Fruitful Connections.

There are more people in more places making more accessories and peripherals for Apples than for any other personal computer in the world.

Thanks to those people—in hundreds of independent companies—you can make the humblest 1978 Apple II turn tricks that are still on IBM's Wish List for 1984.

But now we're coming out with our very own line of peripherals and accessories for Apple Personal Computers.

For two very good reasons. First, compatibility. We've created a totally kluge-free family of products designed to take full advantage of all the advantages built into every Apple.

Second, service and support. Now the same kindly dealer who keeps your Apple PC in the pink can do the same competent job for your Apple hard-disk and your Apple daisywheel printer.

So if you're looking to expand the capabilities of your Apple II or III, remember:

Now you can add Apples to Apples.

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So you'll never miss a shot.

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Good tidings for crunchers of numerous numbers:
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So you can enter numeric data faster than ever before.
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In This Issue

The complete and integrated electronic office is still a few years away. Yet with each new product that computerizes an individual task or an entire procedure, we move one step closer to the day when paper shuffling is just a memory. Someday, as Robert Tinney suggests in his cover painting, workers at all levels will electronically communicate with the aid of the mighty microprocessor. In “Local Area Networks” Harry Saal discusses the need for standardizing communication protocols for physically separated equipment, such as personal computers, mainframes, printers, and disk drives. Steven Barry describes “The Fortune 32:16 Business Computer,” a multiluser, multitasking system that runs enhanced Unix. In “The Movable Conference” Irving A. Lerk reports on computer-modulated conferencing, and in a companion piece, “Electronic Publishing: The New Newsletter,” Arthur S. Bechohoer talks about how a traditional newsletter became a computer-accessed interactive investment advisory service. We have reviews of Radio Shack’s new Model 100 portable computer and of two versions of a new computer from Osborne, the Executive and the Executive II. In “Stalking the East-Asian Microcomputer,” Phil Leonmons chronicles his five-nation tour of the Far East. Steve Ciarcia’s project is to “Build an RS-232C Code-Activated Switch.” Plus our regular features and more reviews.

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DIGITAL MARKETING CORPORATION

Editorial

Signs abound that a long recession—the first to seriously affect computer manufacturers—is just about over. Anticipating upturns in demand, steel and auto makers have been recalling some employees laid off months ago. Declining oil prices cheer economists even as OPEC members gnash their teeth. Consumer prices have stabilized generally, and some economic forecasters don’t expect them to rise again until the second half of the year. Amid these upbeat indicators, however, there is clear evidence that the U.S. economy may never again be able to rely on such former bellwether industries as steel and autos. Millions of American consumers are disenchanted with Detroit because they believe U.S. auto makers no longer produce the type of product they want.

A recent editorial in the Wall Street Journal cited studies that quantify the disenchanted. In that editorial, John Schnapp, vice-president of Harbridge House, a Boston consulting firm, reported that of the buyers of U.S. subcompact cars surveyed recently only 22 percent were completely satisfied with their autos; 41 percent of the buyers of comparable import vehicles expressed complete satisfaction. Schnapp said further that U.S. auto buyers believe that Detroit has failed to deliver on three of their foremost needs—acceptable purchase prices, fuel consumption, and maintenance costs. The editorial concludes, among other things, that “the unlikelihood of a reconciliation between Detroit and the consumer will, unfortunately, dampen the prospects for a strong and broad-based recovery” from the recession.

We agree with Schnapp, but what does all this have to do with computers? We think that the U.S. computer industry can supplant the auto industry as an economic bulwark, especially if the management of computer companies heeds the lessons of Detroit. Simply stated, Detroit fell out of favor with part of the American-car-buying public because Americans no longer believe that U.S. auto manufacturers can satisfy their need for reliable, economical transportation.

As this nation shifts from a smokestack-based economy to a high-technology-based economy, computer manufacturers will face a similar consumer challenge. Both domestic and foreign suppliers have the opportunity now to discern what buyers need and follow through on delivery. Those suppliers who don’t consider consumer wants and needs in terms of economy and reliability will see that opportunity slip away.
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Spreadsheet Programs Help to Simulate Digital Logic

I enjoyed Robert McDermott’s “Simulation of Simple Digital Logic through a Computer-Aided Design System” (January 1983 BYTE, page 396). However, exactly the same results can be achieved with considerably less effort using the built-in Boolean functions of one of the popular electronic spreadsheet programs. I have not seen this application of these versatile programs described elsewhere in print.

As in McDermott’s article, complex digital structures such as D or JK flip-flops can be built up out of gates, simulated by Boolean expressions. Once a library of these structures is built up, the spreadsheet program can store them, and they can be moved about and replicated to form more elaborate structures. Used this way, spreadsheet programs have the same limitations as McDermott’s program: modest size and no way to handle hardware considerations such as gate propagation delay. In addition, care must be taken with feedback loops. However, for the casual user, simulating digital logic with one of these popular programs is far easier than adapting and validating McDermott’s program.

Stephen R. Troy
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Better Software Through Engineering

Allow me to congratulate Daniel Ross on his excellent (succinct) letter (February 1983 BYTE, page 26). I agree with him completely when he contests Jerry Fournelle’s defense of software hacking.

Having spent many years hacking away at my own codes and those of my fellow hackers and watching in embarrassment the inevitable and untimely crashes of those programs, I learned painfully that hacking creates programs that are at best unreadable and at worst unreliable. The (mal)practice is so prevalent and its results so uniformly bad that software maintenance costs are astronomical, and most people have come to assume that all programs have bugs. In fact, widespread hacking undermines the technical and ethical advancement of the software industry.

It is my contention that there will never be a credible software-engineering profession until we can guarantee the performance of our programs the same way a structural engineer guarantees that his bridge will stand. A hallmark of a professional is his legal responsibility for his product. Just as we can sue the physician for malpractice, we can sue the professional engineer if his bridge falls down. Has anyone ever tried to sue a programmer whose program did not work?

It has been my repeated experience that the only programmers who can guarantee that their codes will work are those who are skilled and disciplined enough to engineer their software. Using rigorous and systematic techniques to complement their creativity, these programmers work hard to produce a professional-quality program, a correct program, a program that can be reviewed by other professionals as well as coded in a reliable and maintainable fashion. When the profession climbs out of the mud, these people are the ones who will be able to take full legal responsibility for the work they do. The hackers will have to find another way to make a living.

Robert B. Dial
Comsis Corporation
Wheaton, MD 20902

Benchmark Surprise

In the November 1982 BYTELINES column (see “Latest 32-Bit Microprocessor News,” page 542), it was reported that someone at Berkeley had run benchmarks on several 16- and/or 32-bit microprocessors and then rated them, with a DEC VAX (what model?) being a 1.00.

Surely Intel Corporation’s iAPX-432 can do better than 0.05, when the 8-MHz Motorola 68000 got a 0.6, even if the 432 was running at half the speed of the 68000. Even the 8086 at 5 MHz got into the tens.

Thanks for the great magazine; I’ll keep my subscription going forever at this rate.

The Upjohn Company’s IBM 3081 running I. P. Sharp and Associates’ Spring 1982 release of APL under the IBM MVS operating system. A couple of full runs yielded processor times of around 256 milliseconds for an N of the first 8191 integers. After looking at the resulting list of primes we noticed a few nonprimes; obviously 8190 is not prime, nor are the more subtle 8133 (79 x 103), 8159 (41 x 199), and 8189 (19 x 431).

The above results put us into a debug mode, but as is often the case, debugging turns into a rewrite. We would thus like to submit an alternate APL solution that we believe rivals (beats) the best of the compiled or interpretive languages for speed of execution and memory requirement:

The Sieve Revisited

We read with great interest the January 1983 BYTE article by Jim Gilbreath and Gary Gilbreath, “Eratosthenes Revisited: Once More Through the Sieve” (page 283). Of particular interest to us was the inclusion of an APL solution. We recognized that this APL was of a nonstandard syntax. Typically (per the APL of STSC, I. P. Sharp and Associates, and the ANSI APL Standards Committee), within a statement, interpretation occurs from right to left; but when there are multiple statements per line (statements are separated by the ‘/’ symbol), these statements are considered for interpretation from left to right. The published APL solution required right-to-left line execution.

We transposed the published APL as follows:

```
   ST : PTRv Bp5 ,B ~N ~ ,Bp1 ~8t1 
```

We were then able to give it a try on The Upjohn Company’s IBM 3081 running I. P. Sharp and Associates’ Spring 1982 release of APL under the IBM MVS operating system. A couple of full runs yielded processor times of around 256 milliseconds for an N of the first 8191 integers. After looking at the resulting list of primes we noticed a few nonprimes; obviously 8190 is not prime, nor are the more subtle 8133 (79 x 103), 8159 (41 x 199), and 8189 (19 x 431).

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When we set our function loose on the first 8191 integers it required around 57 milliseconds to find all primes (approximating the time required for the first 10 iterations would thus be \(57 \times 10 + 57 = 222\) milliseconds). Artificially stopping our solution at 10 iterations (rather than letting it stop at the square root of \(N\), the largest integer) produced processor times around 30 milliseconds.

Our solution reduces the execution time by:

1. working primarily with a bit string, \(N\) bits long, rather than the entire list of \(N\) integers. This reduces both the execution time and the memory requirement (note: we were able to search the list of primes up to 792353 in only 300,000 bytes of work space, including space taken up by the program).
2. working with more efficient and fewer bit-string generators and primitives, and
3. taking the square root of the ending integer (used to test end of iteration) only once before the loop rather than taking the square of each newly found integer.

We hope that we have saved the name of APL by showing that although it is an interpretive language (and our processor time represents both interpretation and execution time), it can produce a fast, memory-efficient, and succinct solution. One additional benefit is the flexibility of this solution—without modification (or recompiling, linking, or loading) it may be used to locate primes in variable lists of integers from 1 to \(N\) where \(N \leq 792353\).

Michael C. Rowe, Ph.D.
Donald F. Stoneburner, Ph.D.
The Upjohn Company
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Kalamazoo, MI 49001

You might like to add the following data to your prime-number benchmark database (see the September 1981 BYTE, page 180, and the January 1983 BYTE, page 283). I ran the Sieve of Eratosthenes program on the Apple II in Micromotion FORTH (200 seconds) and Manx C tailored for Apple DOS (400 seconds). On a Data General MV/8000, using FORTRAN 77, I got a benchmark time of 2.2 seconds. The Manx version of C that I used employs a p-code interpreter.

John Figueras
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**BCD Conversion Better by a Bit**

I am a programmer specializing (for the moment) in Apples and working mostly in assembly language, and I find the machine-code program examples in your magazine a fascinating source of entertainment. I always look forward to the chance to analyze them. However, I found a few irregularities in listing 1 of Pat Coghlan and George White's "Another Binary to BCD Conversion Routine" (January 1983 BYTE, page 387). Unless the user has some code located at hexadecimal 1003, line 1440 (JMP $1003) should be changed.

The use of indirect indexed addressing would have eliminated the need for the use of location hexadecimal 56 in lines 1740 and 1750. Line 1750 could have been replaced with ADC (BCD), Y and line 1740 could have been eliminated. This would also save two clock cycles per iteration. Also, the comments in lines 2040 and 2050 state that the incoming carry will be added to the entire BCD (binary-coded decimal) field.

The incoming carry is the most significant bit from the last state of the binary field. However, the PBCD routine (lines 2070 through 2140) deals with only the least significant byte of the BCD field. Furthermore, on the first call to this subroutine, the BCD field is cleared to zeros, and for all other calls the BCD field has just been added to itself. This means that the BCD field will be either zero or an even number, and in either case the least significant bit will be zero.

Because the maximum value added to the BCD field by this routine is one and the least significant bit is always zero, no carry is ever possible. The BCC (branch on carry clear) following the add will always be taken. This causes the BPL (branch on sign flag equals zero) in line 2130 to be always bypassed. I have implemented this routine with the indirect indexed addressing in line 1750 and with lines 2120 and 2130 deleted and the routine still seems to work accurately.

Carl Haddick
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MEXIA, Texas 76667

**Apples and Fords**

In the letters column of the February 1983 BYTE (see page 24), Fred K. Fox draws an analogy between the Model T Ford and the microprocessors of today. I found an automotive approach relevant to the Apple IIe and Lisa computers reviewed in that issue.

Apple's Jobs and Wozniak (like Henry Ford) detected a huge, untapped market and produced a general-purpose machine. With little competition, it swept the field. As the public got used to the new machine, however, people began to develop more focused ideas about what they wanted from it. Other makers brought out models designed to deliver specific packages of features to specific market segments, at prices tailored to the market.

But Ford and Apple misread the resulting erosion of their markets as a need to incorporate the specific features of their competitors into their "universal" machines. Hence Ford tinkered with the Tin Lizzie, and Apple came up with the Apple II Plus and now the Apple IIe. But still, when most people look at the market, there always seems to be a specialized machine that delivers features a little better suited to their specific needs, and/or at a little better price. The machine that sets out to be a jack-of-all trades winds up being the master of none.

Lisa, on the other hand, seems analogous to the DeLorean. Both were designed as "machines of the future," embodying all sorts of bells and whistles that technophiles had been daydreaming about for some time. Most people agree that they're mighty fine machines, with features that it would sure be nice to have. Then they look at the price. After picking their jaws up off the showroom floor, they decide that they can somehow live another few years without those features, and go buy some other model.

Erwin S. Strauss
9850 Fairfax Square #232
Fairfax, VA 22031
TOUGH TO OUTGROW

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CompuStar solves the small business computer dilemma. It's ideal for those first time business users who need only single-user capability. But it's also perfect when those small businesses grow into large corporations. That's because CompuStar is truly expandable...all the way up to 255 workstations, each with its own processor and internal computer memory. And that means fast, fast response, even when many users are on-line at the same time.

Whether you're a small business with big plans or a big business with an eye for economy, CompuStar™ has the performance and versatility that's tough to outgrow...the price/performance ratio that's impossible to beat!

STANDARD FEATURES
• 380K/750K/1.5 MB workstation disk capacities
• 64K RAM and twin processors in each workstation
• An easy-to-read 12-inch non-glare screen
• Operator convenience features—numeric keypad and visual text highlighting
• Microsoft® Basic
• CP/M® operating software
• Truly multi-user and multi-processor

STORAGE OPTIONS
• 10 MB—compact, low-cost and tabletop
• 96 MB—fixed and 16 removable megabytes
• 144 MB—reliable, rugged Winchester storage

CompuStar™ is built and backed by the company that's been in the microcomputer business as long as microcomputers have been in business. Would you trust your business to anything less? CompuStar™ Tough to beat. Tough to outgrow!
# MICROHOUSE NEW LOWER PRICES!

We made business computing affordable.

## WORDPROCESSING

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## APPLE HARDWARE

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## IBM HARDWARE

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**BUSINESS SOFTWARE FOR LESS.**

**PEACHTEXT 5000**  
The new generation wordprocessor featuring Proofreader (spelling), Random House Thesaurus, PeachCalc, Data List Manager, all in one & all for a great price. Call for additional features.  
List Price: $395.00  
Microhouse Price: $249.00

**INFOSTAR**  
Micropro's Database Management System not only combines the already renowned features of Datastar and Supersort but also features a report generator. This means you can enter, sort, retrieve, organize, and print data quickly and easily...and with no need to program! But that's not all...you can edit your reports with Wordstar.  
List Price: $495.00  
Microhouse Price: $279.00

**dBASE II / ZIP**  
A powerful, yet easy-to-use data management system. In constructing and manipulating numeric and character information files, you create databases, append new data, update, modify and replace fields, records, and entire databases. Its special feature allows you to sort, edit, or display a database directly from the keyboard, or program menus and programs to support your specific applications.  
List Price: $700.00  
Microhouse Price: $529.00

**MEDICAL MANAGER**  
The Medical Manager is a powerful office management tool for running all the accounting functions of today's medical office. This menu driven program can maintain multiple doctor practices, generate all financial reports, allow automatic third party insurance billing and has password protection for data security. Every medical practice should have this valuable program.  
List Price: $3500.00  
Microhouse Price: Call!

**MEMORY SHIFT**  
With Memory Shift you assign specific amounts of memory to 9 partitions or screens all of which can contain a different program. Say you're typing a document in a wordprocessor and you'd like to include some calculations. Simply push a key and call up screen 6 which contains your spreadsheet. Do your calculations and automatically incorporate them into your document. It's like having 9 IBM's in one. Call Microhouse for more information!  
Microhouse Price: $95.00

**COMBINED LIST PRICE**  
**MICROHOUSE PRICE**

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**SPECIAL PACKAGES $$**

**DEALERS INQUIRIES WELCOME**  
For technical Support call 215-868-4133.

**MICROHOUSE**  
Your Micro-Computer People!  
1444 Linden St./P.O. Box 499, Dept. 201, Bethlehem, PA 18016  
Circle 306 on inquiry card.
Little Big Computer
The TRS-80 Model 100 Portable Computer

Way back in 1977, Radio Shack introduced the TRS-80 Microcomputer System, a computer we now know as the Model I. It was not the first microcomputer to become available, but it was one of the first complete computer systems to be offered to the general public. The Model I subsequently spawned a whole line of microcomputers. The familiar gray-and-black motif became a standard feature of small businesses all over the country, and Radio Shack became one of the country’s leading computer manufacturers. Now, six years after the Model I, Radio Shack releases the TRS-80 Model 100 (see photo 1), which by its small size, its off-white color, and its easy-to-use features seems to signal a new direction for the Texas company, a direction that may prove to be as significant as that of the original Model I.

In brief, the Model 100 is a big computer in a little package. It features a large (8-line by 40-character) LCD (liquid-crystal display), a standard-size keyboard, a low-power version of the 8085 microprocessor, 32K bytes of ROM (read-only memory), 8 to 32K bytes of RAM (random-access read/write memory), and a cassette interface. It also includes a built-in direct-connect modem with auto-dial and auto-log-on capabilities, an RS-232C serial port, a parallel printer port, a real-time clock/calendar, and even an interface for a bar-code reader. And that’s just the hardware. The built-in software includes an easy-to-use text editor, a Microsoft BASIC interpreter, a communications program for the modem, and an addressbook and appointment-schedule program. This all comes in a box that weighs less than 4 pounds and is smaller than the manual for the Model I. The price ranges from $799 to $1134, depending on the amount of memory you need. Overall, this is a well-designed, integrated machine that should prove to be very useful to a large number of people.

The Model 100 is not perfect for everyone, however. Serious hardware hackers will be frustrated by the inability to swap boards. Software enthusiasts will want more RAM and some disk storage. And professional writers will need a larger display and a lot more memory. Taken in its own context, however, the Model 100 is an extremely successful design. It should be quite useful for three groups: businesspeople who need a portable workstation, advanced computer users who need a portable terminal for their main system, and
Test drive our mouse.

It’s no secret. This is certainly “The Year of the Mouse.”
And the uproar is justified.
This “see and point” interface is the most natural, powerful and efficient way to interact with your computer.
And Mouse Systems’ optical PC Mouse, now available with software support for the IBM PC, is easily the best of its breed; easily the best at making your computer user-friendly.

Grasp The Future of PC Technology
Slide our PC Mouse across its desckpad. It’s optical. There are no moving parts. Your cursor instantly moves across your CRT in response.
No other device gives you such total, accurate control over cursor positioning.
The ergonomically designed PC Mouse is so smooth and natural in its movements, you’ll soon be using it almost subconsciously.
Your attention can thus remain on the screen and not on the keyboard, and your concentration will be increased dramatically.
PC Mouse lets you use this new freedom to take full advantage of today’s “visual” software products.
(For a truly enlightening experience, ask your dealer to demo PC Mouse with IBM’s Personal Editor.)

PC Mouse vs. The Keyboard
Named Mini/Micro’s most significant new product of 1982, PC Mouse lets you bypass your keyboard for instant menu selection and function activation.
And PC Mouse requires no changes in your existing software. All cursor-related functions in Wordstar, VisiCalc, and other popular programs are replaced by the mouse.
In one darting stroke, you eliminate the pondering and second-guessing of typing complicated command codes.
For systems designers and OEM’s PC Mouse’s potential is staggering.

Simplicity, Itself
Just attach the PC Mouse to your PC’s RS-232 port. Each of the three buttons is user-programmable, giving you nine different functions at your fingertips.
And our software compatibility assures instant system integration and simple start up.

Get It Now
PC Mouse is immediately available for $332.00 including control software and all necessary hardware for your IBM PC.
For ambitious software developers, the optional $40.00 MouseWindow™ software package includes routines to do high resolution graphics and “pop-up” windows.
An OEM version of PC Mouse can also be supplied in quantity now, configured to your custom specifications.
For more details see your dealer, or contact Mouse Systems at 2336H Walsh Avenue, Santa Clara, CA 95051. Telephone (408) 988-0211 or Telex 467848.

Mouse Systems
Making Computers User Friendly.
Circle 317 on Inquiry card.

VisiCalc is a trademark of VisiCorp.
Wordstar is a trademark of Micro-Pro, Int'l.
IBM and PC are registered trademarks of International Business Machines.
novices who want to experiment with a useful, powerful computer for a fairly modest cost.

Physical Dimensions

Because desk space tends to get crowded and briefcases rapidly fill, the size of a portable computer is a key factor. As for the Model 100, if you can make space for a standard 3-ring binder, you have more than enough room for this machine. The dimensions are 11½ by 8½ by 2 inches, similar to the Epson HX-20. The weight is 3 pounds, 14 ounces.

The computer's case is off-white, a color that is becoming popular with Radio Shack. The top of the unit shows the display, a low-battery indicator, and the keyboard. On the right side are an on/off switch, a dial for adjusting the LCD's brightness, and an AC adapter connector. On the left side are the bar-code-reader connector and two switches for the modem (direct/acoustic and originate/answer). The rear panel contains the phone connector, the cassette connector, a printer connector, an RS-232C connector, and a well-protected Reset button. The bottom of the unit features the battery compartment, a compartment for an expansion ROM module and an external bus connector, and a RAM power switch (to be turned off only when the machine will not be used for an extended period).

The Display

The first thing you notice about the Model 100, besides its size, is the LCD shown in photo 2. The Model 100 can display 8 lines of 40 characters each. That's a little less than half of the typical home computer screen. It also can display graphics with a resolution of 240 by 64 pixels. Each character is composed of a 5- by 7-pixel area. Lowercase descenders on letters such as p and q make use of the row of pixels below the character area that is normally used to separate lines. The bottom line of charac-
MAX—256K to 1M S-100 Memory

CANOGA PARK—March 30, 1983—Mike Pelkey, Macrotech International president, today released details of the revolutionary MAX line of S-100 memory boards. Pelkey stated: “IEEE-696 now has a new standard for dynamic memory. The MAX product line offers 256K to 1M, at a price that ranges down to less than $0.00023 per bit.” Pelkey continued, “The M1 product line now includes our ultra fast (70 ns)128K static memory, with battery backup capability, plus the 150 ns dynamic memories—in every 128K step from 256K through 1M (1024K) bytes, and add-on kits to permit field upgrade of sizes.”

The extreme density of the MAX family is made possible through the use of proprietary PALs (programmable array logic). Also stated as available for add-on to any size MAX is Macrotech's popular M3 memory mapping architecture. M3 permits the 16-bit address space of an 8-bit processor to be dynamically mapped in 4K pages into as much as 16 megabytes of physical memory.

Parity error detection and 8/16 bit data transfer capabilities are provided as standard on the MAX series memory board.

Software for M3 Available

BURBANK—March 30, 1983—“M3 bank switching for 8-bit processors is much more useful with the new creative systems programs,” states Dan West of Westcom Systems Inc. MP/M II* disk intensive applications are greatly improved with the new Virtual Disk routines now available through Macrotech OEM’s and dealers for their M3 memory boards.

Westcom Systems, as the software consulting firm for Macrotech, has also provided subroutine listings to easily incorporate M3 mapping into the new CP/M 3.0* (CP/M Plus*) Bios module. The advantages of CP/M 3.0* with disk buffering, hashed directories, and user program expansion go hand in hand with Macrotech’s flexible “bank switched” memory capabilities.

All Macrotech software and manuals are available through Dan West’s Compuserve account #70250,102.

Leave comments/questions as E-Mail.

These new techniques can combine the above features with custom needs of the future, such as printer buffering, multi-page display and memory-intensive graphics displays.

The software listings are included in the Macrotech memory board manuals and are optionally available on 8” diskettes.

*CP/M 3.0, CP/M Plus, and MP/M II are registered trademarks of Digital Research Inc.

Circle 271 on inquiry card.
The main problem occurs with tabular material wider than 40 columns. But tables tend to be a problem on about 60 degrees from the horizontal. Contrast can be better than pixel by pixel (smooth scrolled). The display is somewhat reflecting ceiling lights, but apparently it seems a little slower than most video displays, but not objectionably so.

The screen contrast is fairly good, but decreases quickly as you move away from an optimum viewing angle of about 60 degrees from the horizontal. Contrast can be adjusted with a dial on the right side of the machine. I had no problem reading the display whether it was on a desk or on my lap. The LCD does tend to reflect ceiling lights, however, and this could be a problem in certain offices. Placing the unit on your lap should solve this problem somewhat.

As in most displays, scrolling is done line by line, rather than pixel by pixel (smooth scrolled). The display seems a little slower than most video displays, but not objectionably so. Although the display is smaller than the typical home display—and a great deal smaller than the typical 80 by 24 office display—I grew accustomed to it fairly easily. It is a very good size for menus. The main problem occurs with tabular material wider than 40 columns. But tables tend to be a problem on all machines, and fortunately such tables do not occur frequently in general correspondence.

The large size of the characters and the nonflickering quality of the LCD caused me much less eyestrain than the usual cathode-ray tube display.

The Keyboard

The second most obvious thing about the Model 100 is its full-size keyboard (see photo 4). While the display is obviously limited by the small size of the unit, the keyboard exhibits few signs of compromise. In fact, it is one of the nicest keyboards I've used on any machine, large or small.

Most of the keys are in the standard Selectric-style arrangement. The Backspace, Control, and Return keys are in their usual places. The cursor control keys are located just above the Backspace key and are arranged in a horizontal row (L-R-U-D). This cursor key arrangement is fairly common, but I much prefer a diamond arrangement for these keys.

The keyboard is controlled by its own microprocessor, and it has a good type-ahead buffer. No matter how fast I typed, no characters were dropped. Key repeat is also provided.

Special shift keys marked Code and Graph allow you to key in all 256 of the Model 100's characters directly from the keyboard.

Twelve function keys are located above the main keyboard. Four of these are permanently marked and have constant functions in all the application programs that come with the machine. "Paste" works as a Block Insert key; "Label" turns the line of function key labels on and off; "Print" is used to print either the contents of the display or an entire file; and "Break/Pause" either terminates or temporarily halts execution of a process, depending on whether the key is cap shifted or not.

The other eight function keys are programmable and are not permanently labeled although they tend to have the same function in each application program. This is a good design feature. As mentioned previously, the bottom line of the display can be used as a label for these keys. Unfortunately, the labels do not line up exactly with the keys. These keys also have interrupt capabilities that could be put to use by advanced computer users.

A "Num" key converts some of the keys into a slanted numeric keypad. Because I'm not a numeric touch-typist, I couldn't test how easy this strange configuration would be to work with. If a numeric keypad is important to you, I suggest you test this keypad in the store to see if you can work with it.

While the Model 100's display was obviously limited by the small size of the unit, the keyboard exhibits few signs of compromise.
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Inside the Model 100.

The right side are the undersides of the liquid-crystal display (top) and keyboard (bottom). The left side shows the main circuitry. The modem circuitry is in the upper left-hand corner. The random-access memory is in the lower left-hand corner. The 80C85 microprocessor is in the central part of the left side.

One slight problem with the keyboard is the sound each key makes. It's not a click exactly; it's more like a pop—a quite audible pop. In fact, a plane full of business executives typing on these machines might drown out the engine noise. That, of course, is an exaggeration, but the key-popping may cause a slight problem in quiet places such as libraries. Admittedly this is a small complaint, but if I were Radio Shack I would investigate putting some type of sound-dampener under the keys.

Processor

The Model 100 uses the 80C85 microprocessor chip, a low-power CMOS (complementary metal-oxide semiconductor) version of the 8085, which is a well-respected member of the 8080 family. The clock speed for the microprocessor is 2.4 MHz. One of the advantages of the 8085 is its extensive interrupt capabilities, which, as we will see later, are well exploited by the Model 100's BASIC interpreter.

Memory

Each Model 100 contains 32K bytes of ROM. This is used to store a small menu-based operating system and five application programs. As for RAM, you have a choice of 8, 16, 24, or 32K bytes. The 8K-byte RAM machine sells for $799. Each additional 8K bytes of RAM costs $120 plus a $15 installation charge. Thus, a 24K-byte machine should cost $799 plus $240 plus $15, or $1054. Radio Shack, however, is offering a special price for the 24K-byte machine of $999—a savings of $55. A full 32K-byte machine should then cost $135 more, or $1134.

The RAM is of the low-power CMOS type, and it is protected by its own power supply. This memory is powered at all times, whether the machine is on or off. Even after main battery failure, memory power continues for 8 to 32 days. There are apparently only three ways to wipe out the contents of memory: letting the batteries run down and not replacing them for a long time, initiating a cold start or Reset, or turning off the memory power switch on the bottom of the machine (which should be done only when the machine will not be used for an extended period of time).

As on most 8-bit processor machines, the maximum addressable memory space is 64K bytes. The memory appears to be allocated as follows: the bottom 32K bytes of memory (addresses 0 through 31999) are taken up by the ROM. The first 8K bytes of RAM fills the top 8K bytes of memory. Each additional 8K bytes of RAM is installed in the next highest 8K bytes of memory. The topmost part of the first 8K bytes of RAM is used by the computer's operating system for display memory and to store pointers for the BASIC programs and document files. These files are stored in the lowest part of RAM. The part of RAM between the pointers at the top and the files at the bottom can then be used for new files or for arrays for the BASIC programs. With a 32K-byte RAM machine, you have 29.6K bytes of RAM free; with the 8K-byte RAM machine, you have only 5.1K bytes of RAM free.

Future ROM modules for the ROM expansion socket will occupy the same address space as the built-in 32K-byte ROM. You will then be able to switch between the two banks of ROM available.

Some advanced users may feel limited with only 32K bytes of RAM. But programs such as the text editor reside outside of the precious RAM area. Also, the display eats up very little RAM. The result is that you can use almost the entire RAM area for document storage.
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The machine I used had 32K bytes of RAM, and after about 25 hours of typing notes and running BASIC programs, I still had about 16K bytes of RAM left. Even with the 24K-byte machine, I think I would probably run out of batteries or things to write about before I ran out of memory.

I enjoyed using this type of protected RAM. It was a pleasure knowing that I did not immediately have to save everything and that whatever I put into memory would stay there until I deleted it. Still, on this or any other machine, irreplaceable files should be backed up.

Power Supply

For a portable computer that depends on RAM for data storage, the power supply is a crucial issue. On the Model 100, power is supplied by four AA batteries or by the optional AC adapter. Operating life of the batteries is about 20 hours. This time can be shortened if excessive use is made of the various interfaces (modem, cassette, printer, RS-232C). Because these interfaces will probably be used primarily within reach of an AC socket, this power drain should not be a big problem. The low-battery indicator lights when 20 minutes of battery power are left. I used the machine for about 15 hours, making extensive use of the printer and cassette interfaces, before the low-battery indicator went on. And then the machine continued for another hour and a half before it finally died. That seems to be ample warning to get more batteries.

The Model 100's volatile memory is protected by its own power supply, a separate nicad (nickel-cadmium) battery that is continually recharged by the main batteries or by the AC adapter. When the main batteries fail, the nicad battery will continue to power the memory for an extended period of time, depending on the amount of RAM you have. With 8K bytes of RAM, you have 32 days before the memory is lost. Even with 32K bytes, you still have 8 days to get new batteries.

Modem

In keeping with its portable nature, the Model 100 was given extensive communications capability. A key element in this design is its built-in direct-connect modem. All you need is the optional phone connector ($19.95) and you can plug into any standard modular phone jack. If a modular phone jack is not available, you can use an optional acoustic adapter with any regular phone.

The modem is a standard Bell 103-compatible version with a transmission rate of 300 bps (bits per second). Auto-dialing capability is also included. However, it can dial only in the pulse mode, like a standard rotary-dial telephone. Radio Shack says it would have liked to add tone-dialing capability, but it was not available on low-power CMOS chips. If you have a private telephone system that can handle only tone-dialing, you will have to dial manually. The pulse dialing rate, by the way, can be set at either 10 or 20 pulses per second.

You have the option of using several serial communications parameters: the word length can be either 6, 7, or 8 bits. Parity can be handled in one of four ways: Ignore, Even, Odd, or No parity. The number of stop bits can be either 1 or 2. And the pause/continue protocol frequently indicated as XON/XOFF or <Ctrl S>/<Ctrl Q> can be enabled or disabled.

The Model 100's modem in combination with its ROM-based communications program presents a quite powerful package. The only thing I might want to have added is auto-answer capability, but this might not be a cost-effective option. After all, a portable machine like this will probably not be in one place long enough to receive phone calls.

RS-232C Interface

The Model 100 also has an RS-232C serial connector for connecting to serial printers, other computers, or high-speed (1200-bps) modems. This interface uses the same circuitry as the modem, and all communications parameters for the modem will likewise affect the RS-232C connector. Unlike the modem, however, the RS-232C port has a wide range of transmission rates: from 75 to 19,200 bps.

Parallel Printer Interface

For connections to most printers, the Model 100 has a parallel printer port. This takes the form of a 26-pin, dual-row connector on the rear panel of the machine. An optional connector cable converts this to a standard
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Centronics-type plug. I was surprised they didn't put a standard Centronics jack on the machine itself.

The Print key prints out through this interface. I connected the Model 100 to a Radio Shack Lineprinter VIII and it worked without any problem, except for a few of the Model 100's nonstandard graphics symbols that could not be printed.

Cassette Interface

Besides uploading and downloading files over the telephone lines, you can also store files on a cassette. The Model 100's cassette interface stores information at the rate of 1500 bps. This translates to about 20 seconds for a phone line, you can also store files on a cassette. The standard Centronics jack on the machine itself.

The Model 100's nonstandard graphics symbols that could be disconnected the Model 100's cassette interface stores information at the rate of 1500 bps. This translates to about 20 seconds for a phone line, you can also store files on a cassette. The standard Centronics plug. I was surprised they didn't put a standard Centronics jack on the machine itself.

After 10 minutes of not being used, the machine turns itself off to save battery power. This time interval can be lengthened or shortened or it can be disabled.

Options

Perhaps the most valuable option is the phone connector cable. This cable, which sells for $19.95, allows you to insert the Model 100 between a standard modular phone and its phone jack. The cable package also includes automatic log-on sequences for CompuServe and the Dow Jones News/Retrieval services, plus membership in these services and one hour's free time on each. That's quite a bit for $20.

The cassette cable comes free with the optional Radio Shack cassette recorder or can be purchased separately for $5.95. The printer cable for connecting a printer to the Model 100's parallel port costs $14.95.

For people who may not have access to a modular phone jack (as in certain hotel rooms or in phone booths), Radio Shack will be offering an acoustic adapter that consists of two cups that fit onto a regular telephone handset. This should be available some time this summer for about $50.

The bar-code reader is designed to work with a Hewlett-Packard bar-code wand. Software for this option will probably be available at some future time.

The Model 100 also allows for options that have not yet been announced. On the bottom of the machine is a compartment for a 32K-byte ROM module. We can only speculate about what type of software Radio Shack will put on such a chip (a mini-spreadsheet program?). Also in this compartment is a 40-pin external bus connector. Radio Shack is not telling, but this would seem to be perfect for adding storage devices or a larger display.

Software

It has frequently been said that you should buy a machine not for its hardware but for its software. Microsoft, the designer of the Model 100's software, really took that maxim to heart. On top of the impressive collection of hardware that makes up the Model 100 is an equally impressive collection of software. This is one computer you can start using immediately; you won't have to wait six months to a year for the software to be developed.

Not only are the various software packages extensive, easy to use, and of fairly good quality, but they also work well with each other and are all crammed into just 32K bytes of ROM. Of course, judging software is a subjective task, but if you keep in mind the design goal of the machine—an easy-to-use portable workstation—I'm sure you'll agree that this goal has been reached and then some.

When the machine is turned on, a simple operating system is engaged and the system's main menu appears. This shows the time, the date, the amount of free memory available, and a list of all the files in memory. The five built-in application programs are listed with no filename extension. Document files all have the extension "DO"; BASIC programs have the extension "BA".

Choosing a particular file to work with is easy. You simply move the cursor over that file name and press Return. If a document or BASIC program is chosen, the
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text editor or BASIC interpreter, respectively, is automatically invoked. Typical operating-system functions such as file deleting are handled in BASIC.

When you finish with a particular file or program, you press one of the function keys marked Menu. This closes your file and returns you to the main menu again. Having the complete list of files appear on each warm boot, as it were, is a particularly good idea. It makes the system extremely easy to use and would save time on any operating system.

The five application programs included as standard equipment are the following: a text editor (TEXT), a BASIC interpreter (BASIC), a communications program (TELCOM), an address-book program (ADDRESS), and an appointment-calendar program (SCHEDL). These programs work well with each other. TEXT can be used to edit BASIC programs or the data files used by TELCOM, ADDRESS, and SCHEDL. Also, TELCOM and ADDRESS share the same data file.

The Text Editor

TEXT will probably be the most used program on the Model 100. It is a full-fledged character-oriented editor (i.e., not a line editor) with word-wrapping, so that words are not broken mercilessly at the end of those 40-character lines. Owing to its compactness, it lacks many of the features found on large packages such as Wordstar or Perfect Writer, but it is well designed, simple to learn, and fairly powerful.

TEXT contains only the most needed functions of a word processor, but makes up for this shortage of functions by making those it has as easy to use as possible. These functions are Insert, Delete, Search (Find), Copy a block, Delete a block (Cut), Insert a block (Paste), Save on cassette, Load from cassette, Print, and Cancel any operation (Break). Note the use of familiar names such as Cut and Paste.

Using TEXT is simple. To create a file, you merely choose TEXT in the main menu. Because it's already in memory, TEXT "loads" in an instant and asks for a filename for your new file. After that everything you enter becomes part of that file. All controls are handled by function keys. You don't have to remember any control key combinations. For those who prefer them, however, each function key has a corresponding control key combination. Of course, if your text will later be used by another word processor, you can embed the necessary commands into your text.

An interesting thing about TEXT is that it is always in the Insert mode. In other words, you can't "write over" anything you've already written. You must insert the new material and delete the old or vice versa. This took a little while to get used to, but it actually makes a lot of sense and saves time. Most of the editing I do is either inserting or deleting, and this makes the first of the two a bit easier.

As I said earlier, some functions had to be left out, but some of these are quite useful. Perhaps they can be handled by small BASIC utilities. For example, a Search and Replace function could probably be handled by a short BASIC routine. Also, an indication of the file length (which is quite important on a machine with a small display) might be provided by a short BASIC word-counter.

Lastly, the Print function allows you to print either the whole document file or just the contents of the display. It will print in whatever line length you want, and the lines will be word-wrapped. The only problem is you can't set the left margin. Again, a short BASIC routine could probably handle this also.

To test the performance of TEXT, I tried a little text-editing benchmark. I timed how long it would take to retrieve a 150-word letter, change the date, the addressee, the address, and the salutation, and then store the new
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letter. My average time on TEXT was about twice as long as it is when I use Magic Wand, the word processor on my 4-MHz, 280-based office machine, with which I am quite familiar. Undoubtedly, some of this time difference is due to my inexperience with the portable unit; and some of it is due to the fact that TEXT is always in Insert mode, and thus simple write-over corrections require twice as many keystrokes; but a large portion of the difference is due to the slowness of the Model 100's LCD versus the 9600-bps display on my office machine. Subjectively, however, the Model 100 "seemed" faster than my office machine because it did not need extra time to load the text editor and the document file from the disk and later store the document on disk and reload CP/M (do a warm boot).

This illustrates a nice feature of the Model 100. You don't have to wait for the disk drives or for the display tube to warm up. You can take the machine out of your desk drawer, turn it on, and be writing a memo in about 2 seconds.

Overall, I found TEXT to be a good product. It seems perfectly designed for the Model 100, almost like a hand in a glove. Even the novice user should be able to write a short letter on it in about an hour, and there aren't many word processors you can say that about.

**BASIC**

For the Model 100's **BASIC** interpreter, Radio Shack has again gone to its traditional source—Microsoft **BASIC**. Of course, a few commands are missing on the Model 100 version of MBASIC, but several more have been added to take advantage of the interrupt capabilities of the 8085 processor, and it is well integrated with the Model 100's other application programs.

Table 1 describes some selected commands. Of particular note are the interrupt-handling commands, which can work with the modem, the clock, the RS-232C port, and the function keys. For example, in a long program you can insert a routine to handle an interrupt from one of the function keys. Then, whenever that function key is pressed, control is automatically transferred to that routine. The program does not have to continually check the function keys to see if they have been pressed.

As mentioned before, some commands such as **WHILE**...**WEND** are missing, but these can be replaced with combinations of other commands.

As for performance, I timed the **BASIC** interpreter with the **Eratosthenes Sieve** benchmark described in the January issue of *BYTE* page 283. The Model 100 took 2820 seconds for 10 iterations of the routine. Compare this with 2880 seconds for **BASIC** on the TRS-80 Model III, 2806 seconds for Applesoft **BASIC** on the Apple II, and 1950 seconds for **BASIC** on the IBM PC.

Like the other application programs, the **BASIC** interpreter is integrated with the text editor. The result is that you can edit your **BASIC** programs in two ways: either by using the common line-oriented approach or by using **TEXT**. To use the latter method, you merely type **TEXT** while in **BASIC** and your program will be translated into **ASCII** and **TEXT** will be invoked. When you leave **TEXT**, your program will be translated back into its normal tokenized form. Long programs can require a few seconds for these translations to occur.

The Model 100's **BASIC** is also well integrated with the machine itself. Every hardware port and interface seems

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLOAD?</td>
<td>Loads a machine-language program from cassette</td>
</tr>
<tr>
<td>CLOADM</td>
<td>Saves a machine-language program on cassette</td>
</tr>
<tr>
<td>COM ON/OFF/STOP</td>
<td>Enables/disables communications interrupt</td>
</tr>
<tr>
<td>CSAVE M</td>
<td>Saves a high-memory address</td>
</tr>
<tr>
<td>CSSAVEM</td>
<td>Saves vertical cursor position</td>
</tr>
<tr>
<td>DATE$</td>
<td>Returns the current date (MM/DD/YY)</td>
</tr>
<tr>
<td>DATES$</td>
<td>Represents the current date (MM/DD/YY)</td>
</tr>
<tr>
<td>DAY$</td>
<td>Represents the day of the week (e.g., Fri)</td>
</tr>
<tr>
<td>EDIT</td>
<td>Invokes text editor</td>
</tr>
<tr>
<td>ERL</td>
<td>Gets line number of error</td>
</tr>
<tr>
<td>ERR</td>
<td>Returns error-code number</td>
</tr>
<tr>
<td>FIX</td>
<td>Truncates real numbers</td>
</tr>
<tr>
<td>HIMEM</td>
<td>Returns high-memory address</td>
</tr>
<tr>
<td>INP</td>
<td>Inputs data from a port</td>
</tr>
<tr>
<td>INPUTS(N)</td>
<td>Inputs N characters from keyboard</td>
</tr>
<tr>
<td>INPUTS(N,F)</td>
<td>Inputs string of length N from file numbered F</td>
</tr>
<tr>
<td>INSTR</td>
<td>Searches for a given string</td>
</tr>
<tr>
<td>IFL</td>
<td>Defines function key as string</td>
</tr>
<tr>
<td>KEY</td>
<td>Defines function key as string</td>
</tr>
<tr>
<td>KEY LIST</td>
<td>Lists current functions of function keys</td>
</tr>
<tr>
<td>KEY ON/OFF/STOP</td>
<td>Enables/disables function-key interrupts</td>
</tr>
<tr>
<td>LCOPY</td>
<td>Copies screen to printer</td>
</tr>
<tr>
<td>LINE INPUT</td>
<td>Inputs string from keyboard</td>
</tr>
<tr>
<td>LPOS</td>
<td>Returns the current position of printer head</td>
</tr>
<tr>
<td>MAXFILES</td>
<td>Represents the maximum number of open files</td>
</tr>
<tr>
<td>MAXRAM</td>
<td>Returns the maximum amount of RAM available</td>
</tr>
<tr>
<td>MDM ON/OFF/STOP</td>
<td>Enables/disables modem interrupt</td>
</tr>
<tr>
<td>MENU</td>
<td>Closes files and returns to main menu</td>
</tr>
<tr>
<td>ON COM GOSUB</td>
<td>Defines routine to handle RS-232C interrupt</td>
</tr>
<tr>
<td>ON KEY GOSUB</td>
<td>Defines routine to handle function-key interrupt</td>
</tr>
<tr>
<td>ON MD M GOSUB</td>
<td>Defines routine to handle modem interrupt</td>
</tr>
<tr>
<td>ON TIMES GOSUB</td>
<td>Defines routine to handle clock interrupt</td>
</tr>
<tr>
<td>OPEN</td>
<td>Opens file and sets logical file number</td>
</tr>
<tr>
<td>OUT</td>
<td>Outputs a byte to processor port</td>
</tr>
<tr>
<td>POS</td>
<td>Returns horizontal screen position</td>
</tr>
<tr>
<td>POWER</td>
<td>Sets automatic power-down period</td>
</tr>
<tr>
<td>POWER CONT</td>
<td>Turns off power-down feature</td>
</tr>
<tr>
<td>PRESET</td>
<td>Turns off clock interrupt</td>
</tr>
<tr>
<td>PRESET</td>
<td>Turns off the printer head</td>
</tr>
<tr>
<td>RESUME</td>
<td>Resumes execution after error</td>
</tr>
<tr>
<td>SCREEN</td>
<td>Turns off/on function-key label line</td>
</tr>
<tr>
<td>SOUND</td>
<td>Generates a tone</td>
</tr>
<tr>
<td>SOUND ON/OFF</td>
<td>Enables/disables beep when carrier signal comes on telephone line</td>
</tr>
<tr>
<td>SPACES</td>
<td>Defines a string of spaces</td>
</tr>
<tr>
<td>STRINGS</td>
<td>Defines a repetitive string of a given character</td>
</tr>
<tr>
<td>TIMES</td>
<td>Represents the time of day (HH:MM:SS)</td>
</tr>
<tr>
<td>TIMES ON/OFF/STOP</td>
<td>Enables/disables time interrupt</td>
</tr>
<tr>
<td>VAR PTR</td>
<td>Returns memory address of a given variable</td>
</tr>
</tbody>
</table>

Table 1: Some selected commands found on the Model 100's version of Microsoft **BASIC**.
Typically, financial planning on a timesharing service runs $2,000 a month and more. Month after month after month.

And it doesn't take a spreadsheet to figure that as a $24,000-a-year-after-year expense.

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Time's a-wasting.

ASHTON-TATE
In order to take advantage of the built-in modem, Radio Shack has provided the Model 100 with a built-in communications program, and a fairly powerful one at that.

With this program, you can automatically dial a database and execute the required log-on procedures. Once online, you simply press a function key to upload any of your document files onto the database or download a file onto your Model 100. Other function keys let you "echo" your communications to a printer or change from the full-duplex mode to half-duplex.

In the event a database sends you more than eight lines of text at once, Radio Shack has even supplied a function key that lets you refer back to the previous eight lines.

The upload routine includes a very important feature that, surprisingly, is frequently missing from communications software packages. When you upload a document, TELCOM will automatically format it to any line length that your database requires. This is important because some systems cannot handle lines that are longer than a certain length.

The TELCOM program can even be used as an auto-dialer for voice communication.

I found TELCOM a bit harder to use than TEXT or BASIC. The auto-dial and auto-log-on routines use special notation, which is a little hard to remember. Of course, auto-log-on procedures tend to be difficult to encode on any system. Fortunately, Radio Shack will help things by including auto-log-on procedures for both CompuServe and Dow Jones with its optional phone connector. Once these procedures are properly encoded on the Model 100, data communications become easy. In fact, some Radio Shack executives have their log-on procedures for Dow Jones set up so that all they have to do is turn the machine on, press a few keys, and a few seconds later the latest price of Tandy stock appears on their display.

ADDRS and SCHEDL

Two simple programs are provided that can turn the Model 100 into an electronic address book and appointment calendar. ADDR.S can be used to store names, phone numbers, and addresses in a special file called "ADDRS.DO", which is also used by TELCOM. Once the data has been stored in this file, you can use a function key marked Find to locate, for example, all records containing the string "Bill" or "Fort Worth." Upper-case/lowercase distinctions are disregarded.

SCHEDL works similarly to ADDR.S except that it uses dates and times rather than names and addresses. It stores this data in a file named "NOTE.DO". Using the Find key, you can quickly locate all records you've entered for a given date or time or all appointments you've made with a certain person.
Don't let price get in the way of owning a quality printer.

Adding a printer to your computer makes sense. But deciding which printer to add can be tricky. Do you settle for a printer with limited functions and an inexpensive price tag or buy a more versatile printer that costs more than your computer? Neither choice makes sense.

Here's a refreshing option—the new, compact STX-80 printer from Star Micronics. It's the under $200 printer that's whisper-quiet, prints 60 cps and is ready to run with most popular personal computers.

The STX-80 has deluxe features you would expect in higher priced models. It prints a full 80 columns of crisp, attractive characters with true descenders, foreign language characters and special symbols. It offers both finely detailed dot-addressable graphics and block graphics.

And, of course, the STX-80 comes with Star Micronics' 180 day warranty (90 days on the print element).

The STX-80 thermal printer from Star Micronics. It combines high performance with a very low price. So now, there is nothing in the way of owning a quality printer.

*Manufacturer's suggested retail price.

The new STX-80 printer for only $199.
ADDRSS is pretty handy because it shares its data file with TELCOM. SCHEDL seems somewhat limited by contrast. It would have been nice if Radio Shack had incorporated the clock/calendar into it, but I imagine ROM space must have gotten pretty scarce by the time SCHEDL was added. Again, you could probably write a simple BASIC program to do this. For example, it could check the clock/calendar, then check each record of the NOTE.DO file, and sound some type of alarm when the two coincide. Such a program could automatically tell you when you have an appointment and with whom.

Possible Applications
With all this hardware and software, the Model 100 is well suited for a large number of applications. It should be a great tool for writers, programmers, businesspeople, and students. With the bar-code reader, it could even be used at the local supermarket. The Model 100 looks very flexible. It should be interesting to watch applications for it develop.

Limitations
As good as the Model 100 is, it does have certain limitations.
One is the lack of convenient mass storage. There will be times when you wish you could quickly load and store large documents or programs. Looking at the external bus connector on the bottom of the machine, I wouldn't be surprised if Radio Shack already has a mass-storage device in the works. My guess is either a thin-line 5¼-inch floppy disk or a large disk-simulating CMOS RAM module. Of course, 3½-inch floppies and bubble memory are also possibilities.

Another limitation is the display. Although it is of a useful size, it could be a hindrance, for example, in spreadsheet programs. Again, looking at that bus connector, I've got a feeling some type of video display is on someone's drawing board. Also, as LCDs get larger and larger, I wonder if 16-line by 80-character displays are that far down the road.

A small dot-matrix printer would be a useful accessory for the Model 100. Something on the order of the new briefcase-size typewriter from Brother would be handy.

We're completely in the dark as to what that extra ROM socket might be used for. The best bet is a minispreadsheet program. But I wouldn't be surprised if some type of disk operating system were in the works, or even some games. I'm sure Radio Shack will think of something.

Speaking of games, the bit-mapped graphics of the LCD and the interrupt capabilities of the machine might lend themselves nicely to possible game applications.

Documentation
The Model 100 comes with two manuals: a large 200-page spiral-bound manual and a small pocket-size...
For the past five years, ZOBEX has brought you the most reliable S-100 products available. In answer to the overwhelming demands of the rapidly growing market for microprocessors and their peripherals, we have enlarged our inventory. You can now get expansion products for your IBM PC from ZOBEX. Our 12 or 20 MByte Hard Disk Subsystem, 256K RAM, and Serial I/O boards reflect the same excellent quality and efficiency which our S-100 products demonstrate. Our confidence in our designs and craftsmanship allow us to back up these products with warranties of six months up to one year. Today's technology has enabled microprocessors to attain the same level of speed and sophistication already achieved by the larger computers and ZOBEX has the experience to provide you with the most advanced micros and add-on products the industry has to offer. Top quality and low pricing make all ZOBEX products a valuable investment, so when you buy a ZOBEX expandable 8 or 16 bit microcomputer, you are assured of getting the most for your money.

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* For DEC additional Concurrent CP/M Hard Disk version available for IBM PC
The TRS-80 Model 100 is an amazing machine. In one fell swoop, Radio Shack seems to have bypassed the "electronic cottage" and brought us the "electronic shopping bag."

Just out of curiosity I added up what it would roughly cost to buy the separate elements that make up the Model 100, that is, if you could buy them separately. There's the display, the keyboard, the processor, the memory, the modem, the RS-232 interface, the parallel printer interface, the clock/calendar, the cassette interface, the bar-code reader interface, the text editor, the BASIC interpreter, the communications program, and the address-book and appointment-calendar programs. My rough estimate comes to about $1,500, and that doesn't include the tremendous amount of time you would have to spend getting all these things to work together. No matter what your feelings are about the software or the size of the memory or display, I think you'll agree that, at $999 for a 24K-byte RAM machine, the Model 100 is a pretty good bargain.

A few weeks ago a short note on the Model 100 was leaked by the Wall Street Journal. Rumor has it that at least one person saw this note, promptly ran down to the local Radio Shack store, and placed an $800 deposit in a very surprised salesperson's hands.

Radio Shack could probably make money issuing just a mediocre portable computer. Instead, it produced an exceptional machine. The designers of this machine—including Bill Walters of Radio Shack, Bill Gates of Microsoft, and several others at both companies—should be congratulated. And I have a feeling they will be—all the way to the bank.
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| Calif. residents add 6% sales tax American Express Card customers call: 1-(619) 271-8730.

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YOU WILL NEVER AGAIN HAVE TO WASTE TIME WAITING FOR YOUR PRINTER.

MICROBUFFER ALLOWS YOU TO PRINT AND PROCESS SIMULTANEOUSLY.

Microbuffer will instantly increase your efficiency — and eliminate the frustration of waiting for your slowpoke printer.

Now you can simply dump your printing data directly to Microbuffer and continue processing. Microbuffer accepts the data as fast as your computer can send. It stores the data in its own memory buffer, then takes control of your printer.

THERE IS A MICROBUFFER FOR ANY COMPUTER/PRINTER COMBINATION.

Whatever your system, there is a specific Microbuffer designed to accommodate it.

FOR APPLE II COMPUTERS, Microbuffer II features on-board firmware for text formatting and advanced graphics dump routines. Both serial and parallel versions have a power-efficient low-consumption design. Special functions include Basic listing formatter, self-test, buffer zap, and transparent and maintain modes. The 16K model is priced at $259 and the 32K, at $299.

FOR EPSON PRINTERS, Microbuffer/E comes in two serial versions — 8K or 16K (upgradable to 32K) — and two parallel versions — 16K or 32K (upgradable to 64K). The serial buffer supports both hardware handshaking and XON-XOFF software handshaking at baud rates up to 19,200. Both interfaces are compatible with standard Epson commands, including GRAFTRAX-80 and GRAFTRAX-80+. Prices range from $159 to $279.

ALL OTHER COMPUTER/PRINTER COMBINATIONS are served by the stand-alone Microbuffer In-line.

The serial stand-alone will support different input and output baud rates and different hand-shake protocol. Both serial and parallel versions are available in a 32K model at $299 or 64K for $349. Either can be user-upgraded to a total of 256K with 64K add-ons — just $179 each.

SIMPLE TO INSTALL.

Microbuffer II is slot-independent. It slips directly inside the Apple II in any slot except zero.

Microbuffer/E mounts easily inside the existing auxiliary slot directly inside the Epson printer. The stand-alone Microbuffer is installed in-line between virtually any computer and any printer.

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So what are you waiting for? Write to us for more information or ask your dealer for a demonstration.

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The Osborne Executive and Executive II
Adam Osborne’s Improved Portable Computers

Jerry Pournelle
C/o BYTE Publications
POB 372
Hancock, NH 03449

When the Osborne 1 burst on the scene there was plenty of speculation. Would it survive? Would people buy it despite the small screen and generally unaesthetic appearance?

It didn’t take long for those questions to be answered. The Osborne 1 is now one of the top-selling personal computers and is identified with the idea of a “portable computer.” Osborne Computer Corporation also pioneered the concept of including software worth more than the cost of the machine.

Osborne’s second and third computers have been the subject of even more speculation, but this time people at Osborne feel that they’ve done it right. The Osborne Executive features a larger, 7-inch screen with 24 lines of 80 characters each, two thin double-density disk drives, 128K bytes of memory, both CP/M Plus and the UCSD p-System operating systems, and all the previously available software plus a new database management system, Personal Pearl. The Executive II has all of the above features and an 8088 coprocessor board with 128K bytes of its own memory, high-resolution monochrome graphics, both the MSDOS and CP/M-86 operating systems, and the ability to run IBM Personal Computer programs. If that isn’t enough, there are still more options.

Adam Osborne and the Osborne 1

I saw my first Osborne 1 computer when it was introduced at the West Coast Computer Faire two years ago. It’s hard to remember just how radical an innovation the Osborne 1 was: a full Z-80-based computer with the CP/M operating system, 64K bytes of memory, two 5¼-inch disk drives, a 5-inch screen with 24 lines of 52 characters each, a detachable keyboard, an RS-232C serial port and a parallel port, and plenty of software, all in one package for $1795. The programs given away with the machine were some of the microcomputer industry’s best: Wordstar, the top-selling word-processing program; SuperCalc, a VisiCalc-like electronic spreadsheet; Microsoft BASIC, the standard BASIC; and CBASIC, a better business BASIC.

It looked like a natural—if Adam Osborne could produce the machines, and if the public would buy them.

Those issues weren’t in doubt for long. The public had been waiting for an affordable, easy-to-use, business-quality computer. As the Osborne advertisements said, it was inevitable. The Osborne 1 soon had a major chunk of the market all to itself.

There followed a number of product improvements. An external video monitor was optional, for those who

Photo 1: The Osborne Executive with a 7-inch amber screen, two half-height disk drives, and the input/output connectors across the bottom front of the computer.
Your desk-top computer system is only a beginning—plug a low-cost UDS modem into the RS-232 port and a whole new world of communications opens up!

UDS modems add a new dimension to personal computers. For professional use, a modem permits two-way, hard-copy communication between home office and branches or among the branches themselves. Electronic mail becomes a reality. Sales, cost and inventory updates can be sent over ordinary telephone lines at economical, after-hours rates.

When you use your computer for personal applications, the modem allows you to access up-to-date market information, receive news and weather summaries, check airline schedules or even electronically scan out-of-town newspapers. Long-distance game playing and computer-age personal correspondence become instant realities.

The wide range of UDS modems includes one that fits your requirement perfectly. Top of the line is the microprocessor-based 212 A/D which communicates at 0-300 or 1200 bps, stores and automatically dials up to five 30-digit numbers and includes a complete prompting menu and full automatic test capabilities. Yet, with all these features, it costs only $745.

At the other extreme is the $145 103 LP, offering simultaneous two-way communications at 0-300 bps without an AC power cord. This unit siphons operating energy directly from the telephone line!

In between is a large variety of units—many of them in the LP no-power-supply design and all fully FCC certified for direct connection to the telephone system.

Don't be a computer hermit—treat your system to a UDS modem; then you can reach out and byte someone! For details, contact your favorite computer dealer or Universal Data Systems, 5000 Bradford Drive, Huntsville, AL 35805. Telephone 205/837-8100.
didn’t care for the tiny screen. A stylish redesigned case switched ugly-duckling brown for corporate blue and gray. Optional double-density disks offered 204K bytes instead of 102K bytes per disk, and the capability to read a wide variety of 5½-inch disk formats was featured. An 80-column or 104-column screen format could be added. A modem and external battery pack were available. More software was bundled in; a copy of the popular database management program dBASE II was given away if you bought an Osborne 1 during the Christmas sales season. One particularly interesting accessory was the Start-Pack, a combination of flip charts, documents, and audio-cassette tapes that enable a rank beginner to turn on the Osborne 1 and learn to use it in hours. (I know that one works, because we tested it on my Boy Scout Computer Merit Badge class.)

Even with the improvements, the increased competition in the small computer field indicated that enhancements to the Osborne 1 wouldn’t be enough; a more powerful computer was needed. Osborne had two logical choices: keep the size constant and add capabilities, or keep the capabilities constant and make the machine smaller.

Osborne chose the first route, and the Osborne Executive is the result.

The Executive

The Executive shares the same case and colors as the newer Osborne 1. It weighs 28 pounds, making it more transportable than portable; that is, it’s too heavy for most people to carry around with them wherever they go. The first noticeable difference from the Osborne 1 is the screen, which is 7 inches across and amber in color. The character set is excellent, and with the larger screen each 8- by 10-dot character cell is very readable. An external video screen is provided for, but most users won’t need one.

The designers gave the display system a lot of thought. Each character on the 24 by 80 memory-mapped screen has 12 bits of display memory to select blinking, dim, underlining, reverse video, and/or the alternate character set for each 7-bit ASCII (American National Standard Code for Information Interchange) character. Also, the entire display can be reversed to black on amber instead of amber on black. There are two sets of 128 characters, so an alternate character set could easily be defined to be italic, boldface, or even graphics characters. This feature is called a “writable character font” and has many visual possibilities. It’s possible to have up to 256 different characters on the display, and you can define each character if you like. Default character sets are loaded from the disk into screen memory when the system is turned on or reset.

The 128 characters in the first character set are the same as the Osborne 1’s with its 31 simple graphics characters. The alternate character set with an additional 128 characters will probably be TRS-80-style block graphics and possibly some Greek characters. A font-editor utility is supplied with the system to create your own characters.

The flexible terminal emulation program allows the Executive’s keyboard and screen to imitate nearly any standard terminal. Although the Executive uses the same screen and cursor control codes as the Televideo 912 terminal, it can be made to act like the 10 to 15 other terminals in this program’s menu.

The improved keyboard with its 69 keys and 12-key

--

At a Glance

Product Name
The Osborne Executive

Manufacturer
Osborne Computer Corporation
26538 Dand Court
Hayward, CA 94545

Price
$2495

Components
Size: width 20½ inches, depth 13 inches, height 9 inches
Weight: 28 pounds
Electrical needs: 120 or 230 volts AC, 50 or 60 Hz
Processor: 4-MHz Z80A
Memory: 128K bytes of user RAM
Display: 7-inch amber monitor; 24-line by 80-character memory-mapped screen, two sets of 128 characters; 8- by 10-dot character grid; writable character font; 12-bit display memory allows blinking, dim, underlined, reversed characters and/or alternate character set for each character
Keyboard: 69 keys for text and data entry, 12-key numeric keypad, 10 programmable function keys, 4 cursor control keys, redefineable keyboard layout, automatic repeat on all keys, detachable keyboard with coiled cable

Disk Drives: two half-height double-density 5¼-inch floppy-disk drives with 204K-byte storage capacity each, can read Osborne 1, IBM PC, DEC VT-180, Xerox 821, UCSD p-System, and Cromemco disk formats
Input/Output: two RS-232C serial ports for a modem and a printer, one parallel port configurable for IEEE 488 or Centronics-style accessories

Software Included
CP/M Plus (Digital Research) and UCSD p-System run-time (Softech Microsystems) operating systems, Wordstar (Micropro), Supercalc (Scorim), MBASIC interpreter (Microsoft), CBASIC semi-compiler (Digital Research), and Personal Pearl (a database management program)

Options
300-bps direct-connect modem, battery pack

Alternate Configuration
Executive II with the standard features above plus the following:
Coprocessor board with 4-MHz Intel 8088 microprocessor and 128K bytes of RAM expandable to 256K bytes, 640- by 200-dot high-resolution monochrome graphics, MS/ DOS (Microsoft) and CP/M-86 (Digital Research) operating systems, IBM Personal Computer compatibility, connector to external expansion bus
Price: $3195
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"Flexibility" means instantaneous call up of any of this trend-setting machine's many features whether for word processing, data processing, graphics or forms generation. Using either of the two built in interfaces, an external keyboard or downloading from your computer, you can program the Qantex Model 7030 to do more.

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numeric keypad still doesn’t have keys for the entire set of ASCII characters, but as with the present Osborne 1, combinations of keys will produce characters such as the curly braces ({})) and the tilde(—). However, the entire keyboard is software programmable to let you devise and install any keyboard layout you want. There are also 10 user-programmable function keys (control-0 through control-9) and four fixed-function keys (the cursor keys).

The slim-line disk drives to the left of the video screen are another striking feature of the new Osborne Executive. These half-height 5¼-inch disk drives are double-density but only single-sided. The company has been unable to find portable double-sided drives that meet its requirements of reliability and price. Storing information in the Osborne double-density format allows for 204K bytes on a disk.

Meanwhile, the Executive reads a wide variety of disk formats including, naturally, single- and double-density disks from the Osborne 1, but also formats as diverse as the IBM Personal Computer, DEC VT-180, Xerox 821, UCSD p-System, and Cromemco mini-disk.

The standard Executive uses a Z80 microprocessor running at 4 MHz and comes with 128K bytes of RAM (random-access read/write memory) plus 10K bytes of internally-used memory for power-on diagnostics, I/O drivers, and a scratch-pad area. A Zilog SIO chip provides two serial ports where the Osborne 1 had only one. The input/output is now sent to ports instead of being memory-mapped. The standard operating system will be CP/M Version 3.0, also known as CP/M Plus, but the UCSD p-System run-time operating system will be provided as well. (The UCSD Pascal language is extra.) The additional memory beyond the 64K bytes addressable by the Z80 microprocessor is managed by CP/M Plus to allow, for example, larger disk-buffer areas for significantly faster operation. A clock keeps track of the time and date, but only while the power is turned on. A small fan cools the computer.

The connectors and controls on the front of the machine are the two RS-232C serial ports (typically for a modem and printer), a parallel port that can be configured for either IEEE-488 or Centronics-style use, video brightness and contrast, external video, the reset button, an RCA jack for composite video output (so you don’t need an adapter), and the blue power switch. The grill on the right front hides the power supply.

You won’t see a battery-power connector on the front of the machine because Osborne plans to offer an optional battery pack with a 12-volt DC to 220-volt DC converter that the Executive’s power cord can plug directly into. The connector for the converter plugs into the battery pack or your car’s cigarette lighter. (Running the car while the computer is plugged in is not recommended due to voltage spikes.) Jumpers on the back of the Executive allow overseas use of the machine with international voltages.

Another available option is a small 300-bps (bits per second) direct-connect modem that slides into the slot,
Now Our Family Tree Is Complete

SBC-1 (Above) A multiprocessing slave board computer with Z-80 CPU (4 or 6 MHz), 2 serial ports, 2 parallel ports, and up to 128K RAM. Provides unique 2K FIFO buffering for system block data transfers. When used with TurboDOS or MDZ/OS the results are phenomenal!

Systemaster® (Right) The ultimate one board computer; use it as a complete single-user system or as the "master" in a multi-processing network environment. Complete with Z-80A CPU, 2 serial and 2 parallel ports, floppy controller, DMA, real time clock, and Teletek's advanced CP/M BIOS. Also supports MP/M-II, MDZ/OS, and TurboDOS.

HD/CTC (Left) A hard disk and cartridge tape controller combined together on one board! A Z-80 CPU (4 or 6 MHz); 16K ROM, and up to 8K RAM provide intelligence required to relieve disk I/O burden from host system CPU. Round out your multiprocessing system with an integrated mass storage/backup controller.

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normally used for storing disks, below the disk drives. A short cable leads to the DB-25 connector directly below (labeled “Modem”). The power for the modem comes from one of the connector's pins. The modem option is intended to help make the Executive a full computer, capable of communications and nearly any job a microcomputer can do.

The software package with the Executive includes the standard items Osborne offers (Wordstar, Supercalc, MBASIC, and CBASIC), the two operating systems (CP/M Plus and UCSD p-System), and some other goodies like Personal Pearl, a database management package.

Osborne is focusing on office productivity tools and will be offering three synchronous communications packages to make communications with the company mainframe or minicomputer easier. The first package is for IBM 3270 terminal emulation; the second has IBM 3780, 2780, and 3741 protocols; the third is for the X.25 protocol. Site licenses for each package will cost about $1000 but will allow you to use the programs on a number of Executives at one location.

The Executive II

Interestingly, the designers made provisions for the Executive to become an IBM Personal Computer work-alike. The Executive II is an upgraded Executive with a piggyback coprocessor board inside that contains a 16-bit Intel 8088 microprocessor and 128K bytes of memory for its use and provides 640- by 200-dot monochrome graphics. With this board, the machine should be able to run most IBM PC applications programs.

The MSDOS and CP/M-86 operating systems come with the Executive II, so IBM compatibility is assured at the operating-system, disk-format, and monochrome graphics levels. As long as programs for the IBM PC don't use special knowledge of the IBM hardware, they should run fine on the Executive II. However, the Executive II does not copy the IBM PC input/output structure exactly.

The IBM Personal Computer disk format is directly supported by MSDOS on the Executive II, so you can just slip in a disk for the PC and run the programs or read the data. Osborne does not offer any 16-bit programs for the Executive II other than the operating systems. You can buy programs in the IBM PC disk format from existing software distributors and computer stores.

One incompatibility in the system is that you can't share memory between the different processors; they each have their own 128K bytes of RAM. However, the Z80 does handle input/output when the 8088 is in control.

You can expand the memory for the 8088 up to 256K bytes simply by filling the rest of the sockets on the coprocessor board with 64K-bit RAM chips. For real memory expandability, just wait until 256K-bit RAM chips become economical. The coprocessor board has a jumper for operation with these chips to give you 1 megabyte of memory in your portable Executive II. If you want color or other IBM accessories, the coprocessor board has a connector for an IBM-compatible expansion bus like the Tegmar PC-Mate.

"When we announce the Executive," Adam Osborne says, "we'll have several thousand in distributors' warehouses. Customers will be able to buy our machines as soon as they've heard about them." You will have to wait a month after the Executive's introduction for the Executive II to be available. A few months later, you will be able to upgrade an Executive into the Executive II when production settles down. Also, the price on the upgrade has not been set.

I didn't get to play with the machines very long, but I liked everything I saw. At $2495 and $3195, the Osborne Executive and Executive II are going to be major contenders in the microcomputer market, and not just among the portables, either.
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Do you ever find yourself probing through a mass of tangled cables behind your computer? If your computer is like mine, you probably have only one serial port, to which you have to connect both a printer and modem. Of course, whenever you want to use a different peripheral, you have to unplug one and plug in the other.

The variety of peripheral devices necessary to gain full use of a personal computer can create a connection jam at the serial port. Many small computer systems have two I/O (input/output) ports intended to support a printer and modem. Usually the port intended for connection to the printer is a parallel port (although many printers require a serial port), while a serial port (perhaps called a "communications port") is provided for connection to a modem. For the typical user, this may be adequate.

Some of us, however, aren't typical users; we have more than one printer and one modem attached to our computer, or our printer uses a serial interface, not a parallel one. I have three serial printers and two modems, all of which I must connect to my workhorse computer system through a single RS-232C serial port. (It's not that my computer is a small configuration: it has eight parallel ports in addition to the one serial port. It's just that every new peripheral device I buy seems to be serially interfaced, and I can't fit any more serial ports inside the already crowded enclosure.

Recently, while juggling three cables and leaning over the computer, I began to wish for an easier way to switch between devices. I wondered if I could just put together a little box containing a multiple-pole rotary switch wired to a few DB-25 connectors as a workable compromise. But then I thought of a possible better solution as I remembered something I had seen in a catalog of data-communication products: a device called a code-activated switch.

**Functional Analysis**

The function we need here is the ability to multiplex—switch between as needed—several peripheral devices connected to a single I/O channel. A communications multiplexer performs this function. In essence, this device forms a bridge in the communication link between the master device (usually the host computer's I/O port) and one of several slave devices; transfer of data can proceed in either direction over this bridge. The physical linking of the input and output can be accomplished either mechanically or electronically.

**Two Approaches to Switching**

The simplest possible device for the purpose is a four-position mechanical switch box. Available commercially for about $150, a DB-25 switch box allows you to select one of four peripherals for output by turning a four-position multipole rotary switch. This manually activated switch is most frequently used where the communicating devices are at great distances from the computer, and operator is in close proximity. Its major advantage is its relative low cost.

Unfortunately, mechanical switches are subject to deterioration from the elements and, of course, require a human operator to function. Harsh environments call for fully electronic switches. In situations where the communicating devices are at great distances from the computer, some
form of remote-controlled switch must be used. An ordinary electrical relay can provide remote control, but the greatest flexibility and reliability are obtained from a fully electronic, software-controlled, code-activated peripheral-device switch. Let’s look at some of the possibilities.

Electronic Switches

Figure 1a is a simple block diagram of a four-channel electronic RS-232C multiplexer switch. The master input on the left side is intended to be connected to a computer’s I/O port and the four channels on the right side are intended to be connected to four peripheral devices. (In the following discussion, the assumption will be that data is being transmitted by the master device to one of the slave devices, although data can also move in the other direction.)

On the left side of the electronic multiplexer, the input serial data from the master device (the computer) is converted from RS-232C
voltage levels (±15 V) to TTL (transistor-transistor logic) voltage levels (0 to +5 V) and directed to the inputs of four three-state signal buffers (also known as three-state switches) wired in parallel.

Each three-state signal buffer has an active-low enable input. An input voltage of 0 V on this enable input line allows a signal to pass through the buffer. When any one of the four buffers is enabled, the master device's input signal is allowed to pass through it. This signal is then reconverted to RS-232C levels and sent on to the peripheral. Changing the active-low enable signal from the first three-state signal buffer to another diverts the output to a different peripheral device. (In this particular configuration, only one of the four buffers should be activated at one time. Other setups could allow output to be sent to two, three, or all four of the output buffers.)

The method by which the enable lines of the three-state signal buffers are activated determines the complexity of the electronic switch. Two particularly important types of control methods are used by devices called remote-activated switches and code-activated switches.

Both remote- and code-activated switches are designed for hands-off operation. The difference between them is this: selection of an output channel is done in the former by decoding separately conveyed logic-signal inputs and in the latter by decoding signals conveyed as part of the data being transmitted through the multiplexer switch.

In the case of the remote-activated switch, wires for the remote-control signals must be provided in addition to the serial data connection. Furthermore, if the switch is located some distance from the computer, it may be necessary to add line drivers and receivers to these control lines. In the example control circuit shown in figure 1b, only three wires (plus ground) and a single type-74LS155 integrated circuit (a two- to four-line demultiplexer) are required to provide the enable signals to the four buffers. Two of the wires select one of the four control outputs; the third wire serves as a switch-enable line, selecting output from one buffer or none.

In principle, remote-activated switches are not much more complicated than their mechanical equivalents. They are generally cost-effective where high speed is essential or where there are tens of channels with various selection configurations.

On the negative side, remote-activated switches require hardware and software control interfacing and are not easily adapted to different computers.

The Code-Activated Switch

The code-activated switch uses a microprocessor to analyze the characters in the data flowing through the switch. When a particular character or series of characters is received, the microprocessor turns output channels on or off. The only connection between the host computer and the multiplexer is the master input serial line.

Code-activated switches are available with various levels of complexity. The simplest ones merely switch channels upon recognizing a certain code sequence. More sophisticated units can accept incoming data at one data rate, collect it in a memory buffer, and send it to an output channel at another data rate. The most sophisticated units function more as message switchers and data concentrators than multiplexers, allowing party-line conversations and priority-interrupted communications.

Rather than confuse the issue by explaining all the various hardware categories, I've chosen as this month's project an "intelligent" (at least microprocessor-controlled) but rather simple code-activated switch that I call the Micromux. I hope you'll take the opportunity to build it and experiment with it. While useful as a printer or modem switch, this code-activated switch may perhaps find more demanding applications such as message channeling and data acquisition.

Build the Micromux

The intelligence of the Micromux, which is used to decode characters from the serial data, could have been provided by virtually any microprocessor. The only requirement is that the system contain a program-storage area and both a parallel and serial I/O port (the former to send enable signals to the three-state signal buffers, the latter to read and transmit serial data). While I could have chosen a general-purpose microprocessor such as the 6502 or Z80 and then used PIO (parallel input/output) and SIO (serial input/output) adapters, I chose to use the Z8671 variant of the Zilog Z8 single-chip microcomputer to reduce the complexity of the project. The Z8671 was the basis for my Z8-BASIC Microcomputer project (see reference 1) and the new Z8-BASIC System-Controller board available from The Micromint. The connections needed
by the Z8671 to control the four-channel switch are shown in figure 1c.

Much of the hardware and many of the software subroutines required for the task are built into the Z8671 already. This Zilog product contains 256 bytes of RAM (random-access read/write memory), a serial port, two counter/timers, two parallel ports, and a 2K-byte tiny-BASIC (BASIC/Debug) interpreter within a single integrated-circuit package. Combined with a type-2716 EPROM (erasable programmable read-only memory) and a data-rate-selection switch, the five-chip Z8-BASIC Microcomputer system can be easily programmed to monitor RS-232C serial communications and switch channels on cue. The control program can be written in either BASIC or assembled machine language, as you will see.

Figure 2 on page 53 is the schematic diagram of the Micromux. IC1 is the Z8671. Its serial input line (SI) is tied directly to the data input of the master input channel (RD). Four of the Z8671's port-2 output lines serve as the enable inputs to the three-state signal buffers. The program that controls the computer and analyzes the data transmissions has been written into the 2716 EPROM, IC2. IC3 is an 8-bit latch which holds the 8 low-order address bits (from the Z8's multiplexed outputs) during memory and I/O operations. IC5 is configured as a memory-mapped address decoder that enables IC4 when any address over hexadecimal C000 is accessed.

The data rate is selected by the switch settings on the input of IC4. When the system is powered up, these data-rate switches are read (as memory location hexadecimal FFFE) and used to set a counter/timer that divides the signal from the 7.3728-MHz crystal. The data rates that may be thus selected include 110, 150, 300, 1200, 2400, 4800, and 9600 bps (bits per second).

The integrated circuits IC6 through IC9 are type-74LS244 three-state signal buffers. Nothing flows through them unless their active-low enable lines, pins 1 and 19, are at logic 0. IC18 is a type-7407 buffer/driver, which lights one of four LEDs (light-emitting diodes) to show the enabled channel.

RS-232C drivers and receivers are provided, appearing in the schematic as IC10 through IC17. I chose to use only the six most frequently used RS-232C communication signals in this circuit. If you need additional signals, then you'll have to include more three-state signal buffers and driver/receivers. Conversely, if you need only Received Data and Transmitted Data (pins 2 and 3), then you'll need fewer chips in your code-activated switch. (Six signals—Received Data, Transmitted Data, Clear to Send, Ready to Send, Data Set Ready, and Data Terminal Ready—were as many as I was willing to wire by hand.)

**Programming the Micromux**

The Z8671 can be programmed in either tiny BASIC or assembly language. The primary difference is speed. With the Z8671 set to receive data at 9600 bps, only a machine-language program would execute fast enough to digest the data and make control decisions at that rate. But for slower data rates where there is more time for the processor to react, using BASIC makes the programming task easier.

For a multiplexer to switch quickly between four different output channels, four distinct character codes are required. These codes can be single ASCII (American National Standard Code for Information Interchange) characters such as the letters A, B, C, and D or sequences of characters such as "$%&1", "$%&2", "$%&3", and "$%&4". However, because the code-activated switch relies upon the data stream to contain its control codes, it's important that the channel-activation codes be different from any character sequences appearing in the data transmissions, or false channel selection may occur. Obviously, we would not choose the letter A as a practical selection code in most applications, so we choose some multicharacter sequence that would be unlikely to appear. For instance, you would probably never need to print the sequence "$%&1", and it could be used to designate a switch to a printer connected to output channel 1. Similarly, "$%&4" would enable channel 4.

Because the sequence-recognition time is dependent on the code length, an alternative is to use single non-printing characters such as Control-A or Control-D. A single-character switch-control code is recognized faster than a three- or four-character code. When using a machine-language program running at 8 MHz the difference is hardly significant, but in BASIC the difference could be considerable.

**Micromux Control in BASIC**

At this point, let's look at how the
most used RS-232C signals are wired here; the addition of more buffer chips would allow switching of more RS-232C signals. Power connections are shown in table 1 on page 52.

Figure 2: Schematic diagram of the Micromux prototype four-channel code-activated switch. This design uses a Z8671 as a controller to monitor codes embedded in the transmitted data and activate the appropriate signal buffer for the channel. Only the six
Micromux might function with the Z8671 programmed in BASIC.

First, assuming that the switch is to be used only with printers and modems that use printable ASCII characters and commonly used control codes (Return, Backspace, Delete, etc.), I chose the four non-printing characters Control-A, Control-B, Control-C, and Control-D to select the four output channels. For example, when the program sees a Control-C, it activates the enable line to the three-state signal buffer for channel 3.

Figure 3 is a flowchart of a control program written for the Z8-BASIC/Debug interpreter that obeys this convention. The program is seven lines long, as follows:

```
10 @246=0 : @2=255
20 X=@240 : IF X>4 THEN 20
30 IF X=1 THEN @2=254 : GOTO 20
40 IF X=2 THEN @2=253 : GOTO 20
50 IF X=3 THEN @2=251 : GOTO 20
60 IF X=4 THEN @2=247 : GOTO 20
70 GOTO 10
```

Figure 3: Flowchart of a Z8-BASIC/Debug program to control the four-channel code-activated switch at low data rates.

Line 10 configures port 2 for output and sets all enable lines to a logic 1 (not activated). Line 20 examines the serial input register of the Z8 and checks to see if its value is greater than 4. The only ASCII characters with values of 4 or less are the select codes mentioned above plus Control-@. Lines 30 through 60 set the output of the Z8's port 2 according to the control convention or, if a Control-@ is read, to disable all output channels. If the character coming in over the serial input line is not one of these control characters (that is, if its value is greater than 4), the character is sent on to the current output channel (if any), and the port is read again.

Because the read-and-analyze routine is a single program line which returns to itself, it operates fairly fast. The Z8 can be set for any of the 7 common data rates between 110 and 9600 bps. If the multiplexer channel is set before the transmission starts, or if the control code is the very last character in a particular message, then the data rate is irrelevant to the proper functioning of the program. It is only when the control code is embedded in a significant character stream that speed of execution is a consideration.

Regardless of the data rate, about 40 ms (milliseconds) are required to analyze a serial character using this program. As long as a delay of 40 ms is allotted after any of the 5 control codes is sent, the code-activated switch will respond properly. Another possibility is to put several of the same control codes in series so that the program will catch at least one of them.

Machine-Language Control

For the hasty folk who like to send and switch data at 9600 bps, we have to use a machine-language program. A flowchart of such a program is shown in figure 4 on page 55. The increased processing speed using machine language allows us to use more characters in the switch-control code sequence and lessens the likelihood of confusion with data passing through the switch.
Figure 4: Flowchart of a Z8 machine-language program that can control the code-activated switch at data rates up to 9600 bps.
The final program, shown as assembly code in listing 1, uses many subroutines already available in the Z8671's ROM and requires only 88 bytes. It is designed to use a two-character control-sequence-recognition code, followed by a channel number. (I decided not to use unprintable control codes in this example, but any ASCII characters can be used.) The complete sequence is \( @lx \), where \( x \) is a value from 1 to 4. The code sequence \( @13 \), for example, would direct the output of the Micromux to channel 3, while the sequence \( @11 \) would send the output to channel 1. One handy feature of the read-and-analyze routine is that only the 4 low-order bits of the third character in the sequence are used. This allows us to use one of the Control-A, -B, -C, or -D output-selection characters (as used in the BASIC program) as the third character in the sequence in place of the digit.

Because the program of listing 1 runs entirely in machine language, channel changes may occur at any point in the transmission, at any of the available transmission speeds. If you plan on using this program with a printer attached to one of the output channels, you may want to change the \( @1 \) part of the sequence to two nonprinting characters. Simply substitute two ASCII codes of your choice in the program.

In Conclusion

The primary purpose of this article is to present something the average computer hobbyist can successfully build and use. However, if you are an industrious programmer with a lot of experience, you might want to add some additional features, such as storing input in a memory buffer, trapping control-code sequences (which would filter the switching codes out of the data flowing to the output channels), and party-line communication (where data is sent to more than one output channel). Of course, all of these additions would have involved more complex hardware and software.

In my own case, the Micromux
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didn't end up attached to a printer. I'm using the prototype, consisting mostly of a modified Z8-BASIC Microcomputer, to communicate with four other Z8 boards that perform specific control and security assignments, none of which I had previously deemed important enough to merit tying up four separate serial ports.

Listing 1: Machine-language program for the Z8671 to control the code-activated switch at data rates up to 9600 bps.

```
1000 DD 102H } Fill equ 102H
1005 DD POFH, POFH, POFH, POFH, POFH, POFH, POFH
1010 DD POFH, POFH, POFH, POFH, POFH, POFH, POFH
1020 DD POFH, POFH, POFH, POFH, POFH, POFH, POFH
1030 DD POFH, POFH, POFH, POFH, POFH, POFH, POFH
```

Now, of course, I need another code-activated switch for the printers and modems, but I'm not enthusiastic about hand-wiring another one. So if The Micromint decides to make an improved version of the Micromux, I'll take the first one off the assembly line.

Next Month:

New developments in technology have prompted yet another speech-synthesis project, this one using adaptive differential pulse-code modulation.

Reference


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 08520. 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 the articles that were published from July 1980 through December 1981.

If you would like to put together a code-activated switch from off-the-shelf components, you could configure powerful hardware using the new Z8-BASIC System-Controller board (which contains RAM, EPROM, and a Z8671 on board) and a few Z8-BASIC Serial Expansion boards. For information about availability and prices of the Z8671 or other Z8-BASIC board products, contact The Micromint Inc., 561 Willow Ave., Cedarhurst, NY 11516, (800) 645-3479.
The Electronic Office

by Pamela A. Clark, Managing Editor

The term electronic office has been overused to the point where one might believe that the complete electronic office does in fact exist. Nothing could be farther from the truth. While many office tasks are indeed automated—dedicated-function machines share data and a few peripherals—you could hardly say the electronic office is in full bloom. The current level of electronic office automation represents only a very small number of the myriad functions within an entire organization that could benefit from the speed and efficiency of the microprocessor. Companies strongly committed to implementing the electronic office will find the task complicated by the very nature of the change, as well as by confusion in the marketplace.

In the words of Marshall McLuhan, the medium is the message, and electronic transfer of information will profoundly affect the structure and management of an organization. If information is power, then distributed information means distributed power—a new and threatening concept for many companies. Management by divisional competition and conflict must give way to cooperative management as information is shared rather than controlled. Technological advances always create changes in staff hierarchy, performance standards, and human relations. Organization charts may soon reflect more tenets of communication theory than management theory as the organizational functions become inextricably linked to information management. The answer to the fundamental question, "Who has the authority to make changes in a shared database?" could restructure an entire corporation and postpone its electronic birth for a number of years.

The delayed emergence of the electronic office can also be traced to confusing signals from the technical arena. Traditional mainframe vendors tout powerful dedicated systems, but can't deliver the stand-alone features of a workstation, a situation that only perpetuates centralized resources and information. PBX vendors provide excellent low-speed voice and data local networks to channel information throughout a building, but have only recently begun to supplement this with terminals and software. The proliferation of microcomputers increases the impetus for change, but system incompatibility hinders electronic reorganization. The usefulness of integrated software packages remains limited by general-purpose designs aimed at large markets.

Organizations in search of electronic nirvana must still look to multiple vendors for discrete components. Rapid technological changes and the accompanying lag in industry standards combine to sustain that situation and keep the complete, integrated electronic office from realization. However, the entrance of industry giants AT&T and IBM brings a powerful new pressure on the market. These heavyweights have the necessary resources to tackle the many disciplines embodied in the electronic office. The level of technical integration required for a fully functional system is colossal. While the electronic office promoted by these giants may not be as innovative as current speculation would have it, it will be integrated. And if the electronic office is to become a reality, harmony must be the bottom line.

Our theme articles, beginning on page 60, are as diverse and discrete as components in the electronic office. Networks, individual computer systems, and software applications all play an important role in today's office. However, the total electronic office remains only a vision on the horizon.
Local Area Networks
An Update on Microcomputers in the Office

The boom in office communication systems is creating a pressing need for standardization.

Harry Saal
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Palo Alto, CA 94303

The ideal state of computing—in which any computer or office device can communicate with any other device—is still on the horizon. But sharing information between physically separated personal computers, corporate computers, expensive printers, and disk drives is becoming more feasible and desirable every working day.

Often the information that managers would like to analyze with their electronic spreadsheet programs is ready and waiting on databases on the company mainframe computer, waiting for an easy communications link to the workspace in the managers’ desktop computers. Electronic mail will help usher in a new era of office productivity, improving intercompany communications and ending vicious circles of returning calls to people who’ve returned your calls, etc.

Systems of computers and peripherals linked together in adjacent offices and buildings, or local area networks (LANs), will bring about complete office automation and standardize computer interconnections. But we’re not quite there, yet.

Office computers are no longer designed for the exclusive use of computer professionals; from senior management to the receptionist, employees are expected to use computers as standard parts of the office environment. Everyone from a trained analyst to a temporary secretary now needs to have access to information in databases and process it electronically.

In business, a wide spectrum of individuals must share information; rarely is true personal data encountered in corporate situations. One person might enter the basic data, another will edit or modify it, and a third will produce reports or graphic displays from it. Information is typically supplied by many sources but must be merged, managed, and distributed to be useful. Also, because information is a valuable resource, it must be protected from malicious or accidental misuse.

Traditional multiuser computer systems, whether mainframe or minicomputer, are not well suited to this new type of automated applications. Conventional systems require large centralized facilities, inaccessible to the user. They require costly support staffs. Maintenance problems make it difficult to justify new development, resulting in today’s widespread applications backlog.

Conventional systems also lack the responsiveness, ease of use, and user orientation of the newer desktop systems. They are designed for a more sophisticated, trained user, thereby limiting their usefulness for the far broader class of new computer users.

