detailed General Ledger and Summary Trial Balance Reports with Monthly Journals
- Complete General Ledger Reporting with Balance Sheet and Income Statements
- 400 Accounts and 2000 Monthly Postings

PERSONAL PEARL
- A sophisticated data base manager and report generator
- Consistantly in the "10 Top Most Popular Programs"

WORDSTAR®
- The most widely accepted Word Processing Program
- Generates mailing list from Personal Pearl data files

CORRECT-IT®
- A powerful spelling check with a built-in dictionary of 36,000 words
- User may add 36,000 words to dictionary

LOGICALC®
- The electronic "spreadsheet" that computes the "what-if" questions of business projections and financial planning
- Accesses files already created in Personal Pearl

PILOT®
- A user friendly programming language developed by Morrow Designs

MICROSOFT BASIC-80®
- Industry standard BASIC Programming Language

BaZic®
- An advanced programming language, compatible with NorthStar BASIC

CP/M® 2.2
- The Operating System that allows access to more than 2000 business and special application programs

NATIONWIDE XEROX SERVICE

Effective July 1, 1983, XEROX SERVICE GROUP is an authorized service center for Morrow Micro Decisions. XEROX has over 80 service centers nationwide for warranty service, and they offer cost effective, extended warranty contracts for both carry-in and on-site service.

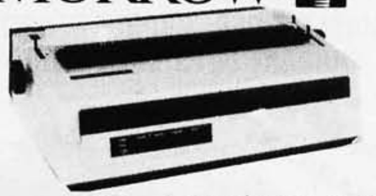
BUMDSMD3	MD3 w/two 5¼" disk drives (Sh. Wt. 27 lbs.)	**$1395.00**
BUPDBMD3T20	MD3 w/MDT20 beige terminal (Sh. Wt. 34 lbs. & 27 lbs.)	**$1895.00**
BUPDBMD3T50	MD3 w/MDT50 black terminal (Sh. Wt. 34 lbs. & 27lbs.)	**$1895.00**

Choice of terminal subject to availability

NEW LOWER PRICES ON MD2, ALSO!!

BUMDSMD2	Same as above except single sided drives and without QUEST™	(Shipping Weight 27 lbs.)	**$ 995.00**
BUPDBMD2T20	MD2 With MDT20 beige terminal	(Sh. Wt. 34 lbs. & 27 lbs.)	**$1595.00**
BUPDBMD2T50	MD2 With MDT50 black terminal	(Sh. Wt. 34 lbs. & 27 lbs.)	**$1595.00**

MORROW



20 cps LETTER QUALITY

Ideal Companion to Your Micro Decision!

The MORROW DESIGNS **MP200** type daisywheel printer provides all of the features that you would require in a letter quality printer. Features such as 96 character set, 10/12/15 character pitch and proportional spacing, full 13.2" printing width, and a Centronics parallel interface to list just a few, are what makes the MORROW DESIGNS **MP200** your first choice in a low cost letter quality printer.

FEATURES:
- 20 cps (Shannon text) print speed
- Bi-directional printing
- 17" paper width paper capacity
- Prints up to 5 part forms
- Front panel controls of PAUSE, LINE FEED, FORM FEED, TOF SET
- POWER, ALERT, and PRINT ON front panel indicators
- Very quiet operation
- Optional tractor feed

Part Number	Description	List price	Our Price
BUMDSMP200	MP200 w/RS232 serial interface (Shipping Weight: 35 lbs.)	$950.00	**$795.00**
BUMDSMPT50TK	MP200 tractor feed		**$125.00**
	RIBBON CARTRIDGES		
BUSRP5504	Single strike film ribbon		**$ 4.95**
BUSRP5505	Multistrike ribbon		**$ 8.95**
	PRINT WHEEL		
BUSRPCOURIER10	Courier 10 pica		**$16.95**
BUSRPCOURIER12	Courier 12, elite		**$16.95**
BUSRPMODERN	Proportional type		**$16.95**
BUSRPSCRIPT	Script elite		**$16.95**

star GEMINI 10X & 15

BUGEM10X	120 cps Parallel Int. 80 col. (20 lbs.)	**$319.00**
BUGEM15	100 cps Parallel Int. 132 col. (26 lbs.)	**$459.00**
BUGEMSERINT	Serial interface card for GEM15 (1 lb.)	**$ 85.00**
BUGEMSERINTX	Serial interface for GEM10X (1 lb.)	**$ 59.00**
BUGEMSERINTX4K	Serial interface & 4 K buffer for GEM10X	**$119.00**

AXIOM $229

AXIOM CORPORATION

BUAXMGP100A	30 cps 8 col. dot matrix (11 lbs.)	**$229.00**

OKIDATA

BUOKIDAT82AT	TRACTOR INCLUDED (25 lbs.)	**$449.00**
BUOKIDAT83AT	TRACTOR INCLUDED (35 lbs.)	**$729.00**
BUOKIDAT92AP	OKIDATA 92A Parallel (25 lbs.)	**$480.00**
BUOKIDAT92AS	OKIDATA92A Serial (25 lbs.)	**$599.00**
BUOKIDAT92AT	OKIDATA92A Tractor (2 lbs.)	**$ 79.95**
BUOKIDAT93AP	OKIDATA93A parallel (35 lbs.)	**$830.00**
BUOKIDAT93AS	OKIDATA93A Serial (35 lbs.)	**$995.00**

MANNESMANN TALLY
LETTER QUALITY DOT MATRIX PRINTER

- 160 cps
- 40 cps (Letter quality)
- Serial & Parallel Interface
- Double wide characters
- Tractor and friction feed
- "Bullet-Proof" cast frame with metal cabinet

BUTALMT160L	160 cps 80 col (21 lbs.)	**$569.00**
BUTALMT180L	160 cps 132 col. (28 lbs.)	**$784.00**

QUME LETTER QUALITY

BUQMES945	45 cps Sprint 9 serial (49 lbs.)	**$1789.00**
BUQMES955	55 cps Sprint 9 serial (49 lbs.)	**$2195.00**
BUQMES1140	40 cps Sprint 11 (45 lbs.)	**$1389.00**
BUQMES11RS232	RS232 Module for Sprint 11 (3 lbs.)	**$ 99.00**
BUQMES11CENT	Centronics parallel for Sprint 11 (3 lbs.)	**$ 99.00**
BUQMES11IEEE488	IEEE488 Module for Sprint 11 (3 lbs.)	**$ 99.00**
BUQMES11IBM	IBM module for Sprint 11 (3 lbs.)	**$ 99.00**
BUQMEBDT	Bi-Directional Tractor (9 lbs.)	**$ 349.00**
BUQMEWB	Wire basket (2 lbs.)	**$ 85.00**
BUQMECSF	Cut Sheet Feeder (20 lbs.)	**$ 849.00**
	PRINTER CABLES	
BUPRIAMPAMP	5' 36 pin Cent. to 36 pin Cent.	**$24.95**
BUPRIAMPTR80	5' 36 pin Cent. to 34 pin Card edge	**$19.95**
BUPRIAMPSKT	5' 36 pin Cent. to 34 pin socket	**$19.95**
BUCNDRS2328F	8' 8conn. Class 1 RS232 Ser. cable	**$19.95**
BUCND5730360	36 pin Cent. solder connector	**$ 9.00**
BUIDC5730360	36 pin Cent. IDC connector	**$ 9.95**

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Circle 365 on inquiry card.

PRIORITY ONE ELECTRONICS

SIEMENS FDD100-8
8" FLOPPY DISK DRIVE
SINGLE SIDED, DOUBLE DENSITY
SHUGART 801R COMPATIBLE

90 DAY WARRANTY!!

$175.00 each
CALL for 10+

OEM INQUIRIES INVITED
(Include $7.00 per drive for shipping)
BUSIEFDD1008

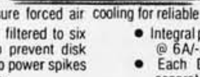
ORDER NOW AND $AVE!

BUY DRIVE & CABINET TOGETHER AND $AVE!!
DUAL 8" SIEMENS FDD1008
DUAL 8" CABINET POWER SUPPLY
AND INTERNAL POWER CABLES
(Include $30.00 for shipping)

- Positive Pressure Filter Cooling
- Power Supply 4A @ +5V, 3A @ +24V 1A @ -5V
- Each output is individually fused
- Hinged to for easy access
- Heavy non-flex .090 aluminum base
- Modular power connectors

IF BOUGHT SEPARATELY: $890.00
SPECIAL SALE PRICE:
$625.00
BUPDBIIISIE (Include $30.00 for shipping)
BUIIFDE002 CABINET ONLY (Sh. Wt. 38 lbs.) **$295.00**

OUR FINEST DUAL 8" DISK DRIVE CABINET!



- Positive pressure forced air cooling for reliable disk drive operation
- AC input EMI filtered to six amps to help prevent disk crashes due to power spikes and line noise
- Integral power supply with 5V @ 6A/-5V @ 1A/24V @ 6A
- Each DC supply and AC separately fused

Part No.		List Price	Our Price
BUIIIUDE004	(Sh. Wt. 40 lbs.)	$495.00	$349.00

With augmented power supply to handle Tandon Slimline, or Winchester disk drives. Includes the disk environment monitor.

BUIIIUDE004AUG	(Sh. Wt. 40 lbs.)	$733.00	$625.00
BUIIIUDE004EM	(Sh. Wt. 40 lbs.)	$584.95	$395.00

THIN THREE 8" DISK DRIVE CABINET

• Supports 3 half-high 8" disk drives • 5V @ 6A, -5V @ 1A, 24V @ 6A • One AC power connector for one full size drive • 5V output over-voltage protected • Optional disk environmer'al monitor is available to monitor and alarm you to internal temperature reaching dangerous levels.

Part Number	List Price	SALE PRICE
BUIIIUDETTT	$495.00	$375.00
WITH DISK ENVIRONMENTAL MONITOR:		
BUIIIUDETTTEM	$584.95	$425.00

DISK DRIVES
TANDON 5¼" HARD DISK

BUTNDTM501	1 platter 6 Mbyte (Sh. Wt. 9 lbs.)	$749.00
BUTNDTM502	2 platter 12 Mbyte (Sh. Wt. 9 lbs.)	$895.00
BUTNDTM503	3 platter 19 Mbyte (Sh. Wt. 9 lbs.)	$1049.00

DUAL HARD DISK ENCLOSURE

BUIIIHD5002	For above drives	$395.00

TANDON 5¼"

BUTNDTM1001	1 Sided 48 TPI	$225.00	2 FOR $195.00 each
BUTNDTM1002	2 Sided 48 TPI	$260.00	2 FOR $235.00 each
BUTNDTM1003	1 Sided 96 TPI	$275.00	2 FOR $250.00 each
BUTNDTM1004	2 Sided 96 TPI	$390.00	2 FOR $365.00 each

(Shipping Weights on above Items: 5 lbs. each)

MPI 5¼" FULL HEIGHT

BUMPI51*	1 Sided 48 TPI	$200.00
BUMPI52*	2 Sided 48 TPI	$270.00
BUMPI91*	1 Sided 96 TPI	$275.00
BUMPI92*	2 Sided 96 TPI	$400.00

*Replace with an "M" for the MPI style bezel, or with an "S" for Shugart style bezel. (Shipping Weight: 5 lbs.)