This unsatisfactory state of affairs, contrasted with the benefits of friendly, fast, and economical personal computing, is spurring current desktop computer development.

The Communications Requirement

Although often separated by distance, allied users must work together cooperatively. On different floors, in different buildings, or in different states and countries, fellow workers must exchange information. For them, communications are no longer a luxury; they are essential and growing daily in importance.

Two recent developments, local area networking and personal computing, provide a way to address the needs of this new class of computer users; community microcomputing is the merger of these two technologies.

Community microcomputing enables a community of users to share information that resides on common peripherals. Users share common programs and data as well as expen-
Attributes of a LAN

Local area networks are a specialized part of the larger class of communications networks. They undertake the job of intercomputer communications within geographically limited distances in a very reliable and cost-effective way. Conventional long-haul (telephone) lines and satellite systems are optimized for the transmission of analog or digital data over thousands of miles. Local area networks are optimized for use in the office or factory, over distances of hundreds to many thousands of feet.

Local area networks typically are bounded by speed as well as distance, running several hundred thousand bits per second to as many as tens of millions of bits per second.

Speed and distance, however, are not the only two design considerations of a local area network. LANs operate with digital data and exhibit high reliability of communications over the distances specified. A system of error detection must be added to the digital information to ensure that even a rare error will be detected. Additionally, an error-correcting mechanism is needed to ensure that the correct data is retransmitted.

To accomplish retransmission, data is split into groups or packets. Each packet contains information regarding its source and destination. Most local area network schemes permit a special form of addressing referred to as broadcasting, whereby a station may send a packet that is destined for all stations connected to the local area net. Multicasting is similar; however, in multicasting the targeted stations are a subset of the totality of connected stations.

Typically, within the data packet, there are various acknowledgments, additional information concerning the sequencing of packets, network addresses, etc. This information is used to provide more sophisticated services to the programs running on the workstations than services simply based on a “point-to-point” transmission medium. Such sophisticated services include routing, distinguishing which programs on a particular machine are addressed, and identifying character sets and protocols in use.

The error-recovery schemes used in local area networks generally make it possible to add a new station to a functioning communications network without disrupting ongoing operations. This possibility results from several factors: First, the act of connecting (or disconnecting) a new station to the actual network medium causes some momentary interference and errors. But the basic design of the network accommodates such errors automatically, by retransmitting the information. Second, because local area networks are designed as fully distributed systems, there is no central station or master list of stations that must be updated in order for the system to continue functioning. This updating of station information takes place dynamically as the system runs. In more conventional communications schemes, it is generally necessary to stop the system and take some global action in order to add or delete a network node.

Network Topologies

The form of the physical connection of stations to the communications medium generally falls into one of three main categories: star, bus, or ring form (see figure 1).

Telephone systems are the best example of the star configuration, or topology. Each instrument is connected via cable to the central office where the switching is done between

![Figure 1: Popular network configurations. The star network (1a) is the most common of the early network types (such as the telephone system) and relies on the central node for control of operations. Bus configuration (1b), as used on the Ethernet and by cable television, allows nodes to be added or removed without impairing the network. The ring network (1c) circulates all messages in one direction and may pass tokens to specify which node may transmit; a failure of any node may interrupt network operation.](image)
stations. To talk to your next-door neighbor, the information must flow to a main switching point, where it is processed by an exchange, then back to the house next door.

Few examples of the star topology used in local area networks exist, other than the private-branch-exchange (PBX) telephone system, due to the problems encountered by having a specialized piece of equipment to service all the stations at the ends of the lines. In computer systems, the services to be performed by the switch are likely to become more complex over time. This may require more than one piece of equipment, which makes it more difficult to arrange the equipment in a star configuration rather than in a bus or ring topology.

The star topology seems most suitable to a PBX-type system in which the main service requirement is data-switching from point to point. The data speed requirements are generally nominal (less than 50K bits per second), and the wiring exists in millions of offices. This type of network works efficiently when fairly powerful multiuser systems are connected to it, thus providing the computing power for low-speed intelligent terminal devices. With many of the existing telephone systems manufacturers preparing to introduce this type of network, it could well dominate in the future.

The bus topology usually involves one long central spine of cable to which each of the nodes is connected. Nodes may connect directly, or in many cases, they may be connected via a cluster box, which provides for multiple station connections. By connecting several cluster boxes, you obtain a treelike structure of interconnected cables, or a "star of stars." This configuration still remains a bus in the sense that stations can still communicate directly without the need of an intermediary station.

Bus schemes are sometimes found with two cables running to each station; one cable receives while the other transmits. In this case, all the transmitters are connected together via a bus that runs to a special head-end retransmitter. This retransmitter takes the signals, amplifies them, and broadcasts them on the receive cable to which all stations listen. Most community antenna television (CATV) systems work in this fashion. This system implies that stations cannot directly talk to each other but only via the intermediate amplifier. In this scheme, it is essential to make the head-end retransmitter extremely reliable, so that it is not the weak link in the network. Using this scheme adds significantly to the basic system cost; this is practical if the network is servicing a unit larger than an individual office, such as a complete building.

A ring can be thought of as a bus that is closed back on itself. The ring topology does not have the flexibility that bus structures have, yet it forces more regularity into the system, thereby assisting in error-diagnostic and repair capabilities. In ring systems, the information circulates (clockwise or counterclockwise), and it is possible to implement a scheme whereby a station can check to see if the data transmitted was received or not. This is done by looking at control information that is inserted or modified by the receiving station and passed around the ring, sometimes followed by a token.

One proposed ring system uses a pair of counter-rotating rings to circulate information. This system permits a nonfunctioning station to be isolated while all the other stations are still interconnected. On the other hand, adding or deleting a station from a ring system is more complex than with either the star or bus approach. The process typically disrupts the closure of the ring for significant periods of time during which the system is not operational.

**Standards**

The office is one of the most heterogeneous of all data-processing environments. Typically, companies have already acquired an assortment of word processors, small computer systems, and telephone exchange equipment and may be using outside timesharing services. Since one of the goals of a local area network is to facilitate the intercomputer com-
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The ISO Reference Model

The International Standards Organization (ISO) established a framework for standardizing communications systems, called the Open System Interconnection (or OSI) Model. The OSI architecture defines seven layers of communications protocols, with specific functions isolated at each level. The purpose of layered protocols is severalfold: one significant advantage is that differing lower-level implementation details can be hidden, while compatibility can still be achieved at the higher levels. This permits considerable variation in the basic electrical technology, while retaining the fundamental information flow between systems.

Level 7 is the Application Level, which handles the utility aspects of network usage. Issues such as the identification of users, selection of services, or global network access are dealt with by Level 7. Typical programs at this level are file transfer programs, terminal-to-terminal emulation capabilities, and electronic message programs. At this level, tasks are performed; all the lower levels are there to support applications.

Level 6 is the Presentation Level, which handles the conversion of data
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from one format to another. This involves the packing and unpacking of data, changes in character set, expansion of graphics commands, and encryption.

Level 5 is the Session Level, in which the establishment and termination of streams of data from station to station are handled. Level 5 is typically responsible for mapping network-oriented addresses into more logical process or port names on the local workstation.

Level 4 is the Transport Level, which manages a lower level of connection than the Session Level and handles the connections needed to deal with messages that exceed the maximum packet size of the network. Making a reliable end-to-end connection across an imperfect basic network is done by Level 4. Error control, sequence checking, handling of duplicate packets, flow control, and multiplexing issues are the main concerns of this level.

Level 3 is called the Network Level. It deals with the routing of information from node to node via intermediate nodes and stations. This is often not required on the local network itself due to the broadcast nature of the information exchange, or because of direct addressing provided by the network hardware. Interconnections between more than one LAN, however, require a functional Level 3.

Level 2 is referred to as the Data-Link Level. The data-link deals with the actual packets themselves and provides for the addition or removal of header and framing information surrounding the actual data contents. These headers provide for timing signals, error-detection checksums, and station addresses for hardware recognition. It is the data-link level that incorporates the access strategy for sharing the basic cable among many stations: for example, whether it is a round-robin protocol, controlled token-passing, or a probabilistic contention scheme.

Level 1 is the Physical Level, which defines the electrical and mechanical characteristics of the network. The particular signaling scheme used, modulation techniques, frequencies, and voltages employed are all specified at this level.

See table 1 for an idea of how the major microcomputer networks fit into the ISO framework.

Adoption of Standards
Clearly a need exists for some level of electrical compatibility at which a standard connector, standard signaling levels, etc., are used to successfully build fully integrated office systems that directly link together disparate office equipment. The most attention has been on the layers that deal with these issues, namely, Levels 1 and 2. This attention should result in the availability of standard components that a variety of manufacturers can use, thus reducing the cost to the consumer. This attention also follows the industry's tendency to feel that once the hardware is compatible, the software "can always be fixed later." It is interesting to note that this
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type of standardization argument actually runs contrary to the purpose of the OSI model; the OSI model attempts to preserve compatibility across applications by permitting variation in the lower levels as long as they are fully shielded from the higher-level programs.

IEEE 802

A great deal of attention has been focused on the activities of the IEEE (Institute of Electrical and Electronics Engineers) 802 Committee. While de facto follow-the-leader-style standardization may be the dominant trend, official standards processes are important in the communications world. Hence, all the major computer manufacturers have participated actively in the IEEE standards work on local area networks.

A curious state of affairs has developed in the IEEE 802 Committee. After substantial initial activity, the Committee finally recognized the impossibility of adopting only one standard that would satisfy the variations in speed, distance, reliability, cabling, etc., required by the computer industry. Rather than to give up entirely, the current plan is to have a series of alternatives, each with several options. However, even this strange and indecisive proposal compares favorably to what is essentially anarchy in the current choice of product offerings.

The IEEE 802 standards are split into three main areas: (1) 802-3, a carrier-sense multiple-access with collision detection (CSMA/CD) system, based on the design of the Ethernet system; (2) 802-4, a token-passing bus network, and (3) 802-5, a token-passing ring network. The latter is especially interesting to industry observers since IBM is its strongest advocate in committee and public technical discussions. Each of these fundamentally different schemes has at least three or four alternatives, which vary such parameters as data rate, transmission medium, distance traversed, and modulation and encoding techniques used. For example, within the token ring scheme, there are four variations of speed (1, 4, 10, and 20 million bits per second) using two different types of cable (150-ohm twinax, or a bundle of three lines of 75-ohm coax).

It is likely that the American standards for the lowest levels will be adopted during 1983. The years of work that went into the standardization process thus far are a portent of even more complex activity needed to standardize at the higher levels of networking protocols. Some companies, like Xerox, have published the standards they have adopted for their own products, and this encourages other companies to do the same. The National Bureau of Standards has proposed a series of higher-level protocols for the transport level and electronic messaging.

For users of networked office systems, this is an unfortunate state of affairs since they are primarily interested in the Application Level. Users want to move information from system to system, have it shared between machines with different internal hardware, and be able to display graphs on a variety of screens with different qualities and features. No doubt this capability is the ultimate goal of
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standards activities for LANs, yet the prospects for resolution appear to be years away.

Office systems buyers should, therefore, not anticipate that a local area network will make it possible for their IBM Displaywriter to talk to their Wangwriter and then to their CP/M machine without the addition of special programs and services to make it possible. Similarly, the adoption of electrical standards, whether by official committee or de facto adoption, does not solve the fundamental difficulties inherent in handling a variety of computers, with different operating systems, languages, and databases. Local area networks expose these problems to the harsh light of day; they are not responsible for having caused them.

Cost and Acceptance in the Office

For a wide range of applications, community microcomputing solutions are far more economical than conventional multiuser minicomputer approaches. Community networks are less expensive to purchase and, due to lower overhead, less expensive to operate. Fitting easily within existing office environments, community networks are less expensive to install than dedicated computer facilities.

More than price alone separates the personal computer local area network solution from traditional computing systems. To achieve productivity gains, workers must accept a system rather than resist it. Using familiar personal computers as workstations significantly aids in that acceptance. If a LAN functions transparently, the users see the network as an extension of their own personal environment rather than as a complex distributed data-processing system in which they feel like mere "nodes." The users feel that they are controlling their environment, not being controlled by it. This feeling of control and individuality by the user is the single most important difference between traditional systems and community microcomputing systems.

This article does not attempt to completely survey the available local area network hardware and software for personal computers in office applications. Instead, I will try to give several particular illustrative examples and let the interested readers follow up directly with their local computer vendor or by study of the references.

First, let's look at some of the microcomputer vendors who have gone ahead and designed their own proprietary networks for their own machines.

Proprietary Networks

Apple Computer Inc. recently announced a network for Apple products but has not delivered actual hardware and software or complete details on it yet. Applenet is described as a 1-megabit-per-second network, connecting as many as 128 stations over at most 2000 feet. It uses a twinax cable, which runs between a series of transformer-coupled boxes that permit as many as four stations to tap in at a time to the main bus. A
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Nonproprietary Networks

Only a few networks were developed by a computer vendor and then subsequently adopted by a number of other companies for their own use. There are three prime candidate networks in this area: the Corvus Omninet, Xerox Ethernet, and Datapoint ARCnet (attached resource computer network).

The Omninet system is designed for educational and small-business markets. As many as 64 stations can be connected to a 1000-foot cable. Repeaters can be used to extend the cable length to as many as 4000 feet.

The three prime candidates for standard networks are the Corvus Omninet, Xerox Ethernet, and the Datapoint ARCnet.

Omninet transmits data at 1 megabit per second, and a variety of microcomputer interfaces is available from Corvus Systems Inc. The interfaces range in cost from about $500 to $750. Corvus has worked with several computer vendors and licensed the technical details to them for use with their own offerings. Some examples of these companies are Dictaphone, Onyx, NCR, and Texas Instruments. Corvus also offers the simpler Multiplexer that shares time on the peripherals and uses the same high-level Constellation software that Omninet does. Corvus now manufactures its own office workstation, known as the Concept, which comes with a network interface as a standard feature.

Xerox Corporation has developed and licensed its own networking system, Ethernet, with the support of Intel, Digital Equipment Corporation, and many other manufacturers. Ethernet communicates at 10 megabits per second and can connect as many as 1024 stations attached to a series of segments that span as much as 7600 feet. Each station is given a unique 48-bit address, and Xerox provides a means of coordinating addresses and protocols on a worldwide basis. The Ethernet scheme provides the technical basis for one of the three IEEE committee standards. Due to the very early availability of the technical details from Xerox, Ethernet achieved a large measure of de facto acceptance prior to any formal adoption. Xerox has also released many of the details of the higher-level protocols, the Xerox Network Systems, that it uses throughout its network products; this, too, has led to significant de facto standardization to date.

Due to Ethernet's high performance and tight technical specifications, Ethernet controllers have been more expensive than other offerings. The recent production of custom very large scale integration (VLSI) chips has lessened the disparity, and the 3COM Corporation has introduced an Ethernet controller for the IBM PC, with a price of $950 per station. The 3COM Corporation also offers a shared hard disk, Ethermaster ($11,500), and software packages to use with it. Etherprint ($750) enables several users to share printers, and an electronic mail package, Ethermail ($1300), provides sophisticated office communication for as many as 1024 users. The 3COM Corporation has agreed to provide Ethernet controller cards to Apple for use in all Apple's personal computers, including the Lisa, and also supplies controllers on an original equipment manufacturer (OEM) basis to companies such as Altos Computers and Digital Equipment Corporation.

Datapoint Corporation introduced its ARCnet system for linking together its own series of office equipment products beginning in 1977. Since then the product has expanded and, due to the thousands of systems being sold, was reduced to VLSI circuitry early. These circuits are available without any licensing fees or restrictions from their manufacturers, which is a more open stance than that taken with the previous two systems. ARCnet communicates at 2.5 mega-
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bits per second, and as many as 255 stations, as far as 4 miles apart, can be connected at a time. ARCnet is a bus-oriented system, i.e., any station can communicate to any other without intervention. But the electrical connection is made (every 2000 feet) through a starlike amplifying and isolating device; thus the physical topology resembles a star or treelike form. The form of access control used is a token-passing scheme, which is a ringlike logical connection.

The issue of installed cabling may be critical in decisions about adopting a network, as was pointed out in the discussion about PBXs earlier in the article. ARCnet uses the standard IBM 3270 coaxial and connectors for its cabling scheme, thus taking advantage of the wealth of field experience and quantity of installed cable (more than 1 million offices). Rather than costing about $1000 per station, as in Ethernet, ARCnet interfaces range from $400 to $600.

ARCnet has been adopted by two other companies to date in the microcomputer arena. Tandy Corporation announced that it will provide ARCnet capability for its Model II and Model 16 products. Tandy will provide a series of shared disk systems and the necessary software for office use.

Nestar Systems provides its PLAN (Personal Local Area Network) 4000 series products, which use ARCnet for their electrical network interconnection. Nestar chose to adopt another de facto standard at the same time, namely, the Xerox Network System (XNS) protocols (Levels 3 to 5), which are used by many Ethernet implementations. This permits the eventual easy interconnection between ARCnet and Ethernet for Nestar products, as well as the use of many XNS-based software products in an ARCnet hardware base.

Nestar’s PLAN 4000 system interconnects IBM PC, Apple II, and Apple III workstations. Software is provided to permit each of these machines to operate in one of several different local-operating-system environments, rather than restricting the user to one particular choice. This may be important in permitting users to select their environment based on the available application software, and not the other way around.

Nestar, like Xerox and Datapoint, provides a fairly complete set of surrounding hardware and software offerings to add to the basic networking equipment. This includes such capabilities as sharing disks, printers, a multitude of mainframe communications packages, electronic mail, etc.

Who’s Missing?
The overview here is partial. Undoubtedly by the time this article is in print, there will have been significant changes in the networking industry. In particular, the offerings from IBM have not yet been unveiled. Once done, we can expect to see many companies shift swiftly in its direction.

The crucial question has to do with activities in the operating system and application software arena. Will we see true embedding of network primitives in the operating systems produced by such companies as Microsoft, Digital Research, and Softech Microsystems? (Digital Research has introduced the CP/NET system, but it has not been an outstanding success as measured by the number of networking companies that prefer to develop their own network-based CP/M support.) And which programs will take advantage of the multiuser database aspects of networks? Will the vendors of software packages trust the security and protection mechanisms of microcomputer-based local area networks? Who will sell networking systems—local computer retailers or specialty houses that work only in selected vertical markets?

Summary
Local area networking of personal computers in the office is a complex subject. The number of solutions offered are bewildering to purchasers of such systems, and it looks as if the product proliferation will continue for some time before any true coalescence occurs. Standardization is a slow process, and the real problems have yet to be addressed. At this time, users need to work closely with
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those vendors and their representatives who are well trained, knowledgeable, and dedicated to the field of networking. It is not as simple as plugging in a card, much as one would plug in a printer interface or memory expansion board. In spite of the complexity, personal computer local area networks are being used for some truly exciting applications, but, for the moment, they are not available as off-the-shelf products. Community microcomputing, the merger of personal computers and local area networking, is becoming a standard offering of most microcomputer vendors, but only a few have recognized the advantages of adopting standards and have avoided the pitfalls of the invent-your-own approach. True office local area networking is still a dream to be fulfilled.

References

Vendor | Product
--- | ---
Action Computer Enterprises Inc. | DPC/NET
Apple Computer Inc. | Applenet
Altos Computer Systems | Altosnet
Corus Systems Inc. | Omnimet, Multiplexer
Cromemco Inc. | C-Net
Datapoint Corporation | ARCnet
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The Fortune 32:16 Business Computer

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Steven H. Barry
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The Fortune 32:16 has garnered its share of publicity as the first well-integrated Unix-based computing system for about $5000. "Under $10,000" might be more accurate, but at any rate the system has several unique and interesting features. User-friendly, the Fortune is directed at the first-time business computer user. In this review I'll describe the system's features, cost, performance, and product support and take a look at the FortWord word-processing program.

An Overview

The basic Fortune 32:16 is housed in three cabinets—the processor unit, the keyboard, and the video display unit (see photo 1). The processor unit contains a Motorola 68000 microprocessor that runs at 6 MHz, 256K bytes of memory (expandable to 1 megabyte of main memory), and a video-display controller board. The system can presently support a four-port serial-terminal controller and a microprocessor-based intelligent-terminal controller. In the future it will support these peripheral controllers as well: an optional storage-module disk interface, a parallel device interface, a high-resolution graphics board, and an Ethernet local-area network board. A console keyboard and video interface are standard, as is an RS-232C serial interface, which is often used for a serial printer.

The unit also contains a programmable-array logic IC (integrated circuit) and PROM (programmable read-only memory) used for loading the operating system, software-security and operating-system parameter tables (parts of which can be modified by the user), and magnetic-disk storage controllers and drives.

The detachable console keyboard is connected to the front of the processor unit by a 4-foot coiled cord with a modular jack. The keyboard is a close cousin of the one found on Wang Laboratories’ word-processing systems, but it has a total of 99 keys, including a 15-key numeric keypad. These are well arranged and color-coded. A Help key provides access to online help pages at nearly any stage of operation. Sixteen programmable function keys, which are used by Fortune-supplied application programs, are available for user-developed programs. The keyboard provides adjustable auditory feedback, good tactile feedback, and two speeds of automatic repeat when a key is held down.

About the Author

Dr. Barry is a senior scientist with Systems Research Laboratories Inc. working on state-of-the-art personal workstations.
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The separate 12-inch (diagonal measure) video monitor has a green-phosphor screen with medium persistence and displays 80 columns by 24 rows. Characters are formed in a 9 by 20 pixel (picture element) cell. A set of up to 288 different characters can be displayed, including a subset of the AT&T videotex character set. The display's several video attributes include blink, inverse video, and bright fields. The monitor is mounted on a sturdy, but too low, pedestal that permits easy tilt and swivel adjustments. The video display is connected to the rear of the processor unit by a 4-foot coiled cord and a modular jack.

The Fortune 32:16 comes with three hard-disk storage options: the disk controller can handle up to four 5-, 10-, or 20-megabyte disk drives. All hard-disk configurations come with a single 5¼-inch double-sided double-density 96-track-per-inch (800K-byte) floppy-disk drive. The floppy-disk drive is used for backup and for removable storage of data and programs. All software releases are on floppy disks. The processor's cabinet can accommodate only two such mass-storage devices. An optional disk cabinet will be available to house additional hard- or floppy-disk drives or a 20-megabyte cartridge-tape unit.

Depending on the user's needs, the system software, languages, and application programs may consume between 3.0 and 6.2 megabytes of disk storage. Thus a business with multiple users would be wise not to consider a system with less than 10 megabytes of hard-disk storage. Memory is also an important resource in Unix systems; it makes good sense to provide plenty of RAM (random-access read/write memory) to avoid excessive swapping to the disk.

Cost

A practical small multiuser configuration would be what Fortune Systems Corp. calls a System 10 (it has a 10-megabyte hard disk with the system keyboard and video monitor, one 800K-byte floppy disk, and 512K bytes of memory) and a four-port serial communications interface. Together with the multiuser-system software upgrade, this configuration will cost $11,980—that's without terminals or application software. The lowest-cost hard-disk-based single-user system is $7990 (a promotional price, $7195 less than list price), including the system keyboard and display, a 5-megabyte hard disk, the ForWord word-processing package (soon to be

### At a Glance

<table>
<thead>
<tr>
<th>Name</th>
<th>Fortune 32:16 computer system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Fortune Systems Corporation</td>
</tr>
<tr>
<td>Address</td>
<td>300 Harbor Blvd, Belmont, CA 94002</td>
</tr>
<tr>
<td>Price</td>
<td>[Price listed]</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Processor unit: 5.8 by 13.9 by 22.3 inches, 30 pounds; Console video display: 12.9 by 13.7 by 12.3 inches, 12 pounds, connected to rear of the processor unit with a 4-foot coiled cord and a modular jack; Keyboard: 2.2 by 6.3 by 22.3 inches, 6 pounds, connected to the front of the system unit by a 4-foot coiled cord with modular jack.</td>
</tr>
<tr>
<td>Magnetic Tape Cartridge</td>
<td>20-megabyte cartridge-tape drive with integral controller in expansion cabinet.</td>
</tr>
<tr>
<td>Operating System</td>
<td>Unix, version 7 with Fortune, University of California, Berkeley, and a small number of System II enhancements. Multiluser capabilities are available for $495. The Fortune-developed user interface (i.e., shell) as well as the Unix pseudostandard Bourne shell are available to the user. Standard Unix file-system structure allows essentially unlimited nesting of user directories. Fortune has implemented file, page, and record locking features. File system and software integrity checking is executed at start-up and shutdown.</td>
</tr>
</tbody>
</table>

* Denotes items that are near release or planned for release at this writing.

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The Accelerator II: Based on a fast 6502 processor with 64K of high-speed memory. Includes built-in fast Language card. Hardware compatible with all standard peripherals. Transparent operation with Apple II software. Special pre-boot diskette included to run Applesoft, PASCAL, and Integer Basic from high-speed RAM. Suggested retail price: $599.

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The Wang system is nearly bug-free (we have one in our office, and it was a major factor in our choice of the Wang Laboratories system. Where differences can be found, they are either enhancements, trivial, or due to a bug. The Wang system is nearly bug-free (we have one in our office, and it was a major factor in our choice of the Fortune 32:16 system. The Fortune program is not bug-ridden, but it is recognizably new.

In general, the Fortune word processor compares favorably with popular alternatives for personal computers. The extensive use of labeled function keys makes learning and using the system far easier than other popular programs such as Wordstar. For:Word, like Wang's editing system, is an early approach to what-you-see-is-what-you-get word processor.

Wordstar does a better job with word wrap, pagination, and line-by-line justification on the screen, but For:Word's printer justification is better. For:Word also does a much better job with printing, hyphenation, formatting, searches, tabulation, and advanced features. Extensive use of screen attributes makes bold print and underlines quite clear. For:Word doesn't handle superscripts and subscripts as well; the material to be half-line shifted is surrounded with vertical arrows. That's much better than Wordstar, but it doesn't make things as nice as a true what-you-see-is-what-you-get system such as the Xerox 8010 Star word processor or Apple's Lisa.

Printing on the For:Word is accomplished by a postprocessor that takes, in our application, from 10 to 40 seconds, depending on file length and system loading to execute before printing begins. On the Wang system, printing starts almost instantaneously.

While the word processor is generally excellent, a few areas need improvement. These include line-by-line justification on the screen at text-entry time, printer-code conversion at text-entry time (to avoid long printer waits), word wrap keyed to a hard hyphen (currently done only at word breaks), the ability to start pagination or hyphenation passes at any arbitrary point in the text, and continuation of format settings (e.g., the Indent feature that keeps a block of text indented until the first hard carriage return is encountered) across page boundaries. Some of these features, such as line-by-line justification, would not look exactly like what you see on the printed page because the Fortune (and Wang) screens are character-oriented rather than bit-mapped (bit-mapped screens can be used to show microspacing on the screen). Some of these features and several others are slated for the For:Word Plus package, which is due out by the second quarter of 1983.

The word-processing screen (see photo 2) is headed by a status line that tells you the document name, the current page, line, and column, and the cursor mode. The cursor mode is the amount of material through which the cursor will move with a press of the left or right cursor-motion keys. There are five cursor-motion modes: word, line, sentence, paragraph, and page. Below the status line is the format line, which is used to control vertical line spacing (no space, quarter spacing, half spacing, single spacing, a space and a half, double spacing, and triple spacing are available). The format page also controls tab stops and line length and provides a visual indication of cursor position on a line. The text area is bounded at its bottom by a double dashed line and the words Document End.

Overall document format standards are set in what is called a prototype document. Default settings such as line length, tabs, line spacing, and page length as well as...
VISUAL 50 and VISUAL 55 represent a new approach in low-cost terminals. Although they cost drastically less, they offer features you expect only from the high priced units. For example, the enclosure is ergonomically designed in lightweight plastic and can easily be swiveled and tilted for maximum operator comfort. A detached keyboard, smooth scroll, large 7x9 dot matrix characters and non-glare screen are a few of the many human engineering features normally offered only on much higher priced terminals.

Another distinctive feature of the VISUAL 50 and VISUAL 55 is their emulation capability. Both terminals are code-for-code compatible with the Hazeltine Esprit, ADDS Viewpoint, Lear Siegler ADM-3A and DEC VT-52. In addition, the VISUAL 55 offers emulations of the Hazeltine 1500 and VISUAL 210. Menu-driven set-up modes in non-volatile memory allow easy selection of terminal parameters.

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default print options are set in this document. Each subsequent use of For:Word is initialized with these default settings.

Text entry begins at line one on a page and continues for as many lines as you want to enter. Pagination is done either manually or in a pagination pass at the end of the text-entry process. (It makes sense to define pages manually as you go along because several functions, such as Insert and Delete, trigger a line-by-line text-rearrangement process that works on a page at a time. "Pages" that are hundreds of lines long take a long time to rearrange.) A Go to Page function makes access to any selected page easy. Each page of the final output has a place for a header and a footer, which are specified by separate pages in the prototype document. Prototype documents offer considerably more format capability than is available with Wordstar.

Human-factors engineering was less a consideration when Wang created its word processor. As a result, some aspects of the generally good user interface are annoying or awkward. For:Word has improved on Wang by making processes and manipulations more explicit (see photo 3), but in some areas the user can still be easily confused. One such area is in the exit process after editing is complete. To exit the word processor text-entry mode, you press the Cancel/Delete key. An "End of Edit?" message appears at the right side of the status line. Pressing the Execute key confirms that editing is done. After pressing Execute, the following menu appears:

```
END OF EDIT
Cancel  erases the changes
Execute  saves the changes
Return   goes back to the editing screen
```

The correct choice looks easy, but in practice many users find the Cancel, Execute, Execute sequence, at first, counterintuitive. You only have to enter Cancel, Execute, Cancel once to appreciate the awkwardness of the whole process. There is no way to retrieve the buffer after such errors.

The HASCI (Human Applications Standard Computer Interface) keyboard, developed for and implemented on the Epson QX-10 computer, solves this problem by providing a Save key. The prerelease example of For:Word Plus that I saw improves on the current state of affairs.
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and some other things as well.

Placement of certain options on menu screens is another source of confusion. To access document directories, you select Index on the main For:Word menu. But documents are placed in and retrieved from archives and libraries by selecting Filing on the main menu. Thus to retrieve a document from an archive you must look it up using Index, use the Cancel key twice to return to the main menu, and enter two levels of menu before you can use the name you remember from Index in order to retrieve the file. Providing an index function within the Filing menu choice would be a simple matter.

In summary, the For:Word word-processing package is a professional system that both secretarial and managerial personnel can use. The system is easy to learn, designed with users in mind, and very flexible. While the package is not complicated, its flexibility is a drawback in certain situations, as is the lack of advanced person-computer design features. Because For:Word emulates the Wang system, the most widely used word processor in the U.S., these criticisms actually apply to that as well.

For:Word has a number of bugs, and Fortune has assured me that a future version of the software will address them. Fortunately, none of these bugs stand in the way of the word processor’s usefulness. Until the bugs are out, however, a list would help users to circumvent the worst of these problems. Because Fortune communicates with its customers only through its dealers, the company misses useful feedback from the field and users miss many of the company’s tips and cautions.

Applications Software

Other software, available now or in the near future, includes a complete Business Accounting System with related applications such as order processing and inventory control along with a coordinated business graphics package, Multiplan spreadsheet software, Pascal, FORTRAN-77, two types of COBOL (one of which is a high-intermediate level), programmers’ tools, Idal database-management software, Sequitur database-management software (third-party software known to work on the machine, but unsupported and without the company’s blessing), general-purpose graphics, a very extended BASIC, a set of filters said to convert code written in other BASICs to the Fortune language (these include Applesoft, MBASIC, CBASIC, and TRS-80 BASIC), the C programming language, and the For:Word Plus advanced word processor.

The Fortune 32:16’s operating system itself is scheduled for an update around mid-year for all users. Selected users have access to an interim upgrade of the operating system. The new version, in combination with replacing some ICs on the disk controller board and the upgrade to For:Word Plus, will make the system much quicker, I’m told. Our dealer will make each of these improvements at no additional cost. The disk-controller upgrade, on the other hand, is being done for all Fortune users. Fortune

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has recommended that the dealers upgrade the operating system for only those customers who "need" it now. I suspect this policy will return to haunt both the dealers and Fortune, if only in the short run. Supporting one version of mass-distributed software is difficult enough, but it will be a nightmare to support two versions until the second and universal release is made.

Fortune would do well to consider providing a software-maintenance service that automatically updates subscribers' software twice a year, supplies revisions to manuals (and any new manuals that are published for the customers' licensed software), and offers hints and tips to the users. Digital Equipment Corporation has done just that very successfully, after a slow and awkwardly administered start. Such a service would keep all users at the same revision level, reduce bugs in the field, keep the customers happy, and enhance the company's image.

Performance

If you're accustomed to 64K-byte dual-floppy-disk-based CP/M (or similar) systems, you'll be appalled at the amount of disk and memory resources Unix systems use. Note, however, that combined program and data memory sizes totaling as much as 880K bytes may be selected on the Fortune system. The user environment, whether it's within the excellent Fortune-supplied menu-driven shell or within the more standard Bourne shell, is much more flexible than CP/M's command processor, and the operating system services are light-years ahead of CP/M's. I will describe some of these advantages in detail below. It's important to keep in mind that the Fortune has a multiuser, multitasking operating system; each user (up to a practical maximum of 12) can run multiple processes simultaneously.

A system on the order of the 64K-byte one described above is the practical minimum for multiuser business applications. In addition to the components described, the system must have terminals and a printer. We use three Fortune Intelligent Workstations along with an NEC (Nippon Electric Company) 7725 letter-quality (55 characters per second) printer. That leaves one serial port available on this configuration for telephone or modem access. Our system is used for two widely disparate types of work; our analysts spend most of their time using For:Word, while the programmers spend most of their time editing, compiling, and testing programs written in one of several languages.

Under most circumstances, the system performs at an acceptable level. Things tend to slow down quite a bit when several users are in For:Word (a lot of "character banging" goes on in this program; for each character typed, about 20 are sent from the computer to the terminal) or when they try to access the disk at the same time or during the execution of a program compilation. System response should improve when a four-port, microprocessor-controlled serial interface replaces the "dumb" unit we are now using. Another 256K bytes of memory should also make things better. Fortune notes that the universal release of an operating-system upgrade (version 2.0) at mid-year will also improve performance.

A word about response degradation is in order. All disk-based multitasking timesharing systems have the same weakness: the average access time for a disk is thousands of times slower than it is for semiconductor memory. Small-business systems usually have relatively limited amounts of memory, compared to the amount that current system and users' tasks and data require.

System tasks called daemons (British for demons) are called from the disk and executed periodically to do housekeeping chores. The process of moving inactive tasks to the disk or making room in memory for large tasks whose turn it is to run is called swapping. The disk is used to minimize the amount of semiconductor memory the system requires and achieves an acceptable compromise between service and cost. The swapping overhead of a system, if excessive, can cause response to become very slow, even though the processor may be idle most of the time.

Generally, delays are particularly noticeable in timesharing systems when the same hard-disk drive is used for systems software, swapping, and user directories. Delays are aggravated by low-performance disk hardware (such as floppy disks, whose average access time is in the 250 to 500 milliseconds range) and by stepper-motor head-positioners on hard-disk drives (about 75 ms). There is a consensus in the Unix community about the performance improvements to be gained from high-speed disks (about 35 ms average access time), optimal placement of direc-

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tories and swap tracks (a feature said to be in Fortune's operating system version 2.0) on at least two disk drives to minimize disk arm movement, the use of overlapped disk seeks, separation of systems software from user directories, and separation of high disk-load users from low disk-load users. The use of only one hard-disk drive on a timeshared system can affect response time when relatively small memory is available. This is true for all timesharing systems, especially those that, like Unix, allow users to execute multiple tasks concurrently.

Product Support

Fortune has a Software Service WATS telephone number for its dealers. Users report problems to the dealers, who attempt to fix them with their own resources or query the software hotline. Because both Unix and Fortune are new to most of the dealers handling the 32:16, they often have to resort to Fortune's dealer-support system.

Because the Fortune 32:16 computer is directed at first-time business-computer users, dealers need to know about and be able to support the application software.

Our dealer, Kramer Systems International in Silver Spring, Maryland, seems to be learning to support this product fairly quickly. The company has perceived the need to provide Unix expertise and dealer support that is more comprehensive than what many microcomputer vendors offer.

Fortune offers its dealers training courses in hardware, operating-system software, and supporting the applications software. Our installation was completed relatively early in the dealer training cycle, before some of the support that's now routine became available. The Fortune 32:16's commercial success seems to be driving the dealers toward better service and, inevitably, away from a willingness to discount. Because the system is directed at the first-time business-computer user, dealers are required to know about and support the application software.

A lot of software is available now, and more is constantly becoming available. The software and manuals I've reviewed seem to be solid, flexible, and nontrivial products. The programs are well debugged at the surface level, and as a whole my impression is that this is good first-release software. Remarkably good, in fact, for an industry that routinely uses its first customers as a final test and inspection department. The software manuals are outstanding for novices, but too superficial for people who know their way around systems and software.

An effective dealer has to invest significant training in both technical and sales staffs to support the depth and range of products to be offered. A financially solid, committed, and technically qualified dealer is a valuable facet of the overall decision to use the Fortune 32:16 in a business environment. As always, it's wise to give some serious thought to the purchase contract, installation support, and maintenance before you purchase any system. Despite a marketing focus on the first-time business-user, the Fortune has (or will have) the tools to support software development on a small scale. The thought of twelve sophisticated programmers working simultaneously on a 32:16 boggles the mind, but for environments in which word processing and packaged applications constitute 80 percent of the system's use, ample resources are available. Here, too, even if you're a Unix expert, good dealer support is highly desirable (if for no other reason than as an information conduit between you and the support people at Fortune, who will not speak to you directly).

The Unix Operating System

Unix, a multitasking operating system developed at Bell Laboratories, has been both praised and damned. Experienced users find it a superb software-development environment. Often, however, a user must navigate through a complex and branching structure to find a particular file. The Unix file structure is much like a branching tree; the top of the structure is called the root but is referred to as / (slash) when addressing that directory.

Like other directories, / is a file, and like all directory files it contains disk address pointers to executable binary files, binary object files (the results of the compilation process or the assembler process), data files, and other directories. The user looks at a directory listing and sees the names of these files, not the pointer value.

A typical Unix file of whatever type has an owner and a set of read/write/execute permissions for other users (naturally, nonexecutable files, such as ASCII text files, can't have an execute permission). By Unix convention, most files and all commands are styled with lowercase characters.

Unix also appears to have a perverse and pervasive unwritten rule requiring all commands be abbreviated to the point of unintelligibility. For example, to get to a file belonging to a user called "george," you use a command like this: cd /usr/george. The command cd changes your current directory to the one specified after the cd command—in this case, the directory george that is itself contained in the user directory. The first / refers to the root, where everything starts; usr refers to the directory in which all user directories are kept, the second / is merely a separator, and george is the target directory. (On the Fortune Unix system, user directories are kept in u instead of usr.)

To execute a program or command, you must first have permission. Then you only need to type the name of the pathway that leads to that program.

The file-system structure enables you to organize files by subject, project, month, or whatever is convenient. Each category name is used as a directory name. Subdivisions of the category can be used as the names for
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names. For example, cp copies files, nroff is a text formatter, and cc calls the C compiler, while cb calls a C beautifier (a program that formats a C program for easy reading and good style). There is a very fuzzy syntax checker for the C language, called lint. The program as calls the assembler for the host machine, and df gives you statistics on the amount of free disk space available, but diff is used to compare the contents of files or directories. Literally hundreds of such commands are available in standard Unix when using the Bourne shell. These commands, together with an environment that makes group programming or other group efforts easy to organize and efficient to monitor, make Unix a very useful system for those who are willing to do the requisite apprenticeship.

Unfortunately (no pun intended), Fortune does not currently supply any Unix documentation with its system and supplies only a relatively minuscule amount of documentation with the C programming language package. I bought a set of manuals for $91 from the University of California at Berkeley, whose version of Unix is the current model for the Fortune operating system. Due to the terse and sometimes irregular syntax of commands, the large number of commands, the potential for disaster if you misuse a command (Unix assumes that you know what you're doing), and the industry-wide lack of Unix documentation for the casual user, many consider the standard shell inappropriate for the average business environment. Luck is on our side, however, because Unix has an answer.

Unix allows the use of many different shells. In fact, each user can have his own shell. The standard shell even lets you program within it to create new commands out of old ones. Thus there's a strong foundation on which you can build a shell that is more appropriate for an office environment. Fortune Systems is one of the companies that has done this.

The Fortune shell is menu-oriented. You sign on to the system by turning on your terminal and typing your name and password in response to screen prompts. If the name and password correspond to entries authorized on the system, you can progress to the Fortune Global Menu (or to the Bourne shell, if your account specifies this option). The Fortune Global Menu has six areas: business applications, professional tools, electronic office tools, communications, training/education, and system tools. Each of these areas has a list of available software.

Figure 1 and photo 4 show the global menu. Note that some entries are brighter than others. The brighter entries signify software options installed on the machine. To select an option, you can use the Return key, which will
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move the cursor through the menu selections sequentially, use the cursor keys to select the application, or type the entry number of the desired option (e.g., el, or E1 for For:Word), followed by pressing the Execute key.

The options within each application are also menu-oriented. Thus it is possible to get three or four menus deep into an application before you can execute a function. This procedure treats the new or infrequent user very gently, but it can be tedious for users who are familiar with their applications.

Menus are also a very slow way to use computer systems. Fortune has provided mechanisms that alleviate some of these lengthy navigations of the system menus, but these commands do not yield complete access to all options. For example, you can go to any previously created document from the Document Index display without climbing and descending a set of menus. Although it is slow and occasionally confusing, the Fortune menu shell and the menu approach to applications are generally very well thought out. Few areas have been neglected, and those are sufficiently technical in nature that the user might well use the standard Unix shell for them.

You can access the Bourne shell whenever you are being asked for a Global Menu choice by typing an exclamation point followed by the desired Unix command. The command is executed and you are returned to the menu shell at its completion.

Summary

The Fortune 32:16 computer offers an outstanding business-operating environment with a reasonably good technical development environment. The system is well designed and easy to use. Dealer support is advised if you're not expert at fending for yourself in complex systems environments. The Fortune operating environment does not encourage tinkering with the inner workings of the operating system, but if you're technically inclined you’ll have a good time with the system.

The major marketing consideration that distinguishes this system from the large number of similar systems on the market is its optional gentle user interface and the wide range of very high quality application software available now or planned for the near future.

Some systems are better adapted to highly technical environments, to the use of industry-standard interface cards (e.g., STD bus or Multibus), and to real-time applications. Fortune Systems has, however, created one of the better systems currently available for business use and for technical efforts that do not require all of the nitty-gritty of standard Unix, the pleasures of the Programmers' and Writers' Workbench modifications to Unix, or the flexibility of systems designed for laboratory environments. Given the technical orientation of the bulk of offerings in the Unix marketplace today, Fortune Systems has chosen the harder row to hoe and has done it very well.
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The Movable Conference
A report on a revolutionary new communications medium: computer-moderated conferencing.

During the eighteenth Egyptian dynasty, about 3500 years ago, a royal scribe named Amenophis, son of Hapu, rose to great prominence. He was such an accomplished communicator that the pharaoh appointed him both hereditary prince and master of ceremonies of the feast of Amun, a position rivaling that of the high priests of Karnak, the great temple city of upper Egypt.

Since that time, the princes of communication have always aspired to power but have rarely achieved the deified status of Hapu’s remarkable son. In 1970, however, an experiment in information science started a movement that, as this decade matures, will extend and transform this most fundamental of human activities and may confer unprecedented power on a new generation of electronic messengers.

Consider the ways we usually communicate (talking, writing, and gesturing) and how we enhance that communication (telephone, gatherings, print, video, signs, radio, etc.). Such exchanges are limited by the environment, by the need for synchrony in time and place for dialog to occur.

The most desirable form of communication is the face-to-face meeting. But face-to-face meetings are unstructured, weighed down with social conventions based on rank, subject to misunderstandings, and vulnerable to information loss. If needed data is not immediately available during the meeting, many decisions will be delayed until some time after the conclusion of the conference. Meeting planners must have exquisite foresight if everything is to run smoothly. If numerous participants are located in different cities, the travel and accommodation costs can be excessive and the meeting cut short, often before anything useful is accomplished. With the computer as communications device, however, the bonds of synchrony can be cut. A conference can now “move” in terms of both time and place to each participant of that conference.

Indeed, the most apparent difference between computer-moderated conferences and face-to-face meetings is in the temporal relationship of the exchanges. In a computer conference, messages are forwarded in time until a participant reads them and replies. Participants may review the proceedings, respond to specific messages, enter new information, ask questions of any participant, or acquire data at any time, day or night. And because each participant needs only a normal telephone line or leased communications line to connect a terminal to a central host computer, the interchange is independent of place as well as time.

In addition, because the computer maintains an accessible record of all transactions, memoranda and synopses are unnecessary; the final documentation can simply be edited from the computer memory. Add a feature for privacy to protect proprietary exchanges, and the system begins to develop a useful shape.

To a limited degree, we already have a measure of this power. The telephone enables us to contact people anywhere, at almost any time, and to carry on group conversations. We can even use the telephone to transmit printed and graphic information. But such teleconferencing must be conducted in the heat of the here and now, and the spoken word is fragile and notoriously elusive. What is obvious to one participant may be opaque to another. Some people may require more time to digest a certain piece of information. Much information is invariably lost.

Thus the conventional ways we exchange information are somewhat limited. But all of this is about to change in a way so fundamental, so profound, that the processes of collating and synthesizing information will cease to exist as separate activities divorced from communication.

---

About the Author
Irving A. Lerch
New York University Medical Center
Division of Radiation Oncology
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EMISARI

In 1970, the White House Office of Emergency Preparedness (OEP) was given the responsibility of administering President Nixon’s wage-price freeze. To accomplish this difficult task, the OEP put into use the first electronic conferencing system, the Emergency Management Information System and Reference Index (EMISARI). The following quote from The Network Nation by Starr Roxanne Hiltz and Murray Turoff (Addison-Wesley Publishing Company, 1978) describes how EMISARI supervised information flow:

The ten regional offices of OEP needed to be able to generate and share timely and useful data on . . . the wage-price freeze. The regional offices had to respond to requests and inquiries from the public in a way that was consistent with the initial guidelines and emerging modifications and interpretations. The central OEP management had to make sure that policy interpretation was consistent from region to region. . . . The primary innovation in EMISARI was the ability to set up alternative communication forms, such as collections of numeric estimates, tables of numbers, and situation report forms, and have these assigned as a permanent responsibility to some member of the communication group who would supply the information on a regular basis. . . . All this was under the control of a human monitor who could tailor the communication structure and the responsibilities as a function of the problem at any time.

As you might imagine, the advent of this unique, computer-moderated conferencing system was accompanied by a great deal of discord between the OEP establishment and the outsiders who invented EMISARI. The story of this conflict, recounted by Hiltz and Turoff (one of the designers of EMISARI) in their book, illustrates the friction generated when control over information changes hands. In spite of this difficulty, however, the concept of computer-moderated conferencing has been employed in a number of communications systems.

From New Guinea to the Electronic Cottage

A few years ago, the multinational Bechtel Corporation approached its telecommunications group with a problem: how could a team of employees scattered across several time zones and continents maintain effective communications? The great geographical dispersion made it clear that only a messaging service would work, yet the traditional methods were inadequate to sustain technical dialog among the 10 to 12 people in a team. Bechtel solved the problem by subscribing to Infomedia’s Notepad system, developed by one of the premier innovators in the field, Jacques Vallee.

An early Bechtel project using Notepad was centered at a Nevada molybdenum mine with no telephone access. In order for the site manager
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to communicate with a central office in San Francisco, he was given a portable terminal. Each evening he jumped into his jeep, drove to the nearest town, and telephoned Information, Inc.'s computer in San Bruno, California, to receive updates on engineering and management messages and details concerning orders and shipments. The system was also successful in managing gold and silver mines in Idaho and Canada and in supporting a nine-month project in the Beluga oil fields in Alaska.

The most spectacular Bechtel conferencing project involves a mining operation in Ok Tedi, a remote province 400 miles from the coast in Papua New Guinea. Altogether, several teams had to be coordinated between New Guinea, Australia, and a central office in Los Angeles.

Ironically, Bechtel does not use conferencing for its internal corporate communications. As is true for many organizations, messaging is accomplished by using switching networks, electronic mail, and similar systems. This may change as computer conferencing is exploited to relieve working groups of the need for extensive travel and real-time discussions.

Two other computer-mediated conferencing systems, Confer and EIES (Electronic Information Exchange System), serve the needs of specialized study groups and business clients who "meet" online to develop documentation, examine specific problems, exchange data, and communicate with allied organizations. The Army's Delta Force, a network of consultants and Department of Defense specialists, uses Confer to examine future needs and organizational requirements. (See "Electronic Publishing" by Arthur Bechhoefer, page 124, for an account of another interesting application of Confer.)

EIES has been the site of professional-society committee deliberations such as those of the Instrument Society of America. Also, 10 hepatitis experts used EIES to organize a new database, the Hepatitis Knowledge Base, for the American Library of Medicine. The Hepatitis Knowledge Base is now available for downloading into physicians' microcomputers. In addition, Starr Roxanne Hiltz, coauthor of The Network Nation and sociologist studying acceptance of the new telecommunications technologies, has employed EIES to present online courses such as Telecommunications in the Future.

In 1978, a conference was organized on EIES, called Politechs, that included federal laboratories, state legislatures, local governments, public-interest groups, technical professional societies, and the White House. The conference was dedicated to promoting exchanges on the impact of science and technology on public policy. As a result of this conference, proposals have been made that aim at developing permanent interchanges for various departments of the federal government.

After the Three Mile Island incident in 1979, the nuclear industry responded by founding an Institute of Nuclear Power Operators that uses Notepad to tie together each utility...
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Communitree: A Microcomputer-Based Conferencing System

An organization in San Francisco called the Communitree Group has developed a computer conferencing system for the Apple II. Designed as an alternative to the many computer bulletin boards around the nation, this system provides a relatively simple messaging structure capable of supporting complex branching communications—hence the name Communitree. In operation, you simply dial the system as you would any other bulletin board. You then obtain a list of parent conferences that can be accessed with a simple READ command. If the selected conference contains a subconference structure, the titles of the branch conferences will be displayed. You may browse with more elaborate systems and enter messages with a simple line editor. Only the system operator has the power to delete or shift messages. Help files assist novices in learning the system's features.

This design is similar to The Source's. Participate in that it provides a message-branching structure. Communitree is much more primitive, however, because machine limitations restrict the resources available to users, but the system's simplicity makes it easy to learn and very suitable for restricted applications.

To run the conferencing software, you must have an Apple II with 48K bytes of RAM (random-access read/write memory) and two disk drives. This will support a maximum of 320 fifty-line messages. The system deletes notes that are not current, and it can easily handle up to 35 users per day if it is kept online 24 hours per day. The Communitree Group also intends to develop software for other personal computers such as the IBM Personal Computer.

The source code is written in FORTH, and the cost of the program and manuals is $150. Additional information may be obtained from the Communitree Group, Suite 207-3002, 470 Castro St., San Francisco, CA 94114.

with consultants, vendors, and numerous organizations.

Participate, a conferencing system that has recently appeared on The Source, has facilitated conferencing among disparate groups. These groups can subsequently organize themselves into communities.

An interesting example of the synthesis achieved in such a structure is the lecture, a project designed and implemented by a group of approximately 20 participants within a three-month period. Jim Rutt, while serving as manager of Product Development for The Source, started with a concept developed by David Hughes, an early exploiter of computer telecommunications as a teaching tool, and suggested that Participate provide popular electronic lectures or "lectures." A conference was started in which the members examined the scope, organization, and operation of an lecture.

Despite the fact that many key members of the conference were periodically absent for extended periods, the group was first able to define the mechanism and procedures that were needed and then put the first lecture online. The "lecturer" was Starr Roxanne Hiltz, and the subject was the computer revolution—how the "electronic cottage" is changing the home. It appeared in seven segments, each segment followed by a ballot and a separate discussion conference. The lecture became a powerful model for colloquia, seminars, electronic publishing, and structured telecommunications.

Where the Conferences Are

As of this writing, approximately a dozen commercial conferencing services are available in the United States. Some of these are run on central computers and can be accessed by terminals or microcomputers via packet-switching networks such as Tymnet and Telenet. Some can be licensed for use on a private mainframe computer. Most of these services are summarized in table 1. In addition, there is even a computer-moderrated conferencing system that runs on a microcomputer.

It is difficult to compare the various conferencing systems because they were designed with different tasks in mind. This has led to certain structural and operational quirks peculiar to each one. However, because some features are shared, there are undeniable family resemblances.

All systems are designed to facilitate many-to-many communications. Participate differs somewhat in that it was designed to accommodate what has been referred to as "inquiry networking." Users of Participate may branch off a main conference and develop their own subconferences, usually based on an inquiry generated in the trunk discussion. This multiple-branching capability is analogous to the organization of subcommittees in a plenary session. The subcommittees are established to examine specific topics and then report back to the full committee. This structure facilitates the problem-solving aspect of conferencing.

Of course, any system that provides such opportunities for multiple-branched conferencing must also supply the user with means to maintain access and control. This requires a more complex set of instructions that can frustrate the unsophisticated subscriber. Initially, users may have difficulty knowing where they are within the conference hierarchy. Most computer conferencing systems have limited branching capabilities and use as simple a procedure as possible in order to achieve user-friendliness.

This does not mean that such systems are simple—far from it. EIES furnishes elaborate subdivisions for specialized information transfers, such as an electronic marketplace for buying and selling information and a "paper fair," a repository of research documents. Participate relies on its branching capability, which users must learn in order to tailor the system to their own needs.

Perhaps the most elaborate system is Augment, which gives the subscriber maximum control over all textual operations, from processing to multicolor page composition. Such a system requires a high degree of user knowledge and skill.

Com, the Swedish entry, has an extremely flexible structure that enables participants to track related messages via the links that interconnect them as a discussion grows. A single command is all that is needed to trace the
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<td>Matrix Transaction Exchange</td>
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<td>Cross Information Co.</td>
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<td>$50 fee plus $25/hour;</td>
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<td>934 Pearl Mall, Suite B</td>
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<td>leasing costs: $1000/month and up</td>
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<td>Boulder, CO 80302</td>
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<td><strong>Augment</strong></td>
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<td>licensing costs: $1000/month and up</td>
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<td>arrangement. Obviously,</td>
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<td>licensing cost depends on implementation</td>
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</table>

Table 1: A list of commercial computer-moderated conferencing systems available today. Most of these systems can be accessed with either a microcomputer or a terminal. In addition, the software for some of these systems can be licensed for operation on a mainframe computer.
You can count on 3M diskettes. Day after day.

Just like the sun, you can rely on 3M diskettes every day. At 3M, reliability is built into every diskette. We've been in the computer media business for over 30 years. And we've never settled in. We're constantly improving and perfecting our product line, from computer tape and data cartridges to floppy disks.

3M diskettes are made at 3M. That way, we have complete control over the entire manufacturing process. And you can have complete confidence in the reliability of every 3M diskette you buy.

If you’re a dealer, OEM, or fairly knowledgeable end user, Vandata has an incredible deal for you — the Vandata Business Software Package. The package includes: General Ledger, Accounts Payable, Accounts Receivable and Payroll with Cost Accounting, plus our custom installation program. **All for only $295.**

Why so low? Because a mature user doesn’t need support. That drastically cuts our costs. And yours.

And if you’re a software dealer, you can resell Vandata Business Software without paying royalties. The Vandata business package is the best-debugged, easiest-to-install enhanced Osborne-based system on the market. It’s well worth up to $995 with your support to end users.

Minimum requirements are 48K RAM, CP/M™, or CDOS, CBASIC™, a CRT and a 132-column printer. The package is available on most CP/M disk formats. Our installation manual is included and the Osborne/McGraw-Hill application manuals are available separately.

Why pay for support you don’t need? Order the Vandata Business Software Package. **Call toll free: 1-800-426-5248.**

---

Microcomputers as Terminals

As mentioned previously, you can reduce online charges by using a microcomputer (or intelligent terminal) capable of supporting text processing and a wide variety of communications tasks. A long document can be composed offline, edited, and then transmitted to the conference. Conversely, documents can be downloaded and read at leisure. And for the corporate executive with a hectic schedule or the computer hobbyist with little money, the microcomputer can wait until an appropriate time (say, after midnight when the network rates are lowest), dial into the conference, upload documents, download messages, and inform the user of the transactions the next day.

---

Designers of the Hub conferencing system from the Institute for the Future (IIFTF) decided to support four basic activities: graphics, programming, documenting, and balloting. Upon conclusion of the developmental and testing phase of the system, Hubert Lipinski and Richard Adler of IIFTF concluded that a more general method of achieving user-mediated access to resources is through a programmable microcomputer, so that connection to the conference computer and the resource computer could occur simultaneously.

Participate, as implemented on The Source, relies on the resources of the host computers in McLean, Virginia. These include various compilers; mathematical, statistical, and financial packages; and management modeling programs. The procedure for accessing these resources is complicated, however: the data must be processed outside the conference, the result placed into a file, and the file transferred into the conference.
Connect an "ANGEL" between your computer and your printer, and let the "ANGEL" do the waiting....

Your valuable computer spends 95% of its time waiting for the printer to catch up ... and while the computer waits, the payroll continues ... and while the computer waits, the payroll continues.

The computer sends data to the "ANGEL" at speeds up to 19.2K baud. The "ANGEL" stores data and sends it to the printer at a speed the printer can handle, and your computer is free to continue working without interruption.

A USER WRITES:
"I tried the "ANGEL" with my Altos system connected to an Epson MX-100, both set at 9600 baud. Without the "ANGEL" it takes 30 minutes to print 210 doctors' requisition forms. With the "ANGEL", installed, my computer is free after 90 seconds."

With "ANGEL'S" self diagnostics and memory test, the entire system thoroughly checks itself every time you power up.

PAGE REPRINT is another unique feature. EXAMPLE: You are printing a 32 page report, and the paper jams at page 11. Reset the printer to the top of the form, press PAGE REPRINT, and resume printing at the top of page 11. Want to restart two pages back? Press PAGE REPRINT twice, and you resume at page 10.

"ANGEL" is compatible with almost all Micro-Computers, including IBM, Apple, TRS-80, Vector Graphic, NordStar, Altos, Xerox, Heath, Zenith, NEC, DEC, etc., with RS-232 serial, Hardware Handshaking, or Centronics compatible parallel interface. The manufacturer reserves the right to change the product specification.

Simple external switch settings, let the "ANGEL" accept either RS-232 serial or Centronics parallel data and can output either/or in any combination, (S-S, S-P, P-S, P-P). The "ANGEL" is compatible with almost all Micro-Computers, and can be installed by anyone in minutes. Switches are clearly marked for ease of operation, and a concise, USER FRIENDLY operator reference card is included with each unit.

The "ANGEL" has a full one year limited warranty.

THE "ANGEL" WILL NEVER KEEP YOU WAITING!

TO ORDER:
CALL TOLL FREE 1-800-323-3304
OR SEND CHECK OR MONEY ORDER TO LIGO RESEARCH

Please rush me ( ) "ANGEL(S)" @ $295.00 each

Sub total

ILLINOIS ONLY Add 6% U.S. sales tax

Delivery charge $4.00

TOTAL

Charge my ( ) VISA ( ) MASTERCARD

MY ACCT. # IS

EXPIRATION DATE

Circle 261 on inquiry card.
The essential capabilities for a microcomputer communications software package are the following:

- to provide a transparent talk utility that relegates the microcomputer to the "dumb" role of inputting key strokes and displaying information sent back by the host
- to record into mass storage all information received in the talk mode
- to upload files to the host computer in the talk mode
- to upload files with a "stop-and-wait" protocol so that large files may be uploaded without exceeding the buffer capacity of the recipient machine (for example, a microcomputer might upload a file until the host sends a continue signal — usually a Control-Q)
- to divert incoming data to a printer if hard copy is needed

Many other capabilities are useful, and much depends on such factors as the data-transmission rate. With slow data transmission, the stop-and-wait protocol is usually not needed. If accuracy is essential, such as when sending binary or numerical data, asynchronous transmission may not be satisfactory.

Existing communications software packages for linking personal computers to such popular subscription facilities as Compuserve and The Source have rather limited capabilities. In contrast to this are the proprietary networks (e.g., Ethernet, Wangnet, and SDnet) developed by office equipment manufacturers for in-house electronic mail, Telex operations, the sharing of peripherals, and other telecommunications.

Recently microcomputer software designers have begun integrating packages for text editing and formatting, database management, and asynchronous communications all into a single system. One such system, MIST (Microcomputer Information Support Tools), was developed by Peter and Trudy Johnson-Lenz and is available from New Era Technologies for licensing on microcomputers using the CP/M 2.0 operating system (MIST requires 56K bytes of volatile memory and two 250K-byte floppy disks).

Ultimately, multitasking multiusr operating systems running on the new generation of microprocessors will enable conferees to access many discussions, databases, and computer resources simultaneously. Without question, this will elevate telecommunications into a new realm about which we can only speculate.

An Example: Participate

The best way to give you a good idea of how computer-moderated conferencing works is to show you an example of transactions with Participate on The Source. Getting into Participate is somewhat easy. After logging onto The Source and requesting command mode, all I have to do is type "PARTICIPATE." My terminal should then respond by displaying the following:

```
[PART!] Version 3.08
Welcome to PARTICIPATE on the Source, IRVING!
"PARTICIPATE" AND "PART!" are trademarks of Participation Systems Inc.
5 waiting notes.

Read, Scan, Batch, Cancel or Hold?
```

When a Source user asks for Participate, the conferencing computer automatically checks its memory to see if the account number is registered and what conferences the customer has access to. In this case, the computer recognizes me as "IRVING." It is more than a name, it is an address to which others can send messages and information. Note that I have five messages waiting for me. If I simply type "Read," I will be asked to respond to them one by one. By batching them together, I can decide what to do at the conclusion. These notes may be conference notes, readable by members of the conference, or they may be addressed to me alone or to groups of respondents.

Let's say I am involved with the engineering section at a computer man-
Gentlemen, start your computers.

Select budget intervals.

Enter sales revenue.

Enter selling expenses.

Time: 0

Time: 0.5

Time: 1.0

Time: 1.5

Your sales budget on the Multiplan electronic worksheet—In record time.

Time: 5.2

First, Microsoft created the Multiplan interactive electronic worksheet, to help you analyze your business problems and explore possible solutions. Without asking you to become a computer expert.

Now we've added the Multi-Tool™ budget and financial expert systems. They can help design and build financial or accounting worksheets tailored to your specific needs. In minutes.

You won't have to worry about developing formulas or formatting screens to build your Multiplan worksheets. Because the expert systems literally do it for you.

For example, the Multi-Tool Budget expert system creates seven inter-related Multiplan worksheets for a total budget planning and control environment.

What's more, each system is developed by experts: business professionals and leading authorities in finance and accounting.

You'll benefit from their knowledge immediately, through the powerful worksheets each Multi-Tool expert system builds for you. And with the sophisticated tutorial manuals that accompany each system. Each manual provides in-depth information about both the design of the worksheets and the areas of finance and accounting they cover.

The result: a tailored electronic worksheet that helps you make high quality decisions.

That's just what you'd expect from Microsoft. The people who let you concentrate on your business rather than on your computer.

Ask your computer dealer to let you test drive the new Multi-Tool expert systems. Better tools that help you put your business in first place.

THE MULTI-TOOL EXPERT SYSTEMS. A POWERFUL ADDITION TO THE MULTIPLAN ELECTRONIC WORKSHEET. Available now:
The Multi-Tool Budget expert system.
The Multi-Tool Financial Statement expert system.

MICROSOFT

Microsoft is a registered trademark, and Multi-Tool, Multiplan and the Microsoft logo are trademarks of Microsoft Corporation.
Less for Your Money

If you do word processing on your personal computer, you probably know that there are many programs for sale to help you with your spelling. But the biggest spelling error you’ll ever make is paying too much for your spelling correction software. The Random House ProofReader gives you less for your money—less trouble, that is, and fewer spelling errors. The Random House ProofReader is based on the world famous Random House Dictionary. It contains up to 80,000 words, depending on your disk capacity. You can add new words with the touch of a key. It shows you the error and the sentence it’s in. It instantly suggests corrections. It even re-checks your corrections. And it costs half as much as other programs with far less power. The Random House ProofReader is compatible with all CP/M 2.2®, MS-DOS® and IBM Personal Computer® systems.

The Random House Dictionary of the English Language

The Random House ProofReader

$50

For orders or information, see your local dealer or call 505-281-3371. Master card and VISA accepted. Or write Random House ProofReader, Box 339-B, Tijeras, NM 87059. Please enclose $50 and specify computer model, disk size and memory.

Random House ProofReader

Manufacturing company, and I have been using a conference on engineering to keep in touch with everyone. The following message illustrates a typical exchange:

"NEW PRODUCTS" Conference 83.34
HENRY, about "THE MANUFACTURE
OF PORTABLE PRINTERS." (answers: 5)
THUR, 01/27 13:35 (254 characters)
The decision has been made to design
and produce portable printers. The
product is to be on the market by the
middle of next year. All members of the
engineering staff are to begin their
preliminary discussions in this con-
ference.

Join to receive future answers?

This message alerts me to the fact that on Thursday, January 27, another conference participant, HENRY, organized a new conference called "NEW PRODUCTS"—the 34th conference of 1983 (83.34)—about the manufacture of portable printers, and that there are already five responses in the conference discussion. I can find out who has already joined and what the topics of the discussions are, or I can join for a while, participate in the discussion, and then leave or quit the conference. Once I leave, however, I will no longer automatically receive notification of new discussion entries each time I log onto the computer.

Let's say I want to start my own conference, "JOINT," to establish communication between the engineering department and the marketing department to help market portable printers. To do this I type "Write" or simply "W" in response to the computer prompt, "Disposition for 'NEW PRODUCTS'?" At this point, I can write my message in a special editable workspace—the scratch pad—set aside by the conference computer.

This is to notify all members of the engineering staff that a joint marketing-engineering conference called "JOINT" Conference has been organized to coordinate activities. A preliminary market survey indicates that there are three manufacturers of portable printers with high inventories. Design failures may have been the largest factor contributing to their lack of sales, and it will be necessary to determine what was responsible for their poor performance.

The above message will be automatically appended to the "NEW PRODUCTS" Conference. At this juncture, I may use the editable workspace to organize the "JOINT" conference. As members of the engineering staff log onto the computer, they will be informed of my message concerning the "JOINT" conference and given the opportunity to join and participate.

This kind of communication system gives everyone the choice to enter, abstain, or simply monitor all goings-on. Only the moderator—the discussion editor—has the power to restrict membership, delete, or modify what has been recorded in the conference. It makes no difference whether HENRY and I are separated by a few feet or 10,000 miles, by seconds or days.

The Computer as Publisher

Some large corporations, primarily those involved in computer technology, have begun to experiment with automated conferencing as a tool to facilitate their developmental work. The Massachusetts Institute of Technology's Center for Information Systems Research has been using Participate to run a conferencing project for a number of corporations. The MIT program has been particularly successful in using Participate to organize meetings and to explore specific conference topics. Notepad was used to organize the Spring 1982 Office Automation show in San Francisco.

In the past, a major meeting required careful planning and volumes of communication, but when the preparatory work is handled in a computer conference, the content and scope of a meeting are easily developed. Computer conferencing cannot substitute completely for all meetings, of course, but it can greatly increase the productivity of meetings when they do take place. Such conferencing also includes a democratizing feature: the organization is open to criticism and discussion among all conference attendees. This immediately points to a poten-
Some people drive fine German machines to work.  
Some people drive them once they arrive.

The tradition of high quality, high performance German craftsmanship and engineering is legend. And while we most often see that tradition in action on America's streets and highways, it is in America's business offices that its future holds the most promise.

The BASIS 108 is the proof.

This powerful small business computer passes higher-priced competitors with ease. Its dual processors—for CP/M® and Apple II® compatibility—open up the largest library of microcomputer software and plug-in peripherals available today. This unique combination also provides compatibility with other popular languages, including Pascal™ and LOGO™.

The detached keyboard is a work of art and practicality. Lightweight and low profile, it features a full one-meter cord for comfortable operation on your desk—or your lap. There’s a full 128-key ASCII character set. Fifteen user-definable function keys that can provide access to 60 distinct functions. A nine-key cursor control block. And a convenient eighteen-key numeric pad. For special applications, you can also custom map the keyboard with a simple exchange of ROMs.

And there’s more. RGB and composite NTSC or PAL video. Keyboard-selectable 80-or 40-column display.

High resolution color graphics. Parallel and serial printer interfaces. Easily accessible outboard I/O connectors. Six Apple II-compatible card slots for peripherals expansion. Even a two-inch alarm or music speaker.

The BASIS chassis is cast aluminum, eliminating heat and RFI interference problems. And there's plenty of room for internal expansion to include hard disk drives and other peripherals.

The BASIS 108. Microcomputing's "Best Of Both Worlds" German craftsmanship and American business savvy.

CP/M® is a registered trademark of Digital Research, Inc. Apple II® is a registered trademark of Apple Computer, Inc. Pascal™ is a trademark of the Regents of the University of California at San Diego. LOGO™ is a trademark of Logo Computer Systems, Inc.

Circle 58 on inquiry card.
Times Consumer Data Base to the network, the user has potential access to publishing. Consider this: with a computer terminal connected to a network, the user has potential access to thousands of information libraries or databases—from the New York Times Consumer Data Base to the Library of Congress Card File. There is no substantial publisher of data that does not put at least part of its information into computer storage. Some commercial information services such as Dialog, a subsidiary of Lockheed, have access to over 45 million records in more than 120 databases on business, science, medicine, technology, the humanities, and politics.

The computer facilitates the search for meaningful information by providing highly selective search strategies. It is no longer true that the proliferation of information is threatening to deluge us with meaningless drivel. The problem is the opposite. Information is not being produced fast enough.

Particularly troublesome is the fact that some scientific and medical articles take a year or more after submission to a journal before emerging in print. Also, the processing of economic statistics can be excruciatingly slow. Such delays are not acceptable. We need more information faster if we are to be able to correlate and organize the diverse pieces necessary to make coherent and prompt decisions.

One exciting solution is for scientific societies to supplement their publishing operations with computerized conferences in which information exchanges can be conducted and subjected to the critical scrutiny of their members. Specialized research groups can also conduct exchanges, partially in public or wholly in private, in order to accelerate the interchange of ideas and data. Ongoing dialogs can be developed and nurtured along diverse, interdisciplinary lines, merging with specialists in different groups when necessary.

The Collective Intelligence

The marriage of cable television with computer technology has already led to a limited form of mass conferencing in certain test markets. On the Qube system in Ohio, subscribers can respond to inquiries, participate in votes, play games, and obtain information through a communications link with their cable service.

In the future—especially as videotex services become more popular—electronic mail, commercial transactions, conferences, magazine abstracts, local reports, and public-interest announcements will be integrated into our daily routine.

How the institutions of our society—business, government, universities, laboratories—will be changed by this technology is difficult to assess. The process of communicating creates new information; new designs for equipment, solutions to marketing problems, the synthesis of scientific and technical knowledge, the testing of hypotheses, the hard work of whittling fact from the raw material surrounding it. And the more people communicate, the more new information will become available. Once expressed, an idea will become part of a percolating turbulence of thought, criticism, and judgment—a collective intelligence.

There will be dangers, however. Information vendors may assume tremendous power; no antitrust laws govern the management of ideas. The great institutions may acquire even greater authority, and a suffocating superclass might emerge to stifle the innovations of the future. Privacy may be difficult to maintain, and privileged information may become the prey of unscrupulous individuals and institutions.

What we gain, however, will be more than what we hazard losing. We will live with a wealth of ideas, in a firmament of information as enormous as the whole of human knowledge.
THE BEST PRICED 256K RAM CARD ONLY HAS 64K.

BUT YOU CAN GET ANOTHER 192K ANY TIME.

Apparat’s RAM Card, priced at $149, is the most economical way to add memory to your IBM/PC today. And have the ability to add-on tomorrow.

The RAM Card, with sockets for up to 256K bytes of RAM with parity, gives you an additional 64K of RAM for your IBM. As the price of RAM chips comes down further or your needs go up, you can add to it easily. Additional RAM is available today at $64 per 64K increments if you need it now. If not, wait and buy it in the future. Apparat’s 64K RAM Card gives you memory and economy. The RAM Card also comes with SDRIVE, enabling RAM memory to be directly accessed as if it were disk memory. And if you use Apparat’s COMBO Card you can have three additional functions; parallel printer, RS232 async communications and clock calendar. The COMBO Card is now priced at just $169. The RAM Card and COMBO Card are compatible with IBM/PC DOS 2.0 to let you use the newest IBM operating system and both carry a one year warranty.

For the dealer nearest you call 800/525-7674 or write Apparat Inc., 4401 S. Tamarac Parkway, Denver, Colorado 80237, 303/741-1778.

IBM PC is a trademark of IBM.
The best software for the IBM Personal Computer. Could it be yours?

Attention, all programmers. Here's a chance to reach the top.

If you've written software that's completed and runs on the IBM Personal Computer, we could be interested in publishing it.

(We also could be interested if it runs on another computer. If we select your software, we'll ask you to adapt it to our system.)

But be advised.

Our expectations are great.

Because the software we publish must be good enough to complement IBM Personal Computer hardware. In fact, the more you take advantage of all our hardware capabilities (see the box at right), the more interested in your software we become.

Think about incorporating color graphics into your program, for example.

Use sound. Consider the power of our keyboard and remember to utilize the ten programmable function keys.

In all cases, we're interested in "friendly" software—with emphasis on quality and wide appeal. Programs with the greatest chance of being published must be easy to use, offer a better way to accomplish a task and provide something special to the user.

What kinds of programs? All kinds.


We select programs that will make the IBM Personal Computer an even more useful tool for modern times.

<table>
<thead>
<tr>
<th>Memory</th>
<th>Display Screen</th>
<th>Permanent Memory</th>
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<tr>
<td>64K-640K bytes</td>
<td>Color or monochrome</td>
<td>(820) 40K bytes</td>
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<tr>
<td>16-bit, 8088</td>
<td>High-resolution</td>
<td>Color/Graphics</td>
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<td>Auxiliary Memory</td>
<td>80 characters x 25 lines</td>
<td>Text mode:</td>
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<td>2 optional internal</td>
<td>Upper and lower case</td>
<td>16 colors</td>
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<td>diskette drives, 5/4&quot;</td>
<td>Operating Systems</td>
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<td>320KB/360KB</td>
<td>DOS, UCSD p-System,</td>
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<td>per diskette</td>
<td>CP/M-86</td>
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<td>Keyboard</td>
<td>Languages</td>
<td>4-color resolution:</td>
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<td>93 keys, 6 ft. cord</td>
<td>BASIC, Pascal, FORTRAN,</td>
<td>5300 x 200v</td>
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<td>attaches to</td>
<td>MACRO Assembler,</td>
<td>Black &amp; white resolution</td>
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<td>system unit</td>
<td>COBOL</td>
<td>640x 200v</td>
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<td>10 function keys</td>
<td>Printer</td>
<td>Simultaneous graphics &amp;</td>
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<td>10-key numeric pad</td>
<td>All-purpose addressable</td>
<td>text capability</td>
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<td>Diagnostics</td>
<td>graphics capability</td>
<td>Communications</td>
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<td>9 x 9 character matrix</td>
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So, if you think your software is the best, consider submitting it. If it's accepted, we'll take care of the publishing, the marketing and the distribution. All you have to do is reap the benefits of our new royalty terms. And you're free to market your program elsewhere at any time even if you license it to us.

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Electronic Publishing
The New Newsletter
How a traditional newsletter became a computer-accessed, interactive investment advisory service.

Computer conferencing is gaining popularity as a solution to the time and place restrictions of conventional business meetings; however, the techniques involved readily lend themselves to other uses. Through the example of the Independent Investors Forum (IIF) I'll show how such conferencing techniques can be applied to the field of newsletter publishing to develop an information service that is highly receptive to the needs of its audience.

Not long ago I found the opportunity to publish a small newsletter for stock market investors. In designing this publication, I had two principal objectives. First, the publication would have to be profitable, even though it would probably circulate to fewer than 500 subscribers. Spreading investment advice to a larger audience, as is done in many newsletters and most notably on public television's *Wall Street Week*, destroys the value of the advice: too many people act on it before you get a chance.

Second, because I wanted the publication's information to help individuals make investment decisions that best meet their own needs, people ought to have some input into the editorial process. They should be able to question the research staff, offer their own opinions, and ask other subscribers what they think. (In practice on the IIF, not only does this dialogue produce better decisions, it keeps our research staff honest. That's why we tell our clients, "Our advice is questionable.")

This second objective presented me with an interesting new application for my personal computer. Originally I had intended to use it simply as a word processor to produce clean copy suitable for a biweekly newsletter. But even a computer novice like me could see at a glance the advantages of a computerized investment service over traditional market advisory letters. The major benefit, of course, is the elimination of the time needed for preparing hard copy and mailing it to subscribers. Investment advice often loses its value rapidly. Timing of purchases and sales is critical, especially for the small investor. With a computer and communications equipment, you can get all the information instantly.

An electronic mail or bulletin board system would be one way to meet this need for rapid communication. But the problem with these systems is that the user often likes to refer back to certain articles and to skip over other articles entirely. The user needs to be able to sort through the entire data file quickly to minimize connect-time costs and to avoid eyestrain from looking at a video display that, in the case of most home systems, is pretty unsophisticated.

Compared with hard copy, the average home computer terminal leaves a lot to be desired. There are no fancy type styles, no photos, and very limited graphics. Everything merely scrolls up a phosphor monitor that displays at best only 80 columns of text. How much of that can you take before you get bleary-eyed or just plain bored? We had a hunch, confirmed by subsequent research,
Tiny BASIC MICROCOMPUTERS
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The “ENGINEER’S” computer is available in three powerful versions offering real-time Tiny BASIC.

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In its price range, the NEW Transwave K-8073B, "XCALIBUR," is the computer for the engineer or technician. Rapidly implemented, the "XCALIBUR" can be up and running sophisticated applications of measurement and control in hours instead of weeks or months. Transwave has added many important features to its original Tiny BASIC K-8073. Memory has been expanded to 24K byte of RAM with 16K battery backup. An additional 8K byte is available for HI RES color video and is contiguous to the first 16K RAM. EPROM is increased to 16K with an on-board programmer. The "XCALIBUR" comes in a heavy-duty extruded aluminum housing with a 16-key data input keyboard and 8-digit, real-time display. A constantly expanding EPROM software library allows fast implementation of many industrial control applications.

*Supplied with 16K EPROM, 6K RAM, 2.5K ROM.
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"Listening in" on the Independent Investors Forum

The following is an edited series of responses on the IIIF. Note that although the item was originally dated June 1982, a participant was able to join in November and get an update.

Item 1 08:56 Jun14/82 20 lines
Arthur Bechhoefer
June Recommendations—Fruits of Labor

Despite the poor functioning of the economy, there are still some stocks worth considering. For June, I continue to recommend high technology stocks in markets that are growing steadily or that have at least cyclical growth potential.

As I noted last month, my two choices continue to be Apple Computer, because of a better than 30 percent growth in the personal computer market, and Cherry Electrical Products, a manufacturer of micro-switches, computer keyboards, and "dedicated" semiconductor circuits for cameras, smoke alarms, and other control apparatus.

You're certainly big on fruit. How about meat and potatoes?

The only item along that line I recommend is Prime Computer, which unlike its two main competitors—Digital and Data General—continues to post profit gains from quarter to quarter and has had recent purchases of its stock by officers and directors...

Six Discussion Responses
1) Howard Finney: How do you feel about DEC overall?
2) Art Bechhoefer: Last May, as reported by the Securities and Exchange Commission, five of Digital's officers sold roughly 10 percent of their stock holdings at prices ranging from $76 to $81. With the stock currently about $84, I think I'd go along with the insiders and sell too, if I owned it.
3) Peter Hollidge: Art, it's now November. Do you still feel the same about Apple?
4) Art Bechhoefer: Peter, yes, basically I feel the same way. See item 31 for an update. I tend to think that the market as a whole is too high right now (November 3) but remember that Apple has been lower relatively speaking, due to Steven Jobs' having sold a bundle of shares to finance a music extravaganza last August.
5) Carolyn Allen: Art—it was Steve Wozniak who blew a bundle on the US festival.
6) Art Bechhoefer: Right you are. Anyway, same difference. A lot of stock went on the market and kept Apple prices artificially low. This was coupled with skepticism in the investment community concerning lack of a new computer to update the Apple II.

that the limit was something like 4 minutes for an article and not more than 10 or 15 minutes for an entire session, including the time to sign on, request the information, read it, and decide on subsequent action.

If we examine these constraints in terms of what they mean for stock market advice, we find that our research articles could cover only basic points—the main reasons behind our buy, hold, or sell recommendations. But the user might be left with quite a few unanswered questions concerning the research data as well as other possible investment alternatives. This suggests that some method for requesting more information, such as two-way communication, is essential in electronic publishing.

Two-way communication provides a basis for dialogue and thus enhances information transfer and learning. What is true for scientists, engineers, or any other professionals, applies equally to those providing investment advice: no one has perfect information. No one has a monopoly on expertise. Some people specialize in one area, some in another. A well-formed investment decision is the product of all the best available information, given the constraints of time and cost. Dialogue speeds the transfer of information and thus makes learning and decision making more efficient.

To facilitate two-way communica-
The new COMPAQ Portable Computer.
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Simple, isn't it? The COMPAQ Portable Computer can do what the IBM Personal Computer does. To go.

It runs all the popular programs written for the IBM. It works with the same printers and other peripherals. It even accepts the same optional expansion electronics that give it additional capabilities and functionality.

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Carry the COMPAQ Computer from office to office. Carry it home on the weekend. Or take it on business trips.

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If you use a portable typewriter, you can use the COMPAQ Computer as a portable word processor instead.

If your company already uses the IBM Personal Computer, add the COMPAQ Portable as a mobile unit that can use the same programs, the same data disks, and even the same user manuals.

There are more programs available for the COMPAQ Computer than for any other portable. More, in fact, than for most non-portables. You can buy them in hundreds of computer stores nationwide, and they run as is, right off the shelf.

With most other portables you'd probably need to buy an additional display screen because the built-in screen is too small for certain tasks, like word processing. The COMPAQ Computer's display screen is nine inches diagonally, big enough for any job, and it shows a full 80 characters across. And the built-in display offers high-resolution graphics and text characters on the same screen.

The bottom line is this. The COMPAQ Computer is the first uncompromising portable computer. It delivers all the advantages of portability without trading off any computing power capability. And what do those advantages cost?

Nothing.

The COMPAQ Portable sells for hundreds less than a comparably equipped IBM or APPLE* III. Standard features include 128K bytes of internal memory and a 320K-byte disk drive, both of which are extra-cost options on the IBM. Memory and additional disk drive upgrades are available options to double those capacities.

In the standard configuration, the COMPAQ Computer has three open slots for functional expansion electronics as your needs and applications grow. It accepts standard network and communications interfaces including ETHERNET™ and OMNINET™.

If you're considering a personal computer, there's a new question you need to ask yourself. Why buy a computer that isn't portable?

For more information on the COMPAQ Portable Computer and the location of the Authorized Dealer nearest you, write us. COMPAQ Computer Corporation, 12330 Perry Road, Houston, Texas 77070. Or call 1-800-231-9966.

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The system, known as Confer II, runs on an IBM 3081 or Amdahl equivalent and is accessed from any of five network host computers via GTE's Telenet network or leased outside lines. Confer II has a number of features that, while not unique, are eminently well suited to electronic publishing:

- The computer conference organizer (editor) can easily create agenda categories for the different types of information that will be presented. The agenda is similar to a table of contents in a magazine.

- The user (reader) always has a chance to respond, discard, or pass on each item (research article) presented. The user can select the latest items and literally throw away the rest, or just read summaries or items dealing only with certain subjects (stocks, industries, investment strategies, and so forth).

- The ability to respond at any time, either openly for all participants or privately for selected individuals, means that the more timid participants don't get shouted down or brushed aside. Conversely, the more assertive participants soon learn that long responses cost more. In some ways these features actually improve the quality of dialogue beyond what might occur in a real-time teleconference or face-to-face meeting. In the context of a publication, it is far livelier than a standard Letters to the Editor column.

- The focus of the conferencing system is on making decisions, not just sharing information. The system software encourages users to contribute information, suggest topics for future research, vote on the conference agenda, or express their preference for particular investment alternatives.

The net effect of these features from the organizer's (i.e., editor's) point of view is to have at one's fingertips a vast amount of feedback, making it possible to provide what the users want, not what the organizer or editor thinks they want. From the
The Most Versatile Integrated System Available! — Without Compromise.

From the crystal clear monitor with a true typist keyboard to the high performance switching power supply—an engineered solution—the 5000IS system is designed to be an economical single-user system (basic system price is $3,295) which is easily field expandable to be the master of a four-user system.

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point of view of the researcher, it puts an end to the notion that there are only a few experts whose words are infallible.

As for the users, our information indicates that they prefer spending no more than 15 or 20 minutes online per session. They sign on mostly during weekends or holidays, thereby reducing their connect-time costs by about 10 percent. Also, if they have appropriately equipped personal computers, they can download items from the host system and store them on disk. The items can then be read at the users' leisure, and connect time will be reduced. Similarly, users can prepare messages on their personal computers before going online, and then quickly upload the messages into the host system, saving even more time.

Although users of the Independent Investors Forum have some difficulty mastering the numerous system commands at first, their capabilities improve quite rapidly, as evidenced by the accuracy and appearance of their responses and other communications. When troubles occur—and they do—the user can call us by telephone. We have a technical advisor who provides advice either over the telephone or online. We also have a tutorial to make the system easier for beginners. A professional conference facilitator helps everyone participate actively, and a monthly user's guide provides technical tips and research articles more suitable for hard copy. Nearly all users who initially selected a 60-day trial membership have converted subsequently to a full year.

In the future, we hope to expand this form of electronic communication by publishing other journals and newsletters for those who need to keep up on what is happening in their field now, not three months from now. Also, because of this system's low cost in comparison with on-site meetings or video conferencing, it would probably be useful for maintaining contact between various divisions or field offices in a corporation. Or it could be used for conducting training seminars without disrupting anyone's work schedule or straining a limited travel budget. All in all, computer conferencing should have a fairly significant impact not only on the way we gather information, but also on the way we work.

Accessing the IIF

The Independent Investors Forum can be accessed by any microcomputer or terminal equipped with a modem and an appropriate communications software package such as ASCII Express "The Professional" from Southwestern Data Systems (POB 582, Santee, CA 92071; (714) 562-3670) or Crosstalk from Microstuf Inc. (1845 The Exchange, Suite 140, Atlanta, GA 30339; (404) 952-0267). Communication is available at either 300 or 1200 bits per second. A one-year membership in IIF costs $300, plus telephone connect charges ($19 per hour, average). A 60-day trial membership costs $125 and includes 3 1/4 hours connect time. Membership and telephone charges may be tax-deductible as investment expenses.

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*Suggested list for model 212A Auto Dial.

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Math level is kept to a minimum and new concept are explained as they are used.

Named "The Best Book on Microcomputer Graphics" by Creative Computing magazine.
[Manual with Disk(Apple) or Tape(TRS-80 Color Computer): $45]

Data Plotting Software for Micros

This softkit contains a system of 18 complete programs which process and display data: pie charts, bar charts, stock market charts, histograms, 3D views of surfaces, log plots, curve fitting, data management, histograms and statistical analysis.

Programs are modular, menu driven, written In BASIC, fully explained and keyed to theory. They are listed in the book alongside theory and equations. Use as-is or modify to best suit your own applications.

Four data base management programs are included. These create x, y, x-y, x-y-z and stock market data files and store them on disk.

Plotting programs read the data files and carry out sorting, statistical analyses and plot results.

Features include automatic scaling, axis marking and numbering, auto replot when data changes, and a special program called LABELER which places text and symbols over graphics using a moving cursor.
[Manual with Disk(Apple or IBMpc) or Tape(TRS-80 Color Computer): $45]

Engineering Software for Micros

This softkit contains 25 fully-documented programs for computer-aided design and analysis on micros. They will show you how to write modern CAD software or they can be used as-is for professional engineering work.

Emphasis is on combining computer graphics with engineering problem solving. Programs are included to interactively create engineering drawings, store them on disk, recall, update, merge, add physical properties such as resistance, thermal capacity and density, and rotate in 3 dimensions to produce isometric views.

After being stored on disk, the drawings are recalled by applications programs which perform mechanics simulation, heat transfer, matrix operations and optimization using Monte Carlo techniques. Programs are also included for Fourier Series and Transforms. These graphically display spectra alongside waveforms.

All programs are menu driven, written in BASIC and fully documented and keyed to theory and equations.
[Manual with Disk(Apple or IBMpc): $48]

IBMpc Graphics

This softkit is a self-teaching guide that will show you how to write your own 2 and 3 dimensional graphics software on the IBMpc, quickly and easily.

Learn how to create 2D and 3D shapes, translate, rotate, scale, stretch, clip, remove hidden lines, shade, create perspective views, calculate and plot surface intersections, produce animations effects, store graphics on disk.

Applications to science, education and business included. Also covers hardware needed for PC graphics, use of the PC's special graphics enhancements, and how to separate text from graphic on the PC's screen.

Contains 61 programs arranged in a tutorial manner leading from one step to the next. Math level is kept to a minimum and new concept are explained as they are used.

Much of this softkit is based on the popular Graphics Software for Microcomputers by B.J. Korites which was named "The Best Book on Microcomputer Graphics" by Creative Computing magazine.
[Manual with Disk(IBMpc): $45]

Structural Analysis Software for Micros

These 11 programs will enable you to carry out sophisticated structural analyses on your micro. They are modular, fully documented and ready to run.

You will be able to create a finite element mesh on the screen, rotate it in 3 dimensions, and store it on disk. Then recall the mesh from disk, recall a file of material properties and carry out a 3d truss or frame analysis. Shape of a deformed truss may be plotted over the original shape.

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Analyses use the modern "direct stiffness" method.