MPI 5¼" HALF HEIGHT

BUMPI501	1 Sided 48 TPI (Sh. Wt. 4 lbs.)	$260.00
BUMPI502	2 Sided 48 TPI (Sh. Wt. 4 lbs.)	$300.00
BUMPI901	1 Sided 96 TPI (Sh. Wt. 4 lbs.)	$300.00
BUMPI902	2 Sided 96 TPI (Sh. Wt. 4 lbs.)	$355.00

SHUGART 8" FULL HEIGHT

BUSHU801R	1 sided (18 lbs.)	$369.00

QUME 8" FULL HEIGHT

BUQMEDT8	2 sided (18 lbs.)	$480.00
		2 FOR $460.00 each

MITSUDISHI 8" FULL HEIGHT

BUMITM289463B	2 sided (18 lbs.)	$380.00

MPI 8" FULL HEIGHT

BUMPI41S	1 sided (11 lbs.)	$380.00
BUMPI42S	2 sided (11 lbs.)	$460.00

MPI 8" DUAL HALF HEIGHT
(SAME SIZE AS ONE FULL HEIGHT)

BUMPI41D	1 sided (22 lbs.)	$760.00
BUMPI42D	2 sided (22 lbs.)	$870.00

TANDON 8" HALF HEIGHT

BUTNDTM8481	1 sided (9 lbs.)	$395.00
		2 FOR $375.00 each
BUTNDTM8482	2 sided (9 lbs.)	$495.00
		2 FOR $475.00 each

MPI 8" HALF HEIGHT

BUMPI41M	1 sided (11 lbs.)	$380.00
BUMPI42M	2 sided (11 lbs.)	$460.00

5¼" DRIVE CABINETS

DUJMR1C5	Single 5¼" Cabinet (5 lbs.)	$69.00
BUJMR2C5	Dual 5¼" Cabinet (9 lbs.)	$89.00
BUJMR2C5C	JMR2C5 w/internal data cable (9 lbs.)	$99.00

DUAL 8" HALF HEIGHT FLOPPY CABINET

- 24V @ 4A, 5V @ 3A -5V @ 800ma
- Fan cooled
- Socketed power connections
- All supplies regulated

		List Price	Our Price
BUIIIDTL002	Dual Thin Line Cabinet (12 lbs.)	$225.00	$165.00

BUY THE CABINET & DRIVES AND $AVE!
With 2 Tandon Thinlines

BUPDBIIITND1	Cabinet w/2 TNDTM8481 - 1 sided (30 lbs.)	$ 885.00
BUPDBIIITND2	Cabinet w/2 TNDTM8482 - 2 sided (30 lbs.)	$1115.00

With 2 MPI Slimlines

BUPDBIIIMPI1	Cabinet w/2 MPI41M - 1 sided (30 lbs.)	$ 920.00
BUPDBIIIMPI2	Cabinet w/2 MPI42M - 2 sided (30 lbs.)	$1080.00

Options

BUIIIDTLMPIKIT	MPI drive adaptor mounting kit (2 lbs.)	$24.95
BUIIIDCCSHU	Shugart / AC/DC power connector kit (2 lbs.) (For full size single SA801 or compatible drives)	$14.95

TERMINALS
VISUAL 50

(Sh. wt.: 41 lbs.)

Part Number	Description	List Price	SALE PRICE
BUVSL50BW	Black & White 12"	$695.00	$625.00
BUVSL50GN	Green Screen 12"	$770.00	$655.00

FEATURE COMPARISON CHART

Feature:	VISUAL 50	Hazeltine Esprit	ADDS Viewpoint	Lear Siegler ADM-5	TeleVideo 910
Tilt & Swivel	YES	NO	NO	NO	NO
Detached Keyboard	YES	NO	YES	NO	NO
N-Key Rollover	YES	NO	YES	NO	NO
Audible Key Click	YES	YES	NO	NO	NO
Menu Set-Up Mode	YES	NO	NO	NO	NO
Status Line	YES	NO	NO	NO	NO
Full 5 Attribute Selection	YES	NO	NO	NO	YES
Smooth Scroll	YES	NO	NO	NO	NO
Line Drawing Character Set	YES	NO	NO	NO	NO
Independent RCV/ TX Rates	YES	NO	NO	NO	NO
Answerback User Programmable	YES	NO	NO	OPT	NO

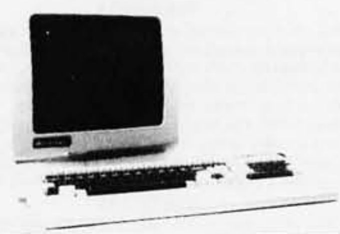
VISUAL 330

The VSL330 terminals will emulate the DEC VT52, Data General D200, Lear Siegler ADM-3A, and Haziltine 1500. Other features include: 12 user programmable function keys, line drawing character set, jump or 2 speed scroll, split screen, full editing, and programmable non-volatile columnar tabbing or field tabbing forward and backward just to name a few.

The **VISUAL 300** has all of the same functions as the 330, but does not have multi-emulation. The **VISUAL 300** is ANSI X3.64 compatible.

BUVSL300GN	ANSI X3.64, 12" Green	$1095.00	$995.00
BUVSL330GN	Green 12" CRT (Sh. Wt. 41 lbs.)	$1200.00	$895.00
BUVSL33014GN	Green 14" CRT (Sh. WT. 41 lbs.)	$1250.00	$949.00

TELEVIDEO



BUPDBTLV9252P	w/2nd page memory kit FREE (A $95.00 Value)	$729.00
BUPDBTW9504P	w/2nd, 3rd, & 4th page memory kit FREE (A 285.00 Value) (above items: 37 lbs. each)	$929.00

BUTLV910	80 col. terminal (37 lbs.)	$558.95
BUTLV970	14" 80/132 col. terminal (40 lbs.)	$1019.00

LIBERTY ELECTRONICS

BULIBF50	Freedom 50 (Sh. Wt. 30 lbs.)	$599.00	$474.00

ADDS

BUADDVWPR	Viewpoint 3A+ (30 lbs.)	$695.00	$575.00

QUME

BUQME102	80 Column Green (Sh. Wt. 30 lbs.)	$550.00
BUQME102AM	80 Column Amber (Sh. Wt. 30 lbs.)	$565.00
BUQME103	80/132 Column Green (Sh. Wt. 30 lbs.)	$765.00
BUQME108	22 function key, 80 col. Green (30 lbs.)	$749.00
BUQME108AM	22 function key, 80 col. Amber (30 lbs.)	$765.00

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SYSTEM CLEARANCE SALE

ITEM (No. & Name)	QTY
DATA GENERAL MICRO-NOVA	
Cabinets w/muffin fans	6
4207 MN Asynch. Control	14
4208 MN Console Debug	5
4225 MN Comm. Controller	7
4226 MN Synch. Controller	7
4227 MN 4 Line Asynch Controller	4
6038 Single Diskette Subsystem	3
6039 Dual Diskette Subsystem	4
6102 12.5 MB Winchester Disk MN	1
8561 MN 9 Slot 4KW Mos	3
8573 MN 8 Kw Mos MEM	15
CENTRONIC PRINTERS	
761 KSR Centronic Printers	8
HAZELTINE VDTs	
1410 Hazeltine Video Terminal	2
CODEX MODEMS	
201 Codex 2400 Baud Modems	9

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Tel: 212-997-3766

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5¼" Specify soft, 10 or 16 sector

	Price/10	Price/100
1 side/double density	$20.00	$185.00
2 sided/double density	34.50	325.00

8" Specify soft or 32 sector

	Price/10	Price/100
1 side/single density	$21.00	$195.00
1 side/double density	29.50	275.00
2 sided/double density	34.50	325.00

Certified Check - Money Order - Personal Check
Allow up to 2 weeks for personal checks to clear.
Add $3.00 to each order for U.P.S. shipping charges.
NJ Residents add 6% NJ Sales Tax

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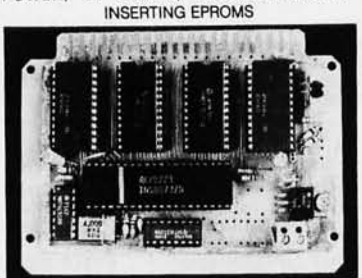
TIRED OF EPROM HASSELS?

WITH THE MICRO XCPU FORGET: 25 VOLT POWER, UV LAMPS, PULLING-ERASING-INSERTING EPROMS



BASIC ON μP — STRINGS, INTERRUPTS, MUCH MORE: HARDWARE 16 BIT MULT AND DIVIDE 37 μS, 42 μS :VOLTAGE REGULATOR, RS-232C FOR PROGRAMMING, 4K EEPROM (X2816A), 4K RAM, AUTO START PR UP :EXPANSION BOARDS AVAILABLE, MICRO XCPU — $195 EPROM BURNER VERSION FOR DIE HARDS — $125

MICRO APPLICATIONS — (305) 725-0944
515 ANDREWS DR,
MELBOURNE BEACH, FL 32951

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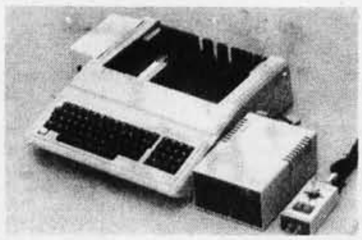

APPLE COMPATIBLE

Disk Drive	$150.00 ea.
Controller Card	$35.00 ea.
Computer Case	$55.00 ea.
Keyboard	$70.00 ea.
Switching Power Supply	$49.50 ea.
Joystick	$15.00 ea.

Prices for dealers in quantities of 25 or more. End User Inquiries welcomes.

ELECTRADE CO.
(408) 946-2541
780 Trimble Rd. Suite 605
San Jose, CA 95131

Circle 167 on inquiry card.

MODEMS

IBM-PC

Rixon PC 212A — **$465.00**

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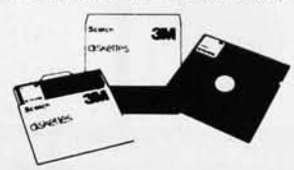

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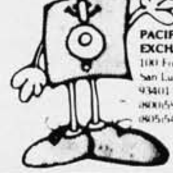

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410	.19	74152	.65
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412	.30	74154	1.25
413	.35	74155	.75
414	.49	74156	.65
416	.25	74157	.55
417	.25	74159	1.65
420	.19	74160	.85
421	.35	74161	.69
422	.35	74162	.85
423	.29	74163	.69
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451	.23	74190	1.15
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4024	.65	74C14	.59
4025	.29	74C20	.35
4026	1.65	74C30	.35
4027	.45	74C32	.39
4028	.69	74C42	1.29
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4030	.39	74C73	.65
4034	1.95	74C74	.65
4035	.85	74C76	.80
4040	.75	74C83	1.95
4041	.75	74C85	1.95
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7824T	.75		
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7812K	1.39	7912K	1.49
7815K	1.39	7915K	1.49
7824K	1.39	7924K	1.49
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14	.99	.75	1.45
16	.99	.85	1.65
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20	1.89	1.25	
22	1.89	1.25	
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28	2.49	1.50	
40	2.99	2.10	4.15

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20	.65	5.70	1.25	11.00
25	.75	6.60	1.32	11.60
26	.75	6.60	1.32	11.60
34	.98	8.60	1.65	14.50
40	1.32	11.60	1.92	16.80
50	1.38	12.10	2.50	22.00

D-SUBMINIATURE

DESCRIPTION	SOLDER CUP MALE	SOLDER CUP FEMALE	RIGHT ANGLE PC SOLDER MALE	RIGHT ANGLE PC SOLDER FEMALE	IDC RIBBON CABLE MALE	IDC RIBBON CABLE FEMALE	HOODS BLACK	HOODS GREY
ORDER BY	DBxxP	DBxxS	DBxxPR	DBxxSR	IDBxxP	IDBxxS	HOOD-B	HOOD
CONTACTS 9	2.08	2.66	1.65	2.18	3.37	3.69	---	1.60
15	2.69	3.63	2.20	3.03	4.70	5.13	---	1.60
25	2.50	3.25	3.00	4.42	6.23	6.84	1.25	1.25
37	4.80	7.11	4.83	6.19	9.22	10.08	---	2.95
50	6.06	9.24	---	---	---	---	---	3.50

For order instructions see "IDC Connectors" below.

CALL FOR MOUNTING HARDWARE

IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDHxxS	IDHxxSR	IDHxxW	IDHxxWR	IDSxx	IDMxx	IDExx
CONTACTS 10	.82	.85	1.86	2.05	1.15	---	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.80	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "**xx**" of the "order by" part number listed. **Example:** A 10 pin right angle solder style header would be IDH**10**SR.

Circle 243 on inquiry card.

Unclassified Ads

FOR SALE: Two AMD Z8000 evaluator boards, includes AMD assembler: $600 each. Also, seeking Assembler programmer for Intel 8051, 8048, and 8085 in the NY, NJ, CT area. Vincent Randy, 139 Rich Ave., Mount Vernon, NY 10550.