This system of programs is patterned after large-computer structural analysis systems such as ADINA and SAPP, but reduced in scale for micro. They were written by B.J. Korites, PhD, former CAD/CAM consultant to the Arthur D. Little Company.
[Manual with Disk(Apple or IBMpc): $95]
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Red Baron Computer Products, 1983
Circle 392 on inquiry card.
To call the Corvus Concept a microcomputer is to miss the point. The 68000-based Concept is a complete system for automating the modern office. Not merely a workstation or a personal computer (although it can be either), the Concept consists of software and hardware modules designed to work together in an office environment.

Getting personal computers to perform useful functions has always been a challenge for designers and programmers. Heretofore, we have had a variety of off-the-shelf solutions to the problems of financial planning, text editing, and communications. Until now, however, if you wanted a spreadsheet that worked with a word processor that worked with a local-area network, you needed to buy each item separately, then modify all three so they would work together. Corvus has done this job for you by combining these functions in one easy-to-use package.

The Concept, which uses a Motorola 68000 microprocessor running at 8 MHz, comes standard with both 256K bytes of memory (expandable to 512K bytes) and an Omninet local-area-network interface. In addition to its two serial ports, the Concept has four I/O (input/output) expansion slots that accept Apple II peripheral cards. The machine features a bit-mapped video display in a full-
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Circle 340 on Inquiry card.
At a Glance

Product
Corvus Concept

Manufacturer
Corvus Systems Inc.
2029 O'Toole Ave.
San Jose, CA 95131

Components
Processor Unit: 8-MHz Motorola 68000 microprocessor; 256K bytes of memory; two RS-232C serial ports; Omninet local-area network; four Apple Ili-compatible expansion slots

Display:
14-inch (diagonal measure) high-resolution black-and-white video monitor; 8 1/2 by 11 1/2 viewing surface; tilt and swivel mounting on top of processor unit; monitor can be rotated 90 degrees to provide either portrait (639 by 639 pixels, 63 lines of 90 characters) or landscape (707 by 479 pixels, 47 lines of 117 characters) aspect ratio

Keyboard:
standard typewriter layout with numeric keypad and 10 software-definable function keys; detached from processor unit with 9-foot coiled cord

Cost
$4995 ($5995 for 512K bytes of memory)

Hardware Options
Hard-Disk Drive:
choice of 6-, 10-, or 20-megabyte-capacity drives (one required); can interface to single workstation via I/O-expansion controller board or to multiple workstations via Omninet network interface

Mirror Unit:
installs between hard-disk drive and user-supplied video-cassette recorder; backup times are approximately 1.8 minutes per megabyte

Floppy-Disk Drive:
Tandon thin-line 8-inch floppy-disk drive in external case that interfaces to processor via I/O-expansion controller and 50-conductor ribbon cable

Software
Operating System: CCOS (Corvus Concept Operating System), designed specifically for the Concept. Accepts most commands from the keyboard's special-function keys (cost included in package price)

Languages: FORTRAN-77 compiler cost: $445 Pascal compiler included with floppy-disk drive

Applications:
EdWord text editor accepts most commands from the keyboard's special-function keys cost: included with floppy-disk drive
LogiCalc spreadsheet program accepts most commands from the keyboard's special-function keys cost: $195
CP/M emulator imitates Intel 8080 microprocessor running CP/M; allows mass storage on hard disk and is capable of accessing IBM 3740-format single-density 8-inch floppy disks cost: $295

page format. It also includes a detached keyboard whose 10 function keys match the software-generated menus. Thin-line 8-inch floppy-disk drives are available. A required hard-disk subsystem and optional companion video-tape interface can connect to the unit or to the Omninet network for access by more than one Concept (see photo 1).

Because the 68000 microprocessor is relatively new and independent vendor software for the Concept is far from abundant, Corvus supplies two of the most important programs: the LogiCalc spreadsheet program and the EdWord word processor. The company also provides two high-level languages, Pascal and FORTRAN, as well as a CP/M emulator.

The Workstation Approach

Its designers intended the Concept to be an individual workstation operating within a local-area network. With this arrangement, each user receives the full resources of a computer, but can also share both information and peripheral devices. The networked computer offers some attractive cost advantages and allows several people to work simultaneously on the same task.
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A second feature of the Concept workstation is the absence of individual mass storage. Whenever a system must process large amounts of data, hard-disk drives are a necessity. Because these drives are expensive, providing one for each user can be too costly. For this reason, the Concept allows several users to share a single hard disk.

Corvus also realizes that the office market contains many potential users who know little about using computers. All the bundled software programs—including the operating system, spreadsheet, and text editor—focus on people who want to use a computer with their work, but who don't want to solve puzzles to make that happen. In fact, the software menus make it possible for a computer novice to use either the spreadsheet or text editor with less than an hour of tutoring.

**Fingers and Keys**

The Concept detachable keyboard has 91 keys in a standard typewriter layout with additional function keys and a calculator pad. In addition to the standard features, you get three keys labeled Fast, Alternate, and Command. Although any key will automatically repeat when held down for more than one-half second, pressing the Fast key simultaneously increases the repetition rate. The Alternate key works like the Control key in special applications.

Across the top of the keyboard are the special-function keys, arranged in two groups of five (see photo 2). These keys correspond to menu selections appearing at the bottom of the display screen. The Command key allows you to toggle between menu selections when more than 10 functions are available for a particular application. The function keys also let you select additional menus. After a bit of practice, your speed with the function keys can become quite impressive because they make it unnecessary for you to memorize and type a complex command. Additionally, the Concept's keyboard buffer lets you rapidly enter commands, while the machine continues to execute them in order. If you forget what a function can do, pressing the Help key and then a function key produces a description of the second key's function.

**A New Look**

If the Concept's keyboard is a good idea, the video display is an amazing one. It sits atop the processor cabinet secured by a swivel joint that lets you tilt and pivot it as you wish. In its vertical position, which is great for text editing, the screen contains 90 columns by 63 lines in a display about the size of a sheet of notebook paper. You can also unlock the display, rotate it 90 degrees, and secure it in the holder to get a display of 117 columns by 47 lines, which works well with the spreadsheet. Besides the option of two display modes, the Concept offers both white-on-black and black-on-white characters. You have a choice of supplied type fonts and can also create your own character sets. A large blank matrix lets you redefine characters using a process similar to painting (see photo 3).

The video display also divides into windows or rectangles of user-defined ratio and size. Each window becomes an independent display area with its own attributes, providing the user with a powerful and convenient feature. In a window you can show text in any font, display black or white characters, and scroll the text independently of the rest of the display. For example, you could use EdWord to write a report while creating a separate window of information from a LogiCalc model.

**Under the Hood**

Considering all the functions that the Concept provides, the hardware formula is simple: combine the
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Circle 339 on Inquiry card.
local-area-network interface and the capability to use Apple II peripheral cards. The Omninet network provides users with one of the best-defined network standards in the marketplace and provides the convenience of local communication and rapid data-transfer rates necessary to many business applications. By duplicating the Apple II expansion bus, the Concept can take advantage of the hundreds of expansion boards already on the market (see photo 4). In addition, Corvus did not forget the need for local I/O devices and provides two RS-232C serial ports for connection to a printer and modem.

### Software Details

The Concept uses menu-driven software that appears to the user as a single hierarchical system. From the operating system to the lowliest editing command, all functions are menu items. At any point, your options are obvious and you can easily move to the previous or following menu. The first menu of available functions, the Dispatcher level, presents all the major software features (see table 1). This level, similar to the operating system in other computers, gives you a choice of four menus: File Manager, Window Manager, System Manager, and running programs. Selecting any of these options produces a submenu of choices, and some of those choices produce still further menus.

File Manager becomes a frequent choice because the Concept requires that you divide the hard-disk storage into separate volumes to limit information access to particular users. While the size may vary, each volume has a name and a directory, much like a floppy disk. When you

### Table 1: The Concept's functions are accessed via a series of menus beginning with the Dispatcher level.

<table>
<thead>
<tr>
<th>Dispatcher Functions</th>
<th>File Manager Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ClrWndow</td>
<td>Clears the current window, leaving cursor in upper left corner</td>
</tr>
<tr>
<td>Const II</td>
<td>Runs the Constellation II utilities; produces its submenu</td>
</tr>
<tr>
<td>CPM</td>
<td>Runs the CPM emulator</td>
</tr>
<tr>
<td>CreWndow</td>
<td>Allows creation of windows on the video display</td>
</tr>
<tr>
<td>EdWord</td>
<td>Runs the word processor; produces its submenu</td>
</tr>
<tr>
<td>ExecFile</td>
<td>Executes a file of commands</td>
</tr>
<tr>
<td>FileMgr</td>
<td>Runs utilities for maintenance of files; produces its submenu</td>
</tr>
<tr>
<td>Help</td>
<td>Produces a help message for any function label</td>
</tr>
<tr>
<td>LogiCalc</td>
<td>Runs the spreadsheet program; produces its submenu</td>
</tr>
<tr>
<td>ListVol</td>
<td>Lists all volumes online or names of all files on a disk volume</td>
</tr>
<tr>
<td>MountMgr</td>
<td>Runs utilities for mounting disk volumes; produces its submenu</td>
</tr>
<tr>
<td>Restart</td>
<td>Causes the system to be completely reloaded from disk</td>
</tr>
<tr>
<td>RevBackgnd</td>
<td>Reverses the background color of the current window</td>
</tr>
<tr>
<td>SelWndow</td>
<td>Assigns one window as the current window</td>
</tr>
<tr>
<td>SelVol</td>
<td>Used to select which volume is to be current</td>
</tr>
<tr>
<td>SystmMgr</td>
<td>Runs utilities for setting system attributes; produces its submenu</td>
</tr>
<tr>
<td>WndowMgr</td>
<td>Provides functions for setting window characteristics; produces its submenu</td>
</tr>
</tbody>
</table>

### Table 2: Disk-file-management functions are available through the File Manager menu.

<table>
<thead>
<tr>
<th>File Manager Functions</th>
<th>Dispather Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ClrWndow</td>
<td>Clears the current window, leaving cursor in upper left corner</td>
</tr>
<tr>
<td>ConcFile</td>
<td>Concatenates files</td>
</tr>
<tr>
<td>CreWndow</td>
<td>Allows creation of windows on the video display</td>
</tr>
<tr>
<td>Crunch</td>
<td>Recclaims unused disk space within a volume</td>
</tr>
<tr>
<td>CopyFlle</td>
<td>Copies disk files</td>
</tr>
<tr>
<td>DelFlle</td>
<td>Erases disk files</td>
</tr>
<tr>
<td>DelTemp</td>
<td>Erases a temporary disk file from a volume</td>
</tr>
<tr>
<td>Exit</td>
<td>Returns to previous menu</td>
</tr>
<tr>
<td>Help</td>
<td>Produces a help message for any function label</td>
</tr>
<tr>
<td>ListFlle</td>
<td>Lists the contents of a text file</td>
</tr>
<tr>
<td>MakeFlle</td>
<td>Creates a disk file</td>
</tr>
<tr>
<td>MountMgr</td>
<td>Runs utilities for mounting disk volumes; produces its submenu</td>
</tr>
<tr>
<td>RevBkgrnd</td>
<td>Reverses the background color of the current window</td>
</tr>
<tr>
<td>RenameFlle</td>
<td>Changes the name of a disk file</td>
</tr>
<tr>
<td>SelWndow</td>
<td>Assigns one window as the current window</td>
</tr>
<tr>
<td>SelVol</td>
<td>Used to select which volume is to be current</td>
</tr>
<tr>
<td>Spool</td>
<td>Sends output to a temporary disk file from which it may be read and printed elsewhere on the network</td>
</tr>
</tbody>
</table>

16/32-bit architecture of the 68000 with a large amount of RAM (random-access read/write memory). Most of the flexibility and many of the special features of this system result from this combination of power and memory. For instance, the microprocessor positions each of the screen's 350,000 pixels, which allows you a variety of display options such as windows and programmable character sets.

Access to the outside world comes from an Omninet

---

Photo 4: The drawer containing the Apple II-compatible expansion connectors.
Once CLI P is in control, entry of text into strokes that you use to edit the text can be written. With file searching you can keep files that which disk or user number you are currently at. This can save precious disk and directory space.

All input text can be edited. Once CLI P is in control, entry of text into strokes that you use to edit the text can be written. In addition, a special command file can begin working whenever your computer is turned on.

Command sequences that you use often can be placed in a command file. From then on you'll never type the commands again, since typing the name of the file will execute the commands as if you typed them by hand. These files can ask questions and perform different tasks depending on the answers received. In addition, a special command file can begin working whenever your computer is turned on.

Built-in file editor

Clip contains a simple editor for editing command files, programs, or data files. English-like commands simplify any editing task.

Automatic file searching

With file searching you can keep files that are frequently accessed in a common place. CLIP will find them when requested by a program or command file, no matter which disk or user number you are currently at. This can save precious disk and directory space.

Help Files

Extensive on-line help is available for each of the 50+ commands in CLIP. You can also add your own help files to customize your working environment.

Built-in calculator.

CLIP has a built-in 16-bit calculator with the functions: +, -, *, /, remainder, AND, OR, XOR, and NOT. The calculator has 10 memory registers and works in any base from 2 to 16.

Command sequences that you use often can be placed in a command file. From then on you'll never type the commands again, since typing the name of the file will execute the commands as if you typed them by hand. These files can ask questions and perform different tasks depending on the answers received. In addition, a special command file can begin working whenever your computer is turned on.

A Unix like environment with I/O redirection and pipes.

With CLIP you can direct screen output from any program to a file for later viewing or printing. CLIP can also take any program's input from a file instead of the keyboard. "Pipes" force the output from one program into the input of another automatically.

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Encryption $49.95 ($25.00 with CLIP)
CLIP user's manual can be purchased separately for $25.00.

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turn on the Concept, your current or active volume is System (named /CCSYS), and you use the File Manager option to make any other volume your current volume (see table 2).

Using the Window Manager option, you can create, manipulate, and display up to 17 windows on the Concept's screen. The user moves, clears, scrolls, and deletes windows, which are limited only by their rectangular shape and their need to fit within the Concept's display. Various utility programs available from the System Manager menu allow you to select the I/O drivers, specify printing parameters, and edit the character set. In addition, other utilities let you format floppy disks, automatically load a floppy disk, and execute a printer spooler. The Concept's printer spooler lets you send output to a special volume named /PIPES, and when the network's printer is available, that stored output is printed (see table 3).

When you decide to run a program, the EdWord text editor may be your first stop. If it weren't for its Undo and Redo features, EdWord would be just another unremarkable text editor (see photo 5). The service provided by this combination of features is essentially a "flight recording" of your editing progress. If you blunder and delete a hefty section of an important report, the Undo feature restores the text to its preedited condition.
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EdWord operates solely on files residing in its workspace, a special area of a disk volume that you create. Several files or workpads must be included in this area. These workpads include the text file you are editing, a formatted print file (if you intend to print the text), files for the Undo and Redo information, copy space for your cut-and-paste operations, and a directory of this workspace. The smallest allowable workspace is 50 blocks (512 characters to a block) with the upper limit determined by the size of the volume containing the workspace.

Several important and variable editing parameters are displayed with graphics. A column rule indicating the width of the editing window tops the EdWord display. At the bottom of the screen is a thermometer-like scale that reveals the proportion of the workspace that is free. Another linear scale in the lower left of the screen displays the cursor's present position within the document being edited. In addition to these graphics representations, the system also shows the actual line number, column number, and number of lines in the text at the bottom of the display screen.

One advantage that EdWord provides over most present editors is the ability to execute system functions without exiting to the operating system. If you want a directory of available files, you simply request it from within the editor.

LogiCalc
A chronic problem of most spreadsheet programs is the limited size of the video display. The Concept solves this problem by allowing you to rotate the monitor 90 degrees, displaying a spreadsheet with 38 lines and 10 cells of 12 characters (see photo 6). With more than 500K bytes of memory available, a LogiCalc model might contain 1000 active cells. Like EdWord, LogiCalc provides the expected functions and a few pleasant surprises. The expected functions involve cursor control and data entry. The surprises are more sophisticated, presenting the user with a calculator, linear-regression functions, formatting commands, averaging and summation functions, and even user-definable functions. Although these are not unheard of in spreadsheets, it's rare to find them all in one program (see table 4).

Development Tools
Even with a text editor and spreadsheet, an obvious lack of business-applications software still limits the Concept. In particular, database-management programs and graphics and accounting packages will be necessary before this machine can take an active role in the office. Corvus is taking steps to encourage the development of more software by providing Pascal, FORTRAN-77, a 68000 assembler, and a CP/M emulator. It is hoped that this step will promote program development by software houses.

Corvus Pascal, developed by Silicon Valley Software, is compatible with the ISO (International Organization for Standardization) Level 0 standard and provides most
If you own a TS-1000 or ZX-81 computer and want to bring out the power within it, you'll want Memotech. From easier input to high quality output and greater memory, Memotech makes the add-ons you demand. Every Memotech peripheral comes in a black anodized aluminum case and is designed to fit together in "piggy back" fashion enabling you to continue to add on and still keep an integrated system look.

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**SEIKOSHA GP 100A PRINTER** The Seikosha GP 100A uses a 5x7 dot matrix printing format with ASCII standard upper and lower case character set. Printing speed is 30 characters/second with a maximum width of 80 characters. The printer uses standard fanfold paper up to 9-1/2 inches wide. The GP 100A is offered as a package including cable and interface. Other printer packages are also available through Memotech.

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**MEMOTECH CORPORATION**

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All the built-in CP/M commands are available, as well as the transient commands: ASM, DDT, DUMP, ED, LOAD, PIP, STAT, SUBMIT, SYSGEN, and XSUB. Because of the software overhead, however, the emulator runs slower than the average CP/M system. In the emulation mode, the Concept provides access to as large a quantity of hard-disk storage space as the user wants. In fact, you can assign 16 CP/M logical-disk drives to the mass-storage volumes. By adding the optional 8-inch floppy-disk drive, the Concept can also read standard IBM 3740-format single-density disks. When you use the emulator, the screen and keyboard appear to CP/M as a Lear Siegler ADM 3A video terminal.

Documentation

Bluntly, the lack of documentation for the Concept is a tragedy. While some manuals are available, they don't begin to cover what you need to know to set up an office automation system, and the Corvus Concept definitely falls into that category. The only saving grace is that Corvus worked very hard to ensure that users won't need to refer to the manuals during day-to-day operations. The manuals supplied with the system are listed in table 5. Most of the ones we received were readable, but they were also stamped “Preliminary” and all contained errors and confusing passages.

Conspicuous by its absence is an introductory manual providing an overall view of the Concept. The user needs to know what to expect from this system, how to set it up, and something about the philosophy behind the system design. Although installing the system and getting it to run required only that we make simple connections and follow straightforward procedures, everything had to be done in the right order—which was not always obvious. After a dozen phone calls during a four-week period, we finally got our two workstations and the hard-disk drive with a video-cassette-recorder backup communicating over the network.

Considering that the Concept is aimed at the business market, Corvus should make the installation as fast and painless as possible. A big step in that direction would be an improved set of manuals. The current materials are primarily a set of dry references for the applications software packaged in impressive suede-cloth binders. Still lacking are tutorials for the novice, quick-reference cards for the advanced user, and some nitty-gritty technical manuals on the software and the circuitry. With support materials like these, independent consultants and data-processing managers would have no qualms about recommending this system to clients, and third-party developers could provide much-needed software and add-on boards.

Performance

While user-friendliness is an important consideration, the Concept must also be able to work for a living. The machine's particular combination of features—graphics potential, powerful processor, large memory, FOR-
SuperSoft FORTRAN is the answer to the growing need for a high quality FORTRAN compiler running under CP/M-86 and IBM PC DOS. It has major advantages over other FORTRAN compilers for the 8086. For example, consider the benchmark program used to test the IBM FORTRAN in InfoWorld, p. 44, Oct. 25, 1982. (While the differential listed will not be the same for all benchmark programs, we feel it is a good indication of the quality of our compiler.) Results are as follows:

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TRAN, and Pascal—makes it attractive to scientists and designers, as well as to the business community. To determine a performance rating of the Concept in a time-sensitive environment, we compiled the Pascal version of Jim Gilbreath’s prime Sieve benchmark (see “Eratosthenes Revisited: Once More through the Sieve,” January 1983 BYTE, page 283). The compilation was fast, less than 8.2 seconds, with an execution time of 21.26 seconds, slower than the times of most 8-MHz 68000s running Pascal. We also compiled the FORTRAN version of the Sieve with a compilation time of 30 seconds and an execution time of 4.5 seconds—a quite respectable performance.

While multiuser systems always exhibit a loss of response time as more users come on line, this result may not occur with a distributed processing system such as the Concept and Omninet combination. In this case, the only possible waiting occurs when two users try to access the same shared resource, for instance, the hard-disk drive or a printer. We were unable to detect any difference with either one or two active users, even when both were performing tasks involving a high level of disk I/O.

**Prices and Options**

Today, the Concept does not offer many options. The basic workstation with 256K bytes of memory costs $4995. Another $1000 gets you an additional 256K bytes. Included with the workstation are the operating system, two serial ports, and the built-in Omninet interface. The required hard-disk drive, available from Corvus with capacities of 6, 10, and 20 megabytes, costs an additional $2495 to $4495. You can install the hard-disk drive in an expansion slot, if it is intended for use on a single Concept, and through the Omninet interface, if it is to be shared by more than one workstation.

The only real options are a thin-line 8-inch floppy-disk drive and the Mirror backup unit for the hard-disk drive. The floppy-disk drive, in its own enclosure, connects to an interface board installed in the workstation’s expansion slot. The Mirror, which connects between the hard-
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Service
While Corvus Systems Inc, is not a small company, getting a Concept repaired won’t be as easy as with some other popular personal computers. This is a sophisticated machine, and the only place to get one fixed is at a Corvus-authorized dealer. Presently, there are only two dozen of these dealers across the country. It’s likely that these dealers will need technical manuals to perform the necessary repairs, and there is also no word yet about the availability of service contracts. This seems to mean that Concept owners are taking a chance if they rely on one machine. With a large networked system, you can usually weather an occasional failure. At this point, I should add that we haven’t had any problems in more than 100 hours of use.

The Envelope Please
I approached the Concept with high expectations, which for the most part have been realized. The designers have included some features that are very special. They have created menus for every possible situation. The keyboard and video display should set a standard for mass-produced personal computers. The bundling of a complete package of business software and hardware is also an idea to be imitated. These features make the Concept a highly usable computer system.

I would like to see Corvus attend to a few details. My most nagging concern is with the inconsistencies encountered when you move from level to level in the menus. When you want to return to a parent menu, you must select a function button. Depending on which level you are at, however, that key is labeled Quit, Exit, Edit, Cancel, or (Cncl). One of the advantages of function keys is not having to memorize the commands. With this arrangement, you must still memorize a set of commands for each level. Adding to the confusion is the fact that the same function label has a different result in different menus. For example, in one menu Cancel returns you to the most recent menu; at another level, it returns you all the way back to the first level, the Dispatcher.

I also found a few cases in which a function listed on the screen was not yet implemented, specifically the <Para and Para> functions in EdWord and the print spooler. In only one case did I find an improperly implemented function, which was a minor problem. Overall, Corvus has done many things right in creating the Concept, but the system needs much more applications software to take advantage of its features. Although the manuals seem to be a major stumbling block, if a sufficient number of companies develop programs and boards for this computer, the Concept could still become a very popular machine.
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Achieving Greater White-Collar Productivity in the New Office

The conversion to automated tools in an office must address many issues, especially human factors.

The issues of automated office management and white-collar productivity are no longer the stuff for futurists. The spiraling availability of high-technology office equipment, coupled with inescapable economic forces like increasing labor and management costs on the one hand and decreasing costs of electronics and communications on the other, mandate that top management address the issue of how to increase office worker productivity in this new environment.

The trend is clear: improved white-collar productivity has become a key to increased profitability. There is a twofold reason for this: the white-collar work force now accounts for the majority (53 percent) of workers and, simultaneously, past blue-collar productivity gains show little leeway for further improvements. According to Labor Department statistics, while industrial productivity rose 83 percent during the past decade, there was a mere 4 percent advance among white-collar workers, despite huge outlays for new technological equipment. The shift away from an industrial work force to an office work force adds greatly to the importance of automation as well as to the potentials for greater output.

Today, business is on the verge of enormous changes spawned by the development of new technologies for distributed word processing, smart copiers, effective terminal PBXs, computerized filing and data banks, laser printing, and the like. As a result, management is faced with the strategic issue of collectively committing tens of billions of dollars to the new and evolving technology of office automation. Executives are asked to weigh technologies that are often not completely understood, factor them into potentially disruptive human elements, and then decide to what extent they should commit to a relatively new office work-style or mode of operation.

The Two Reactions to Office Technology

There have been two general reactions to the challenge of office technology. Both are extremist and contribute to poor results in automated ventures. The majority trend has been to wait for the emergence of time-proven office systems and technologies that present minimum risk. Unfortunately, this trend often leads to a loss of competitive edge in the marketplace.

The second reaction falls to the breed of executives who, so overly enthralled with new technologies, ignore bottom-line reality. To some degree, the reason that investment to date in advanced office equipment has not paid off in more visible productivity dividends is because this Buck Rogers group—by focusing predominantly on equipment at the expense of integrating advances into office procedures and human factors re-
## Price War!

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<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>MailMerge™</td>
<td>$369</td>
</tr>
<tr>
<td>dBASE II™</td>
<td>$489</td>
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<tr>
<td>SuperCalc™</td>
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<td>Multiplan™</td>
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<tr>
<td>SuperWriter™</td>
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American industry invests enormous amounts of capital in its workers—and is growing rapidly as the U.S. economy evolves from primarily a manufacturing base to a service base economy. The federal government predicts that by 1985 about 55 million workers of the projected 104 million person work force will be working in offices. For a national economy that historically has had a farming and manufacturing base, this is a revolution indeed. The Commerce Department estimates that the office has become the next trenched in inefficient paper, mail, and filing systems and relies on antiquated facilities, most office workers are far from being as productive as they can be. In a recent Lou Harris poll conducted for Steelcase, between 67 and 80 percent of white-collar workers reported their individual productivity could be increased if the office work load were reorganized and analyzed so work flowed more smoothly from person to person and department to department. In fact, almost all executives surveyed said they backed investment in more computer terminals and electronic filing, typing, copying, and other equipment to increase office efficiency.

Business executives give top rankings to conversion to electronic processing telecommunications and data-processing methods as these offer the most visible productivity gains. In addition, the need to enhance overall functioning, and the need to seek better physical layouts that would positively affect employee productivity, play important roles in the reorganization and refining of the office environment.

Despite the investment in labor and the clearly perceived need for productivity increases, the total investment in information resources has reached only about $73 billion, which, impressive as it might seem, does not clear the threshold necessary for meaningful productivity improvement. In a recent survey of professional productivity, it was determined that professional staff interfaces with computers less than 1 percent of the time. Pens and pencils, at 65 percent, were by far the most popular tool. Overall, it is clear that integrated systems with their synergistic effect on productivity have not yet been put into the right place in significant numbers.

The Spread of Automation: The Rationale

Of course, many current office systems have at least some equipment that can help boost output. Although U.S. business is generally still entrenched in inefficient paper, mail, and filing systems and relies on anti-
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<tr>
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<th>SUPER Time</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Set up/Program</td>
<td>5:20 min.</td>
<td>12:18:00 hrs.</td>
</tr>
<tr>
<td>Input 100 records</td>
<td>50:29 min.</td>
<td>1:27:50 hrs.</td>
</tr>
<tr>
<td>Sort &amp; Print Labels</td>
<td>6:41 min.</td>
<td>4:18 min.</td>
</tr>
<tr>
<td>Totals</td>
<td>1:02:30 hrs.</td>
<td>13:50:08 hrs.</td>
</tr>
</tbody>
</table>

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EASY TO USE - SUPER won because of its ease of use. Since it is menu-driven, office personnel can easily learn to use SUPER to set up their own applications, speeding and simplifying dozens of tasks without the need of programmer support.

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quate typing equipment and “dumb” copiers, there also are electronic data-processing machines, leased or owned private branch exchanges or key systems, and increasing numbers of basic word processors (mainly stand-alone, single systems). And these devices can, and do, improve productivity. But productivity improvement is not always the only issue. In fact, productivity increases when not offset by staff reduction or cost avoidance will not benefit the organization. And it takes careful control to ensure the savings are captured.

It is estimated that U.S. business can anticipate a productivity and cost reduction of about $300 billion annually by 1990, simply by adapting new technology and focusing work forces in the right direction. Jack Walsh, Director of Information Services at Avon Products, feels that productivity is a secondary consideration. He says, “Most managers are concerned with profitability. Those of us in the trenches, who understand the day-to-day needs of coordinating human resources, machinery, procedures, etc., see productivity as a realistic goal, but senior management will lean toward profitability. Until our offices mature, the profitability of installing automated equipment will overshadow productivity issues.”

In addition to productivity improvement and profitability concerns, an added benefit of automation is to allow top management to make far faster, higher-quality decisions because of the new systems’ capabilities for organizing, sorting, and storing huge amounts of data at speeds measured faster than ever thought possible. And, in fact, other “soft” benefits, such as improved customer service, faster research and development, better marketing information, etc., are all outgrowths of office automation.

Therefore, the executive charged with determining policy on automation must understand both hard and soft improvement opportunities and pressures and the three basic rationales for conversion.

Improving Corporate Profits. Current competitive patterns and seemingly intractable lags in productivity make this a persuasive argument for automation. The significance to a company’s competitive position, of course, varies with the industry. In banking and insurance, for instance, automation is a critical issue. But at some point in the next 5 to 7 years it is clear that automation will be a necessity that is driven equally by increasing overhead and more automated competition.

For example, some banks have increased their market share by taking greater advantage of information technology to provide 24-hour banking and instant access to customer records. This strategy stems from the highly competitive environment of banking. Similarly, legal firms use terminals to query court proceedings and other legal information as a counter to the growing volume and complexity of precedent searches. In helping to achieve these goals, office automation becomes a strategic issue as well as an operating decision.

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Conventional office support systems are not only outdated, but inefficient. Labor-intensive jobs like secretarial typing, shorthand, etc. can be greatly reduced or eliminated by automation. In addition, potential staff reductions through improved processing by machinery can often reduce the number of employees required to perform the more redundant tasks.

Increasing Professional Productivity. In the average company, professional salaries account for about half of total salary costs. As the largest segment of the work force salary, increased professional productivity becomes a prime target and justification for automation and increased output. An outlay for equipment, therefore, can be recouped very quickly. Although difficult to quantify, the benefit of providing complete and correct data to professionals is, perhaps, the greatest profit improvement office automation will offer. According to James Folts, Vice President, Corporate Development at Syntrix Incorporated, "Automation as a management tool is the single most important factor in office automation. Historically, management has viewed office automation as a secretarial tool. However, this approach is the least cost-effective. When used as a professional tool, automation can have an impact on productivity for outweighing the simple increases in document production many companies see as the chief benefit of automation systems."

While word processing and data processing have initially focused on clerical and secretarial staff, increased professional productivity is now seen as a major priority in business. Professional staff salaries have the greatest impact on white-collar costs because much of professional work can be defined as decision making. The key factors in improving productivity are timely handling and processing of information and a reasonable amount of information upon which to base decisions. When people don't have the correct information resources, decision making becomes more complex, and usually less effective. Conversely, if you inundate people with facts, details, and ideas, they are unable to effectively analyze this profusion of information and the right decisions will become impossible to make. The crux is that the proper amount of information provided in a timely fashion permits reasonable decisions. A chief objective within the office, therefore, is to provide professionals with reasonable tools that give them the information they need to make practical, timely decisions. Information must also be presented in a useful form and automation enhances the availability of information. Hence, the obvious relationship between decision making and automation.

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Profitable automation will be forthcoming from research and development groups working at beta test sites across the country, and the fear of becoming involved in automation too early, or of being locked into obsolete equipment, should be put into its proper perspective. A timely start, despite the hazards involved, will ensure a smoother transition, as automation makes further advances, along with the development of a core of internal expertise that can provide hands-on knowledge and a leading edge on the competition.

But this does not mean that one should opt for an overnight plunge into the so-called, much-touted "office of the future." Because most offices exist with yesterday's systems (or lack of them), an orderly update to the "office of today" makes more sense and avoids the trauma, expense, and serious disruptions that an overly ambitious or, perhaps, premature program will invariably cause.

Of course, outright purchase of equipment in a climate so volatile is rarely desirable, although some underfinanced manufacturers make their rentals virtually punitive versus relatively attractive lease/purchase plans. The cash flow and capital situation of the company is, of course, also a factor. In fact, cost-justification and return on investment become highly complex.

**Quantifying Benefits: Justifying the Investments**

There is, typically, a "backbone" application that must exist to justify automated equipment within each area of a company. Frequently, that backbone is word processing—the task of text-editing and manipulating words—where productivity can be dramatically increased by automation with the least outlay of capital and most quantifiable resultant savings. In promoting a recently announced multipurpose office system, for example, salespeople stressed its application simply by cost-justifying it as an automatic typewriter. Despite many other capabilities, products from Xerox, Syntrex, IBM, and Wang are also marketed in this manner to capture the most obvious audience.

Chuck DeNapoli, General Sales Manager at Micom, explains, "Our marketing approach is to appeal to the clients' common ground, and then augment it. New accounts usually feel more comfortable approaching advanced automation applications as an add-on to their current typing process rather than a completely new and different mode of operation. Improved typing is often the best avenue to travel on first applications."

But once a terminal is in place for word processing, additional peripherals can add sex appeal and accrue additional benefits for very little or no extra cost. Applications like automatic filing, conferencing, or electronic mail can complement the backbone application.

Electronic mail alone, for instance, is rarely cost-justifiable except in unique situations requiring both speed and accuracy. But without a large installed base of preexisting terminals as a backbone, it realistically is both prohibitive in cost and in usefulness.

Another key issue is to determine to what extent potential and achieved benefits can be quantified. By and large, the task of quantifying clerical work has been accomplished through systems as sophisticated as MTM and other industrial engineering techniques. Secretarial productivity, however, is somewhat more ephemeral. If a secretary received 20 calls today, versus 40 yesterday, is she half as productive? Clearly, the task is more complex because, in addition to measuring output, a value must be placed on it. Yet administrative support audits can—and do—quantify secretarial efficiency, typically finding cost reduction opportunities of about 20 percent in most studies.

If secretarial productivity quantification is somewhat difficult, it's a cinch compared to the issue of quantifying professional and managerial productivity, which raises far more questions as to its value or its feasibility.

The difficulty, of course, is in assigning a dollar value to creative and intangible activities that may or may not eventually result in tangible
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benefits to the company. Is a trip to a convention productive? By what standard? How do the hours spent preparing for an internal meeting contribute directly to the bottom line of profits? Should productivity be determined by the number of reports read or memos written or meetings attended? Obviously not, but finding out what methods to best use is difficult. The target group may not be willing to cooperate and there are many aspects of professional activity that cannot be measured. Finally, in addition to support staff and professional quantification, those "soft" benefits or value of more complete, timely, or accurate information must also be considered.

A "backbone" application must exist to justify automated equipment within each area of a company.

For example, putting a price tag on the speed and accuracy with which market data, government regulations, competitive analyses, sales figures, inventory, etc. are available is difficult but can make a significant difference on the bottom line of a company. In terms of government reporting alone, the burden for some companies is immense. For example, a report released in March 1979 estimated that each of the 48 largest U.S. companies spent an average of $54 million annually on government reporting.

However, implementation cannot begin, even after benefits have been established and costs justified, without careful consideration of how quickly implementation can take place within a particular company's individual environment. Its resources, potential user acceptance, and funding availability must all be realistically appraised. Appropriate planning is critical, and the environment will define how fast changes can be implemented and how quickly benefits will accrue.

Managing Change in the Office

The mechanics of managing office automation present another side to the environment issue. In putting together a plan, one must determine:

- size of staff necessary to implement and convert the facility
- the function of each staff member
- study methodologies used to study, justify, and design the system
- productivity measurements
- result quantifiers

Of course, top management most frequently asks: "How much will automation cost?" Although this is a valid query, it is impossible to answer in generalized terms. Costs will depend on the company's current level of automation, the industry, and individual needs and must reflect them. As a general rule of thumb, hardware costs should be offset by labor savings and productivity increases within about 18 to 36 months, and sometimes can be realized sooner.

Cost considerations are being helped by continuing breakthroughs in microelectronics and other technologies. Cost reductions of 85 percent and more are being realized, and further reductions are certain to appear as the volume of production of automated office equipment continues to run counter to general inflationary trends.

If an implementation plan is being created, it is important to also determine the best way to integrate the plan to a corporation's internal attitudes. Should a task force or committee be set up to assist in the planning and conversion process? What involvement should end users have? Who in the firm should take on day-to-day operational responsibilities? How should such a plan be structured to ensure integration with complementary functions such as data processing and personnel?

The management philosophy of a company will dictate the appropriate method of involving employees. Democratic, highly communicative firms typically opt for committees, with high user feedback and re-
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beyond cash flow and debt considerations. Programs that are demonstrably self-liquidating can go far toward ease financing problems that may extend beyond cash flow and debt considerations. Programs that are demonstrably self-liquidating can go far toward convincing boards of directors and activist stockholders of the viability of new technologies.

Picking the Hardware: Defining the Function
The concern that is raised with greatest frequency by users at professional conferences, seminars, and on consulting assignments is always: "What equipment should we be using in automating our office?" Unfortunately, the push from zealous vendors has focused attention on equipment, and all too often users are made to believe that it is the machine rather than the procedures that is the key to a successful conversion. Management is also intimidated by the technology and fearful of making a wrong choice.

Publicity and media overexposure, coupled with a host of manufacturers jumping into this hot marketplace, have inevitably led to confusion over the viability of the "office of the future." But when you define office automation needs by function, rather than with a hardware bias, equipment falls relatively easily into five basic functional categories.

Of course, equipment will vary considerably and continue to do so, but can best be judged by the components most systems use and then individually compared.

**Input.** This converts information from the human-recognizable form of the typed page to electronic storage form, for example, the keyboard on a word processor is the input component through which an operator translates a handwritten draft into impulses on magnetic media.

**Output.** The component that performs the reconversion translating from electronic/ storagable form to human-recognizable form, e.g., laser printers that translate magnetic coding into typewriter-quality, human-readable documents.

**Storage.** The electrical, magnetic, and optical filing of information that can be done on microfilm or microfiche, computer disk, cassette, magnetic card, or other media, both on line or off. These media have the unique ability to conserve space by thousands of percentages.

**Transport.** The transfer of information either electromagnetically or optically between devices, as in OCR scanning or facsimile transmission.

**Processing.** The capability to perform logical arithmetic or formatting manipulation of information, as well as the control of all four previous physical components through software procedures.

By determining the requirements of a particular office, one can select the category of functions that need to be fulfilled and judge available equipment by the quality and features of the components that fulfill these functions. The old hardware categorizations, such as "stand-alone word processor" or "executive terminal," are not really relevant. To be sure, to address business needs, the process must involve defining current support requirements and potential benefits of automation, designing the appropriate systems, and estimating resource requirements to achieve the plan.

Some firms have even created a position to address this need, such as Director of Office Automation, Vice President of Productivity, etc. Although the titles vary, and the responsibilities range from simple advisory to wholesale implementation and management duties, the position is, in almost all cases, that of a company-wide coordination ensuring an integrated and compatible approach to office automation.

This sort of approach requires a management commitment to change. And although no totally futuristic or empirically more productive automated office exists in today's business place, beta test sites and partial conversions are springing up nationwide. Many have been instigated by relocation projects—company moves are a perfect opportunity for reevaluation and change.

Converting the Office: A Blueprint for Change
Planning and bringing to successful completion a conversion to office automation must successfully address all the issues already described. The approach suggested below can assist in ensuring success, but the solution,
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of course, must vary depending upon the unique needs of the situation. The outline below helps make sure that all aspects of office automation strategic planning are covered, but, realistically, the skill of a Houdini still may be needed to pull it off.

**Step 1. Create a detailed work plan for the project.** Because of the implications and tremendous breadth of an undertaking like this, a fully detailed, time-phased plan is necessary to describe tasks that must be undertaken, manpower necessary, elapsed time for each task, and target due dates, which may extend over a period of years. Such a plan will help control an unwieldy, major undertaking. Most important, the plan should be approved by top management before the program begins, which guarantees its knowledge of and involvement in various steps. Interface with office corporate groups is also necessary to ensure compatibility in planning between sites.

**Step 2. Assess business needs and relate them to automation/productivity implications and opportunities.** Those involved in designing automated systems must understand the future business directions and strategies of the corporation and compare the operating objectives, long-term positioning, and economic and regulatory constraints to available technological solutions. For instance, rapid growth, industry needs, competitors' capabilities, and even the overall economy are important considerations when designing a system. Governmental policies, new business strategies, cash flow, or changing marketplace conditions all should impact the plan.

Because of the certainty that meaningful office automation will vastly affect both day-to-day operations and strategic outlook for the enterprise, rigid analysis of where the company is and where it intends to go is essential. When the planning process is ended, if it is successful, the firm will commit itself to a phased implementation program that will merge downstream with the company's evolving business and market strategies to capture potential productivity gains.

**Step 3. Select applications and concepts that will profit and improve business.** By applying the set of available automated office concepts to business needs, a backbone application as well as additional peripheral applications should evolve.

It is critical, then, that the benefits of technology specific to industry and business be determined. For example, electronic mail is most attractive when internal communications need enhancement. For a firm with largely external communications needs, electronic mail will not be a great boon. It is the role of the office automation practitioner to overlay the business needs onto the available technology, determining applications.

Armed with what amounts to a first-cut solution, the planners must then determine resource requirements to bring about such a solution. Financial and personnel needs must be weighed carefully and then factored in with a prudent estimate of what future technical, human, and financial resources the company can commit. Without an assessment of the "real" constraints as perceived by future end users, office automation planners may find themselves in a situation where "client" departments are very resistant to change and feel left out of the planning process involved. Needless to say, "solutions" presented without first going through this feedback loop are doomed to failure.

**Step 4. Conceptualize the architecture of the system.** The user must develop a conceptual design of the proposed system based on available technology, price/performance, and vendor service and support records. Systems architecture must be described in terms of the five physical elements previously mentioned: Input, Output, Storage, Transport, and Processing.

At this point, organizational alternatives must be considered. Should devices be located in centers, in clusters, or individually? Should they
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be used by dedicated full-time operators or by multifunction personnel? Should devices be located at the professional workstation, by secretaries, or perhaps only one should be assigned within a department?

Often, enormous flexibility can be achieved through the use of distributed information systems, which sometimes permit equipment to be located at great distances from the main computer.

During rapidly changing business conditions when inventory control is especially crucial, this sort of option can have enormous economic impact. As architecture falls into place, planners need to establish a system of priorities that combines the predetermined criteria for potential solutions and the interrelated business strategies they must address. Also, planners must begin working toward specific rather than general goals. Therefore, it is important that past work and estimates of future needs be checked for accuracy.

Step 5. Define and address human resource issues. The reaction of the end user to automated office support systems must be considered, including behaviorism; staff orientation, training, and preparation; and habit changes. In fact, it is the people problems that are perhaps the most difficult issues to resolve.

New positions, new tools, and new roles for office staff are bound to create fear and concern among office workers. Job security status and salary issues will need to be addressed. In addition, human resources to undertake the physical conversion must be located and allocated to the tasks ahead. In this area, senior office systems practitioners must take a strong hand during the planning process. Subordinates and those with experience in early, less sophisticated office equipment may press for less than optimum solutions as they seek to defend or enlarge their own power—this can prove fatal in such a venture.

Senior office automation practitioners must consider whether current staff with expertise in the fields of data processing and word processing, telecommunications, and the like have the abilities to move into crucial management roles in the new office structure. Often, new technologies involve massive and potentially dangerous change, and top management should view the decisions made on the issues of supervision, reporting, and authority levels to be as important as they would be when establishing a new division upon which the firm places major hopes for future profitability.

Step 6. Select appropriate hardware. Basic assumptions must now be made about the equipment itself. Key considerations are availability, level of support, price flexibility, and the performance of hardware, software, telecommunications, and related items. Architectural requirements will begin to emerge as the list of expected information flows is juxtaposed against technology assumptions. Negotiations with vendors must begin, equipment must be selected and displayed, and operating staff must be trained.

Step 7. Design the management process cycle. With a workable program for implementing office automation, planners still have not completed work on critical issues. An especially crucial consideration involves the management processes necessary if the new systems are to work at optimum and productive levels. A most common cause for failure in achieving hoped-for productivity gains from automated office equipment is not establishing new management systems that will provide smooth and efficient operations.

A number of critical new management processes must be developed to translate the plan into a successful set of operations. Cost audits and post-installation reviews need to be devised to enable the user to establish and maintain the cost-effective, efficient, service-oriented automated office environment. A permanent staff of service-oriented, technically knowledgeable, bottom-line-oriented personnel must be recruited or developed to manage the new systems.

Step 8. Address key corporate issues. Finally, identify and resolve organizational issues such as end-user
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Apple II by Apple
Apple II Plus IIIB by Apple
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Apple IIgs by Apple
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Apple IIg by Apple
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As many different word-processing jobs exist as there are things that people want to write. But the capabilities you may need in a system do fall into a few broad categories. For instance, Dr. Larry Press, in a 1980 article in onComputing magazine (precursor to Popular Computing, see reference 8), outlined four major kinds of word-processing work, typified by four users: an author writing long continuous articles, a marketing manager doing mass mailings of form letters, a secretary typing many short personalized letters, and a newsletter editor concerned about document merging and exact formatting.

There are also a number of ways to test word-processing programs. Some authorities count the number of available features; some weigh the balance of features for different tasks. Some people look for only one or two features that may be vital in certain jobs; others avoid characteristics judged undesirable. No list of features can fully capture the feel of using a program, just as knowing the weight and length of a hammer gives you only a rough idea of what it will feel like to pound a nail with it. My method of evaluating these programs has been partially subjective, and here I should state my prejudices.

Although I have on occasion done work similar to that of each of the four hypothetical users above, my everyday use of a word-processing program is closest to that of the author: writing, rewriting, and editing lengthy articles. The first program I ever used was Magic Wand running on a Z80-based CP/M-80 system with a Cops-10 video terminal. (Magic Wand, now called Peachtext by its distributor, Peachtree Software, is not reviewed here because a version of it was not available for the IBM Personal Computer when I started this project.) I am a
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moderately fast touch-typist (I usually can type faster than I can think), and I like to place the detached keyboard in my lap.

Simply using Easywriter II, Volkswriter, Wordstar, and The Final Word was the most important test I could put them to, but my conclusions are inevitably affected by the factors I've listed above. Your needs and desires will inevitably differ from mine. That's all the more reason to try any program before you buy.

Easywriter II

Only the name is the same here. Easywriter II is a completely different program from the Easywriter sold by IBM. The II suffix is intended to distinguish this Easywriter package, written in the C language for IUS by the Basic Software Group, from the IBM-distributed program (Easywriter 1.0 and Easywriter 1.1), written in FORTH by Cap'n Software. Easywriter II is being sold directly by and through the dealers of Information Unlimited Software Inc., not by IBM.

Information Unlimited Software certainly has learned from IBM how to package Personal Computer software; Easywriter II is sold in a boxed, 9½-by-8-inch, linen-covered loose-leaf binder that is perfectly coordinated in appearance with IBM's Personal Computer documentation.

IUS was not able to coordinate certain other characteristics of its new program quite as well, at least at first. In
Word Tools for the IBM Personal Computer

Richard S. Shuford
Special Projects Editor

“Aha,” someone said, reading from the screen, “IBM is offering an impressive set of software: Microsoft BASIC, Visicalc, the Peachtree business package, UCSD Pascal, CP/M-86, and . . . Easywriter?” We were sufficiently surprised at the appearance of this program from the realm of Apple computers that we later called Phil to double-check; the Easywriter word-processing program, from Information Unlimited Software, just didn’t seem to fit with the other pieces of software in that initial announcement.

Before long, many purchasers of the IBM Personal Computer (PC) were also surprised by Easywriter, and unpleasantly so. The first Easywriter package, Version 1.0, quickly developed a reputation for user-unfriendliness and annoying bugs. Eventually IBM released the improved and more reliable Version 1.1, but the impression had been made and many independent developers of software perceived a ripe opportunity to sell an alternative word-processing program for the IBM PC.

In trying to seize this opportunity, some developers rushed dubious programs to market in the guise of word-processing software. But enough time has now gone by that a state of dynamic equilibrium (although certainly not a state of calm) has settled over the market for IBM PC word-processing programs, and most users will be able to find a program that meets their needs. In this article, I’ll tell you about four candidates: Easywriter II, a new and different pro-

Photo 1: Four currently available word-processing programs for the IBM Personal Computer (Model 5150): Easywriter II, from Information Unlimited Software; Volkswriter, from Lifetree Software; Wordstar, from Micropro International; and The Final Word, from Mark of the Unicorn. (All photos by Ed Crabtree.)

The BYTE editorial staff was clustered in the computer lab eagerly watching text scroll up the screen of a video display. The date was August 13, 1981, and we were watching Phil Lemmons’ first report on the announcement of the IBM Personal Computer (reference 6) come in through a modem connection.

May 1983 © BYTE Publications Inc
The Easywriter II software was divided into two parts: a "system" disk and a "housekeeping" disk. Even such a simple operation as copying document files required an annoying number of manual disk changes, and operation on a single-disk-drive system was impossible. Only single-sided floppy disks were supported, with a capacity of less than 100,000 bytes' worth of documents on one disk (on a double-sided drive, only one side was used). A utility program on the housekeeping disk converted Easywriter II files to PC-DOS format and vice versa, but it could copy correctly only onto single-sided disks; this undocumented fact caused me some frustration. "Importing" a 21,504-byte file to an Easywriter II disk took 2½ minutes.

At least one of the effects of the Easywriter II disk structure was good. The structure allowed long (30-character) document names (like "TEC FinanceCommittee 17 Jan 83") and the keeping of a certain amount of document history: author's and typist's names, size in pages, and dates (but not times) of creation and last modification (see photo 2). Each document on a data disk was assigned a sequence number by the system, so that you did not have to type those long file names; you referred to documents by number.

The verbs in the preceding section are intentionally past tense. According to a telephone conversation I had with a representative of IUS, a new version of Easywriter II should be available by the time you read this. The new version is intended to run under PC-DOS, and most, if not all, of the inconveniences caused by the disk environment should be removed.

I found the editing command structures in Easywriter II to be quite different from those of the other microcomputer word-processing programs I have used. Easywriter II is organized around pages and modes. The computer's video-display screen is used as a window onto one page of the document (see photo 3); normally, you can scroll only up and down on this single page, and you have to issue an explicit command to move to the next page or a previous page, either of which takes about 4 seconds. The most text you can cram into one logical page is about 200 lines, and the computer will remind you of every line entered on a page past line 54 (or a number you set).

The action of any editing and most cursor-movement commands depends upon the current object mode. Seven possible modes each correspond to one defined text object (character, word, sentence, paragraph, line, block, and page). Each command acts upon the object named by the mode currently in effect. To select the object mode, you press one of the 10 assignable-function keys (Fl through F10) on the left side of the keyboard or, in some cases, a function key plus the Shift key. Some of the more dangerous operations (like delete page) require explicit
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Photo 4: Easywriter II relies heavily on "help" screens to coach new users on how to use the system, rather than lengthy chapters in the written documentation or online tutorial files. After you hit the F2 function key, you are presented with a menu of possibilities. Shown here is the explanation of the merge function.

Easywriter II depends quite heavily on use of both on-screen menus and the function keys. The use of menus is common enough, but use of the function keys deserves some attention. The assignable keys F1 through F10 are used both unaugmented and along with the Shift and Alt (alternate) keys. IUS provides a reference sticker as an aid in remembering what the function keys do, and I gather that you are supposed to affix the sticker to the front panel of the IBM PC system unit, between the disk drives and the IBM nameplate. The sticker has one great deficiency: it's too small. The words within the key outlines seem to be in 5-point type and are impossible to read without leaning up close.

The page orientation, the object modes, and the heavy, enforced use of the function keys combined to make me dislike editing with Easywriter II. I don't put much significance on page divisions in the documents I write and edit (this article, for instance), and it's much more convenient to be able to scroll up and down through a large buffer containing the whole document. And with Easywriter II, block-move and block-copy operations cannot occur in block sizes greater than one page.

When editing text, I like to make both large and small changes in the same pass through the text. Easywriter II assumes that you will make changes mostly at the level of one text object at a time. I also found myself forgetting what mode was in effect (even though a status line on the screen indicates this) so that I often changed the wrong text object. Furthermore, I like to leave my fingers in the home position on the keyboard, so that I'll know where they are and only rarely need to look at them to guide my keystrokes. Using Easywriter II, you have to use the function keys a lot to change between the modes, and you have to lift your hands out of the home position and look down at them to hit most of the function keys (while confirmation. The keys of the numeric/cursor-control keypad on the right are also used.

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squinting at the reference sticker). This sort of thing slows me down. You use the keyboard's directional cursor keys, which require you to move from home position, to move the cursor. It's not that I object to function keys in themselves, but there should be a way for expert users to streamline their actions.

My objections don't apply to some users. If you are new to computers (see photo 4), you may appreciate having certain keys dedicated to common functions, and if you are a hunt-and-peck typist you won't care about the home position. And again, if you do only light editing of your text once you have entered it, these problems will be negligible. But once you have learned the system, if you come to use it frequently for editing and revision, you just might get tired of moving your hands back and forth every other keystroke.

You format text for printed output from Easywriter II chiefly by getting it to look on the screen the way you want it on paper. (I'll have more to say about such screen-oriented formatting later on.) A “ruler” line on the screen defines tab settings, margins, and page centering; as many as eight rulers may be used for each document.

Decimal-tab settings allow easy alignment of columns of figures, although no column-move facilities are provided. Different headers and footers may be defined for left and right pages, with page numbering placed as desired.

Printing can occur while editing is taking place, including immediate printing of the page just edited. The version of Easywriter II that I tested was unable to drive a serially interfaced Integral Data Systems Prism printer at full speed; IUS is planning to speed up the new version to avoid this problem.

The program I had didn't contain a true global search-and-replace function (the updated version is supposed to have one). An update of the documentation is planned, giving more tutorial examples.

A few other comments are in order: Online help for most functions can be gotten by simply pressing the F2 key. Whenever you wish to take a break from working, you can hit the Escape key, and the page you are working on will automatically be stored on disk against the possibility of some system mishap while you're gone. Sections of one document may be tagged to be merged with another document. No extra backup copies of files required from being on the disk.

Different header s and footers may be defined for left and right pages, with page numbering placed as desired.

Comparative properties of four word-processing programs for the IBM Personal Computer.

<table>
<thead>
<tr>
<th>Property</th>
<th>Easywriter II</th>
<th>Volkswriter</th>
<th>Wordstar</th>
<th>The Final Word</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$350</td>
<td>$195</td>
<td>$495</td>
<td>$300</td>
</tr>
<tr>
<td>Printed documentation</td>
<td>9\text{1/4}-by-8\text{1/4}-inch binder, 92 typewriter pages, 5-page index; function-key sticker</td>
<td>9-by-7-by-1\text{1/4}-inch binder, about 70 typewriter pages, 5-page index</td>
<td>12-by-10\text{1/4}-by-1\text{1/4}-inch binder, 230 pages, 5-page index, 14 pages specific to IBM PC; pocket reference card; separate tutorial workbook</td>
<td>12-by-10\text{1/4}-by-2\text{1/2}-inch binder, 402 pages, 8-page index; reference card; function-key chart</td>
</tr>
<tr>
<td>Minimum practical hardware configuration</td>
<td>64K bytes of RAM, 80-character display, two 5\text{1/4}-inch floppy-disk drives (reviewed version supports only single-sided drives), and printer</td>
<td>64K bytes of RAM, 80-character display, one 5\text{1/4}-inch floppy-disk drive, and printer</td>
<td>128K bytes of RAM, 80-character display, two 5\text{1/4}-inch disk drives (double-sided recommended), and printer</td>
<td>128K bytes of RAM, 80-character display, two 5\text{1/4}-inch double-sided floppy-disk drives, and printer</td>
</tr>
<tr>
<td>Maximum number of characters directly manipulable</td>
<td>window sees only one page at a time; number of pages in file varies with disk size</td>
<td>window with 128K bytes, 58,570 characters; with 64K bytes, 18,370 characters</td>
<td>varies according to disk size</td>
<td>varies according to disk size and user-set size of swap file</td>
</tr>
<tr>
<td>Editing universe</td>
<td>window into one page of file</td>
<td>window into buffer in RAM</td>
<td>window into buffer automatically paged to and from disk</td>
<td>window into buffer automatically paged to and from disk; supports two windows and multiple buffers</td>
</tr>
<tr>
<td>Command structure</td>
<td>mode-oriented; uses menus and special- and assignable-function keys plus Alt and Shift keys</td>
<td>uses special- and assignable-function keys plus Alt key</td>
<td>control keystrokes organized by two-level menu, limited function-key support</td>
<td>control keystrokes organized by three-level menu, user-definable function-key support; mode-oriented</td>
</tr>
<tr>
<td>Tutorial course for beginners?</td>
<td>first chapter in user's manual</td>
<td>files for online tutorial provided on disk</td>
<td>separate stand-up beginner's workbook (introductory textbooks available from independent sources)</td>
<td>nine chapters of user's manual, some chapters also provided on disk for online practice</td>
</tr>
<tr>
<td>Online help during editing?</td>
<td>separate screen displays explaining function keys and editing procedures, placed on screen after user types F2</td>
<td>brief descriptions of function keys placed on screen after user types F2</td>
<td>command menus appearing at top of screen after user types proper control character (menus may be suppressed by expert users)</td>
<td>command menus at top of screen appearing after user types Control-X, also brief messages on command sequences and keystroke functions</td>
</tr>
</tbody>
</table>

Table 1: Comparative properties of four word-processing programs for the IBM Personal Computer.
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SOFTWARE
<table>
<thead>
<tr>
<th>Property</th>
<th>Easywriter II</th>
<th>Volkswriter</th>
<th>Wordstar</th>
<th>The Final Word</th>
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<tbody>
<tr>
<td>Longest line length that can be set</td>
<td>255 characters (horizontal scrolling possible)</td>
<td>80 characters</td>
<td>240 characters (horizontal scrolling possible)</td>
<td>65,535 characters (no horizontal scrolling; line is wrapped back onto screen for display only)</td>
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<tr>
<td>On-screen status information shown during text entry and editing</td>
<td>text-object mode in use; percentage of document disk used; current date; cursor position (column, line, page); document name; margins; tab stops; page center; right-hand word-wrap zone; other transient messages</td>
<td>disk drive being used for file accesses (logged drive); cursor line and column; percentage of buffer unused; cursor is enlarged during insert mode; additional transient messages</td>
<td>active file name; current page; cursor line and column; insert mode on or off; line spacing; margins and tab stops; page breaks; various line-ending codes; optional command menus; other transient messages</td>
<td>version of The Final Word in use; text insert/alignment mode; current buffer name; file name associated with current buffer; percentage of buffer contents behind cursor; &quot;**&quot; if buffer has been modified; &quot;+&quot; if new deletions will be appended to old; &quot;H&quot; if new text will be highlighted; current &quot;verb&quot; (actually adverb); transient messages</td>
</tr>
<tr>
<td>Screen location of status information</td>
<td>three lines at top, normal character attributes</td>
<td>bottom line, inverse video</td>
<td>top two lines (if menu suppressed) of rightmost column; menus occupy several lines at top of screen, in both normal and bright intensities</td>
<td>next-to-bottom line, inverse video; transient messages appear on bottom line; menus on several lines at top of screen</td>
</tr>
<tr>
<td>Use of IBM PC function keys</td>
<td>extensive, mandatory; uses Alt and Shift keys with assignable keys; function-key sticker provided</td>
<td>extensive, mandatory; Alt key doubles functions; on-screen key menu</td>
<td>optional; curious choice of key assignments</td>
<td>optional; uses Alt, Shift, and Control keys with assignable keys; key chart provided; assignments may be changed by user</td>
</tr>
<tr>
<td>Action of Del key</td>
<td>deletes current text object</td>
<td>deletes character to the right of cursor</td>
<td>deletes character to the left of cursor</td>
<td>deletes character at cursor</td>
</tr>
<tr>
<td>Action of back-arrow key</td>
<td>nondestructive backspace (replaces character with a space)</td>
<td>destructive backspace</td>
<td>nondestructive backspace</td>
<td>delete character backwards</td>
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<td>Decimal tab stops?</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
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<td>Column-move capability?</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
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<tr>
<td>Possible insertion of nonprinting ASCII control characters?</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>no</td>
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<tr>
<td>Formatting scheme</td>
<td>on-screen</td>
<td>on-screen; some printing parameters stored in disk files</td>
<td>on-screen</td>
<td>both on-screen and embedded-command formatting possible</td>
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<tr>
<td>Transition time from edit mode to printing start (includes answering queries as fast as reasonably possible)</td>
<td>reviewed version: 25 seconds for 28,469-character (or 9-page) file</td>
<td>128K-version: 16 seconds for 28,469-character file printed directly out of buffer; 64K-version: 48 seconds for same file, includes saving to disk</td>
<td>60 seconds for 28,469-character document, includes saving to disk</td>
<td>(or 28,187-character document, without embedded-character formatting: 1 minute, 35 seconds; for same document with formatting: 4 minutes</td>
</tr>
<tr>
<td>Print while editing?</td>
<td>not reliably</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Obtain file directory without leaving program?</td>
<td>document files only</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Can user change default parameters?</td>
<td>some (with menu-driven utility program)</td>
<td>those in format (.FMT) files</td>
<td>only printer-support parameters</td>
<td>most print and edit defaults (with menu-driven utility program)</td>
</tr>
</tbody>
</table>

Table 1 continued on page 192
WE HAVE THE JUMP ON THE COMPETITION

Kangaroo ™

in QUALITY and PRICE!

Kangaroo—the best disk at any price!

CERTIFIED 100% ERROR FREE
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EXCLUSIVE NORTH AMERICAN DISTRIBUTOR:

Circle 537 on Inquiry card.
<table>
<thead>
<tr>
<th>Property</th>
<th>Easywriter II</th>
<th>Volkswriter</th>
<th>Wordstar</th>
<th>The Final Word</th>
</tr>
</thead>
<tbody>
<tr>
<td>Document assembly during editing</td>
<td>includes &quot;tagged&quot; sections of other document files</td>
<td>can include entire files</td>
<td>can include entire files; marked blocks of files may be written to disk</td>
<td>marked blocks of text may be transferred between two buffers</td>
</tr>
<tr>
<td>Document assembly during printing</td>
<td>no documented method</td>
<td>can embed entire files in output</td>
<td>needs optional Mailmerge program at extra cost</td>
<td>can embed entire files in output</td>
</tr>
<tr>
<td>Accept operator input for immediate inclusion in printed output?</td>
<td>no</td>
<td>no</td>
<td>needs Mailmerge</td>
<td>yes</td>
</tr>
<tr>
<td>Automatic formatting capabilities (other than defaults)</td>
<td>multiple-line headers and footers, alternating left and right</td>
<td>page formatting through .FMT files</td>
<td>single-line headers and footers</td>
<td>extensive and complex capabilities through embedded commands</td>
</tr>
<tr>
<td>Default text justification style</td>
<td>flush-left (ragged-right margin)</td>
<td>flush-left (ragged-right margin)</td>
<td>fully justified</td>
<td>fully justified (as distributed; user can change)</td>
</tr>
<tr>
<td>Can documents be printed without being saved to disk?</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Difficulty of changing from single spacing to double spacing</td>
<td>difficult</td>
<td>easy</td>
<td>difficult</td>
<td>easy, requires use of formatter</td>
</tr>
<tr>
<td>Can text be searched for printing attributes?</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Printers supported (not all printers can output all text attributes)</td>
<td>IBM Parallel Printer; Epson MX-80; Diablo 1610; Diablo 1650 (with sheet-feed); Diablo 630; NEC 5510; and C. Itoh Parallel* (others, without full capability)</td>
<td>IBM Parallel Printer; Epson MX-80 (with and without Grafflex); Smith-Corona TP-1; Brother HR-1; Comrex CR-1; NEC 8023-A; and NEC 3550 (other printers, without full capability)</td>
<td>IBM Parallel Printer; Epson MX-80 with Grafflex; C. Itoh B510; Leading Edge Prowriter; Diablo 1610/1620; Diablo 1640/1650; Diablo 630; NEC 8023A; NEC 3550; NEC 5510/5520; Qume Sprint 9/35; IDS 440460; IDS Prism; Centronics 7377/739; and Radio Shack Daisywheel II (others, with varying capability)</td>
<td>partial support</td>
</tr>
<tr>
<td>Special features of disk-file format</td>
<td>nonstandard file format in tested version; file-conversion utility produced normal PC-DOS files; new version to use PC-DOS files</td>
<td>&quot;§&quot; character (ASCII decimal 20) at hard returns, &quot;§&quot; character (ASCII decimal 21) at page ends; otherwise normal PC-DOS files</td>
<td>high bits of character bytes set at ends of words and at soft returns; soft (ghost) hyphens and other special attributes use nonprinting ASCII values</td>
<td>normal PC-DOS files; high bits of character bytes set only in highlighted text</td>
</tr>
<tr>
<td>Checking of spelling integrated into program?</td>
<td>no</td>
<td>no</td>
<td>yes (with optional program Spellstar at extra cost)</td>
<td>no</td>
</tr>
</tbody>
</table>

Table 1 continued on page 194
# Interactive Videodisc System

**$4995= COMPLETE**

<table>
<thead>
<tr>
<th>QTY</th>
<th>DESCRIPTION</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TOUCHÉ SYSTEM, including a fully assembled desk-top enclosure, housing:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• APPLE II motherboard with 64K</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Single floppy disk drive and controller card (256K)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• IIAT touch sensitive color monitor (13&quot;)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• PIONEER laser videodisc player</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• IIAT video/touch interface circuitry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Audio amplifier switchbox</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Course authoring language</td>
<td></td>
</tr>
</tbody>
</table>

I'm ready to go with the IIAT system — it meets all our training and point of information needs. And it costs $3000 less than any I've found. Let's stop looking and start using it —

SEE US AT NCC BOOTH D 1402
Most annoying characteristics

- Multiplicity of text-object modes; (in version tested) incompatible disk format, single-sided-use even on double-sided drives, necessity to change disks for routine functions; lack of ability to search text for printing attributes.

Most pleasing characteristics

- Quickness of screen scrolling; simplicity of design; storage of canned formats; ability to insert almost any ASCII character into text.

Miscellaneous comments

- Special telephone-help service may be purchased for $70 per year. Second serial port cannot be used for printer.

You purchase a version tailored to run on a 64K system; when you send in the registration card, you are sent the 128K version. Owners of version 1.1 may receive an upgrade to 1.2 for $20.

Wordstar has provision for helping hyphenate words during reforming of paragraphs. Text is displayed on screen in bright attribute, menus in normal attribute.

Co-owner Jack Abbott says, “If you’ve been reading my review series in Byte magazine on Database Management Systems. Please call me at (602) 842-1133 if I can be of help in solving your software requirements.”

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- #Condor III Call
- #T.I.M. #Infostar Call

**CP/M UTILITIES**

- Package Price, Wordstar, Mailmerge, Spell Checker, for CP/M 80 and for IBM PC $445
- Above package with Spell Star $495
- #Wordstar $295
- #Mailmerge $125
- #Wordstar & Mailmerge $395
- #Spellstar $145
- Calstar $135
- Aspen 50K Spell Checker $90
- C-Basic $115
- Lotus 1, 2, 3 (IBM Only) $375

**SPECIALS**

- #TCS AR, PAY, AP, GL Augmented Version $400 or $125 each module
- dBase II includes special extra disk of example programs including inventory, invoicing, and mail list at no extra charge. Also included is Everymans Data Base Primer, 300 pages on dBase II Call

**IBM PERIPHERALS**

- IBM Disc Controller Adapter w/par. or serial port $249
- Seven Function Board—64K expandable to 256K, par. port, async port, real-time clock w/battery, game paddle port, print spool software, ramdisk software, 1 year warranty
- Piggyback Board—Expands multi function board by 256K (No Ram) $395
- 4 Function Board, same as 7 function board without the RAM or the software $250
- 64K RAM expandable to 256 w/Async port $295
- Tandon 100-2 D/S D/D Drives 320K for IBM PC Call
- 5MEG Winchester w/removable cartridge Call

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**SPECIAL OF THE MONTH**

<table>
<thead>
<tr>
<th>COMPUTER</th>
<th>DISK DRIVE</th>
<th>VIDEO TERMINALS</th>
<th>DISKETTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEC 8023A</td>
<td>$435</td>
<td>Qume QVT 102</td>
<td>$550</td>
</tr>
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<td></td>
<td></td>
<td>Televideo 910</td>
<td>$570</td>
</tr>
<tr>
<td></td>
<td></td>
<td>910 Plus</td>
<td>$570</td>
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<td></td>
<td></td>
<td>920</td>
<td>$735</td>
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<td></td>
<td>950</td>
<td>$915</td>
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<tr>
<td></td>
<td></td>
<td>970</td>
<td>$1100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zenith Z-19</td>
<td>$670</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Z-29</td>
<td>$640</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZT-1 Keyboard Only</td>
<td>$350</td>
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#### DISK DRIVES

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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<tbody>
<tr>
<td>Percom</td>
<td>$400</td>
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<tr>
<td>Elite 1</td>
<td>$265</td>
</tr>
<tr>
<td>Elite 2</td>
<td>$420</td>
</tr>
<tr>
<td>Elite 3</td>
<td>$550</td>
</tr>
<tr>
<td>Controller (w/Drive only)</td>
<td>$75</td>
</tr>
<tr>
<td>1000 (For Atari)</td>
<td>Call</td>
</tr>
</tbody>
</table>

#### VIDEO TERMINALS

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qume QVT 102</td>
<td>$550</td>
</tr>
<tr>
<td>Televideo 910</td>
<td>$570</td>
</tr>
<tr>
<td>910 Plus</td>
<td>$570</td>
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<tr>
<td>920</td>
<td>$735</td>
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<tr>
<td>925</td>
<td>$730</td>
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<tr>
<td>950</td>
<td>$915</td>
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<tr>
<td>970</td>
<td>$1100</td>
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<tr>
<td>Zenith Z-19</td>
<td>$670</td>
</tr>
<tr>
<td>Z-29</td>
<td>$640</td>
</tr>
<tr>
<td>ZT-1 Keyboard Only</td>
<td>$350</td>
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</table>

#### DISKETTES

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxell MD-1 (Qty. 100)</td>
<td>$250</td>
</tr>
<tr>
<td>Scotch 744-0 (Qty. 100)</td>
<td>$225</td>
</tr>
<tr>
<td>Elephant S/S S/D (Qty 100)</td>
<td>$180</td>
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**ATARI**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
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<tbody>
<tr>
<td>Special 800 System</td>
<td>$640</td>
</tr>
<tr>
<td>1200</td>
<td>Call</td>
</tr>
<tr>
<td>800 (48K)</td>
<td>$525</td>
</tr>
<tr>
<td>400</td>
<td>$225</td>
</tr>
<tr>
<td>810 Disk Drive</td>
<td>$1440</td>
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<tr>
<td>850 Interface</td>
<td>$170</td>
</tr>
<tr>
<td>410 Recorder</td>
<td>$75</td>
</tr>
<tr>
<td>830 Modem</td>
<td>$155</td>
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**COMMODORE**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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<tbody>
<tr>
<td>64</td>
<td>$395</td>
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</table>

**AXLON**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>Rampower 48 for Atari</td>
<td>$140</td>
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<tr>
<td>Rampower 128 for Atari</td>
<td>$355</td>
</tr>
<tr>
<td>Ramdisk 128 for Apple</td>
<td>$355</td>
</tr>
<tr>
<td>Ramdisk 320 for Apple</td>
<td>$1035</td>
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<tr>
<td>Data Link</td>
<td>$300</td>
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**PRINTERS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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<tbody>
<tr>
<td>Anadex 9620A</td>
<td>$1445</td>
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<tr>
<td>C-ltoh F-10-Parallel</td>
<td>$1165</td>
</tr>
<tr>
<td>55 CPS-Series</td>
<td>Call</td>
</tr>
<tr>
<td>8510 Parallel (Prowriter)</td>
<td>Call</td>
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<tr>
<td>Computer International Daisywriter 2000 w/16K</td>
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<tr>
<td>Daisywriter 2000 w/48K</td>
<td>$1000</td>
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<tr>
<td>Comrex CR-1-P</td>
<td>$675</td>
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<tr>
<td>Data south DS 180</td>
<td>$1170</td>
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<tr>
<td>Diablo 620 RO w/Tractors</td>
<td>$920</td>
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<tr>
<td>630 RO w/Tractors</td>
<td>$1730</td>
</tr>
<tr>
<td>IDS Microprism 480</td>
<td>$515</td>
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<tr>
<td>Epson All models</td>
<td>Call</td>
</tr>
<tr>
<td>NEC PC-8023A</td>
<td>$435</td>
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<tr>
<td>3510</td>
<td>$1375</td>
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<td>3560</td>
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<td>7720</td>
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<tr>
<td>Okidata All models</td>
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<tr>
<td>Smith-Corona TP-1</td>
<td>$650</td>
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<tr>
<td>Star Micronics Gemini-10</td>
<td>Call</td>
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<tr>
<td>Gemini-15</td>
<td>Call</td>
</tr>
<tr>
<td>Tally 1805/1802</td>
<td>$1455</td>
</tr>
<tr>
<td>MT 1601 w/Tractors</td>
<td>Call</td>
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<tr>
<td>MT 1801 w/Tractors</td>
<td>Call</td>
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<tr>
<td>MT 180</td>
<td>Call</td>
</tr>
<tr>
<td>Texas Instruments 810 Basic</td>
<td>$1260</td>
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<td>Toshiba P1350</td>
<td>$1475</td>
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**COMPUTERS**

<table>
<thead>
<tr>
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<tr>
<td>Atlas ACS 8000-15</td>
<td>$3550</td>
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<tr>
<td>Series 15D</td>
<td>$2125</td>
</tr>
<tr>
<td>Series 5-5D</td>
<td>$3900</td>
</tr>
<tr>
<td>Series 5-10</td>
<td>Call</td>
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<tr>
<td>NEC 8001</td>
<td>$730</td>
</tr>
<tr>
<td>8012</td>
<td>$470</td>
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<td>8031</td>
<td>$730</td>
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<tr>
<td>APC</td>
<td>Call</td>
</tr>
<tr>
<td>Northstar Advantage</td>
<td>$2800</td>
</tr>
<tr>
<td>Advantage w/5MB</td>
<td>$3600</td>
</tr>
<tr>
<td>Horizon II 84K QD</td>
<td>$2625</td>
</tr>
<tr>
<td>Sanyo MBC-1000 w/Microprobe Software, S-Basic, CMPS</td>
<td>Call</td>
</tr>
<tr>
<td>Above w/2 Drives</td>
<td>Call</td>
</tr>
<tr>
<td>Televideo Systems</td>
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<tr>
<td>TS-802</td>
<td>$2599</td>
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<td>TS-802H</td>
<td>$4450</td>
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<tr>
<td>Sony Z-120</td>
<td>$3100</td>
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<td>Z-110</td>
<td>$3025</td>
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**MONITORS**

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<td>Zenith 12&quot; Green Screen</td>
<td>$95</td>
</tr>
<tr>
<td>Amdek Video 300</td>
<td>$130</td>
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<tr>
<td>Video 300A</td>
<td>$145</td>
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<tr>
<td>Color I</td>
<td>$285</td>
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<td>Color II</td>
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<td>Color III</td>
<td>$360</td>
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<tr>
<td>BMC 12&quot; Green</td>
<td>$85</td>
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<tr>
<td>13&quot; Color</td>
<td>$265</td>
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<tr>
<td>Comrex 13&quot; Color Composite</td>
<td>$290</td>
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<tr>
<td>13&quot; RGB</td>
<td>$455</td>
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<tr>
<td>NEC JB 1201</td>
<td>$155</td>
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<tr>
<td>JB 1260</td>
<td>$115</td>
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<tr>
<td>Taxan 12&quot; Amber</td>
<td>$125</td>
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<tr>
<td>9&quot; Amber</td>
<td>$130</td>
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<tr>
<td>12&quot; Amber</td>
<td>$150</td>
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**MODEMS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hayes Smartmodem</td>
<td>$210</td>
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<tr>
<td>Novation CAT</td>
<td>$140</td>
</tr>
<tr>
<td>D-CAT</td>
<td>$155</td>
</tr>
<tr>
<td>J-CAT</td>
<td>Call</td>
</tr>
</tbody>
</table>

---

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**Order Line Hours:** Mon.-Fri. 10-5 MST Saturday 9-1 MST

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are made unless you give explicit commands to cause it. No automatic-hyphenation functions are provided. A crude kind of "undo" command can, under most conditions, cancel changes to a page made since it was called up. Some other specific features are delineated in the comparison in table 1 (see pages 186-194).

Volkswriter

Volkswriter, or VW as its devotees call it, was one of the first alternatives to the original Easywriter. VW runs under PC-DOS and is one of the few word-processing programs for the IBM PC that can be run (although not at top performance) on a fairly small hardware configuration, i.e., 64K bytes of user memory and one 5¼-inch floppy-disk drive. Lifetree Software provides two different sets of program files (see photo 5) for registered users of VW: one set, to be used in systems with 64K bytes, contains separate programs (linked in execution by batch files) for Volkswriter's editing and printing functions; the other set, to be used with 128K bytes or more, combines the two programs into one.

In keeping with its modest hardware demands, Volkswriter is moderately priced. With a suggested list price of $195, VW is the least expensive of the four tools considered in this article. The program is simple in design, and I found it quite straightforward to use for modest writing projects. It's a no-frills piece of software: it has just enough features to get most jobs done.

Lifetree Software doesn't come as close as Information Unlimited Software in imitating IBM's user's manuals, but some thought was given to the matter, because the loose-leaf binder and box are roughly the same size as IBM's, although covered with slick paper instead of linen.

To initiate first-time users to the concepts of word processing and its peculiarities, VW depends less on the user's manual than on a series of interactive lessons. You take the lessons by editing a set of files that comes on the Volkswriter distribution disk. I found the lessons to be well done except for a couple of problems, such as a search-and-replace lesson that became unintentionally modified by being searched and replaced. (These glitches can be considered minor if a knowledgeable user can be consulted by the person taking the lesson.)

In contrast to Easywriter II's page orientation, Volkswriter treats the display screen like a window onto a large, continuous buffer, or storage area, containing the entire text you are editing. Both the buffer and the Volkswriter program itself must fit simultaneously in user memory, so that the amount of text you can work on in a 64K-byte system is limited to around 15,000 characters. But this limitation makes possible great speed in moving the window around in the buffer. You never have to wait for the word-processing program to read more text from a floppy disk; it's always immediately accessible. In a 128K-byte system, you can work on a buffer size of as many as 60,000 characters. The status line at the bottom of the screen tells you what percentage of the buffer is available for entering text, although for some reason it starts out at 93 percent empty instead of 100 percent.

Like Easywriter II, Volkswriter uses the 10 assignable-function keys heavily to invoke various commands; the Alt key is used to double the commands available with the assignable-function keys. Also as in Easywriter II, you must use these keys; there is no alternative for the expert user. The keys of the numeric/cursor-control keypad on the right side of the keyboard are used also as they are marked. My feelings about having to use the assignable-function keys in Easywriter also apply to VW, but 1
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didn't find editing with VW as objectionable as Easywriter II, perhaps because the effects of VW's commands are not modified by a lot of object modes.

Lifetree does not give you a reference sticker to look at, but by pressing the F1 key, you cause a menu of the assigned command functions to appear at the top of the display screen (see photo 6). (Incidentally, use of F1 makes more sense than Easywriter II's use of F2.) The legends are somewhat cryptic to the new user, but once you have become familiar with Volkswriter the display makes sense. Also, the F10 key is used as a kind of panic button; you can press it to halt an operation you did not intend. The system is kind to inexperienced users in that it asks you to confirm your intentions when you give it a command that could wipe out a large part of the text.

The printed output that Volkswriter produces is formed on the page according to parameters specified by special format files (given "FMT" extensions). The parameters vary somewhat depending on what printer you are using, but they can include the character pitch to be used, the margins on the page, line spacing, justification, and starting page number. You can set up separate format files (see photo 7), automatically invoked, for each type of document that you produce, or you can use the default format. You can even change the formats during printing with a command embedded in the text.

In the document file, you can embed any number of header and footer lines, with justification specified to alternate between left and right pages. You can set temporary indentations for quoted paragraphs or other special material. You can embed almost any arbitrary character code in the text, perhaps to activate a special function.
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function supported by your printer or to use one of the
IBM PC's special display characters. Or you can generate
certain printing attributes (such as boldface, underlined,
or accented characters) by brute force, by explicitly caus­
ing two or more lines of text to be printed on top of each
other.

Volkswriter has been around long enough to have
already undergone some changes from its original design.

One change applauded by many users has been the dis­
continuation of the copy protection of the VW distribu­
tion disks; other changes are not as obvious: reassign­
mement of the F3 key, inclusion of conditional page breaks,
provision for sub- and superscripting, and support for
more printers. One change that has not been made is to
provide for placement of block markers to allow block­
move operations on pieces of text other than mere groups
of lines (such as a sentence partly on one line and partly
on another).

Volkswriter is a basic, functional tool for working with
words. If your major use of the IBM Personal Computer
is for some purpose other than word processing, Volksw­
writer would be a good, moderately priced software purc­
chase to extend the capabilities of your system.

But if your needs are like mine, you'll want to explore
more versatile (and, alas, more expensive) word-process­
ning programs like . . .

Wordstar

This product of Micropro International Corporation is
without doubt the best-known and probably the most
widely used personal computer word-processing pro­
gram. Wordstar was developed for use on 8080A- or
Z80-based CP/M-80 systems and was first sold in June
1979. It has become a point of reference for word­
processing capabilities; whenever a new word-processing
program comes on the market, people ask, "How does it
compare to Wordstar?"

Wordstar really is a very versatile tool, well suited for
many types of document composition and editing, but it
is not flawless, and the $495 list price may seem high to
many potential buyers. Dr. Larry Press reviewed it in
onComputing, along with three other programs (see ref­
erence 8). He rated it best of the four in certain kinds of
work.

The version of Wordstar that I tested was 3.2, which
seems to be a translation to the 8086/8088 processor and
PC-DOS from the CP/M-80 version. The programmers
at Micropro who adapted Wordstar to the IBM PC
evidently did a lackluster job. The documentation sup­
plied, contained in a large loose-leaf binder, was that
written for the CP/M-80 product, plus a 14-page adden­
dum on features unique to the IBM PC program that con­
tained some confusing typographical misinterpretations.
The Wordstar package also contains a self-standing
tutorial workbook.

One of Wordstar's hallmark characteristics is its multi­
ple-menu-oriented command structure. When you begin
execution of the program, a "no-file" menu appears on
the display screen (see photo 8). You select one of the ac­
tivities listed among the menu items by typing a single
alphabetic character. Included in the menu choices are
running the optional, extra-cost Spellstar spelling-check
program and the Mailmerge form-letter program. If you
type a "D" from this menu, you will be asked for a docu­
ment file name; after you respond, Wordstar will load
the file into its working text buffer and go into edit mode (see
photos 9 and 10 on page 204).
You can’t take advantage of many of the printing capabilities of the Epson MX-80 (or the similar MX-100) printer when you use Wordstar, as distributed by Micropro International for the IBM Personal Computer, unless you change the user-addressable printer-driver routine. This can be done easily using the PC-DOS DEBUG utility program.

Following the procedure given here, you can upgrade Version 3.2 of Wordstar so it can use more of the capabilities built into the Epson MX-80 equipped with Graftrax-Plus. These modifications will enable printing of double-width, italic, and compressed characters, along with superscripts and subscripts.

Here’s how to do it, as derived from information in Appendix C of the Wordstar reference manual and Appendix B of the Epson user’s manual:

1. Copy the Wordstar file WS.COM onto a disk that you can use for experimentation (in case something goes wrong). Also copy the PC-DOS file DEBUG.COM onto the disk. Don’t make these changes to your master copy of Wordstar.

2. Put the experimental disk into disk drive A of your IBM Personal Computer.

3. From the PC-DOS command prompt A>, enter the command:
   DEBUG WS.COM
   This begins the process of modifying the program.

4. Type the characters
   E 0784
   and press the Enter (Return) key. The computer’s display should now show
   -E 0784
   04B5:0784 00
   E 0789
   After the “00.” in the computer’s response, type “E8” and press Enter. The screen will look like this:
   -E 0785
   04B5:0785 00.8E

6. Now type
   E 0789
   After the computer prints the “00.”
   type “1”. The display will show
   -E 0789
   04B5:0789 00.1

7. And finish this stage by entering
   E 078A
   After the “00.”, put “94”. The display will show
   -E 078A
   04B5:078A 00.94

You have just given Wordstar the ability to tell your MX-80 to print double-width characters. After these instructions have been put into Wordstar, you can use the embedded command “PW” (Control-P, W) to start double-width output and “PE” to turn it off. (Double width will also be turned off automatically at the end of the line.)

But you’ve just started. The remainder of the changes to Wordstar are done in much the same way. Perform the following summarized steps:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>E0793</td>
<td>04B5:0793 00.2</td>
</tr>
<tr>
<td>E0794</td>
<td>04B5:0794 00.1B</td>
</tr>
<tr>
<td>E0795</td>
<td>04B5:0795 00.34</td>
</tr>
<tr>
<td>E0798</td>
<td>04B5:0798 00.2</td>
</tr>
<tr>
<td>E0799</td>
<td>04B5:0799 00.1B</td>
</tr>
<tr>
<td>E07A</td>
<td>04B5:077A 00.34</td>
</tr>
<tr>
<td>E07B</td>
<td>04B5:077B 00.9B</td>
</tr>
<tr>
<td>E07C</td>
<td>04B5:077C 00.53</td>
</tr>
<tr>
<td>E07D</td>
<td>04B5:077D 00.1</td>
</tr>
<tr>
<td>E07F</td>
<td>04B5:077F 00.2</td>
</tr>
<tr>
<td>E07G</td>
<td>04B5:0780 00.9B</td>
</tr>
<tr>
<td>E07H</td>
<td>04B5:0781 00.48</td>
</tr>
<tr>
<td>E07I</td>
<td>04B5:0781 00.48</td>
</tr>
</tbody>
</table>

Now this is important: you must, after entering all the preceding commands in DEBUG, do one more thing. Enter the following:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>W04B5:0100</td>
<td>Writing 5000 Bytes</td>
</tr>
</tbody>
</table>

It makes your changes to your experimental copy of Wordstar. Then exit DEBUG by typing “Q” and pressing Enter.

You’re now through and can try out Wordstar’s new capabilities. Use superscript commands in text in the following way: “5” “T2” “T” “Q” will print “5 sapiens”. Use subscripts this way: “E” “V3-x” “V” “Q” will print “E_n”.

Have fun.
Once in the edit mode, a new, main menu appears on the screen. Because typing ordinary characters inserts them into the text buffer, you access items on this menu by typing control characters—requiring two keystrokes, one to hold down the Control (Ctrl) key and the other to hit the letter key. Four of the command items in the main menu activate other menus containing less frequently used commands, so some functions (for instance, “move cursor to beginning of buffer”) require striking three separate keys (including the Control key). The four submenus are called Quick, Print, Block, and On-Screen. If you have memorized which commands go with which combinations of keys, you can type the keys fast enough so that the secondary menus never have time to appear on the screen, or you can give a command to prevent the menus from appearing on the screen at all. The cursor-movement control keys are grouped in an efficient arrangement around the left hand’s home position; you can take the cursor anywhere without lifting your arm. (If you want to lift your arm, you can use the IBM’s special cursor keys on the right.)

This structure makes a lot of sense to me and suits my working style (although my left little finger does get tired from pressing the Control key). But a lot of people complain that all those menus are confusing. If menus and control characters bother you, you’d better stay clear of Wordstar.

Part of the adaptation from CP/M-80 to the IBM PC was the assignment of many of the multikeystroke commands to the special-purpose or assignable-function keys on the IBM PC’s keyboard. The cursor-pad keys were sensibly assigned, but I don’t understand some of the assignments of F1 through F10. Keys are dedicated to functions like “set help level” and “set left margin” when functions that you need all the time, like “reform paragraph,” are left out in the cold (or out in the menu). And there is no way I know of to change these assignments. Micropro doesn’t even give you a function-key sticker.

The other famous characteristic of Wordstar is its screen-oriented print formatting. The popular description of this feature is “what you see is what you get,” but in most cases this is not strictly true. The IBM PC’s display adapters are not capable of replicating many of the variations of printing styles that a lot of today’s printers are capable of producing, including 132-column output, microspace justification, expanded character sizes, italic fonts, and sub- and superscripts. So what you see is sometimes only a hint of what you get, and these hints often show up in the displays as embedded extraneous characters. (Wordstar does have a command to make these temporarily disappear.)

Screen-oriented print formatting is nice if you are doing short business letters, reproducible newsletters, and other documents that you will always want to print in exactly the same format you entered the text. However, if you have an article manuscript, as I often do, that you want to print in both single- and double-spaced versions, Wordstar’s style of print formatting is a bother; you have to print one version and then go back into edit mode to
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 reform all the paragraphs, then print the second version. And even if you want only a double-spaced version to be printed, you might want to type in the text in singlespaced mode so that you can see more of it on the screen at once.

 Another defect in Wordstar that shows up in similar circumstances is that you cannot use the search function to locate embedded printing-attribute characters. If you want to change all your underscored text to boldface, you have to search for it the hard way-by eye.

 Wordstar encourages printing with even right and left margins (producing fully justified output) even on printers that cannot perform proportional spacing according to the width of characters (such printers are properly called "fixed-escapepaper," although Micropro calls them "Teletype-like"). As a result, a lot of Wordstar users routinely produce printed output that has been justified only by insertion of multiple full spaces between words. Such printouts look impressive at first glance, but they are actually harder to read than text that is printed flush-left, with a ragged right margin. Full justification should be set as a default condition only when the program has been customized to use a printer that can print in microspace increments. (This could form part of Wordstar's installation process.)

 For all its versatility, Wordstar does not have some functions that would be useful. As distributed, it does not support the special printing attributes of the popular Epson MX-80 printer. (The MX-80's alter ego, the IBM Parallel Printer, can do the fancy printing only if the Graftrax-Plus option has been installed. There do exist ways to use the Epson attributes; see page 203.) Most of Wordstar's built-in printer options are for expensive formed-character (usually daisywheel) printers.

 The default settings of most parameters cannot be changed by users. The program cannot use all the memory space available to the 8086 microprocessor-it must swap portions of the text of a long file to and from the disk. And to do any combining of files and interactive defining of the output text during printing, you must have the Mailmerge program at an additional cost.

 The Final Word

 This program is a product of Mark of the Unicorn, a software house that established its reputation with a product called MINCE, which gave to microcomputer systems an editor with most of the capabilities of the bigcomputer editor EMACS. (The name is a recursive acronym: MINCE Is Not Complete EMACS.) One of my discoveries in this project has been TPWMN: The Final Word is Not MINCE. The two programs share a common heritage, many similar features, and even some code (in the C language), but there are differences in the organization of editing commands and in output facilities. (MINCE for CP/M-80 systems was reviewed in BYTE by Christopher Kern; see reference 4.)

 The Final Word is an extremely flexible word-processing system. You can use it to effortlessly produce types of output that would possibly require great effort using any
MAGICALC is a completely new second generation spreadsheet program for Apple II. This state-of-the-art system includes 70-column upper and lower case video, full 80-column board display, hard disk compatibility, individual column widths, invisible columns for confidential data, and full compatibility with VisiCalc that lets you utilize existing VisiCalc models. Refer to the box below for a comparison of MAGICALC and VISICALC.

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<table>
<thead>
<tr>
<th>Feature</th>
<th>MAGICALC</th>
<th>VISICALC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preboot required</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>70 column upper and lower case video display</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Full 80 column board display</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Individual column widths</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Invisible columns for confidential data</td>
<td>YES</td>
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</tr>
<tr>
<td>Hard disk compatibility</td>
<td>YES</td>
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<tr>
<td>Full compatibility with VisiCalc</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Program plus 128K RAM</td>
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</tbody>
</table>

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The Final Word has several unusual features including the following: You can view and edit two separate active documents (see photo 11), each in its own buffer and half-screen window, and you can transfer sections of text between the buffers. You can restore ("undelete") small segments or even large chunks of text that you have inadvertently or purposefully deleted. You can create files containing disk directories. And you can terminate execution of the program, do some other task with the computer, and then reactivate The Final Word to find your text buffers and even editing modes in place just as they were when you quit. This last capability is provided through information stored in the buffer-swap disk file, which also provides automatic protection against system crashes and interruptions. (Mark of the Unicorn calls this feature State Save.)

During editing, one special disk file, called FW.SWP, holds the swapped-out text from the currently used set of buffers. After you have stopped typing for seven seconds (or a duration you set), The Final Word automatically saves the segments of text you have changed and stores them on disk. This storage allows you to return to where you were after a power outage or other interruption with little trouble. You can set the size of this file according to your needs.

Some of the characteristics of The Final Word will seem strange to people who have been accustomed to some other editing system. For instance, block moves of text are accomplished by deleting the block, moving the cursor to where you want it to go, and then "undeleting"
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<table>
<thead>
<tr>
<th>Feature</th>
<th>Esprit III</th>
<th>TVI 925*</th>
<th>TVI 950*</th>
</tr>
</thead>
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<tr>
<td>Buffered mode</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Programmable function keys</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
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<td>Line graphics</td>
<td>Yes</td>
<td>No</td>
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<td>Page/line transmit</td>
<td>Yes</td>
<td>Yes</td>
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</tr>
<tr>
<td>Smooth scrolling</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Price</td>
<td>$895</td>
<td>$995</td>
<td>$1,195</td>
</tr>
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</table>

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the block. Anyone who has ever lost several hours' work on a computer system because of a careless erasure command will become quite nervous performing The Final Word’s block-move procedure. (And you do have to be careful, because you can't do any further deletions to the block at its intended destination without destroying it.)

In any attempt to rate word-processing programs by counting the number of commands, The Final Word would win hands down, at least in the group of programs reviewed here; there are nearly 160 different commands. It sounds like you could sink into a morass of control possibilities, but the program uses a logical series of menus to organize them. The structure of menu use seems somewhat akin to Wordstar’s system, except that The Final Word goes one step further: three levels of menus for most commands, instead of two.

The most frequently used commands are assigned to single control characters (which you type with two key-strokes, of course). The two commands I used the most were the ones that change the direction of operation, either forward or backward. Most of the operations available in The Final Word proceed relentlessly in the selected direction. A set of commands select the operation that is to be performed, such as search for a string, delete an object forward, and delete ("kill") an object backward. Other commands select the text objects on which other commands operate. The objects are characters, words, sentences, lines, paragraphs, edges of lines, viewscreen sets, and buffers. (Does this remind you of Easywriter II? It’s superficially similar, but the syntax is much more usable.) And some single control-character commands activate miscellaneous functions, such as "do the last operation again," "change the capitalization style of the word after the cursor," and "transpose the last two characters typed." This last command I found handy in correcting a common typographical error.

You type Control-X to cause a menu of menus to be displayed on the top section of the screen (see photo 13). You then type a character to select one of the submenus; when the submenu shows up, you type another character to activate the desired function. For instance, you can type Control-X to obtain the list of menus, then type "M" to select the Miscellaneous menu, and then type "Q" to select the Query Replace operation. As in Wordstar, if you type the commands fast enough, the menus don’t show up on the screen. (The list of menus includes Buffers, Capitalization, Files, Help, Layout, Miscellaneous, Regions, Set, and Windows.)

If you don’t like using the menus, you can use the function keys instead. And The Final Word has these in abundance, too. The directional cursor keys on the right work as you would expect (actually providing a mode of cursor movement not available through the Control-character functions). The Ins (insert) key works according to The Final Word’s current mode.

Over on the left side of the keyboard, the assignable-function keys are used, consistent with the rest of The Final Word, in an exhaustive manner. First, ten functions are assigned to the unaided keys F1 through F10. Ten more functions can be invoked by holding down a Shift key while pressing F1 through F10. Ten more are available through combinations with the Control key, and ten more by using the Alt key. These 40 functions have been reasonably assigned by Mark of the Unicorn, but if you don’t like the assignments you can change them yourself. If you like to use function keys, this surely gives you as many as are practical on the IBM PC.

But this is not for me. I can remember mnemonically assigned control-character functions, even through three levels of menus, much better than I can remember arbitrary associations of numbered keys. ("Hmm... let me see; Alt-F2 is ‘turn fill mode on or off,’ but Shift-F2 is ‘place cursor at marker,’ or was it the other way around?”) You do get a reference chart describing the uses of all 40 functions, but I think very few people will bother to learn more than the unaugmented set of 10.

The documentation for The Final Word is more than 400 pages in a large loose-leaf binder. Most of these pages are a reference and installation guide, but the first 10 chapters are a comfortably paced set of lessons for inexperienced users. Some of the lessons use tutorial text files, provided on one of the distribution disks, to enable you to practice using a basic subset of the editing and formatting commands. And if you forget a command during an editing session, you can obtain an explanation of the use of most commands from an online help file.

In formatting output, you can use The Final Word the same way you use the other three programs we've discussed: make the text look the way you want on the video-display screen and transfer the document to the printer in that format. But there is another choice.

The Final Word has a powerful advanced-formatting facility that can be invoked through an advanced-print command. You can embed any number of special formatting commands in the text to obtain perfect formal output arranged spatially and typographically into chapter titles, enumerated indented lists, subheads, tables of contents, indexes, and even cross-references. The formatter can rejustify text according to specifications given at print time, automatically number items, produce headers and footers with section and page numbers, and print numbered footnotes. Character attributes may be switched easily, and proportional spacing can be obtained via microspace justification on printers capable of it. (A large number of printers are supported by the output routine.) The formatter can even invoke the inclusion of sections of text not in the active document, but stored in a disk file, and you can type in text from the keyboard during printing for inclusion in the output. Page breaks are not normally shown on the video-display screen, but you can request a “view” output from the formatter.

There are two prices to be paid for all this wonderful capability (besides the cost of the program). The first price is learning the complications arising from inserting format commands into the text. It will probably take you many hours and much experimentation to become proficient in using the embedded commands. Fortunately, the
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commands are plainly recognizable in function: some typical commands are:

@Address[text]
@Majorheading[text]
@Style[Topmargin 6 lines]

There is even a @Verse format for those who are inclined to write poetry. Nonetheless, learning to write proper formatting commands is like learning to write programs for a FORTRAN compiler—error messages can suddenly come after the formatter has been running for three minutes, and you have to edit the file and start over.

The second price is the time required for the software to recognize and interpret all those embedded commands and the time needed by the formatter routine to process them. The time taken for The Final Word to do its housekeeping and begin printing a large document after you give the command can increase greatly when the formatter routine is called as part of the process. For instance, a 28,167-character file (last month's Ciarcia's Circuit Cellar) required 1 minute, 35 seconds for printing to begin without formatting; the duration jumped to 4 minutes with advanced formatting. If you want to format a lot of long documents, you'll find yourself taking a lot of enforced coffee breaks. But once the file has been formatted, you can start editing again as it prints. If most of your writing work involves producing documents with complicated structures, I think you'll gladly wait while the computer sorts it all out for you.

In addition to taking up time, the operation of the formatting routine also consumes a great deal of disk space. Unless you severely restrict your use of The Final Word, you'll need at least the disk space provided by two double-sided 5¼-inch floppy-disk drives.

Mark of the Unicorn, in contrast to Micropro International, allows you to customize your copy of The Final Word in a simple, menu-driven fashion. You can set up your preferred default conditions for editing and formatting parameters (such as indentation, tabs, preferred justification style, and page margins). You can define your own keyboard usage, binding functions to keys as you please. If you need help, you can call or write Mark of the Unicorn.

Conclusions
The four programs I've discussed here are a representative sample of the word-processing programs available for the IBM Personal Computer.

Two of them are important because of their wide commercial success: the February 1983 issue of Softalk for the IBM Personal Computer (reference 9) ranked Wordstar as the best-selling IBM PC program during December 1982, with Easywriter II ranked eighth in the same survey. (Wordstar is also important because of its many good features. I can't speak so highly of Easywriter II.)

The other two programs are significant because of the value they offer in functionality: Volkswriter provides simple, easily understood word-processing capability at a
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Photo 13: When you type Control-X, a top-level menu of menus appears at the top of the screen. You then type a character (control or regular) to select one of the menu choices, such as the menu of Capitalization commands shown here. You then hit one more key to invoke the desired operation.

This display, produced on an Amdek Color-II RGB (red-green-blue) video monitor, shows that portions of text designated to be highlighted on the screen show up in blue. Such highlighted text is underlined when the Monochrome Display Adapter is used.

relatively low price, while The Final Word, selling at a higher price, offers an amazing amount of flexibility for writing complex documents.

If I had to choose one of the four, I would probably buy The Final Word, because of its great flexibility, and yet there are things I don't like about the Mark of the Unicorn product. So I am still looking for the word-processing program of my dreams. In fact, I wrote most of this article using a fifth program I received too late to include in the project. So perhaps I'll be writing another review soon. In the meantime, consider your needs when you are choosing a word-processing program, and try before you buy.

References

**BASIC vs. JRT PASCAL:**

**A NO-HOLDS-BARRED COMPARISON.**

---

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By dividing programs into modules, JRT Pascal makes even very complex programs—of nearly any size—a breeze to manage. Pascal code is self-documenting; program sections are identified by meaningful names, not line numbers.

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For power—the ability to write better, cleaner programs, faster—Pascal is the run-away winner. Example: JRT simplifies programming by accomplishing complicated operations (for Basic) with one command:

- **Basic**
  - JRT Pascal

  ```
  IF AS = "V" OR IF A IN ('V', 'Z') THEN...
  AS = "W" OR
  AS = "X" OR
  AS = "Y" OR
  AS = "Z" THEN...
  ```

**FLEXIBILITY**

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**Fast one-step**

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**Efficient**

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**Maximum program size:** more than 200,000 lines

---

More than 200 verbal error messages

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A Comparison of Five Database Management Programs

Actual field use uncovers surprising results.

Jack L. Abbott
8525 North 10th Ave.
Peoria, AZ 85345

Database management systems, or DBMSs, are general-purpose programs that accept data in a format that you determine, process the data according to your requirements, and then output the data in the report format that you specify. While a review of such a program may tell you about its major features, only by comparing several DBMSs can you determine which program best fits your needs.

A good DBMS should fill the gap between a custom-designed application program and an off-the-shelf general-purpose package. I designed a comparison test of five DBMSs around that specification. I looked at the Selector V by Micro-Ap Inc., dBASE II by Ashton-Tate, FMS-80 by Systems Plus, Condor III by Condor Computer Corporation, and Analyst and Qsort by Structured Systems Group. By using an actual inventory file maintained by two jewelry stores as test data, I uncovered some significant differences in these programs.

Essentially, DBMSs perform four functions: data input, selection and sorting, processing, and report output. The comparison test included all these functions. In table 1, you see a typical example of the data-input format used to maintain the inventory for the two jewelry stores. The two stores have a total of 1007 different types of jewelry pieces with varying quantities of each type. The data-input format consists of 15 descriptive items or fields about each different piece of jewelry. The complete description of one piece of jewelry requires a total of 128 characters (bytes) and is called a record. The 1007 records make up the inventory file. This file occupies between 135K and 155K bytes of disk storage depending on the storage method used by the particular DBMS.

After establishing the input format, I displayed this information on the screen. The display is similar to that of table 1, except that blank spaces are provided after each field name so the inventory data can be typed in for each record. After entering the jewelry stores’ inventory data, I translated the jewelry-store file to the individual formats of the five DBMSs. I used the file as a benchmark to compare these programs.

Data-input functions include defining the structure of the records as shown in table 1. Custom input screens may also be generated by some of the DBMS programs. Instead of the columnar input format, a custom screen permits placement of identifying labels and adjacent blank spaces where you can type in the field information. An example is a screen display of a purchase-order form. You enter the order data into the blank spaces of that form for each field in the record. The DBMS then saves the data for subsequent processing.

The second function is selection and sorting. Let’s assume that, after all the jewelry store inventory data has been entered, you want to find all individual records that pertain to rings. The most effective way is to first either sort or index records on one or more selected fields. Sorting a file aligns all the records in ascending or descending order based on the alphabetical or numeric values in one field. Indexing a file accomplishes almost the same result but requires much less disk storage space because only a single selected field of a record (with an index pointer to the full record) is sorted.

In my example, the CATEG (category) field of each jewelry-file record tells whether the record pertains to chains, rings, watches, brooches, etc. To find all the ring records, you ask the DBMS to sort or index the file, placing each record in alphabetical ascending order based on
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| RS 232 Cable ................................ $ 30
| 8748 family socket adaptor, ..... $ 98
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| XASM65 ................................ 6502
| XASM68 ................................ 6800/01
| XASM68F .................................. $3870
| XASM02 ................................ 2B
| XASM4000 ........ COP4000
| XASM75 ................................ NEC 7500
| (Coming soon: XASM68K ... 68000)

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| XASM09 ................................ 6809
| XASM18 ................................ 1802
| XASM48 ................................ 8048/8041
| XASM51 ................................ 8051
| XASM65 ................................ 6502
| XASM68 ................................ 6800/01
| XASM68F .................................. $3870
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STRUCTURE FOR FILE: JEWELRY.DBF
NUMBER OF RECORDS: 00000
DATE OF LAST UPDATE: 00/00/00
PRIMARY USE DATABASE

<table>
<thead>
<tr>
<th>FLD</th>
<th>NAME</th>
<th>TYPE</th>
<th>WIDTH</th>
<th>DEC</th>
<th>Explanatory note:</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>STOCKNB</td>
<td>C</td>
<td>010</td>
<td></td>
<td>STOCKNUMBER</td>
</tr>
<tr>
<td>002</td>
<td>CATEG</td>
<td>C</td>
<td>008</td>
<td></td>
<td>CATEGORY (RINGS, BROOCHES, ETC.)</td>
</tr>
<tr>
<td>003</td>
<td>STYLE</td>
<td>C</td>
<td>010</td>
<td></td>
<td>STYLE (LADIES, MENS, GOLD, ETC.)</td>
</tr>
<tr>
<td>004</td>
<td>QTY</td>
<td>N</td>
<td>004</td>
<td></td>
<td>QUANTITY</td>
</tr>
<tr>
<td>005</td>
<td>COSTGM</td>
<td>N</td>
<td>010</td>
<td>002</td>
<td>COST PER GRAM</td>
</tr>
<tr>
<td>006</td>
<td>COSTCT</td>
<td>N</td>
<td>010</td>
<td>002</td>
<td>COST PER CARAT</td>
</tr>
<tr>
<td>007</td>
<td>TOGWT</td>
<td>N</td>
<td>010</td>
<td>002</td>
<td>TOTAL GRAM WEIGHT</td>
</tr>
<tr>
<td>008</td>
<td>TOTCW</td>
<td>N</td>
<td>010</td>
<td>002</td>
<td>TOTAL CARAT WEIGHT</td>
</tr>
<tr>
<td>009</td>
<td>STNWTEA</td>
<td>N</td>
<td>008</td>
<td>002</td>
<td>STONE WEIGHT EACH</td>
</tr>
<tr>
<td>010</td>
<td>STNWTTOT</td>
<td>N</td>
<td>008</td>
<td>002</td>
<td>STONE WEIGHT TOTAL</td>
</tr>
<tr>
<td>011</td>
<td>COSTEA</td>
<td>N</td>
<td>008</td>
<td>002</td>
<td>COST EACH</td>
</tr>
<tr>
<td>012</td>
<td>TOTCST</td>
<td>N</td>
<td>010</td>
<td>002</td>
<td>TOTAL COST</td>
</tr>
<tr>
<td>013</td>
<td>STORE</td>
<td>N</td>
<td>001</td>
<td></td>
<td>STORE</td>
</tr>
<tr>
<td>014</td>
<td>VENDOR</td>
<td>C</td>
<td>007</td>
<td></td>
<td>VENDOR</td>
</tr>
<tr>
<td>015</td>
<td>ENTDATE</td>
<td>C</td>
<td>008</td>
<td></td>
<td>ENTRY DATE</td>
</tr>
</tbody>
</table>

**TOTAL** **00128**

Table 1: Example of data-input format used for the jewelry-store inventory. FLD is the field number, NAME is field description, TYPE describes whether the entry is alphabetical or numeric, WIDTH is the number of characters in the field, and DEC is the number of decimal places used in the field.

A comparison of the alphabetical values in the CATEG field.

After the data file has been sorted or indexed at your typed-in request, the DBMS will rapidly run through the file or the index and select all the records in the rings category. At your option the selected records are then either displayed, printed, or placed in a separate file for further processing.

For the third function, processing, you tell the DBMS to perform specific operations on the selected records. Using the ring example, let's say you want to record a 20 percent price increase for all rings. First, you ask the DBMS to divide the COSTEA (cost each) field of every ring record by .80 to reflect the 20 percent price increase. You then multiply the QTY (quantity) value by the COSTEA value and store the result in the TOTCST (total cost) field. You can perform similar mathematical operations on any fields in the record.

The fourth function, output, may be a simple listing of the selected data or a more elaborate presentation, including statistical summaries, subtotals, and totals on a formatted page report. The more sophisticated DBMSs include report output generators that make it possible for you to print your data output as mailing lists, checks, purchase orders, invoices, or in any desired format.

DBMS designers use two general methods for function selection. One method displays a list of general functions as soon as the DBMS starts to run on the computer. From this list, or menu, you select a submenu that expands your selected function into a detailed list of tasks. The second method presents you with a blank screen after the DBMS is loaded. You must initiate the DBMS directly, using its commands individually, or through a command file. A command file is simply a series of DBMS commands written in sequence. You use a single initiating command to execute that entire sequence of commands. The sequence may include commands to accomplish specific tasks or to display Help information and menu selections.

Ideally a DBMS should handle any application. In actuality design trade-offs occur, making some DBMSs more effective than others for a given application. The jewelry-store inventory, for example, has only one relatively short data file, but it must be accessed and updated as quickly as possible. An important characteristic of a DBMS for a jewelry-store inventory would be speed. In another application (for example, when processing personnel records), the DBMS must readily access several different files (such as payroll, hiring, and job performance information). Information may be required about one person from many files, a number of people from one file, or a number of different people from a number of different files. The DBMS must provide data from all these files with reasonable speeds, but definitely not the rapid access required by the inventory application. Additionally, the DBMS that processes personnel records must handle longer record lengths and a larger number of files than a DBMS that handles inventory data. Hierarchical or network DBMSs are better for simultaneous, multiple-file access while relational DBMSs are most efficient when extracting data from one file at a time.

Data Storage Requirements

For each of the five DBMSs discussed here, you should have available two disk drives with (depending on your application) a minimum capacity of at least 300K bytes per drive. (Table 2 presents the system requirements for each of the DBMSs plus the maximum number of records, file size, and record length that each DBMS will handle.) As I mentioned earlier, the example jewelry-
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store database file of 1007 records occupies from 135K bytes to 155K bytes of storage on a disk depending on the disk storage format. Each time you sort the file on a different field, an additional equal amount of storage is required. Indexing a file is similar to sorting but requires much less disk storage space. In the jewelry-store example, a median disk storage requirement for an index file on the CATEG field is 35K bytes. This figure will vary depending on the number of characters in the indexed field.

While not absolutely necessary, it is desirable to have the DBMS and required CP/M utilities on one drive and the data file on another. Compare my example file with your own intended application. Consider that if I keep all the jewelry file data on one drive, the example file will occupy 135K bytes, and with one additional sort the files will occupy a total of 270K bytes on a typical 320K-byte system drive.

Analyst and Qsort are written in CBASIC2, but a runtime interpreter is furnished and need not be purchased separately. FMS-80, dBASE II, and Condor are written in assembly language. Selector V is written in compiled CBASIC2. Assembly-language coding is the fastest and most efficient, followed by compiled CBASIC, with interpreted CBASIC the slowest. The compiled CBASIC program Selector V performs some functions more rapidly than assembly-language-coded programs. However, assembly-language-coded programs require less memory and disk storage space.

Timing Comparison

Table 3 shows how the five DBMSs fared in timing tests that were run on a Dynabyte 8/1 8/4 Z80 microcomputer running at 4 megahertz with 64K bytes of RAM (random-access read/write memory), two 8-inch drives, and a Televideo 925 terminal. Benchmark tests on this machine place it as average or a little better in comparison to the processing times of most popular microcomputers. Significantly better times will be obtained if you have a hard-disk drive or use a RAM drive. (A RAM drive is a program and additional RAM that look to the computer like a very fast simulated disk drive and speed up processing greatly.)

Now let's consider some of the factors influencing the test results for each of the five DBMSs:

**Analyst and Qsort** ($350 from Structured Systems Group, 5204 Claremont, Oakland, CA 94618; (415) 547-1567): The longer times required for this DBMS to load individual menus are a result of its being written in interpreted CBASIC2. Once the menus are reached, processing times are very fast. This program does not have file indexing. A sequenced file is obtained by sorting. The disadvantage is that a sorted file takes up as much disk storage space as the original file. Its file-sort time is the best of the five DBMSs. Times to locate a record after the sort is finished are comparable to indexed files.

**Condor III** ($995 from Condor Computer Corp., P.O. Box 8318, Ann Arbor, MI 48107; (313) 769-3988): Because this DBMS is written in assembly language, the time required to bring up the program or to switch from one function to another is 2 or 3 seconds. There is no menu, but you can easily construct one using a command file and the supplied screen-display generator. Condor will sort a 128K-byte file in 3 minutes and 30 seconds. By chance, the jewelry file is 128K bytes. To sort a file over 128K bytes in length, you must split the file into sections and then sort each section. The individual sections must then be recombed. This is a time-consuming and somewhat complex procedure and is a serious deficiency if you plan to generate large files. (The latest version of Condor is now able to sort files larger than 128K bytes.)

**dBASE II** ($700 from Ashton-Tate, 10150 West Jefferson Blvd., Culver City, CA 90230; (213) 204-5570): Like Condor, this DBMS does not have menus for the individual processing tasks. The program will load and be ready for operation in 2 or 3 seconds. You must remember the commands to implement the program's functions. As an alternative, it is a simple matter to use the supplied screen display generator to construct a command file help menu. You can request the help menu to be displayed at the outset. Command file menus can also be generated to select groups of sequenced commands.

The most significant deviation from the other four DBMS processing times is listed in comment 5 of table 3. It took 1 hour and 21 minutes to delete 50 records from the database and re-index the file on one field. This is not as serious as it might first appear because records are first marked for deletion but are not permanently erased until
a pack operation is accomplished. Marking the record for deletion takes little time. It is simply a matter of finding the record in the file and then marking it. Records can generally be located within a few seconds. After the record is marked it will be ignored by the program for most processing or selection tasks. To complete the process and regain the disk storage space used by the deleted records you must then execute a pack command. Next the file must be written to the disk to condense the CP/M disk file. The records can be marked for deletion during normal operations and then at night or during a slack period the pack operation and file rewrite can be performed.

FMS-80 ($990 from Systems Plus, 3975 East Bayshore, Palo Alto, CA 94003; (415) 969-7047): This DBMS has menus for each function. It is written in machine language and the times to bring up the various menus are short. It took 15 minutes to merge and re-index the file after entering 50 new records. This is longer than the time taken by the other DBMS programs to perform this function. In addition, each time you first ask FMS-80 to find a record by searching the index file, it responds, "please be patient, re-establishing index file." This took another 25 seconds with the jewelry file. Subsequent searches take only 2 or 3 seconds to find a record. A very good feature not reflected in the timing charts is the capability to modify (but not delete) records directly from the index file. This can be accomplished in seconds. This may explain why the file must be re-established each time it is used.

Selector V ($495 from Micro-Ap Inc., 7033 Village Parkway, Suite 206, Dublin, CA 94568; (415) 828-6697): The times for Selector V, a compiled CBASIC2 program, to bring up its menus are much shorter than those required for Analyst and Qsort, an interpreted CBASIC2 program, and are comparable to those of FMS-80, a machine-language program. The times to go to the different functions of Selector V are very good indeed.

Distinguishing Features
Of course, there’s more to a database management system than storage requirements and execution times. Now I’ll discuss the individual systems in terms of those features that set each DBMS apart from the rest.

<table>
<thead>
<tr>
<th>Maximum Fields Per Record</th>
<th>Maximum Field Length</th>
<th>Digits of Screen Accuracy Editing</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>255</td>
<td>14</td>
</tr>
<tr>
<td>127</td>
<td>127</td>
<td>10</td>
</tr>
<tr>
<td>99</td>
<td>255</td>
<td>10</td>
</tr>
</tbody>
</table>

Analyst and Qsort: Program functions are selected from menus. Times to load program modules to accomplish different functions are slower than for the other DBMSs. This may not be a handicap if a number of records are processed at a time. After a function menu has been displayed and the program module loaded, processing execution times are excellent. File indexing is not available. The same results are obtained by sorting the file. Logical selection times for individual records or groups of records are as short as for indexed files. Qsort can be used as a stand-alone program to sort data generated by other programs. Report outputs are limited to six lines for each record unless the program structure is modified. This permits mailing-label generation but limits the output formats available to forms less than six lines in length. Analyst always puts in a form-feed prior to starting a report.

Command-file generation procedures are not available. Report output procedures are complex to establish, but the descriptive documentation is excellent. To use any of the CP/M operating-system commands, you must exit the Analyst program. This is the lowest-priced of the DBMSs reviewed and should be considered if it can accomplish your application.

Condor III: This DBMS has an excellent screen and report generator. Although Condor, dBASE II, and FMS-80 all include a programming language for generating command files, the Condor programming language is the easiest of the three to learn. Indexing can be automatically accomplished on one field after new records are entered. Condor is especially well suited for accounting applications because a number of commands are tailored specifically for that use. Every time that you bring up Condor, you must enter a six-digit serial number, otherwise the program will not perform properly. I don’t like this feature because it takes time and is nonproductive. A major drawback of this DBMS is the limitation of not being able to sort files over 128K bytes in length without dividing and then recombining them. This is particularly annoying because it is necessary to sort a file to permanently remove deleted records. An outstanding interface is maintained with CP/M, and any required operating-system commands, including calling up disk directories, are available without leaving the DBMS. Command files can be generated that enable the program to perform sequenced commands or display a user-designed menu with only one command entry. In the processing area, Condor DBMS has no mathematical precedence established and does mathematical operations in the same order they are entered. Fractional results will always be rounded off to two decimal places. The Condor documentation is good, but it would be helpful if examples of more applications were included.

dBASE II: One of dBASE II's strongest points is its ability to access a data file rapidly and to find and display or print out single or groups of logically selected records with a minimum of operator direction. Simple application programs can be easily generated by the newcomer to computing. For more complex applications, the
The documentation is reasonably well done. If you are a new user I recommend you obtain Robert A. Byers's *Everyman's Data Base Primer Including dBASE II* (available for $16.95 from Ashton-Tate, 10150 West Jefferson Blvd., Culver City, CA 90230). It lists several programs, including a mailing-label program. Simple step-by-step instructions on how to design and use the programs are included.

FMS-80: Like Condor and dBASE II, this DBMS is written in assembly code, but unlike the others, it has menu selections for the different functions. Command files can also be generated. The CP/M interface to run CP/M commands is limited when compared with Condor or dBASE II. A formatted report capability is available but it is complex to set up. Initial setup of the applications programs developed with FMS-80 should be done by someone with a programming background. Adding new records to a file is time consuming in comparison with the other DBMSs. The documentation should be expanded to better explain a number of program functions, including report generation.

Selector V: This DBMS and Analyst each come close to the classic definition of a network or hierarchical DBMS, as opposed to the other three, which may be loosely defined as relational. Data can be extracted from multiple files more easily with a hierarchical than with a relational DBMS. Accessing multiple files with a relational data-

---

**Table 3: Comparison of times required for the Dynabyte 8/1 8/4 microcomputer to perform the tasks listed in the left column. Don't place too much emphasis on speed. It is only one of the criteria involved in choosing a database management system for your needs.**

<table>
<thead>
<tr>
<th>Program Operation or Function</th>
<th>Analyst and Qsort</th>
<th>Condor III</th>
<th>dBASE II</th>
<th>FMS-80</th>
<th>Selector V</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Time from when initiating command is typed in until database main menu is displayed or until the database is ready to accept commands if there is no menu.</td>
<td>35 sec.</td>
<td>3 sec.</td>
<td>3 sec.</td>
<td>28 sec.</td>
<td>18 sec.</td>
</tr>
<tr>
<td>2. Time to go from main menu, or time until database program is ready to accept commands to examine, edit, or enter data.</td>
<td>30 sec.</td>
<td>3 sec.</td>
<td>3 sec.</td>
<td>5 sec.</td>
<td>5 sec.</td>
</tr>
<tr>
<td>3. Length of time to return to the main menu from data examine, edit, or enter-data function.</td>
<td>15 sec.</td>
<td>3 sec.</td>
<td>5 min.</td>
<td>5 sec.</td>
<td>5 sec.</td>
</tr>
<tr>
<td>4. Time required to accept, merge, and sort or (where applicable) re-index on one field 50 records into the 1007-record test inventory file. Does not include time required to type in the record data.</td>
<td>2 min. &amp; 50 sec.</td>
<td>3 min. &amp; 45 sec.</td>
<td>3 min. &amp; 25 sec.</td>
<td>15 min.</td>
<td>1 min.</td>
</tr>
<tr>
<td>5. Time required to delete 50 records from the 1007-record test file. This includes cleaning up and compacting the file after the records have been marked for deletion but does not include the time required to mark or select the records for deletion.</td>
<td>20 min.</td>
<td>7 min. &amp; 30 sec.</td>
<td>1 hour &amp; 21 min.</td>
<td>40 sec.</td>
<td>20 sec.</td>
</tr>
<tr>
<td>6. Time required to sort the 1007-record inventory example file on one field. All the records are aligned in alphabetical order based on the information contained in one field.</td>
<td>2 min. &amp; 46 sec.</td>
<td>3 min. &amp; 30 sec.</td>
<td>14 min. &amp; 30 sec.</td>
<td>12 min.</td>
<td>3 min.</td>
</tr>
<tr>
<td>7. Time required to index the 1007-record file on one field.</td>
<td>not applicable</td>
<td>3 sec.</td>
<td>3 min. &amp; 30 sec.</td>
<td>4 min.</td>
<td>4 min.</td>
</tr>
<tr>
<td>8. Time to find a single record by key search with the record located at the other end of the 1007-record file from where the search is started.</td>
<td>3 sec.</td>
<td>3 sec.</td>
<td>3 sec.</td>
<td>3 sec.</td>
<td>3 sec.</td>
</tr>
<tr>
<td>9. Time required to extract 50 selected records spaced equidistantly throughout the 1007-record file.</td>
<td>6 min. &amp; 30 sec.</td>
<td>20 sec.</td>
<td>4 min.</td>
<td>2 min. &amp; 30 sec.</td>
<td>1 min.</td>
</tr>
<tr>
<td>10. Time required to go from the main menu or from when the DBMS is ready to accept a command to the start of printing a selected report.</td>
<td>25 sec.</td>
<td>3 sec.</td>
<td>3 sec.</td>
<td>6 sec.</td>
<td>18 sec.</td>
</tr>
<tr>
<td>11. Time required to return to the main menu after the report is printed.</td>
<td>15 sec.</td>
<td>3 sec.</td>
<td>3 sec.</td>
<td>6 sec.</td>
<td>8 sec.</td>
</tr>
</tbody>
</table>
Meet 1-2-3 — the remarkable new software package that puts more raw power at your finger tips than anything yet created for the IBM PC. 1-2-3 actually combines information management, spreadsheet, and graphing in one program that can perform all three functions interchangeably and instantly at the touch of a key. That's power.

To explain: since 1-2-3's information management, spreadsheet and graphing functions exist in memory simultaneously, you can go from retrieval to spreadsheet calculation to graphing instantly, just by pressing a few keys. So now you can experiment and recalculate and look at data in an endless variety of ways. As fast as your mind can think up new possibilities. There's no lag between you and the computer. And that's a new kind of power — power that's greater than the sum of its programs.

The spreadsheet function.

If 1-2-3 were just a spreadsheet, you'd want it because it has the largest workspace on the market (2048 rows by 256 columns). To give you a quick idea of 1-2-3's spreadsheet capabilities: VisiCalc's spreadsheet for the IBM PC offers 15 arithmetic, logical and relational operators, 28 functions and 32 spreadsheet-related commands. 1-2-3 has 15 operators, 41 functions and 66 commands. And if you include data base and graphing commands, it actually has 110!

In addition, 1-2-3 is up to 50 times as fast as established spreadsheets. With all the features you've ever seen on spreadsheets, 1-2-3 also gives you the capability to develop customized applications (with 26 macro keys) and lets you perform repetitive tasks automatically with one keystroke. If 1-2-3 were just a spreadsheet, it would be a very powerful tool. But it's much more.

The information management function.

Add to 1-2-3's spreadsheet a selective information management function, and the power curve rises at an awesome rate. Particularly since 1-2-3's information management capability reads files from other programs such as WordStar, VisiCalc and dBase II. So you can accumulate information on a limitless variety of topics and extract all or pieces of it for instant spreadsheet analysis. Unheard of before. Specific 1-2-3 information management features include sorting with primary and secondary keys. Retrieval using up to 32 criteria. 1-2-3 performs statistical functions such as mean, count, standard deviation and variance. It can produce histograms on part or all of the data base. 1-2-3 also allows for the maintenance of multiple data bases and multiple criteria.

The graphing function.

1-2-3 enables you to create graphs of up to six variables using information already on the spreadsheet. And have it on screen in less than two seconds! Once you've made a graph, three keystrokes will display it in a different form. If data on the spreadsheet changes, you can display a revised graph with one keystroke. This instant relationship of one format to another opens up a whole new application area. For the first time graphics can be used as a "what if" thinking tool!

For a full demonstration of 1-2-3's remarkable power, visit your nearby 1-2-3 dealer. For his name and address, call 1-800-343-5414 (In Mass. call 617-492-7171). Lotus Development Corporation, 55 Wheeler Street, Cambridge, MA 02138.
base can be done easily only by using command files. Even so, most of the newer DBMSs are relational due to the added complexity of the hierarchical or network type.

As indicated on the timing charts, Selector V, written in CBASIC2 and then compiled, compares favorably with the machine-language DBMS in running time. Report generation using Selector V is complex, even though the documentation is, for the most part, well written. It is time consuming to find a record not in sequence in a file. You must generate a select definition that defines the characteristics of the wanted record and run a search subprocess.

There is no interface with CP/M commands, and it is necessary to leave Selector V and return to CP/M to list the directory. When using a mailing list generated by Selector V, there is no way to start at any position on the mailing list other than at the beginning, or to pick out and print individual names and addresses other than generating a separate individual report. Command files cannot be generated.

**Summary**

After doing the tests on these DBMSs, which one do I prefer? This is a tough question to answer because each individual DBMS has some very good features not found in the others.

Analyst and Qsort are inexpensive, work well, and have excellent documentation, but they are slow in bringing up program menus and have limited report-output capability. Qsort can be used as a stand-alone program to sort any type of file.

The dBASE II system can select, edit, manipulate, and display or print any record or groups of records in a file easily and quickly. Simple application programs are very easy to accomplish even for an inexperienced computer user. The dBASE II programming language is somewhat complex and not too easy to learn, but it is very comprehensive and will accomplish almost any programming task.

Condor has excellent capabilities for accounting or personnel processing functions, an outstanding screen and report generator capability, and is easy to learn. However, it cannot carry mathematical operations to beyond two decimal places or sort files longer than 128K bytes without extra programming effort.

FMS-80 works well, but is quite complex to use even for an experienced programmer.

Selector V runs as fast or faster than the assembly-language-coded DBMSs and has definite strengths in multiple file accesses, but the current version cannot easily select and display or print groups of records. Formatted report outputs are complex to generate.

Representatives of Micro-Ap, the producer of Selector V, say that a new version will soon be released that will speed up and simplify selection and display of individual or groups of database records.

If cost were not a limiting factor I would prefer Condor for accounting applications and dBASE II for other programs. For overall effectiveness, my selection is dBASE II. I would accompany it with Quick Code, a screen-display, report, and automatic-code generator (available for $295 from Fox and Geller, POB 1053, Teaneck, NJ 07666). Designed specifically to supplement dBASE II, Quick Code greatly simplifies the use of the programming language and furnishes an effective screen and report generator.

I have spent many hours working with these DBMS programs. A lot of effort has gone into their development, and it shows. The combined documentation for the five DBMSs totals well over 1000 pages. I have pointed out some weak points in all of these systems, but if you compare the expense of buying a DBMS with the effort and study required to write your own application program in assembly language or a high-level language (BASIC, Pascal, etc.), you'll find that any of these DBMSs can provide good value for the price.

For more information on the database management systems (or their predecessors) discussed in this article, see the following reviews by Jack L. Abbitt: "Analyst and Qsort by Structured Systems Group" (January 1983 BYTE, page 346), "Condor Series 20 DBMS" (December 1982 BYTE, page 404), "Database Management with Ashton-Tate's dBASE II" (July 1982 BYTE, page 412), "Selector IV by Micro-Ap: An Information-Management Program" (April 1982 BYTE, page 371), and "Systems Plus: FMS-80" (October 1982 BYTE, page 446).
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Stalking the East-Asian Microcomputer

Phil Lemmons
West Coast Editor
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San Francisco, CA 94111

Although the products of Asia's modern technologies do not yet rival its ancient treasures, they soon will. The five-nation Far East Electronics Tour in October and November 1982 delivered this message to one group of Americans through a series of six electronics trade shows: the Japan Data Show and the Japan Electronics Show (both covered in the first part of this article, "New Japanese Microcomputers," April BYTE 1983, page 110), the Korea Electronics Show, the Taiwan Electronics Show, the Hong Kong Consumer Electronics Show, and China Comm 1982, in Beijing. Firms in all these countries except China manufacture microcomputers of local design.

The first stop on the tour was Japan, where the trade shows exhibited the most significant new microcomputers and where a remarkable Tokyo neighborhood showcases the vigor of the domestic Japanese microcomputer market. The rest of the tour revealed interesting developments in the other countries as well. (For those who are thinking of joining the 1983 Far East Electronics Tour, the organizer is Commerce Tours International, 870 Market St., San Francisco, CA 94102, telephone (415) 433-3072.)

Akihabara, Tokyo, Japan

If the object is electronics, then every tour of Asia should begin and end in Akihabara. This remarkable neighborhood in Tokyo is as interesting as the Japanese electronics shows. Akihabara (pronounced with the accent on the third syllable) covers an area of several square blocks. More than 400 electronic shops of varying size are packed into buildings about five to eight stories high. Escalators take you from the middle of one shop and drop you into the middle of another. There are probably more shops selling microcomputers and related products in Akihabara than in any other neighborhood in the world, except perhaps in Osaka, the great industrial city that boasts a neighborhood called Nipponbashi said to rival Akihabara.

Many scenes in Akihabara strike the Western eye as improbable: a man riding a bicycle with an NEC PC-9801 16-bit computer strapped on the back fender; a shop with bins full of a remarkable hybrid device, a combination electronic calculator and mechanical abacus; integrated-circuit shops packed with customers of all ages and pocketbooks standing side by side poring over the latest chips; a
Photo 2: A no-frills electronics store in Akihabara.

Photo 3: Typical Akihabara store display.

Photo 4: The Samsung SPC-1000 Z80A-based home computer from Korea.

Photo 5: The thronged exhibit booth of the Multitech Industrial Corporation at the Taiwanese Electronics Show.
Some of Akihabara's larger stores sell all kinds of Japanese-made electronics—audio, video, music, home appliances. Each devotes an entire department to microcomputers; often a whole floor is packed with machines from most of the major Japanese manufacturers.

Some large stores—notably Yamagiwa Tecnica, shown in photo 1—sell microcomputers only. Yamagiwa Tecnica has six floors: one devoted to software, another to home computers, another to more powerful computers (mostly 16-bit), word processors, and so on. The one-floor NEC Bit-Inn has nothing but NEC machines ranging from the PC-2001 hand-held computer to the NS200 (known in the U.S. as the Advanced Personal Computer) and the PC-9801, both 16-bit computers. Expansion boards and accessories for these computers are in stock. Another store, shown in photo 2, offers no frills but good prices on boxed computer products, mostly from NEC. Customers walk where they can, mostly behind the rows of boxes. Typically, the interiors of the retail computer stores are packed with equipment on display. Photo 3 shows a section of a typical store interior.

Many small stores in Akihabara specialize in various kinds of components. One storefront devoted to semiconductors was selling 64K-bit dynamic RAM chips at 8 for 9000 yen, or about $4.25 per chip. (The lowest price I've seen in this country is $5.50 per chip, from a mail-order firm.) Customers had the choice of NEC, Mitsubishi, or Toshiba RAMs. The man behind the counter complained that 64K-bit RAMs were in short supply, which led me to believe that the prices were probably no lower than usual. Another small shop sold disk drives, power supplies, single-board computers, circuit cabinets, and the like.

Many of us foreign shoppers were concerned about the reliability of these low-priced goods. Were we being offered factory rejects? A Japanese businessman allayed our fears, saying there was no need to worry about getting defective goods in Akihabara. If a Japanese electronics manufacturer discovered that defective goods bearing its name were being sold by any shop, the company would never again deal with that shop. In effect, the manufacturers police the retail trade.

The neighborhood was so much like a bazaar that I found the impulse to haggle irresistible. But I was worried: Would haggling be possible when I spoke no Japanese and the shopkeeper spoke almost no English? Would the concept of bargaining be clear? Would the shopkeeper find bargaining offensive? Could he recognize the English words for numbers? At last I ventured to ask, "Discount?"

The shopkeeper replied, "Target price?" and handed me a pad and pencil. The list price was 120,000 yen, then worth about $450. I wrote, "90,000." The shopkeeper laughed pleasantly and wrote, "100,000." We soon reached agreement on a price of 96,000 yen. A NEC memory board for the Advanced Personal Computer with a list price in the United States of $700 then changed hands in Akihabara for only $362.

The flourishing electronics industry that makes Akihabara possible has in part resulted from efforts of the Ministry of International Trade and Industry (MITI). Because MITI's Industrial Electronics Division funds research, some Americans have charged that Japan's electronics manufacturers enjoy an unfair advantage in competing with American manufacturers. Toshiro Takai, who worked in MITI for 25 years before becoming executive vice-president of the Electronic Industries Association of Japan, denies the charge. He says, "MITI funds only basic research, and MITI's research money cannot be used for development of commercial products." Takai also points out that there is nothing to stop the government of the United States from funding research in electronics as MITI does in Japan.

**A NEC memory board costs $700 in the United States but sells for $362 in Akihabara.**

Seoul, Korea

Our introduction to the Korea Electronics Show was unlike what we encountered elsewhere on our journey. As my group arrived at the trade center, we saw dozens of black sedans that formed a semicircular barricade in front of the exhibition hall. Perhaps a hundred men in dark business suits, some holding handguns, arrayed themselves behind the barricade. All the Koreans who approached the exhibition hall were stopped by these guards, but Westerners could pass through. In addition to the guards, the only Koreans inside the barricade were old women stooping over crude short-handled brooms, sweeping every speck of dust from a wide path leading to the entrance of the hall. As we watched, several more black sedans arrived and passed through the barricade to park in the protected semicircle. More guards emerged from the newly arrived cars. All the guards now appeared poised for action, their eyes watchful. One guard opened the rear door of a car and out stepped a lone man in a dark business suit. All eyes followed that lone man as he walked down the clean-swept path and disappeared into the hall. "The President," someone said.

Inside, exhibits of consumer electronics and components and a few Korean microcomputers vied for our attention. Photo 4 shows the Samsung SPC-1000 home computer, a Z80A-based machine with a 32K-byte ROM containing Samsung-HuBASIC, 70K bytes of RAM, a music and sound generator, and an audio cassette built in for mass storage. Samsung also makes the Samsung Personal Computer, the SPC-2000. It is a 64K-byte CP/M-based system with dual 5¼-inch floppy disks, a detached keyboard with programmable keys, and a video monitor that tilts and swivels. Gold Star, Taihan, DMS, Trigem Computer, and a few other companies also displayed microcomputers.

The Trigem 20 is a 64K-byte Apple look-alike with a 12K-byte BASIC in ROM (read-only memory). The Trigem 20 has sound and color-graphics capabilities, game input/output, and eight empty expansion slots as standard equipment. Company spokes-
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The Japanese Microcomputer Marketplace

Kurt Veggeberg
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Over the past four years Japanese microcomputer manufacturers have seen their share of Japan's domestic market increase from 10 to 75 percent. Clearly, advances in technology and marketing techniques make this the market to watch throughout the decade.

Almost every Japanese electronics company, large and small, is in the personal computer business. Fierce competition is seen in all price ranges as each firm attempts to carve its own market niche. A great boon to consumers, the lively market is producing microcomputers that come fully equipped with features hardly imaginable just a few years ago when Apple and Radio Shack dominated the Japanese market. By following the competition's footsteps, the Japanese are able to offer compatibility with existing hardware and software plus improvements in reliability, service, features, and price. As an added advantage, many companies supply themselves with semiconductor chips and have their own well-established distribution networks.

Today's typical Japanese microcomputer usually has a Z80 microprocessor and offers a variety of standard features such as separate numeric keyboards, programmable function keys, selectable 40- or 80-character displays and Japanese or graphics character sets. Each company tries to include a feature in its machine that sets it apart from the competition. For example, some of the newer VLSI chips like the 64K-bit RAMs are appearing in many computers. Additional features seen recently include bubble memory, plug-in ROM packs, built-in terminal functions, and Japanese character sets with 3000-7000 characters. The 16-bit microprocessors are generating a lot of excitement as well. The 8088 appears to be winning the 16-bit popularity contest. One of the earlier 8-bit systems already offers an 8088 plug-in card.

Traditional excellence in miniaturization is evident in the current crop of Japanese pocket and portable computers. Even though the Japanese have little outside competition, the domestic market is characterized by fierce scrambling.

A move toward office automation is keeping the domestic microcomputer market booming. Despite the initial high cost of dedicated word-processing systems (around $12,000), they quickly became essential office equipment. Word processors use one of several methods to enter and manipulate the Japanese language, which consists of two syllabaries, or kana, and thousands of individual characters. One entry method uses a board with several thousand characters printed on it. A stylus helps the user select the characters to enter. A more popular method uses a keyboard with the syllabaries. Using about 50 characters only, this method is easily implemented on a query-style keyboard. The user simply types the symbols for the sound of a character and then presses a button. The machine decodes the input and produces a character. Most systems can even determine the character you want from the context in which it's being used. This capability is essential with a language in which many characters have the same sound. These word-processing systems are usually sold complete with dot-matrix printers (24 by 24 dots) that produce good-quality printouts. Hardware and software advances have brought the prices for these systems down to around $3000 and the low cost is a factor in the growing strength of the domestic market.

The Software Scene

While Japanese hardware distinguishes itself with special advanced features, several problems plague the software development effort.

With the two syllabaries and thousands of characters, the Japanese language is much more difficult than English to manipulate electronically. Few of the current microcomputers can easily be used for word processing, although some progress is evident. Another factor in the software industry's slow growth is that use of disk drives is not as widespread as it is in the U.S. This places a severe limitation on the type of software that can be marketed to a wide audience. Additionally, the use of computers in business applications lags far behind that in the United States. Electronic spreadsheets such as VisiCalc are having an effect on the use of microcomputers in Japan, but this is a recent development.

Availability of software is another important issue. The number of domestic private software houses remains small and premium prices are charged for imported software—usually a 100 percent markup over the U.S. list price. However, the situation could

3000, with a 9-inch green-phosphor video monitor selling for $68 in the same quantities.

The Korean electronics industry developed rapidly, and by 1981 consisted of almost 800 companies employing 270,000 people. Two-thirds of the $3.8 billion annual production is components, with another one-fifth devoted to consumer electronics. The Korea Institute of Electronics Technology and the Korea Electro-technology and Telecommunications Research Institute have concentrated on digesting and improving imported technologies. The Electronic Industries Association of Korea expects these research institutes to generate advanced technol-
change soon because most Japanese microcomputer manufacturers are concentrating their efforts on standard operating systems. This should encourage the development of software in Japan and also encourage the importation of American software with a corresponding increase in the exportation of Japanese hardware.

Both production and distribution of software are rapidly becoming part of the book publishing domain. Simple cassette programs appear alongside magazines and other printed materials in bookstores across Japan. Most of the stores provide microcomputers so potential software buyers can try programs before purchasing. As you might expect, this attracts a lot of attention and so far I have been unable to push past the children to try any programs myself.

Intense Interest

The Japanese express a great deal of interest in microcomputers and appear to be welcoming them into their lives. A current television series on microcomputer programming is aimed at beginners and more conventional instruction is offered in a variety of places from computer stores to private schools. These courses target every possible group of future computer users. Japanese computer magazines reflect the growing demand for computer information with their multiplying numbers and rapid increases in size.

Although the Japanese have not yet made a strong showing in American markets, they’re fully aware of the potential for profit in the U.S. Japanese domestic products are well designed and competitively priced and their success with low-cost printers and video displays indicates their ability to play a strong role in the American personal computer market. While this competition may bring difficulties for manufacturers, the benefits for end users should be plentiful.

Taipei, Taiwan

The Taiwan Electronics Show, held at the China External Trade Development Council Exhibition Complex in Taipei, had 511 exhibitors. While most products displayed were consumer electronics or components, I saw a lot of computer products too.

The most common microcomputers made in Taiwan are blatant copies of the Apple II. Also shown were an apparent copy of the Radio Shack TRS-80 Color Computer and two copies of the Osborne 1. An Osborne 1 copy called the Datatree Portable Business Computer had a 9-inch screen, two double-density floppy-disk drives, and all the software usually bundled with the Osborne 1; this machine cost $800. The second Osborne-like portable, made by GRE Rong Electronics, includes a 6502 processor, as well as a Z80, and claims compatibility with both the Apple II and the Osborne 1.

I didn’t get to see, as promised, a third Osborne look-alike. Its designer refused to bring his prototype to the Taiwan Electronics Show and insisted on a private meeting with me miles away at the office of one of his friends. When the designer arrived, more than an hour late, his appearance presented quite a contrast to the usual conservatively dressed Taiwan businessman. Half-inch-long white stitches left me no doubt about how his purple suit was put together. His purple and orange floral print shirt and inch-wide white polka dots in his purple tie set up a high-frequency oscillation with the seams of the suit.

Under the circumstances, there was real danger of my overlooking the business of the meeting. But, I asked, "Where’s your Osborne look-alike?"

His eyes shifted from place to place as if looking for assassins. "If anyone saw it," he said earnestly, "they might copy my design."

If it happened to Adam Osborne, it could happen to him.

Some businessmen on the island explain the epidemic of Apple II copies as a response to the Nationalist Chinese government’s ban of video games. Many companies in Taiwan had bought great quantities of discrete logic circuits and 6502 microprocessors in preparation for an expected boom in the game-machine market. The government’s ban left these companies with huge inventories of chips useful for building Apples. That might explain the Apple copies, but what about the bastard Osbornes?

Because U.S. Customs officials are watching for products from Taiwan that infringe upon American patents and copyrights, Americans would be ill-advised to rush off to Taipei to pick up a $245 Apple or an $800 Osborne clone. Furthermore, some local insiders told me during the show that many electronics firms in Taiwan are pushing the government there to ban the export of these illicit products. Many in Taiwan believe that copyright and patent infringements in electronics damage the reputation of the entire electronics industry in the Republic of China and injure the island nation’s trade. Despite great economic advantages, some foreign companies are reluctant to manufacture in Taiwan for fear that designs will be copied by local entrepreneurs and sold on the open market at unbeatable prices.

Some respectable Taiwan firms that make legal Apple-compatible products are tired of having to defend themselves against charges inspired by illicit Apple-lookalikes made by other firms. For instance, Stan Shih’s Multitech Industrial Corporation produces the successful and lawful 6502-based Micro-Professor II, and Shih is incensed when people call that compact machine a copy of the Apple. The Micro-Professor II packs 64K bytes of RAM and a 16K-byte ROM BASIC into a unit slightly larger than an average modem. The computer will execute most Apple II software because its own software uses system calls compatible with those in the Apple’s operating system. Priced in Taiwan at around $200, the Micro-Professor II is not an imitation of an Apple but an improvement on it. The Micro-Professor II accepts software cartridges as well as audio-cassette-based software (the audio recorder and a disk-drive controller are optional). According to Shih, the Multitech BASIC interpreter has 90 instructions more than Applesoft BASIC.

Micro-Professor II has enjoyed great success in Taiwan (see the thronged

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Multitech show booth in photo 5) not only because of its compactness and low price, but also because of its optional Chinese character controller (CCC). The Z80-based CCC adds another 64K bytes of ROM and 2K bytes of RAM to the little Micro-Professor II, and gives the user access to 22,000 Chinese characters, each displayed in a 16 by 16 matrix. With the CCC installed, the MicroProfessor permits the user to enter BASIC programs in either Chinese or English. Multitech recently remedied the only obvious deficiency of Micro-Professor II—its small keyboard—by offering a full-size typewriter keyboard as an inexpensive option. The optional keyboard has cursor keys and two "fire" keys, the latter for games. At least one member of the Far East Electronics Tour left Taiwan with a Micro-Professor II in his luggage.

Multitech now has more than 250 employees and annual revenues of $20 million. The company's future products will include a portable computer.

Tony Jwang of J. E. Computer Company says that the only way for Taiwan's microcomputer companies to survive is to stop copying foreign machines and design their own. However, J. E. Computer now produces computers compatible with the Radio Shack TRS-80 Color Computer and the Apple II.

Taiwan's answer to Japan's MITI is ERSO, the Electronics Research and Service Organization of the Taiwan Industrial Technological Research Institute. Since 1974, ERSO has been transferring electronics technologies to local industry. ERSO develops electronic products more advanced than those of local industry and then assigns the manufacturing rights to a private Taiwan company. Recent ERSO products include the EMB86/01, an 8086-based single-board computer for the Multibus. ERSO also developed the BC-1000, a multiuser Z80A-based computer running the MP/M multiuser operating system, and turned manufacturing and marketing over to PECOR (President Enterprises Corporation), a private company in Taipei. ERSO's highest priorities now include development by 1984 of VLSI (very large-scale integra-
The second was the amount of attention devoted to the trade mission by officials of the Fourth Ministry of Machine Building of the People's Republic of China, also known as the Ministry of the Electronics Industry. Three representatives, Huang Zhao Ming (seen in the dark gray coat at center in photo 6), president of the China Electronics Import and Export Corporation (CEIEC), and Li De Guang and Sun Shunxing, respectively vice-president of the corporation and director of the corporation's Department of Trade Relations, met with members of the trade mission for several hours.

While some discussions centered on the particular trading interests of the members of the trade mission, the Chinese emphasized their desire for the relaxation of export restrictions on American technology. At dinner one night at Beijing's International Club, the tour members joined the Chinese officials in repeated moutai toasts to the easing of restrictions on LSI and VLSI technology. (Moutai looks like vodka and tastes like death.) To date, the United States government has turned down export licenses for all integrated-circuit technology more complex than that of 2K-bit RAMs.

According to Peter Handley, a commercial officer in the United States Embassy in Beijing, CEIEC has in recent years imported about $160 million in electronic equipment annually, including computers from Hewlett-Packard, DEC, IBM, Apple, Intel, and Cromemco. Photo 7 shows the crowded Osborne Computer booth at China Comm 1982, an exhibition of Western communications and computer equipment. The Stalin-Gothic-architecture Beijing Exhibition Center was packed with Chinese visitors; the only free space was inside the booths, as shown in Hewlett-Packard's large and popular booth (see photo 8). Other exhibitors included California Computer Products, Burroughs, Cromemco, Honeywell, IBM, Perkin-Elmer, Prime, and Wang.

CEIEC prefers importing entire production lines rather than products. France recently sold China a complete plant for making minicomputers, magnetic disks, and printers. Four Japanese firms have sold China complete production lines for electronic components. West Germany and the United Kingdom have made similar deals. In the past two years, the United States has sold China only one electronics factory, valued at $8 million.

Handley says that China's main goals for electronics imports are field-effect transistors, acoustic wave filters, integrated circuits and LSI manufacturing equipment, magnetic recording heads, and satellite earth stations. China wants to buy 15 satellites and the technology required for manufacturing its own.

The CEIEC arranged a tour for our group of the Beijing Wire Communications Factory, which makes telephone exchanges and 32-bit and 48-bit minicomputers. Photo 9 shows the front panel of one of these minicomputers. The 32-bit machine comes with 64K bytes of RAM; the 48-bit machine has 32K bytes of RAM expandable to 128K bytes and runs FOR-
TRAN, ALGOL, and BASIC. The factory has been working in cooperation with Honeywell for about a year and several of its staff members are currently living in Minnesota for training.

Many members of the tour were surprised by the level of poverty in the Chinese capital. Since no one has refrigeration, in late fall the Chinese pile bok choy (Chinese cabbage) high in vacant lots and on roofs and balconies in the hope that nature will preserve it as the only green vegetable for the winter months. Everywhere men and women are engaged in brute, physical labor, and the sight of a woman pulling a cart full of rocks or bricks is all too common.

China is seeking to quadruple its annual industrial and agricultural output by the year 2000. During the trade mission’s visit, the English-language Beijing Review quoted Premier Zhao Ziyang as saying that meeting the country’s production goals depends on progress in science and technology. To quote that publication:

Addressing a national science and technology awards conference held in late October, Premier Zhao specified a guiding principle for China’s economic construction: develop science and technology in order to boost the national economy. He said that every department engaged in national economy must stress achieving technical progress so as to gradually shift production to a new technological basis.

Zhao went on to say that building new factories would not be enough; old factories must be technically transformed as well. In the same issue of the Beijing Review (November 1, 1982, volume 25, number 44), Hi Qiamou, honorary president of the Chinese Academy of Social Sciences, was reported to have endorsed the maxim “Let a hundred flowers blossom and a hundred schools of thought contend” in scientific and cultural work.

During the trade mission’s days in Beijing, the Chinese made no effort to hide the backwardness of their industry; instead, they appealed for help. Most members of the trade mission felt sympathy and expressed hope for wider trade, but a few raised concerns about possible military uses of microprocessor technology if the Chinese leaders once again come to regard the United States as an arch-enemy.

The impression of centralized power is so forceful in Beijing that I believe no action by the Chinese government can be ruled out. The Chinese tour guide denounced the emperors for denying the common people even the right to use colors other than gray and dark blue, reserving brighter colors for the nobility and yellow for the emperor alone. But almost all the people of Beijing still wear gray or dark blue. When the guide pointed out the building from which the premier now governs the People’s Republic, Americans noticed that the roof is the same yellow as the tiles on the roof of the Imperial Palace. Americans can hardly predict the ultimate uses of microprocessors in a land that still thinks in such terms.

For background information on the Japanese microcomputer industry see “The Japanese Computer Invasion” by Stan Miasek, August 1981 BYTE, page 200. The May 1982 issue of BYTE also contains several articles on Japanese microcomputers, the state of the industry, and the manufacturers themselves.
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The desire to have letter-quality printing for the output of programs such as word processors is common among computer hobbyists. Purchasing a letter-quality printer, such as a Diablo terminal, is usually out of the question because of the high cost—$1500 to $3000. One option is to buy a used IBM Selectric typewriter and install a commercially available computer interface. This process does have drawbacks, however. It ends up costing more than $1000 and can require major modifications to the typewriter.

Another option is the solenoid-activated key-pusher, a unit that fits over a standard typewriter keyboard and emulates a human typist. This method has two major drawbacks. First, because the key-pusher is mechanical, it tends to decay with time; second, the quality of the text is limited to the quality of the typewriter itself.

These two forms of typewriter conversion share the same goal: translating a computer's digital-control signals into the mechanical actions necessary for printing. With the recent introduction of the low-cost Olivetti electronic typewriter (see photo 1), the manufacturer has tackled this problem for you. The question now becomes: How can the hobbyist interface a home computer to the electronics? This article describes a low-cost interface between a typical hobbyist computer or small business computer and the Olivetti Praxis 30 electronic typewriter.

The Typewriter

The Olivetti Praxis 30 is a portable electronic typewriter with high-quality print. Its retail price is about $250. Like the popular Diablo terminal, it uses a carbon ribbon cartridge ($4 each) for crisp type and has interchangeable print wheels ($30 each) for variations in style. The Praxis typewriter is controlled internally by two mask-programmed Fairchild F8 microprocessors. All functions—such as tab stops, margins, carriage movements, printing, and keyboard scanning—are controlled by these two chips, with some help from SSI (small-scale integration) interface chips. This electronic control makes the Praxis typewriter ideal for interfacing to a computer.

Interfacing the Praxis Typewriter

It is possible to interface the Praxis typewriter to a typical home computer in two obvious ways. The first method requires that the F8 microprocessors be removed and their functions emulated by your computer. These functions include control of the carriage stepper motor, print-wheel motor, type motor, and other motors and sensors. This approach offers the most versatility in determining interletter spacing and print speed. (The interletter resolution determines the output quality of most word processors.) I tried this way first and failed miserably. While controlling the carriage stepper motor is relatively easy, controlling the print wheel is not because the print-wheel motor is a standard DC motor, not a stepper.

After many hours of observation using a logic analyzer, I determined that the Praxis typewriter microprocessors position a character for typing by carefully pulsing the print-wheel motor in one direction, causing the character to pass beyond the print hammer, and then reversing the motor with timed pulses until the character is properly aligned under the hammer. This timing varies with the character positions on the print wheel, and I was unable to determine the algorithm. Because Olivetti considers this timing information proprietary, calling its engineering department led to a dead end.

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Table 1: The columns of this scan matrix are the bits (and corresponding pins) that are individually pulled low by Processor B for keyboard scanning. The rows are the bits (and pins) that are sensed by Processor A. Blanks in the matrix are either unsigned or unidentified scan positions.

<table>
<thead>
<tr>
<th></th>
<th>B33</th>
<th>B32</th>
<th>B31</th>
<th>B30</th>
<th>B29</th>
<th>B28</th>
<th>B27</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>A6</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>A9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>A10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>A11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>A12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>A13</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>A14</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>07</td>
<td>A15</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

- **Table 1:**
- **Processor A** is held low during the sense/assert operation for the character to be shifted.
- The keyboard is software debounced by the Praxis typewriter's microprocessors, which means that a key must remain closed during four scans to be recognized as a valid entry. In the controlling program, the action of sensing and pulling low is repeated four times.

The advantage of this sense/assert interface is that the typewriter keyboard can still be used for normal typing without disconnecting anything. The resolution of your word-processing program is limited by the resolution of the typewriter (one-half space). The only required modification to the typewriter is to solder 19 wires to the pins of the two microprocessors.

**Hardware Configuration**

To interface the Praxis typewriter to your computer, you need nine output, or assert, lines (eight as part of the scan and one for the shift function); eight input, or sense, lines; and a couple of grounds. These usually come from a parallel-port board or chip. A good choice is the Intel 8255 parallel-interface chip, which has 24 I/O (input/output) lines. Ideally, your port's output lines should go through an open collector buffer to allow the keyboard to bring Processor A's inputs low when a key is
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Circle 372 on inquiry card.
pressed. However, the 8255's tem-
po le ou tputs don't see m to mind the
brief short circuit to gro
un d.

The first step in connecting your
port to the Praxis typewriter's pro-
cessors is to disassemble the typewriter and remove the computer control board. The step-by-step pro-
cedure is as follows:

1. Turn off and unplug the
   typewriter. With it facing you, lift
   the hinged cover that protects the
   print mechanism. It hinges on a
   rod that runs horizontally through
   the platen. Gently pull the right
   end of the cover until the plastic
   hinge clears the rod. Then slide the
   left side of the cover off the rod.
2. Twist off the plastic platen hand-
grips by rotating each one counter-
clockwise. Also, it is a good idea to
remove the ribbon cartridge.
3. Turn the typewriter over and re-
move the four screws that hold the
plastic base on—two at the front
edge and two at the rear.
4. Right the typewriter and lift off the
   plastic case. The keyboard remains
   mounted to the base.
5. Remove the two screws that hold
   the keyboard assembly to the base
   and lift the keyboard up slightly.
   Five cables must be unplugged
   from sockets on the rear of the
   keyboard assembly. Remember
   their orientation. Photo 2 shows
   the keyboard assembly with the
   Praxis typewriter cables removed.
   The two cables at the bottom are
   from the parallel port.
6. The keyboard can now be re-
   moved from the base. Turning it
   upside down, you discover that the
   circuit card is held to the keyboard
   card by three nuts. Remove these
   nuts and save the two grounding
   flanges (remembering the orienta-
   tion of the flanges).
7. The processor card can now be
   separated from the keyboard card
   with the flexible ribbon cable act-
   ing as a hinge. Orient the boards as
   shown in photo 3. Note the loca-
   tions of Processors A and B and
   the new cable wiring.

I suggest using a ribbon cable to at-
tach your parallel port to the circuit
card. Figure 1 is an interconnection
diagram between an Intel 8255 port
chip and the Praxis typewriter micro-
processors. Solder the cable wires to
the pins of Processors A and B on the
foil side of the printed-circuit card.
Use the same caution you would to
solder a microprocessor into a board.

[Editor's Note: Unless you have had
some kit-building and soldering ex-
perience, you should not attempt to
solder wires to a printed-circuit
board.] Plug the other end of the
cables into your parallel port and use
an ohmmeter to check for proper wir-
ing. The cables can be brought out of
the typewriter by cutting slots in the
ventilation holes in the case under the

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keyboard. Reassemble the keyboard and typewriter by reversing the disassembly steps.

Software
The interface program (see listings 1 and 2 on pages 254-261) fits in less than 1K bytes, plus however much RAM you wish to allocate for buffer space. I assume a 2K-byte buffer in my code. The software is written in the C language and Z80 assembly code. C can be easily translated into assembly code or BASIC. The assembler I use has nonstandard (but Zilog-like) mnemonics. Assembly language is necessary for the interrupt handling and the critical timing of the keyboard sense/assert loops. I use interrupts because characters arrive from a host computer on a serial line to my special-purpose Z80 system, but other hardware/software combinations might not require interrupts.

Figure 2 is a flowchart of the control program. The typewriter is inherently a very slow device. Some speed is gained by taking advantage of the 12-character buffer that the typewriter's microprocessors use, but there is a danger of overflowing this buffer if the delay constants in the C program are changed. These con-
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Figure 2: A flowchart of the controlling software as implemented in the C and Z80 assembler programs.

The assembly-language routines and their functions are detailed below. Names preceded by an underscore are symbols external to the C program.

**int**—Called on an interrupt that occurs when a character is received in the serial port. The character is queued by int, which also transmits a Control-$S$ to the host computer when the character queue is in danger of overflowing.

**start**—The parallel and serial ports are configured here. All variables are cleared and the queue pointers are set to their initial values. The stack pointer is set and interrupts are enabled. Finally, the C program is entered at its beginning (**main**).

**putc**—A character passed by **getc** is output on the serial line to the host.

**getc**—This routine is called from C to check and return characters from the queue. If no character is available, a -1 is returned; otherwise, a character from the queue is returned and the queue pointers are updated. If this causes the queue to empty, a Control-$Q$ is sent to the host and the pointers are set to the base of the queue.

**put**—This routine is called with two arguments. The first is the value that Processor B will be asserting (and we will be sensing) when the desired key is being scanned. The second argument is the value we assert on Processor A's pins. The shift line is pulled low if the C program has set the variable **upper** to 1.

The delay loops in the C program assure that the characters are not sent to the typewriter faster than it can type or buffer them. If you have hardware timers available, the size of the program can be reduced. I have designated two Escape sequences to control typing. Until the TYPE_ON code (ESC followed by Control-B) is received, characters are returned from the queue by **getc** but are ignored in the C loop. To type a character, a delay is first calculated. This delay allows time for the typewriter mechanics to print the character and/or move the carriage. Special

Text continued on page 262
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Listing 1: The C program.

```
// Global variables
char upper;

// Upper case flag used in put routine
unsigned int delay, delays[];

// After assembly code initialization, the program
// is completed here.

while(1) // Infinite loop
// Gets the assembly language routine
// that checks for a character in the queue.
// If the queue is empty, `getc` returns a EOF.

if (getc == EOF) continue;

// If the character begins an escape sequence
// get another character in the queue.

if (delay) if (*delay == EOF) continue;

// Otherwise, the character is returned.

if (delay) (*delay++) = EOF;

// The character is read.

while (*delay)
// The character is displayed.

// Gets the assembly language routine
// that checks for a character in the queue.
// If the queue is empty, `getc` returns a EOF.

if (getc == EOF) continue;

// If the character begins an escape sequence
// get another character in the queue.

if (delay) if (*delay == EOF) continue;

// Otherwise, the character is returned.

if (delay) (*delay++) = EOF;

// The character is read.

while (*delay)
// The character is displayed.

// Gets the assembly language routine
// that checks for a character in the queue.
// If the queue is empty, `getc` returns a EOF.

if (getc == EOF) continue;

// If the character begins an escape sequence
// get another character in the queue.

if (delay) if (*delay == EOF) continue;

// Otherwise, the character is returned.

if (delay) (*delay++) = EOF;

// The character is read.

while (*delay)
// The character is displayed.

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// that checks for a character in the queue.
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// get another character in the queue.

if (delay) if (*delay == EOF) continue;

// Otherwise, the character is returned.

if (delay) (*delay++) = EOF;

// The character is read.

while (*delay)
// The character is displayed.
```