WANTED: Position in the field of medical applications of computers sought by experienced clinician and medical administrator with a special interest in recording clinical information. Bernard N. Millner, MD, 919 Berkeley Ave., Trenton, NJ 08618, (609) 695-0696.

WANTED: To trade software and exchange ideas about the TRS-80 Color Computer. A. Adachi, 30 Lockwood Rd., Scarsdale, NY 10583, (914) 723-1582 after 6 p.m.

WANTED: Any model TRS-80 Color Computer, any condition (used OK) but must be working. Will pay $50 plus shipping. Jim Norman, 1116 Northeast 14th Ave., Gainesville, FL 32601, (904) 375-6047.

WANTED: Problems and/or solutions encountered with the Kaypro computer and Perfect software for possible inclusion in book I am writing. Let's share experiences. John L. Parker, 503 East Georgia St., Tallahassee, FL 32308, (904) 222-9841.

FOR SALE: One complete unused copy of Bristol Software Silicon Office for Commodore 8096 with 8050 disk. All-in-one office software in original packaging, lists for $999, will sell for $500 or best offer. Steve Bolger, Gloucester Computer Inc., One Blackburn Center, Gloucester, MA 01930, (617) 283-7719.

FOR TRADE: Heath H-10 paper-tape reader/punch in good working condition with parallel interface card for Q-bus. Includes cables and manuals; works with any DEC LSI-11 computer. Will swap for LSI-11 software; RT-11, TSX, COBOL. Mort Spelas, 847 East Sheridan, Phoenix, AZ 85006, (602) 253-7637.

FOR SALE: Odyssey 2 video-game system in good condition with four cartridges, all instructions, and original cartons: $150 or best offer. Assorted video game and computer magazines: $1 each. Also, I would like to correspond with Commodore VIC-20 users who wish to exchange software and information. Joseph Brown, 2683 Charlestown Dr., #31-D, College Park, GA 30337.

FOR SALE: Black Box A/S-1 protocol converter. Translates bisynchronous EBCDIC (IBM 2770, 2780, or 3780 format) to asysnchronous ASCII (with X-Off/X-On support): $1000 or best offer. Lee Jones, 509 Black Hills Dr., Claremont, CA 91711, (714) 621-9008.

FOR SALE: Exatron Stringy Floppy for the TRS-80 Model III in superb condition. Manual, software, 30 wafers, and a wafer wheel for storage are included. $300 value; will sell for $200. Bernard F. Biron, 141 English Village Rd., Manchester, NH 03102, (603) 669-1269.

FOR SALE: The Digital Group 40K-byte Z80 computer system with Phi-Deck cassette system. Also, all software and two unpopulated 32K-byte (4044) memory boards. Plenty of room for expansion; asking $1000. Peter V. Beckmann, 4113 Cedar Ave., Palm Beach Gardens, FL 33410, (305) 622-0347.

FOR TRADE: Send a list of your better Apple software and I will send you mine. Or send a disk with your better programs and I will return it promptly with mine. I am interested in arcade games and educational programs. P. Rathod, Revefaret 4, Oslo 4, Norway.

WANTED: To upgrade TRS-80 Model I, Cat. No. 26-1006, Expansion Interface, Cat. No. 26-1142, and related software. W. C. Russell, 4027 Holly Rue, Erie, PA 16506.

FOR SALE: Voicebox II for Atari. Used only a couple of times: $115. I will ship in U.S. or add $5 for shipping outside U.S. Voicebox I for Atari: $100. Add $3 if you want it shipped COD. Will Hudson, 519 Linden, East Lansing, MI 48823.

FOR SALE: IBM 5100 portable computer, 64K RAM, built-in BASIC and APL, with IBM 5103 DM Printer. Also, business software, all manuals, and lots of blank tapes. Best offer. Rich Larris, 388 Main St., Danbury, CT 06810, (203) 792-7300 days.

FOR SALE: AIM 65 with 4K RAM, BASIC, PL-65, Assembler, enclosure, power supply, and full documentation. Best offer over $300. Ben Pashkoff, POB 4994, College Station, TX 77844, (409) 846-1075.

FOR SALE: 32K Interact Color Computer with built-in 1500-bps cassette player. Also, typewriter keyboard, RS-232C connector, two joysticks, schematics, BASIC manual and over 100 programs. New cost $2000, asking $895. Barbara Bridges, POB 42, Badger, CA 93603, (209) 337-2885 evenings.

WANTED: Information exchange wth Interact owners/users. Would like to join or start Interact users group, in person or by mail. Can do: 8080 ML programming, rewire Atari, Odyssey etc., joysticks. Paul Donnelly, 10 Idle Day Dr., Centerport, NY 11721.

FOR SALE: Processor Technology Sol-20 with S-100 bus and five expansion slots, 8080A processor, parallel and serial communications interface, 64K RAM, and an 8-inch disk drive. Also includes CP/M 2.2 operating system, MBASIC, Electric Pencil word processor, utilities, and game packages; all with full documentation. Asking $2000 or best offer. Joe Vaccarello, 254 Chamberlain Ave., Paterson, NJ 07502, (201) 790-8463.

FOR SALE: Brand new, never opened Apple II with 80-column card, expandable to 64K with Artsci Magic Words Text Processor, Magic Words Spelling Proofreader, and Magic Calc Spreadsheet Program: $350. Marc Ries, 13977 Coteau Dr. #2, Whittier, CA 90604, (213) 946-3073.

FOR SALE: Rockwell AIM-65 system with heavy-duty aluminum case, power supply, printer, and paper. Never used; asking $225 or best offer. Andy Chiang, (212) 565-6784 or 425-0658.

FOR SALE: Back issues of BYTE: vol. 2, No. 8 through vol. 7, No. 9; like-new condition; $225 plus shipping. W. R. Elmendorf, 31 Fair Way, Poughkeepsie, NY 12603, (914) 462-0721.

FOR SALE: CPM 2.2, 15-slot S-100, Compupro Z80A and 65K static memory, Morrow Multi I/O, Morrow Floppy and HD controllers, Shugart 2S/2D 1.2MB 8-inch floppy disk, Fujitsu 10MB hard disk, Televideo 910C, Texas Instruments 810-B and stand, Smartmodem, all cables and technical manuals included. Used 1 year, $5500 or best offer. John Bohn, 7440 East Hwy. 140, Merced, CA 95340.

WANTED: A disk drive or a printer (include interface if needed) in old condition for an Atari. Send information about your peripheral if asking price is less than $370. Robert Liu, 155 Kings Rd., Madison, NJ 07940, (201) 822-2527 after 5 p.m.

FOR SALE: Vector 3 system including NEC 5515 Spinwriter, computer and printer stands, and dual disk drives. Software includes word processing, accounting, and execplan. Financing may be available for a 30-month term: $9000 or best offer. Michael Wolf, Suite 200, 10350 Santa Monica Blvd., Los Angeles, CA 90025, (213) 277-5191.

WANTED: Schematic diagrams and data sheets or any other information about the Video Brain Family Computer Model 101A. Matthew A. Goglia, 33 Musket Dr., Nashua, NH 03062.

WANTED: Experienced hobbyist, specialized in software development mainly for Z80/8080 systems, is looking for interesting assignments. Bart Rutten, Azielaan 284, 3526 SJ Utrecht, The Netherlands, tel: (0)30–89 63 67.

FOR SALE: Graphics terminal, Lear-Siegler ADM 3A + with Digital Research Retro-Graphics card containing Z80 and onboard memory. Emulates Tektronix 401X series. Has numeric keybad, RS-232C printer port. Only three years old, all documentation included, shipped in original carton. Shipping included: $1400 or best offer. Randy Girard, RR3 Box 36, Chillicothe, IL 61523, (309) 274-5540 or 578-3336.

FOR SALE: TRS-80 Model I 48+, expansion interface, upper- and lowercase, number keys and Scripsit keys, RS-232C, HD interface, two DD disk drives, Synthesizer and Voxbox, tape drive, cables, and documents. Software includes Scripsit, Profile, Visicalc, Versafile, Assembly, FORTRAN, LDOS-HD, comm-Videotext, Microfile, GenLedger, AcctsPay, AcctsRec, Model II to Model I converter, and more. Just serviced by TRS: $2000. Not compatible with new VAX-780. Gene Gropper, 71 Nimitz Rd., Yonkers, NY 10710.

FOR SALE: 8K BASIC ROM to upgrade Sinclair ZX80 to ZX81: $25. Assorted ZX81 Software. Send SASE for list and prices. R. Cummings, 124 West 10th, Andover, KS 67002.

FOR SALE: Commodore VIC-20 color computer with manual, Programmers Reference Guide, cassette recorder, 8K memory expander, power supply, and game software. A little over a year old. Paid $590, asking $230. Leland Gershell, 515 West End Ave., New York, NY 10024, (212) 877-2322.

FOR SALE: Back issues of BYTE Nov. 1977 to present; *Creative Computing* July 1979 to present; *Personal Computing* May 1978 to present; and other miscellaneous titles. Myron Ellis, 1300 South 19th St., Terre Haute, IN 47803, (812) 235-3851.

FOR SALE: Epson MX 80F/T and switched serial interface for a couple of Apple IIs. Includes two CCS 7710A asynchronous serial interface boards, one Practical Peripherals MBS-8K buffered interface, and three cables totaling 60 feet in length. Works great at 19.2K bits per second. Rick Bullen, 26 Pinecrest Dr., Hastings-on-Hudson, NY 10706, (212) 398-8474 days or (914) 478-2940 evenings.

WANTED: Service manuals and schematics for all types of minicomputers. Send name, address, and telephone number with name of literature and asking price. B. J. Currier, 57 Oxford St., Manchester, CT 06040.

FOR SALE: S-100 boards: Tarbell double-density floppy-disk controller, little used: $300. Fully populated TRACE 32K static RAM, works at 2 MHz: $100. VDM-1: $25. Bruce Kinney, 4201 Tynes Dr., Garland, TX 75042, (214) 276-7650.

FOR TRADE: Will exchange programs for the TRS-80, Atari 800, and the Apple II in both BASIC and assembly language. I am especially looking for simulation programs for the Atari 800 and the Apple II. Will trade programs of equal size for those received. Send your listings plus SASE for a return listing. Don C. Jacobs, Box 3913, Ingleside, TX 78362.

WANTED: I will swap any BASIC game programs with TI-99/4 and 4A users. Send your programs on cassette or list them on paper. I will return your programs with some of mine. Eric Ng, 4506 Georgetown Dr., Columbia, MO 65201.

FOR SALE: TRS-80 Model III 5¼-inch formatted floppy disk with business-type, custom-made software (inventory/bill-writing/daily balancing). I must sell out my personal software packages from owner/operator business. Will customize to your specs if requested. Mike Keller, 422 Central Manor Rd., Mountville, PA 17554, (717) 285-4853.

WANTED: Copy of Byte Nybble #109, "An APL Interpreter in Pascal." Will gladly pay copy costs and postage. W. R. Mitchell, POB 1627, Poughkeepsie, NY 12601.

WANTED: The Saginaw Michigan Computer Users Group is assembling a nondenominational directory of users groups. Groups with general and/or special interests in computing as well as from all geographic areas are welcome. Send club name, address, and interests. Computer User's Directory-SMCUG, 2534 Nebraska St., Saginaw, MI 48601.

WANTED: Back issues of *Dr. Dobb's Journal*. I will buy all the 1981 and 1982 issues you want to sell—at your price—if your offer includes certain key issues I am missing. Barry G. Knapp, 4695 Osage Dr., Boulder, CO 80303, (303) 494-8390.

FOR SALE: North Star Horizon 48K with two single-sided single-density floppy disks. Also, all my North Star software: $1500. R. Riggio, 18047 Audette, Dearborn, MI 48124.