Listing 1 continued on page 256
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Listing 1 continued:

```c
// Case of escape character
char case[8][8] =
{
    EMPTY, '1', '2', '3', '4', '5', '6', '7', '8', '9', 'TAB', '0',  '1', '2', '3', '4', '5', '6', '7', '8', '9', 'TAB',
};
```
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Listing 1 continued:

```
  1. This subroutine checks in 'array' for the
  2. character in 'v'. If not found, 0 is returned. Otherwise, the character's
  3. row and column positions are corrected
  4. to make 8-bit bytes. The array 'byte' is 'bit' and
  5. passed in the assembly language routine part
  6. Upon return from 'put', delay 1, if set.
  7. delay2 are counted down to zero.

  8. lookup' array' v
  9. register char array [8][8]

  10. 0: x. y:
  11. 12. for y = 0: y < 8: y+1
  13. 14. -1: x = array[y][x];
  15. 16. if (byte[y][x] = not found) then
  17. 18. (byte[y][x]) = x:
  19. 20. if x & y & (byte[y][x]:)
  21. 22. byte[y][x] = x:
  23. 24. end-
  25. 26. return 1: character was not in 'array'

Listing 2: The Z80 assembler program.

These are the assembly language routines.
The semantics are similar in Filly's.
Check the F80 assembly language
Programming Manual and you will see the
similarities.

Some examples:
- Here
  1. lda mn 0x1274
  2. iddshn 11.17 12a
  3. iddshn 1.12a 0x1274
  4. pushq de
  5. pushq de
  6. pushq de
  7. pushq de
  8. pushq de
  9. pushq de
  10. pushq de
  11. pushq de
  12. pushq de
  13. pushq de
  14. pushq de

Numbers in the form 0x1234 are hex

Listing 2 continued on page 260
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delays are needed for carriage returns, backspaces, and tabs. The carriage-return delay is calculated by multiplying the current print position by a constant and adding the linefeed delay. If this number exceeds 65,535, a second delay must count the difference. The tab delay assumes a nominal 8-character tab width.

A character to be typed is first looked up in the lower case (lowercase) array. If it is not found there, the upper case (uppercase) array is checked. A character never found is ignored. The row and column indexes corresponding to the character's position in the array are converted by the bit array to one-of-eight codes. If the character is found in ucase, the upper variable is set to 1. The two one-of-eight codes are passed to the put assembly-language subroutine. On return, the C program counts down the previously calculated delay and continues checking the character queue. The program will stop typing when a TYPE_OFF sequence (ESC followed by Control-A) is found in the buffer. Note that typing will not stop immediately if there are characters in the buffer ahead of TYPE_OFF.

Typewriter Setup

I have selected control characters to perform the typewriter's programmable functions. These are found in Table 2. It would be helpful to follow an example of their use. To set the tabs and margins, the host sends a TYPE_ON sequence followed by the hexadecimal ASCII (American National Standard Code for Information Interchange) codes 11, 0F, and 12 for "EXPR TABC REP." As explained in the Praxis typewriter operating guide, this sequence will clear all tabs and margins and return the carriage to position 0. Because my program does not calculate a delay for these control codes, the host should wait a second or two before sending more characters. The host can now set the tabs and margins by sending space characters (hexadecimal ASCII 20) to move the carriage to the desired column followed by the control functions MARL, TABS, and MARR as appropriate. Subsequent characters sent by the host will be printed by the typewriter until a TYPE_OFF sequence is found in the queue.

Table 2: This table shows control character mapping. I have assigned the special functions of the typewriter to ASCII control codes.

| Function | Hexadecimal Value | Typewriter
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<tr>
<td>RELOC</td>
<td>03</td>
<td>reloc</td>
</tr>
<tr>
<td>MARB</td>
<td>04</td>
<td>margin bypass</td>
</tr>
<tr>
<td>CORR</td>
<td>05</td>
<td>correction key</td>
</tr>
<tr>
<td>HALF</td>
<td>06</td>
<td>half space</td>
</tr>
<tr>
<td>MARL</td>
<td>07</td>
<td>margin left</td>
</tr>
<tr>
<td>BS</td>
<td>08</td>
<td>backspace</td>
</tr>
<tr>
<td>TAB</td>
<td>09</td>
<td>tab</td>
</tr>
<tr>
<td>MARR</td>
<td>0b</td>
<td>margin right</td>
</tr>
<tr>
<td>LOCK</td>
<td>0c</td>
<td>shift lock</td>
</tr>
<tr>
<td>CR</td>
<td>0d</td>
<td>carriage return</td>
</tr>
<tr>
<td>OH</td>
<td>0e</td>
<td>½</td>
</tr>
<tr>
<td>TABC</td>
<td>0f</td>
<td>tab clear</td>
</tr>
<tr>
<td>TABS</td>
<td>10</td>
<td>tab set</td>
</tr>
<tr>
<td>EXPR</td>
<td>11</td>
<td>expr</td>
</tr>
<tr>
<td>REP</td>
<td>12</td>
<td>repeat</td>
</tr>
</tbody>
</table>

Conclusions

I have tuned the delay constants in the program for the fastest possible typing speed. However, because I rely on the Praxis typewriter's internal buffer, I run very close to overflowing it. You may have to return these constants for your particular system speed. Along the lines of improvements, it may be better to sense when the typewriter has finished printing a character by reading the F8 lines that control the mechanics.

One keyboard function I did not implement is the KB-I/KB-II switch. Being a toggle switch, it cannot be pulled like the momentary switches. A relay would do the job nicely.

I am quite pleased with the operation of the typewriter. It may seem that $250 is a lot to spend on a portable typewriter. With letter-quality computer printers costing three to six times as much, however, the Praxis typewriter looks comparatively good. The quality of the type is excellent—crisp characters perfectly aligned.

I have written several driver programs on my host system to manipulate the typewriter. One program sets up tabs and margins and prints a file previously run through a word-processor program. A library of subroutines can be included in other programs to print output on the typewriter. One application is an elaborate checkbook program that uses the typewriter to print out checks.

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<td>CP/M</td>
<td>DEC RT-11</td>
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<td>CP/M-86*</td>
<td>IBM 3740</td>
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<td>TRS-DOS II</td>
<td>CP/M</td>
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Painter Power
An Electronic Paintbrush for Artists

Chris H. Pappas and William H. Murray
Computer Science Department
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Painter Power is a high-resolution graphics program that lets Apple II users create paintings on a color screen. Completed paintings may be viewed in a slide show on the color monitor or printed if a screen dump routine is available.

Painter Power allows you to use the Apple II keyboard, game paddles, or a joystick to paint color pictures. You use them to create "brushes" and to move objects around on the "canvas." We recommend, as a minimum, the purchase of a pair of high-quality, noncentering joysticks for the creation of brush shapes. (A noncentering joystick remains in position when released, easing figure and brush creation.) The brush moves across the screen at a predetermined rate of speed: snail, turtle, rabbit, and blitz. You control where the brush goes by the joystick and whether or not the brush is touching the canvas (i.e., painting or not painting).

Painter Power operates in two modes: beginner and advanced. The beginner level is not as powerful as the advanced, which requires time and patience to master. With the beginner level, you can be up and painting in a flash. We estimate that it will take about an hour to master the beginner mode and probably a month of painting to master the advanced mode—it has a lot of features. With either mode, you can really paint creatively.

Beginner Mode
The beginner mode supplies a preformed brush. You can create a different brush by using the brush-create mode and preferably a joystick. You can also control the brush's width and shape in the creation process and, hence, the patterns made with a stroke.

At a Glance
Name
Painter Power

Use
Permits the use of a color television or monitor to serve as a painter's canvas for creating pictures from the Apple's high-resolution mode.

Manufacturer
Micro Lab
2310 Skokie Valley Rd.
Highland Park, IL 60035
[312] 433-7550

Price
$39.95

Features
Contains two modes: beginner and advanced. The beginner mode is easier to use but has fewer options. Both modes allow an artist to select background color and brush colors and shapes. The brush shape can be controlled from the keyboard, game paddle, or joystick.

Format
A locked 5¼-inch floppy disk.

Computer
Designed to run on an Apple computer with a 16-sector disk drive. Requires 48K bytes of memory and Applesoft in read-only memory or a language card.

Documentation
44-page manual

Audience
Anyone wishing to create color paintings for personal pleasure or presentation.
Once satisfied with the brush shape, you change to paint mode and select the background color for the canvas. Your choices are green, purple, white, orange, blue, and black. As with oil paints, you can paint over previous work. This lets you experiment with a shape on the canvas before making it a permanent part of the picture.

If unsatisfied with a painting, you can “purchase” a new canvas by hitting the “C” key and clearing the pattern. Masterpieces can be saved on disk for a future showing.

**Advanced Mode**

While the beginner mode will get you painting with a minimum of frustration, the real power of Painter Power lies in the advanced mode. It uses the keyboard, as many as four paddles or a joystick, two high-resolution screens (one for brush making and the other for the painting), and four text lines (for controlling the display) at the bottom of the canvas. A wraparound mode extends the canvas from -256 to +255 points in both directions on the beginner canvas to -512 to +511 points on the advanced canvas.

Two vectors on the text screen show the brush’s location on the high-resolution display. The form is -100, +70, where -100 is 100 points left of the starting position and +70 is 70 points above the starting position of the brush. While the brush is painting, these numbers are constantly changing, which helps you position it precisely.

Painter Power lets you design and save as many as eight different brush shapes. A ninth shape, called Quickstroke, is available from among the eight original brushes. With Quickstroke, predefined patterns may be selected and painted on the canvas.

With the advanced mode, you can create patterns with mathematical functions. These shapes include circles, flower petals, spirals, ellipses, and sine or cosine waves. You have control over the size, scale, number of repeats, and beginning and ending angles.

**Slide Shows**

The Slide Show option is a creative feature of this software. As many as 50 paintings can be shown along with optional titles. Each slide can be viewed for as long as one minute. The presentation is automatic. Once created, a slide show can be run by typing “N” when prompted.

You and your loyal admirers can then view the gallery as many times as you like.

**Painter Power’s Weaknesses**

A major disadvantage of Painter Power became obvious when we tried to make a backup copy: the disk is locked. Shortly thereafter, we couldn’t get the joystick to function correctly in the beginner mode. It took a letter, a telephone call, and two weeks to get a new disk. Replacements cost $5 after the 30-day warranty period. Can you imagine the frustration an artist would feel if the joystick failed to operate in the middle of a masterpiece? It would be like running out of paint and having to wait for a new shipment.

Another disadvantage was a lack of total control over the brush. We had several frustrating moments when the brush took off on its own across the canvas. This disad-
vantage probably becomes less of a problem with experience in using the system.

Conclusions

Despite its drawbacks, Painter Power is a real bargain for the price. It is a well-documented program with many deluxe features.
Ferment in Silicon Valley

Phil Lemmons
West Coast Editor
McGraw-Hill Publications
425 Battery St.
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There is as much ferment—of a different kind—in Silicon Valley as in all of California's wine lands. Just as the soil and climate in Napa Valley are ideal for growing varietal grapes, the dynamism of Silicon Valley is ideal for starting high-technology companies.

Engineers and programmers will move from an established company whose top management decides against developing their ideas into products to an environment favorable to their work. Middle managers who believe their companies are neglecting a certain market segment look discreetly for engineers who can design a product that meets that segment's needs. Graduate students and faculty at Stanford and other universities in the area sometimes turn their best ideas into real products instead of dissertations and journal articles. Veteran entrepreneurs follow the evolution of technology and the emergence of new markets, trying to make a match. Venture capitalists patrol the towns along routes 101 and 280 in search of bright, energetic people with original ideas and plausible goals. In recent years, venture-capital firms have gone beyond bankrolling people who come to them with ideas; these firms now study the marketplace in search of unfulfilled needs and then look for someone to start a company that will make a product that meets those needs. It's no wonder that new companies are constantly bubbling to the surface.

How do companies get started? Profiles of four newcomers reveal different strategies.

A sampling of a few new companies illustrates the variety of startups in Silicon Valley. Victory Computer Systems introduced two new microcomputer systems at last fall's Comdex in Las Vegas. The Learning Company produces educational software for children aged 3 to 13. Adaptec develops and manufactures VLSI (very large-scale integration) controllers for Winchester disks. Evotek designs and manufactures high-capacity 5¼-inch Winchester disks. Although the products of these companies represent different technologies aimed at different markets, all four companies show the same imagination and drive and face similar challenges.

Victory Computer Systems
Roger Vass, a co-founder of Altos Computer Systems of San Jose, California, had been walking the floors of computer shows for some time wondering what kind of system he should build. He knew that the microcomputer market was crowded, and as a former vice-president of marketing for Altos, he knew that he had to identify the right market niches before proceeding to design.

Vass's ideas gelled sometime between the Dataquest conference on the microcomputer industry held at Silverado, California, in January 1982 and the Hanover Fair held in West Germany the following April. Vass had considered building a desktop workstation using color graphics and voice input/output but decided that the time had not yet come for a successful product combining those technologies. In the end, he decided to build a multiuser system rather than an integrated workstation. "It's my conviction," Vass says, "that video-terminal technology and microcomputer technology are different. I'm not sure you can do a good job with both at the same time."

Instead Vass chose to build a "clustered, shared-resource computer with an unburdened 16-bit host." Victory's computers use not only a 16-bit microprocessor, but also a 16-bit hard-disk controller and an 8-bit
A Generic Portable Computer?

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Mr. Vass and Bill Daugherty, now vice-president for finance, used Visicalc to make projections and a business plan. In July 1982, Vass gave consultants the first contracts for the design of the two systems he planned to build. In August, Vass added electronics designer Jim Willott, who formerly worked at Zilog and Altos, to the Victory staff. Willott developed and oversaw further consulting contracts for the design of the Victory computers. Victory Computer Systems, which was not incorporated until September 7, 1982, announced its two systems at Comdex late in November.

The two Victory series of microcomputers differ only in the central-processing unit board. Both systems use the high-speed VME (versa module European) bus, derived from the Motorola Versabus and adopted by Motorola, Mostek, Thompson, Philips, Signetics, and other companies. (Victory expects to market 60 percent of its computers in Europe, the other 40 percent in the United States.) Both systems include integral fixed Winchester disks holding 20, 40, or 85 megabytes of data, and integral tape backup. Both systems can run CP/M on 4 terminals while running a 16-bit operating system on another 12 terminals. Both systems will be capable of running new friendly software that requires advanced graphics capabilities. The C. Itoh terminals, customized to Victory specifications, have options for color graphics with 640 by 480 resolution.

The Victory Spirit Series of computers is based on Intel's 80186 and runs operating systems from the Digital Research family. Victory made both choices in light of the many independent software development projects currently in progress for that hardware/software combination in the business market.

The Factor Series is based on the Motorola 68000 microprocessor and runs the Unisoft Uniplus System 3 Unix operating system, which includes some of the enhancements to Unix developed at the University of California at Berkeley. The Factor Series targets the industrial-applications and process-control market. Because Vass sees that market as "software-development intensive," he chose the Unix operating system and its noted virtues as an environment for developing software.

With a couple of important qualifications, Victory Computer Systems is following the classic model of raising venture capital. In this model, start-up companies raise capital in three rounds. The first round is for organizing the company and designing a product. If that goes well, the outside capitalists will agree to finance a second round, which is for building a prototype. After the prototype is completed and working, the venture capitalists examine the existing competition and decide whether to invest in the third round, which involves manufacturing and distribution. In exchange for venture capital, the founders of start-ups surrender a percentage of their companies. Victory Computer Systems differs from this model in that its management team was able to put in a substantial amount of its own money and Vass was able to move into production much faster than the usual start-up. As well, Vass's background at Altos—his successful "track record"—reduced the percentage of the company that the founders had to surrender to the venture capitalists.

The greatest impetus in the founding of Victory Computer Systems was Roger Vass's willingness to use his own assets as capital. Now the company has opened new manufacturing facilities in the Berryessa industrial park in San Jose. The sales and executive offices remain in Gateway Place in the same city.

The Learning Company
Ann Piestrup, founder of The Learning Company, is an educational psychologist who spent 10 years studying children's thought and language and especially the problem of how to maximize learning of basic
skills. She decided to develop educational software “when I first saw that computers could do colorful, musical, playful things.” Piestrup’s studies had shown that active learning is the key to understanding, but when she looked at existing educational software for microcomputers, she saw little that actively involved the children or that exploited the computer’s ability to generate immediate feedback using color graphics. In December 1979, Piestrup expressed her views and goals to Carolyn Stauffer, former director of the Apple Education Foundation. As a result, the foundation gave Piestrup an Apple II Plus with a language card, graphics, and Super­talker and added $1000 so that she could hire a programmer. Piestrup founded Advanced Learning Technology, a sole proprietorship, in order to receive the grant. 

Piestrup and another expert on learning, Barbara Jasinski, designed the first program, specifying every screen on graph paper to show exactly what the low-resolution color graphics should do. Alice Chiang, a consulting programmer to International Business Machines, turned the specifications into an executable program. (Jasinski is now active in another new educational software company called Stepping Stones.)

Piestrup used the company’s early experience as the basis for a proposal to the National Science Foundation and the National Institute of Education. Those two organizations were jointly awarding nine grants to both profit and nonprofit organizations for the advancement of the use of computers in education. Piestrup’s proposal won a grant of $130,000 and she founded The Learning Company to receive it.

At that stage, Piestrup brought in Dr. Teri Perl, a mathematics educator, and Warren Robinett, who has a master’s degree in computer science from the University of California, Berkeley, and was a member of the original group of programmers at Atari. The programs resulting from the collaboration of Perl, Piestrup, and Robinett during the year’s funding from the NSF/NIE grant are in the public domain, but they convinced many people that The Learning Company’s approach to educational software would make for commercial success.

Among those convinced were Tom Whitney, who formerly worked at Apple Computer Inc., and Jack Melchor of Melchor Venture Management in Los Altos, California. The Learning Company raised $300,000 in January 1982 from the Los Altos venture-capital firm and individual investors. Since then the company has grown to a staff of 14, three of whom are programmers. The Learning Company employs outside subcontractors as well. By January 1983, TLC had developed seven educational programs for children aged 3 to 13. The programs all use color graphics and are interactive, self-pacing, nonviolent, and easy for children to use on their own. Reception has been quite favorable. Both Apple and Atari market TLC products, and TLC has signed with 14 distributors, including Softsel, Micro D, and Bell & Howell. TLC is now in
the enviable position of deciding whether to accept a second round of venture-capital financing. TLC may not need more outside money.

Adaptec

Adaptec was started to design and manufacture LSI circuits for producing inexpensive high-performance hard-disk controllers for microcomputers. Adaptec's founders came from large companies. Larry Boucher, Adaptec's president, spent 10 years at IBM working on high-performance input/output systems. Boucher left IBM to join Shugart Associates in 1979 and was soon responsible for developing integrated circuits and designing disk controllers. Boucher and Bernie Nieman, then an engineering manager at Shugart, developed the Shugart Associates System Interface (SASI) for connecting small computers and small hard disks. SASI has since been proposed as the ANSI (American National Standards Institute) Small Computer Standard Interface (SCSI).

Boucher's decision to found Adaptec was not instantaneous. "It grew," he says, "out of an inability to do what I wanted to do within the organization that I was working in." Shugart Associates was emphasizing disk drives and Boucher's primary interest lay in disk controllers and custom LSI chips.

When Boucher founded Adaptec early in 1981, he brought in Nieman and another former employee of Shugart Associates, Wayne Higashi, who had been manager of design assurance. This group of three ex-Shugart employees brought in John Hulme, an expert in LSI technology who had worked as an engineer and manager of semiconductor projects at Fairchild, Hewlett-Packard, and Siliconix.

Boucher, Nieman, Higashi, and Hulme agreed to contribute $15,000 each and to work for one year without salary. They took some space in an old converted apartment building in Campbell, west of San Jose, and set about designing their first hard-disk controller. Ignoring noise from rockband rehearsals and cabinet makers in adjoining apartments, Adaptec's founders worked hard using their own S-100 personal computers and some surplus breadboards to develop a prototype. In the same period, Boucher refined Adaptec's business plan. "We did the numbers manually," Boucher recalls, "but we used Wordstar running on an S-100 system to write the plan." Within six months of the company's beginning, the prototype controller and the business plan attracted $1,650,000 in venture capital.

In the two years since its founding, Adaptec has grown to a staff of 20 and expects to have 40 employees before the end of 1983. The firm now has its headquarters in Milpitas, California. Adaptec has received another $4,300,000 in equity funding from four venture-capital firms: Lawrence, WPG Partners, of San Francisco; Technology Venture Investors, Menlo Park; New Enterprise Associates, San Francisco; and Merrill, Pickard, Anderson & Eyre, San Francisco.

Forecasting sales of $10 million in 1983, Adaptec produces LSI products for Winchester-disk-drive control: chip sets for use in high-performance, multitasking applications and a single controller chip for use in personal computers. According to Phil Devin, an Adaptec product marketing manager, the company has "had evaluation-unit orders from all the major microcomputer companies and some of the major drive manufacturers." The Winchester Controller Chip will cost $52 in large quantities in 1983 but that price is expected to fall to $36 in 1984.

Evotek

Sometimes venture capital comes through acquaintances. George Brennan, who has held senior management positions at Memorex, Honeywell, and the Marshall Electronics Group, knew some of the people at Ibis Systems in Los Angeles. Ibis makes high-capacity hard disks using thin-film media for use with IBM 3300 series computers. Brennan saw a need for high-capacity, high-performance 5½-inch Winchester disks to be used with microcomputers, and he approached Ibis about licensing its technology for the microcomputer market. Ibis agreed and soon Brennan was developing a business plan for Evotek.

After people at Ibis looked at the plan, they asked Brennan if they could send it on to two venture-capital firms that backed Ibis. These were the Hillman Group, reputed to be the largest of the venture-capital firms, and Rothschild Inc., of New York City. Brennan agreed and soon both venture firms backed Evotek, with the Hillman Group putting up $3 million.

Evotek was incorporated in June 1981 with George Brennan as president. Burton Sisco, another founder and the vice-president of engineering, had worked with Brennan at Memorex. Gordon Steel, vice-president of finance, and Edmund Turek, vice-president of operations, also had experience at large companies.

Turek sought candidates for employment at Evotek who had experience designing 14-inch Winchester disks. From the beginning, Evotek's goal was to bring the technology for large hard disks down to the 5½-inch size commonly used with microcomputers.

By June 1982, Evotek had prototypes ready to be exhibited at the National Computer Conference in Houston. Evotek then had 50 employees. In late November 1982, Evotek showed "preproduction" disk drives developed from the prototypes, and in January 1983 Evotek began shipping a family of hard disks that use thin-film media to store from 7.8 to 51 megabytes. The company now occupies a 50,000-square-foot building in the Sutter Hill-Fremont Business Center, a business park in Fremont, 10 miles north of San Jose. The number of employees had grown to 160 by February 1983.

Looking for Venture Capital?

People looking for sources of capital may find the Directory of Venture Capitalists useful. The publication is available for $20 from the Western Association of Venture Capitalists, Building 2, Suite 260, 3000 Sand Hill Rd., Menlo Park, CA 94025.
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NAPLPS: A New Standard for Text and Graphics
Part 4: More Advanced Features and Conclusions

A standard way to encode color mapping and animation, closing with some predictions on how NAPLPS will be used by personal computers.

This is the fourth and final part of this series of articles on NAPLPS, the North American Presentation-Level-Protocol Syntax, a new communications standard for encoding both textual and graphics information. With this standard, graphics information can be sent from computer to computer, or from peripheral to peripheral, with little regard to inherent differences in the display capabilities of the various machines available. Such a standard will be particularly important for proposed mass-market data-communications systems such as videotex.

The first part of the series presented an overview of NAPLPS. The second part gave a detailed analysis of its basic features. And last month, some of the advanced features of NAPLPS were discussed. This month I will continue that discussion and conclude with some predictions about the future of NAPLPS.

About the Author
Jim Fleming is a member of the ANSI X3L2 Committee on Character Sets and Coding. He is an independent consultant specializing in interactive computing systems.

These predictions are based on the premise that personal computing has not yet reached the majority of people in the world. For that to happen, personal computers must be very easy to use. Those readers who may be dreaming about the day when everyone will be assembling S-100 kits and toggling in bootstrap programs should probably reassess their thinking.

Advanced Color Capabilities
As was mentioned in part 1, NAPLPS supports a variety of color modes. The most primitive one (mode 0) is quite portable and will be used in the majority of applications. As was previously described, colors are specified in color mode 0 by indicating the relative amounts of red, green, and blue that should be mixed to form the desired color.

Color modes 1 and 2, however, use a technique called color maps or color tables. As shown in figure 1, a color table is a set of indexes and their corresponding colors. These are tied together using the Set Color and Select Color commands. As can be seen in the figure, a given mixture of primary colors can be used more than once, and all the indexes do not have to be used. Note that the index value does not have any direct relationship with a hardware drawing value at this point.

In order to make an entry in the color table, you must first use the Select Color command to specify a

<table>
<thead>
<tr>
<th>INDEX</th>
<th>RED</th>
<th>GREEN</th>
<th>BLUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.2</td>
<td>0.8</td>
<td>0.0</td>
</tr>
<tr>
<td>4</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td>5</td>
<td>0.5</td>
<td>0.8</td>
<td>0.0</td>
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<td>0.0</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>25</td>
<td>1.0</td>
<td>1.0</td>
<td>0.1</td>
</tr>
<tr>
<td>26</td>
<td>0.6</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>27</td>
<td>0.6</td>
<td>0.0</td>
<td>1.0</td>
</tr>
<tr>
<td>31</td>
<td>0.0</td>
<td>1.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Figure 1: A typical color table used with color modes 1 and 2 in NAPLPS. Each index value corresponds to a specific color. Note that the index values are arbitrary and that no index value appears more than once. Each color is represented as a mixture of the primary colors red, green, and blue.
certain index (see figure 2). This index value is encoded in the byte or bytes following the command and usually ranges from 0 to 63, although indexes as high as 16,777,215 can be encoded. After an index is chosen, you can then use the Set Color command to specify the mixture of red, green, and blue values that should be associated with the index.

When you want to select a color for drawing in color modes 1 and 2, you must specify the index for that color—not the actual color. The primary difference between modes 1 and 2 is that mode 2 allows you to specify a background color for text characters.

As shown in figure 3, when a picture is drawn into display memory, a drawing value is allocated to each index. This value is written into the display memory. The color information currently associated with each index is put into a hardware register associated with each drawing value, and anything drawn with that display-memory value will have that color. Note that a display value is allocated to an index only when drawing occurs. Also, each display value is allocated to only one index.

In order to create blinking and animation effects, the color associated with an index can be changed using the Select/Set sequence de-

Figure 2: The Select Color and Set Color commands used to specify a color-table index value and a red, green, and blue mixture, respectively. (The codes 3/14 and 3/12 are an alternate way of indicating the hexadecimal numbers 3E and 3C.) In color mode 2, two indexes can be specified in the Select Color command if a background color for text is desired. The normal sequence used to load the color table is to first select an index and then set a color for that index. These actions cause a relationship to be established between an index value and a color. After a table is set up, each set color can be used by using the Select command. Also, the color associated with each index value can be changed by using another Set Color command.

Figure 3: A typical color-table implementation. Note that special color-map hardware is required. The drawing value is the one used when drawing occurs in the display memory. It is an index into the hardware-based color map.
Figure 4: The Blink command is used to establish one or more asynchronous blink processes. These processes automatically modify the contents of the color map. In short, the Blink command causes the color of the current color index to be temporarily changed to that of the "to" color index. The on, off, and phase-delay times are specified in 1/10-second resolution, which allows this system to be compatible with both North American (60 frames per second) and European (50 frames per second) television systems. These times are used to control how often the color map is modified.

**Color-Table Animation**

The Blink command is used to set up automatic color-table animation sequences. As shown in figure 4, the Blink command is followed by several bytes that indicate a color-table entry to the index specified by the "to" color index. If the new color is different than the old color, a visual result will be seen. Similarly, during the off time, the color information saved in the process-control block is restored to the color index specified by the "from" color.

For simple blinks or flashing, the "to" color index can specify a constant color that is used for copying purposes but not drawing. At this point it should be clear why hardware drawing values are not allocated to an index until actual drawing occurs. This technique allows each screen-based color to have a unique "from/to" color pair without requiring that colors be shared.

If you are following carefully, you will note that, at the beginning of the

---

**Description of Figure 4**

- **Blink Command**: Establishes one or more asynchronous blink processes.
- **Color Map**: Contents modified temporarily.
- **On Interval**: Color changed to "to" color index.
- **Off Interval**: Color restored to "from" color index.
- **Phase Delay**: Times control how often color map is modified.

---

**Legend**

- **OP CODE**: (3/15)
- **X**: Operands
- **Msb**: 1
- **Lsb**: 1
- **TO**: Color Index
- **ON INTERVAL**: Color change occurs.
- **OFF INTERVAL**: Color restored.
- **PHASE DELAY**: Times used for control.

---

**Code List**

- **OPERANDS**: X
- **FORMATS**: 1
- **TABLE INDEX**: COLOR
- **ENTRY**: 1
- **INDEX**: SELECTED
- **BLOCK**: PROCESS
- **DRAWING**: VALUES
- **COPYING**: PURPOSES
- **DRAWING**: OCCURS

---

**Notes**

- **Opaque Code**: 3/15
- **Single Value**: OPERAND
- **Fixed Format**: OPERANDS
- **BYTES**: 1
- **INDEX**: SPECIFIED
- **INDEXES**: MAPPED
- **VALUES**: ALLOCATED
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<thead>
<tr>
<th>Whose personal computer offers...</th>
<th>Olivetti M20 Personal Computer</th>
<th>Challenger #1</th>
<th>Challenger #2</th>
<th>Challenger #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microprocessors: 16 bit Z8001/8086; 16 bit BUS</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memory: 128K-512K</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disk Storage: 320K-640K floppy disks; 11MB Winchester</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Resolution Graphic Display: 512 X 256 monochrome or color</td>
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<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Systems: PCOS, CP/M80, 86, 8000, MSDOS</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communications: parallel, serial and IEEE interfaces, TTY, RBTE, 3270, real-time clock</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Application Software: integrated WP with data base and communications, integrated electronic work sheets with graphics, integrated accounting packages and vertical market packages</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Price:* under $3,000</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Circle 527 on inquiry card.
on time, the color in the “to” color index is copied to the “from” color index. This copy is made independently of any blink activity that may be set for the “to” color. Thus, this copying could occur during a time when the “to” color has been changed by another blink process. The result is that multiple blink processes can be set up to allow colors to ripple around the color table in regular and irregular patterns. These patterns can be used to produce dramatic animation effects under full control of the terminal and without the need for host interaction.

These animation effects, plus the other features described in the previous articles, should establish NAPLPS as the most extensive information-exchange protocol available. As time goes on, it is expected that NAPLPS will replace ASCII (American National Standard Code for Information Interchange) as the standard for information interchange. As this occurs, almost every area of computing will be affected. In order to prepare for this impact, we need to look into the future to see how NAPLPS will help shape the world.

Predictions and Conclusions

If one sits back and attempts to predict the future of personal computing and information exchange, some obvious predictions come to mind:

1. Integrated text and graphics will be essential in all visual information exchange.
2. Personal computers must be designed to be so easy to operate that a casual user can begin doing useful things immediately.
3. A personal computer will be used as a link to the rest of the world rather than a diversion from it.
4. People’s efficiency will be increased by allowing concurrent activities.
5. The average personal computer user will be more of a consumer than a producer.

It should be noted that I have said nothing about the size of memory chips or the density of disk drives. These predictions involve only functionality and the user’s view of computing capability. I am a firm believer that the consumer will be the ultimate decision maker when the fate of the personal computing field is decided. These users will make these decisions based on what they see, hear, and touch. They will not make their decisions based on how many chips are in a box or whether interrupts are enabled during DMA disk transfers.

Using these predictions and a little imagination, we can hypothesize what the ultimate personal computer will be like. Figure 6 illustrates my view of such a machine. Four functional servers are clustered around a central switching, control, and com-
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Figure 6: The ultimate distributed personal computer system for the serious user. Each of the components is an independent entity, each with the power of a typical personal computer available today. The diagram illustrates functionality and does not necessarily imply physical partitioning. NAPLPS is the language used between all components, especially between the User Interface and the Central Computational Component. The User Interface may be able to run a variety of local screen-based text and graphics editors without informing the Central Computational Component.

The database in the optimum way based on the user's answers to certain queries.

The User-Interface Server would be an extremely high resolution colorgraphics display with a variety of user-input devices. All input editing would be handled by this server. The user should be able to enter text and graphics with equal ease. The ability to point to objects on the screen should be available from any of the input devices. And the User-Interface Server should be able to support multiple windows, representing various concurrent activities currently in progress.

The Central Computational Component would be a multitasking system with the computational capability similar to most multiuser timesharing systems. A process (or task) would be active for each window in use in the User-Interface Server. Additional processes could be created to perform tasks for the user.

The Central Computational Component would also be responsible for coordinating all server-to-server interactions. It would also act on the user's behalf if some attention is needed and the user is busy. For example, electronic mail received via the Communications Server would be stored in the File Server without the user becoming involved. The user would be able to retrieve the mail at a later time.

Given this model of an ultimate personal computer, it becomes useful to begin charting an evolutionary path from our current position to this ultimate system. It is obvious in figure 6 that the User Interface must be present in the system before any other component. It is not obvious that the user needs any other component as long as the User Interface has access to a Central Computational Component.

The first step along the evolutionary path is to give the user a User-Interface Server. From that day forward, the user's view of the system begins to form. (The old adage "love at first sight" can be applied to comp-
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Figure 7: The User-Interface Server can be connected to the Central Computational Component in a variety of ways. A modem or a network arrangement allows a person to start using a User-Interface Server long before the Central Computational Component is needed.

This terminal should be standardized, and everything but the kitchen sink had better be available, because the capabilities of that terminal will help shape all future services. And the interface to that terminal must be clearly defined before any terminals are given out.

This is where NAPLPS becomes involved—as the text/graphics terminal-interface protocol for the User-Interface Server. As shown in figure 7, a NAPLPS terminal can be connected via a variety of mechanisms to a Central Computational Component. From the first day of use, the user sees a certain set of capabilities and begins to get used to the local editing features available in the terminal. If a user is connected to a host via a modem, all computation and information are obtained from the remote host. The spectacular text/graphics displays are there from the beginning and are not something the user must dream of having.

From the host computer's point of view, the user is now a constant, a known entity with a standard interface. Services can be developed with the assumption that the user will not be a moving target. This stability gives the developers of the host system more incentive to develop more services. More services attract more users, and more users of course mean more money, etc., etc.

The user begins to consume the prepackaged information and services. Most users may not want to become programmers or system administrators; they merely want to accomplish a task and get on with the rest of their lives.

At some point in life, however, a user may become more sophisticated and require a dedicated processor. A Central Computational Component...
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can be purchased by the user and added to the original User-Interface Server. Many of the services that had been available on the remote host will probably be available on the dedicated processor.

Additional servers could be added to the Central Computational Component as the user desires. One interesting thing to note is that the display capabilities of NAPLPS are such that the Hard-Copy Server can use the same protocol. Also, because the File Server will certainly be able to store NAPLPS, we see that a complete, integrated personal computing system begins to emerge. NAPLPS becomes the common language in the system for information interchange.

The addition of the Communications Server is the mechanism by which a user and personal computer become an entity on a local-area network. Keep in mind that the addition of the Communications Server allows a far more sophisticated system than when the user was remoted to a host via an unspecified network. The remoting was done to create the link between the User-Interface Server and the Central Computational Component. The Communications Server was not involved. Figure 7 illustrates this difference.

If I have not lost you completely and you are good at reading between the lines, it should be clear that NAPLPS is a small part of a large, integrated personal computing system. Many of the parts of the system still need to be specified and implemented. Luckily, the part of most concern to users is quite mature and currently available in the marketplace. I predict that in three to four years systems similar to the one I have described will be commonplace in personal computing.

Those of you who are familiar with the various videotex systems that have been proposed may realize that my ultimate personal computer would be fairly compatible with such systems. In most videotex systems, a network of inexpensive home terminals with enhanced graphics capabilities are connected to a host computer. Ideally, the manufacturers of these terminals will design them so that at some later date the user can add the above-mentioned servers.

As I said at the outset of this article, personal computing has not yet reached the majority of people in the world—but someday it will. If you are currently a personal computer user, you should feel honored to be among the pioneers. As the personal computing field begins to evolve into a mass-market, consumer-oriented, network-based information system, do not be surprised if you begin to feel like the odd man out. Also, do not be surprised if one day your neighbors invite you over to see their new computer that costs one fourth to one tenth the price of yours and has access to thousands of services via networking. And do not get upset when you find out that your neighbors cannot tell you which processor their computer uses or what transmission rates their modem supports. Instead, just feel good about the fact that you know a little bit about the language their computer uses to talk to the rest of the world.
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- integers
- disk I/O
- integers with exponents

types
- user defined types
- enumeration types (no I/O)
- records and selected components
- derived types

attributes
- relational operators for arrays and strings
- labels
- goto
- exit

in out/out mode parameters for subprograms
- list
- print
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Better Software Manuals

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Incomplete, disorganized, and unreadable—that's the way to describe many of today's software manuals. And indeed, what other reaction could there be to the following:

- a 79-page software manual that on page 69 describes "the first thing you will have to do before performing anything . . ."
- a manual that claims the user doesn't need to read other manuals, then, three pages later, refers the user to another manual for necessary information.

About the Author
Dana Sohr is a freelance technical writer and editor. He writes a column on computers for a national trade magazine and is a consultant on office computers for the newspaper industry. His recent work includes a manual for LITMAS' (a cross-indexing program for the Apple II) and one for Calc Result (a spreadsheet program for the Commodore 64).

Acknowledgment
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- a manual containing sentences such as: "The insert/delete key deletes characters to the left of the cursor position if operated in lowercase and if the Shift key is held down at the same time as pressing INST/DEL all characters to the right of the screen cursor are moved one position to the right with every keystroke and spaces created." (This manual, believe it or not, supports a $500 program.)

You don't have to look very far to find such examples, and you don't have to listen very long to hear complaints. Software manuals today are like the bicycle-assembly instructions of yesterday—those notorious documents responsible for unassembled bicycles left rusting away in basements everywhere.

Let's face it: many software manuals are patchwork affairs thrown together at the last minute either by programmers or by technical writers who write too technically. Both assume that the user, given a few scraps of information, can figure out the rest.

This approach certainly saves time and money, but in the long run it is economic suicide. With more computer novices entering the software market, and with similar programs competing for everyone's attention, purchasing decisions will be made not so much on program features but on how easy programs are to learn and use. Thus, purchasing decisions will increasingly be made on the strengths and weaknesses of manuals.

Imagine this scenario: a hardware-store owner is shopping for a computer. He's attracted to the Apple II because he's learned that the Apple can run software to write invoices. But lo and behold, the local computer store stocks five invoicing programs for the Apple—programs that just aren't all that different.

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Define Your Audience
To create the right tone, think of the user, then tell that user what he wants to hear. If the program handles accounts receivable, tell the user how quickly and accurately he can send out his bills. Then tell him how easy the program is to learn and use. If the program does payroll, tell the user how quickly and accurately he can print checks. Then tell him how easy the program is to learn and use.

Entice and assuage the user by giving him what he wants, then go on with the business of listing necessary equipment, describing specific features, and detailing how to go about using the program.

Your target audience will determine whether you transmit information at a breakneck speed or parcel it in doses. Study your intended users, and ask yourself some questions. What does the program do? Does it compile BASIC code, or does it teach BASIC? Different programs mean different users. The user of the first program, who is already writing his own code, understands something about programming. The user of the second program, who would like to write his own code, understands far less.

A manual for the experienced user should transmit information at a faster pace than does the manual for the novice. (For example, the first manual should not stop along the way to explain variable arrays; the second manual should.) By making educated guesses about the intended users of a program, you can determine what information the manual should transmit, and at what pace it should be transmitted.

In tutorials for novices, tone and pacing are crucial. Novices are bound to be shy about using a computer, and in some cases they will be terrified. Remember, many computer users today do not voluntarily decide to work with a computer; the decision is made for them by their managers. A manual for these novices must do several things. It must soothe fears (“You can’t hurt the computer, and the computer can’t hurt you”); it must motivate (“The computer does the mindless tasks you always hated to do”). Only after you’ve created the
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right tone should your manual go on to provide well-paced, step-by-step knowledge.

Often you can’t classify the typical user of a program. For example, both novices and seasoned computer users buy word-processing programs. In this case your word-processor manual should cater to the novice. The manual will not neglect the experienced user because all the information is provided, just at a slow pace. The experienced user knows how to use the keyboard, how to control the cursor, and how to protect disks; he can bypass such instructions and get to information he hasn’t encountered before. Rather than resent the manual for slowing him down slightly, he’ll probably wish that when he was a computer novice such a manual was the rule, not the exception.

Now that you know who the user is, how to create the right tone, and how to pace the manual, think about how to transmit information in a way that makes learning easy. After all, the user might be receptive to new information, but the information serves no purpose unless he can understand and recall it. Learning hinges on the way information is organized and the way it’s presented.

Organize by Tasks

No matter who the intended user is, a manual should be task-oriented—organized according to the tasks the program performs.

Although software manuals are, as a group, moving toward this orientation, a large number retain a more primitive organization. Many manuals are option-oriented; they begin with a section on the program’s first menu option, then proceed to a section on menu option 2, and so on. That’s fine—unless the user cannot perform the options in numerical order.

Consider chapter 1 of a certain bookkeeping-program manual. This chapter describes how to prepare invoices because “Invoices” is listed as menu option 1. In chapter 13, the user is instructed on recording customers’ names and addresses because “Customers” is listed as menu option 13. Unfortunately, until the user records his customer information (chapter 13), the program won’t let him prepare invoices (chapter 1). So the user must read all the way to chapter 13 before actually doing work with the program. And after getting to chapter 13 and recording customers, the user must then try to figure out what to do next. Can he now go back to chapter 1 and prepare some invoices, or does he have to do something else first? The manual doesn’t help him at all.

Learning hinges on two basic factors: the organization and presentation of information.

An option-oriented manual doesn’t synthesize information; it dumps it in the quickest (and cheapest) way possible. The user must read every chapter at one sitting, then try to arrange the information into some sort of logical order.

This scheme of manual organization makes great sense to the programmer, who organizes a task by breaking it into discrete sections of code, but it makes no sense to the user, who needs to be told what tasks to do and when to do them. For example, a word-processor manual should not begin with instructions on creating disk files because the program can’t be used that way. Instead, the manual should first tell the user about editing and formatting, then tell him how to save material.

Task-orientation is no great mystery. Before you begin writing your manual, analyze the various tasks the program performs, then describe those tasks in the order in which the user should perform them. Make sure that all information needed to do the tasks is provided and that extraneous information isn’t included. Most users don’t care how a program works; they just want to know how to use it.

Organizers

The manual shouldn’t joggle the user with unexpected material because the user won’t understand it fully. And if he doesn’t understand it, he certainly won’t be able to recall it.

To prepare the user for new information, include organizers in your text. The organizer, a very simple tool, can be a short introduction to a new section or chapter. An organizer for chapter 2 of a word-processor manual might look like this:

In chapter 1 you learned how to format and edit what you type. In this chapter you will learn how to save what you type. Saving text on the disk will create a “disk file.” Think of a disk file just as you would think of a file in a file cabinet. You can look at a disk file at any time, just as you can look at a file in the file cabinet. You can also add things to the disk file, change the file, or throw the file away . . .

With this organizer in mind, the user can easily understand the purposes of the SAVE, REPLACE, and ERASE commands.

As the example shows, the organizers should look backward and forward at the same time. They should tell the user where he’s been, where he is, and where he’s going. A new computer program is a strange land in which the user can easily get lost. If the manual provides organizers, the user is always on solid, familiar ground. If organizers aren’t provided, the user wanders aimlessly. He’s never certain where he is, and the little that he learns is gained by trial and error.

Move from the Whole to the Parts

Organizers alone don’t ensure that the user will understand and recall new information. The manual should also move from the whole to the parts. At the same time, new information should be linked to knowledge the user already has.

Consider a wholesaler who buys an accounts receivable program. Like most software, this program was purchased because it makes a particular task easier to do; the wholesaler already knows a lot about that task before he lays his hands on the manual. He already knows, for instance, how to prepare an invoice. He
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knows that the invoice should include
the customer’s name and address, inven­
tory codes, prices, and so forth. He also
knows that, according to his usual method,
after preparing an invoice he must manually adjust cus­
tomer accounts, tax accounts, sales­
man accounts, and so on.

However, while he knows how to
prepare an invoice by hand, his new
program does it differently. And the
manual can use these differences to its
own advantage.

People learn partly by contrast;
new information isn’t understood
until a person compares it to a pattern
created by older knowledge. For ex­
ample, the statement “red is a bright
color” can be understood only by
mentally comparing red to other
colors. Likewise, the wholesaler
won’t understand his accounts
receivable program until he compares
it to what he already knows. The
manual should make that connection
for him. It should briefly summarize
how invoices are prepared by hand,
then summarize how the program
prepares invoices. This links new in­
formation to old knowledge, creating
a clear contrast from which the
wholesaler learns. “In the old days,”
he thinks, “I had to do all this stuff by
hand. Now, after I prepare an in­
voice, the program automatically ad­
justs my customer, tax, and salesman
accounts.”

By starting at a simple whole and
by linking new information to old
knowledge, the manual gives the user
his bearings. Now it can safely move
on to the separate parts of the task
and present step-by-step detail on
preparing invoices.

Repeat, Repeat

Sure, the user is intelligent; he
bought your software, didn’t he? But
don’t assume that he will instantly
grasp important points. You have to
repeat those points several times,
then mention them once more in sum­
mary passages.

I’m not advocating that manuals be
written for the addled. What I am
arguing is that learning a new pro­
gram is not unlike being in third
grade and learning multiplication.

Remember third grade? How many
hot afternoons did you spend at the
flash cards until you could remember
that 9 times 9 equals 81?

Because manuals should move from
simple to complex information,
it’s critical that you make sure the
user is with you every step of the
way. This means that every im­
portant piece of information should be
highlighted and dwelled upon, then
drilled into the user’s head. You can
do this subtly, by providing several
examples of a feature new to the user.
Or you can do it directly, by repeat­
ing a definition. In a word-processing
manual, for example, the user could
be told several times the purpose of a
command: “Remember, when you
use the REPLACE command, the file
were working on replaces the old
version of the file.” Using this direct
repetition, you run the risk of irritat­
ing those users who understood the
REPLACE command immediately.
But if you skim over important
points, you run the risk of frustrating
many users.

By orienting the manual around the
tasks that must be performed, by pro­
viding organizers, by linking new in­
formation to old knowledge, and by
repeating important information, you
take a long step toward ensuring that
the user can understand and recall
new information. But that’s only half
the story. You also must present in­
formation in a way that helps users
learn.

Write Actively and Logically

When you prepare a software
manual, you serve as a teacher. Un­
fortunately, you can’t communicate
verbally with the user. You can’t
shout and wave your arms and prod
the user awake. You don’t even know
when the user’s attention is lagging.
However, if you write to engage the
user at all times, presenting your
material in a warm and lively style,
you stand a good chance of commu­
nicating effectively. Dry, passive,
turgid writing is not only boring, it
hinders communication.

Use active verbs. A passive sen­
tence such as, “The program was
bought by Mary,” takes about 25 per­
cent longer to comprehend than the
sentence, "Mary bought the program." Moreover, the second sentence, because it is more vigorous than the first, is easier to remember.

Arrange instructions in correct sequence because that’s how the user should perform the instructions. If you give the instruction, “press the ‘x’ key while holding down the Shift key,” the user will probably press the ‘x’ key, then the Shift key, and discover that nothing happens. Change the instruction to, “hold down the Shift key, then press the ‘x’ key.”

Illogical instructions disrupt and sometimes destroy your message. You should also avoid pointless redundancy (e.g., “a total of four disks”), inconsistency (a command is first “SAVE” then “Save”), pretentiousness (using “determine” where “check” would do), and vagueness (“enter the file name”).

Write Relevantly and Simply

Make your writing more personal, more relevant to the user. Use the pronoun “you,” not “we,” as the former is more relevant to the user. Use the present tense; again, it is more relevant to the user.

Make the manual human. Use humor. Use familiar, everyday examples and analogies. Use hypothetical characters. Talk to your reader, don’t just write at him.

Such techniques are, unfortunately, considered to be the tools of novelists alone. What the manual writer often forgets is that he, too, must serve his audience. He must instruct the user, but that’s impossible when the user is bored and frustrated. Literary techniques applied with discretion keep the user interested and receptive.

Write as simply as you can. Avoid abstract nouns and verbs (e.g., concept, conceptualize). Abstractions do nothing but disrupt your efforts to teach the user. Above all, don’t use jargon unless it’s necessary and unless you’re willing to define it the first few times you use it.

Use artwork wherever possible. Photographs and illustrations break up large bodies of type, attract the user’s attention, and make information more relevant. Instead of simply describing how to load disks, include an illustration. Rather than just describing an important screen image, include a photograph.

Evaluate with the Eyes of a User

The evaluation is the last line of defense against errors, but too often vendors and writers ignore it (judging by their final products).

The evaluation doesn’t have to cost a lot of money, and what money is spent comes back in the form of customer loyalty, goodwill, and sales. During the evaluation, you should identify and correct the manual’s shortcomings; errors should be removed and omissions filled in. A critical evaluation produces a well-written, truly instructive manual that will make friends of users and computer-store owners alike.

You can evaluate the final draft of a software manual in various ways. Some methods cost more than others, and some are more effective than others, but no single method is sufficient. A thorough evaluation will incorporate two or more of the following methods:

Editing: Hire a professional editor on a temporary basis, preferably an editor experienced with instructional materials. An experienced editor can read the manual as the user would, and he can correct writing deficiencies.

Checklist: The checklist, a very simple method of evaluation, sets standards for what the manual should provide. Here’s an example of a much simplified checklist:

• Does the manual include (1) a table of contents, (2) an index, (3) introductory and summary material for each section and chapter, (4) a tutorial section in which the user gains hands-on experience with the program’s functions, and (5) a quick-reference section in which the user can find information quickly and easily?

• Is the manual task-oriented?

• Does the manual move from the whole (a nontechnical overview) to...
the parts (step-by-step knowledge)?
• Does the manual tell the user how to recover from errors, and are all error messages listed and explained in a section where the user can find them easily?
• Do section headings give a good idea of what the sections contain?

To devise a thorough checklist, examine existing manuals. What mistakes did you make in the past? What did you omit? Why did users complain?

Devising a checklist takes time, care, and effort. Fortunately, it can be used to evaluate future manuals, too. But the checklist alone is not a thorough method of evaluation. It uncovers mechanical errors but cannot uncover missing or ambiguously worded instructions.

Self-review: Self-review, like the checklist, is a simple method of evaluation. The manual writer tests to see if he can use the program based only on the manual’s instructions. In the process he typically uncovers missing or ambiguous instructions, incomplete descriptions, misspellings, and grammatical errors.

Self-review should be used for every manual but not as the sole method of evaluation. The writer, if he has any ego at all, isn’t objective about his writing; he likes what he has written. Further, he already knows how to use the program, and during the self-review he may unconsciously supply information that is missing from the manual.

Programmer review: Have the developer review the manual. The programmer checks to see that the manual has covered all the program’s functions and that it has covered them correctly. Unfortunately, while the programmer is the person best qualified to evaluate the technical accuracy of the manual, he will probably be of less help in evaluating the manual’s organization and presentation.

User walk-through: Select potential users of the program, hand them the manual, and see how quickly they learn the program. (Select worst-case users—people who have no computer experience.) Are they confused and frustrated by certain sections of the manual? Do they have trouble finding information they need? Revise the sections where users run into trouble. Include more introductory and summary material, provide more examples; provide whatever the users believe is lacking. Then repeat the process with another group.

Users, after reading the manual, can be formally tested on their proficiency with the program. Can they perform all of the program’s functions? How long does it take them? If a large percentage can’t perform a certain function, revise the sections where that function is covered.

Users will often respond in mysterious ways to instructions that seemed perfectly clear to the writer. Those instructions can easily be revised. Users also uncover missing instructions and incomplete descriptions better than the writer or programmer can.

Field test: If you’re willing to spend some time and money, conduct a formal field test of both the program and the manual. Install the program at several sites, provide drafts of the manual, and then wait for the phone to ring. Are the test users calling day and night? Can they understand the manual? Can they use the program? It costs less to answer these questions now, when only a few people are trying to use the program, than when 1000 buyers are calling in for help.

After two weeks, ask the users for comments and suggestions. Accept criticism, then use it to improve the manual. As in the user-walk-through method described above, test the users for specific knowledge, then revise the sections that don’t seem to be communicating effectively.

Conclusions

Buyers want and expect good manuals, and they will buy from anyone who can provide them. Thus, the poor quality of many of today’s manuals offers a tremendous opportunity to enterprising vendors. Those who make a serious effort to produce well-written, instructive manuals will have a big advantage over their competitors; those who do not make the effort will eventually fall by the wayside.

In all things—preparation, organization, presentation, and evaluation—all decisions hinge on the user—who he is, what he knows, and how he learns. If you constantly keep the user in mind, you’re on your way to producing a readable, usable software manual.

Bibliography
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Let me begin with a confession: while I have a lot of fun with this column, I have an ulterior motive. True, this is the User's Column, and it will always be primarily for the benefit of computer users rather than hackers.

(As did many computer terms, "hacker" seems to have originated at MIT. The original German/Yiddish expression referred to someone so inept as to make furniture with an axe, but somehow the meaning has been twisted so that it now generally connotes someone obsessed with programming and computers but possessing a fair degree of skill and competence.)

My ulterior motive is to seduce my readers into becoming interested in what's happening in their machines, and in the computing world generally. For example, you may never learn a programming language, but the availability of good programming languages vitally affects you as a computer user; if hackers can't get powerful, well-documented, and highly portable languages, programs are going to cost far too much. In the worst case, we might drift back toward the "high priest" syndrome that dominated computers back in the days of clean rooms and white coats.

So: for those who've written to ask, that's why I am and remain interested in languages for microcomputers. On which subject . . .

The big news is that Modula-2 runs on the Sage II computer. Modula-2 is the new language by Niklaus Wirth, the inventor of Pascal. If I'd known about it, I might not have started the Pascal Prime Project; Modula-2 is supposed to have most of the fixes we've all wanted for Pascal, plus a lot of other features.

(The Pascal Prime Project is a meeting of publishers of Pascal implementations for microcomputers; the meeting will, we hope, establish some standards for Pascal extensions.)

Pascal was intended as a teaching language, to be "compiled" on paper by instructors. A lot of people liked it, and transformed it into a "real" programming language. It was limited, particularly in text-handling and I/O (input/output) features, but it attracted a lot of adherents.

Modula-2 (short for modular language) was intended from the beginning as a full-fledged language. It was produced by Wirth after nine years' study of the problems of Pascal, including a year's sabbatical working with Mesa, the "Pascal-like" Xerox internal-development language. Modula-2 is supposed to have all of Pascal's desirable features, plus corrections for all its drawbacks.

We'll see. I only just have it running, so I can hardly claim to be an expert. On the other hand, I've liked everything I've seen so far. Modula-2, as the name implies, is compiled in chunks; once a chunk is working, it can be put into a library, accessible to any program that wants it. No more endless compile operations!

In particular, all Modula-2 I/O is "magic"; each implementation comes with a standard library of I/O routines that look a lot like an operating system. Programmers simply import them from their black box, and once they're available, invoke them as standard procedures. For example, you could have a module of CP/M I/O routines. It
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would contain error-handling routines—including the infamous BDOS errors, but supplemented with real information as to what has happened and what you should do now.

Note that the I/O routines are not part of the compiler. On the other hand, once they've been perfected and tested, they need never be compiled again; in fact, the compiler will complain if you try to compile (or link in) more than one version of the routines. The bottom line is that a good Modula-2 package should make I/O at least as convenient as CP/M or the better grades of BASIC—with plenty of capability for improvement if wanted.

I don't really know what that means in terms of compiler writing problems, but I don't have to care. From the user's point of view, many of Pascal's I/O problems vanish, and that's what's important.

The only microcomputer implementation of Modula-2 that I know of comes from Volition Systems, a group of computer hackers from the San Diego area. Its Modula-2 comes with a thick stack of documents, including Wirth's book *Programming in Modula-2*. Volition Systems claims that a good Pascal programmer can become proficient in Modula-2 within a week. I can't vouch for that, not having had a week at it yet. I can testify that the documents seem to be written in English, and I've had no problems with the (rather small) parts I've waded through.

Late addition: Logitec of Los Gatos, California, promises a Modula-2 native-code compiler for the 8086 computer before June 1983. At present, it runs on Niklaus Wirth's machine in Switzerland.

My initial reaction to both the language and Volition Systems' implementation is positive. A few of the language constructions seem a little odd, and I know I would not have done certain things quite the way Wirth did—but they do make sense; at least those I've encountered do. Unlike my first experiences with Pascal, I don't find myself continually wondering, "Why the daylight did he do that?"

As I said, we'll see. Just at the moment, the only thing we have here that can run Modula-2 is the Sage; that's not a problem, because the Sage works beautifully. By next month we'll have thrashed it about, and I'll be able to report benchmark times and things like that. Meanwhile, our love affair with the little Sage II continues; if you like UCSD Pascal and the "Scud" (UCSD p-System) operating system, you'll love that machine.

Volition Systems' Modula-2 runs on virtually any machine that can run p-System Pascal; in particular, that includes the Apple II and III as well as the Sage.

More Good News

One of the best things that happened to microcomputers in 1982 was the pseudo disk: a system for fooling your computer into thinking that a bunch of memory is a disk drive. This really speeds up compilations, assemblies, and other tedious work.

I'm told it started in England under the name "Silicon Disk." My first experience was with the "Warp Drive" developed by G&G Engineering (San Leandro, California); this used the 8088 in a Compupro 816 dual-processor computer to turn superfluous ordinary memory into a pseudo disk. Later, that got modified into what is now called M-Drive, and I use it all the time.

Then came Semidisk—a board especially intended to be a pseudo drive; unlike the Compuro M-Drive that required a dual processor and a direct-memory-access disk controller, the Semidisk board would work with any S-100 system. (There are also versions for the IBM Personal Computer.) We installed it in our Compuro as the N-Drive, and I've happily used it ever since.

Now comes the Compupro M-Drive/H. This, too, is a half-megabyte pseudo-disk board that can be connected to any S-100 system. It's a little faster than the Semidisk, although you won't notice that unless you're using a superfast processor. M-Drive/H lists for about $100 less...
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Circle 479 on inquiry card.
than Semidisk; both are sold at discounts by various mail-order houses. Neither is at all difficult to install given familiarity with CP/M and the innards of your system. (If you don't know or care what a number in base 16 is, find someone who does before trying it.)

You can put in more than one M-Drive/H if you need a pseudo disk larger than 500K bytes; or you can get a full-megabyte Semidisk board for $2995. I've never needed more than half a megabyte, so I've tried neither method, but I've no doubt both would work.

There seem to be as many new sources of pseudo-disk boards as there are manufacturers of memory boards, so I expect competition will drive the price down a lot during 1983.

Lobo Howls Again

Barry Workman of Workman and Associates has his new Lobo. Lobo calls it a Max-80. Barry calls his Ralph. As far as I can see, it was love at first sight.

The Lobo comes with a completely reprogrammable keyboard and extensive documents; there's even a disk source for both the keyboard and the screen codes. Thus, if you want the key that most people believe is the "E" to be the Return key, you can set things up that way. If I ever get one, I probably will change the key-tops; I can't say I care for the Teletype keyboard layout Lobo has chosen (although my late mad friend would have liked it, and my colleague Robert Silverberg is used to a key layout that has quote marks above a number)

It has a lot of neat features, such as a built-in, battery backup clock; also, a controller able to handle 8-inch, 5¼-inch, and hard disks, all at the same time and in any combination. For those unable to afford an S-100 system with Semidisk or Compupor's M-Drive, for $95 extra the Lobo comes with an additional 64K bytes of memory plus software to turn that memory into an I-Drive—that is, to fool the system into thinking that the extra memory is a small, but very fast, disk.

The Lobo processor is a 5-MHz Z80A, making it faster than Alex's 4-MHz CCS S-100 machine, and nearly as fast as Zeke II, my Compupor 6-MHz Z80B. Indeed, the Lobo runs as fast as the 8085 in my Compupor 816 dual-processor machine, since we had to slow that down to 5 MHz to accommodate Jim Hudson's 8087 math chip.

All in all, at $820 ($915 with the extra 64K-byte memory) including CP/M 2.2, the Lobo is a strong candidate to be one's first machine. If you get one, consider getting the Zenith 12-inch Green Screen, which I've seen at Priority One for as low as $89.50. I think it's slightly better than the Amdek that Lobo sells, and costs less. You'll also need disk drives; but I note that dual-drive 8-inch systems (single-sided) complete with case and power supply can be had for as low as $600, and are regularly for sale at considerably less than $1000.

There is this problem: Lobo does not furnish the source to the CBIOS (customized basic input/output system; the "hooks" by which your system talks to CP/M); and this means that you can't be sure that all disk systems will work properly with the Lobo. You can assume that all those Lobo sells will work, of course; but if you want to replace them, or you already have disks, you take your chances.

I don't understand why Lobo doesn't give you the CBIOS source. It's not as if it were a valuable secret, and I must have a score of letters detailing awful problems that would never have arisen if my correspondents only had the source to the CBIOS. With all-in-one package systems like the Osborne, there's not such a strong need for the CBIOS source. After all, Osborne has a big network of dealers to provide support for purchasers who get in trouble, and you're not supposed to be adding non-Osborne stuff to the machine anyway. However, systems like the Lobo are useful in large part because of their flexibility—but not having the CBIOS reduces that flexibility by a lot.
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If you're free between the hours of six and midnight, make a date with one of the world's fastest, most powerful online information services — at a fraction of what it would cost during the business day. All you pay is a $50 registration fee to receive your classified user's password. Then, any evening, you can summon up a wealth of information for as little as $6 per hour.

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Either Smartmodem is a perfect match for many different computers. And if you have an IBM PC. Hayes also provides the perfect communications software.

Smartcom II™ We spent a lot of time developing our software, so you can spend less time using it. Smartcom II prompts you in the simple steps required to create, send, receive, display, list, name and re-name files. It even receives data completely unattended—especially helpful when you're sending work from home to office, or vice versa.

And if you need it, there's always "help." One of several special functions assigned to IBM function keys, this feature explains prompts, messages, etc. to make communicating easy extra.

With Smartcom II. it is. The program remembers communication parameters for 26 different remote systems. Just punch a key, you're all set.

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Special offers for Smartcom II owners! Dow Jones News/Retrieval Service has a special introductory offer for Smartcom II owners. By calling a toll-free number, they receive a free password and one free hour of service anytime after 6:01 p.m., local time.

You'll also be entitled to a valuable...
Anyway, Barry Workman and my son Alex like their new Lobo. Me, I'll continue to reserve opinion until I've watched for a few months; but I'll admit that I'm impressed by what I've seen so far.

Things My Postman Brings Me

A lot of people seem to think I'm a last resort for advice. Sometimes I can help, but fair warning: I try to answer all my mail, but work here ebbs and flows, and when it's at flood tide it can take weeks to months for me to get at something. I apologize, I was brought up to believe one should promptly answer one's mail, and John Carr and I try; but some days the press is just too much, and letters get into places they shouldn't, from which moldering piles they surface only by accident.

I've recently received a stack of horror stories. One, from Professor R. W. Marks at Villanova, concludes:

The sum total of my experiences have led me to several rules for microcomputer buyers. (1) Will an abacus do? That is, will the grief you have to put up with be compensated by the advantages of a big machine rather than a toy? (2) Don't be misled by the size of a company. As Lily Tomlin says, "We're the phone company. We don't care. We don't have to." XXX and YYY (two large mail-order dealers) don't care. They don't have to.

(Note: I don't name the two firms, because I've had no bad experiences with the one, and no experience at all with the other. As a matter of policy, I insist on several instances before naming names. . . J. E. P.)

(3) Unless you want to learn one hell of a lot about the S-100 bus and the BIOS and the other pieces of alphabet soup, buy a system already integrated, or pay someone to do the integration. I'm not very impressed with what Apple offers for the money, but the thing runs as soon as you plug it in. (4) Under no circumstances trust salesmen or manufacturers to tell you anything remotely close to the truth about a product before you buy it. You will get all the rude surprises only after you have paid for the thing.

(5) Don't assume that expensive pieces will come with manuals.

I discovered it had come without any documentation, missing the main fuse and fuse cap, and seriously dented in one corner. I immediately called Jade and was told (no joke) that it was supposed to come without documentation, fuse, or fuse cap, and they were sorry about the dent, but it wasn't a Jade item and they were not responsible . . .

Eventually, through persistence, he got someone at Jade to admit that the box was supposed to have documents; and finally they arrived. (Dr. Marks found them "surprisingly good.")

The story goes on, but the point is made: in dealing with mail-order houses, bigger is not necessarily better; and you'd better be prepared to be patient. Perhaps then, one should go to a computer store? It's time to hear from another reader.

Larry Hansford, a systems consultant in New Carlisle, Ohio, says:

A typical scenario is a businessman who goes to the nearest computer store and tells the salesperson that he needs a computer for accounting and word processing. He walks out of the store with boxes in hand containing a computer, printer, software, supplies, and very little idea what to do with it.

Some time later, I get a call from an irate businessman who feels he has been taken advantage of. Unfortunately, he probably has been! I have been less than impressed with the knowledge of the salespeople in most of the computer stores. Their goal is to get a commission, not to make a satisfied customer. Most are, however, near experts on computer games of any and all types. I appreciate the resulting business I get, but I resent having to clean up the mess. If they'd gotten competent advice in the first place, they'd have paid less and gotten more.

Unfortunately, both my correspondents are right. Buying parts by mail order can, if you're not careful, bring you unrelieved grief; but going to the local computer store can be an even less satisfying (and more expensive) experience. What, then, is one to do?

One solution is proposed by Erwin Strauss, sometimes known to science-
fashion conventions as the folksinger Filthy Pierre (indeed, his letter is signed Filthy). Strauss complains that my advice, namely that one should deal with systems-integration specialists who know what they're doing, is impractical. "Pournelle," he says, "gets special service because of his BYTE connections, and as for that nighttime visit by Tony Pietsch, that's like the New York Times' restaurant critic asking a top chef to whip up something and deliver it. For us mere mortals, it's more like getting a neurosurgeon to come over at midnight to put on a Band-Aid: if we succeed, we'll need scientific notation to figure the bill." He continues:

I have some advice that's more practical. First, choose a computer that's been widely promoted (preferably on TV) for at least a year. Jerry may dream about the day when makers "no longer use their customers as a quality-control department," but for now the best thing is to let those who always have to be first on the block be the guinea pigs. If there hasn't been a big stink about a heavily hyped machine after a year, it's probably not too bad. This rule also means there'll probably be a service shop near you that's seen a good number of broken computers come in over the counter, so they should be able to diagnose accurately, and fix quickly, the problems that are characteristic of your machine.

Of course, this cuts the field down to names on the order of IBM or Apple or Radio Shack and such. I can already hear Jerry moaning over the features of his Godbout and Televideo and suchlike gear; but a novice has no business with that level of equipment.

Strauss goes on at some length, ending by saying that if you have unlimited money ("as long as it stays within, say, four figures") you should pop for an IBM PC; otherwise, get a TRS-80 Model III. He's not so certain about the Apple II (despite its widespread publicity), and he hates the Apple III. He concludes, "Whatever the off-the-shelf system you get, you can be sure that it won't do everything you like, and it won't do much of what it does quite as handily as you'd like. But it will be serviceable, and at an affordable price, and with a minimum of start-up hassle."

That's one opinion. I have another.

### How to Buy a Computer

First, regarding Strauss's comment that "a novice has no business with that level of equipment," I couldn't disagree more. True: I certainly wouldn't aim a novice user at one of Bill Godbout's newest state-of-the-art systems; but then neither would Dr. Godbout. Tony won't let me have some of the new stuff I own until he's thoroughly bashed it about and found its limits.

### Buying by mail order can, if you're not careful, bring you unrelieved grief.

However: because a company is out at the frontiers of computer technology doesn't mean it can't and doesn't make good stuff for the ordinary user. Indeed, Compupro is an excellent example: here in this room I have three of its systems. One is Zeke II, the Z80 I'm writing this on now. The Z80 has been around so long that it's practically old hat; and Zeke II is utterly reliable, quiet, and operates nearly invisibly.

(Truly: we have customized the screen output and keyboard on Zeke II; but the system itself is very much standard from Compupro, and it works quite nicely with either the Televideo 950 or the Zenith Z-19 terminals.)

The second is an 8085/8088 dual-processor computer, as staid and stolid as you can get nowadays. When we first brought it up, Compupro was the only outfit that had a dual-processor machine, and I certainly wouldn't have recommended the system to a beginner; now it has become a standard, and consultants like Bill Grieb and Colin Mick recommend dual processors for vanilla systems.

Moreover, you can get a good S-100 system for at least no more than you'd pay for an IBM with comparable capabilities, and I for one prefer the more flexible system. My motto remains, "Iron is expensive, but silicon is cheap." With an S-100 system you can upgrade for less than with anything else I know of; and upgrades can be very significant.

I see many exciting new systems in development: 16-bit systems, even 32-bit systems, all upward-compatible with what I have at present. Right now all I have to do to make my 8085/8088 dual processor into a 68000 system is replace one board; all the memory, disk drives and controller, modem, I/O boards, and such like will work fine.

My third Compupro machine is utterly experimental, with a 12-MHz 8086 board. Now I certainly wouldn't recommend that for a novice; not this year, anyway. Next year, though, might be a different story.

Moreover, my experience with TRS-80 and Apple systems hasn't been as pleasant as Strauss implies yours will be. We hadn't had our Apple a month before it required major repairs; its switching power supply blew and took with it the motherboard and every card in the system. Then we had the experience of updating our DOS (disk operating system): more than $60 for a single ROM (read-only memory) chip and a disk. This wasn't to get a new DOS, you understand; it was merely to update what we had. Now, they tell me, Apple won't even let you off that easily. In the future it will cost a great deal more to upgrade an old Apple II.

In fairness, I have to say that Carl Helmers has had five Apples for years. All run UCSD Pascal. His total repair bills for all five machines sum to less than $500. Carl admits the machines are limited, but he has no complaint about their reliability.

What he calls reliable, though, is not my definition, I agree with Bill Godbout: "If the error rate is high enough to measure, it's too high." I've watched a lot of computer users shake cables, reboot disks, flick switches on and off, and in general put up with glitches that would have me on the phone to Tony Pietsch in seconds. I trust my living to these machines. I cannot and will not put up with "rather more or less . . ."

The Apple is great for Epyx's (marvelously fun) Crush, Crumble, and Chomp, but when I develop pro-
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grams in UCSD Pascal or Modula-2, I’ll use the Sage, and I won’t regret the extra $1500 it costs.

As to our TRS-80 Model I, we trashed that sucker long ago. It was always unreliable, and repeated trips to the local Radio Shack outlet didn’t help. The problem was that Tandy cut corners; I have a letter from a Tandy official referring to “the realities of the mass market.” If you’re selling 100,000 machines, saving five dollars a unit can be significant—both in profits to the maker and misery to the user. Our system internally generated so much radio noise that anything additional—even an airplane using Doppler radar!—could cause it to spontaneously reset.

We got the TRS-80 for the boys, but they were never happy with it. When they tried to use it, they might or might not be able to boot the system disk on the first try. There was always doubt as to whether they’d be able to save programs—or even save text they’d written. It was clearly an undesirable situation for young people learning to use and like computers, and eventually I got rid of it.

Again, in fairness, I understand that a lot of people are happy with the new computers Tandy puts out. My point is that advertising budgets don’t have that strong a correlation with system utility and reliability. Just because a system is advertised on national TV doesn’t make it a good buy any more than “as advertised on NBC” is a guarantee that your new car won’t be a lemon.

Unfortunately, computer stores aren’t the answer either. Example. I acquired a well-cared-for, second-hand Apple II from Bjo Trimble, the Star Trek lady. It was an older machine.

I knew nothing about Apple computers. The boys pointed out that we had a bale of software, mostly Epyx games, that wouldn’t run with the disk operating system that came with our Apple. They’d looked over the games and very much liked them, and birthdays were coming up . . .

I could, I suppose, have studied up on Apples; but there’s a lot to do here, and it wasn’t convenient just then, so instead I packed the whole mess up and went out to Compusil. After all, it specializes in Apples now, and I’ve been doing business with this outfit for more than five years, going back to the time when it was Computer Components and sold surplus equipment.

I arrived. Waited patiently. Got a salesman. Explained that I had an old Apple II, didn’t know what boards were in it, and was interested in how to upgrade it.

The result could have been drawn up as a Doonesbury cartoon. The salesman cut loose with a string of jargon that certainly made no sense to me—and which I suspect couldn’t have made sense to anyone else. He touted some games programs. I explained that I had plenty of games programs. He mentioned printers. I told him I had a printer.

I began to get the brush-off. Clearly, the commissions on bells and whistles for the Apple aren’t worth a salesman’s time; not that it mattered, because it also became clear that the
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salesman didn't even know what was available. He never mentioned any of the stuff I'd come prepared to talk about, like Pascal, or a Microsoft Softcard. Fortunately the cashier was well informed and took the trouble to give me some advice; without her, the trip would have been an utter waste of time.

Even so, I left thinking about a letter I got a year or so ago. It said, "Some day the salespeople in computer stores will be able to recognize a customer when they see one. Then maybe they can learn what to do when they find one . . . ."

Some computer stores are excellent. Many more are not. Unfortunately, those who can tell the difference aren't the customers with problems; it's precisely those who need help the most who can't tell whether the help they're getting is of any use.

So What Do You Do?

First, as I've said before; systems-integration consultants will earn their fees. True, Tony Pietsch isn't out looking for that kind of work now—but he was when I first met him. Filthy Pierre seems to have forgotten that when I met Tony he was a graduate student, and I was a science-fiction writer. This column grew out of my experiences, and, yes, I know I'm likely to get better than average treatment from people who know who I am now; but it wasn't always that way.

How do you find good systems consultants? How do you find any other professional help? The same principles apply. People who know what they're doing leave a trail of satisfied customers behind them. The really good ones don't hesitate to give references: their previous customers are their best salespeople.

Second, I do agree with Strauss on one point: unless you know what you're doing, don't go buy something brand new, particularly not from an outfit you never heard of. Wait for evaluations. Plenty of honest reviewers are in this field. Read what they have to say; and if all the reviewers ignore a system, ask yourself why. It may be we know something. Most of us would rather write an enthusiastic rave than a negative review. I know I would.

Third, ask yourself what you really want. Most of the horror stories I hear come from readers who tried buying their systems a piece at a time at sale prices. You certainly can save some money that way; but even if you're pretty sharp, you'll pay with your time. Take Barry Workman's Lobo system as an example: he bought his disk drives on sale from Priority One. The Lobo worked fine first thing out of the box when connected to my Compupro drives; but it took a couple of days fooling with configuration jumpers to get it working with Barry's new Siemens drives. If he hadn't been here, with access to Priority One's helpful salespeople like Keith Burgess and able to call Nor Singh, it might have taken a lot longer.

And that, I think, is the real bottom line: unless you know what you're doing, deal with people who do; which is to say, don't try to outsmart the system. If people who seem to know about these small machines try to tell you that we haven't yet got to where a naive user can put together a business-quality computer complete with software for less than a couple of thousand dollars, perhaps you ought to listen.

I don't know any magic way to get a system dependable enough to bet your livelihood on-serviceable, convenient, complete with software—for so-called home computer prices. I do see a lot of computers, and I know what I'd buy as of this afternoon; but that's a different thing.

When Roland Green, the Chicago author who worked with me on my new book, Janissaries II: Clan and Crown, wanted advice on a first system, I told him to look at the Osborne. It's not an optimum system, but I don't know a better beginner's package complete with software for a price Roland could afford.

When I went looking for a replacement for Ezekial, my dormant friend who happened to be a Cromemco Z-2, I did have an advantage: the casual buyer doesn't have: I knew most of the major software developers, as well as a number of successful systems consultants. It seemed to me that people whose businesses depended on reliable equipment might have strong opinions on what was best; so I asked them what they used. When many more than half told me they had Compupro systems, it was enough for me, especially when I found that Tony had come to the same conclusion by studying the system specs; so that's what I bought. We sent in an order for the whole package direct to Compupro; and I haven't been disappointed.

When I go shopping again, I'll do the same thing; somehow I have more faith in the judgment of people like Richard Frank of Sorcim and Mike Lehman of Digital Research than in TV advertisements. But that, I hasten to say, is my view.

JRT Pascal, Revisited

A few issues ago I mentioned that when my son Alex finished his Pascal Tutorial Package for the Pascal/M and Pascal/MT+ compilers, he intended to work one up using the $29.95 JRT Pascal compiler.

I was premature in that statement. Alex, it seems, has a wild talent: he carries a Murphy field about with him. Whatever Alex works with, it is very literally true that if something can go wrong, it will. He also likes to work things to their limits.

Example: we were overhauling my Minimum Data Base for Barry Workman, and Alex found bugs and failure modes that must have been in there for years without my noticing them. When I fixed those, he found others.

Another example: when trying deliberately to create a run-time error to use as an example for the Pascal Introduction, I found that Pascal/M will cheerfully allow you to divide by 0. Not only does it not report an error, but it thinks that 3/0 = 0.
The Juki 6100 printer. It should cost a lot more than $699.

The new Juki model 6100 letter quality daisy wheel printer has full features you'd expect to find on a more expensive printer.

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0.0E-65, rather the opposite of what you'd expect infinity to look like. (Pascal/MT+ allows the division, but reports an error; it sets 3/0 equal to a very large number, which is more reasonable.)

Something like that happened in analyzing JRT Pascal. It seems there are bugs in the compiler. Not terribly serious bugs; indeed, we found nearly as bad in Digital Research's Pascal/MT+ and Sorcim's Pascal/M. There's a difference, though. Whereas Pascal/M and Pascal/MT+ try to be standard Pascal, with nonstandard extensions, the JRT Pascal compiler doesn't. JRT is intentionally a nonportable dialect, and programs written in JRT Pascal haven't a chance of running under any other Pascal compiler; worse, programs that will compile in standard Pascal blow JRT Pascal sky-high.

Worse yet, though, is the error handling. Pascal was designed as a teaching language, and it has a standard set of error messages. They are numbered and have a standard format, and experienced Pascal programmers know most of them by heart. For example:

```pascal
Program Badhello (Output);
BEGIN
  writeln('Hello, world.');
  writeln('foo') (* note undeclared variable *)
  writeln('Hello again.');
END {badhello}.
```

obviously isn't going to compile. Pascal/M and MT+ give you a standard message:

```
Error 6, Illegal symbol (possibly missing ; on line above)
```

which is probably the most common error encountered in Pascal. That error is rendered somewhat differently by JRT Pascal:

```
— Semicolon expected
```

This is reasonable, although it doesn't do much for teaching you what standard Pascal messages look like. However:

```pascal
BEGIN
  writeln('Hello, world.');
  writeln('foo') (* note undeclared variable *)
  writeln('Hello again.');
END {silly}.
```

has far different results. The error messages generated by Pascal/M and Pascal/MT+ are shown in listings 1 and 2. These are about what you should expect. JRT Pascal generates the stuff shown in listing 3. Note that the only reference to an undeclared variable will have scrolled off the screen (it happens fast, too), and that there is no reference to the actual problem in the symbol table. The whole thing is pretty intimidating to someone just learning Pascal.

Pascal/M and Pascal/MT+ will show you where the error took place and offer you an opportunity to continue. JRT Pascal doesn't print the line, doesn't continue, and doesn't really identify the problem.

There has been a great debate in Dr. Dobbs Journal about JRT Pascal, with one reviewer contending that the language has its uses. He says it's a good production language for writing business programs and is certainly worth $29.95. Another reviewer says it isn't acceptable at any price. I'm not going to get involved in that argument. I do say that it is not a language for beginners. It has funny bugs and gives confusing error messages.

Beginners don't have enough experience to know whether their problems are caused by flaws in the compiler or in their program. Add error messages not related in any obvious way to the error—there are lots more that I haven't room to show—and you have a situation tailor-made for undermining the student's self-confidence. Thus, Alex has decided against writing a version of his introductory package for the JRT compiler.

Those who know Pascal might find JRT Pascal useful; I'm told by experienced programmers that you can, if you're clever, program around its bugs. However, beginners should stay away from it, and anyone dis-
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The bad news is that Digital Research put out the new Pascal/MT+86 Reference Manual, and the manual for the MT+86 Speed Programming Package, before Franusich joined the staff; and lordy does it show.

I'm a great fan of the Pascal/MT+ Speed Programming Package (SPP). That, you may recall, is a combination Pascal text editor, source-code formatter ("pretty printer"), and syntax checker that adds many of the best features of UCSD Pascal to the CP/M Pascal/MT+ compiler. It became even more important for Pascal/MT+86, because I don't have an editor that works under CP/M-86, and thus without the SPP, I couldn't write Pascal programs to run with my 8088.

Actually, that's not strictly true: thanks to the chaps at RR Software, I have Vedit for CP/M-86; alas, due mostly to sloth, I have not yet installed it, which isn't really fair to the Vedit people. I'll have to get it up if I'm going to use the 8088 side of my dual processor, since it is, at the moment, the only general-purpose editor I have that can work with the 16-bit processor.

Anyway, when Jim Hudson was over to show me how to use the 8087 math chip in combination with Pascal/MT+86, he helped me get the SPP editor installed, and it works fine, as does the MT+ compiler. Unfortunately, the old Digital Research "technical writing" staff got hold of the SPP documents and did for them about what it did for Eubanks' CBASIC manual. We did get lucky, though: the Pascal/MT+86 manual seems to be essentially unchanged from the last MT+ version, except for a global replacement of MT+.
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with MT+86. In fact, it's somewhat improved, with a few additional examples.

Of course, it does have that irritating "All Information Presented Here is Proprietary to Digital Research" inanity at the bottom of each page. Even so, although the manual is not what I'd call exemplary, it hasn't been ruined either; and with the new team in Digital Research's document foundry, we can hope for an update that will be a real improvement.

Unaligning the Osborne

In my December column I complained that the Osborne 1 lacks certain ASCII character keys. A dozen or more readers have written to tell me I was mistaken.

Although this is not documented anywhere that I (or any of those who wrote) know of, you can get the "missing" ASCII characters on the Osborne with the following key combinations:

Control-\ produces { (Control-
less than) produces left curly
brace)
Control-< produces } (Control-
greater than) produces right curly
brace)

Control/- produces - (Control-
slash produces tilde)
Control-= produces = (Control-
equals produces accent grave)

I thank all those who took the trouble to inform me. Also, I appreciated the kind remarks many of you enclosed.

Fastest Benchmark Yet

I continue to get new data using my matrix-multiplication "benchmark of sorts" from the October column. This "test" fills two matrices with real numbers, multiplies them, then sums their elements to give a checksum. Although the algorithm used to fill the matrices produces integers, the elements should be declared as real numbers.

For a time, the record was held by the Sage II running UCSD Pascal. Then Jim Hudson came over and installed his piggyback 8087 board that rides on the Compupro 816 dual-processer machine, and that, running under Pascal/MT+86, took over the leadership.

Aaron Fox of the Department of Physiology at UCLA reports an even faster time. Fox writes:

Recently our lab acquired several Lomas Data Products computers. This computer has a 10-MHz Intel 8086 processor operating with fast static memory. The October BYTE, with your matrix-multiplication benchmark, was of particular interest to me since it gave more times to test our Lomas against. For a 20 by 20 matrix the times for the Lomas were as follows:

2.9 seconds using Microsoft BASCOM-86
34 seconds using Microsoft BASIC-86

Thus, the 10-MHz 8086 is about 7.5 times faster than your 8085 for BASCOM, but only about twice for MBASIC. It seems that the interpreted BASIC is not a fast implementation. (This may explain why all the benchmarks I have seen with the IBM PC running interpreted BASIC are quite similar in speed to the same programs running on a 4-MHz 8080.)

The point of this letter is that the 16-bit machines are fast and they are available with software today. As Sol Libes points out in the November BYTE, a 5-MHz 8086 is equivalent to 0.4 VAX, a fast and powerful machine.

The Word, Revisited

I've received several letters asking about spelling programs. This is a subject of considerable interest to me, and I think I have tried every spelling program available for my machines.

I continue to use Wayne Holder's The Word Plus program, version 1.2, from Oasis Systems. This version allows me to transfer the programs, plus the dictionaries, over to a pseudo disk for really fast operation. The Word Plus has a number of nice features, including the ability to look up the word in its dictionary; if it sees anything it thinks might be what you intended, it offers it as a candidate spelling and gives you the opportunity to correct the word.

The Word Plus is fast and easy to use, and it offers me a lot of information, such as a table of the words I've used sorted by frequency of use, thus allowing me to see how many times I've used " alas" and such like. (Do
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people really prefer "unfortunately"? Alas, some have written to say they do.) The only improvements I’d make in The Word Plus have to do with defaults; I wish it would let me enter the name of the “specials” dictionary once and for all, instead of making me type it in its name each time I invoke the program. That’s hardly a major criticism. I can’t imagine anyone not liking The Word Plus.

For All You Atari Users
Vincent Cate of USS Enterprises continues to improve his Critical Connection. This device lets you connect an Atari 800 to an RS-232C serial I/O port on a CP/M computer, and thereby use the CP/M system as the Atari’s disk drive.

The device now lets your CP/M system simulate up to four Atari disk drives. We don’t yet have an Atari 800 (I plan on getting one next month), so I’ve lent my test copy of the Critical Connection to an associate who does have both CP/M and an Atari. It works. Given the expense of Atari drives, and their slowness, anyone with an Atari and a CP/M system should seriously consider getting one.

When Shall We LISP?
One thing I’m greatly looking forward to is a good LISP running under CP/M-86. All the versions for the smaller microcomputers are very limited because 8-bit machines have such severe memory problems. (Hah. A sign of the times. I can recall when I thought 48K bytes of memory would be plenty, and 64K bytes more than enough for any purpose.)

Meanwhile, various friends keep urging me to try LISP. “Anything you can do in Pascal or BASIC you can do much quicker and more elegantly in LISP,” they tell me. “How are you going to learn about artificial intelligence without it?” When I protest that I just don’t know enough about LISP, they send me books.

So far I’ve successfully resisted learning LISP, but once there’s a good version for my 8086 I fear I’ll be doomed. Meanwhile, I can look over the books.

One, Programmer’s Guide to LISP by Ken Tracton, is the darndest thing I ever saw. Some of it is absolutely clear, the easiest to understand discussion of parts of LISP that I’ve yet seen. Some of it is absolutely opaque. The really odd part, though, involves strange omissions.

The index, for example, is horrible. Many of the most important terms and concepts in LISP simply aren’t there. No CONS, no CAR, no CDR, no LAMBDA. In another place there’s a glossary of sorts, but some of the definitions are frivolous (LAMBDA—something like DEFINE), while others (CONS, for example) are not there at all.

This sloppiness seems typical of Tab Books, which must employ the laziest and most incompetent copy editors in the publishing business; comic books have fewer typos. Also, cheap paper and an unaesthetic typeface are used.

For all that, I found Tracton’s book rather valuable, since it does give a lot of examples, and much of the beginning discussion is clearer than I’ve seen anywhere else. It’s a pity his publisher didn’t think enough of his book to assign it a decent editor.

Let It GOTO Blazes...
Jeffrey Savit of the Savvy Computing Company writes at length about my (mild, I thought) defense of the GOTO statement in the December column. He says:

One way to think about this is to consider that the problem with the GOTO is not always the GOTO itself, but rather the label it arrives at. First, there is no enforced textual relationship between the GOTO and the target label. If the GOTO is being used as an escape from a loop, the label will appear immediately after the loop body, but there is no way for the compiler to know it was intended as an escape if the label is accidentally placed elsewhere in the program . . .

The other problem with the label is that its presence means that there is less knowledge about the state of the program at the program text that follows it. The code after a label could have been reached by falling through the preceding text, or from any of the statements that GOTO the label. To understand this piece of the program the reader has to examine the entire program for GOTOs that might land there.
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Certainly it is possible to comment both the \texttt{GOTO} and the label to the effect that one and only one \texttt{GOTO} refers to that label, and that it is being used to escape from a loop, but that is precisely what a \texttt{"leave"} or \texttt{"break"} does without depending on the programmer not making a mistake . . .

On reflection, I agree with what Mr. Savit has said here. In my defense I'll point out (1) that Pascal has no \texttt{"break"}, and my column speculated that a \texttt{GOTO} used as a substitute for \texttt{"break"} would do no harm, and (2) that \texttt{"break"} is one of the proposed extensions for the Pascal Prime Project.

In any event, Modula-2 has \texttt{"break"}, and has no \texttt{GOTO} whatever; so if Modula-2 takes over from Pascal, this is one debate that will swiftly become history.

**Coming Attractions**

I much enjoyed COMDEX, not only for the software and equipment I saw, but for the people I met. For example, at the Zenith party I met John and Sue Matlock of Micro Peripherals Inc. of Salt Lake City. John had connected an MPI impact dot-matrix printer to a Zenith Z-100, and the printer was merrily making hard copy of everything that appeared on the Z-100 screen: words, symbols, graphics, swirls, and squiggles.

I've never had a dot-matrix printer, but that looked interesting. I got to talking with John Matlock about it. The upshot was that in the next room sits an MPI Printmate 150 impact dot-matrix printer. Although it can be configured for driving by an RS-232C (serial) port, this one happens to expect a Centronics-style parallel input. There's a Centronics port on the Interfacer-4 board in my dual-processor system, but I don't recall precisely how Tony wrote that
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Microprocessor Systems, Interfacing and Applications is an excellent introduction to microprocessors and data links in terms of signal paths and communication functions. Technically up to date and very readable, the book is aimed at "engineers, students, technicians, and managers who use microprocessors and design them into new devices and systems."

Wisely, Robert J. Bibbero and David M. Stern based their discussion not on a particular chip or family of processors but on a well-balanced cross section of current chips. In doing so, the authors successfully integrate the main concepts of their book throughout its seven chapters. To illustrate how they do this, I'll look at several chapters.

In the first two chapters, the authors quickly review digital logic and microprocessor fundamentals. As you might expect, they cover such topics as number systems, base changes (including fractional numbers), digital logic gates, and the architecture and instruction sets of popular microprocessors. Unfortunately the authors "squeezed" the three topics that form the cornerstone of their book into the first chapter. Address decoding, signal driving over transmission lines, and timing deserve closer examination; more examples would have helped. A detailed discussion of benchmarks in chapter two merits attention.

Chapter three addresses the problems of transmitting data. Logically presented with many helpful details, the discussion goes from signal buses to drivers and systems that include parallel and serial transmission of data. Particularly noteworthy is a section on microprocessor buses. In chapters four and five, Bibbero and Stern contrast programming languages for microprocessors. Chapter four, devoted exclusively to BASIC, includes a good discussion of top-down structuring, flowcharting, algorithm development, and high-order languages. Unfortunately, the chapter is unspecific as far as actually writing BASIC programs goes. Chapter five looks at high-level languages such as FORTRAN, PL/I, FORTH, C-Code, and Pascal in terms of common points and strengths and weaknesses. More programming examples would have enhanced the discussion.

The chapter on device displays is typical of what you might find in most books on microprocessors. It describes the most popular displays, including seven-segment devices and CRTs.

Chapter seven deals exceptionally well with multiple microprocessor communication. Topics range from hierarchical processing layers, architecture and protocols of networks to topology, routing, and protocol. Ethernet and Proway are used to illustrate communications networks that operate between computers and microprocessor terminals.

I have just a few minor squabbles with the book as a whole. Because Microprocessor Systems, Interfacing and Applications covers so many topics in so few pages (192), many details are left out. For example, in the section that deals with addressing and decoding the authors give no examples of how an address decoder actually decodes. The authors attempt to illustrate several programing languages with examples, but again leave you begging for a few more details. And just a minor annoyance, but noteworthy, is that illustrations of digital logic gates do not conform to industry drafting standards.

Readers who have worked with digital electronics or microprocessors should have no difficulty with the concepts presented or vocabulary used. In fact, the text may be too elementary for experienced engineers, technicians, and managers. It is an excellent primer on the microprocessor and data link in terms of signal paths and communication functions and would be particularly useful in classroom instruction.
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The Enhanced VIC-20

Part 4: Connecting Serial RS-232C Peripherals to the VIC’s TTL port

Joel Swank
12550 SW Colony #3
Beaverton, OR 97005

Owners of Commodore’s VIC-20 personal computer know the fascination that can overcome the new computer user. Simplicity, of course, is both the VIC-20’s main attraction and the reason for its low cost. And its uncomplicated nature makes the VIC-20 a good place for the beginner to start to explore the power of a microprocessor. But the real thrill comes with the machine’s inevitable expansion to peripherals.

Commodore’s Kernel operating system allows access to the VIC-20’s serial user port. As a result, you can connect the VIC to modems, printers, and other serial devices. A modem opens the door to the world for the VIC-20. An ever-increasing number of information services are accessible via telephone lines: stock-market quotations, bulletin boards, and program exchanges are just a few examples, and many of these are free. With the proper software and hardware, two VIC-20 users can communicate directly to exchange programs and data.

The User Port

Table 1a summarizes the standard RS-232C pin assignments used with most microcomputer systems, and table 1b shows the pin assignments of the VIC-20’s user port. Notice that the VIC-20 uses a subset of the standard instead of all the circuits defined in the standard (13 possible subsets are listed in the standard’s application notes, but the VIC-20 subset does not match any of them). Commodore’s Programmer’s Reference Manual defines two possible subsets of the VIC-20’s user-port interface: the X-line interface and the three-line interface.

Software access to the VIC-20’s user port is via logical device 2. Routines in the Kernel provide proper timing and logic to send and receive data by this device. Users can also access the port by way of the BASIC statements OPEN, CLOSE, and I/O.

Overcoming Incompatibilities

The circuitry in the VIC-20 does not provide the voltages specified by the RS-232C standard; rather, it transmits data using TTL (transistor-transistor logic) level signals. In the VIC-20, signals between 0 V and 0.8 V (volts) represent a logical 0, while those greater than 2.4 V represent a logical 1. The RS-232C standard specifies that a logical 1 is any voltage more negative than −3 V, while a logical 0 is any voltage greater than +3 V. Thus the VIC-20 needs additional circuitry to properly interface with RS-232C devices.

Two ICs (integrated circuits) have been developed to solve this rather common problem. The 1488 contains four TTL-to-RS-232C line drivers, and the 1489 contains four RS-232C-to-TTL line receivers. These ICs are used in virtually every digital device that handles RS-232C voltage levels, and they’re both inexpensive and easy to come by. You’ll need one of each to build the VIC-20/RS-232C interface.

Editor’s Note

This is the fourth and final article in Joel Swank’s series on “enhancing” the Commodore VIC-20.
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Table 1: Pin assignments and signal names. The information in table 1a, a summary of RS-232C signals, comes directly from the RS-232C standard; the VIC's serial port signals, shown in table 1b, can also be found in Commodore's Programmer's Reference Manual for the VIC.

---

RS-232C Interface Connector Pin Assignments

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Circuit Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AA</td>
<td>Protective Ground</td>
</tr>
<tr>
<td>2</td>
<td>BA</td>
<td>Transmitted Data</td>
</tr>
<tr>
<td>3</td>
<td>BB</td>
<td>Received Data</td>
</tr>
<tr>
<td>4</td>
<td>CA</td>
<td>Request to Send</td>
</tr>
<tr>
<td>5</td>
<td>CB</td>
<td>Clear to Send</td>
</tr>
<tr>
<td>6</td>
<td>CC</td>
<td>Data Set Ready</td>
</tr>
<tr>
<td>7</td>
<td>AB</td>
<td>Signal Ground (Common Return)</td>
</tr>
<tr>
<td>8</td>
<td>CF</td>
<td>Received Line Signal Detector</td>
</tr>
<tr>
<td>9</td>
<td>—</td>
<td>(Reserved for Data Set Testing)</td>
</tr>
<tr>
<td>10</td>
<td>—</td>
<td>(Reserved for Data Set Testing)</td>
</tr>
<tr>
<td>11</td>
<td>—</td>
<td>Unassigned</td>
</tr>
<tr>
<td>12</td>
<td>SCF</td>
<td>Secondary Received Line Signal Detector</td>
</tr>
<tr>
<td>13</td>
<td>SCB</td>
<td>Secondary Clear to Send</td>
</tr>
<tr>
<td>14</td>
<td>SBA</td>
<td>Secondary Transmitted Data</td>
</tr>
<tr>
<td>15</td>
<td>DB</td>
<td>Transmission Signal Element Timing (DCE Source)</td>
</tr>
<tr>
<td>16</td>
<td>SBB</td>
<td>Secondary Received Data</td>
</tr>
<tr>
<td>17</td>
<td>DD</td>
<td>Receiver Signal Element Timing (DCE Source)</td>
</tr>
<tr>
<td>18</td>
<td>—</td>
<td>Unassigned</td>
</tr>
<tr>
<td>19</td>
<td>SCA</td>
<td>Secondary Request to Send</td>
</tr>
<tr>
<td>20</td>
<td>CD</td>
<td>Data Terminal Ready</td>
</tr>
<tr>
<td>21</td>
<td>CG</td>
<td>Signal Quality Detector</td>
</tr>
<tr>
<td>22</td>
<td>CE</td>
<td>Ring Indicator</td>
</tr>
<tr>
<td>23</td>
<td>CH/CI</td>
<td>Data Signal Rate Selector (DTE/DCE Source)</td>
</tr>
<tr>
<td>24</td>
<td>DA</td>
<td>Transmit Signal Element Timing (DTE Source)</td>
</tr>
<tr>
<td>25</td>
<td>—</td>
<td>Unassigned</td>
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</table>

User-Port Lines (6522 Device 1)

<table>
<thead>
<tr>
<th>Pin ID</th>
<th>6522.10</th>
<th>Description</th>
<th>EIA Circuit Abbreviated Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>PBO</td>
<td>Received Data</td>
<td>(BB) Sin IN 1 2</td>
</tr>
<tr>
<td>D</td>
<td>PB1</td>
<td>Request to Send</td>
<td>(CA) RTS OUT 1 2</td>
</tr>
<tr>
<td>E</td>
<td>PB2</td>
<td>Data Terminal Ready</td>
<td>(CD) DTR OUT 1 2</td>
</tr>
<tr>
<td>F</td>
<td>PB3</td>
<td>Ring Indicator</td>
<td>(CE) RI IN 3</td>
</tr>
<tr>
<td>H</td>
<td>PB4</td>
<td>Received Line Signal</td>
<td>(CF) DCD IN 2</td>
</tr>
<tr>
<td>J</td>
<td>PB5</td>
<td>Unassigned</td>
<td>( ) XXX IN 3</td>
</tr>
<tr>
<td>K</td>
<td>PB6</td>
<td>Clear to Send</td>
<td>(CB) CTS IN 2</td>
</tr>
<tr>
<td>L</td>
<td>PB7</td>
<td>Data Set Ready</td>
<td>(CC) DSR IN 2</td>
</tr>
<tr>
<td>B</td>
<td>CB1</td>
<td>Received Data</td>
<td>(BB) Sin IN 1 2</td>
</tr>
<tr>
<td>M</td>
<td>CB2</td>
<td>Transmitted Data</td>
<td>(BA) SOUT OUT 1 2</td>
</tr>
<tr>
<td>A</td>
<td>GND</td>
<td>Protective Ground</td>
<td>(AA) GND IN 1 2</td>
</tr>
<tr>
<td>N</td>
<td>GND</td>
<td>Signal Ground</td>
<td>(AB) GND IN 1 2, 3</td>
</tr>
</tbody>
</table>

---

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Connectors are another possible area of incompatibility: most RS-232C devices use a female subminiature D-type connector with 25 contacts termed DB-25; the VIC-20's connector is a card edge with 12 pins per side on 0.156-inch centers. If you intend to connect these two types of devices, you'll need a male DB-25 and a 24-pin edge-card connector.

Connecting to Serial Peripherals

Several modems will accept the VIC-20's TTL-level signals. Commodore sells one, of course, as do Bizcomp and Micromint. If you use the VIC modem, you need no additional hardware, but if you use another TTL-level device, you'll need to make a cable with the proper connectors on each end. Figure 1a shows how signals should be routed.

Figure 1b is a diagram of the signal adapter you'll need to connect the VIC-20 to full-duplex RS-232C peripherals. The Commodore manual refers to this adapter as the three-line interface. The biggest problem with this circuit is that it requires a negative power supply to match the voltage requirements of the RS-232C standard. I used a 9-V transistor-radio battery connected to provide negative voltage. (The circuit can be constructed on a small piece of perforated circuit board; the VIC connector is glued to one edge, and the DB-25 connector is attached by a three-wire cable.)

The user port can also communicate with a printer, a plotter, a video terminal, and several other RS-232C devices, but most of these, like the VIC-20, will be designed to fit the DTE (data-terminal equipment) category of the RS-232C standard. Because a DTE device is intended to be connected to DCE (data-communications equipment) instead of another DTE device, you have to fool both devices into thinking that the other is a DCE device. Figure 1c is a schematic diagram of how to accomplish that. It's simply a matter of using the same three signals used in figure 1b, but you also cross the wires and add a handshake line. This is the X-line interface Commodore refers to in its manual. The handshake

Text continued on page 338
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Listing 1: The assembly listing of VICTTY, a program to send data to an RS-232C printer that requires handshaking signals.
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mission routines causes the printer can handle more data, it informs the VIC-20 by sending it to a 2400-bps printer connected to the serial port, DTR (data-terminal ready) input.

for example, you would enter device, whether it's a printer, a synthesizer, or some other peripheral. This signal must be sent to the VIC-20's DTR (data-terminal ready) input.

Handshaking is necessary because the VIC-20 can send data much faster than most serial devices can handle. At times, for example, a printer must ask the computer to stop sending data so that it can catch up. When the printer can handle more data, it informs the VIC-20 by asserting DTR.

Software

Unfortunately, an error in the VIC's serial data-transmission routines causes the computer to ignore signals on the DSR line. In other words, if the printer sends the "wait" signal, the VIC-20 ignores it and continues sending data, which is thus lost. To circumvent this problem, I use a program called VICTTY (adapted from the terminal-communications routines in the monitors of the KIM and AIM computers). See listing 1 on page 336.

VICTTY can be used to send data directly to the user port. While it bypasses all the fancy buffering done by the VIC's routines, it does pay attention to the DSR signal, waiting for the printer so that no data is lost. The program echoes to the printer any characters that are sent to the screen and is activated by entering SYS 45056 at the keyboard.

The transmission rate can be selected by using a BASIC POKE instruction to store a number in location 781 prior to activation. Unlike the VIC-20 routines that are limited to 1200 bps (bits per second), VICTTY will work at up to 9600 bps (see table 2 for data rates and the corresponding values to store).

To list a BASIC program currently in memory and send it to a 2400-bps printer connected to the serial port, for example, you would enter

POKE 781,5:SYS 45056:LIST

When the listing is done, deactivate VICTTY by typing SYS 45121 or all the screen output will be sent to the printer. You can also deactivate VICTTY by pressing the Run/Stop and Restore keys. VICTTY can also be used from within BASIC programs—just include the same POKE and SYS commands in the program before you send the output to the screen.

A Word about ASCII

It takes a bit of doing to make serial data from the VIC-20's port compatible with most standard printers. VICTTY alters the data as follows. First, it inserts a line-feed character after every carriage-return character (most terminals and many printers need both between lines). Second, it translates the VIC-20's uppercase/lowercase character set into standard ASCII (American National Standard Code for Information Interchange) characters. The VIC-20 has two character sets: in one, the ASCII lowercase codes are replaced by special graphics characters; in the other, the ASCII uppercase codes produce lowercase characters, while the ASCII uppercase codes with the high-order bit on are used to produce uppercase characters.

Other Uses

In its present form, VICTTY can only handle transfers of data out of the computer, although the hardware is capable of both transmitting and receiving. Still, VICTTY could be used to echo VIC-20 screen output to an 80-column video terminal that would enable you to see more information at a time. If the terminal does not handshake, connecting pin 4 of the 1489-type line receiver to +5 V will enable the interface in figure 1c to work.

Other RS-232C devices can be used with this software/hardware combination; some might require you to modify the interface arrangement. The VIC routines supplied by Commodore can be made to work with the interfaces shown as long as handshaking is not required. With any luck, this series will start you on your way to exploring such advanced peripherals as plotters, digitizers, and speech synthesizers, all of which are now available for the home market.

The program in this article has been incorporated into a full-featured printer program for the Epson and other printers. It includes VIC graphics and access to all Epson functions via standard BASIC OPEN, CLOSE, and PRINT statements (no SYS calls). It also has a special mode for BASIC listings that formats BASIC statements for readability. It will communicate to the printer via either a Centronics parallel interface cable or an RS-232C interface at up to 9600 bits per second with handshaking. For more information contact United Microware Industries Inc., 3503C Temple Ave., Pomona, CA 91768.
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<tr>
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<td>Apple III</td>
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Design Philosophy Behind Motorola's MC68000

Part 2: Data-movement, arithmetic, and logic instructions

Last month, in part 1, I discussed the design philosophy behind the Motorola MC68000, a powerful 16-bit processor with multiple 32-bit registers. This month I'll describe the data-movement, arithmetic, and logic instructions of the MC68000. A thorough reading of the MC68000's user's guide (available from many computer bookstores and Motorola distributors) will give you all the details of each instruction's operation, but a look at the general categories of instructions, a discussion of why certain design decisions were made, and mention of some special capabilities of the instructions will give you insight into the power of this instruction set.

Instruction Format and Addressing Modes

Before I get into the instruction groups, let's首先 look at how assembly-language instructions are written. Table 1 illustrates a common instruction format and the choices that can be made within it. First, of course, you can pick one of several microprocessor instructions—for example, an addition (ADD), comparison (CMP), arithmetic shift left (ASL), or data move (MOV). If the instruction is one that handles data, you can, with the MC68000, select one of three data sizes: 8, 16, or 32 bits. This selection is made by following the mnemonic with a period and either a "B", "W", or "L", for byte, word, or long word; if no size is specified, the assembler will assume a 16-bit operation.

On a data operation, you need to make one or two more decisions, i.e., which addressing mode to use for the one or two operands the instruction requires. (See the text box on data organization on page 354 for more details.) Typically, you can select one of 14 modes; within most of these modes, one of eight address registers is selected. On many operations, you need to select a second addressing mode; this usually involves selection of one of eight data registers, but for the data-movement instruction, any addressing mode can be selected.

All MC68000 instructions are fully defined with 16 bits of op code. (Op code is short for operation code; it is the pattern of bits that a microprocessor interprets as a specific machine-language instruction executable by it.) Depending on the instruction or the addressing mode(s) selected, additional 16-bit extension words may follow the op code. These extension words provide additional addressing information and may make the total instruction length as long as 10 bytes. Because the instruction is always lengthened by multiples of 16 bits, you can ensure that instructions always begin on even-byte boundaries; because of the way the MC68000 fetches 16-bit quantities from memory, this placement of instructions increases the speed of program execution.

By far, the most common operation in any processor application is the movement of data. Other microprocessors move data with LOAD, STORE, PUSH, PULL, POP, and input/output (I/O) instructions. When you boil it all down, each instruction simply moves data from one location to another. So why not call them all MOVE? Simplicity of expression is a fundamental theme throughout the MC68000's instruction set: all similar operations should perform similarly in a number of respects. For example, if you can use an ADD operation with two 32-bit quantities, you should be able to use an add-with-carry operation with two 32-bit quantities. If you can select from 14 addressing modes to use an ADD operation, you should be able to select from 14 addressing...
Photo 1: The MC68000 microprocessor chip, which contains more than 68,000 transistors, is 246 by 281 mils (6.24 by 7.14 mm) in size. This photo shows the location of the major functions of the chip. "Int. Log." stands for "Interrupt Logic"; "AO Mux Control", for "Microcode AO Multiplexer Control"; and "FC Log.", for "Function Code Logic." The labels "μ.ROM" and "NROM" indicate two areas of microcode. "Trap and Ill. Inst. PLA" stands for "Trap and Illegal Instruction Programmable Logic Array"; "IRD Reg.", for "Instruction Register Decode Register"; and "ALU Control", for "Arithmetic and Logic Unit Control." The Data Execution Unit houses the main functions of the arithmetic and logic unit, while the two Address Execution Units perform the arithmetic associated with the calculation of an address.
modes to use SUB (subtract). If certain status register codes are modified to reflect the results of an ADD, the same codes should also be modified when a SUB or NEG (negate) instruction is performed.

Varieties of MOVEs

With this philosophy in mind, all of the old LOAD, STORE, PUSH, PULL, POP, and I/O instructions from other microprocessors were rolled into one very powerful and flexible MOVE instruction in the MC68000. Let’s look at just what this one instruction can do.

The MOVE instruction can move 8-, 16-, or 32-bit data from practically any location to practically any other. And a wide selection of addressing modes and registers for both the source and the destination should cover about any way you want to find the operands. Table 2 lists the different combinations of addressing modes available on both the MC68000 and the Intel 8086 families. Let’s look at what some of the MC68000 addressing-mode combinations allow you to do.

Certainly, you can copy data between registers, but you can also copy data to or from a register to memory using any of the memory-addressing modes. Most microprocessors allow the programmer to transfer data on the top of a stack to or from a register only. What if the data is really needed elsewhere in memory? You must run a second instruction to make the second move and use a register for a temporary holding space. The MC68000 allows you to move top-of-stack data to or from any register, another stack, a queue, any memory location, or any I/O location, all in one smooth motion. And why shouldn’t you be able to? An added advantage of the MC68000 comes from its ability to use any one of the eight address registers as a stack pointer; this allows you to build as many as eight different stacks without having to swap out registers.

You can also do direct memory-to-memory moves. There are 10 different

Table 1: General format for MC68000 instructions.

<table>
<thead>
<tr>
<th>mnemonic</th>
<th>size</th>
<th>source,destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADD.L D1,D2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MOVE.B #15, -1(A0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADD D1,D2</td>
<td>(size assumed to be &quot;.W&quot;)</td>
<td></td>
</tr>
<tr>
<td>BGE LOOP1</td>
<td>only one argument</td>
<td>(no arguments)</td>
</tr>
</tbody>
</table>

Explanations:

- mnemonic = instruction abbreviation (ADD, CMP, MULS, etc.)
- size (optional) = operand size:
  - .B means byte data (8 bits)
  - .W means word data (16 bits; default size)
  - .L means long word data (32 bits)
- source (optional) = source operand addressing mode
- destination (optional) = destination operand addressing mode

Table 2: Addressing modes available to the Motorola MC68000 and the Intel 8086. The information at the intersection of a row and a column indicates the availability of that source/destination addressing-mode combination for each microprocessor.

<table>
<thead>
<tr>
<th>destination</th>
<th>Dn</th>
<th>An</th>
<th>(An)</th>
<th>(An)+</th>
<th>- (An)</th>
<th>d16(An)</th>
<th>d6(An,Xn)</th>
<th>Abs.W</th>
<th>Abs.L</th>
</tr>
</thead>
<tbody>
<tr>
<td>source</td>
<td>#options</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>128</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Dn</td>
<td>8</td>
<td>MI</td>
<td>MI</td>
<td>MI</td>
<td>MI</td>
<td>MI</td>
<td>MI</td>
<td>MI</td>
<td>MI</td>
</tr>
<tr>
<td>An</td>
<td>8</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
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<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>(An)</td>
<td>8</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>(An)+</td>
<td>8</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>- (An)</td>
<td>8</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
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<td>M</td>
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<tr>
<td>d16(An)</td>
<td>8</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>d8(An,Xn)</td>
<td>128</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Abs.W</td>
<td>N/A</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
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<td>M</td>
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<td>M</td>
</tr>
<tr>
<td>Abs.L</td>
<td>N/A</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>d16(PC)</td>
<td>1</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>d8(PC,Xn)</td>
<td>16</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Immediate</td>
<td>1</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
</tbody>
</table>

Notes:
1. "M" means this combination available on the Motorola MC68000.
2. "I" means a comparable combination available on the Intel 8086 family.
3. "#options" refers to the number of different ways an addressing mode can be used in the MC68000 due to the availability of multiple registers that can be used; for example, the "d8(An,Xn)" option can use 8 An registers and 16 Xn registers for a total of 128 combinations. "N/A" means "not applicable."
4. Most of the source and destination addressing modes are explained in the text box "Data Organization and Addressing Modes."
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memory-addressing modes to select from for the source operand and seven for the destination. Also, keep in mind that each addressing mode can use any of the eight address registers, further increasing the versatility of these move instructions. (Actually, in one mode, you have 16 registers to choose from—six address and eight data registers.)

Just how many different ways are there to move general data in the MC68000? When you couple all of the combinations allowed with the selection of registers available, there are 34,888 different ways, and each can be used for 8-, 16-, or 32-bit data. That ought to solve most programmers' data-shuffling problems!

The remaining data-movement instructions include SWAP, for instance, which exchanges the contents of any two data and/or address registers. You can read or modify the status register codes with a MOVE SR (Status Register) instruction.

The MC68000 was designed to interface directly to the MC6800 line of 8-bit peripherals so that all the existing peripheral circuits could easily be used on the MC68000. (Many of the 8-bit peripherals provide very useful functions that would need to be included in a 16-bit system.) To bring the best of the 8-bit peripheral world into the universe of 16-bit software, designers included a special MOVEP (Move Peripheral) instruction in the MC68000. Here's how and why it works.

Frequently, you must set up registers to ready a peripheral for operation. You need to connect an 8-bit peripheral to either the upper or lower half of the 16-bit-wide data bus. This means that the registers connected to a peripheral appear within the MC68000 memory address space as successive-even or successive-odd addresses. The MOVEP instruction will move either 16 or 32 bits of a given data register out to memory in 8-bit chunks, starting at a given location (see figure 1); addresses for each successive byte are incremented by two, not by the one that the normal MOVE uses. This allows the 2 or 4 bytes being transferred to be loaded into the proper peripheral port addresses. Thus, you can load as many as four 8-bit registers in one simple instruction. The MOVEP instruction is bidirectional, so that the registers can be either loaded or read.

Two special types of the MOVE instruction are the MOVEQ (Move Quick) and the MOVEM (Move Multiple Register). Often a register is used as a counter or a constant, with values that are typically rather small. The MOVEQ instruction makes it fast and easy to initialize a register to such values. MOVEQ will take any signed 8-bit immediate value between -128 and 127, extend its sign bit so that it will be correctly interpreted as a 32-bit number, and load it into one of the data registers. The op code for MOVEQ includes the 8-bit immediate value; this means the microprocessor can perform the operation very quickly. Because the small immediate value is part of the MOVEQ op code itself, the instruction is classified as a separate addressing mode of the MC68000 called the "quick immediate" addressing mode.

It is common in machine-language programming to have to save the contents of various on-chip registers, use the registers for some other purpose, and then restore their former contents. This happens when you are beginning or ending a subroutine, executing an interrupt handler, changing tasks, or calling the operating system. The MC68000 has a very handy instruction that makes this a fast, efficient operation. The MOVEM instruction will take any combination (or all) of the 16 data and address registers and move them either to or from memory in an organized manner. These registers can be transferred to or from any stack or to a specific location in memory. They are put in memory and taken from memory in reverse order to ensure that each register receives its proper contents. An option of the MOVEM instruction is that either the lower 16 bits of the registers or the entire 32-bit registers can be transferred. An example of this instruction is:

```
MOVEM.L D0/D4-D7/A4/A5,40(A6)
```

which would save the registers as shown in figure 2. (The instruction will save registers D0, D4 through D7, A4, and A5 into memory starting at the location pointed to by the value in register A6 plus the value 28 hexadecimal.) The list of registers to be transferred is compactly encoded in a 16-bit value that follows the MOVEM op-code word—an "on" bit indicates the associated register is to be transferred. Not only is the MOVEM instruction both compact and useful, it is also as fast as possible for the number of bytes of information that must be transferred.

**Orthogonality**

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do the bulk of the work. The arithmetic and logic instructions allow programmers to write code exactly as they desire without having to rearrange data, gather more data, or do things in an unnatural order. As with so many other characteristics of the MC68000, the design of the arithmetic and logic instructions is very orthogonal—more so than for any previous microprocessor. Orthogonality can be defined as the ability of any allowed operation to use any resource in any way that any other operation may.

The arithmetic and logic instructions are very similar in the way they function, the way the condition codes are affected as a result, and the selection of addressing modes, registers, and operands available to them. The advantage of this is that, when coding, the programmer has only one uniform set of rules to remember. Older microprocessor designs forced programmers to have different sets of rules for even similar instructions, which decreased programmers' productivity by forcing them to recall and use correctly large amounts of essentially arbitrary information.

All of the dual-operand arithmetic instructions are true "one-and-a-half" address operations (i.e., one operand can be specified as a memory address, but the other must be an internal register—the result overwrites one operand). Thus, you can add any register to any register, a constant to any register, the top of a stack to any register, a value buried in a stack to any register, a table entry to any register, an input from an I/O device to any register, or any memory location to any register. Or, because the order may be reversed, you can add any register to any of the same (except that you can't add to a constant, and you can't use the program-counter relative addressing mode to specify a destination). Also, remember that any of these instructions can occur with 8-, 16-, or 32-bit data.

Arithmetic Instructions

Let's look at the types of arithmetic instructions that are available. Add (ADD), subtract (SUB), and compare (CMP) instructions are general two-operand instructions. ADDX and SUBX are used to work on numbers longer than 32 bits (the X condition bit in the MC68000 performs a function similar to the one the carry bit performs in most microprocessors). Two multiply and divide instructions are available: signed (MULS and DIVS) for single-precision instructions and unsigned (MULU and DIVU) for multiple-precision instructions.

The negate (NEG) and clear (CLR) instructions require only a single operand, and you can use a NEGX to negate multiple-precision values. To blend mixed sizes of data, the MC68000 provides a sign-extend instruction (EXT), which performs sign extension on data to make them use useful with all data sizes. The MC68000 also implements several instructions to test and set registers. The MC68000 provides a special instruction called the indivisible test-and-set (TAS), which performs software synchronization in multimicroprocessor operations.

One variation on the ADD instruction enables the MC68000 to overcome a common limitation of other microprocessors. The normal "one-and-a-half" address design of most processors makes it difficult to use constant (immediate) values with anything but registers. The MC68000 overcomes this with the ADDI instruction, which allows a byte, word, or long-word immediate value to be added to an operand in memory using any legal destination-memory addressing mode.

The MC68000 has no increment or decrement instructions. Why? Remember, the idea is to treat all similar instructions the same. An increment instruction adds 1 to a quantity and is often used to step to the next element in a table of byte-wide values. But the MC68000 programmer will often be manipulating 16- and 32-bit data, which require increments of 2 and 4, respectively, to the table address. The design team wanted to generalize the increment and decrement instructions to make them useful with all data sizes yet still retain the speed associated with an instruction that does not have to fetch an immediate argument. To solve these problems, and then some, the designers gave the MC68000 "add quick" (ADDQ) and "subtract quick" (SUBQ) instructions, which allow any number from 1 to 8 to be added to or subtracted from any register or any memory location. The instructions accomplish this in the shortest possible time by using 3 bits within the 16-bit op code to hold the increment or decrement
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amount (in this scheme, the bits 000 indicate an operand value of 8, not 0). Then, not only can you quickly and easily change an address pointer by 1, 2, or 4 for 8-, 16-, or 32-bit data, but you can also change counters by 3, 5, 6, 7, or 8. And the effect is identical to that using the standard ADDI instruction—even the 16-bit value into a 32-bit expression), duplicate its upper portion by 3, 5, 6, 7, or 8. And the status register codes are all the same.

Some odds and ends of arithmetic instructions include sign-extend (EXT), clear (CLR), and test (TST) instructions. Since three different sizes of data can be used in the MC68000, there should be a convenient way of changing size. If you want to move only part of a datum (for example, the bottom 16 bits of a 32-bit register), you need only use a MOVE instruction of the proper data size. If, however, you want to convert a datum to a larger-sized two's-complement value (for example, making a 16-bit value into a 32-bit expression), you need a special instruction. The EXT instruction will take an 8-bit or a 16-bit datum and duplicate its uppermost bit position through the higher portions of any data register in order to convert the datum to 16 or 32 bits wide, respectively. CLR simply loads a set of 0s into the destination. TST sets the negative and zero condition bits (discussed in the next section) according to the nature of the given operand.

Status Register Codes and Multiple-Precision Arithmetic

What if you are dealing with binary integers that require more than 32 bits for expression? Say you want to add two 128-bit (16-byte) numbers. If both of these numbers were in the MC68000 registers, all eight data registers would be in use. More likely, the two values would be in 16 consecutive bytes of memory, starting with the most significant byte of data. The normal procedure to add two such numbers is to add the two least significant bytes, remember the carry, go to the previous bytes and add them, remember the carry, and so on. This sequence of operations is handled neatly in the MC68000 by the predecrement address-register deferred mode, which uses the notation "- (An)". Use two address registers to point to the byte just past each operand. Each execution of an ADDX -(Am), -(An) instruction will decrement the values in the Am and An registers (m and n stand for numbers between 0 and 7), then add the two numbers pointed to by those registers. By putting this single instruction in a loop, you can quickly create the code needed to operate on multiple-precision numbers.

Let's detour for a second to discuss the status register of the M68000 (see figure 3). It contains the standard carry (C), overflow (V), zero (Z), and negative (N) bits found in other microprocessors. It also has a status-register bit not found on other microprocessors, the X (or extend) bit. This bit was created to eliminate confusion caused by traditional overuse of the carry bit.

To explain the extend bit, I should describe the carry bit. In most microprocessors, the carry bit is overused. It is changed by (among other things) an addition instruction, but it is used in two different ways. Sometimes it is used in a later addition, such as in multiple-precision additions; sometimes a program tests the bit and branches according to the carry bit's state. So programmers use the carry bit for two different purposes: for extended-precision arithmetic and for program control.

The MC68000 has a bit for each purpose. Both the carry and the extend bits are changed according to the results of an addition instruction. However, the carry bit is used by the microprocessor during testing for program control purposes, while the extend bit is used as an input for multiple-precision arithmetic operations. For ADD, SUB, NEG, and specified shift and rotate instructions, both the carry and extend bits are updated. Other instructions—MOVE, AND, OR, TST, CLR, MUL, and DIV—change only the carry bit. This design helps prevent inadvertent changes to either bit.

Because of the extend bit, the familiar "add with carry" operation in the MC68000 becomes ADDX or "add with extend bit." Look at why this is important. Once you start a multiple-precision arithmetic operation and get a partial result, the integrity of the extend bit will be maintained even if you have to suspend the addition to do some data movement with the MOVE instruction. Programming becomes easier because you don't have to save the status register codes when interrupting a multiple-precision operation.

I should mention one other thing about multiple-precision arithmetic. When you have finished the multiple-precision operation, what does the negative bit mean? It correctly indicates that the result was positive or
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Data Organization and Addressing Modes

Motorola designed the MC68000 to offer a versatile set of data sizes and addressing modes for the assembly-language programmer. To understand fully the power of this machine, you must first understand how the MC68000 organizes and moves data.

Although the MC68000 "sees" its memory space as a collection of 8-bit bytes, it works on several different data sizes. It can address memory in the following sizes: byte (8 bits), word (16 bits), and long word (32 bits). In addition, it can manipulate individual bits—a bit is specified by the byte it is in and its bit number (between 0 and 7) within the byte.

The MC68000 has a definite preference for addressing 16- and 32-bit quantities that start at even addresses. In particular, it was designed to access quickly 16-bit quantities that start on an even address. Even though this speed comes at the expense of words and long words that begin at odd addresses (which would take two, not one, fetch operations to be accessed), this is not a serious disadvantage. MC68000 op codes are always 16 bits wide, and any arguments the MC68000 requires are always stored as one or more 16-bit words (even if the argument is only a byte quantity). Because of this, code that starts on an even-byte boundary will stay on an even-byte boundary and thus will be accessed at the fastest rate possible.

The MC68000 register set (see the figure) indicates the microprocessor's commitment to long-word data; even though this is a 16-bit machine, all the internal registers are 32 bits wide. The dotted lines in the data registers denote those registers' ability to handle 8-, 16-, or 32-bit-wide data. The address registers can handle either 16- or 32-bit-wide data.

The MC68000 supports six major addressing modes; although I will not go into the variations available in each mode, a short description of each will show you the basic ways the microprocessor can get its operands.

- Inherent addressing: the instruction itself tells the microprocessor where to get its operand. An example of this is RTS, return from subroutine, which gets the return address from the stack.
- Register addressing: the operand is a data or address register. An example is MOVE D1,D2, which moves the contents of data register D1 to data register D2.
- Immediate addressing: the operand is specified as part of the instruction. An example is MOVE @3,D2, which moves the value 3 into data register D2.
- Absolute addressing: the operand is specified by a 16- or 32-bit address that is appended to the instruction. An example is MOVE @3F01,D2, which

negative. In most microprocessors, though, the zero bit indicates only that the most significant portion of the result is 0, not that the entire result is 0. The multiple-precision arithmetic instructions in the MC68000 are designed so that the zero bit will accurately depict the status of the entire result. This is done by allowing multiple-precision instructions to reset the zero bit (denoting a zero result). With this scheme, the programmer's only responsibility is to set the zero bit before beginning the multiple-precision operation.

One final issue can come up in the middle of arithmetic operations, and the MC68000's handling of the problem illustrates another fundamental difference between it and so many other microprocessors. How many times have you interrupted a series of arithmetic operations to modify some memory pointers and later discovered that your completed arithmetic operation gave a wrong result because you inadvertently modified certain status register code bits? When you get right down to it, when you add 12 to a memory address, who cares if a carry was generated or if the result was negative? In fact, the negative bit has no meaning in relation to addresses. We as programmers are hurt
moves the contents of the word at address 3F01 hexadecimal into data register D2. This is also called direct addressing because the operand address is being directly supplied. 

- Register-deferred addressing: this mode has a lot of variations. Since these modes get rather complicated, I'll speak of them in terms of what the effective address is—that is, what memory location will be used to supply the source or destination operand.

The simple address-register deferred mode makes no register but the contents of the register the effective address. Because the register contents is itself the address of the given operand, this addressing mode is often called indirect addressing—the register indirectly supplies the effective address. Suppose that register A1 contains the value 100 and that the word at address 100 contains 12D hexadecimal. Then the instruction MOVE (A1),D2 will put the value 12D hexadecimal into data register D2. The notation “(An)” denotes address-register-deferred (or indirect) addressing using data register An.

Two related variations on address register deferred are called address-register deferred with postdecrement and address-register deferred with postincrement; they have notations of “−(An)” and “(An)+,” respectively. In the postdecrement variation, the address register An is decremented before its contents is used as the effective address; in the postincrement variation, the contents of the address register is used as the effective address, then the register is incremented. These modes are often used in loops for repetitive operations on sequential areas of memory; they usually replace an explicit increment or decrement instruction, thus providing more compact, faster code. The incremental or decremental amount will be 1, 2, or 4 depending on whether the operand is a byte, word, or long word.

Another variation is called address-register deferred with displacement: in this mode (denoted “d16(An)”), the effective address is the contents of address register An plus the signed 16-bit value d16. Suppose address register A1 contains the value C100 hexadecimal and the word at address C25E hexadecimal contains 0. Then the instruction MOVE $15E(A1),D2 moves the value 0 into data register D2. (The effective address, C25E hexadecimal, is the sum of the displacement 15E hexadecimal and the contents of register A1, C100 hexadecimal.)

The variation called address-register deferred with index and displacement (denoted “d8(An,Xn)” limits the displacement to an 8-bit signed number but makes the effective address the sum of three numbers: the displacement, the contents of the address register An, and the contents of an index register Xn, where the index register can be any of the address or data registers. The extra register is added into the effective address calculation to allow the same instruction to point to the base of a table (using d8 and An) and, during execution, to refer to different nearby memory locations by putting different values into the index register Xn. The word “index” in the addressing mode name refers to the commonplace use of the index register to index into an array of numbers stored sequentially; in such a case, the value in the index register equals the subscript of the array element desired. Given the example directly above (register A1 contains C100 hexadecimal, word C25E hexadecimal contains 0) and the information that data register D6 contains the value 100 hexadecimal, the instruction MOVE $5E(A1,D6),D2 moves the same value (0) to data register D2 as the instruction MOVE $15E(A1),D2 would. In both cases, the effective address is C25E hexadecimal.

- Program-counter relative addressing: this mode has two variations, “d16 (PC)” and “d8 (PC, Xn)”; these are similar to the two forms of address-register deferred addressing described above. It is different in two ways: first, it uses the program counter (PC) instead of an address register; second, you cannot use this mode to specify a destination operand. The main advantage of this mode is that it allows you to write position-independent code. Because the program counter contains the address of the next instruction after the one currently executing, its use allows the current instruction to refer to data (or program locations for branches) relative to the instruction itself. The MC68000 designers included the restriction against using this mode for a destination operand to protect a program with errors from inadvertently destroying itself. In addition, this restriction prevents programmers from writing self-modifying code, a dangerous practice that programmers occasionally try to increase program performance.
address registers A0 through A7. If a word operation is performed, the 16-bit quantity is first sign-extended to 32 bits before it is used.

**Processor Speed**

How fast does the MC68000 execute instructions? Because of the consistency of the microprocessor, the answer for addition instructions will serve as a guide for all arithmetic and logic instructions. A prefetching mechanism in the MC68000 keeps decoded instructions waiting to be executed. So while the timing information given refers only to the time it takes to pass through the adder, recall that the prefetcher will have fetched the next op code while the current op code is being executed.

The minimum time it takes the MC68000 microprocessor to access memory (to read or write) is 4 clock cycles. With a clock frequency of 8 MHz (the frequency used in the standard MC68000 microprocessor), this bus cycle will take 500 ns (nanoseconds). (All subsequent timings will be given in clock cycles, which is a meaningful measurement for all the MC68000-family microprocessors, regardless of the speed of their system clocks—8, 10, or 12.5 MHz.) Every instruction will take at least 4 clock cycles to complete because this is the time it takes to fetch the next op code.

The MC68000 has only one 16-bit arithmetic and logic unit (ALU) for data operations. Therefore, 8- or 16-bit operations can be performed in a single pass through this unit; this takes 4 clock cycles. A 32-bit operation will require a second pass. Memory-addressing modes increase the time needed for an operation because the microprocessor requires more time to calculate the addresses, and a bus cycle is required for each 16 bits of addressing information or actual data that needs to be transferred. An indexed addressing mode, or anything with a displacement, for instance, will require 1 additional bus cycle for the address extension word and another to get the data (2 if the data is a long word); add about 8 more clock cycles (12 if the data is a long word) to the execution time of a given instruction that uses this mode. Some sample worst-case clock timings for various addition instructions are given in table 3.

Like the ADD instruction, other MC68000 arithmetic instructions come in several forms. The subtract instructions have forms analogous to the add instructions—SUB, SUBA, SUBI, SUBQ, and SUBX. Instructions for compare operations that are all similar (CMP, CMPA, CMPI) perform the subtractions without storing a result (the net effect is to set the appropriate status register bits). A memory-compare instruction (CMPM) allows two strings of binary integers in memory to be compared by sequencing through them to higher memory. Two versions of the single-operand negate instruction, NEG and NEGX, ignore and include, respectively, the state of the X bit.

### Multiplication and Division

Two versions of multiply and divide instructions make fast work of more complex arithmetic. The two versions are unsigned (MULU and DIVU) and signed (MULS and DIVS) instructions; these versions interpret their operands as one's-complement and two's-complement numbers, respectively. All of these instructions can include immediate values as the multiplier or divisor so that variables can be operated on by constants.

The multiply instructions take two 16-bit operands (one from any memory location by any addressing mode or any data register, and the other from the lower 16 bits of any data register), multiply them, and place the resulting product into the full 32 bits of the same data register. The divide instructions take the dividend from any 32-bit data register and divide it by a 16-bit divisor, which may come from memory using any addressing mode or any data register. The quotient is placed in the lower 16 bits of the same 32-bit data register, while the 16-bit remainder is placed in

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADD.B D6,D2</td>
<td>adds the lower 8 bits of D6 to D2 (takes 4 clock cycles)</td>
</tr>
<tr>
<td>ADD.L 52(A1,D7,W),D6</td>
<td>the effective address is the sum of the constant 52, the contents of register A1, and the lower 16 bits of register D7; the long word at the effective address is added to the contents of register D6 (20 clock cycles)</td>
</tr>
<tr>
<td>ADD.W D3,(A7)</td>
<td>adds the lower 16 bits of D3 to the element on top of stack pointed to by A7 (12 clock cycles)</td>
</tr>
<tr>
<td>ADD.L #$400,D1</td>
<td>adds 400 hexadecimal to the 32-bit contents of D1 (16 clock cycles)</td>
</tr>
<tr>
<td>ADDA.W - (A5),A2</td>
<td>the effective destination address is the sum of the 30B hexadecimal and the contents of register A5; A9 hexadecimal is added to the byte at the effective address (20 clock cycles)</td>
</tr>
<tr>
<td>ADDA.W - (A5),A2</td>
<td>decrement register A5 by 2, then add the word pointed to by register A5 to register A2 (14 clock cycles)</td>
</tr>
<tr>
<td>ADDA.W - (A5),A2</td>
<td>add the value 100 to the contents of register A5 (12 clock cycles)</td>
</tr>
<tr>
<td>ADDA.W + (A5),A2</td>
<td>add 1 to the word pointed to by register A5, then increment register A4 by 2 (12 clock cycles)</td>
</tr>
<tr>
<td>ADDX.L 01,02</td>
<td>add 3 to the contents of register D7 (4 clock cycles)</td>
</tr>
<tr>
<td>ADDX.L - (A2),- (A5)</td>
<td>after decrementing both registers A2 and A5 by 4, add together the X bit and the two long words pointed to by A2 and A5 (30 clock cycles)</td>
</tr>
</tbody>
</table>

**Table 3: Examples of MC68000 addition instructions. The clock times given are worst-case times for the instruction.**
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The multiply instructions take fewer than 70 clock cycles to execute using register operands, and the divide instructions require fewer than 140 clock cycles for an unsigned operation (158 cycles for a signed operation); however, different combinations of 1s and 0s in the operands can make these operations take less than these times to execute. A short MC68000 routine that performs a 32-bit by 32-bit multiplication is shown in listing 1. It executes in about 60 microseconds, which is less time than that taken by the dedicated instruction that does the same thing in the Z8000.

For a number of reasons, there are no instructions to multiply two 32-bit numbers or to divide a 64-bit number by a 32-bit number. First, the need for such instructions is very infrequent in most applications. Second, there are no other facilities in the machine to handle 64-bit quantities. Finally, because such instructions would take a lot of time to execute, the MC68000 would occasionally take much longer to respond to an interrupt—a situation the designers did not want to create.

The multiply instructions take fewer than 70 clock cycles to execute using register operands, and the divide instructions require fewer than 140 clock cycles for an unsigned operation (158 cycles for a signed operation); however, different combinations of 1s and 0s in the operands can make these operations take less than these times to execute. A short MC68000 routine that performs a 32-bit by 32-bit multiplication is shown in listing 1. It executes in about 60 microseconds, which is less time than that taken by the dedicated instruction that does the same thing in the Z8000.
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Binary-Coded Decimal Arithmetic

The final type of arithmetic instructions handles decimal digits. The most common form of human-interface data comes as binary-coded decimal or BCD data. This method of encoding numeric information as a string of bits stores each decimal digit of the number as a 4-bit binary number. Numbers are easily encoded into BCD format; once inside the computer, they are easily printable in human-readable form (much more so than numbers encoded in signed floating-point binary form). Because the BCD format is so useful, most microprocessors include instructions that operate on BCD numbers. To allow these BCD types of data to be manipulated, the MC68000 has three instructions that add (ABCD), subtract (SBCD), and negate (NBCD) packed digits. Each of these instructions works on two BCD digits packed into a byte.

Because BCD numbers may be many digits wide, the BCD instructions work as multiple-precision operations, which means they have the characteristics of the other multiple-precision instructions. The operands can be in data registers or in memory (in which case, they are operated on using the predecrement addressing mode). The value of the X status register code bit is included in the BCD operations, and the Z status register bit is handled so that it properly reflects the state of the entire result, not just the final portion.

Once again, the best thing about these instructions is the simplicity with which they operate, especially when compared with the often mysterious code a programmer had to write to do BCD arithmetic on most older microprocessors. A glance at MC68000 code performing BCD functions (see figure 4) shows how simple such code is. Here, two 6-digit numbers need to be added. While a short loop might make the routine more generally useful, inline code is fastest and illustrates the point best.

First, we must load the two address registers to be used as memory pointers with the correct values. The next instruction (SUB D1,D1) is a quick way of both setting the Z bit and clearing the X bit, though a MOVE $504,CCR would do virtually the same thing.

The three ABCD (add binary-coded decimal) instructions begin at the least significant two digits and move toward the most significant;

Figure 4: An example of multiple-precision binary-coded decimal (BCD) arithmetic. Because the predecrement addressing mode used ("ABCD-(A1),-(A2)") decrements the register pointers before performing the BCD addition, registers A1 and A2 must be loaded with a value that points to the byte immediately after the least significant byte of the number to be worked on.
The arithmetic shift-right instruction (ASR) shifts the least significant bit to the left as the arithmetic instructions.

Similar subtraction and negation operations can be built in the same way.

### Logic Instructions

The MC6800 logic instructions are simple but powerful. The AND, OR, exclusive-or (EOR), and NOT instructions, like the arithmetic instructions, allow 8-, 16-, and 32-bit quantities in data registers or in memory to be operated on with any data register or an immediate constant, or to be inverted. These instructions are just as fast as the arithmetic instructions. Additionally, ANDI, ORI, and EORI instructions are used to set, clear, or toggle individual status register code bits.

A serial shifter in the MC68000 can be moved any number of bits to allow for shifting of 8-, 16-, and 32-bit data. The arithmetic-shift-right instruction (ASR) shifts the least significant bit to the X and C status bits while duplicating the most significant bit before moving it to the right. In the arithmetic shift left (ASL), the logical shift right (LSR), and the logical shift left (LSL), the bit shifted out of the data area goes into the X and C bits, while the bit into which no bit is being shifted is filled with a 0.

The rotate instructions shift bits around in a circular manner so that bits shifted out of one end of an operand are shifted in the other end, with the bit being shifted out of the data area also being copied into the C status register code bit and, optionally, the X bit. The rotate instructions are rotate right and rotate left (ROR and ROL); the ROXR and ROXL instructions are used when you want to update both the X and C bits.

### Table 4: Examples of Shift and Rotate Instructions and their Effect on Registers and Memory

<table>
<thead>
<tr>
<th>Status Register Instruction</th>
<th>Register</th>
<th>Status Register Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASR.B #3,D3</td>
<td>(D3 before) 10111010 01011111 01101010 10101100</td>
<td>X X X</td>
</tr>
<tr>
<td></td>
<td>(D3 after) 10111010 01011111 01101010 11110001</td>
<td>1 1 1</td>
</tr>
<tr>
<td>ASL.L #5,D1</td>
<td>(D1 before) 11101000 10100010 10101010 00101011</td>
<td>X X X</td>
</tr>
<tr>
<td></td>
<td>(D1 after) 10001010 01011011 10101010 11110000</td>
<td>1 1 1</td>
</tr>
<tr>
<td>LSLW D5,D7</td>
<td>(D5 before) 00101000 10001111 11101001 00000000</td>
<td>X X X</td>
</tr>
<tr>
<td></td>
<td>(D5 after) 10111010 01111110 01111011 01001001</td>
<td>0 0 0</td>
</tr>
<tr>
<td>ROLL D2,D1</td>
<td>(D2 before) 01001010 10111011 10111010 00101000</td>
<td>X X</td>
</tr>
<tr>
<td></td>
<td>(D2 after) 10101111 01111011 01111011 01001001</td>
<td>0 0 0</td>
</tr>
<tr>
<td>ROXR.W #4,D6</td>
<td>(D6 before) 10111010 01011111 01101001 00001010</td>
<td>X P X</td>
</tr>
<tr>
<td></td>
<td>(D6 after) 10111010 01011111 01101001 10010100</td>
<td>0 0 0</td>
</tr>
<tr>
<td>ROR $A0000</td>
<td>(word A0000 before) 10011110 10101101 00001000</td>
<td>x x x</td>
</tr>
<tr>
<td></td>
<td>(word A0000 after) 10011110 10101101</td>
<td>1 x 0</td>
</tr>
</tbody>
</table>

Notes:
1. An "x" status-register bit may represent either a 0 or 1 value.
2. Notice that in the LSL.W and ROLL examples the bottom six bits of the source operand (D5 and D2, respectively) are used as the number of bits to be shifted or rotated.
3. The "P" status-register bit in the "ROXR.W #4,D6" example is specially marked to show that it is shifted into the body of the D6 register as a result of the ROXR.W instruction. Note that W causes only the bottom 16 bits of the register to be rotated.

This must be done to get accurate results from use of the extend bit. The result replaces the BCD number pointed to by A2; when the routine has finished, A2 points to the first byte of the BCD result (which is stored in order of most to least significant digit). Similar subtraction and negation operations can be built in the same way.

The MC6800 logic instructions are simple but powerful. The AND, OR, exclusive-or (EOR), and NOT instructions, like the arithmetic instructions, allow 8-, 16-, and 32-bit quantities in data registers or in memory to be operated on with any data register or an immediate constant, or to be inverted. These instructions are just as fast as the arithmetic instructions. Additionally, ANDI, ORI, and EORI instructions are used to set, clear, or toggle individual status register code bits.

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One single shift or rotate instruction can move register data as many as 31 bit positions in the selected direction. You can specify this count value either statically (as a value between 1 and 8 encoded into the instruction op code) when the instruction is written or dynamically (as a value between 0 and 63 stored in a specified data register) when the instruction is executed. For simplicity, memory operands to be shifted or rotated are limited to displacements of 1 bit and operations on word-sized data only. Table 4 illustrates some shift and rotate instructions, their timing, and their effects.

An important aspect of programming that until the MC68000 was quite limited is that of individual bit manipulation, the ability to single out bits of memory, test them, set them, and clear them. Such operations are useful; in I/O, for instance, you frequently need to sense the state of a single input line, drive a particular output line high, or turn a servomechanism off. These operations involve only a single bit associated with a latch, peripheral, or memory location.

In the past, most of us have done the best we could by executing AND, OR, and EOR instructions to the desired location. But the difficulty with these operations is their crudeness. Sure, they allow us to change more than 1 bit at a time, but it turns out that much more secure code can be written when single events or conditions affect single outputs. Also,
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because it is impossible to sense the state of more than one input at a time, nothing is gained by the ability of such instructions to work on multiple bits.

Four powerful MC68000 instructions make all bit-manipulation functions far simpler. They are the bit test (BTST), bit test and set (BSET), bit test and clear (BCLR), and bit test and change (BCHG) instructions. How will you specify the target bit? The MC68000 uses two methods, similar to those used for shift and rotate instructions. Either a data register or a series of bits in the bit-instruction op code names the bit to be affected; in this case, however, the bit number can be from 0 to 31 if a register is affected, or from 0 to 7 if the area affected is a memory location. (In the MC68000, bits in memory are identified by the bit number of the byte in which they reside.)

With true bit-manipulation instructions, not crude logic instructions, bit-manipulation operations—sensing the state of inputs, driving outputs, setting register bits, setting attribute bits, transposing bit matrices, or just building special data types—are straightforward tasks, not the chores they usually are with other microprocessors. The MC68000 makes it very easy to specify precisely the bit to be changed.

Conclusions

The computation and data-movement instructions that perform the major work in any MC68000 program are numerous, comprehensive, and, perhaps most important, straightforward and easy to use. The versatile MOVE instruction on the MC68000 replaces a confusing variety of data-movement instructions on other microprocessors. Flexible add, subtract, compare, negate, multiply, and divide instructions operate on any register, with constants, on stacks, and in memory using any addressing mode. For digital data rather than binary data, pairs of BCD numbers can be added, subtracted, and negated. The common logic operations of AND, OR, exclusive-or, and NOT can similarly operate on data registers and constants, and in memory.

When data needs to be shifted about, it can be arithmetic-shifted, logic-shifted, or rotated left or right. It can also be shifted or rotated multiple bit positions, with the count of the movement either predetermined and constant, or variable and dependent upon other data.

Individual bits in data or I/O can be separately tested to determine their state; they can also be set, reset, or toggled. The bit to be worked on can be chosen either when the instruction is written or, based on other data, when it is run.

All the above instructions can operate on 8-, 16-, or 32-bit data, with a uniform yet flexible set of addressing modes. This combination of good instruction set design, computational power, and ease of use make the MC68000 microprocessor an excellent one for assembly-language programming. Next month, I’ll discuss program-control instructions and several advanced instruction groups.
Building a Hard-Disk Interface for an S-100 System

Part 3: Software

How to alter the CP/M operating system so that it will accommodate a Winchester disk drive and controller.

Andrew C. Cruce and Scott A. Alexander
ASC Associates Inc.
POB 615
Lexington Park, MD 20653

In part 1 of this series we described Winchester disk technology in general and the benefits it would provide for microcomputer systems. We then gave an overview of the work that would be required to add such a disk to an existing computer system. In part 2 we discussed the rationale you should use in choosing a particular Winchester disk drive and disk controller (we decided on a Miniscribe disk drive and a Xebec controller). We then described in detail the construction of the hardware interface—the host computer adapter—required to integrate the disk drive into the S-100 system. In this last article of the series we will describe the final ingredient needed for our Winchester disk-drive subsystem: the software.

First we'll review the operation of the CP/M basic disk operating system (BDOS) and basic input/output system (BIOS) software. Specifically we will describe the process through which application programs use the BDOS to access disk file information and how the BDOS uses the BIOS to obtain specific information from a particular peripheral. This will highlight what has to be done to write a BIOS to handle the Winchester disk system.

Next we will describe the operation of the disk drive and controller as accessed through the host computer adapter (HCA). We'll show how disk commands are initiated from software and what commands are available from the disk controller. With this background out of the way, we will identify requirements for a Winchester disk-subsystem BIOS and how these requirements can be satisfied. We will then describe how a BIOS is structured and how the BIOS routines for the Winchester disk system can be included with the original system BIOS routines to support the other peripherals. Finally, we will briefly review the CP/M procedures required to include the combined BIOS in a new CP/M system.

This will essentially complete the integration process. However, we can improve system performance even further by putting the system's bootstrap routine on the Winchester disk. We'll describe how a bootstrap program operates and how you can develop a new bootstrap and install it on the Winchester disk drive. We'll also spend some time discussing various debugging techniques that will probably be very helpful when you integrate the hardware and software.

BDOS and BIOS

The CP/M operating system basically consists of two separate elements called the BDOS and the BIOS. The BDOS is supplied by Digital Research Inc. and is the essence of the CP/M operating system. In addition to the BDOS, however, the system requires a set of routines known as the BIOS to handle the hardware-peculiar functions of each peripheral in the system. These routines are usually supplied by the disk-drive manufacturer and must be modified by the user to include other system peripherals.

Accesses to disks and other peripherals by application programs are usually handled by calls to the BDOS. These calls are made by loading specified registers with information required by the BDOS and then performing a call to location 05. In the case of disk accesses you must load a function code into the C register and a pointer to the file control...
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to execute requested functions.

The BDOS disk functions are described in the standard CP/M documentation and include such functions as Open a File, Close a File, Read Next Record, and Write Next Record. The data structure that drives all these operations is the FCB, which is initially created by the application program and is updated by various BDOS functions. Figure 1 shows the structure of the FCB, which includes, among other things, the file name and file type along with 16 bytes of data that are used by CP/M in the calculation of a physical device address for access to the requested data. Additional data in the FCB is used to keep track of the drive the FCB is currently active on, a pointer to the current record, and a pointer to the current extent. If you are not familiar with the FCB construct, you can find additional information on it and the normal BDOS disk I/O functions in Digital Research's CP/M Interface Guide.

In order to understand the requirements for the Winchester disk BIOS, it is necessary to understand how this BIOS is used during the normal access of data from files contained on the Winchester disk. Figure 2 illustrates the steps that are performed in opening an existing disk file and reading the first 128 bytes of data from this file. This process is representative of the majority of the communications that occur between the BDOS and the BIOS during normal disk operations.

The process starts with the application program establishing which disk is to be active in the subsequent operations by loading the appropriate information in the C and E registers, as shown in the figure, and then calling the BDOS. The BDOS takes this information and passes it on to the BIOS, which then returns to the BDOS the address of a table that defines the physical characteristics of the disk that was selected. At this point, control is returned to the application program.

Next, the application program defines a DMA (direct memory access) buffer for subsequent disk operations by loading the DE register pair with the DMA buffer address, loading register C with 1A hexadecimal, and calling the BDOS. The BDOS in turn passes the DMA address to the BIOS for use in subsequent disk read/write operations.

After setting up the DMA buffer, the application program next opens the file that is to be read. First, the application program constructs an FCB for that file by reserving the required amount of space for the FCB, filling in the file-name and file-type portions of the FCB, and setting the Current Extent and Next Record fields to zero. The application program then calls the BDOS with the DE register pair pointing to the FCB and register C containing 0F hexadecimal. The BDOS must now search the file directory on the selected disk to determine if the file mentioned in the FCB is actually contained on the disk. In doing this the BDOS uses the BIOS to read each sector of the selected disk directory into memory and then searches for a match with the requested file name. When a match is found, the BDOS uses the information contained
in the directory entry to load the disk-allocation portion of the FCB. After filling in the required information in the FCB, the BDOS returns control to the application program.

The function of the disk-allocation portion of the FCB is to determine the physical disk address of particular records within a disk file. In the case of our Winchester disk system, the 16 bytes of disk-allocation information correspond to eight pointers, each containing 16 bits. These pointers refer to 2K-byte storage areas on the disk. Each of these 2K-byte storage areas is in turn made up of sixteen 128-byte logical sectors of disk information as required by CP/M. When a particular record is accessed, the value in the Next Record field of the FCB is divided by 16 to determine which disk-allocation vector to use in the disk-address calculation, and the remainder from this division is used to determine which logical sector in the storage region is required. This process is shown in more detail in Figure 3. It should be noted that a single file entry only provides access to 16K bytes on the disk. To access a larger file you must use extents, which are duplicate file entries containing unique pointers for different portions of the file.

The information derived from these calculations is used by the BDOS when the application program next issues the Read command to the BDOS. In this case the DE register pair is loaded with the address of the FCB, and register C is loaded with 14 hexadecimal when the BDOS is called. The BDOS then uses the data in the FCB to calculate a sector and track address for the requested data. First it passes the sector-address information to the BIOS (through the SETSEC entry point) followed by the track address information (through the SETTRK entry point). We'll discuss the design of the BIOS and the required entry points later. After the sector and track information have been passed, the BDOS then asks the BIOS to perform a Read operation of the identified sector.

At this point the BIOS takes the sector- and track-address information and constructs a device control block (DCB) that commands the Xebec controller to read the data from the requested sector of the disk. As we explained earlier in this series, the commands go from the computer, through the host computer adapter (HCA), to the disk controller. The disk controller then performs the requested Read operation from the disk, placing the data in a local memory area on the controller card. The BIOS can then begin to access the data being read from the disk and move it to the DMA memory buffer specified by the original SETDMA command. Once
all 128 bytes of the requested logical sector are moved into the DMA area, the Read operation is complete and control is returned to the application program.

In this overview of the combined operation of an application program, the BDOS, and the BIOS in accessing and reading information contained on the disk, some of the intricacies of the process, such as extents of disk files and detailed operation of the BDOS, have been glossed over. However, the illustration should provide enough information for you to understand the design and construction of a BIOS for a Winchester disk subsystem, and we refer you to CP/M documentation to gain a more in-depth understanding of the CP/M file control services (FCS) and the operation of the BDOS.

As you can see from the above example, only a few primitive functions have to be performed by a Winchester disk BIOS for it to be compatible with a CP/M system. Table 1 presents a complete list of these primitive functions along with a brief description of each function. In a complete BIOS, each of these functions is a separate entry point into the BIOS, and all you have to do to establish a BIOS is write code for each entry point to perform the necessary function. But first you must understand the hardware operation and software interface to the Winchester disk, which is our next topic.

### Disk Primitive Operation

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELDSK</td>
<td>Selects a particular disk in the system as the “active” disk. The routine must keep track of which disk is selected and pass the address of a disk-characteristics table describing the selected disk to the BDOS.</td>
</tr>
<tr>
<td>SETTRK</td>
<td>Sets the track number for the next Read or Write operation.</td>
</tr>
<tr>
<td>SETSEC</td>
<td>Sets the sector number for the next Read or Write operation.</td>
</tr>
<tr>
<td>SETDMA</td>
<td>Defines the 128-byte buffer that is to be used to get data during disk-write operations or receive data during disk-read operations.</td>
</tr>
<tr>
<td>READ</td>
<td>Reads 128 bytes of data from the selected track and sector in the DMA buffer area.</td>
</tr>
<tr>
<td>WRITE</td>
<td>Writes 128 bytes of data from the DMA buffer area into the selected track and sector.</td>
</tr>
<tr>
<td>SECTRAN</td>
<td>Performs logical-to-physical sector translation to improve overall CP/M disk response.</td>
</tr>
<tr>
<td>HOME</td>
<td>Moves the head on the selected disk to sector 0, track 0.</td>
</tr>
</tbody>
</table>

Table 1: A list of disk-related primitive functions that have to be performed by the Winchester disk BIOS in order to be compatible with CP/M.

### Hardware Operation and Software Interface

As we discussed last month, the communications interface between the BIOS routines for the Winchester disk drive and the drive itself consists of four I/O ports on the S-100 bus. The addresses of these ports are selected in a contiguous block of four ports by switch settings on the HCA card. We will refer to ports 0 through 3 to indicate particular ports in this block.

Commands and data are sent to the controller by writing to these ports. The HCA retrieves data from the controller by reading from these ports. Each command to the controller consists of a block of 6 bytes of command information. This 6-byte block is the device control block mentioned earlier. Figure 4 shows the general format of the DCB and how this format is used for three different disk commands. The DCB always contains the op code and command types as shown in the general description of the data structure. In addition, the DCB may contain up to 21 bits of physical address information when an actual Read or Write operation is being performed. It also may contain additional control information specifying such things as the number of retry operations to perform in the event that an error condition is detected. For more information on the details of the DCB, see the Xebec controller manual. For a Write command, the 6 bytes of the DCB are sent to the controller followed by the 256 bytes of data to be written into the physical disk sector specified in the command. After receiving the 256 bytes of data, the controller returns 2 bytes of error status information to the HCA. A Read operation works similarly in that the 6 bytes of the DCB are sent to the disk, which then returns 256 bytes of data from the sector specified in the command block. The controller also tags on an extra 2 bytes of error status information at the end of the transfer. In addition, the Xebec controller offers a Request Sense Status function that returns 4 bytes of more detailed error status information at the end of the command.

In typical operation, the disk and controller would be reset on a cold boot by performing an output to port 3. Once this is completed, the disk controller would be put in a command mode by outputting a 1 to the data port (port 0) followed by a Write to the status port (port 1), which activates the SEL signal. (This and many of the signals referred to in this section were described last month.) The disk-access routine then examines the REQ line by performing an input from port 1 and testing the proper status line. When the REQ line becomes active the routine outputs the first of the 6 command bytes to port 0. This output automatically generates the ACK signal to complete the handshake between the HCA and the controller. The software then monitors the REQ line until it again becomes active and then sends the second command byte. This process is repeated until all 6 command bytes have been sent to the disk controller. The routine then uses the same process to read or write the appropriate number of data bytes at port 0 depending on the particular command that was sent. In the case of a BIOS routine, the disk address that is to be accessed is derived by the BDOS from...
the information contained in the FCB. This information is then passed to the BIOS routines at the SETTRK and SETSEC entry points and the BIOS uses this information to construct the DCB for the actual disk access.

Generating a Combined BIOS

The BIOS structure is very simple. A table of jump vectors is placed at the beginning of the BIOS code. This includes jumps to each of the primitive functions that the BIOS performs. Table 2 shows that these functions include the disk-oriented primitives presented in more detail in table 1 as well as the necessary functions to handle the other peripherals in the system, such as terminals and printers. The BIOS routines for peripherals other than disks are used without modification in the construction of a new combined BIOS. The existing disk and boot functions are augmented as shown in figure 5. The cold boot functions for both the existing disk system and the new Winchester disk are combined to ensure that all peripherals on the system are properly initialized when the system is booted. A new SELDSK function is written that keeps track of which disk system is selected and passes the proper disk-definition-table address back to the BDOS. Finally, a series of disk-handling routines are written for the Winchester disk. These routines are used as the initial vector addresses for the initial jump table. Depending on the particular entry point, these routines either perform the indicated function for the Winchester drive and then transfer to the appropriate function for the existing floppy drive or test to see which drive is selected and simply transfer control to the appropriate routine for the selected drive. An example of the first case is the SETDMA function, which causes the DMA buffer address to be set for both the Winchester and any other disk drives in the system. In the case of an actual READ function, however, a test is made for the selected disk and then control is passed to the proper disk-read routine. Listing 1 on page 386 presents a skeleton of a combined BIOS that includes all the BIOS routines for the Winchester disk drive and comments indicating where routines from an existing BIOS should be placed.

The code presented in listing 1 has been tested and will operate with a Xebec controller connected to a Miniscribe disk using the HCA described in last month's article. The SELDSK entry point keeps track of which disk is selected and uses register pair HL to pass the address pointer of the selected disk characteristics table to the BDOS. This table is located at DPBASE in the BIOS code and has been created using two macros, DISKS and DISKDEF, supplied by Digital Research. These macros and the structure of this table are described in Digital Research's CP/M System Alteration Guide. The code for the cold boot entry point, BOOT, assumes that a new copy of the sys-
Table 2: A complete list of primitive functions for the BIOS in CP/M. Note that this includes the disk-related primitives in table 1.

<table>
<thead>
<tr>
<th>Entry Point</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOOT</td>
<td>System initialization on hardware boot.</td>
</tr>
<tr>
<td>WBOOT</td>
<td>Reads a new copy of BDOS into memory and initializes the system</td>
</tr>
<tr>
<td>CONIN</td>
<td>Reads the next character from the current console device.</td>
</tr>
<tr>
<td>CONOUT</td>
<td>Writes a character to the current console device.</td>
</tr>
<tr>
<td>LIST</td>
<td>Sends a character to the list device.</td>
</tr>
<tr>
<td>PUNCH</td>
<td>Reads next character from the read device.</td>
</tr>
<tr>
<td>HOME</td>
<td>Returns the read/write head of the currently selected disk to track 0.</td>
</tr>
<tr>
<td>SELDISK</td>
<td>Selects the current disk.</td>
</tr>
<tr>
<td>SETTRK</td>
<td>Sets the track for the next Read/Write operation.</td>
</tr>
<tr>
<td>SETSEC</td>
<td>Sets the sector for the next Read/Write operation.</td>
</tr>
<tr>
<td>SETDMA</td>
<td>Sets the DMA buffer area for the next Read/Write operation.</td>
</tr>
<tr>
<td>READ</td>
<td>Reads data from the selected disk.</td>
</tr>
<tr>
<td>WRITE</td>
<td>Writes data to the selected disk.</td>
</tr>
</tbody>
</table>

Additional Utilities

Two other software utilities must also be written prior to completing the installation of the hard-disk system. The first of these is a formatting utility that will format the disk and check for any bad tracks on the disk. The second is a system-generation utility that will write the new operating system beginning at track 0, sector 0 on the Winchester disk after the combined BIOS has been integrated into a CP/M system. This last process places a hardware-bootable system on the hard disk.

A new Winchester disk drive is delivered in an unformatted condition. This means that the disk has no information identifying the beginning and end of each sector. Once the HCA and other disk hardware is integrated into the system, you must create a routine to write this formatting information on the disk. A formatting routine is then used to issue a DCB to the controller, commanding it to format the disk. The controller takes care of the rest by writing the required formatting information onto the disk.

When the disk formatting is complete, the formatting routine should then read each sector on the disk to determine if the drive hardware was delivered with any bad sectors on the disk. For Winchester disk drives, it is logical sectors of 128 bytes. This means that each disk-read operation places two logical CP/M sectors into the local memory on the controller card and that each disk-write operation must write two logical CP/M sectors to the disk. The READ and WRITE routines keep track of which of these two logical sectors is currently being pointed to in the controller memory and determine what action to take to properly read or write the data on the disk. For example, in the case of a Write, because CP/M requests transfer of only 128 bytes of data to the disk, the BIOS must read the appropriate 256-byte record from the disk, place the 128-byte CP/M buffer over the proper half of this longer record, and then write the combined 256-byte record back out to the disk.
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not uncommon for a disk to have several bad sectors. The test program reads all sectors on the disk and saves the location of any bad sectors identified during the Read process. The routine then identifies these bad sectors to the controller, which constructs an alternate track assignment for each of the bad sectors on the disk. After this alternate assignment is complete, the existence of bad sectors on the disk is transparent to the system. The controller keeps the alternate-track data on the disk and, when a disk access is made to a bad sector, the controller automatically switches to the alternate track to read or write the data.

The second utility, the system-generation program, is used to write the new operating system to the Winchester drive or to read an existing operating system from the Winchester drive into memory. Installation procedures for a combined Winchester drive BIOS are the same as for any typical CP/M BIOS and will be covered in the next section. At the end of the configuration process, a system image will reside in memory starting at location 900 hexadecimal. The locations 900 to 980 hexadecimal contain the system loader, and the locations from 980 hexadecimal contain the newly configured operating system. A WRITE routine must be designed to take the data from these locations in memory and write them to the Winchester disk drive starting at track 0, sector 0. Similarly, a READ routine must be designed to take information from track 0 of the disk and place it into memory starting at location 900 hexadecimal.

Building a New BIOS
One other program must be written before a new BIOS can be built and installed in a CP/M system. This is the system loader that is used to initially read in the system from the disk. This program is written to run at location 80 hexadecimal and is restricted to 128 bytes in length. It is used to load the system during the bootstrap process that we will describe later. The program is designed to read the system starting at track 0, sector 1 of the Winchester disk and, when the load is complete, to transfer control to the proper entry point of CP/M to start the operating system running.

Once the system loader and the BIOS code are complete, the next step is to assemble both of these programs and remove any assembly or syntax errors. In the case of the BIOS, the symbolic variable MSIZE must also be defined before assembly to correspond to the size of the system being generated. Assuming that you have achieved an error-free assembly, the next step is to build a new CP/M system that contains the new system loader and BIOS and to write this
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new system to the Winchester disk drive starting at track 0, sector 0. In this process you should first use the MOVCPM utility (provided by CP/M) to create a new copy of CP/M that is properly sized for the system. Then, as instructed in the MOVCPM utility, this new copy of the operating system must be saved on the disk for later retrieval by using CP/M's standard SAVE utility. Once the new copy of the system is saved, the next
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step is to read the system back into memory using the DDT utility. If the system was saved under the name CPMNN.COM you can use the following CP/M command to initiate DDT and read the new copy of the system into memory:

```
DDT CPMNN.COM
```

After this command is executed, the new system will be located in memory starting at location 900 hexadecimal, and DDT will be running. The next step is to overlay the new system loader and new BIOS on top of the copy of CP/M in memory by using two DDT commands: I (insert) and R (read). These commands place the new system loader into memory at location 900 hexadecimal and place the BIOS at location 1F80 hexadecimal. Once these overlays are complete, the system is properly configured for the Winchester disk drive.

Next we must get out of DDT and return to CP/M while leaving the newly created copy of the system in memory. First, issue a G0 command to DDT that transfers control to CP/M. Once you are back in CP/M, the final remaining task is to run the system-generation utility to load the newly constructed system, which now resides in memory starting at location 900 hexadecimal, onto the Winchester disk starting at track 0, sector 0. Figure 6 graphically summarizes these steps.

Building a New Bootstrap

At the completion of the process we just described, a copy of a properly configured CP/M system and system loader is on the first track of the Winchester disk. The one remaining task is to develop the software to bootstrap this system into memory and to configure the hardware so that this bootstrap is executed when a hardware boot command occurs. The actual bootstrap code is very simple. All it has to do is read the first 128 bytes from track 0, sector 0 on the Winchester disk drive into memory starting at location 80 hexadecimal and, when the read is complete, transfer control to the beginning of this code. This bootstrap code should be written to run at whatever location is going to be assigned to the PROM (programmable read-only memory) chip on the HCA, which we mentioned last month. When properly assembled and linked, the bootstrap code is burned into the HCA PROM and the software installation is essentially complete. The processor board is then "restrapped" so that the bootstrap address corresponds to the beginning of the PROM on the HCA.

Once this modification has been completed, a hardware boot command (i.e., pressing the RESET button) results in the sequence of events presented in Figure 7. At the boot command, the processor begins executing code at the beginning of the HCA PROM. This code reads the first 128 bytes of data from the first physical sector of the first track on the disk into memory starting at location 80 hexadecimal. When the read is complete, the code in the PROM
Figure 7: The Bootstrap process. Pressing the hardware bootstrap (Reset) button causes the microprocessor to transfer control to the PROM chip on the host computer adapter. The code in the PROM reads the first 128 bytes of data from track 0 of the hard disk into memory starting at location 80 hexadecimal and then transfers control to that location. This code in turn loads the CP/M system off the first track of the Winchester disk. Then, when the load is complete, the code transfers control to location 0 hexadecimal to start CP/M running.

transfers control to location 80 hexadecimal, which now contains the system loader. This code now reads the remainder of the CP/M system from the first track on the disk into memory and then transfers control to the CP/M system. The result is that a properly configured system, which includes the Winchester disk drive, is left running in memory, waiting to respond to any user commands.

System Debugging

No matter how careful you are in building the hardware and software we have just finished describing, it is a fact of life that when plugged into the system there will be something wrong. This is when the really interesting portion of the system integration process begins, namely, finding and correcting the inevitable bugs in the hardware and software. This debugging process can be broken into three separate areas. The first is debugging the HCA. The second is debugging and examining the HCA, disk controller, and disk system. The last is debugging the CP/M interface software. We will now describe some of the techniques that can be used in each of these areas.
The first thing to debug is the HCA card. Debugging this device involves making sure that the various combinations of possible input conditions result in the expected outputs to the disk controller. You can do this most efficiently by writing a set of driver routines in assembly language to write messages to the various output ports on the HCA. If you write these routines to loop continuously, you can use an oscilloscope to check the output registers on the HCA to ensure that the card is acting properly.

When you’ve verified proper operation of the HCA to the maximum extent possible, connect the disk controller and the Winchester disk drive to the HCA. This simple connection begins the debugging process for the Miniscribe disk drive, which has extensive self-test features and continuously monitors its own operation to check for faults. If a fault is detected, the drive communicates with the user by flashing a Morse code letter (using the drive select light) to identify the particular fault that was detected. Once the disk is operating properly, the way to debug and test the rest of this total system is to pass various DCBs to the disk controller and see if the disk responds to these DCB inputs as expected. For example, you can test the disk by performing a controller self-test, formatting the disk, writing information to a particular sector, reading the information back, and testing for error conditions. This type of testing not only verifies proper disk operation but also provides you with valuable insight into the disk operation, which you can use during the remainder of the integration process.

Once the disk subsystem hardware is operating properly, the next step is to integrate the software. We described this integration process earlier. However, during the initial testing it is convenient to modify this procedure to allow use of some of the CP/M debugging tools to debug the interface software. To do this, you should create a “false” CP/M system that runs inside (i.e., at a lower memory address than) the current CP/M system running on the computer.

This keeps the initial user system intact and allows you to run the new CP/M system under control of an existing debugged CP/M system, so you have access to the standard debugging tools from CP/M, such as DDT, to aid in debugging the new version of the BIOS.

Conclusion
We have now described the entire process of adding a Winchester disk subsystem to an S-100 computer system running CP/M. As we have tried to show, this is a rather substantial undertaking and should not be started lightly. The main advantage in performing such an integration project is the learning that takes place during the project. If your main goal is to obtain additional storage capability for a microcomputer, you could obtain this storage less expensively and certainly with less effort by buying a commercially available unit such as the one we manufacture. Because of quantity pricing and volume discounts, complete Winchester disk-drive subsystems are commercially available at a cost comparable to what a hobbyist would spend for the hardware portion of the system alone.

However, if you are interested in doing the work yourself and you have the necessary time and expertise, we encourage you to attempt this project and use this series of articles as a guide.

The Winchester disk drive subsystem described in these series of articles is available as a completely assembled unit from ASC Associates of Lexington Park, Maryland. In addition to the S-100 version discussed, versions are also available for TRS-80 and Apple computers. The disk-drive systems for these computers use the same drive and controller hardware as the S-100 version but use a different host computer adapter and interface software. Until a nationwide dealer distribution network is established, these systems will be available by mail order for $1995. To order or obtain further information, write to ASC Associates Inc., POB 615, Lexington Park, MD 20653, or phone (301) 863-6784.
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Listing 1: A complete listing of the BIOS needed to integrate a Winchester disk drive into a CP/M-based microcomputer.

```
Listing 1: A complete listing of the BIOS needed to integrate a Winchester disk drive into a CP/M-based microcomputer.

CP/M MACRO ASSEM 3.0 #001 BIOS FOR A.S.C. ASSOC. HARD DISK SUBSYSTEM 7/18/82

TITLE "BIOS FOR A.S.C. ASSOC. HARD DISK SUBSYSTEM 7/18/82"

COMBINED BIOS INDICATES WHERE THE USER IS TO UPDATE SPECIFIC SUBROUTINES IN ORDER TO REPLACE THE EXISTING CP/M BIOS WITH THE A.S.C. ASSOCIATES CUSTOM BIOS.

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THIS BIOS USES THE DIGITAL RESCUE BIOS, DISK DEFER, AND SECTOR BLOCKING AND DEBLOCKING ROUTINES SUPPLIED WITH THE STANDARD CP/M 3.1 SOFTWARE PACKAGE AND IS THEN COMBINED WITH THE A.S.C. ASSOCIATES HARD DISK BIOS SOFTWARE DRIVER.

THROUGHOUT THIS CODE COMMENTS DELIMITED USING THE FOLLOWING FORMAT ARE TO BE CHANGED WHEN ADDING USER DISK ROUTINES.

>>>> COMMENT <<<<<

002A =

002C =

0036 =

0040 =

0048 =

004C =

0050 =

0054 =

0058 =

005C =

0060 =

0064 =

0068 =

006C =

0070 =

0074 =

0078 =

007C =

0080 =

0084 =

0088 =

008C =

0090 =

0094 =

0098 =

009C =

00A0 =

00A4 =

00A8 =

00AC =

00B0 =

00B4 =

00B8 =

00BC =

00C0 =

00C4 =

00C8 =

00CC =

00D0 =

00D4 =

00D8 =

00DC =

00E0 =

00E4 =

Listing 1 continued on page 388
```
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<thead>
<tr>
<th>TRANSMISSION TIMES**</th>
<th>Std. Tel Rate (7am-1pm)</th>
<th>Dist. Tel Rate (1pm-6pm)</th>
<th>Econ. Tel Rate (6pm-7am)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 MINUTE</td>
<td>$2.37</td>
<td>$1.78</td>
<td>$1.42</td>
</tr>
<tr>
<td>3 MINUTES</td>
<td>$5.03</td>
<td>$3.78</td>
<td>$3.02</td>
</tr>
<tr>
<td>6 MINUTES</td>
<td>$9.02</td>
<td>$6.78</td>
<td>$5.42</td>
</tr>
</tbody>
</table>

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Listing 1 continued:

```assembly
E281+0000 DW 0 ;CHECK SIZE
E283+0100 EQU 0 ;NO ALLOCATE TABLE
0000+ XL/00

>>>>> ADD YOUR HARD CODED OR MACRO GENERATED
<<<<

>>> DISK PARAMETER TABLES HERE.
<<<<

UTILITY MACRO TO COMPUTE SECTOR MASK
SHR MACRO
COMPUTE LOG2(HBK), RETURN 8X AS RESULT
BY SET 0
XX COUNT RIGHT SHIIFS OF BY UNTIL 1
IF 8X 1
EXIT
ENDIF
ENDIF
ENDIF
ENDIF
ENDIF

CP/M TO HOST DISK CONSTANTS

R000 = HBSIZE EQU 2048 ;CP/M ALLOCATION SIZE
R010 = HPSIZE EQU 256 ;HOST DISK SECTOR SIZE
R020 = HOSTPS EQU 32 ;HOST DISK SECTORS/PSP
R020 = HOSTBKC EQU HOSTPS 256 ;CP/M SECTORS/HOST BLOCK
R040 = CP/MPS EQU HOSTBKC HOSTPS ;CP/M SECTOR/SPACE
R060 = SECSIZE EQU HOSTBKC 1 ;SECTOR MASK
R080 = CP/MSPACE EQU 8X ;LOG2(HBK)

BOOT: SIMPLTEST CASE IS TO STOP PERFORM PARAMETER INITIALIZATION
XRA A ;EXECUTE IN THE ACCUM
E285 32A800 STA CXIER ;SELECT DISK 0
E285 32A885 STA FACTOT ;HOST BUFFER INACTIVE.
E285 32A865 STA UNACCT ;CLEAR UNALLOC COUNT.
E285 32A885 OUT ASCFH ;TURN OFF BOOT FROM

>>>>> ADD ANY SPECIFIC SYSTEM HARDWARE INITIALIZATION
<<<<

CHCK CODE HERE (EG. USRAM INITIALIZATION CODE)
<<<<

E281 33D200 JNP G0CP/M ;INITIALIZ AND GO CP/M

NBBOOT: SIMPLTEST CASE IS TO READ THE DISK UNTIL ALL SECTORS LOADED
E284 32A800 STA CXIER ;SELECT DISK 0
E284 32A885 STA FACTOT ;HOST BUFFER INACTIVE.
E284 32A865 STA UNACCT ;CLEAR UNALLOC COUNT.
E284 32A885 LXI SP,080H ;SAVE BACO BUFFER FOR SPACE
E284 32A885 MVX C,S ;SELECT DISK 0
E284 32A885 CALL SELDIS ;GO TO TRACK 0
E284 32A885 CALL HOME

E284 060E MVX B,ACCT ;B COUNTS 8 OP SECTORS TO LOAD
E284 060F MVX B,C,B ;C FOR THE CURRENT TRACK NUMBER
E284 1001 MVX D,D ;D HAS THE NEXT SECTOR TO READ

LOAD1: LOAD ONE MORE SECTOR
E284 F5 PUSH B ;SAVE SECTOR COUNT, CURRENT TRACK
E284 F5 PUSH D ;SAVE NEXT SECTOR TO LOAD

Listing 1 continued on page 390
```
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LISTING 1 continued:

E00C C94E2 : JNE WOOTB ; JUMP THE ENTIRE NOPE IF AN ERROR OCCURRED

E013 81 : NO ERROR; MOVE TO NEXT SECTOR

E014 31 8000 : POP R ; RECALL DMA ADDRESS

E015 D9 12 : LDX $ ; DMA-DRA; $12

E016 81 0D : DAD H ; DMA ADDRESS IS IN H.L.

E017 81 81 : POP D ; RECALL SUTTON ADDRESS

E018 81 0D : DAD H ; NUMBER OF SECTORS REMAINING, COPY THIS TO

E019 81 81 : DEX A ; NEXT-SECTORS-1

E01A C2 2D02 : JS CALL GCPM ; TRANSFER TO CP/M IF ALL DATA FINISHED

E01B 14 : INR B

E01C C3 APE2 : JMP LDBA ; LOAD MORE CODE

E020 3C03 : END OF LOAD OPERATION, SET PARAMETERS AND GO TO CP/M

E021 3C00 5000 : MVI A, 0,CH8 ; CS IS A JMP INSTRUCTION

E022 2E00 8000 : STA 0 ; FOR JMP TO WOOTB

E023 2E00 0D00 : LIX $ ; WOOTB, USE ENTRY POINT

E024 2A00 1200 : SLD B,1 ; SET ADDRESS FIELD FOR JMP AT 0

E025 2D00 5201 : STA 5 ; FOR JMP TO DBS

E026 2E00 0D00 : LIX H, BDOS ; BDOS ENTRY POINT

E027 2D00 6000 : SLD H, 6 ; ADDRESS FIELD OF JUMP AT 5 TO BDOS

E028 01 0000 : LIX B, BD ; DEFAULT DMA ADDRESS IS BDH

E029 C3 9333 : CALL SETOA

E02A 3A0400 : LDA CODE ; GET CURRENT DISK NUMBER

E02B 4F : MOV C, A ; SEND TO THE CCP

E02C 3C00 : JMP CCP ; GO TO CP/M FOR FURTHER PROCESSING

E02D 43F3 : >>>jähr THE FOLLOWING SIMPLE I/O ROUTINES MUST BE <<<

E02E 43F9 : Filled WITH THE USERS OWN SYSTEM ROUTINES <<<

E02F 33E2 : CONST ; CONSOLE STATUS, RETURN BUFFER IF CHARACTER READY, Dw NOT

E030 C3 C3 E2 : JMP XCONST ; SENT TO USER JMP VECTOR

E031 3C00 : CONIN ; CONSOLE CHARACTER INTO REGISTER A

E032 3C00 : JMP XCONIN ; SEND TO USER JMP VECTOR

E033 3C00 : CONOUT ; CONSOLE CHARACTER OUTPUT FROM REGISTER C

E034 3C00 : JMP XCONOUT ; SEND TO USER JMP VECTOR

E035 3C42E2 : LISP ; LIST CHARACTER FROM REGISTER C

E036 3C00 : JMP XLIST ; SEND TO USER JMP VECTOR

E037 3C00 : PUNCH ; PUNCH CHARACTER FROM REGISTER C

E038 3C00 : JMP XPUNCH ; SEND TO USER JMP VECTOR

E039 3C00 : READER ; READ CHARACTER INTO REGISTER A FROM READER DEVICE

E03A 3C48E2 : JMP XRREAD ; SEND TO USER JMP VECTOR

E03B 3C00 : I/O DRIVERS FOR THE DISK FOLLOW

E03C 3C00 : FOR NOW, WE WILL SIMPLY STORE THE PARAMETERS AWAY FOR USE

E03D 3C00 : IN THE READ AND WRITE SUBROUTINES

E03E 3C00 : READ TO THE TRACK 00 POSITION OF CURRENT DRIVE

E03F 3C00 : TRANSLATE THIS CALL INTO A BETTER CALL WITH PARAMETER 00

E040 01 0000 : LIX B, B ; SELECT TRACK 0

E041 C3 9333 : JMP XSECTOR ; WE WILL MOVE TO 00 ON FIRST READ/WRITE

E042 3C00 : SELECT DISK

E043 3C00 : MOV A, L ; SELECTED DISK NUMBER

E044 3C00 : STA TEDISK ; SEEK DISK NUMBER

E045 3C00 : STA SEDSK ; LOAD ALTERNATE DRIVE

E046 3C00 : STA PEAL DISK

E047 3C00 : STA SEDSK ; GO SELECT ALTERNATE DRIVE

E048 3C00 : STA INR C ; RESTORE HARD DISK NUMBER

E049 3C00 : LDX $ ; LOAD ERROR CODE

E04A 3C00 : STA LXDOS ; CHECK AGAINST MAX 4 DISKS

E04B 3C00 : STA LXDOS ; NO CARRY IF GREATER

E04C 3C00 : MOV L, A ; DISK NUMBER TO HI

E04D 3C00 : MOV $0000 ; DISK NUMBER TO LO

E04E 3C00 : MOV 7600 ; MVY, 0 ; MULTIPLY BY 16

E04F 3C00 : DAD B ; ENDM

E050 3C00 : ENDM

SHELDR

E051 3C00 : SEL DATE TRACK GIVEN BY REGISTERS BC

E052 3C00 : MOV B, B

E053 3C00 : MOV C, C

E054 3C00 : MOV D, D

E055 3C00 : SLD D, SERVR ; TRACK TO SEEK

E056 3C00 : >>>>> ENTER YOUR SYSTEM SET TRACK ROUTINE HERE <<<

E057 3C00 : PUSH H ; SAVE DMA ADDRESS

E058 3C00 : MOV C, D ; CEP SECTOR ADDRESS TO REGISTRY C

E059 3C00 : CALL SETSEC ; SET SECTOR ADDRESS FROM REGISTRY C

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Listing 1 continued:

| E286 C1 | POP B | RECALL DMA ADDRESS TO B,C |
| E287 C5 | PUSH B | REPLACE ON STACK FOR LATER RECALL |
| E288 CD39E3 | CALL SETOMA | SET DMA ADDRESS FROM B,C |
| E289 CD48E3 | DRIVE SET TO 0, TRACK SET, SECTOR SET, DMA ADDRESS SET |
| E28E FF50 | READ CPI | ANY FINISH?
| E32F C351E2 | MAYBE THIS CALL IS FOR ANOTHER DRIVE | BETTER GO SET THE TRACK NUMBER |
| E332 78 | MOV A,C | STA SEK8BC | SECTOR TO SEEK |
| E333 C0BE | PLACE YOUR SYSTEM SET SECTOR ROUTINE HERE. | <=<=|
| E336 C35AE2 | MAYBE THIS CALL IS FOR ANOTHER DRIVE | BETTER GO SET THE SECTOR NUMBER |
| E339 60 | MOV B,B | STA DMAADR | LOAD DMA ADDRESS |
| E33A 69 | MOV L,C | PLACE YOUR SYSTEM ROUTINE HERE. | <=<=|
| E33B 2B32E5 | MAYBE THIS CALL IS FOR ANOTHER DRIVE | BETTER GO SET THE DMA ADDRESS |
| E33C C357E2 | MOV | XST8BC |
| E341 2A8BE5 | LDA SEK8BC | GET DISK NUMBER |
| E344 57 | ORA A | CHECK FOR HARD DISK |
| E345 C283E2 | PLACE YOUR SECTOR TRANSLATION ROUTINE. | <=<=|
| E348 69 | MOV R,B | STA XST8BC | TRANSLATE SECTOR NUMBER BC |
| E349 69 | MOV L,C | E34A C9 | RET |
| E34B 2A8BE5 | LDA SEK8BC | GET DISK NUMBER |
| E34E 57 | ORA A | CHECK FOR HARD DISK |
| E34F C25AE2 | PLACE YOUR SECTOR TRANSLATION ROUTINE. | <=<=|
| E352 2A | XRA A |
| E353 32A6E5 | STA UNACMT |
| E356 2B32E5 | STA DBDOP | READ OPERATION |
| E35B 2B31E5 | STA DBFLG |
| E35C 2B32E5 | STA WRITEL |
| E35D 2B32E5 | STA WRITET |
| E35E 3C08E3 | JMP XST8BC | STA | GET UnALLOC |
| E360 2B32E5 | JMP XST8BC | STA WRITEL |
| E361 2B32E5 | JMP XST8BC | STA WRITET |
| E362 2B32E5 | JMP XST8BC | STA | GET UnALLOC |
| E363 3C08E3 | JMP XST8BC | STA WRITEL |
| E364 2B32E5 | JMP XST8BC | STA WRITET |
| E365 3C08E3 | JMP XST8BC | STA | GET UnALLOC |
| E366 3A8BE5 | LDA SEK8BC | GET DISK NUMBER |
| E369 57 | ORA A | CHECK FOR HARD DISK |
| E36A C25DE2 | PLACE YOUR SECTOR TRANSLATION ROUTINE. | <=<=|
| E36C 32A6E5 | XRA A | WRITEL |
| E36D 32B1E5 | STA UNACMT | READ ALT DISK |
| E371 79 | MOV A,C | STA WRITET |
| E372 2B32E5 | STA WRITEL |
| E375 FF02 | CPI WRITEL |
| E377 C913E3 | JMP CHEUNA | CHECK FOR UNALLOC |
| E37A 3810 | MVZ A,BLSS1/128 |
| E37C 32A6E5 | STA UNACMT | WRITE UNALLOC DISK |
| E37F 3A8BE5 | LDA SEK8BC |
| E382 3A75E5 | STA UNACMT |
| E385 2A3CE5 | LSHD SEK8BC |
| E388 32A6E5 | LDA SEK8BC |
| E389 32A6E5 | STA UNACMT |
| E38A 32A6E5 | LDA SEK8BC |
| E38B 32A6E5 | STA UNACMT | UNACMT | SECKTR |
| E38C 32A6E5 | LDA SEK8BC |
| E38D 32A6E5 | STA UNACMT | UNACMT | SECKTR |

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**THE READ ENTRY POINT TAKES THE PLACE OF THE PREVIOUS BIOS DEPOLNMENT FOR READ.**

**THE WRITE ENTRY POINT TAKES THE PLACE OF THE PREVIOUS BIOS DEPOLNMENT FOR WRITE.**

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Using IBM’s Marvelous Keyboard

It’s simple to change IBM’s keyboard to the Dvorak layout or use the keyboard with other computers and software.

David B. Glasco
Murray Sargent III
Optical Sciences Center
University of Arizona
Tucson, AZ 85721

Perhaps the most stunning feature of IBM’s Personal Computer is its beautiful streamlined keyboard. Slim, solid, artistic, and versatile, it defines a new standard in keyboard design. Where did its unique layout come from, and is it superior to others? Can you obtain just the keyboard itself, and how can it be used with other computers? In this article, we’ll study the IBM keyboard from the inside out to answer those questions. You’ll see how to take full advantage of its power, and we’ll show IBM Personal Computer owners a simple way to redefine the keyboard using the operating system. This will allow you to switch to the more efficient Dvorak keyboard layout, or to create your own layout that better suits special needs, such as entry of foreign-language and mathematical text.

Solidly built and with excellent tactile feel, the futuristic IBM Personal Computer keyboard can rest on a flat surface or be inclined and is detached from the main case of the Personal Computer so you can move it around to suit your mood. The choice of characters includes the English letters, Arabic digits, complete ASCII (American National Standard Code for Information Interchange) punctuation characters, 10 special-function keys (labeled F1 to F10), three shift keys (Ctrl, shift, and Alt), two shiftlock keys (Caps Lock and Num Lock), and 15 “cursor/numeric keypad” keys. One badly needed key that isn't provided is a key labeled “Help.” What might be accomplished by typing a Help key depends on software, but user-friendly systems should support such a key. Because the IBM Personal Computer lacks this key, the use of F1 as the Help key is becoming standard procedure in a lot of software.

Acknowledgments
We thank Mike Aronson, Curtis Feigel, Rick Shoemaker, and Mark Tiddens for helpful suggestions.

About the Authors
Murray Sargent III is a professor of optical sciences at the University of Arizona and an author of textbooks on laser physics and microcomputer interfacing. David B. Glasco, a microcomputer owner, is a senior at Canyon Del Oro High School.

heavy lamented in the U.S.A. because touch-typists are used to finding one large shift key that starts in the backslash position. A point partially justifying IBM’s choice is that it’s symmetric. On standard keyboards, e.g., the IBM Selectric typewriter, the forward slash occupies the position between the right shift key and the period, so why not have the backslash intervene between the Z and the left shift key? Furthermore, the right little finger has to move the same distance to reach its shift key as the left little finger does to reach its on the IBM Personal Computer keyboard.

The design follows the German DIN (Deutsche Industrie Norm) standards, for which extensive ergonomic studies were made to determine the most comfortable way for people to type. The backslash (or some other) character is often found between the left shift key and the Z on European keyboards, so Europeans feel this is quite natural. At any rate, after a few hours of experience, the backslash no longer presents a problem for a touch-typist (and it never did for anyone else; if this placement really bothers you, the programs provided here show how to change the keys to any order you desire). In addition, the standards specify labeling the backspace, tab, shift, and carriage-return keys with various arrows,
which is a bit confusing at first and presents typographical problems when one writes about these keys. Curiously enough, the IBM Personal Computer is only just now being marketed in Europe, despite the support of special foreign-language characters on the display screen.

Of Keyboards and Codes
IBM sells just the keyboard itself for $279. But, as with other components of the Personal Computer, the keyboard has been "cloned" by other manufacturers; it is available from Key Tronic, of Spokane, Washington, for $212, so you have more than one source for this kind of keyboard.

The Key Tronic version of the IBM Personal Computer keyboard has the same layout and comes with a variety of encoding options. One, called "IBM Personal Computer plug-compatible," works fine with the IBM Personal Computer. This particular model has small red indicators that light up when the Caps Lock or Num Lock functions have been activated. The keys have a very different feel from the IBM keys. As you press one of the Key Tronic keys, it offers almost no initial resistance, then when contact is made, it offers substantial resistance, thus giving a nice tactile feedback. If desired, you can continue to push down against this increased resistance until the bottom of travel is reached. With some practice, this keyboard requires less effort to type on than the IBM keyboard. In addition, it is less expensive and substantially quieter (you can type away while on the telephone without offending the other party).

On the other hand, the keyboard doesn't feel or look as solidly built as the IBM version and lacks the IBM's convenient ledge that is useful for storing pencils and for supporting dust covers. Having used both fairly extensively, we prefer the IBM version somewhat but feel the Key Tronic is better than virtually any other keyboard we've used (and the people at Key Tronic would probably be willing to add a Help key).

One super feature of the IBM keyboard (and the Key Tronic clone) is that you can cause any key combination to create any code you want. To understand how this is done, let's examine the key-encoding scheme. The keyboard contains an Intel 8048 single-chip microcomputer that constantly scans all the keys. It sends out a serial pattern of bits (called the make code) when a key makes contact, and a similar pattern (the same pattern but with the high-order bit set, called the break code) when the contact is broken. If the contact is present for more than 1/2 second, the keyboard sends out the make code repetitively 10 times a second.

Each key is treated identically by the keyboard; any key could represent a shift key, a number, or a special function. And, because the duration of the depression of a key is reported precisely, you can use the keyboard for playing music and simulating simple joysticks, in addition to the usual typewriter applications. Meanwhile, the main computer doesn't have to waste time monitoring and "debouncing" the keyboard—that's all done by the dedicated 8048 microcomputer. The penalty one pays for this completely general flexibility is that the main computer does have to translate the make and break codes into standard ASCII, but that seems a minor price to pay.

Like other components of the PC, the keyboard has been "cloned" by other manufacturers.

The Joy of Software
Because of the great flexibility of the keyboard, you're really limited only by software—specifically, by the operating system. In this connection, perhaps the most significant improvement of PC-DOS over the 8-bit versions of CP/M is run-time extensibility. You can run a program that defines or redefines some capability in the system and leave it resident until the system is reloaded. Furthermore, when PC-DOS is reloaded, it automatically executes programs named in the AUTOEXEC.BAT file, so that you can bring up a substantially modified operating system with very little effort.

One example of run-time extension is the program in listing 1; it can redefine the keyboard to your specifications. The incoming make code or break code may be translated into any other make code or break code, so that any key can be made to play the role of any other. Then, if neither the Ctrl nor the Alt key is pressed, control is transferred to an appropriate point in the ROM BIOS (read-only memory basic input/output system) to finish the processing, translate the key's code into ASCII, or perform the function specified by the key.

If the Ctrl key is pressed, a couple of special values are checked to give meaning to Ctrl-uparrow and Ctrl-downarrow combinations. For these cases, the jump into the ROM BIOS occurs after all ROM translation and just before the final bit pattern is stored in the keyboard buffer. If the Alt key is pressed, a second table lookup translates the code into any desired 8-bit value and jumps to the ROM BIOS to store the new code in the keyboard buffer. (It is easy to convert our Z80 translator in listing 2 to run on the IBM and bypass the ROM BIOS routine altogether; however, it requires somewhat more memory, so we prefer this hybrid version.)

For the sake of demonstration, the program is initialized to set up the infamous backslash key as a shift key and the cursor pad's minus key as the backslash key. In practice, we've decided we really prefer to leave these keys alone so that they do what they are labeled to do. When running the program, you can switch to a Dvorak key layout by typing a Ctrl-enter combination. (This layout was proposed by Dr. A. Dvorak and his associates after carrying out extensive research on the relative use and sequences of letters. In particular, they placed the keys A, O, E, U, I, and D, H, T, N, S under the left-hand and right-hand standard positions, respectively. Because these characters...
Listing 1: This program takes over the IBM PC keyboard interrupt (INT 9), translating input codes to values given in the internal tables. Initially, the layout is changed as detailed in the text. Typing a Ctrl-Enter combination switches the computer to the Dvorak keyboard layout; a Ctrl-Esc combination returns to the initial layout. Ctrl-backtab, Ctrl-uparrow, and Ctrl-downarrow combinations are translated to 'O, 'U, and 'J for use with the Psene screen editor. Certain uppercase and lowercase letters are given alternate values. Control is then passed to the ROM routines for further processing.

```
Listing 1 continued on page 405
```
Listing 1 continued:

```assembly
finish:    rep    movsb
          mov    dx,di     ;End program but leave keyboard resident
int 27h

table db  43,42,74,43,0 ;backslash -> left shift, keypad-> > backslash

;For a Dvorak keyboard use

tabled db 16,40,17,51,18,52,19,25,20,21,21,33,22,23,24,46,24,19,25,38,26,53
          30,30,31,24,32,18,33,22,34,23,35,32,36,35,37,20,38,49,39,31,12
          44,39,45,16,46,36,47,37,48,45,49,48,50,50,51,17,52,47,53,44,0

c_table db 15,15,72,21 ;backtab -> "O", "uparrow" -> "U"
          80,10,0 ;"downarrow" -> "J"

altic db 30,132,46,135,18,130,49,164,24,148,22,129,23,161,51,174,52,175
          02,173,53,168,03,253,13,240,32,235,0

altuc db 30,142,46,128,18,138,49,165,24,153,22,154,02,173,53,168,05,156
          41,247,13,241,32,127,0

keyend:

cseg ends

rom segment at 0f000h;IBM ROM BIOS keyboard entry points

assume org

romadr label far ;Perform all but initial processing
org 0e9a8h

k26 label far ;Reboot (Ctrl-Alt-Del addr)
org 0e9e5h

k1234 label far ;Turn off shift bits
org 0e81h

k61 label far ;Store char in keyboard buffer and return
org 0e0ch

rom ends

keyadr equ (offset keybrd - offset start) + 100h
keylen equ offset keyend - offset keybrd
tabladr equ (offset table - offset keybrd) + 5Ch
tabledb equ (offset table - offset keybrd) + 5Ch
c_table db 15,15,72,21 ;backtab -> "O", "uparrow" -> "U"
          80,10,0 ;"downarrow" -> "J"
al tic db 30,132,46,135,18,130,49,164,24,148,22,129,23,161,51,174,52,175
          02,173,53,168,03,253,13,240,32,235,0

altuc db 30,142,46,128,18,138,49,165,24,153,22,154,02,173,53,168,05,156
          41,247,13,241,32,127,0

end start
```

Listing 2: KYBRD is a program to convert IBM PC keyboard codes given by call to KEYR into extended ASCII codes (returned in A with extension code in C). Standard keys work as they do for regular ASCII, with ASCII code returned in A and C equal to 0. If the Alt key is pressed, bit 7 of A is set. Special-function keys, TAB, BS, CR, and cursor-pad keys return a code in A (the ASCII code if relevant) with C equal to hexadecimal FE for TAB, BS and CR, and C equal to hexadecimal FF for all others. For these special keys, pressing Alt sets bit 7 of A, pressing Ctrl sets bit 6 of A, and pressing the shift key sets bit 5 (so that the numeric keypad works reasonably). The program includes the routines (starting with KEYR) to time the keyboard waveforms using a TRS-80 (printer-port pin 28). For practical use, one should use a UART to read the keyboard and preferably incorporate KYBRD as part of an interrupt-handling routine.

```assembly
Z80
.radix 16

;comment KYBRD is a program to convert IBM PC keyboard codes given by call to KEYR into extended ASCII codes (returned in A with extension code in C). Standard keys work as for regular ASCII, with ASCII code returned in A and C=0. If the Alt key is depressed, bit 7 of A is set. Special function keys, TAB, BS, CR, and cursor pad keys return a code in A (the ASCII code if relevant) with C=00ffh for TAB, BS, and CR, and C=00ffh for all others. For these special keys, Alt depressed sets bit 7 of A, Ctrl depressed sets bit 6 of A, and SHIFT depressed sets bit 5 (so that the numeric keypad works reasonably). The program below includes the routines (starting with KEYR) to time the keyboard waveforms using a TRS-80 (printer-port pin 28). For practical use, one should use a UART to read the keyboard and preferably incorporate KYBRD as part of an interrupt-handling routine.

;Test program

START:  xor    a            ;Turn off shift bits
         id     (SHIFT),a
LOOP:   call    KYBRD       ;Get next character
         jr     c
         jr     z,LOOP1
         inc    c            ;Display char alone if c=0
         jr     c
         jr     z,LOOP2
         ld     c,5
         jr     z,LOOP3
         ld     c,8
         jr     z,LOOP4
LOOP2:  push    af
         call   co
         pop    af
LOOP3:  ld     c,a
         jr     LOOP
         jr     LOOP2
         jr     LOOP3

;Main decode routine

KYBRD:  call    KEYR       ;Get next code
         ld     c,a          ;Save it
         or     a
         ret
         res    7,a          ;Turn off break bit
         ld     h,16,TAB1-1  ;Point to TAB1
         ld     d,0          ;Clear d
```

Listing 2 continued on page 406
Listing 2 continued:

id e.a ;Index table
add hl,de ;Get ASCII code
id e.a ;Save key code
id hl,SHIFT ;Check for shift keys
jr z,SHIFT cp 83 ;Alt key?
jr z,SHIFT id b,80 ;Clear d
id b,40 ;Put code in e
add hl,de ;Index table
id a,(hl) ;Get shifted code
jr RET

OTHER: set 5,a ;Between 'Z' and 'a'
jr ret

RET: id a,7e ;Shift ** to **
jr ret

ret 7,(hl) ;Turn off bits 5 and 6
ret 7,a ;Turn on high bit

\[ Process non-shift keys \]

id e.a
add hl,de ;Index table
id a,(hl) ;Get ASCII code
id e.a ;Save key code
id hl,SHIFT ;Check for shift keys
jr z,SHIFT cp 83 ;Alt key?
jr z,SHIFT id b,80 ;Clear d
id b,40 ;Put code in e
add hl,de ;Index table
id a,(hl) ;Get shifted code
jr RET

:Process non-shift keys

jr nz,RET3 ;and all non-shift codes
jr nz,RET3

:Process shift keys

SHF: bit 7,c ;Test for break
SHF1: id a,b ;Special char?
jr nz,SHFOFF ;Reset shift bit if break code
id c,SPEC ;No Letter?
jr nc,OTHER cp 7b ;Yes. Check shifts
jr nc,OTHER id b,20 ;NumLock key?
jr c,SHIFT cp 80 ;Right SHIFT key?
jr z,SHIFT id b,4 ;Shift character
jr z,SHIFT id hl,SHFL ;Point to shift status
jr z,SHFL id b,1 ;CapsLock key?
jr z,SHFL

KYBRD1: and 6 ;No CapsLock. Shift key depressed
id a,e
jr z,KYBRD2
jr RET

KYBRD2: res 5,a ;Shift character
jr RET

OTHER: id a,(hl) ;Not letter, shift, or special
and 6 ;Must be number or punctuation
id a,e ;Shift?
jr z,RET cp 60 ;Yep. ***?
Listing 2 continued:

```
SPEC1:  set 5,a ; Yep. Convert to number
SPEC2:  bit 6,(b) ; Ctrl on
SPEC3:  set 6,a ; Yep. Set control bit in code
SPEC4:  ld a,e ; Save code
         ld c,0feh ; Load return code for TAB, BS, and CR
         cp 0e ; TAB?
         jr z,SPEC4
         cp 0f ; TAB?
         jr z,SPEC4
         inc c ; 0ffh is return code for all others
jr RET1 ; Choose Alt bit and return

; TRS-80 waveform decode programs

DATA equ 0f8 ; Input port of keyboard (printer handshake port
             ; on TRS-80)

KEYR:  in a,(DATA) ; Get keyboard byte
        bit 7,a ; Is bit keyboard bit high (Change this bit check to
        jr nz,KEYR ; the bit you are inputting the keyboard signal on)
         ld b,22 ; Disable interrupts
STALL:  dznz STALL ; Stall until next bit is ready
         ld c,6
         ld b,8
GETIT:  in a,(DATA) ; Get bit
         ria ; Shift into carry
         rc ; Shift carry into c
         call DELAY ; Delay until next bit is ready
         dznz GETIT ; Read 8 bits
         ld a,c ; Put code in a
         ei ; Reenable interrupts
         co:  ret ; Console display routine
         ret ; Return
         dec a ; Delay for 1 bit period
         ret
SHIFT:  db 1 ; Shift byte: B0=CapsLock, B1=SHIFT, B2=SHIFT
          ; B3 = B4 = B5=Ctrl, B6=NumLock, B7=Alt

; Comment: Key code translation table. Translates ASCII characters
; into codes 80-8F and special characters into codes 1-19h. These codes
; are further processed by the program. Key changes can be made by substituting desired
; translated codes for those in table. The appropriate table rows for the Dvorak keyboard
; are given as comments following the table.