FOR SALE: Heath H-89, professional assembled, mint condition. Includes serial-interface board, Heath disk operating system, Text Editor, Epson MX-80 driver program, games, and Morse code practice programs on disk. Nearly complete collection of REMark issues through 4/83. All manuals, schematics, and software documentation. Package price: $1500. C. Frye, 2545 Nevada Ave., Oroville, CA 95965, (916) 534-7491.

FOR SALE: Adds Viewpoint terminal, 80-character by 24-line black-and-white terminal with detachable keyboard; looks and runs like new: $400. Dick Manning, POB 4386, Allentown, PA 18105, (215) 439-0351.

FOR TRADE: Want to swap programs for the TRS-80 Model III, any disk or tape program or utility. Send your list of programs and I'll send you mine. Tom Trepanier, 35 Lincoln Ave., Ardsley, NY 10502, (914) 693-6398.

FOR SALE: ZX81, 1K with BASIC and owners manual: $50. Andrew Case, 4565 Westcott Dr., Friday Harbor, WA 98250.

FOR SALE: Digital Group Z80A system with 56K RAM, audio-cassette board, eight parallel ports, Quad Phi-Deck drive with controller, D. G. Printer, full ASCII keyboard, and 9-inch Javelin monitor. Matched cabinets for all. Phimon, Opus, BASIC (4 versions), Assembler, Disassembler, and others. All for $900 or best offer. Roy Aydelotte, 620 Hibiscus Dr., Satellite Beach, FL 32937, (305) 773-3405.

FOR SALE: LNW-80 computer 48K RAM, double-density disk controller with DOS-PLUS 3.4 LNW BASIC for high-resolution graphics, 24 by 80 display, and more. Asking $900. Anh Pham, 3651 Beth Ct., Santa Clara, CA 95050, (408) 988-6294.

FOR SALE: Completed video-board kit with chips and RF modulator: $40. Decided to purchase display. Richard J. Willis, 10325 Caminito Cuervo #168, San Diego, CA 92108.

FOR SALE: OSI Challenger 2P 8K, plus some programs. Also, BYTE January through December 1978. Best offer. Robert Keelan, 11405 South Talman Ave., Chicago, IL 60655.

WANTED: Manual for the TI Silent 700 terminal. Wish to interface with Commodore 64. Need all data re; hardware, software, cables, etc. Am a writer and definitely an engineering novice. D. Cascio, 112-28 68th Dr., Forest Hills, NY 11375.

FOR SALE: TRS-80 Color Computer with 32K Extended BASIC: $325, disk drive: $295, modem: $70, line printer VIII: $395. Software included with processor, switchbox with printer. Dave Edick, 15938 Gramercy Dr., San Leandro, CA 94578.

FOR SALE: Sinclair ZX80 with 1K, full-sized keyboard, game cassette, and flicker-free board. Compatible with almost all ZX81/TS1000 products: $125 or best offer. Alvin Lam, 690 Sunset Pkwy., Novato, CA 94947, (415) 883-5286.

FOR SALE: SOROC IQ120 video terminal, more than a year old, excellent condition. Asking $400 or best offer. Niels Lauritzen, c/o Tryntje Lauritzen, 6250 Wissahickon Ave., Philadelphia, PA 19144.

FOR SALE: Sinclair ZX-80, slightly-used, with sound synthesizer, cassette cable manuals, learning lab, and 32 game program book. All for $70. Lance Gropper, 5020 Coldwater Cyn. Apt. #203, Sherman Oaks, CA 91423.

UNCLASSIFIED POLICY: Readers who have computer equipment to buy, sell, or trade or who are requesting or giving advice may send a notice to BYTE for inclusion in the Unclassified Ads section. To be considered for publication, an advertisement must be noncommercial (individuals or bona fide computer clubs only), typed double-spaced on plain white paper, contain 75 words or fewer, and include complete name and address. This service is free of charge; notices are printed once only as space permits. Your confirmation of placement is appearance in an issue of BYTE as we engage in no correspondence. Please allow at least three months for your ad to appear. Send your notices to Unclassified Ads, BYTE/McGraw-Hill, POB 372, Hancock, NH 03449.

Unclassified Ads

FOR SALE: IMSAI 22-slot S-100 system, IEEE-696 compatible. Front panel, 64K static 200ns RAM, Z80, and 8080 processor cards, 2SIO/2 serial I/O card, Micromation DD disk controller, and two disk drives. CP/M BIOS and all necessary disk utilities included. Excellent starter system working: $2000 firm. You ship or I deliver within 75 miles. A. L. Bender, 641 Victoria Terrace, Paramus, NJ 07652, (201) 652-0157.

WANTED: Apple II Plus-compatible software to swap. I am particularly interested in utilities and educational programs (including CP/M). Send a list of your programs and/or a disk of your more advanced programs. I will promptly return the same with some of my programs. Ursula Suesser, 2444 Northwest Green Circle, Corvallis, OR 97330, (503) 754-0293.

FOR SALE: Equipment left over from several large club projects. 49 2532 TI EPROMS @ $4 (almost new); 200 + 8-inch 128 byte IBM disks @ $2; 95 8-inch DS/DD IBM disks @ $3; 17 DECtape reels in cannisters @ $3. Roman Pawnyk, 8380 Pinehurst Dr., Parma, OH 44129.

FOR SALE: Radio Shack Mini-Disk Drive (cat no. 26-1161) in excellent condition: $400 or best offer. Richard Havanec, 575 Sedgewick Ave., Stratford, CT 06497, (203) 377-4080 after 5:30 p.m.

FOR SALE: North Star 18MB hard-disk drive with North Star HDOS. No bad spots. Less than a year old: $3095. John Strauch, 417 West 1st, Sonora, TX 76950, (915) 387-2273 days and 387-3784 evenings CT.

FOR SALE: ASR 33 with manuals. Hardly used: $200, pay shipping on delivery. Also, two Processor Technology 16K RAM boards modified to 64K less 4116 memory chips: $60 each. M. Gilbert, 154 Munson Ave., West Hempstead, NY 11552, (516) 486-0367.

WANTED: I am writing a book about software. Seeking unique or specialized software like manufacturing robots and general business software. Send SASE. Anthony Klosky, 1529 North Noble St., Chicago IL 60622.

FOR SALE: HP-41CV hand-held computer/calculator system including printer, bar-code wand, card reader, timer module, PPC ROM, statistics ROM, Extended functions/memory, and many hardware extras. All like new. Much software (scientific/medical applications) and documentation from HP and PPC (12 inches). Asking $750 or best offer including shipping. Will consider sale by the piece. S. J. Davidson, 1008 Kater St., Philadelphia, PA 19147, (215) 928-1551 or 842-6544.

WANTED: Used computer system, complete with display screen, printer, and software for word processing, etc. J. Leonard, 5700 Arlington Ave., Riverdale, NY 10471, (212) 548-9325.

FOR SALE: Texas Instruments Model 840 RO printer, configured as follows: tractor and friction feed, device forms control, 2K buffer, requires RS-232C, prints 75 cps, excellent condition: $725. Will send print samples if desired. Barry Kosoris, 509 Pecos Trail, Belton, TX 76513, (817) 939-2660.

WANTED: Apple II Plus computer with one disk drive, 3.3 controller. Very good condition, price negotiable. Mike Wexler, (201) 572-2970.

WANTED: Need information on the IMSAI MDIO Disk Controller card, especially schematic, I/O routines, and CP/M bios. David Schuler, 3032 Avon Rd., Bethlehem, PA 18017.

WANTED: Send a list of your Apple programs and I will send you mine. I am mainly interested in entertainment software. Please include a SASE. Greg Burns, 448 West Rd., New Canaan, CT 06840.

FOR SALE: Kaypro II computer; software and manuals included: $1650. Bruce Haedrich, POB 242, Eliot, ME 03903, (207) 439-0094.

FOR SALE: Zenith Data Systems Z-100, brand new, in the box, desktop, all-in-one computer. 192K RAM, one DSDD 5¼-inch floppy disk, 11.3-megabyte Winchester, 8- and 16-bit operating system with BASIC. Asking $4995. Steve Bergere, POB 311, Shenorock, NY 10587, (914) 241-0850.

FOR SALE: SOROC IQ 140 video terminal. Never used. Excellent condition. Make an offer. Watson Klincewicz, 1020 Ethel Ave., Fairview Village, PA 19403, (215) 539-6515.

FOR SALE: Dynabyte DB 8/1 and 8/4, 128K, MP/M, dual user, two 8-inch floppy disks, SSDD, DB Hayes Micromodem, software includes over 30 CPMUG, Microsoft BASIC compiler, Reporter spreadsheet, etc: $2995. Michael Block, 2700 North 29 Ave. #308, Hollywood, FL 33020.

BOMB
BYTE's Ongoing Monitor Box

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June BOMB Winners

Readers lauded the User's Column this month with first place going to Jerry Pournelle's "Zenith Z-100, Epson QX-10, Software Licensing, and the Software Piracy Problem." Dr. Pournelle wins $100. Second place and $50 goes to Steve Ciarcia for his article entitled "Use ADPCM for Highly Intelligible Speech Synthesis." Tim Paterson takes third place with "An Inside Look at MS-DOS," an overview of the popular operating system.

Correspondence

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At $249.95 retail it's an ideal and inexpensive companion for personal computers like Apple® (or Apple "look alikes" such as Franklin® or Albert®), TI,® Commodore,® TRS-80,® Kaypro,® Timex,® Osborne,® etc.

After that, it's merely comparable to other printers that can cost up to three times as much: 10″ carriages (to handle standard 9½″ paper), 80 columns, graphics capability, 10 characters per inch (expandable to 5 cpi) draft-quality print (for perfectly acceptable form letters, data processing, business reports, etc.) tractor feed (for precise alignment and quick loading), parallel or serial interface (take your pick), self-inking ribbon cassette (for long life and easy installation), 10 portable pounds in weight, and compatibility with so many of the most popular personal computers on the market.

Plus its printhead features a unique single-hammer design that eliminates a lot of moving parts, to eliminate a lot of annoying repairs.

That's the Banana: silly name, serious service. It's everything the expensive dot-matrix printers are . . .

Except expensive.

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Leading Edge Products, Inc., 225 Turnpike Street, Canton, Massachusetts 02021
Toll-free: 1-800-343-6833; In Massachusetts (617) 828-8150. Telex 951-624.

Compare Radio Shack's TRS-80® Model 4 With IBM® and Apple®

Model 4 Wins! And You Save Up to $1014

Description	Radio Shack Model 4	IBM PC	Apple IIe
Two-Drive Unit	**$1999**	$1864	$1995
Formatted Disk Capacity	**174Kb each (TRSDOS)**	180Kb (DOS 2.0) 160Kb (DOS 1.0)	124Kb (DOS 3.3)
80-Column	**Included**	Included	Included
Monitor	**Included**	$345	Included
Monitor Adapter	**Not Required**	$335	Not Required
First Drive	**Included**	Included	Included
Second Drive	**Included**	$289	$395
Parallel Printer Interface	**Included**	Included	$165
Serial Interface	**Included**	$120	$195
Reference Books	**Included**	Included	$50
Numeric Pad	**Included**	Included	$159.95
Diskette Operating System	**Included**	$60	Included
Total	**$1999***	$3013	$2959.95

TRS-80 Model 4 Is the Logical Choice. For performance and price, our Model 4 desktop computer is the professional approach to improving your productivity. It has features built-in that cost extra in other computers—features that will make your job a lot easier.

Designed to Make Hard Work Easy. The easy-to-read 80-character by 24-line display and 64,000-character memory make Model 4 perfect for complex spreadsheet analysis. To speed operations, our "MemDisk" emulates a super-fast disk drive in memory for keystroke-quick responses instead of time-consuming disk access. A built-in print spooler lets you work on one job while printing another.

Versatile and Powerful. We designed Model 4 to be completely compatible with our existing line of word processing, time management, electronic filing—in fact, *all* TRS-80 Model III software. And soon you'll be able to choose from thousands of CP/M®-based programs.

See It Today. Get a demonstration of the TRS-80 Model 4 (Cat. No. 26-1069) at your nearest Radio Shack Computer Center, participating store or dealer. Be sure to ask about our leasing, training and service plans, too.

Radio Shack®

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