TAB1:  ; For key code value, add units and decade
        ; Key code units:
        ; Esc  1 2 3 4 5 6 7 8
        ; db 1b,31,32,33,34,35,36,37,38 ; (0) Code decade
        ; 9 0 0  0  0  0  0  0  0  0 ; (0) Code decade
        ; 9 39,30,2d,3d,08,09,71,77,65,72 ; (0) Code decade
        ; 9 y u i o p i ] CR Ctrl
        ; 9 db 74,79,75,69,6f,70,5b,5d,0d,82 ; (0) Code decade
        ; 9 as d f g h j k l ;
        ; 9 db 61,73,64,66,67,68,6a,6b,6c,3b ; (0) Code decade
        ; 9 o SH @ x c v b n
        ; 9 db 27,60,81,5c,7a,78,63,73,62,6e ; (0) Code decade
        ; 9 m , / SH PS AL CL F1
        ; 9 db 6d,2c,2e,2i,80,0f,83,20,85,01 ; (0) Code decade
        ; 9 F2 F3 F4 F5 F6 F7 F8 F9 F0 NL
        ; 9 db 02,03,04,05,06,07,08,09,0a,84 ; (0) Code decade
        ; 9 SL K7 K8 K9 K- K4 K5 KG K+ K1
        ; 9 db 0c,17,18,19,0d,14,15,16,0b,11 ; (0) Code decade
        ; 9 K2 K3 K0 Del
        ; 9 db 12,13,10,0e ; (0) Code decade

; Comment: The Dvorak keyboard is given by substituting the following
; line for the corresponding lines above (identified by the decode code at the end of each line)
        ; 9 db 39,30,2d,3d,08,09,71,77,65,72 ; (0) Code decade
        ; 9 y u i o p i ] CR Ctrl
        ; 9 db 74,79,75,69,6f,70,5b,5d,0d,82 ; (0) Code decade
        ; 9 as d f g h j k l ;
        ; 9 db 61,73,64,66,67,68,6a,6b,6c,3b ; (0) Code decade
        ; 9 o SH @ x c v b n
        ; 9 db 27,60,81,5c,7a,78,63,73,62,6e ; (0) Code decade
        ; 9 m , / SH PS AL CL F1
        ; 9 db 6d,2c,2e,2i,80,0f,83,20,85,01 ; (0) Code decade
        ; 9 F2 F3 F4 F5 F6 F7 F8 F9 F0 NL
        ; 9 db 02,03,04,05,06,07,08,09,0a,84 ; (0) Code decade
        ; 9 SL K7 K8 K9 K- K4 K5 KG K+ K1
        ; 9 db 0c,17,18,19,0d,14,15,16,0b,11 ; (0) Code decade
        ; 9 K2 K3 K0 Del
        ; 9 db 12,13,10,0e ; (0) Code decade

Shift table for punctuation and numbers follows

TAB2:  db 22,00,00,00,00,3c,5f,3e,3f,29 ; Shifts codes 27h
       ; db 01 2 3 4 5 6 7 8 9 ; to 3dh (***)
       ; db 21,40,23,24,25,36,26,2a,28,00
       ; ; < =
       ; db 3a,00,2b

        ; and START
are Á, Ö, and Ú. Similar translations are made for Spanish and French characters. The choices are dependent on values stored in the program, and so require a little work to change, but the program does show how to modify the keyboard output. In our technical word-processing system, we assign alternates that correspond to the characters on the IBM Selectric symbol type ball. Along with a screen character-generator change, this allows you to edit mathematical text on screen. The program takes over the keyboard interrupt (number 17) accessed by PC DOS. Hence all standard software receives character codes set up by the routine (this method is very powerful). See the references for detailed information on these techniques.

**Encoding**

With this overview in mind, let's
now consider the encoding scheme in detail. Figure 2 shows the decimal values of each key's make code. The corresponding code when the key closure is broken (break code) is the same code plus 128. In binary, this corresponds to setting the high-order bit of a byte to 1.

Internally the keyboard generates this bit stream using the Intel 8048 as diagrammed in figure 3a. Five output bits from the 8048 cause a data-distributor circuit to pull one of 23 normally high lines to a low level. A particular key connects one of these lines to one of four interrogation lines that run to a data-selector circuit read by the 8048. The 8048 scans the keyboard-switch array by continually checking the four lines one at a time to see if any are low. When it finds a closure, it waits a few milliseconds (ms) to let the contacts stop bouncing. The 8048 then stores the make code in a buffer for transmission to the remote computer.

Similarly, if the 8048 notices that a key closure is broken, it stores the break code. The codes are sent out serially as described above. The 8048 also automatically repeats any key that remains down for longer than 1/2 second. The circuit in figure 3a includes a clock output line used by the IBM Personal Computer interface, reproduced in figure 3b, and an input

![Diagram](image)

Figure 3: Interface circuitry used by IBM. Figure 3a is a partial diagram of the transmission circuitry used by IBM in its keyboard, as shown on page D-12 of the IBM Personal Computer Technical Reference Manual. The Personal Computer's keyboard input-port interface, from page D-10 of the manual, is shown in figure 3b.
reset line. (The reset line is toggled by the restart routines of the IBM Personal Computer, but it's not necessary. The Key Tronic keyboard does require toggling of this line to function. The effect is that you can disconnect your IBM keyboard and reconnect it with no problem, but you have to perform a power-on restart before expecting the Key Tronic keyboard to continue after unplugging it.)

You can unscrew the covers of either keyboard to examine the circuits inside. This is necessary to exercise the many options available inside the Key Tronic but, as far as the IBM goes, will only satisfy your curiosity about how the IBM looks—there's nothing to change. The Key Tronic options allow interchanging the codes of certain keys and other features. We prefer to implement most of these options in software rather than by modifying jumpers inside the enclosure.

Figure 4 represents how the IBM keyboard transmits a code serially. When no code is being sent, the output remains low (0 volts). To indicate the start of a code, the keyboard output line goes high for 0.2 ms. The 8-bit pattern then follows at 0.1 ms per bit, low-order bit first.

This serial encoding is similar to that used on standard serial terminals. For these, an LSI (large-scale integration) circuit called a UART (universal asynchronous receiver/transmitter) is typically used to translate between the parallel and serial formats. One difference, however, is that the UART output stays high in the absence of character transmission—the opposite of the IBM Personal Computer keyboard. Also, UARTs start a character with a low signal for one bit period, whereas the IBM keyboard uses two high bit periods. But the IBM keyboard does send low-order bits first, followed by a parity bit.

Interfacing to Other Hardware

Fortunately, you can easily take care of these differences. Although IBM did not choose to do so, the serial output of the keyboard can be read using a UART, provided you invert the signal. The keyboard's output is, in fact, very close to the EIA's (Electronic Industries Association) RS-232C voltage convention; effectively, the voltage polarity of the bit stream is inverted by this convention: a 1 is represented by a signal in the range of −15 V to +15 V, while a 0 falls between +3 V and +15 V. This convention is so common that standard integrated circuits (ICs) are manufactured to convert UART levels to the RS-232C standard.

The 1489-type quad line receiver yields a high for any signal less than about 0.8 V, and a low for any signal greater than about 1.7 V. To use the IBM keyboard with an RS-232C serial port, simply use the connection shown in figure 5. The data-transfer rate is usually 10,100 bps (bits per second, slightly less than 0.1 ms per bit period) because the break bit is a little shorter than 0.1 ms in duration. Except for the breaks, 9600 bps would work fine.

The next problem is that the "start bit" from the IBM keyboard is 2 bit periods long (hence you must disregard what the UART perceives as the low-order bit). Meanwhile, 8 significant bits follow, but the UART accepts only as many as 8 bits plus a parity bit, so we've developed the program in listing 3. It ignores the low-order bit, shifts all the more significant bits down one place, and replaces the high-order bit with the parity bit. (You can run this program and use a standard IBM serial port with the data rate set to 10,100 bps, but be very careful not to plug the output of the keyboard directly into an RS-232C line, or you'll destroy the output driver.) This method can also be used for the Key Tronic keyboard, which uses a data rate of 30,000 bps.

Other methods of reading the serial stream come to mind. You can copy the circuit used in the IBM Personal Computer itself, since it's published in the IBM Personal Computer Technical Reference Manual on page...
D-10. This manual is a must for working with the keyboard because it gives the internal schematic of the keyboard. Figure 3b shows this circuitry but includes only those lines and integrated circuits that pertain to keyboard functions. (One advantage to using a UART is that it can communicate directly on a computer system's bus and requires no intervening parallel-port hardware.)

Very quickly, the operation of the circuit is as follows: The KBD CLK line from the keyboard is delayed two system clock periods and inverted by the pair of 74LS175 latches. This new signal is used to shift the KBD DATA bits into the

74LS322 serial-parallel shift register. When 8 bits have been shifted in, the 74LS322 carry is latched to provide an interrupt on the IRQ1 line. This calls IBM's INT 9 interrupt handler to read the character through the 8255 parallel input/output (I/O) circuit and to clear the interrupt. No data rate needs to be specified because the data is shifted in synchronously with the keyboard 8048 microprocessor.

Because the bit stream is quite simple, it can also be decoded directly using a single input line of a parallel port. To do this successfully, the computer must begin reading immediately after the start bit is sent. To avoid wasting time waiting for start bits, the rising edge of the start bit should be used to interrupt the computer. This interrupt should have the highest priority of all interrupts and require that the other interrupts be disabled for the 1 ms required for decoding the bit stream. (Such an interrupt-driven scheme is not desirable; keyboards are substantially more powerful when interrupt driven, as described in references 1 and 2. In particular, you don't lose

The bit stream is quite simple and can be decoded directly.

74LS322 serial-parallel shift register.

Listing 3: UART decode program.

```
LISTING 3: UART DECODE PROGRAM.

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<th>rs232 decoder</th>
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<td>.z80</td>
<td></td>
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<tr>
<td>.radix 16</td>
<td></td>
</tr>
<tr>
<td>STATUS equ 1 ; status port of UART</td>
<td></td>
</tr>
<tr>
<td>DATA equ 0 ; data port of UART</td>
<td></td>
</tr>
<tr>
<td>CI:</td>
<td>in a,(STATUS) ; get status of UART</td>
</tr>
<tr>
<td></td>
<td>ld b,a ; put status byte into b</td>
</tr>
<tr>
<td></td>
<td>and z ; is a character waiting</td>
</tr>
<tr>
<td></td>
<td>jr z,CI ; wait if no character</td>
</tr>
<tr>
<td></td>
<td>out (STATUS),a ; clear status port</td>
</tr>
<tr>
<td></td>
<td>in a,(DATA) ; get character</td>
</tr>
<tr>
<td></td>
<td>or a</td>
</tr>
<tr>
<td></td>
<td>jr a,EVEN ; go if even parity in a</td>
</tr>
<tr>
<td></td>
<td>jr z,CONT ; go if no error</td>
</tr>
<tr>
<td>STC:</td>
<td>scf ; set carry</td>
</tr>
<tr>
<td>CONT:</td>
<td>rra ; rotate carry into high bit of character</td>
</tr>
<tr>
<td></td>
<td>cpl ; complement a</td>
</tr>
<tr>
<td></td>
<td>push af ; save character</td>
</tr>
<tr>
<td></td>
<td>ld a,37</td>
</tr>
<tr>
<td></td>
<td>out (STATUS),a ; clear status port</td>
</tr>
<tr>
<td></td>
<td>pop af ; get character back</td>
</tr>
<tr>
<td></td>
<td>ret</td>
</tr>
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```

Listing 4: Parallel-bit decode subroutine.

```
LISTING 4: PARALLEL-BIT DECODE SUBROUTINE.

<table>
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<tr>
<th>DATA equ 7 ; port being used</th>
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<td>WAIT: in a,(DATA) ; input from port</td>
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<tr>
<td>bit 2,a ; is input bit high</td>
</tr>
<tr>
<td>jr x,WAIT ; wait if not high</td>
</tr>
<tr>
<td>di b,38 ; disable interrupts. if interrupt-driven, this is already done</td>
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<tr>
<td>STALL: djnz STALL ; stall through two start bits</td>
</tr>
<tr>
<td>ld c,6</td>
</tr>
<tr>
<td>GETIT: in a,(DATA) ; input bit</td>
</tr>
<tr>
<td>rra ; rotate into carry</td>
</tr>
<tr>
<td>rra ; use one rra for input bit zero</td>
</tr>
<tr>
<td>rra ; two for input bit one, etc.</td>
</tr>
<tr>
<td>rr c</td>
</tr>
<tr>
<td>call DELAY ; stall until next bit is ready</td>
</tr>
<tr>
<td>djnz GETIT ; continue until all 8 bits received</td>
</tr>
<tr>
<td>ld a,c</td>
</tr>
<tr>
<td>ret</td>
</tr>
<tr>
<td>DELAY: ld a,8 ; delay, ld a with 8 for 4MHZ clock</td>
</tr>
<tr>
<td>DELAY: dec a</td>
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<tr>
<td>jr nz,DELAYO</td>
</tr>
<tr>
<td>ei</td>
</tr>
<tr>
<td>ret</td>
</tr>
<tr>
<td>end</td>
</tr>
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</table>
```
characters when you type faster than a program can process, and you can stop a program gone haywire to examine things with a machine-language monitor.) The IBM Personal Computer itself has several hardware interrupts, including the one for the keyboard, and is all the more powerful because of them. A program to decode the serial stream is shown in listing 4.

Interfacing to Other Software
To perform truly useful functions, you must translate the complete set of make codes and break codes into the standard ASCII codes and useful extensions. Our translation scheme

Figure 6: Flowchart of complete keyboard-encoder program shown in listing 2.

![Flowchart](image-url)
works the same way as the IBM Personal Computer's for the ASCII subset but differs with respect to the special-function keys and the Alt key. The incompatibilities can be removed easily. Our algorithm is more powerful, simpler to understand and implement than IBM's, and one third as long. In any event, it illustrates how one can go about translations in general. IBM's program is published for the Intel 8086 microprocessor in the technical reference manual starting on page A-24.

Figure 6 shows the flowchart for a keyboard translator written for the Z80 microprocessor using the Microsoft M80 assembler. (The program itself is given in listing 2.) The 128 standard ASCII codes are returned in the accumulator (the A register) with values given in table 1. If the Alt key is pressed when one of these codes is deciphered, bit 7 of the accumulator is set to 1. This immediately produces an alternate set of codes that round out the 256 possibilities available with 8 bits. We often make the alternate set correspond to a second daisy wheel for printing mathematical documents. The alternate set plays the role of the IBM Selectric symbol ball, but other uses abound.

These 256 standard-key codes are returned in register A with a value of 0 in register C. The codes returned by the special-function and cursor-pad keys are also returned in A but with register C equal to hexadecimal OFF.
Their values are given in table 2. As for the codes in table 1, if the Alt key is depressed, bit 7 of the code is set to 1. The shift and Ctrl keys set bit 5 and bit 6, respectively. This somewhat strange (relative to ASCII) choice was made so that the codes correspond to the names. For example, the numeric keypad's numeral keys should return their ASCII codes when the shift key is depressed, in contrast to their counterparts on the typewriter portion of the keyboard, which return the ASCII codes while unshifted.

The special-function keys F1 through F10 correspond to codes 1 through hexadecimal 0A (decimal 10), and the numerals 0 through 9 correspond to codes hexadecimal 10 through 19, allowing you to remember them easily. The backspace, tab, and carriage-return (enter) keys give the values 8, 9, and D, respectively; but, unlike their counterparts Ctrl-H, Ctrl-I, and Ctrl-M, the value hexadecimal 0FE is returned in the C register. This allows you to distinguish between the control characters, the function keys, and these special keys—a very useful feature for word-processing systems.

Because any combination of Ctrl, shift, and Alt keys are returned along with the special keys, many combinations are available for word processing and other applications. In particular, the software used by the IBM Personal Computer doesn't return anything for Ctrl-uparrow. This is too bad because text editors typically use Ctrl-leftarrow to mean move back a word and Ctrl-rightarrow to mean move forward a word, and similarly, you'd like Ctrl-uparrow to mean move up a few lines, and Ctrl-downarrow to mean move down a few lines. In this connection, it's interesting to note that touch-typists typically find the regular control characters easier to use for cursor motion than cursor-pad or special-function keys because the regular keys can be touch-typed without departing from the usual typing position. For example, this article was written using the super Pmate context/screen editor, which fully supports both the regular control characters and all IBM's special keys. However, we seldom use the special keys because they require looking at the keyboard.
cludfog an implementation of the how you can tailor the keyboa rd input driver to suit your needs, in­such a ple­asure to use. With the sim­ 1es. •

Table 2: Hexadecimal key values returned in register A for special-function and cur­ on numeric keys with no shift keys pressed, or one alone. Additional combinations can be made by pressing two or three shift keys simultaneously, e.g., shift-Ctrl-F1 yields 61. Shift sets bit 5, Ctrl sets bit 6, and Alt sets bit 7. Register C returns with hexadecimal 0FF for all combinations except BS, TAB, and CR, for which C equals hexadecimal 0FE (so as not to be identical to F8, F9, and ). BS stands for back­ arrow, and CR stands for carriage return. Note that codes returned in A for keys like the regular keyboard keys (e.g., the shifted digits 0 through 9) are the same as the ASCII values. The value in register C allows the user to differentiate between these codes.

Finishing Up
We've described the aesthetic and practical features of the IBM Personal Computer keyboard, showing how the keyboard both looks and acts like the leader in the field. We've shown how you can tailor the keyboard input driver to suit your needs, including an implementation of the Dvorak keyboard layout. The keyboard plays a significant role in making the IBM Personal Computer such a pleasure to use. With the simple interfacing described in this article, you can increase the pleasure of using other computers.

References
2. For further discussion, see M. Sargent Ill and R. L. Shoemaker, Interfacing Micro­computers to the Real World, Reading, MA: Addison-Wesley, 1981

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Strongly Typed Languages

Ada, Pascal, and other new languages let you define your own data types

In recent years, new programming languages have introduced the concept of strongly typed data—a novel idea for persons experienced in the earlier, weakly typed languages such as FORTRAN, COBOL, BASIC, and PL/I. This article explains the reasons behind the strongly typed concept and how it can be used to the programmer's advantage.

Background

All high-level programming languages define a set of basic data types, such as INTEGER or REAL, and operations appropriate for those types. A data type and the set of legal operations for that type have come to be known as a data abstraction. Abstraction is not used here in the sense of complex or difficult; it merely means the essential feature of a datum, such as the fact that it is an integer quantity. This is an extremely useful concept because it lets programmers concentrate on the problem at hand, rather than on the details of its solution.

First-generation languages such as FORTRAN, COBOL, and PL/I support useful and powerful data abstractions. In FORTRAN-77, for example, a character-string operation, say concatenation, cannot be legally applied to data of type REAL. If this were attempted, the compiler would indicate an error.

Many problems, however, can snare the unwary programmer. For example, the FORTRAN data abstractions for REAL and INTEGER types are ambiguous: they use the same symbols for most operations. Both types, for example, use the slash symbol (/) for division, but its meaning differs in each case. This results in the common error of 1 divided by 2 returning 0 when 0.5 was expected. An experienced programmer is aware of the problems resulting from poorly defined data abstractions and avoids them.

The problem with data abstraction in first-generation languages, however, goes even deeper. First-generation data types are too abstract. It is possible, for example, to add INTEGER variables, even though they represent different classes of objects, such as apples and oranges. Because the language does not recognize such concrete data types, it cannot warn the programmer when they are incorrectly combined. In listing 1, for example, a FORTRAN compiler cannot prevent the addition and assignment operations because it is not "apples" and "oranges" being summed, but rather integer values for which addition and assignment are legally defined. Note that in this values problem, FORTRAN would allow the identifiers to assume negative values, even though such values might be meaningless. Programmers are expected to recognize and avoid such illogical operations. The result is usually a longer and more tedious debugging phase than would otherwise be necessary.

A Solution

Problems such as these have led to the extension of the data-abstraction concept into a more powerful form in a new generation of strongly typed languages of which Pascal and Ada are representative examples. Developed as a teaching tool, Pascal is widely available and is used at most universities as the language of choice among computer science faculty and students. Ada, an extension and generalization of Pascal, was sponsored by the Department of Defense and is expected to attain wide use in both civilian and military applications. Ada is more strongly typed than Pascal; some examples discussed in this article apply only to Ada.

About the Author

Earl E. McCoy is a professor at Central Connecticut State College in New Britain. He teaches courses in computer science and management-information systems.

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Printers, printers, and more printers.
A strongly typed language like Ada helps programmers avoid contextual logic errors by allowing them to define their own data types. The Ada program shown in listing 2, for example, uses the TYPE statement to define two new data types, “apples” and “oranges,” which may have integer values ranging from 0 to 1000. Because both types are instances of the predefined type INTEGER, they inherit all the operations allowable for integers. Thus, all identifiers of the type “apples” may be added among themselves; so too may all identifiers of type “oranges.” However, identifiers of type “apples” and type “oranges” may not be added together because they are of a different type. Identifiers of differing types may not be operated upon, even though they may be of the same underlying primitive type, as in this case. Thus, the data-abstraction concept provides a mechanism for enforcing logical correctness upon a program.

For this enforcement policy, a penalty must be paid in processing overhead. For instance, subrange values must be checked during program execution, which slows down the program somewhat. However, if the subrange check guarantees correct operation of the program, it’s probably worth the price. Moreover, most type checking can be done at compile time, which exacts a small penalty for the benefit returned.

Programmers may avoid the overhead penalty. For example, in listing 2, a programmer could have avoided the subrange checking by not specifying a range in the TYPE statement. To eliminate the compile-time type check, the programmer could omit the TYPE statements entirely and simply declare the identifiers as integers, as is done in FORTRAN.

More Data Abstractions

In addition to inheriting operations from primitive data types, user-defined types can also specify new operations. This allows a programmer to define a data abstraction in the full sense of the term.

In an image-processing program, a programmer might want to operationally limit contrast enhance, edge detect, and brighten digitally encoded "pictures." In Ada, this may be accomplished by first defining a type “picture” in terms of more primitive types as shown in listing 3. Specifically, a picture datum is defined as a 256 by 256 array of picture elements (pixels), each having 64 possible gray levels.

The type "picture" does not inherit any of the operations valid for an array because it is defined (implicitly) as a private type (a special feature of Ada). Instead, the programmer defines the operations valid for picture data via the subprogram units shown in listing 3.

The advantage of user-defined data types is that they enable the computer to ensure that procedures process only data of the correct type. For example, defining a data structure as in listing 3 enables the computer to ensure that only pictures with the proper size, picture elements, and valid shades of gray are passed to the picture-processing procedures. Weakly typed languages can offer such protection only for predefined primitive data types.

New Primitive Data Types

Complementing the usual predefined primitive data types, such as INTEGER, CHARACTER, and REAL, Pascal and Ada have a new data type, called scalar in Pascal and enumerated in Ada.

Enumerated types make for more readable programs. Identifiers of this type may assume only those values listed by the programmer (see listing 4). The enumerated values may be
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strings of alphabetic characters but are not to be confused with character strings. In listing 4, the identifier "air" could be assigned a value by executing the following statement:

    air := clean;

If that identifier were of type character string, the assignment statement would have to read:

    air := "clean";

Enumerated types can also be used as array subscripts, which can lead to very readable programs because arrays can be indexed by names of objects rather than as integers, as in FORTRAN or COBOL. In addition, enumerated data can be used in CASE statements to make very readable multibranch tests.

In sum, the full-blown data-abstraction mechanisms of modern languages enable a computer to check the logical consistency of a program, which is all to the programmer's benefit. A programmer may choose to ignore this feature out of laziness or to avoid extra overhead. But once learned, this concept is easy and can help to produce error-free programs and ease maintenance of existing programs.

References

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Designing efficient passive solar residences and small office buildings is a complicated process. Although the basic principles of passive solar design are simple, their successful execution requires a thorough understanding of their physics and practical application. The four programs in the Solarsoft package enable the experienced architect/engineer or owner/builder to fine-tune the design of any passive solar building. The following is a review of the four programs.

Sunpas
Sunpas is an interactive program that can quickly estimate the auxiliary (or backup) heating requirement and solar contribution ("percent solar") of a passive solar building. The program uses monthly correlations developed at the Los Alamos Scientific Laboratory (LASL) in Albuquerque, New Mexico. This Solar Load Ratio method has become the standard estimation technique in the solar industry and is described in detail in the Passive Solar Design Handbook, vol. 2. (DOE/CS-0127/2), available from NTIS (National Technical Information Service), 5285 Port Royal Rd., Springfield, Virginia 22161.

The method uses the Solar Load Ratio (SLR) as the main parameter for estimating building performance. The SLR is the ratio of solar gains absorbed by a building in a given period of time (usually a month) to the heat lost during the same period. From this, the program calculates the Solar Savings Fraction (SSF), which yields the auxiliary heating requirement. The SSF is the building's "solar savings" divided by its "net reference thermal load." For most buildings, the net reference thermal load is the load on an equivalent building without the passive system, and thus the SSF is in fact the percent that the solar system contributes toward the heating of the building.

Sunpas is menu driven. A setup menu specifies the required input data, including building heat loss, internal heat gains, shading, and location information.

The "climate responsive takeoff" menu asks the user to define each building surface as to type (solar or nonsolar), area (width and height), and overall u-factor (heat-loss coefficient). If a surface is solar, the user must specify its azimuth and tilt, solar absorption, night insulation R-value (resistance, or measurement of the tendency of a material to retard the flow of heat), two key fixed shading overhang parameters, and one of five user-defined monthly shading patterns.

The "ground responsive" heat-loss menu allows the designer to specify heat loss with reference to a constant temperature source such as the earth—a nice feature. Although the heat-loss value may not be entirely accurate, it gives a good approximation of basement heat loss when the ground temperature is accurately estimated.

The "infiltration and perimeter" menu asks only for the total building volume and the average air infiltration rate in air changes per hour (AC/hr). The AC/hr value is important because it is generally a large part of the total heat loss. Average uninsulated houses have values approaching 1.0 AC/hr, while superinsulated houses are near 0.2 AC/hr. If there is a slab instead of a basement or crawl space, the perimeter heat loss can be defined in this menu section by the length of the exposed perimeter and a single heat-loss coefficient.
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At a Glance

Name
Sunpas, Sunop, Tswing, and Solgain

Type
Monthly SLR correlation method and economic analysis of passive solar buildings

Manufacturer
SolarSoft Inc.
POB 124
Snowmass, CO 81654
(303) 927-4411

Price
$700 for all four programs together; $395 for Sunpas and Sunop only, $395 for Tswing and Solgain only

Format
5¼-inch floppy disk

Language
Applesoft BASIC

Computer Needed
Apple II Plus with 48K bytes and two disk drives with an optional 80-column printer

Documentation
160 pages, in 3-ring binder (includes 11 complete examples)

Audience
Architect/engineers and owner/builder involved in design of passive solar buildings

The "internal gains" menu allows the user to specify the average daily level of internal heat gains from people, lights, and appliances. These gains partially reduce the heating load. The menu also asks for the average thermostat setpoint. This is the setting, weighted hourly, of the thermostat. For instance, a 68°F day and 60°F night setting would yield an average of about 65°F. This value has a pronounced effect on the total heating load of a building and should therefore be selected with care.

Before running the analysis, the user must ensure that the disk contains monthly average climatic data for the building site. The data includes the latitude and altitude of the site, the monthly average ambient temperatures and daily swing (needed to calculate monthly average degree-days for any base temperature), and the average daily solar radiation. (This information is available for some 200 cities in the U.S. and Canada in the DOE handbook previously mentioned. The data disk of examples supplied with the software has approximately 15 cities on it.)

You run the program from the analysis set of menus. During the calculation phase, the program periodically delivers messages of its status so that the user is not left in the dark. The calculations usually take less than a minute, although the execution time may be longer if a large number of passive systems are present. The results can be printed directly and saved on disk as well.

The analysis menu lists three printing options for the computed results: the "complete print," which gives detailed information for each passive system specified; a "partial print," which repeats all important input data and all total building results (table 1); and "final results," which gives only the monthly SSF and auxiliary heating values.

I find that the "partial print" option is the best, because it repeats the input values and gives a nice breakdown of heat-loss sources and a summary of the monthly solar radiation absorbed. The final monthly results lists the net backup fuel requirement, the yearly total auxiliary use, and solar saving fraction. The complete printout gives the same information, but with the solar radiation data listed for each system.

A Sunpas graphics routine, available from the general graphics menu, produces a bar chart of the monthly auxiliary heating load, with the solar contribution highlighted. Title labeling requires user-supplied graphics text-editing software. Figure 1 shows what is possible.

Sunop

Sunop accepts input from the Sunpas program and either calculates life-cycle costs of the passive solar system or determines the optimal mix of energy conservation and passive solar features for particular design and system cost regimes. Additionally, Sunop can graph a variety of parameters for presentation. Economic variables and analysis menus are used to set up and run the program.

The economic-variables menu allows the user to enter or edit default economic values, including financial period, down payment fraction, mortgage term, annual loan interest rate, discount rate, fuel inflation rate, maintenance and insurance costs, and fixed and variable system costs. The analysis follows the method found in the Passive Solar Design Handbook (see chapter H and appendix E of that publication for defini-
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WINDOW | 134.4 | 18.9 | 0.0
WINDOW | 56.0 | 7.9 | 0.0
W WALL | 19.1 | 2.7 | 3.5
DOOR | 2.9 | 0.4 | 0.5
E WALL | 17.9 | 2.5 | 3.3
WINDOW | 20.2 | 2.8 | 0.0
WINDOW | 8.4 | 1.2 | 0.0
N WALL | 21.3 | 3.0 | 3.9
DOOR | 2.9 | 0.4 | 0.5
WINDOW | 6.7 | 0.9 | 1.2
WINDOW | 13.4 | 1.9 | 2.4
GABLES | 17.6 | 2.5 | 3.2
S ROOF | 54.7 | 7.7 | 10.0
N ROOF | 86.0 | 12.1 | 15.7

Table 1: A typical partial print report from Sunpas.

Figure 2: Graphic output of one of Sunop's life-cycle cost runs.

Tswing

Tswing is a thermal network analysis program that calculates the temperature at different locations throughout a passive solar building on an hourly basis. These locations are known as nodal points. A heating and cooling thermostat can be associated with any node (a maximum of two). Engineers will recognize this technique of network or nodal analysis as a generalized method for solving transient heat flow problems by the implicit finite difference technique. (In fact, this program is general enough to solve many nonsolar heat transfer problems.)

A thermal network consists of a system of interconnected nodes (figure 3). The user must specify the capacitance (ability to store heat) of each node and the conductance (rate of heat transfer between nodes) of each interconnection. In addition, the user must define heat gains from external sources such as sunlight, lights, and appliances. Tswing is able to calculate the hourly temperatures of each node for up to 14 days and plot any node over a 24-hour period. Graphic overlays are also possible.

Tswing is an ideal program for fine-tuning the thermal storage mass in passive buildings. In particular, it allows the designer to check for living space overheating and potential freezing problems in unheated areas such as sunspaces.

Tswing Submenus

Tswing contains five submenus that help the user to input data and run the program. From the main menu, the user can describe the building either node by node or zone by zone. Most novices choose the zone menu because it prompts the user for specific values and then automatically creates the matrix for the analysis. The experienced user usually selects the node-by-node menu because it is quicker. The user must define, in addition to building-related data, the weather data through the weather menu. Finally, the run menu is used to set up and perform the actual hour-by-hour analysis.

The zone menu is divided into three sections. The zone section prompts for such data as number of zones, floor area, thermal capacitance, exposed-wall area, volume, and heat-transfer coefficients. The mass section prompts for the number of nonwater thermal mass units and the number of their layers and amount of surface area, as well as the heat-transfer coefficient between them and the house air. The water section asks for the number of water mass units and their diameter and height, as well as various heat-transfer details.

The node menu requires that the user enter data via the submenus of capacitances, conductances, and constant
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Figure 3: Tswing describes a building as a thermal network of heat conductances and capacitances.

Figure 4: Tswing enables a user to test the effect of various parameters such as airflow rate on a solar design.

loss. Next, the user defines other important parameters that describe the operation of the building through the following submenus: movable night insulation, internal heat gains, thermostat setpoint, and solar distribution patterns.

A nice feature of Tswing is that as many as five different solar distribution patterns can be defined and then varied in the run sequences. Thus one pattern may consist of radiation for a south-facing window with an overhang, another for a south-facing window without an overhang, another for a 30-degree skylight, another for an east-facing window, etc.

The weather menu requires the user to define the ambient temperatures and solar radiation for as many as fourteen days. In the solar radiation section, the user is able to enter hourly radiation values from sunrise to sunset for each of five different surfaces. These surfaces

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must correspond to the five different solar distribution patterns mentioned above. Actually, a user needs to enter only the total daily radiation and the number of sunlight hours. Tswing will compute the values automatically in a sine-wave pattern with the peak at noon. The hourly ambient temperatures are entered in a similar fashion. The same sine-wave auto-entry feature can be used here as well. The user needs to enter only the average temperature and the daily temperature swing.

Before the actual simulation can start, the user must first define the initial temperatures of each node (default values are 65°F), the number of days in the simulation, and the specific display format on either the screen or the printer. The selection of the number and type of days is very crucial. For instance, the user can define a clear, cold day and a cloudy, cold day, etc. Then by simply changing the order or number of days, the user can quickly “see” the building’s performance in all possible weather scenarios.

At this point, the user is ready to begin the simulation. The best way to do this is to print the results first (selected nodal hourly temperatures and net backup heat-

Figure 5: Solgain computes the heat gained by a building as a result of the sun’s rays passing through its windows.

ing and/or cooling load) and then rerun selected parts of the simulation for graphic presentation. An unfortunate limitation of the software is that only one day can be graphed. It is possible, however, to overlay different simulations (as in a parametric study) on one graph (figure 4). This is an excellent feature to have when you are presenting different options of a design to a client for review.

Solgain

Solgain calculates the clear-day solar gains on the twenty-first of each month. It calculates, from the horizontal and overhang size, incident and transmitted radiation through single- or double-glazed windows, with varying shading coefficients, orientation, and tilt. Solgain menus prompt for some 16 input parameters. These include the window’s latitude, angle from the horizontal, azimuth, shading coefficient, heat-transfer factor, dimensions, and fixed and adjustable overhang details and dimensions.

Solgain displays results either graphically or in table form. A nice feature is its ability to plot hourly solar gains (figure 5). The user has the choice of selecting any two of the following solar radiation components: incident, incident (shaded), transmitted, or transmitted (shaded).

Conclusion

The Solarsoft package is a tour de force for quantifying passive solar building performance. The Sunpas, Sunop, Tswing, and Solgain programs are the state of the art in microcomputer estimation techniques. Our architectural and engineering firm regularly uses the Sunpas and Tswing programs to analyze and fine-tune the passive solar buildings we design and are consulted about. They are a quick and inexpensive alternative to mainframe simulation methods.

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The Ins and Outs of the TRS-80 Color Computer

Find out how the Color Computer interfaces with the outside world.

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My TRS-80 Color Computer was not home long before I was searching through back issues of BYTE to find out what was known about the internal workings of the unit. My interest aroused by a few excellent articles (see references 1 and 2), I was soon "peeking" and "poking" around inside my new purchase to find out more.

This article should further whet your appetite for exploration by giving you details on how the Color Computer interfaces with the outside world. I have also included some other tidbits of information to help you on your way to a better understanding of the internal workings.

The Peripheral Interface Adapter

The MC6809E microprocessor interfaces with the outside world (and some other internal devices) through a PIA (peripheral interface adapter) integrated circuit (IC), numbered MC6821 by Motorola. The MC6821 pin configuration is shown in figure 1.

The purpose of the PIA is to enable the microprocessor to receive and transmit signals and interrupts from the outside world. Because these needs vary so much with each application, the MC6821 has been designed with maximum flexibility in mind. The IC contains two independent interface circuits, which are nearly identical in operation. Each circuit can receive or transmit as many as eight digital signals in any combination (three in, five out; one in, seven out; etc.). In addition, each has two control lines, one dedicated to input and the other selectable as either input or output.

There are actually two PIAs in the Color Computer, one mainly for accepting keyboard entry (PIA1) and the other for external communication (PIA2). Each PIA is assigned four memory locations; PIA1 has hexadecimal addresses FF00 through FF03 and PIA2 has hexadecimal addresses at FF20 through FF23. In fact, only the least significant 2 bits of the address are used, along with the "chip-select" signal, making hexadecimal addresses FF00 and FF08 through FF1C for PIA1 equivalent to hexadecimal FF00. Also, only the least significant 2 bits are used with the other PIA1 and PIA2 addresses.

A block diagram of the input/output (I/O) components in the Color Computer is shown in figure 2. The PIAs receive and transmit signals to the digital-to-analog (D/A) converter, keyboard, joysticks, joystick fire buttons, cassette port, RS-232C port, video-display generator IC, analog comparator, audio-output selector, single-bit sound output (produces sound by switching one bit on and off rapidly), memory size jumpers, and interrupts used for timing purposes.

Figure 3 shows the allocation of the I/O and control lines of the two PIAs. The function of each of the identified lines is given in the following sections.

The Cassette Interface

Both the incoming and outgoing audio signals are passed through signal-conditioning circuits. Data is recorded on tape by a frequency-shift-keying (FSK) technique. This circuit can be used for many purposes not related to cassette storage. The output of the D/A converter is connected to lines PA1 through PA7 of PIA1 via
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a scaling circuit. This results in an analog voltage at pin 5 of the cassette socket. This voltage varies from 55 millivolts (mV) to 1.126 volts (V) in 17-mV steps. Outputting numbers from 0 to 63 onto the upper 6 lines of PIA2 will set the voltage. To demonstrate this, connect a voltmeter or oscilloscope (set to direct-current coupling) to the cassette output, pin 5. Then enter and run this BASIC program:

```
10 FOR I=0 TO 63
20 POKE 65312,(PEEK(65312) AND 3) OR (I*4)
40 NEXT I
50 GOTO 10
```

Your meter or oscilloscope will show a slowly rising direct current (DC) voltage, which will suddenly fall to 0 and then start rising again. The result will be a positive-going sawtooth waveform. The slowness is due to the relative slowness of the BASIC interpreter. A machine-code routine would be much faster.

In line 20, multiplying I by 4 shifts the value of I to bits 2 through 7. Using the AND function with 3 and the current contents of the address returns the value of bits 0 and 1. Use the OR function with the result and the desired number, and put the final result back into the PIA. This is an important technique that you will see used elsewhere in this article. It allows modification of selected I/O lines without interfering with others.

Remember that this output is a voltage signal and that no power can be drawn from it. However, it can be interfaced with operational amplifiers and other analog devices to perform an unlimited number of control functions, enabling your Color Computer to control a variety of analog hardware with the right interface circuit. Possibilities include temperature control, model train

---

**Figure 1:** The peripheral interface adapter (MC6821) provides a flexible general-purpose interface between any of the 6800 series microprocessors and the outside world.

**Figure 2:** The TRS-80 Color Computer input/output system. The two PIAs are efficiently used to perform all of the I/O tasks needed by the Color Computer. The PIAs pass signals that are used for functions ranging from keyboard entry to cassette-recorder control to graphic-display control.

**Figure 3:** The PIA pin assignments. All available connections to the two PIAs are used, in some cases for more than one purpose. The great flexibility of the MC6821 makes this efficiency possible.
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The RS-232C Interface

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The Color Computer has a subset of the available signals in the RS-232C standard. They are Data Transmit, Data Receive, Carrier Detect, and Signal Ground. The Color Computer owner's manual will give you the pin locations. Transmitted signals from the Color Computer are at approximately plus or minus 10-V levels.

The functions of all signals, with the exception of Carrier Detect, are implied by their names. Carrier Detect is a signal sent to the Color Computer by the other device (modern, etc.) to say that the device is there and ready.

You can output data through the port by connecting a 9-V battery between Signal Ground and Data Receive. Put the negative side of the battery to Signal Ground. Then, type LLIST to output your program through the port output line (put your oscilloscope on the line if you have one), and the OK prompt will reappear. If the program is long, it might take a while because transmit speed is only 600 bps (bits per second, or about 60 characters per second) using LLIST.

RS-232C data is transmitted serially as one 0 start bit, seven data bits (least significant bits first), a 0 for bit 8, and two 1 stop bits. A total of 11 bits are sent for each character. The "at-rest" condition of the line is a 1.

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bps to be compatible with Radio Shack printers. You can change this rate by putting parameters into hexadecimal addresses 0095 and 0096. The first holds the most significant byte. Initially the value is 87 (0 in 0095, and 87 in 0096), generating 600 bps. Experiment with different addresses 0095 and 0096. The first holds the most significant byte. Initially the value is 87 (0 in 0095, and 87 in 0096), generating 600 bps. Experiment with different numbers, and you'll find that the speed can be varied from 110 to at least 4800 bps. An 18 will give 2400 bps, and 180 results in 300 bps, for example.

Many RS-232C interfaces are commonly implemented using a universal asynchronous receiver/transmitter (UART) IC. This takes care of all timing and synchronizing. A UART has the capability of receiving and transmitting data simultaneously. But the Color Computer doesn't have a UART, so these functions must be performed by software, requiring some pretty fancy programming. However, I can demonstrate here that the Color Computer is capable of transmitting at various rates through the RS-232C port.

The program in listing 1 is in machine code and will continuously send a character you type, at the rate you select. It uses a machine-code loading technique described in the Color Computer BASIC manual. No heed is paid to the Carrier Detect or Data Receive lines for this demonstration. Repeating the character triggers your oscilloscope, allowing you to study the waveform of the data. Remember, it transmits the character in ASCII (American National Standard Code for Information Interchange).

Study the flow diagram in figures 4a and b to see how the program works. Delays are developed using loops in machine code similar to FOR...NEXT in BASIC. Small delays can also be created using the NOP (no operation) machine-code instruction, which causes the microprocessor to do nothing for two machine cycles, or the BRN 00 (branch never) instruction, which uses up three machine cycles.

The Color Computer runs at 0.895 MHz, making each cycle last 1.117 microseconds (µs). The machine-code routine must delay the program for 93 machine-code cycles times the bps code, between outputs of each bit. A

Listing 1: Variable-bps-rate RS-232C transmitter. This demonstration program polls the keyboard for a depression and continually transmits the ASCII code for that character via the RS-232C port. An oscilloscope lets you study the resulting waveform.

5 CLEAR 25,2950
6 DIN RATE(7)
7 FOR I=1TO7:READ_DATA(1):NEXT
8 DATA 84,32,16,0,2,1
9 A=3957
12 AA=AA
17 DATA AH,9F,AA,00
19 DATA 27,OH
21 DATA 81,03
23 DATA 26,04
25 DATA 4F
27 DATA 7E,84,FP
29 DATA 6A,6A,6A
30 DATA 6A,6C,67
31 DATA 6A,6C,66
32 DATA 6A,6C,63
33 DATA 6F
35 DATA R7,FP,20
37 DATA 26,00
39 DATA 26,00
41 DATA 26,00
43 DATA 26,00
45 DATA 80,0C,32
47 DATA 10,8E,00,0B
49 DATA 86,8C,4D
51 DATA 86,02
53 DATA R7,FF,20
55 DATA 80,0C,23
57 DATA 6E,8C,42
59 DATA 31,0E
61 DATA 26,EF
63 DATA 26,00
65 DATA 12
67 DATA 80,02
69 DATA R7,FF,20
71 DATA 26,00
73 DATA 8F,00,04
75 DATA 26,00
77 DATA 30,82
79 DATA 26,FA
81 DATA AD,0C,06
83 DATA AU,0C,03
85 DATA 86,8C,45
87 DATA 8E,00,03,12,12,30,82
89 DATA 26,FA,8E,8C,15,CO,01
91 DATA 27,0B,26,00,8E,00,06
93 DATA 12,12,30,82,26,FA,6E
95 DATA 8C,EE,39
97 DATA LAST
99 PRINT "LOADING MACHINE CODE...."
100 READ HEXS
102 IF HEXS="LAST" THEN 150
105 C$SUB 1000
110 PRINT "ADDRESS: A,"DATA: "HEXS:" /;BYTE
120 POKE A,BYTE
125 A=A+1
130 IF A<0095 THEN PRINT "OUT OF MEMORY:"END
135 GOTO 100
150 B=INT (I/A)/256
155 POKE 275,B
160 POKE 276,AA-B*256
165 PRINT "CODE ENTRY CORRECT"
166 INPUT "RETURN TO CONTINUE":A$170 C$PRINT "BAND RATE SELECTION"
171 PRINT 360,"0"-STOP
172 PRINT100,"2"-300
173 PRINT139,"3"-600
174 PRINT169,"4"-1200
175 PRINT199,"5"-2400
176 PRINT229,"6"-48CO;PRINT2260,"7"-9600
177 PRINT326,"SPEED"
178 INPUT BD
179 IF BD>=0 THEN C$=END
180 IF BD<0 THEN C$=END
190 C$=""192 PRINT230,"PRESS ANY KEY TO"
193 PRINT262,"TRANSMIT ITS CODE"
194 PRINT292,"BREAK TO SET SPEED"
200 POKE 4081,D (BYTE)
210 A=BYTE(0)
220 GOTO 170
240 IF LEN (HEXS)>2 THEN PRINT "DATA ERROR:"END
255 USE ASC (HEXS)
260 LOAD ASCII (RIGHTS (HEXS,1))
265 BYTE=0
270 IF UP=55 AND UP=7 THEN BYTE=(UP-55)*16:C$=0 TO 1050
285 IF UP=47 AND UP=0 THEN BYTE=(UP-47)*16:C$=0 TO 1050
290 PRINT "DATA ERROR:" ;HEXS
300 RETURN
310 GOTO 1030
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subroutine is used to create this time delay, resulting in the equation:

\[ \text{bps code} \times 93 \times 1.117 = \text{delay in microseconds} \]

The bps code for each desired rate is computed by:

\[ \text{bps code} = \frac{\text{maximum bps}}{\text{required bps}} \]

In this program, the maximum bps is 9600. The variable bit rates and codes are shown in the following table. After each bit is loaded into the output port, this delay is called and the associated data-rate output results.

<table>
<thead>
<tr>
<th>Data Rate</th>
<th>Bps Code</th>
<th>Required Delay</th>
<th>Actual Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>64</td>
<td>6.67 ms</td>
<td>6.65 ms</td>
</tr>
<tr>
<td>300</td>
<td>32</td>
<td>3.33 ms</td>
<td>3.32 ms</td>
</tr>
<tr>
<td>600</td>
<td>16</td>
<td>1.67 ms</td>
<td>1.66 ms</td>
</tr>
<tr>
<td>1200</td>
<td>8</td>
<td>0.833 ms</td>
<td>0.831 ms</td>
</tr>
<tr>
<td>2400</td>
<td>4</td>
<td>0.417 ms</td>
<td>0.416 ms</td>
</tr>
<tr>
<td>4800</td>
<td>2</td>
<td>0.208 ms</td>
<td>0.208 ms</td>
</tr>
<tr>
<td>9600</td>
<td>1</td>
<td>0.104 ms</td>
<td>0.104 ms</td>
</tr>
</tbody>
</table>

The Audio Interface

When you use Color BASIC's sound-producing instructions, audible signals are routed through the television modulator to your television speaker. Complex sounds generated by the game cartridges may also be directed to the speaker. The switching is performed by one half of a dual four-channel analog multiplexer (Motorola MC14529B). The other half is used for the joystick inputs described later. The MC14529B selects one of four analog sources to switch to the output, based upon a 2-bit binary code. The IC can also be totally disabled by making PIA2, line CB2, equal to 0. Figure 3 shows the PIA outputs that feed to this IC. Figure 5 shows the logic circuit that accomplishes this switching.

There are only three sources of audio signals (AUDIO ON, SOUND, and a game cartridge), so the fourth line is unused. To select the audio multiplexer, PIA2, line CB2, must be a 1, and the right code must be output from PIA1, lines CA2 and CB2. The following table shows the audio-selection-code combinations and their effects.

<table>
<thead>
<tr>
<th>PIA2 CB2</th>
<th>PIA1 CA2</th>
<th>PIA1 CB2</th>
<th>Resulting Output To Television</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>D/A converter</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>cassette</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>not used</td>
</tr>
</tbody>
</table>

To set and clear PIA2, line CB2, use:

POKE 65375,(PEEK(65375) OR 8)
POKE 65315,(PEEK(65315) AND 247)
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Circle 95 on Inquiry card.
Listing 2: BASIC sound-generator program. The D/A converter may be used to produce audible sounds if you switch the digital number fed to it. This program demonstrates the technique.

10 POKE 65495,0
11 POKE 65315,PEEK(65315) OR 8
12 POKE 65315,PEEK(65315) AND 247
13 POKE 65281,PEEK(65281) AND 247
14 POKE 65283,PEEK(65283) AND 247
15 POKE 65281,0
16 POKE 65293,PEEK(65281) AND 247
17 POKE 65312,252
20 POKE 65312,252
25 POKE 65312,282
40 GOTO20

To set and clear PIA1, line CA2, use:

POKE 65281,(PEEK(65281) OR 8)
POKE 65281,(PEEK(65281) AND 247)

To set and clear PIA1, line CB2, use:

POKE 65283,(PEEK(65283) OR 8)
POKE 65283,(PEEK(65283) AND 247)

Listing 2 shows a demonstration of the use of the D/A converter to generate a sound. This program switches the D/A converter lines from 0 to 255 and sends the resulting square wave to the television speaker. To increase the frequency of the sound (BASIC is rather slow), the microprocessor is run at the dual speed, as described in the articles in the references. (This technique may not work on your Color Computer and should never be used on disk-based systems.) Even so, the resulting sound is a low-frequency buzz and not the clean sound made by the machine-coded SOUND instruction.

Finally, it's worth mentioning the existence of a single-bit sound output. PIA2, line PB1, is normally configured as an input. However, it is connected to the same point as the audio multiplexer output, as shown in figure 5. Therefore it is possible to reconfigure the port to make PB1 an output and send bit-stream sound to the television. Imaginative programming in machine code should create some interesting sounds from this output. Care should be taken when using this feature to prevent conflicts between this output and the one from the multiplexer.

The Joystick Interface

In the section on the cassette interface, I discussed how an analog signal can be obtained from the Color Computer under program control. It may have occurred to you that it would be nice to also have the unit read in an analog signal from outside. Not only can your Color Computer do this, but it can do it for four different analog signals! This is because the joysticks develop two analog signals each, depending upon the up-down, left-right position of the stick. But the range of the analog input signal is 0 to +5 V, so care should be taken not to exceed either of these limits.

If analog signals are to be read in by the Color Computer, they can be connected to the joystick pins and read by the JOYSTK instruction. Don't forget, though, that you must execute a JOYSTK(0) before reading any other joystick input (see the Color Computer BASIC manual).

The joystick selection is made by PIA1, lines CA2 and CB2, as shown in the following table of joystick input selection codes.

<table>
<thead>
<tr>
<th>PIA2</th>
<th>CA2</th>
<th>CB2</th>
<th>Resulting Input From</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>right joystick (side-to-side motion)</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>right joystick (up-and-down motion)</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>left joystick (side-to-side motion)</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>left joystick (up-and-down motion)</td>
</tr>
</tbody>
</table>

With the information in the preceding table, you should be able to write a BASIC routine to perform the successive-approximation A/D conversion and read the analog value at any one of the analog ports. The possibilities for this capability are endless. Some that quickly come to mind include using your Color Computer to monitor indoor/outdoor temperature, monitor and analyze weather variables, and digitize and display analog waveforms like an oscilloscope wave.

Just as the cassette output provided a digital output signal via the motor control relay, the two joystick inputs can be used to enter digital inputs to the Color Computer. The "fire" push buttons on each joystick change the contents of address FF00 from 255 (or 127) to 254 (or 126), as described in the Color BASIC manual. The alternates to each number are due to the comparator being input into PA7 (the most significant bit) of this address; this bit could be a 1 or a 0.

The push buttons ground the input lines when pressed and are therefore digital inputs. Any digital input that goes from short to open (such as a relay contact) can be connected to these inputs and read by a program in the same way as described for the push buttons. Because there are two inputs of this type, the Color Computer could be made to read any 2-bit digital input, thus giving you four possible combinations.

Conclusion

From this article you should have some insight into how the Color Computer connects to the outside world. The microprocessor in the Color Computer is a powerful device, capable of performing many interesting and useful tasks. A better understanding of the I/O structure is essential if you want to take full advantage of these capabilities.

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A Conceptual Approach to Real-Time Programming

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Indeed, any situation in which events happening in the logical world of the computer must interact in a timely fashion with events happening in the outside world requires real-time programming. Furthermore, using efficient real-time programming techniques even when a particular job does not absolutely require them is always good practice. A program that spends equal time on computation and output can run almost twice as fast if it’s based on a real-time approach. A well-crafted real-time program can be written in a high-level language, do its job, and still be loafing while a poorly designed assembly-language program doing the same job barely keeps up. Finally, skills developed in writing real-time applications programs can be transferred directly to systems programming—all multiuser operating systems are real-time programs.

This article presents a conceptual approach for defining real-time problems and specific programming techniques for solving them. All real-time programming jobs involve three or more of the following subjob types:

- **Data collection**—This subjob class includes reading the keyboard, reading analog and digital inputs, etc. All real-time programs collect at least some data, and usually this task is their first priority.
- **Data analysis**—Analysis may be as simple as monitoring the input data for special values or as complex as performing Fourier transforms on blocks of data. As a general rule, the time required for data analysis depends on the input data: for example, in a word processor the time required to deal with an input character calling for a block move is much greater than the time necessary for data analysis on most characters.
- **Data display**—Display includes not only output to a video display or printer but also any outputs—digital or analog—used to control events in the real world. Outputting results may be a high-priority job (if, for example, the computer is in a control loop) or a low-priority job (as in word processing, where keeping up with the keyboard is much more important than displaying characters).
- **Data storage**—Writing results to a mass-storage device is logically equivalent to displaying data, but it is practically different in that data typically has to be transferred in blocks. Thus, data storage is an ultra-high-priority task during the actual transfer but is at the bottom of the pecking order most of the time.

**Batch-Programming Approach**

The normal or batch-programming approach to these four subjobs is to do them serially, i.e., wait for input, analyze it, and provide an output. The problem with this approach is twofold. First, peripherals are much slower than microprocessors so that a vast amount of time is wasted waiting for input or output devices to set their READY flags. Second, a batch program that may have plenty of time to analyze data, output results, and get back to the top of its loop when deal-
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The efforts of the real-time programming with most inputs can have real trouble when it encounters input data requiring more extensive analysis. The efforts of the real-time programmer are directed at figuring out how to do useful work when the typical batch program is inactivate while waiting for peripherals or performing only simple data analysis.

The basic ingredients necessary for writing efficient real-time programs are two powerful programming tools: buffering and coprocessing. To illustrate these techniques I will show how any real-time task could be accomplished efficiently in an ideal hardware environment. The secret of success is to allow each of the subjobs to execute independently, and the easiest way to do that is to assign one processor to each subjob, as indicated here:

- **Processor #1** collects data as it becomes available from an input device and stores it in a first-in/first-out (FIFO) buffer. A FIFO buffer can be thought of as a pipeline: one device puts data into one end of the pipe, while another takes data out of the other end.
- **Processor #2** gets data, as the data is needed or as it becomes available, from the FIFO, which is fed by processor #1. Processor #2 then analyzes the data and passes results to FIFO buffers for display and storage.
- **Processor #3** displays the data placed in its buffer by processor #2.
- **Processor #4** transfers into a local buffer data from the buffer that is fed by processor #2. When its local buffer is full, processor #4 writes the buffer contents to the storage device and then returns to collect any data that processor #2 provided while processor #4 was busy. An alternate and more efficient approach involves having two or more local buffers for processor #4, which can tell processor #2 which buffer is available for receiving data.

This scheme is worth studying in some detail because it is more subtle than it appears. Note that everything works asynchronously. Processors are doing their job, waiting for a peripheral or waiting for data to appear in their input buffers. Processors may be temporarily ahead of or behind each other (as, for example, when processor #4 needs to write to the storage device or when processor #2 is performing an especially long analysis), but the FIFO buffers take up any slack. The only constraints are that the FIFO buffers must be big enough to absorb all the data generated by a source processor while the receiving processor is doing whatever jobs keep it from servicing its input buffer and that on the average each receiving processor must be fast enough to process its input data; time lost on long jobs must be made up later. Thus, if we all had multiprocessor computers, real-time problems could be solved simply by parceling out jobs and providing interprocessor-communication buffers. Unfortunately, most computer systems have only one processor; the rest of this article describes techniques for making one processor act like many.
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DMA."C"™ — A "C" language compiler which will generate either Z80 or 8086 assembly language code. Due to a unique optimization routine which is based upon a functional "P-code" model, the efficiency of DMA."C" will far exceed that of existing compilers.

SYNC/COM™ — A bisynchronous communication package that will be configurable for a variety of systems and include a flexible interface to the operating system.

The 8086 O. S. Converter™ — A program which will permit programs written for Digital Research's CP/M-86™ to execute under IBM's PC DOS.
To map the general real-time algorithm onto only one processor, you can set up a number of logically independent subprograms that pass control of the processor back and forth under either software or hardware control. These subprograms may be either subroutines or coroutines in actual structure, but it is best to think of them as coroutines in order to keep close to the multiprocessor model. Many programmers are unfamiliar with the concept of a coroutine, but it is basically simple. Coroutines differ from subroutines both conceptually and structurally: Conceptually, coroutines can be thought of as equal partners in performing a job rather than as master and slave. Structurally, coroutines differ from subroutines in that control of the microprocessor may be relinquished at any point in the coroutine and then resumed at that point when other coroutines return control; in contrast, subroutines are initiated at their beginning every time they are called. To logically model multiple processors, you set up multiple coroutines that relinquish control of the microprocessor when they are waiting for a peripheral, waiting for data to appear in their input buffer, or performing a low-priority task. The exact programming techniques to use depend on whether input/output (I/O) is programmed, interrupted driven, or under direct-memory-access (DMA) control.

**Programmed I/O**

When I/O is programmed, the microprocessor directly monitors the state of peripherals by reading status registers and doing conditional branches as appropriate. The big advantage of this approach is that programs can be written in a virtually hardware independent manner; for example, all commercially available programs designed to run under CP/M use programmed I/O. Some very sophisticated real-time programs have been written this way; Wordstar, a word processor, can concurrently print a file, monitor the keyboard, and update the screen display in real time. Unfortunately, the disadvantages of using programmed I/O for real-time programs are enormous. The major problem is that implementation of any useful real-time algorithm requires tricky and hard-to-modify programming because the program must always check flags fast enough to catch desired inputs; these checks must be done at frequent intervals, no matter what path the program takes.

As an example of a solution to a real-time problem in a programmed I/O environment, listing 1 (see page 464) outlines a program that periodically reads analog data, analyzes it, and outputs results to a printer. Written in Pascal, the program uses three coroutines (the main routine, CHECK_A_TO_D, and ANALYZE_DATA) and two subroutines (OUTPUT_RESULTS and CHECK_KEYBOARD), all operating asynchronously and passing data to each other via FIFO buffers. In looking at the listing, note how awkwardly the coroutines are implemented.
Collector Edition

BYTE COVERS

The Byte covers shown below are available as beautiful Collector Edition Prints. Each full color print is 11 in. x 14 in., including a 1 1/2 in. border, and is part of an edition strictly limited to 500 prints. Each print is faithfully reproduced from the original painting on museum quality acid-free paper, and is personally inspected, signed and numbered by the artist, Robert Tinney. A Certificate of Authenticity accompanies each print attesting to its quality and limited number.

Collector Edition Prints are carefully packaged flat to avoid bending, and are shipped first class. The price of each print is $25, plus $3 per shipment for postage and handling ($8 overseas). The prints are also available as 4-print sets: Set 9-12, Set 13-16, and Set 17-20. Each set costs $80, plus postage and handling.

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Hardware interrupts can eliminate these problems.

**Interrupt-Driven I/O**

Almost all micro- and minicomputers support hardware interrupts. An interrupt is a subroutine CALL initiated at the request of a peripheral device; modern computers have vector-interrupt schemes that allow each interrupting peripheral device to initiate a CALL to its own service routine. Most bus standards specify a priority-interrupt arrangement whereby a high-priority device may interrupt the service routine of a lower-priority device. The main program usually does the lowest-priority tasks (i.e., any device may interrupt it), but the interrupts may be disabled (locked out) when it has a high-priority job to do or when intertask communication buffers are being updated.

The advantages of using interrupt-driven I/O for real-time jobs are substantial: first, the technique greatly reduces time lags in servicing input devices; this feature is especially important when you are sampling analog data at supposedly regular intervals. Second, programs run faster because they require little overhead for switching between coroutines or reading status registers. Third, devices requiring frequent servicing may be accommodated while the microprocessor is still doing useful data analysis. And last, clean real-time programs practically fall out of an interrupt-driven I/O environment; the main routine (usually doing the job of processor #2, data analysis) and the interrupt service routines can be thought of as coroutines doing one of the four types of subjobs in the general algorithm. The disadvantage of interrupt-driven programs is that they are hardware dependent, an insuperable problem for commercial CP/M programs unless a hardware package is provided with the software. Listing 2 (page 467) shows the same real-time problem treated in listing 1, but in listing 2, it is solved using interrupt-driven I/O. I have tried to illustrate most of the tricks you will need and pitfalls you will encounter in setting up an interrupt-driven program; in particular, remember that you rarely know when any peripheral is going to request service.

In my discussion so far I have avoided one of the biggest real-time programming headaches—writing to mass-storage devices. I mentioned earlier the schizophrenic nature of the data-storage function: a low-priority job most of the time, it's absolutely uninterruptible during the actual data transfer (an 8-inch double-density floppy disk must get a new byte every 16 microseconds when writing a sector). And most storage-device-handling routines do not even allow interrupts during noncritical operations (e.g., when a disk is seeking a new track), thus further compounding the problem. There are, however, several solutions.
Micromint will put both a computer development system and an OEM dedicated controller in the palm of your hand for as little as $127.

The Z8 Basic Computer/Controller represents a milestone in microcomputer price-performance. The entire computer is 4" by 4½" and includes a tiny BASIC interpreter, 4K bytes of program memory, one RS-232C serial port and two parallel ports plus a variety of other features. The Z8 microcomputer board is completely self-contained and optimized for use as a dedicated controller. Can be battery operated. Comes with over 200 pages of documentation.

### Z8 BASIC COMPUTER/CONTROLLER

- Uses Zilog Z80871 single chip microcomputer
- On board tiny BASIC interpreter
- 2 parallel ports plus serial I/O port.
- Just connect a CRT terminal and write control programs in BASIC.
- 4K bytes of RAM, EPROM pin compatible
- Baud rates 110-9600 BPS
- Data and address buses available for 124K memory and I/O expansion
- Consumes only 1.5 watts at +5, +12 & -12v.

**BCC01 Z8 Basic Computer**
- Assembled & Tested: $199.00

**BCC02 Z8 Basic Computer Kit**
- $169.00

### COMING SOON

**A/D Converter 8 Channel 8 Bit AC I/O Board**
- 4 Channel 115Vac inputs
- 4 Channel 115Vac outputs
- 20 MA ADAPTER

**Z8 MEMORY, I/O EXPANSION & CASSETTE INTERFACE**

The Z8 Memory, I/O Expansion & Cassette Interface Board (Z8 Expansion Board for short) allows you to add up to 8K of additional memory plus three 8-bit parallel ports to your Z8 Basic Computer/Controller. The memory expansion will support any combination of byte wide RAM memory chips or 2716 or 2732 EPROM. The cassette interface is 300 baud Kansas City Standard (2400Hz/1200Hz).

**BCC03 Z8 Expansion Board**
- w/4K memory: $149.00
- BCC04 Z8 Expansion Board
  - w/8K memory: $176.00

### Z8 EPROM PROGRAMMER

The EPROM Programmer board allows you to transfer application programs in BASIC or Assembly language directly from RAM to either 2716 or 2732 EPROMS. Requires Z8 Basic Expansion Board for operation.

**NOTE:** We recommend the higher current UPS03 or UPS04 power supply when using the EPROM Programmer.

**BCC06 Z8 EPROM Programmer**
- Assembled & Tested: $145.00

### Z8 SERIAL EXPANSION BOARD

The Serial Expansion Board adds an additional RS-232C serial port to the Z8 system. It runs at 75 to 19,200 baud in all standard protocols. The 20 ma. current loop is opto-isolated for reliability and protection.

**BCC07 Z8 Serial Board**
- Assembled & Tested: $180.00

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**MB02 Z8 Mother Board**
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- +5 @ 1 amp, +12 & -12V @ 50 ma.
- UPS03 Assembled and Tested: $60.00
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- 4 Channel 115Vac inputs
- 4 Channel 115Vac outputs
- 20 MA ADAPTER

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- XAS03 For CP/M-8: $150.00

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The only solution available in a programmed I/O environment is just to work around the problem: output a Control-G to beep the console and write "stop typing" to the console before beginning any disk I/O; save the time when you start the write (if you have a clock), read the time when you get back, and then somehow deal with the gap in your input data. In an interrupt-driven I/O environment, two other solutions are available when floppy disks are the storage media: the first involves getting into your disk driver and moving the disable-interrupt instruction (DI) so that it executes just before the actual write command (after completion of all that time-consuming seeking); in this case, only 167 milliseconds (ms), at most, will be unavailable for interrupts (one revolution of the disk). If your peripherals interrupt infrequently, you can employ an alternate solution: remove all DI instructions from the disk driver. Occasionally a peripheral will interrupt when an actual data transfer is in progress, but such an interrupt generates only a soft error (a lost-data error condition set in the disk-controller status register) for most disk drivers. Data transfer should succeed on one of the error retries. I am somewhat ashamed to ever suggest these stopgap measures, since the only proper solution is to buy, borrow, steal, or manufacture direct-memory-access hardware for your mass-storage devices (hereafter assumed to be floppy disks).

Direct-Memory-Access I/O

A peripheral with DMA capability can be set up to act exactly like an independent coprocessor for the all-important fast-data-transfer task. It works like this: before sending a write command to the disk controller, the microprocessor tells the DMA controller where its buffer is located and how many bytes it needs to transfer. Then the write command is initiated, and the microprocessor goes on about its business. When the disk controller has found the proper sector it sets a flag indicating that it's ready for data. The DMA controller responds to the flag by requesting control of the bus from the microprocessor. At the end of its current memory cycle, the microprocessor relinquishes control of the bus and acknowledges the bus request. Upon receiving bus acknowledgment, the DMA controller reads a data byte from its buffer and transfers the data byte to the disk controller. The DMA controller then returns the bus to the microprocessor and increments its buffer address and byte count. If the byte count is exhausted, the DMA controller sets status flags and generates an interrupt if it has been so programmed (usually the disk controller is allowed to do the interrupt for end of transfer because the write command might abort on an error before transfer is complete). The whole process takes only a few microseconds for each byte; the microprocessor is hardly slowed down at all, and an interrupt can safely occur any time during the transfer.

A number of disk controllers with DMA capability are now available
**DISKULATOR**

**THE MOST VERSATILE AND EXPANDABLE MEMORY BOARD**

**FOR THE APPLE II COMPUTER IN THE WORLD 84K - 512K**

The DISKULATOR allows operation of virtually all software developed for use with other memory boards. By simple user selection you can operate the board in different modes.

The DISKULATOR will allow you to start BIG and get even BIGGER! Buy a DISKULATOR board now and arrange for an upgrade later to a higher size if you then need more memory. The DISKULATOR has no cable and will operate like a language card in your Apple II or IIe.

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 Incredible NEW utility software supplied includes:

- **MACRODISK-MULTI** which automatically handles boards of different sizes or bank-select standards, and allows you to select the size and number of RAMMONKs (up to 3x 18k increments). Also supplied are MACRODISK for Pascak and CP/M.

- **MACROPEED**, the fantastic HIGH-SPEED COPY program you've been waiting for. Multiple copies are now quick and easy!

- **UPLOAD/DOWNLOAD** programs which enable high speed backup and retrieval of a whole disk automatically or under program control.

- **MEMORY DIAGNOSTICS**

Dealers, distributors and software developers - you cannot afford to ignore the most expandable and flexible memory board on the market. Contact us today!

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**MACROTECH Computer Products Ltd.**
for the S-100 bus and are definitely worth the extra $100 if you ever plan to write a real-time program. Most manufacturers supply software, but to get to know a machine inside out, you should try writing an interrupt and DMA-driven disk I/O routine. Furthermore, standard software routines wait while the write takes place to prevent the calling program from corrupting the buffer area before the transfer is done. If the manufacturer supplies a listing of its software, a little creative tinkering can defeat the wait and enable one of the coroutines in the calling program to monitor the transfer to see when the buffer is free for more data; alternatively, you could alter the end-of-transfer interrupt service routine to perform whatever services your data storage subjob needs then. Poor or enthusiastic hardware hobbyists might want to experiment with the powerful DMA controller chips available for most microprocessors.

Final Words and Warnings

There are some tricky spots where you should watch your step. Because the key to good real-time programming is buffering and asynchronous processing, some strange time relationships can develop between events in the real world and events in the logical worlds of the coroutines. In fact, the term real-time is misleading because all programs work on data that was collected at some prior real-world time. Consider, for example, a 500-byte input buffer filled at a one-byte-per-second rate by an analog/digital-converter service routine; if the data analysis routine got temporarily behind for some reason (e.g., it needed to do a lengthy calculation), real-time for the data-analysis routine might be several minutes behind real-time from the point of view of a keyboard service routine. Normally, these time shifts are advantageous because they allow more useful work to be wrung out of the computer while still catching all input data. But they can cause problems in some situations. For example, if the computer is used as a smart controller in a feedback loop, then both data input and control output must have high priority; time-consuming tasks in the data-analysis routine should not interfere with delivery of timely control data to the output routine (two data-analysis coroutines might be appropriate in this case: one to compute and pass along control data and a second to do other lower-priority analysis).

While data buffering occasionally can have some confusing side effects, it also comes with a bonus. After a program has been running awhile, the input buffer contains a log of the input data. Thus, any data-analysis routine can detect an event and then look back to see what led up to it. (This ability is the primary selling point for digital oscilloscopes and logic analyzers, devices that are just real-time-programmed digital processors.)

If you follow the general rules outlined here, you will find real-time programming to be a creative and rewarding activity.
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Listing 1: Furnishing an example of a solution to a real-time problem in a programmed-I/O environment, this program periodically reads analog data, analyzes it, and outputs results to a printer.

PROGRAM MEASURE_ANALOG_PULSE;
(* This listing illustrates a solution to a real-time task using programmed input-output; the program is not complete since hardware or implementation dependent procedures are shown as stubs only. *)

The task that this program executes is as follows:
1) An A-D converter is read every time a clock flag is set by a programmable clock. The A-D converter is assumed to return values from 0 to 999 (i.e., a 12 bit converter).
2) If the analog value is greater than some threshold (initially set to 2000) then the program keeps track of how many sample periods it remains supra-threshold and keeps a running sum of the values.
3) When the analog value then drops below the threshold value, the duration of the supra-threshold pulse and the average analog value during the pulse are printed to a listing device.
4) The threshold may be changed at any time by hitting one of the keys '0' through '9' to set the threshold from 400 to 2000 in increments of 400 (e.g., '12' sets the threshold to 2000). Whenever the threshold is changed the new value is printed on the listing device. Hitting any key other than '0' through '9' terminates execution.

At no time should keyboard input be missed, and all analog values should be read within a few ms of each clock pulse. These conditions should continue to be met even during periods when analog pulses occur frequently.

The program is largely self-documenting. *)

(* Three FIFO buffers are used: one for the A-D values, one for keyboard input, and one for lister output. The first part of the definitions is related to implementing these buffers. *)

CONST
A_D_BUF_LENGTH = 100;
KEY_BUF_LENGTH = 20;
OUT_BUF_LENGTH = 200;
LONGEST_BUFFER = 200;

TYPE
BUFFER_HEADER = RECORD
  INPUT_POINTER, OUTPUT_POINTER, BUFFER_LENGTH : INTEGER;
  BUFFER_FULL, BUFFER_EMPTY : BOOLEAN;
END;

VAR
  A_D_HEADER, KEY_HEADER, OUT_HEADER : BUFFER_HEADER;
  A_D_BUFFER, KEY_BUFFER, OUT_BUFFER : FIFO_BUFFER; (* In this example all buffers occupy the
same amount of storage space even though their lengths are different. *)

I had to do it this way here because of the strong type checking of standard Pascal; there are a number of ways around this problem in most implementations (e.g., use the NEW function to allocate space at run time and rewrite the buffer handling procedures to use accesses with true pointer type variables). *)

(* End of buffer definitions & start of Globals needed by other procedures. *)

LIST_FILE : TEXT; (* File var for the listing device *)
A_D_SEGMENT;
ANALYZE_SEGMENT : INTEGER; (* Used to control flow of the Coroutines *)
ERROR, DONE : BOOLEAN; (* Booleans to control program termination *)
(* The following variables are used in the data analysis *)
THRESHOLD, PULSE_COUNT : INTEGER;
PULSE_SUM, AVERAGE_PULSE_HEIGHT : REAL;
LAST_VALUE_ABOVE_THRESHOLD : BOOLEAN;

(* The following three procedures implement the FIFO buffers *)

PROCEDURE INIT_BUFFER(VAR B_HEADER : BUFFER_HEADER; B_LENGTH : INTEGER);
BEGIN
  WITH B_HEADER DO BEGIN
    INPUT_POINTER := 1; (* Next location to be filled *)
    OUTPUT_POINTER := 1; (* Next location to be read *)
    BUFFER_LENGTH := B_LENGTH;
    BUFFER_FULL := FALSE;
    BUFFER_EMPTY := TRUE
  END;
END;

PROCEDURE STORE(VAR B_HEADER : BUFFER_HEADER;
                 VAR BUFFER : FIFO_BUFFER;
                 VALUE : INTEGER);
BEGIN
  WITH B_HEADER DO IF NOT BUFFER_FULL THEN BEGIN
    BUFFER[INPUT_POINTER] := VALUE;
    IF INPUT_POINTER = BUFFER_LENGTH
      THEN INPUT_POINTER := 1
      ELSE INPUT_POINTER := INPUT_POINTER + 1;
    BUFFER_FULL := INPUT_POINTER = OUTPUT_POINTER;
    BUFFER_EMPTY := FALSE
  END;
END;

FUNCTION RETRIEVE(VAR B_HEADER : BUFFER_HEADER;
                    VAR BUFFER : FIFO_BUFFER) : INTEGER;
BEGIN
  WITH B_HEADER DO IF NOT BUFFER_EMPTY THEN BEGIN
    RETRIEVE := BUFFER[OUTPUT_POINTER];
    IF OUTPUT_POINTER = BUFFER_LENGTH
      THEN OUTPUT_POINTER := 1
      ELSE OUTPUT_POINTER := OUTPUT_POINTER + 1;
    BUFFER_EMPTY := OUTPUT_POINTER = INPUT_POINTER;
    BUFFER_FULL := FALSE
  END;
END;

(* The following procedures are all implementation dependent and are
shown as stubs with a description of what they have to do. *)

PROCEDURE INIT_LIST_FILE;
BEGIN

...
Listing 1 continued:

This procedure should initialize the file variable, LIST_FILE, to the listing device; e.g., AS(MENV(LIST_FILE,'LST:')); etc...

END;

PROCEDURE START_CLOCK;
BEGIN
  (* Set up the clock to set a flag whenever the A-D needs to be read, and start the clock *)
END;

FUNCTION CLOCK_FLAG_SET: BOOLEAN;
BEGIN
  (* Returns TRUE if clock flag is set, FALSE otherwise. *)
END;

PROCEDURE START_A_TO_D;
BEGIN
  (* Initialize an analog to digital conversion. *)
END;

FUNCTION READ_A_TO_D: INTEGER;
BEGIN
  (* Reads the A-D and returns a value from 0 to 4095 *)
END;

FUNCTION KEY_HIT: BOOLEAN;
BEGIN
  (* Returns TRUE if key flag is set from the keyboard stack *)
END;

FUNCTION LIST_DEVICE_READY: BOOLEAN;
BEGIN
  (* Returns TRUE if the list device is ready for a character *)
END;

PROCEDURE WRITE_STRING_TO_OUT_BUFFER(VAR STRING: STRING20);
BEGIN
  (* This procedure puts the characters into the output buffer until it encounters a "^A" *)
VAR
  I := INTEGER;
  C := CHAR;
BEGIN
  I := 1;
  REPEAT
    C := STRING[I];
    I := I + 1;
    IF C = 'A' THEN BEGIN
      ERROR := ERROR OR OUT_HEADER BUFFER FULL;
      STORE(OUT_HEADER, OUT_BUFFER, ORD(C))
    END
  UNTIL (I = 21) OR (C = 'A') OR ERROR
END;

PROCEDURE WRITE_CEIL_TO_OUT_BUFFER;
VAR
  LOCAL_STRING: STRING20;
BEGIN
  LOCAL_STRING[I] := CHR(I); (* Carriage return *)
  LOCAL_STRING[I+8] := CHR(I+8); (* Line feed *)
  LOCAL_STRING[I+2] := '$'; (* String terminator *)
  WRITE_STRING_TO_OUT_BUFFER(LOCAL_STRING)
END;

PROCEDURE WRITE_INTEGER TO OUT BUFFER(VALUE: INTEGER);

VAR
  LOCAL_STRING: STRING20;
BEGIN
  (* You need to work out some way here to write the character string conversion of a binary integer VALUE to the variable LOCAL_STRING. Most Pascal compilers allow some way of doing "redirected I-O" so you don't have to write the integer conversion routines yourself. In this routine, the integer character string, followed by a space, and a "^A" should be written to LOCAL_STRING. Then: *)
  WRITE STRING TO OUT_BUFFER(LOCAL_STRING)
END;

(* The following procedure sets everything up and is only called once *)

PROCEDURE INITIALIZE_PROGRAM;
BEGIN
  INIT_BUFFER(A_D_HEADER, A_D_BUF_LENGTH);
  INIT_BUFFER(KEY_HEADER, KEY_BUF_LENGTH);
  INIT_BUFFER(OUT_HEADER, OUT_BUF_LENGTH);
  (* Initialize variables *)
  A_D_SEGMENT := 1;
  ANALYZE_SEGMENT := 1;
  INIT_LIST_FILE;
  DONE := FALSE;
  ERROR := FALSE;
  LAST_VALUE WAS OVER_THRESHOLD := FALSE;
  THRESHOLD := 2000;
  PULSE_SYM := 0;
  PULSE COUNT := 0;
  WRITE('Hit RETURN when ready to start'); (* File var OUTPUt is assumed to be the console screen *)
  READLIN; (* File var INPUT is assumed to be the keyboard *)
  START_CLOCK;
END;

(* The following procedure is the first coroutine. It monitors the clock, reads the A-D whenever necessary, and puts the value in the A-D buffer. This procedure performs the highest priority task and is called as often as possible. The coroutine function is implemented using the CASE statement and the variable A_D_SEGMENT to control the flow. *)

PROCEDURE CHECK_A TO D;
VAR
  VALUE: INTEGER;
BEGIN
  CASE A_D_SEGMENT OF
  1: IF CLOCK_FLAG SET THEN BEGIN

  START_A_TO_D; (* but we don't need to wait for conversion *)
  END;

  2: BEGIN
    VALUE := READ_A_TO_D; (* plenty of time for conversion by now *)
    ERROR := ERROR OR A_D_HEADER BUFFER FULL;
    STORE(A_D_HEADER, A_D_BUFFER, VALUE);
    A_D_SEGMENT := 1 (* set up for last section of coroutine again *)
  END
END (* of CASE statement *)

END;

(* The following procedures are subroutines to check and read the keyboard and to output results. Both routines just check peripheral status flags and do the data transfer as necessary. This is a simple, one-step task so they are implemented as subroutines rather than coroutines. *)

Listing 1 continued on page 466
Listing 1 continued:

PROCEDURE READ_KEYBOARD;
VAR C : CHAR;
BEGIN
    IF KEY HIT THEN BEGIN
        READ(C);
        ERROR := ERROR OR KEY_HEADER.BUFFER FULL;
        STORE(KEY_HEADER,KEY_BUFFER,ORD(C))
    END;
END;

PROCEDURE OUTPUT_RESULTS;
BEGIN
    IF NOT OUT_HEADER.BUFFER EMPTY AND LIST_DEVICE READY THEN
        WRITE(LIST_FILE,CHR(RETRIEVE(OUT_HEADER,OUT_BUFFER)))
    END;

(* The following procedure is the coroutine that does all of the data
analysis. The coroutine structure is implemented with the case statement.
Note now the data analysis function has been broken up so that this
procedure does not hog the CPU while doing complex data analysis. The
coroutine relinquishes control whenever its buffers are empty and at
short intervals during data analysis; the whole idea is to make sure
the clock gets serviced at frequent intervals so that analog data is
sampled at close to the proper time. Note also that the amount of data
analysis necessary is highly dependent on the input data; e.g., a whole
bunch of stuff needs to be done when the analog value falls below the
threshold value. *)

PROCEDURE ANALYZE_DATA;
VAR C : CHAR;
BEGIN
    PULSE, SUPRA_THRESHOLD : BOOLEAN;
    A_D_VALUE : INTEGER;

    CASE ANALYZE_SEGMENT OF
    (* Case 1 checks our input buffers to see if we have any data to
deal with. Some minimal analysis is done in case 1 if we have data. *)
    1 : IF NOT KEY_HEADER.BUFFER EMPTY THEN BEGIN
        C:=CHR(RETRIEVE(KEY_HEADER,KEY_BUFFER));
        DONE := NOT (C IN ['0'..'9']);
    END;
    IF NOT DONE THEN
        THRESHOLD := (ORD(C)-ORD('0'))#1000;
        ANALYZE_SEGMENT := 5 (* we relinquish control here because
we've already spent a long time figuring out the new threshold.
The coroutine transfers to case 5 where the new threshold is
printed out via the output buffer, of course. *)
END;
ELSE (* if no data in keyboard buffer, we check A-D buffer. *)
    IF NOT A_D_HEADER.BUFFER EMPTY THEN BEGIN
        A_D_VALUE := RETRIEVE(A_D_HEADER,A_D_BUFFER);
        SUPRA_THRESHOLD := A_D_VALUE > THRESHOLD;
        END PULSE := LAST VALUE WAS OVER THRESHOLD
        AND NOT SUPRA_THRESHOLD;
        LAST VALUE WAS OVER THRESHOLD := SUPRA_THRESHOLD;
    IF END PULSE THEN ANALYZE_SEGMENT := 2
    ELSE IF SUPRA_THRESHOLD THEN BEGIN
        PULSE_COUNT := PULSE_COUNT+
        PULSE SUM := PULSE SUM + A_D_VALUE
        END;
END;

(* Cases 2 through 4 are the segments of the coroutine that analyze
the data at the end of a pulse and output results. Case 2 does
a time consuming floating point division and then relinquishes
control; analysis is taken up again at case 3 which outputs the
pulse length; integer to string conversion is time consuming so
Case 3 relinquishes control and analysis continues later at case 4
where the average pulse height (computed in case 2) is output.
Control then returns to case one to catch up on any keyboard activity
and accumulated analog values. *)

2 : BEGIN
    AVERAGE_PULSE_HEIGHT := PULSE_SUM/PULSE_COUNT;
    ANALYZE_SEGMENT := 3
END;

3 : BEGIN
    WRITE_INTEGER_TO_OUT_BUFFER(PULSE_COUNT);
    ANALYZE_SEGMENT := 4
END;

4 : BEGIN
    WRITE_INTEGER_TO_OUT_BUFFER(ROUND(AVERAGE_PULSE_HEIGHT));
    PULSE_COUNT := 0;
    PULSE SUM := 0;
    ANALYZE_SEGMENT := 1
END;

(* Case 5 is a continuation of the analysis that occurs when a new
temperature is specified from the keyboard. It outputs the new
threshold value (already computed in case 1). *)
5 : BEGIN
    WRITE_STRING_TO_OUTPUT('New Threshold is:');
    (* Note that the string had to be filled out to 20 chars
    to satisfy Pascal's type checking *)
    WRITE_INTEGER_TO_OUTPUT(THRESHOLD);
    WRITE_GRLF_TO_OUTPUT;
    ANALYZE_SEGMENT := 1
END;

END (* of case statement *)

(* The following is the main program of MEASURE_ANALOG_PULSE. It should
properly be thought of as a coroutine whose function is to pass control
around to the other coroutines and subroutines on a priority weighted
basis. Note that the high priority routine, CHECK_A_TO_D, is given
control as often as possible. *)

BEGIN
    INITIALIZE_PROGRAM;
    REPEAT
        CHECK_A_TO_D;
        ANALYZE_DATA;
        CHECK_A_TO_D;
        OUTPUT_RESULTS;
        CHECK_A_TO_D;
    UNTIL DONE OR ERROR;
END;

(* The reader may have noticed that there are alternate ways to
accomplish the job of MEASURE_ANALOG_PULSE without the unusual CASE
statement constructs. For example, the procedure ANALYZE_DATA
could have been written in a straightforward manner and then sprinkled
with calls to a procedure CHECK_PERIPHERALS to make sure that peripherals
Listing 1 continued:
were serviced in a timely fashion (see Listing 2 where this is done automatically by hardware interrupts).
I used the approach shown here because it more clearly illustrates the concept of a coroutine and because a cleaner program structure can be developed if interlaced procedure calls are avoided. This program could be easily modified to do different or more extensive data analysis.  

Listing 2: Able to handle the data-collection task outlined in listing 1, this program is based on interrupt-driven-I/O techniques.

PROGRAM MEASURE_ANALOG_PULSE_USING_INTERRUPTS;
(* This listing illustrates a solution to the same real-time problem treated in Listing 1, but here we use interrupt driven I-O rather than programmed I-O. Three types of interrupt situations are illustrated: 1) a case where random inputs must be captured (the keyboard input in the present example). 2) a case where a peripheral is allowed to interrupt when there is work for it to do, but not allowed to interrupt otherwise (outputting results to a listing device here). 3) a case where an interrupt from one device (the clock in our example) sets up another device (the A-D converter) to interrupt later. The program is written in Pascal for general readability and because it should be easy for programmers to do as much programming as possible in high level languages. However, interrupts are intimately associated with the hardware in a system, so there are restrictions on the types of high level languages. First, you must have some way of including assembly language instructions and/or procedures in your program. Second, the language should be of the direct compiling type since interpreters (e.g., p-code interpreters) are normally not written using reentrant code (in this case, interrupt service routines have to be written entirely in machine code so they won't trash the interrupt temporary storage locations). Third, if you are using a multi-user operating system or any other operating system designed to run with the interrupt on (e.g., RT-11 for the LSI-11 CPU's) you must understand and support the operating system's interrupt environment.
In this example, I have assumed that a direct compiling Pascal (such as Pascal/1 or Pascal/1+) is being used with an operating system that does not support interrupt driven I-O (e.g., standard CP/M). I have further assumed that there is a priority interrupt scheme such that the clock interrupts have the highest priority. *)

(* Three FIFO buffers are used: one for the A-D values, one for keyboard input, and one for lister output. The first part of the definition is related to implementing these buffers. Buffers are implemented exactly as in Listing 1. *)

CONST
  A_DBUF_LENGTH = 100;
  KEYBUFF_LENGTH = 20;
  OUTBUFF_LENGTH = 200;
  LONGEST_BUFF = 200;

TYPE
  BUFFER_HEADER = RECORD
    INPUT_POINTER,
    OUTPUT_POINTER,
    BUFFER_LENGTH : INTEGER;
    BUFFER_FULL,
    BUFFER_EMPTY : BOOLEAN;
  END;

PROCEDURE D_E_DELAY(HEADER : BUFFER_HEADER;)
BEGIN
  BUFFER_HEADER.TIMER := TIMER;
END;

PROCEDURE STORE(var B_HEADER : BUFFER_HEADER;
                 B_LENGTH : INTEGER);
BEGIN
  WITH B_HEADER DO BEGIN
    INPUT_POINTER := NEXT_LOCATION_TO_BE_FILLED;
    OUTPUT_POINTER := NEXT_LOCATION_TO_BE_READ;
    BUFFER_LENGTH := LENGTH;
    BUFFER_FULL := FALSE;
    BUFFER_EMPTY := TRUE;
  END;
END;

PROCEDURE INIT BUFFER(var B_HEADER : BUFFER_HEADER;
                        B_LENGTH : INTEGER);
BEGIN
  WITH B_HEADER DO BEGIN
    OUTPUT_POINTER := LENGTH;
    INPUT_POINTER := HEADER;
    BUFFER_LENGTH := LENGTH;
    BUFFER_FULL := TRUE;
    BUFFER_EMPTY := FALSE;
  END;
END;

FUNCTION RETRIEVE(var B_HEADER : BUFFER_HEADER;
                   VAR BUFFER : FIFO_BUFFER ;
                   VALUE : INTEGER);
BEGIN
  WITH B_HEADER DO IF NOT BUFFER_FULL THEN BEGIN
    BUFFER.INPUT_POINTER := VALUE;
    IF INPUT_POINTER = BUFFER_LENGTH THEN INPUT_POINTER := 1
    ELSE INPUT_POINTER := INPUT_POINTER+1;
    BUFFER_FULL := INPUT_POINTER = OUTPUT_POINTER+1;
    BUFFER_EMPTY := BUFFER_LENGTH = 0;
  END;
END;

Listing 2 continued on page 468
Listing 2 continued:
(*) All procedures from here to WRITE_CRLF_TO_OUT_BUFFER are hardware and/or
implementation dependent. Most are shown as stubs with descriptions of what
they have to do, but necessary code is also shown. (*)

PROCEDURE INIT_LIST_FILE;
BEGIN
(* This procedure should initialize the file variable, LIST_FILE,
to the listing device; e.g. ASSIGN(LIST_FILE,'LST:'); etc... *)
END;

(*) The procedures shown from here to RESET_ALL_PERIPHERALS are device
dependent. These procedures set up the peripherals to generate interrupts to
the proper service routine. The setup routines usually must: 1) give the
peripheral device its interrupt vector location, 2) place the address of the
service routine in memory at the proper vector location, and 3) send command
code(s) to the peripheral to set it in the proper operating mode. For those
devices where the interrupt must be turned on and off by the program, setup
still takes place as above except that the command that enables the peripheral
interrupt is placed in a separate procedure. Example, the Z80 PIO (parallel I-
O) chip interrupt can be enabled by the command byte $3 hex and disabled by $3
without interfering with its already programmed operating mode. *)

PROCEDURE SET_CPU_INTERRUPT_MODE;
BEGIN
(* Some CPU's (the Z80, for example) have different interrupt modes
or have to be initialized in some special way to deal with interrupts.
For an 8080 CPU nothing needs to be done here since that processor
has only one interrupt mode. *)
END;

PROCEDURE START_CLOCK;
BEGIN
(* Set up the clock to generate an interrupt to the procedure
SERVICE_CLOCK whenever the A-D needs to be read, and start the clock *)
END;

PROCEDURE SET_UP_A_TO_D;
BEGIN
(* Set up the A-D so that it generates an interrupt to the procedure
SERVICE_A_TO_D at end of conversion. No conversion is started here,
however. *)
END;

PROCEDURE START_A_TO_D;
BEGIN
(* Initiate an analog to digital conversion. *)
END;

FUNCTION READ_A_TO_D : INTEGER;
BEGIN
(* Reads the A-D and returns a value from 0 to 4095 *)
END;

PROCEDURE SET_UP_KEYBOARD;
BEGIN
(* Set up the keyboard interface so that it generates an interrupt
to the procedure SERVICE_KEYBOARD whenever a character is received
from the keyboard. *)
END;

PROCEDURE SET_UP_LISTER;
BEGIN
(* Set up the list device interface so that it is capable of generating
an interrupt to the procedure SERVICE_LISTER when the listing device
is ready for another character, but do not actually enable lister interrupts
here since we won't have anything to print until later
when some results are generated. The global Boolean variable
LISTER_INTERRUPT_OFF lets the output routine know when the interrupt
needs to be turned on. Thus, *)
LISTER_INTERRUPT_OFF := TRUE
END;

PROCEDURE PRINT_CHAR_AND_ENABLE_LISTER_INTERRUPT( C : CHAR);
BEGIN
(* This procedure is called when the list device interrupt is
not enabled and we want to start listing results. Here we
print a character to get things going (the list device will
always be ready to print when this procedure is called), and
then enable the list interface so that it interrupts to
SERVICE_LISTER when it's ready for another character. *)
WRITE(LIST_FILE,C);
(* Enable lister interrupts here *)
LISTER_INTERRUPT_OFF := FALSE
END;

PROCEDURE TURN_OFF_LISTER_INTERRUPTS;
BEGIN
(* This procedure is called by the lister interrupt service routine
when it gets an interrupt but has nothing left to print in its buffer.
The procedure just disables list device interrupts, and: *)
LISTER_INTERRUPT_OFF := TRUE
END;

PROCEDURE RESET_ALL_PERIPHERALS;
BEGIN
(* This procedure is called just before the end of the program.
It should set up all peripherals so that they are as the normal
operating system expects to find them (e.g., keyboard interrupts
should be disabled for most operating systems). *)
END;

(*) The following procedures are utility routines that are needed
to deal with interrupts. They will generally have to be written in assembly
language; most Pascal compilers allow you to insert inline assembly code
into programs and most allow you to externally compile assembly language
procedures. *)

PROCEDURE ENABLE_INTERRUPTS;
BEGIN
(* Enable CPU interrupt acknowledge. Always a single assembly language
instruction (e.g., EI in 8080 and 280 assembly language). *)
END;

PROCEDURE DISABLE_INTERRUPTS;
BEGIN
(* Disable CPU interrupt acknowledge (DI in 8080 and 280 code). *)
END;

PROCEDURE SAVE_REGISTERS;
BEGIN
(* This is a crucial procedure. Its function is to save CPU registers
and any temporary locations used by both the main routines and by
Listing 2 continued:

interrupt service routines. This procedure should also do whatever your
CPU and peripherals need to let them know that the interrupt is being
serviced. If more than one device can interrupt at a time (i.e., if a
priority interrupt scheme is used, as assumed in this example) then the
registers need to be saved on a stack rather than in local variables.

As an example, the following would work for 808 CPU's:

```assembly
EX (SP),HL ;Get our return address & push (i.e., save) HL.
PUSH AF ;Save flag.
PUSH DE ;Save flags.
PUSH HL ;Save our return address back on the stack.
RTI ;Let peripherals know interrupt is being serviced.
```

Note that the above takes 10 bytes of stack space, plus whatever stack
space the service routine uses, plus whatever stack space any routines
that interrupts this one uses. In other words, you must always
have lots of extra stack available (Pascal is good about this, but operating
systems sometimes switch to a small local stack when performing services
for you) or you can switch to a local stack pointer here.

Most CPU's turn the interrupt off when servicing an interrupt; we'll
turn it on later before returning from the interrupt service routines. 9)

PROCEDURE RESTORE Registers;
BEGIN (* This procedure is called just before returning from an interrupt
service routine to put the machine back into its original state.

First get this routine's return address off stack.
Next, get reg's off stack in reverse order
Finally, get old HL & push current return address.
We already did the RTI in SAVE Registers. 9)
END;

(* The following procedures are the interrupt service routines; they are
presented in order from the simplest to the trickiest.

There are some general rules for interrupt service routines that will
avoid most common pitfalls. First, you never know where the main program
is going to be interrupted, so save all registers and avoid calling non-reentrant
routines that are also used elsewhere (e.g., multiple run-time routines are
typically not written in reentrant code even if the Pascal procedures
themselves are reentrant; avoid doing anything in the service routine that does
not generate in-line code). Second, where the same procedure must be called
from both the main program and interrupt routines (as in the calls to the
buffer handling routines in this program) make sure to turn off the interrupt
in the main program around sections of code where the same variables might be
accessed by a service routine; don't be afraid to bracket short sections of
code with disable-enable interrupt instructions - better safe than sorry.
Third, in a priority interrupt scheme, remember that a service routine might be
interrupted by a higher priority device. Lastly, for devices capable of
interrupting frequently, make sure that the device does not interrupt its own
service routine; the service routine itself may be reentrant (the ones shown
here are) but the FIFO buffers are not! A device interrupting its own service
routine will either corrupt the buffer pointers or will put data into the
buffer in the wrong order. 9)

PROCEDURE SERVICE_KEYBOARD;
VAR C : CHAR;
BEGIN
```
```
Listing 2 continued:

```
PROCEDURE WRITE_STRING_TO_OUT_BUFFER(VAR STRING : STRING20);
(* This procedure puts the characters into the output buffer until
it encounters a "\". *)
VAR
  I : INTEGER;
  C : CHAR;
BEGIN
  I := 1;
  REPEAT
    C := STRING[I];
    I := I + 1;
    IF C <> ' \" THEN BEGIN
      ERROR := ERROR OR OUT_HEADER BUFFER FULL;
      DISABLE INTERRUPTS; (* We cannot let the printer interrupt
while the output buffer pointers are being updated. *)
      STORE(OUT_HEADER, OUT_BUFFER, ORD(C));
      ENABLE INTERRUPTS
    END
    UNTIL (I = 21) OR (C = ' \") OR ERROR;
(* Now we need to start printing if we actually put something in the
output buffer and the lister isn't already going. *)
END;
PROCEDURE WRITE_CRLF_TO_OUT_BUFFER;
VAR
  LOCAL_STRING : STRING20;
BEGIN
  LOCAL_STRING[1] := CHR(13); (* Carriage return *)
  LOCAL_STRING[2] := CHR(10); (* Line feed *)
  WRITE_STRING_TO_OUTPUT_BUFFER(LOCAL_STRING)
END;
PROCEDURE WRITE_INTEGER_TO_OUT_BUFFER(VALUE : INTEGER);
VAR
  LOCAL_STRING : STRING20;
BEGIN
  (* In this routine, the integer character string, followed by a space,
and a " \" should be written to LOCAL STRING. Then: *)
  WRITE_STRING_TO_OUTPUT_BUFFER(LOCAL_STRING)
END;
PROCEDURE INITIALIZE_PROGRAM;
BEGIN
  INIT_BUFFER(A_D_HEADER, A_D_BUFFER_LENGTH);
  INIT_BUFFER(KEY_HEADER, KEY_BUFFER_LENGTH);
  INIT_BUFFER(OUT_HEADER, OUT_BUFFER_LENGTH);
  (* Initialize variables *)
  INIT_LIST_FILE;
  DONE := FALSE;
  ERROR := FALSE;
  LAST_VALUE_WAS_THRESHOLD := FALSE;
  THRESHOLD := 2000;
  PULSE_COUNT := 0;
  WRITE('H: file var OUTPUT is assumed
to be the console screen');
  READLN; (* File var INPUT is assumed to be the keyboard *)
  START_CLOCK;
SET UP A TO D;
SET UP KEYBOARD;
SET UP LISTENER;
SET CPU INTERRUPT_MODE;
ENABLE INTERRUPTS
END;
```

```
PROCEDURE ANALYZE_DATA;
VAR
  C : CHAR;
  END PULSE,
  SUPRA_THRESHOLD : BOOLEAN;
  A_D_VALUE : INTEGER;
BEGIN
  AVERAGE_PULSE_HEIGHT := PULSE_SUM / PULSE_COUNT;
  WRITE_INTEGER_TO_OUT_BUFFER(PULSE_COUNT);
  WRITE_INTEGER_TO_OUT_BUFFER(ROUND(AVERAGE_PULSE_HEIGHT));
  WRITE_CRLF_TO_OUT_BUFFER;
  PULSE_COUNT := 0;
  PULSE_SUM := 0.0
END;
```

```
BEGIN
  IF NOT KEY_HEADER BUFFER EMPTY THEN BEGIN
    C := CHR(RETRIEVE(KEY_HEADER, KEY_BUFFER));
    DONE := NOT (C IN ['0'..'9']);
    IF NOT DONE THEN BEGIN
      THRESHOLD := (ORD(C) - ORD('0') + 1) * 400;
      WRITE_STRING_TO_OUT_BUFFER('New Thresholds &
      WRITE_INTEGER_TO_OUT_BUFFER(THRESHOLD);
      WRITE_CRLF_TO_OUT_BUFFER;
    END
  END;
```

```
PROCEDURE DO END PULSE DATA ANALYSIS;
BEGIN
  IF NOT A_D_HEADER BUFFER EMPTY THEN BEGIN
    DISABLE INTERRUPTS; (* We cannot have the A-D interrupting
and trying to update the pointers in the A-D buffer while
we are trying to do the same thing here. *)
    A_D_VALUE := RETRIEVE(A_D_HEADER, A_D_BUFFER);
    ENABLE INTERRUPTS;
    SUPRA_THRESHOLD := A_D.VALUE = THRESHOLD;
    END PULSE := LAST VALUE WAS OVER THRESHOLD AND
    LAST_VALUE WAS OVER THRESHOLD := SUPRA_THRESHOLD;
    IF END PULSE THEN DO END PULSE DATA ANALYSIS
    ELSE IF SUPRA_THRESHOLD THEN BEGIN
      PULSE_COUNT := PULSE_COUNT + 1;
      PULSE_SUM := PULSE_SUM + A_D.VALUE
    END
  END;
```

```
BEGIN
  INITIALIZE_PROGRAM;
  REPEAT
    ANALYZE_DATA
UNTIL DONE OR ERROR;
  WHILE NOT LISTENER INTERRUPT_OFF DO; (* Loop till all printing is done. *)
  DISABLE INTERRUPTS;
  RESET ALL PERIPHERALS; (* So the operating system finds them as it expects *)
  IF ERROR THEN WRITELN('Buffer overflow abort.').
END.
```
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Regression Fitting to Economic Indexes

An Apple II program can help determine base rates of inflation through analysis of the Consumer Price Index.

An interesting application of regression analysis fits an exponential curve to indexes such as the Consumer Price Index (CPI). Such fits provide historical information on prices and can also be used to extrapolate from recent behavior to future performance. Working with such regression analyses demonstrates determining the base rate of inflation despite variations on top of the base rate. The method and the program also suit analysis of many other interesting national indexes.

The Program

Although written for an Apple II computer with 48K bytes of RAM (random-access read/write memory), the program (see listing 1) can run with less RAM if you limit the amount of historical data stored or if you choose not to plot the results. This latter option releases the high-resolution memory space.

In the program, the matrix designated CPI(26,12) stores 26 years' worth (1955 through 1980) of monthly CPI data (lines 570 through 820), here taken from the Business Conditions Digest, published by the Bureau of Economic Analysis, U.S. Department of Commerce. The vector Y(26) stores the years of the data.

Lines 40 through 60 read in the values of the CPI and the corresponding years. Line 70 allows you to choose just to fit the data or to fit and plot it. Lines 90 and 100 allow selection of the starting and ending months and years, thereby permitting a subset of data values to be used in calculations.

Lines 170 through 320 form the subroutine that fits the best compound-interest curve to the chosen data. The routine's analysis is based on a linear-regression fit to the natural logarithms of the CPI data. In a sense, the analysis fits the best exponential curve to the raw CPI data for the years and months chosen, using logarithmic weighting factors.

Program variable XS sums the time, measured in years; YS sums the natural logarithms of the corresponding CPI values. Variable XY sums the products of times and logarithms; X2 sums the squares of the times. Lines 280 and 290 use these variables to calculate the best values of the slope M and the intercept B of the straight line representing the logarithm of the CPI as a function of time. The variable R is the best value, according to the least-squares criterion, of the compound rate of increase.

Lines 330 through 520 form a subroutine that plots the chosen data in high-resolution graphics. Note that line 340 finds the best-fit curve using the subroutine beginning at line 170. C0 and C9 are the bottom and top values for the graph. In lines 450 and 460, the variables X9 and Y9 are the points to be plotted. Again notice that the graph is a plot of the natural logarithms of the CPI against time. Lines 490 through 510 plot the best-fit line calculated by the line 170 subroutine.

The Regression Fit

Using a least-squares criterion, the program fits the logarithms of the CPI to a straight line. This fit is equivalent to fitting, by a regression analysis, the raw CPI data to an exponential curve, \( y = C e^{rt} \), where \( C \) and \( M \) are the best-fit constants and \( t \) is the time.

This fit is equivalent to fitting the data to a compound-interest curve, \( y = C(1 + R)^t \), where \( C \) is the same constant (notice the values at \( t = 0 \)) and \( R \) is the compound-interest rate. If \( C e^{rt} = C(1 + R)^t \), then \( \log(C) + Mt = \log(C) + t \log(1 + R) \), where \( \log \) stands for the natural logarithm of the number.

About the Author

John Merrill has used computers in his teaching at Dartmouth, Florida State, and Hendrix. He has published a book, Using Computers in Physics, and several monographs and journal articles. His present interests are uses of DEC VAX-11 systems and microcomputer systems.
logarithm, matching the BASIC notation. Thus, \( M = \log (1 + R) \), so that \( R = e^M - 1 \), which is the equation used in program line 300. In program line 290, the variable \( B \) is the best value of \( \log(C) \).

The details of linear-regression analysis, including information on how to calculate the best values of \( M \) and \( B \), are discussed in many statistical-analysis books. One such source is Hugh D. Young's *Statistical Treatment of Experimental Data* (McGraw-Hill, 1962), pages 145 and 146.

**Program Results**

Figures 1 and 2 illustrate program results. Figure 1 shows the fit of (the natural logarithm of) the CPI from January 1955 through December 1980. Because the CPI has several very different base rates of increase over that period of time, the best-fit line (a compound rate of increase of 0.7 percent per year) does not represent the data very well.

Figure 2, on the other hand, shows a fit for January 1955 through June 1956 (a period with little change in the CPI), and were the corresponding graph displayed, this fit would represent the CPI variation quite well with a compound rate of increase of 0.7 percent per year. The second half of the run in figure 2 and the plot shown there are the fit of the CPI from June 1978 through December 1980. Here, the compound rate of increase is 12.7 percent per year, and the straight line is a good representation of the actual base rate of inflation throughout this period. You can also see the relatively small variations around the base-rate line. A number of the points, which represent the raw CPI values, are covered by the best-fit line. This covering is quite clear on the video screen because the program plots the monthly points and then draws the line right over them. To estimate where the covered points lie, remember that the CPI values come in equal steps in time (every month).

**Conclusion**

The program reported in this note represents one illustration of an instructive application of regression analysis to real-world data.
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Figure 2: Demonstrating use of the listing 1 program, the prompting and response messages in (2a) and (2b), respectively, show program operation for Consumer Price Index data from January 1955 through June 1956 (at a 0.7 percent-per-year compound rate of increase) and June 1978 through December 1980 (12.7 percent-per-year compound rate of increase). The graph in (2c) results from the (2b) inputs: the discrete points are individual Consumer Price Index values.
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BYTE May 1983 481
Sorting Algorithms for Microcomputers

Programmer ingenuity and search of the existing literature can significantly improve sort performance.

Terry Barron
1901 East Lynn St.
Seattle, WA 98112

George Diehr
1500 38th Ave.
Seattle, WA 98122

Many applications require organizing data into ascending or descending order—sorting. This can be an extremely time-consuming job, especially if a too simple algorithm is used. On a large machine the inefficiency may not be noticed—one second versus ten may not be worth worrying about. On a microcomputer, however, one minute versus ten may be quite important, especially if you’re sitting at a terminal waiting for the results.

In this article we examine two fairly simple and closely related sorting algorithms: Shuttlesort and Shellsort. Shellsort is a generalization of Shuttlesort, requiring only a small added expenditure of programming effort but yielding astounding improvements in performance.

In addition, we examine the sorts’ performance on a variety of machine-language combinations to give some idea of their relative power on a common practical task.

When faced with a common problem such as sorting, someone has probably developed efficient methods—what you need to know is where to look. References 1, 2, 4, and 5 are convenient sources of sorting algorithms.

Types of Sorts

If the sort program and all the data to be sorted fit into central memory, we can use an internal sort. If not, some kind of external sort must be used. Such sorts involve sorting parts of the data in central memory, writing these sorted parts to a disk, and then merging the parts together to create a file of sorted data. This article deals with internal sorts, which can be used during the internal phase of an external sort.

Many internal sorting algorithms are available, each with advantages and disadvantages. Broadly speaking, we can classify the sorts by two characteristics: efficiency and complexity (see table 1).

Shellsort occupies an interesting position in this classification: it is in the same efficiency class as sorts such as Quicksort yet is easier to program. In addition, it is more efficient than the Shuttle/Bubble varieties yet no more difficult to program. This is only a small exaggeration. Shellsort is slightly more complicated than those in the Shuttle category. Also, it is slightly less efficient, at least theoretically, than Quicksort and Treesort. Nevertheless, in most situations Shellsort represents the best choice in trading machine time for complexity. Furthermore, Shellsort requires no more space than Shuttle-sort while Quicksort does require additional space.
Table 1: Common sorting methods can be classified by two characteristics: efficiency and complexity.

<table>
<thead>
<tr>
<th>Complexity of Algorithm</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Low</td>
<td>Shuttle</td>
<td>Bubble</td>
<td>Pair Exchange</td>
</tr>
<tr>
<td>Medium</td>
<td>Shellsort</td>
<td>Quicksort</td>
<td>Tressort</td>
</tr>
<tr>
<td>High</td>
<td></td>
<td>Linear-Time</td>
<td>Sort</td>
</tr>
</tbody>
</table>

Listing 1: This Applesoft version of Shuttlesort includes a GOSUB at line 20 to branch to code that generates data used to perform the tests described in the text. The sort proper is the code from line 50 through line 200.

10 DIM X(1024)
19 REM BRANCH TO GENERATE N RANDOM VALUES
20 GOSUB 1000
50 FOR I = 1 TO N - 1
60 FOR J = I TO 1 STEP - 1
70 IF X(J) < = X(J + 1) THEN 200
80 TX = X(J); X(J) = X(J + 1); X(J + 1) = TX!
100 NEXT J
200 NEXT I

Because Shuttlesort serves as the starting point for Shellsort, we consider it first. It is useful for sorting small lists of items (e.g., up to 30 or so on a microcomputer). Shuttlesort is also used as part of more complex algorithms such as modified Quicksort. (Reference 5 is an excellent source for more information on all the sorts noted in the table except the linear-time sort, which is covered in reference 6.)

Shuttlesort

For a concrete demonstration of the Shuttlesort algorithm, we will assume that we want to sort the following list of single characters into normal alphabetical order:

<table>
<thead>
<tr>
<th>Location</th>
<th>Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>X</td>
</tr>
<tr>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>3</td>
<td>D</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
</tr>
<tr>
<td>5</td>
<td>A</td>
</tr>
<tr>
<td>6</td>
<td>B</td>
</tr>
</tbody>
</table>

The Shuttlesort algorithm starts by comparing the first two items, X and C, and exchanges them if they are out of order. Because X should come after C, they are exchanged. The algorithm next compares locations 2 and 3. Because X should come after D, they are exchanged.

The sort now determines how far up in the list the value D should be moved (to the left in our display). Therefore, C and D are compared. Because they are in the right order, no exchange is made. The comparisons resume at locations 3 and 4; X should come after M and they are swapped. The list is now

<table>
<thead>
<tr>
<th>Location</th>
<th>Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C</td>
</tr>
<tr>
<td>2</td>
<td>D</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
</tr>
<tr>
<td>4</td>
<td>A</td>
</tr>
<tr>
<td>5</td>
<td>B</td>
</tr>
<tr>
<td>6</td>
<td>X</td>
</tr>
</tbody>
</table>

Values at locations 4 and 5 are compared next. Because X should come after A, they are exchanged; next, M and A are compared and another exchange occurs. Two more exchanges—D and A—are made, and C and A—place A in location 1. The sort resumes by comparing X and B. B travels up the list until it stops at location 2, finishing the sort.
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Although our example sorts single characters, the algorithm applies equally to real values, integers, or arbitrarily long strings. The performance tests presented here use randomly ordered real values.

Listing 1 shows an Applesoft version of Shuttle sort for real-valued data. The FOR loop from lines 50 to 200 controls the traversal down array X so that the first comparison for a given value of 1 is X(I) and X(I+1). The inner FOR loop, lines 60 through 100, moves the value at X(I) up the list until it encounters a smaller (or equal) value or until it reaches the top of the list. The exchange of X(I) and X(I+1) in line 80 moves data elements up the list.

As noted in table 1, Shuttle sort is in the same class as the Bubble and Pair Exchange sorts. A sort shown in the Apple BASIC Programming Reference Manual (page 15) is a Pair Exchange sort. The efficiency of these sorts can be described by the increase in sorting time as the number of items to be sorted increases. If it takes T seconds to sort N items, these sorts will require about 4T seconds to sort 2N items: the sort time increases with the square of the number of items. Algorithms with this efficiency are said to be order N-square in performance. Sorting time can get out of hand very quickly with an order N-square sort.

A clue to this algorithm's inefficiency can be seen in our letter-sorting example. The value A starts in location 5 but belongs in location 1; Shuttle sort needs four exchanges to move it to the top. Similarly, the movement of value B to location 2 also requires four exchanges. As the number of items to be sorted increases, the number of exchanges for each item increases. The total number of exchanges is proportional to the number of items times the number of exchanges for each—one-hence the order N-square performance.
If Shellsort could move items more than one position at a time, it might be more efficient. One way to make larger moves is to compare items farther apart than just one location. This is the idea behind Shellsort; reference 7 discusses Shell's original work.

**Shellsort**

Shell sort works by dividing the list of data into sublists. Shuttlesort is used to order each sublist and finally merge them into the final, completely sorted list. The final pass of Shellsort is identical to a Shuttlesort. Earlier passes try to move small values near the top of the list in large steps. On the final (Shuttlesort) pass values don't have far to move.

To demonstrate Shell sort, we use the larger list of data shown in figure 1. Instead of comparing immediate neighbors, the algorithm starts by comparing items some fixed distance apart, 5 for the first figure 1 pass. The Before section shows the original list of data and the five sublists that result when items five locations apart are compared. The algorithm effectively applies a Shuttlesort to each of these sublists. The After section shows the now-ordered sublists and the resulting whole list at the end of the pass. Note that only six comparisons have managed to move letters in the first half of the alphabet to the top half of the list and letters in the last half of the alphabet to the bottom half of the list.

The next pass uses a distance of 3, resulting in the three sublists shown in figure 2. Each sublist is sorted (using Shuttlesort) with the result in the After section. The first quarter of the list now contains letters from the first quarter of the alphabet and so on. The list becomes partially ordered very quickly.

The final pass uses a distance of 1, resulting in only one sublist, the entire list of values. Clearly, applying Shuttlesort to that list assures that the final result is completely ordered. Note the small distance items need to move in this final pass to find their final position; no item need move more than two locations.

The changes required to convert Shuttlesort to Shellsort are minimal. First, lines 50 through 200 in listing 1 are modified to use distance D rather than the fixed distance 1. After each pass, the value of D reduces to INT(D/2) at line 230 of listing 2. When D is reduced to 0, we know that the pass just completed was the Shuttlesort on the whole list. Thus, the sort is complete.

**Determining Distances**

How do we choose the distances? Although the algorithm's performance is known to be rather sensitive to the distances, there is no known way to select the ones that guarantee minimum sort time. However, the initial distance and all subsequent distances should be odd. One of the most commonly used set of distances with this property was developed by Hibbard (see reference 3). He uses an initial distance of

\[ D = \lfloor \log_2(\log_2(N)) \rfloor - 1 \]
## Table 2: Comparing Shellsort with Shuttlesort

<table>
<thead>
<tr>
<th>Number of Items</th>
<th>Number of Comparisons</th>
<th>Number of Exchanges</th>
<th>Number of Comparisons</th>
<th>Number of Exchanges</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>280</td>
<td>251</td>
<td>159</td>
<td>70</td>
</tr>
<tr>
<td>64</td>
<td>1050</td>
<td>992</td>
<td>411</td>
<td>180</td>
</tr>
<tr>
<td>128</td>
<td>4186</td>
<td>4063</td>
<td>1142</td>
<td>555</td>
</tr>
<tr>
<td>256</td>
<td>16,802</td>
<td>16,552</td>
<td>2515</td>
<td>1108</td>
</tr>
<tr>
<td>512</td>
<td>64,761</td>
<td>64,255</td>
<td>6395</td>
<td>3089</td>
</tr>
<tr>
<td>1024</td>
<td>264,233</td>
<td>263,223</td>
<td>15,740</td>
<td>813</td>
</tr>
<tr>
<td>2048</td>
<td>1,032,218</td>
<td>1,030,176</td>
<td>34,994</td>
<td>17,698</td>
</tr>
<tr>
<td>4096</td>
<td>4,141,646</td>
<td>4,137,563</td>
<td>84,969</td>
<td>46,277</td>
</tr>
</tbody>
</table>

Listing 2: Comparing this Applesoft version of Shellsort with the listing 1 program demonstrates that only two lines—45 and 230—need be added to a Shuttlesort program to form Shellsort. The variable \( D \) generalizes the distance between comparisons; this distance is fixed at 1 in Shuttlesort.

```
10 DIM X(1024)
19 REM BRANCH TO GENERATE N RANDOM VALUES
20 GDOSUB 1000
45 D = 2 * INT ( LOG (N) / LOG (2)) - 1
50 FOR I = 1 TO N - D
60 FOR J = I TO 1 STEP - D
70 IF X(J) < = X(J + D) THEN 200
80 TX = X(J) ; X(J) = X(J + D) ; X(J + D) = TX
100 NEXT J
200 NEXT I
230 D = INT (D / 2) : IF D > 0 THEN 50
```

Each subsequent distance is

\[ D = \text{INT}(D/2) \]

(Note that \( \text{LOG}(N)/\text{LOG}(2) \) is the base 2 logarithm of \( N \).) The values of \( D \) are always of the form \( 2^P - 1 \) for some positive integer \( P \). For example, if we have 100 items to sort, the initial \( P \) is 6 and the initial \( D \) is 63. In subsequent passes, \( D \) equals 31, 15, 7, 3, and 1. (For our little example, we should have used an initial distance of 7, but we chose 5 to make it a bit more interesting.)

We now have all the parts necessary for the algorithm. The Apple BASIC program is in listing 2.

### Performance Evaluation

We claimed in the beginning that Shellsort was well worth the minor programming changes. The acid test of this is the time required to sort.

often turns out that an algorithm that has superior theoretical performance realizes its advantage over another algorithm only for very large values of \( N \). For example, suppose we code an algorithm that is order \( N \)—that is, doubling the number of items to sort only doubles the time. But suppose it takes 1000 seconds to sort 100 items, while our order \( N \)-square algorithm takes 100 seconds. Sorting 200 items requires 2000 and 400 seconds respectively; sorting 500 items requires 5000 and 2500 seconds respectively. Only when we sort more than 1000 items will the order \( N \) algorithm be superior. In such situations, the choice of algorithm depends heavily on the number of items to sort.

Therefore, we compared timings for Shuttlesort and Shellsort for several machines and languages. In addition to time measurements, we also counted the number of exchanges and comparisons required by each method. While the time will certainly differ for different hardware, the counts will not, so they provide insight into algorithm efficiency independent of hardware/software considerations.

Another measure for a sort algorithm is the amount of memory required. Each method requires only minimal extra memory beyond the list to be sorted. Furthermore, this extra space does not increase as the number of items increases. Thus, space use is order \( N \). In contrast, algorithms that are slightly more efficient than Shellsort typically require significant extra space. For example, some require space for pointers—possibly two pointers per item.

For the performance comparisons, random real values were generated. This probably represents the most challenging type of data for both algorithms—with integers or strings, duplicate values are more likely to occur and sort time would be reduced for both.

Table 2 shows the number of comparisons and exchanges for the two algorithms for lists of size 32, 64, 256, 512, 1024, 2048, 4096. The superiority of Shellsort is obvious throughout. Scanning the Comparisons and Exchanges columns under Shuttlesort reveals its order \( N \)-square nature—when \( N \) doubles, the number of operations increases fourfold. Also note how the number of exchanges is close to the number of comparisons. Exchanges are expensive—they require three LET statements.

The rate of growth of the number of comparisons and exchanges for
Sort time in seconds for:

<table>
<thead>
<tr>
<th>Number of Items</th>
<th>Shuttlesort</th>
<th>Shellsort</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>7</td>
<td>3.5</td>
</tr>
<tr>
<td>64</td>
<td>26</td>
<td>7.5</td>
</tr>
<tr>
<td>128</td>
<td>103</td>
<td>20</td>
</tr>
<tr>
<td>256</td>
<td>413 (1662)</td>
<td>51</td>
</tr>
<tr>
<td>512</td>
<td>295</td>
<td></td>
</tr>
<tr>
<td>1024</td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>2048</td>
<td>706 (105,730)</td>
<td>295</td>
</tr>
<tr>
<td>4096</td>
<td>121</td>
<td>5142.5</td>
</tr>
</tbody>
</table>

Table 3: Comparison of sort times for Shuttlesort and Shellsort algorithms written in Applesoft BASIC support table 2's indication of Shellsort's superiority. The numbers in parentheses are estimated times.

Shellsort is far slower. Instead of an order N-square increase, it is approximately proportional to N^{1.28}. Thus, doubling N results in an increase of roughly 2.4 times in the number of operations. Furthermore, the number of exchanges is much less than the number of comparisons, usually about half. (Note that different data produce different counts, but the relationships remain approximately equal to those we measured.) These counts show the effectiveness of early passes in moving items a long way up and down the list with few comparisons and exchanges.

From the counts of comparisons and exchanges, Shellsort should be much faster. It is: table 3 shows sort times in seconds for the two algorithms using Applesoft interpreted BASIC. (Some of the times have been estimated because they are so long. The estimation method is described in the next section.) As you can see, as N grows Shuttlesort becomes impractical very quickly:

- Sorting just 256 values requires almost 7 minutes. By comparison, Shellsort can order four times as many values, 1024, in less time. Even though the Apple has enough memory to sort 4096 values, do you have the patience to wait out a Shuttlesort? The estimated time is about 29 hours.

Using Shellsort, it is practical to sit at the machine while it sorts 1024 values. Sorting 2048 values calls for a coffee break (12 minutes), while you might schedule a sort of 4096 values for a quick lunch (about 28 minutes).

Predicting Sort Times

It is quite easy to develop simple and accurate estimates for sort times for both algorithms. Based on the order of the methods, estimates of the following forms are used:

\[
\text{Time(Shuttlesort)} = C N^2
\]

\[
\text{Time(Shellsort)} = K N^{1.28}
\]

The constants C and K are estimated from actual times from table 3. The estimates are usually better if larger values of N are used. For example, using N=256 to estimate C gives

\[
C = \frac{413}{256^2} = 0.006302
\]

Using this value for C gives an estimate for N=128 of

\[
\text{Time(Shuttlesort)} = 0.006302 \times 128^2 = 103.25
\]

giving with our observed time. The estimate for 1024 items is

\[
\text{Time(Shuttlesort)} = 0.006302 \times 1024^2 = 6608 \text{ seconds}
\]
or almost 2 hours.

For Shellsort, the estimated K using N=1024 is

\[
K = \frac{295}{128^{1.28}} = 0.0475
\]

The estimate for sorting 128 values is

\[
\text{Time(Shellsort)} = 0.0475 \times 128^{1.28} = 21.5
\]

agreeing fairly well with the observed 20 seconds.

Pushing Shellsort Further

Many algorithms can be "tuned" to give additional performance improvement, although often no improvement in order of performance. This is the case with Shellsort. We can reduce times by about 25 percent with the following change: when we find a value that is out of place, say \(X(I+D)\), it is stored in \(TX\). \(TX\) is then

---

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Listing 3: In an Applesoft version of Super-Shellsort, exchanges are delayed so that fewer LET statement executions are required than in the usual Shellsort algorithms. This program reduces sort times by about 25 percent compared with the listing 2 program.

10 DIM X(1024)
19 REM BRANCH TO GENERATE N RANDOM VALUES
20 GOSUB 1000
45 D = 2 ^ INT (LOG (N) / LOG (2)) - 1
50 FOR I = 1 TO N - D
55 IF X(I) < X(I + D) THEN 200
57 TX = X(I) + D
60 XCJ + D = X(I)
60 FOR J = I - D TO 1 STEP - D
70 IF TX = X(J) THEN 120
80 X(J + D) = X(J)
100 NEXT J
120 X(J + D) = TX
200 NEXT I
230 D = INT (D / 2) IF D > 0 THEN 50

compared up the list, moving displaced values down by distance D until the proper place for TX is found. Thus, moving a value up in M steps requires only M - 1 moves and one exchange instead of M exchanges. (This improvement is discussed in reference 3.) This version of the program appears in listing 3.

This tuning reduces the time to sort 1024 values from 295 seconds to 223 seconds. The time to sort 4096 values is now about 20 minutes compared to about 28 minutes.

In theory, there are quicker algorithms than Shell’s. For example, based on statistics reported in reference 5 (page A41), Quicksort seems to be about three times faster. However, Quicksort involves significant manipulation of pointers and transfers of control, operations that are especially expensive with an interpreter. We once tried Quicksort on an 8080-based microcomputer using Microsoft BASIC. The results were miserable—the seconds required by Shellsort became minutes with Quicksort. We have not repeated the experiment with the Apple.

The Apple versus IBM and Two of the Dwarfs
How powerful is the Apple? What is the performance gain from compiling? How do BASIC and FORTRAN compare in performance? We did not embark on an exhaustive performance comparison, but having several computer systems available and for some time having harbored suspicions about Grosch’s law (explained later) we coded Shellsort and Shell sort on several machines using several languages:

- Apple with Applesoft BASIC
- Apple with Microsoft BASIC compiler
- IBM Personal Computer with Microsoft BASIC interpreter
- Digital Equipment Corporation VAX-11/780 with BASIC compiler
- DEC VAX with FORTRAN (compiled)
- Control Data Corporation Cyber 170-750 with BASIC compiler
- CDC Cyber with FORTRAN (optimizing FTNS compiler)

Table 4 summarizes the results and shows the ratios of sort times for 1024 values using Shellsort. The underlined values represent comparisons that are probably the most accurate reflections of machine power as opposed to comparison of languages or compilers/interpreters. For example, row 2 indicates that the VAX is about 47 times faster than the Apple (both using compiled BASIC). The CDC is somewhere between 2.6 and 4.3 times faster than the VAX depending on whether we compare BASICS or FORTRANs.

If you have a BASIC compiler for your Apple, you probably know...
about the significant speed improvements it affords. Using the Microsoft BASIC compiler with integer variables for everything except the actual array of values to be sorted, 1024 values can be sorted in 33 seconds, and 4096 values require 166 seconds (there went your coffee break). The average improvement is a factor of about 7.5.

Now, what about Grosch's law? Herbert Grosch hypothesized a relationship between computer cost and performance that claimed a quadrupling of performance for a doubling of cost (a quadratic relationship). This seemed to hold true for many years, especially if performance was based on measures of raw computing power such as add times. Because internal sorting requires primarily brute computational power, as opposed to input/output operations, our performance measures should be a fair test of the law.

In order to make some sense of cost/performance trade-offs, we calculated for each machine the following quantity:

<table>
<thead>
<tr>
<th>System</th>
<th>Cost</th>
<th>Cost Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple BASIC</td>
<td>$1500</td>
<td>1.00</td>
</tr>
<tr>
<td>VAX BASIC</td>
<td>$100,000</td>
<td>1.42</td>
</tr>
<tr>
<td>VAX FORTRAN</td>
<td>$100,000</td>
<td>0.47</td>
</tr>
<tr>
<td>CDC BASIC</td>
<td>$1,000,000</td>
<td>5.33</td>
</tr>
<tr>
<td>CDC FORTRAN</td>
<td>$1,000,000</td>
<td>1.06</td>
</tr>
</tbody>
</table>

Table 5: A comparison of the cost index of various computer systems.

<table>
<thead>
<tr>
<th>Applesoft</th>
<th>7.6</th>
<th>1.46</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple BASIC Compiled</td>
<td>47</td>
<td>145</td>
</tr>
<tr>
<td>IBM PC BASIC</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>VAX BASIC</td>
<td>2.6</td>
<td>13.2</td>
</tr>
<tr>
<td>VAX FORTRAN</td>
<td>1.3</td>
<td>4.3</td>
</tr>
<tr>
<td>CDC BASIC</td>
<td>1.00</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Table 4: These relative performance comparisons of various hardware/software combinations are based on sorting 1024 values with Shellsort. Table entries are the ratio of the row-system sort time to the column-system sort time; for example, the VAX BASIC system runs Shellsort 47 times faster than the Apple BASIC Compiled system does. Underlined values are those most appropriate for comparisons of the relative power of different hardware.
Performance is 1/\text{time to sort 1024 items.} The results are shown in table 5. The cost index tells how many Apples you could buy for each unit of Apple performance obtained when using specific machine-language combinations. Even more to the point, if you could divide a job into pieces that could be run simultaneously, this indicates that in all cases except the VAX/FORTRAN combination it would be cheaper to buy a bushel of Apples in place of the larger machine. For example, with the CDC/BASIC combination you could buy 5.33 Apples for each unit of Apple performance that the CDC provides. Because the CDC/BASIC combination sorted 1024 values 125 times faster than the Apple, you would spend $125 \times 1500 = $187,000 in Apples versus about $1,000,000 for the CDC.

Although this is certainly a crude comparison, it is quite interesting. If Grosch's law held, we should see the cost index dropping rapidly with increasing machine cost. Because the CDC costs about 667 times as much as the Apple, Grosch's law implies that its performance should be about 444,444 times better, that is, $(1,000,000/1500)^2 = 444,444$. In fact, the CDC performance is at best about 626 times better.

**Conclusions**

Small changes in a program can yield dramatic performance gains. About the only good reason for ever using one of the order N-square sorting algorithms is for illustrative or educational purposes. Minor tuning can also give significant improvements.

If you do a significant amount of numerical computing and are using an interpreted BASIC, you should probably look into a compiler. The performance improvement is much greater than the gain possible by moving to a faster chip (e.g., a Z80 or 8088 in place of the 6502).

Finally, if you have a spare quarter of a million dollars, you can purchase a machine that will give you a proportional performance improvement over the Apple, but don't expect to reap much in the way of economies of scale.

**References**

1. Association for Computing Machinery. Communications.
2. Association for Computing Machinery. Collected Algorithms of the ACM.
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Random Rumors!
American Bell is reportedly reading a desktop workstation computer running the Unix System 5 operating system; it may be introduced this summer. The firm is also expected to introduce a minicomputer in the same class as Digital Equipment Corporation's (DEC's) VAX, as well as several personal computer products. There are rumors that American Bell has had discussions with Fortune Systems to purchase manufacturing rights to the Fortune 32:16 system (see page 82 of this issue for Steven H. Barry's review of the 32:16). . . . Word has it that DEC is working on a desktop version of the VAX; already DEC has produced a "PDPC-11-on-a-chip."

Apple Computer Inc. is believed to be working on a DOS (disk operating system) with a file format that will allow files to be moved between the Apple II, Apple IIE, Apple III, and Lisa.

Pick Systems may be close to releasing a version of its popular Pick Operating System for the IBM Personal Computer. . . . Several local telephone companies are reportedly seeking to sell personal computers in their telephone stores. . . . There are rumors that several low-cost portable computers are due here from Hong Kong and Taiwan. The portable market appears to be the hottest, considering the number of new units being introduced this year.

Commodore News:
Commodore appears to have scrapped its 16-bit microprocessor, in development for over four years, and has entered into an agreement to manufacture the Zilog Z8000 and related peripheral chips.

Apparently, Commodore will use the Z8000 in a new 16-bit personal computer because the agreement allows the company to use the Z8000 chip in its own products only and precludes Commodore from selling it on the open market. The fact that both CP/M and an excellent version of Unix developed by Zilog are already available for the Z8000 may have prompted Commodore's decision; however, little applications software is available for that device.

Despite the fact that the Customs Service has already seized a large number of these imports, more and more U.S. companies are importing them.

Radio Shack News:
Tandy has announced that it will replace the present operating system used on the Model 16 with Xenix, the Unix-like operating system from Microsoft. It will be furnished to all owners of previously sold Model 16s. This will make more than double the number of Xenix users. To run Xenix, a user will need 256K bytes of memory and a hard disk. The standard Unix utilities and software tools are extra. Thus a base-priced system will be over $9000; still a low price for a Unix system. The two companies are also developing a single-user, floppy-disk-based Xenix for mid-1983.

Finally, Tandy, the last holdout among major suppliers, has agreed to furnish Digital Research's CP/M operating system for the new TRS-80 Model 12 system.

Is Integrated Software the Key to Success? The next generation of personal computers will be here shortly, and it will be characterized by highly integrated software/hardware systems. The first two such systems have already been demonstrated and should be in users' hands in the next two to three months. I am talking about the Apple Lisa, Visicorp's Visi On system, and a new unnamed operating system I am expecting Microsoft to announce shortly.

The new-generation systems offer a high degree of integration between applications software, operating-system software, and hardware. As a result, these systems will create an applications environment. Their common distinctive features are the new user interface, integration of applications programs, and greater reliance on graphics. Up until now, user interfaces have been geared to the programmer, a highly trained user willing to spend many hours studying cryptic manuals; but these new systems are designed with a degree of simplicity rarely seen before; networking and integration of multiple applications such as word processing, data handling, and spreadsheet use are also considered important. Many of these concepts were promoted by Xerox in its Alto system (built for internal use by researchers at Xerox's Palo Alto Research Center) but it now appears that personal computer designers will really bring them into wide use.

These systems encourage the user to view the graphics display as a desktop. Graphic representations of familiar objects (called icons) are visible on the desk, including sheets of paper on top of one another, in and out baskets, a mailbox, file folders, a printer, etc. These are actually windows allowing the user to view simultaneously the execution of multiple applications programs. Users can rearrange the overlapping papers to their hearts' delight and can point to a graphics representation of a desired function using a mouse. There is one icon that is always present, the Help icon. (The Visi On system as implemented on the IBM Personal Computer, with limited graphics capability, uses labeled, highlighted boxes instead of icons.) Visicorp will no doubt be a leader in this area, if its product lives up to the recent

BYTE LINES
News and Speculation about Personal Computing
Conducted by Sol Libes
Computers or chase are impressed ports only based however, integrated solution graphics most complete on the section of CP/M, acts VisiOn, similar many IBM Personal Computing Machinery's Special Interest Group (SIGGRAPH) standard compatible graphics interface to CP/M and improvements such as concurrency and memory- and disk-management features, still relies on independent vendors for applications software; this has resulted in a distinct lack of integrated software under CP/M. (SIGGRAPH is the Association for Computing Machinery's Special Interest Group on Graphics.) Use of the standard will make it easier for outside software vendors to integrate their software; still, Digital Research seems to be missing the integrated-software boat.

It's still questionable whether the $10,000-and-up prices for these integrated systems will limit their acceptance in the marketplace; after all, Xerox tried to pioneer this area two years ago with the Star (at a $16,000 base price) and was not successful. Will users be willing to pay $10,000 to $12,000 for these features? It may be that Apple is really counting on its Machintosh system, due for introduction later this year, that will have some of the Lisa features and a lower price.

LAN Standard Endorsed: Thirteen firms have endorsed the LAN (local-area network) standard currently being worked on by an IEEE (Institute of Electrical and Electronics Engineers) committee. Called the IEEE P802.3 draft standard for CSMA/CD (Carrier Sense, Multiple Access with Collision Detection), it integrates the Ethernet and EMA (European Computer Manufacturers Association) specifications. The companies endorsing the proposed standard include Bridge Communications, Data General, DEC, Fujitsu America, Hewlett-Packard, Intel, Interlan, National Semiconductor, Siemens, Tektronix, 3Com, Ungermann-Bass, and Xerox.

Prices Continue Dropping: Toys 'R Us, a large chain of toy stores, is opening computer sections that in some cases will occupy a quarter of a store's floor space. This is just a sign of the major changes occurring in the home computer marketplace.

The competition in the mass-merchandised personal computer market is getting fierce. I have already seen the Timex Sinclair 1000 advertised for $66 minus a $15 rebate (list price is $79) and the Commodore VIC-20 for under $135. Texas Instruments (TI), via its rebate program, has brought the model 99/4A down to under $150, and now Atari has introduced a rebate for the model 400 that brings its price down to under $200. The more powerful Atari 800 is now retailing for under $500.

Mattel, Magnavox, Emerson, and Video Technology are also entering the fray in the under-$200 market. Emerson expects to do this by offering a keyboard attachment for the Atari 2600 video-game unit; however, Atari has announced its own keyboard for that unit. Mattel and Coleco are doing likewise for their game systems.

Atari expects to double the number of stores carrying its units to 15,000 by the end of this year and to spend 50 percent more on advertising, with most going into television spots.

Commodore has also dropped the price on its Model 64 and offered it for sale via mass merchandisers. The under-$100 market, now currently dominated by Timex Computer Corporation, will soon see entries from Commodore, Sharp, and Casio.

Personal Robotics: Numbers of home experimenters have built personal robots during the last few years. Tod Loufbourrow, for example, wrote a book five years ago describing the construction details for his robot, which had a primitive sensory system and could respond to a limited set of commands in its master's voice. Over the last three years, several companies have introduced robotic arms controlled by personal computers; however, these are essentially expensive teaching tools, some costing as much as $5000.

The introduction of the HERO-1 from Heath will have a profound impact on personal robotics (see "HEATH'S HERO-1 Robot" by Steven Leining, January 1983 BYTE, page 86). Although still intended as an educational product, its $1500 price (in kit form) puts it well within the range of many schools and home experimenters. Thus we can expect to see homemade improvements, added features, and peripherals for this and similar robotic kits; perhaps newer kits will be available at even lower cost. For example, Nolan Bushnell (founder
BYTELINES

of Atari) has formed a new company called Androbot, in Sunnyvale, California, that has announced two home robots. One is expected to sell for under $1000 and use a radio link to a home computer; the second will be a $2500 robot with onboard brains using three 8086 microprocessors and 3 megabytes of memory. The Robot Shack, of El Toro, California, is offering its 7-inch-high Droid 10 for $99 and a 38-inch-high PR-1 for $499; both offer remote-controlled motion, speech recognition, and speech output.

We are at a point in personal robotics comparable to the situation in the early 1970s when home experimenters were building primitive computers with the Intel 8008 microprocessor. It took only another three to four years for these systems to move from basements to computer stores; by the end of the decade, computers were being mass merchandised. I therefore predict that by the end of this decade we will see personal robots mass merchandised just as personal computers are today.

Further, the Japanese government gave industry a 40 percent tax deferral on software revenues for the first four years of any developed program's life. Some of the larger companies, such as Hitachi, spun off their software operations into independent subsidiaries to make them less bureaucratic. Although most experts feel that Japan is still about 10 years behind the U.S. in software development, in some areas the Japanese have made significant strides. Japan has already developed banking and airline-reservation software considered equal to that used in the U.S. Further, its video games and robotics software are considered first rate.

U.S. Firms Establish Foreign Software Operations: More and more U.S. computer makers are setting up software development operations outside the U.S., most notably in England and Europe. For example, DEC, Hewlett-Packard, Honeywell, Prime, Perkin-Elmer, and Modcomp all have established software operations near London. This has led to the creation of a large number of independent software shops. Packages for software development, games, database management, videotex, electronic mail, transaction processing, and packet-switched communications have already appeared from these operations. Increasing numbers of these software packages are being sold in this country. Most notable are packages for microcomputers, such as The Last One, Pearl, and CIS COBOL, all developed in England by independent software shops.

Public-Domain Software: It never ceases to amaze me how few personal computer users are aware of the existence of large libraries of public-domain software. That is, software that has not been copyrighted and thus can be legitimately copied. There are dozens of...
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these libraries in existence, run mainly by computer clubs. Typically, these clubs gather software donations from their members or from exchanges with other clubs.

For example, the club that I belong to the Amateur Computer Group of New Jersey—ACG-NJ has a library of CP/M-compatible programs that fills over 100 disks. Each disk is packed with about 240K bytes of programs; in other words, there are over 24 megabytes of free software in the library. The club asks members to contribute $1 each time they copy a "volume" (disk); if members wish, they may telephone a computer system maintained by the club that contains much of this software and is capable of downloading files. The club will furnish a printed catalog of its software offerings for just $2 (request it from SIG/M, POB 97, Iselin, NJ 08830).

The ACG-NJ SIG/M and the CPMUG (CP/M User's Group, 1651 Third Ave, New York, NY 10028) libraries are without doubt the largest such organizations in existence. For example, in their libraries, one will find 13 different language interpreters and compilers, many in source-code form so that those who wish to add enhancements or just want to study how a language is created can do so. Also available are BASIC (six versions), ALGOL, FOCAL, RATFOR (Relational FORTRAN), Pascal, STOIC (a FORTH-like language), PISTOL (Portably Implemented Stack Oriented Language), ACTOR, SAM (both string-processing languages) PILOT (Programmed Inquiry, and Learning), PIDGIN, and TINCMPI.

East Bloc Personal Computing: I have recently received a number of software listings from Hungary and Yugoslavia, two European socialist countries. From reading these newsletters it would appear that personal computing is starting to take hold in these countries in much the same way as it started here in the U.S. These hobbyists appear to be about four to six years behind those in the U.S. Surprisingly, much of their equipment is either U.S.-made or copied from U.S. equipment. For example, the TRS-80 Model I and copies of it are popular.

S-100 Update: In my March 1983 BYTElines (page 492), I estimated that there were 150 manufacturers of S-100 products making over 500 plug-in boards. A recent survey conducted by Microsystems magazine has turned up the fact that there are over 200 manufacturers making over 1000 different S-100 products. Thus, although the S-100 marketplace is very diverse, when taken as a single group, it represents the largest segment of the current microcomputer-peripherals market.

Z800 Update: In my February 1983 column (page 430) I reported that Zilog expected to start offering samples of its new Z800 in the spring, with production expected in the fall. I regret to report that I was wrong; the firm expects to start supplying samples in the fall with production expected early next year.

Random News Bits: The deregulation of the Bell System has allowed Western Electric, the manufacturing arm of AT & T, to go into the business of manufacturing components. Western Electric has hired salesmen to go out on the road to sell components that were previously available only within the Bell System. This will include a new 256K-bit semiconductor memory, bubble memory, and microprocessor parts.

... Xerox has disclosed that its Office Products division, which sells the 820 desktop computer and the Star workstation, had a significant loss last year....... IBM has finally begun distributing the Personal Computer outside the U.S. The firm has also introduced an upgraded version of the Personal Computer, the XT (see page 520 for more on the new machine).

MAIL: I receive a large number of letters each month as a result of this column. If you write to me and wish a response, please include a self-addressed, stamped envelope.

Sol Libes
C/O BYTE Publications
POB 372
Hancock, NH 03449

BYTE's Bits

Call for Papers on Industrial Electronics

Papers are being solicited for the International Conference on Industrial Electronics (IECON '83) to be held from November 7-11 at the Hyatt Regency Hotel in San Francisco. Send papers to R. C. Born, Eaton Corp.: Cutler Hammer, 4201 North 27th St., Milwaukee, WI 53216, (414) 449-7474.

Comments on BASIC Standard Needed by July

The public comment period for the proposed American National Standard for BASIC is now in effect. Copies of the draft may be obtained by writing to:

X3 Secretariat
Computer and Business Equipment Manufacturers Association
311 First St. NW
Washington, DC 20001

Request document X3J2/82-17, called "Draft Proposed American National Standard for BASIC." The price is $20 (check or money order). Comments should be sent to the same address by mid-July.
May 1983


Computer Literacy for Lawyers, various sites throughout the U.S. This seminar will bring together sellers and individual computer systems. For details, contact The Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (617) 879-4502.

Data Processing Courses, the Hartford Graduate Center, Hartford, CT. Among the courses being offered are "ANS COBOL Programming Workshop 1" and "CICS/VS Command Level Coding Workshop." These data-processing courses are available for on-site presentation. For details, contact Don Florek, The Hartford Graduate Center, 275 Windsor St., Hartford, CT 06120, (203) 549-3600, ext. 252, 253, or 254.

Intel Microcomputer Workshops, various sites throughout the U.S. Among the workshops to be held are "Introduction to Microprocessors" and "IAPIX 86, 88, 186 Microprocessors." Intel Custom Training courses are available for on-site presentation. For details, contact Intel Corp., Mail Stop SY3-1, 3065 Bowers Ave., Santa Clara, CA 95051.

Intensive Seminars of Interest to Data Processing Professionals, Boston metropolitan area. Among the two-to-five-day seminars offered are "Project Management" and "Systems Design." Registration fees range from $495 to $975. For a seminar bulletin, contact Ms. Ginny Bazarian, Office of Continuing Education, Higgins House, Worcester Polytechnic Institute, Worcester, MA 01609, (617) 793-5517.

Management Development Programs, Providence, RI, Boston, MA, and Hartford, CT. The Center for Management Development offers seminars on a variety of topics, including communications, industrial relations, and electronic data processing. Many of the Center's programs can be conducted on location for your organization. For complete information, contact The Center for Management Development, Bryant College, Smithfield, RI 02917, (401) 231-1200, ext. 314.


Office Automation: Tee to Green, various sites throughout the U.S. This three-day seminar for administrative and information-systems professionals addresses the complex production issues and opportunities presented by automation of the office workplace. Seminar objectives include developing a productivity program, establishing long-range office systems plans, and developing integrated communications systems. The fee is $385 for members of the Data Processing Management Association Education Foundation (DPMA/EF) or $410 for non-members. For registration information, contact DPMA/EF Conferences, D. L. Hiler & Associates, 14536 Island Dr., Sterling Heights, MI 48078, (313) 247-8444.

Professional Development Seminars, various sites throughout the U.S. Data communications, database management, software and systems, and computer-aided design/manufacturing are some of the areas investigated in seminars offered by the Institute for Advanced Technology. For a detailed catalog, contact the Registrar, Institute for Advanced Technology, Control Data Corp., 6003 Executive Blvd., Rockville, MD 20852, (800) 638-6590; in Maryland, (301) 468-8576.

Seminars in Simulation, Management, Statistics, and Computer Science, various sites throughout the U.S. "Simulation Modeling for Decision Making," "Database Design," and "Satellite Communications Technology" are some of the topics to be presented. For information, contact the Institute for Professional Education, POB 756, Arlington, VA 22216, (703) 527-8700.

May-July
Productivity '83, various sites throughout the U.S. and Canada. This is Hewlett-Packard's hands-on showcase for more than 32 computer products and 17 seminars. It's designed to provide data-processing professionals and novices with answers to problems confronting the industry. For details, call (800) 453-9500.

May-July
Technical Courses from Zilog, Campbell, CA. A wide variety of such courses as "Z80 Assembly Language" and "ZEUS/System 8000 User Course" are offered. Fees range from $175 to $875. For a complete schedule, contact Zilog Inc., Training and Education Department, 1315 Dell Ave., Campbell, CA 95008, (408) 370-8092.

May-August
Courses in C Language and Unix, various sites throughout the U.S. Three 5-day courses are offered by Plum Hall Inc. The "C Programming Workshop," a hands-on course, covers all aspects of the C language for individuals to program in another language. The "Advanced Topics Seminar" covers efficiency, portability, readability, debug, and interfacing. The "Unix Workshop" is an introductory course that focuses on software development. For further details, contact Joan Hall, Plum Hall Inc., 1 Spruce Ave., Cardiff, NJ 08823, (609) 927-3770.

May-December
Courses from the AMA, various sites throughout the U.S. The American Management Associations (AMA) offers an on-going series of seminars in such areas as human resources, information systems, and manufacturing. Fees range from $75 to $875. For more information, contact the AMA Education Department, 1315 Dell Ave., Campbell, CA 95008, (408) 370-8092.

May-August
IEEE Conferences and Meetings, various sites around the world. The Institute for Electrical and Electronics Engineers (IEEE) sponsors conferences, meetings, and workshops covering high-technology issues. For details, contact the IEEE Computer Society, Suite 300, 1109 Spring St., Silver Spring, MD 20910, (301) 589-8142.

May-10
Selecting a Microcomputer for Scientific and Engineering Applications, Golden, CO. This short course reviews software and hardware technology for potential buyers of microcomputers in relation to scientific and engineering applications. The fee is $195. Contact the Space Office, Colorado School of Mines, Golden, CO 80401, (303) 273-3321.

May-11

May-12-13
The Fourth Annual Computer Law Institute, University of Southern California Law Center, Los Angeles. This year's institute will present a program on structuring agreements for the distribution of computer products domestically as well as inter-

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nationally. Other topics include proprietary rights, anti-trust issues, and major system procurements. An optional session on the basics of computer products and technology will be offered. Contact Ami Silverman, USC Law Center, University Park, Los Angeles, CA 90007, (213) 743-2582.

May 13-15
Applefest, Bayside Exposition Center, Boston, MA. This is the third annual Boston Applefest. More than 400 displays of Apple-compatible products will be featured. Complementing the exposition will be seminars, conferences, workshops, and panel discussions. Call or write Northeast Expositions, 826 Boylston St., Chestnut Hill, MA 02167, (800) 841-7000; in Massachusetts, (617) 739-2000.

May 14-15
Toronto PET User's Group Conference, George Brown College, Casa Loma campus, Toronto, Ontario, Canada. Speakers, workshops, a trader's corner for used equipment, and exhibits of hardware, software, and accessories highlight this event. Contact Chris Bennett, TPUG Corresponding Secretary, 381 Lawrence Ave. W, Toronto, Ontario M5B 1B9, Canada, (416) 782-9252.

May 15-20
Problem-Solving Leadership, San Francisco, CA. This workshop, designed to help managers and technical leaders enhance their problem-solving effectiveness, is sponsored by the Data Processing Management Association Education Foundation (DPMA/EF). Further information is available from Judy Cook, Weinberg & Weinberg, R R #2, Lincoln, NE 68505, (402) 781-2542.

May 16-18
Computer Graphics for Engineering/Drafting Practice, University of Texas, Austin. This course will stress developing the ability to prescribe and implement computer graphics equipment for specific engineering applications. A two-day hands-on workshop follows the course. Contact the College of Engineering, University of Texas, Austin, TX 78712, (512) 471-3396.

May 16-18
Mini-Conferences and Professional Growth Seminars, Loews Anatole, Dallas, TX. A special feature of this event will be the introduction of the data-entry certification program. Among the topics to be addressed are motivation, training, and interviewing. Contact Marilyn S. Bodek, Data Entry Management Association, POB 3231, Stamford, CT 06905, (203) 322-1166.

May 16-19
National Computer Conference, Anaheim and Disneyland Hotel Convention Centers, Anaheim, CA. This show features exhibits of computer products and services, technical sessions, seminars, and formal addresses. For complete information, contact the American Federation of Information Processing Societies Inc., 1815 North Lynn St., Arlington, VA 22209, (703) 558-3624.

May 16-19
Patent Your Software for Profit, Anaheim, CA. This seminar, which runs concurrently with the National Computer Conference, will explore software patent examples and offer advice on patenting and licensing software. Patent reference materials will be provided. Full details are available from Delbert L. Keenon, Automation Inc., 3410 Mona Lee, Houston, TX 77080, (713) 462-4151.

May 16-20
Auditing In the Contemporary Computer Environment, New York, NY. This course is designed for internal auditors and staff and data-processing professionals. Participants will learn a comprehensive audit approach for computer-based systems, including how to evaluate controls and how to design a program of testing using questionnaires, checklists, software tools, and flowcharts. Contact Marge Umlor, EDP Auditors Foundation, 373 South Schmale Rd., Carol Stream, IL 60187, (312) 682-1200.

May 16-20
Auditing Integrity Controls in the Contemporary Com-
MARGARET UMLOR, EDP Auditors Foundation, 373 South Schmale Rd., Carol Stream, IL 60187, (312) 682-1200.

May 18-20
Session '83, Skyline Hotel, Ottawa, Ontario, Canada. The theme of this annual conference of the Canadian Information Processing Society (CIPS) is "Converging Technologies." Des Cunningham, president of Gandalf Technologies, will be the keynote speaker. For further details, write Session '83, POB 2577, Station D, Ottawa, Ontario K1P 5W7, Canada, or call Ron Elliott, (613) 234-4333.

May 18-19
Third Annual Computer Conference, Iona College, New Rochelle, NY. This conference is devoted to the newest developments in the use of microcomputers, with an emphasis on education and business. Seminars, workshops, formal papers, and product exhibits will be featured. The fee is $35 per day. Contact Mr. McCallion, Iona College, New Rochelle, NY 10801, (914) 636-2100.

May 18-20
The Fifth National Conference of the Cognitive Science Society, University of Rochester, Rochester, NY. This conference will consist of lectures, panels, commentaries, and papers. Contact the Cognitive Science Conference, Dewey Hall, University of Rochester, Rochester, NY 14627, (716) 275-5402.

May 18-20
Man Machine Interface, Palo Alto, CA. For full details, contact the Continuing Education Institute, Oliver's Carriage House, 5410 Leaf Treader Way, Columbia, MD 21044, (301) 596-0111; on the West Coast, call (213) 824-9545.

May 18-20
Mipro-83: The Sixth Microprocessors/Microcomputers Course/Conference, Congress Center, Hotel Adriatic, Opatija, Yugoslavia. The theme for this conference is "Advanced Microcomputer Application Techniques and New Trends." It is geared toward hardware and software specialists and managers involved with the development, production, and management of microcomputer-based systems. For details, contact Mr. P. Dragojlovic, Mipro Secretariat, Trg P. Togliatti 4, 51000 Rijeka, Yugoslavia.

May 19-20
Computers in Construction, Denver, CO. This seminar is designed to assist construction contractors and construction management firms in acquiring computer systems. The registration fee is $395. For further information, contact CIP Information Services Inc., 1105-F Spring St., Silver Spring, MD 20910, (301) 589-7933.

May 19-22
Maryland Computer Show and Office Equipment Exposition, Convention Center, Baltimore, MD. Address inquiries to Dee Harris, Computer Exhibitions Inc., POB 3315, Annapolis, MD 21403, (800) 368-2066; in Maryland, (301) 263-8044.

May 20-22
Computers and Personal Values: Sharing from Experience, Sign of the Dove, Temple, NH. This workshop offers individuals in the computer community the opportunity to examine personal, ethical, or moral questions associated with their work and with the impact of computers on society. The format includes small and large discussion groups and invited speakers. The cost is $150.
For more information, contact Arthur Fink, Prince St., Box 614, Wilton, NH 03086, (603) 654-6518.

May 21
The Sixth Annual Spring Microcomputer Show & Tell Conference, University of Oklahoma, Norman. This conference is designed to let computer enthusiasts share ideas and information. Speakers will demonstrate their devices and field questions from the audience in six show and tell periods. Also featured is an on-the-spot programming contest. For additional information, contact Dr. Richard V. Andree, Mathematics Department, University of Oklahoma, Norman, OK 73019, (405) 325-3410.

May 22-23
The Eighteenth Annual Meeting and Exhibit Program of the AAMI, Loews Anatole, Dallas, TX. Topics on the docket include anesthesia instrumentation and technology, computer applications, personnel management, and technology transfers. Roundtable discussions, tutorials, and an exhibit program will be featured. For details, contact the Association for the Advancement of Medical Instrumentation, Suite 602, 1901 North Fort Meyer Dr., Arlington, VA 22209, (703) 525-4890.

May 22-26
Annual Industrial Engineering Conference and Exposition, Galt House Hotel and Commonwealth Conference Center, Louisville, KY. "Racing for Productivity" is the theme of this event sponsored by the Institute of Industrial Engineers (IIIE). More than 130 educational sessions will address a broad range of issues; computer hardware and software, material handling and systems, and process-control equipment will be shown. Preconference seminars will be held from May 19 to 22. Registration fees are $240 for IIIE members and $290 for nonmembers. Contact the Registrar, Conference Department, IIIE, 25 Technology Park/Atlanta, Norcross, GA 30092, (404) 449-0460.

May 23-25
The Technology of Personnel Conference, Grand Hyatt Hotel, New York, NY. Spon­sored by the Association of Human Resource Systems Professionals (HRSP), this conference will offer a range of presentations and workshops covering human resource technology and the social and psychological implications of this technology on workers and organizations. Contact HRSP Inc., Mills Square Tower, 100 South Ellsworth Ave., San Mateo, CA 94401, (415) 593-4461.

May 23-27
Auditing Integrity Controls in the Contemporary Computer Environment, New York, NY. For details, see May 16-20.

May 24-26
Microprocessor Background for Management Personnel, Palo Alto, CA. The fee for this course is $565, which includes text and program materials. Contact Continuing Education in Engineering, Department 532N, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151.

May 26-27
Interact, Hilton Hotel, Denver, CO. This convention is for members of the international users group of Management Science America's (MSA's) Human Resource System. More than 1200 payroll, personnel, and data-processing professionals are expected to attend. Contact MSA Inc., Suite 1300, 3445 Peachtree Rd. NE, Atlanta, GA 30326.

May 31-June 2
The Second Canadian Computer-Aided Design/Computer-Aided Manufacturing and Robotics Exposition and Conference, International Centre of Commerce, Toronto, Ontario, Canada. Leading international companies will demonstrate industrial robots, automatic assembly equipment, optical scanners, and numerically controlled machine tools. Technical papers will focus on such topics as robot-vision systems and design analysis. For information, contact Hugh F. Macgregor & Associates, 662 Queen St. W, Toronto, Ontario M5J 1B5, Canada, (416) 363-2201.

June 2-4
The First Annual Sunbelt Educational Computing Conference, Texas Tech University, Lubbock. The theme for this conference is "Practical Applications and Current Issues in Educational Computing." For details, write to Dr. Cleborne D. Maddux, College of Education, Texas Tech University, POB 4560, Lubbock, TX 79409.

June 2-4
Personal Computer Interfacing and Scientific Instrument Automation, Charlotte, NC. This workshop provides each participant with hands-on experience in wiring and testing interfaces. The fee is $395. Call or write Dr. Linda Leffel, C.E.C., Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, (703) 961-4848.

June 5-8
Consumer Electronics Show (CES), McCormick Place, Chicago, IL. This show is sponsored by the Electronic Industries Association (EIA). For information on this popular event, contact the CES Shows Office, Suite 1607, Two Illinois Center, 233 North Michigan Ave., Chicago, IL 60601, (312) 861-1040.

June 5-8
Mini-Conferences and Professional Growth Seminars, Registry Resort Hotel, Scottsdale, AZ. For details, see May 16-18.

June 5-9
The Twelfth Annual International Software AG Users' Conference, Fairmont and Royal Sonesta Hotels, New Orleans, LA. This conference will feature speakers, presen-
And then there were none.

The list of already extinct animals grows... the great auk, the Texas gray wolf, the Badlands bighorn, the sea mink, the passenger pigeon...

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recommendations for computer systems, network information services, communications and teleconferencing, office systems, and departmental integration. Contact Robert B. King, Quantum Science Corp., 1114 Avenue of the Americas, New York, NY 10036, (212) 997-0070. In Europe, contact Constantine E. Adaktas, Quantum Science Corp., 16 Charles St., London WY4 0QU, England; tel: (01) 839-5347.

June 7-11
The Third Rochester FORTH Applications Conference, Laboratory for Laser Energetics, University of Rochester, NY. This conference is sponsored by the Institute for Applied FORTH Research Inc. Speakers will cover robotics and FORTH in a special one-day session. For complete details, contact Diane Ranochia, Institute for Applied FORTH Research Inc., 70 Elmwood Ave., Rochester, NY 14611, (716) 235-0168.

June 8-10
The International Conference on Consumer Electronics—ICCE, Ramada the O’Hare Inn, Des Plaines, IL. Technical papers and panel discussions will address such issues as personal computing, low-cost printers, and computer-aided design/ manufacturing techniques. Products will be displayed. This conference is sponsored by the Consumer Electronics Society of the Institute of Electrical and Electronics Engineers. Contact ICCE, POB 149, Bloomingdale, IL 60108.

June 9-11
Microcomputers in Education, Watertown, CT. This hands-on workshop is designed for teachers and administrators at all levels. Topics include microcomputers in science and mathematics instruction, Logo, Pascal, machine language, and microcomputers and the education of students with special needs. Contact Ms. Sharon Woodruff, Technical Education Research Centers, 8 Eliot St., Cambridge, MA 02138, (617) 547-3890.

June 11-12
NJ-NY-CT Microcomputer Show and Flea Market, Meadowlands Hilton Hotel, New York, NJ. More than 75 commercial exhibitors and 200 flea-market booths will feature hardware, software, magazines, and accessories for all popular computing systems ranging from Apple to Zenith. Registration is $5 for adults and $2 for children under 12. Contact Kengore Corp., POB 13, Franklin Park, NJ 08823, (201) 297-2526.

June 13-15
Analysis and Design-Oriented Techniques, Los Angeles, CA. For details on this power-electronics course, contact Teslaco, Suite 6, 490 South Rosemead Blvd., Pasedena, CA 91107, (213) 795-1699.

June 13-15
Systematic Software Maintenance, Chicago, IL. Topics to be addressed include structured methodologies, solutions for effective testing, resource allocation, and status determination. Full details are available from Edutech Inc., Suite 907, 162 North State St., Chicago, IL 60601, (312) 641-1370.

June 14-16
Introduction to Microprocessors, University of Texas, Austin. This course will stress basic concepts with hands-on experience. Participants will write and run simple programs on a Z80-based MicroProfessor training system. Contact the College of Engi...
neering, University of Texas, Austin, TX 78712, (512) 471-3396.

**June 14-16**

Omnicon/83, High-Technology Electronics Exhibition and Convention, Cobo Hall, Detroit, MI. For details, contact Electronic Conventions Inc., 999 North Sepulveda Blvd., El Segundo, CA 90245, (800) 421-1816; in California, (213) 772-2965.

**June 14-16**

Technology Opportunity Conference, Washington, DC. This conference will focus on the convergence of optical-storage, videodisc, and computer technologies. For full details, contact Technology Opportunity Conference, POB 14817, San Francisco, CA 94114, (415) 626-1699.

**June 15-17**

Electronics, Earl Court Exhibition Centre, London, England. This exhibition on laboratory technology aims to show the latest in instrumentation, equipment, and services for life and physical sciences. For details, contact Good Relations Ltd., 15 Aeline Place, London WC1B 3AJ, England; tel: (01) 636-6561; Telex: 265903.

**June 15-17**

Basics of Power Electronics, Los Angeles, CA. For information on this course, contact TeslaCo, Suite 6, 490 South Rosemead Blvd., Pasadena, CA 91107, (213) 795-1699.

**June 15-17**

The Twenty-first Annual Meeting of the Association for Computational Linguistics, Massachusetts Institute of Technology, Cambridge, MA. Papers to be presented will address syntax, the representation of knowledge, machine and machine-aided translation, and other linguistically and computationally significant topics. Information is available from Don Walker, Artificial Intelligence Center, SRI International, Menlo Park, CA 94025, (415) 859-3071.

**June 16-17**

Clinical Laboratory Computers: Symposium 1983, Towsley Center for Continuing Medical Education, Ann Arbor, MI. Course credit will be offered. Contact the Office of Continuing Medical Education, Towsley Center Box 057, University of Michigan Medical School, Ann Arbor, MI 48109, (313) 763-1400.

**June 16-18**

Personal Computer Interfacing and Scientific Instrument Automation, Reston, VA. For details, see June 2-4.

**June 17-19**

PC '83/West, Brooks Hall/ Civic Center Complex, San Francisco, CA. This show will bring together users, developers, distributors, and retailers of products that are compatible with the IBM Personal Computer. Seminars, workshops, demonstrations, and a conference program will aim to educate users on product features and capabilities. Further conference information is available from Northeast Expositions, 826 Boylston St., Chestnut Hill, MA 02116.
MA 02167, (800) 841-7000; in Massachusetts, (617) 739-2000.

June 19-23
Conference on Computer Vision and Pattern Recognition—CVPR '83, Crystal City Hyatt, Arlington, VA. This program, formerly known as the Pattern Recognition and Image Processing Conference, provides a forum for the presentation of papers on vision, pattern recognition, and computer processing. For full details, write to CVPR '83, POB 639, Silver Spring, MD 20901.

June 19-24
Problem Solving Leadership, Washington, DC. For details, see May 15-20.

June 20-July 15
Computers in Education '83—CE '83, Rutgers State University, New Brunswick, NJ. The theme of this conference is "Necessary Direction for Computer Education: Navigational Aids for the 80s." The focus will be on the impact of microcomputers on elementary, secondary, and college-level education. Conference highlights include presentations, special-interest sessions, a software exchange, and a film festival.

Running concurrently with CE '83, the Summer Institute for educators offers 40 short courses, ranging in length from one to twelve days. Topics include "The Turtle is the Teacher: An Introduction to Logo," "Using Computers in the Elementary School," and "Algorithm Design." Courses are $95 per day. Conference registration is $145. For more information, contact Dr. Mitchell E. Batoff, Director CE '83, Institute for Professional Development, Suite D, 245 Nassau St., Princeton, NJ 08540, (609) 924-8333.

June 23
The Twenty-second Annual Technical Symposium of the Washington DC Chapter of the Association for Computing Machinery, National Bureau of Standards, Gaithersburg, MD. The theme for this event is "Microcomputer Systems: Tools or Toy?" Topics of interest include systems software, human factors, and office systems. For further details, contact Howard Weeks Associates, 15201 Shady Grove Rd., Rockville, MD 20850.

June 27-30
The World of CAD/CAM, Marriott Resort, Newport Beach, CA. 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) 791-8601.

June 27-July 1
Auditing Integrity Controls in the Contemporary Computer Environment, San Diego, CA. For details, see May 16-20.

June 28-30
National Educational Computer Conference, New York Statler Hotel, New York, NY. The theme of this conference is "Higher Instructional Techniques in Education." Seminars, exhibits, hands-on demonstrations, and workshops will highlight this event. Additional information is available from the National Educational Computer Library, POB 293, New Milford, CT 06776, (203) 354-7760.

June 29-July 1
Microcomputers, Electronic Toys, and Genius Machines in Early Childhood Education, Teachers College, Columbia University, New York, NY. This conference will examine the effect of the growing use of new technology on the entertainment and education of children. Events will include panel discussions, workshops, a computer fair, and a film festival. Participants can attend on a noncredit basis for $125 or for graduate credit at $240 per point. For further information, contact the Program in Early Childhood Education, Box 9, Teachers College, Columbia University, New York, NY 10027, (212) 678-3971.

June 29-July 1
Tertiary Education for the Age of Communications, Royal Melbourne Institute of Technology, Melbourne, Australia. Formal presentations will focus on the educational implications of new technologies as they reflect both on the needs of industry and the requirements of curriculum development. Areas of interest include telecommunication, engineering, and computer and information sciences. For details, contact the International Conference on Communications, Royal Melbourne Institute of Technology, G.P.O. Box 2476V, Melbourne, Victoria 3001, Australia; tel: 3452822; Telex: AA36406.

July 1983

July

July-October
Repair of Microcomputer-based Equipment, various sites throughout the U.S. and Canada. This seminar describes general servicing practices that are applied to the subsystems of any microprocessor family. This lecture/laboratory sequence is intended for field-service personnel, engineers, and technical writers. For details, contact the Registrar, Testek Consultants Inc., 1000 North Patton St., Arlington Heights, IL 60004, (312) 577-2134.

July 5-7

July 8-10
Computerfest '83: The Eighth Annual Midwest Affiliation of Computer Clubs Computerfest, Harbourside, Toronto, Ontario, Canada. Talks, exhibits, and sessions on computers and children will be held. Carl Helmers, editor of Robotics Age magazine, is the featured speaker. Further information is available from the Toronto Region Association of Computer Enthusiasts, POB 6922, Toronto, Ontario M5W 1X6, Canada.
The Role

Seminars, workshops, demonstrations, and manufacturer displays will highlight this event. Topics of interest include ear training, improvisation, computer basics for the teacher, choosing the right computer, and using computers in music for the handicapped. The fee is $25 a day; $40 for both days. Contact Michael Ferrelli, Triton College, 2000 Fifth Ave., River Grove, IL 60171.


July 11-13


July 11-15

Technology Opportunity Conference, Los Angeles, CA. For details, see June 14-16.

July 12-14

Audio-Visual America, Hyatt Regency Hotel, Chicago, IL. The second annual Audio-Visual America will feature hardware and software exhibits, screenings of shows, and approximately 60 workshops on planning, production, and management. For more information, contact A-V America, IF Associates, 3150 Spring St., Fairfax, VA 22031, (703) 273-8272.

July 14-16

Personal Computer Interfacing and Scientific Instrumentation, Charleston, SC. For details, see June 24.

July 15-20

Robot Manipulators, Computer Vision, and Automated Assembly, Artificial Intelligence Laboratory, Massachusetts Institute of Technology, Cambridge, MA. The emphasis of this short course will be on developing strategies for the solution of problems that will arise in advanced automation: sensing, spatial reasoning, and manipulation. The use of current industrial robots and binary vision systems will be covered. For details, contact the Director of the Summer Session, Room E19-356, Massachusetts Institute of Technology, Cambridge, MA 02139.

July 16-28

Microcomputer-based Instrumentation for Schools, Midleton, OH. This workshop is designed for secondary school and college science and mathematics teachers. Participants will learn how to construct and use simple, low-cost analog-to-digital (A/D) and digital-to-analog (D/A) converters for monitoring and controlling physical phenomena in the classroom and laboratory. Contact Bill Rouse, 301E McGuffey Hall, Miami University, Oxford, OH 45056, (513) 529-2141.

July 17-21

Token-based Local Networks, Washington, DC. This program is the second of four parts in the Architecture Technology Corporation's 1983 Forum Series. The series will bring together manufacturers and users of local network schemes to exchange information and in an informal setting. The format includes presentations, panel discussions, and a technological summary. The fee is $395 per person. For details, contact the Architecture Technology Corp., POB 24344, Minneapolis, MN 55424, (612) 935-2035.

July 20-23

Computer Graphics of the Association for Computing Machinery (SIGGRAPH ACM). This show features tutorials, films and video tapes, exhibits of computing equipment, and a formal technical program. For full details, contact the SIGGRAPH '83 Conference Office, 111 East Wacker Dr., Chicago, IL 60601, (312) 644-6610.

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In order to gain optimal coverage of your organization’s computer conferences, seminars, workshops, courses, etc., please contact the Editor of this product 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 for enough in advance.
Apple

Bolo, an arcade-type game. You must maneuver your tank through the maze to avoid or destroy enemy tank bases. This game features nine levels of play and five maze densities. For the Apple II; floppy disk, $34.95. Synergistic Software, Suite 201, 830 North Riverside Dr., Renton, WA 98055.

Graphical Analysis. With this graphics-utility program, you can plot graphs based on numerical data in high-resolution graphics. This program is designed to be especially useful for science classes. For the Apple II; floppy disk, $24.95. Vernier Software, 2920 Southwest 89th St., Portland, OR 97225.

Killer T-Cell, an educational-maze game based on biomedical discoveries in cancer research. You control the movements of a T-lymphocyte, a type of white blood cell that destroys cancer cells. All proceeds will fund cancer research at the University of Texas System Cancer Center. For the Apple II; floppy disk, $20. Killer T-Cell, M.D. Anderson Hospital and Tumor Institute, Texas Medical Center, Box 6, 6723 Bertner Ave., Houston, TX 77030.

LIMITS Programs for Calculus Students, an introductory calculus course that covers the fundamentals of the derivative and integral with graphics, drills, and explanations. For the Apple II Plus; floppy disk, $65. Dale T. Hoffman, Division of Science and Mathematics, College of the Virgin Islands, St. Thomas, U.S. Virgin Islands 00801.

Math I, a tutorial program that covers basic mathematical skills up to simple algebra for grades 1 through 8. For the Apple II Plus; floppy disk, $38. Personal Computer Art, 1007 Far Hills Dr., East Peoria, IL 61611.

Nutritionist. Using interactive graphics, this diet-analysis program helps you develop nutritionally balanced meals and diets for both personal and professional uses. For the Apple II; floppy disk, $145. N-Squared Computing, 3318 Forest Ridge Rd., Silverton, OR 97381.

Precision Timer. Using auxiliary equipment, this utility program turns the computer into a flexible laboratory timer. Save timing data on disk and analyze it later. For the Apple II; floppy disk, $39.95. Vernier Software (see address above).

Ray Tracer, a program on the laws of geometrical optics. See how light behaves when you place various interfaces and optical devices on the screen and produce ray diagrams. For the Apple II; floppy disk, $24.95. Vernier Software (see address above).

Secur-A-Text, a data-encryption/decryption program that prevents files from being loaded into your computer unless you know the master- and local-key numbers for access. For the Apple II; floppy disk, $49.95. T & F Software Co., 10902 Riverside Dr., North Hollywood, CA 91602.

Stan, a statistical-analysis system. You can enter data to analyze for variance or regression coefficients and produce a graph. For the Apple II; floppy disk, $300. Statistical Consultants, Park Plaza Office Bldg., 462 East High St., Lexington, KY 40508.

Taxmode, a tax-planning program. You can compute the components of individual federal income tax liability for the years from 1980 to 1984 according to current tax laws. For the Apple II Plus; floppy disk, $250. J.P. Sawhney & Co. Inc., 888 Seventh Ave., New York, NY 10106.

Trickster Coyote, an educational word-game that will help increase a child's vocabulary. With animations in high-resolution graphics and sound, this program is for four players age 8 and older and includes a built-in dictionary. For the Apple II; floppy disk, $48.96. Reader's Digest Services Inc., Microcomputer Software Div., Pleasantville, NY 10570.

Word Attack, a four-part educational word-game program helps build vocabulary skills by displaying up to 675 words in illustrative sentences for students age 8 through adult. For the Apple II Plus; floppy disk, $49.95. Davidson & Associates, 6069 Geovoo Place #12, Rancho Palos Verdes, CA 90274.

Atari

P.M.P. 2000, a property-management program. This program is a template for Visicalc to help you maintain status reports, invoicing, and income/expense schedules on rental properties. For the Atari 800; floppy disk, $219.95. T & F Software Co., 10902 Riverside Dr., North Hollywood, CA 91602.

Reactor, an arcade-type game. Your ship is trapped in a nuclear reactor. You must bounce dangerous nuclear particles into the control rods to prevent a meltdown of the reactor. For the Atari Video Game System; cartridge, $30. Parker Brothers, POB 1012, Beverly, MA 01915.

Slot Trivia, a question-and-answer game. If you can answer a trivia question in one of eleven categories, the slot machine will pay off. For two players. For the Atari 400/800; cartridge, $39.95. Innovative Design Software Inc., POB 1658, Las Cruces, NM 88004.

CP/M

Buyssel, several mathematical-analysis programs. This package is designed to help investors decide what to buy and sell in the stock, commodities, and options markets. For CP/M-based systems; floppy disk, $125 (Canadian funds). Software City, 35 Downsview Cres., Nepean, Ontario K2G 0A4, Canada.

Calendar/1, a calendar-generation program that lets you print out a personalized calendar displaying your events planned for each day. Formatting commands allow for customized calendar designs. For CP/M-based systems; floppy disk, $60. Clear Systems, Suite 404, 309 Santa Monica Blvd., Santa Monica, CA 90401.

E/T, a text-oriented screen editor. This program offers all essential editing features. It can be reconfigured for different terminals and automatically backs up your files. For
SOFTWARE RECEIVED

CP/M-based systems; 8-inch floppy disk, $95. Softwest Products, 11379 Kelowna Rd., San Diego, CA 92126.

M/PC, a custom disassembler. This program will disassemble an unmodified version of CP/M 2.2. It also provides a source code complete with labels and comments keyed to each address. For CP/M-based systems; 8-inch floppy disk, $35. C. C. Software, 2564 Walnut Blvd. #106, Walnut Creek, CA 94598.

Mailmate, a database-management program. Any of 15 fields of data entry in this program can be used for a sort or search. It also maintains mailing-label and customer lists, and can merge with some word-processing programs. For CP/M-based systems; floppy disk, $99. Computerworks Inc., 4010-A Carlisle NE, Albuquerque, NM 87107.

Micro Pascal, a Pascal subset compiler that is specifically designed for control and interface applications. It requires 24K bytes of memory and includes a runtime program. For CP/M-based systems; floppy disk, $175. Muson Engineering, 417 Montana Circle, Ojai, CA 93023.

Pathfinder, a project-planning and scheduling system. This set of four programs uses the critical path method to assist in the scheduling of up to 500 activities. For CP/M-based systems; 8-inch floppy disk, $500. Garland Publishing Inc., 136 Madison Ave., New York, NY 10016.

RXWRITER, a prescription-writing program for physicians that maintains a list of drugs, prints two copies of each prescription, and creates a patient/prescription file. For CP/M-based systems; 8-inch floppy disk, $50. Hall Design, 250 Maple St., Wilmette, IL 60091.

Rhesus is an erased-file recovery program that recovers accidentally erased files not yet overwritten by other disk operations. It features both automatic- or user-controlled functions and help screens. For CP/M-based systems; floppy disk, $65. Olsen Software, POB 91, Van Nuys, CA 91408.

COMMODORE

Cosmic Bandit, an arcade-type game in which your task is to prevent the alien hordes from freeing their compatriots locked in the space jail. For the Commodore PET/CBM; floppy disk, $6. Supersoft, Winchester House, Canning Rd., Welldon, Harrow, Middlesex HA3 7SJ, England.

Cosmic Lemmings, an arcade-type game. Your mission is to destroy the aliens as they drop toward you from their mother ship. For the Commodore PET/CBM; floppy disk, $8. Supersoft (see address above).

The Cracks of Doom, an adventure-type game loosely based on Lord of the Rings. Features include a help command that may tell you something useful. For the Commodore PET/CBM; floppy disk, $16. Supersoft (see address above).

Goblin Towers. Designed as a starter game, this adventure will teach you many of the skills necessary to try more difficult games. For the Commodore PET/CBM; floppy disk, $14. Supersoft (see address above).

Lemuria, an adventure-type game. Lemuria and Atlantis, two superpowers of the ancient world, have ended diplomatic relations. You are able to plan their destinies. For the Commodore 64; cassette, $8.95. RSVP Inc., 1332 Old Bridge Rd., Fort Myers, FL 33903.

Sidebar. This utility program lets you construct, edit, and save horizontal bar graphs with up to 17 variables. Graphs may then be reviewed, edited, and stored on tape. For the Commodore VIC-20; cassette, $9.60. MFJ Electro Enterprises, POB 13076, Kanata, Ontario K2K 1X3, Canada.

Super Gloopo, an arcade-type game. Four gloopers eaters chase you around the maze as you gather dots to increase your score. If you eat a large dot, you can eat all of the gloopers. For the Commodore PET/CBM; floppy disk, $8. Supersoft (see address above).

Tank Zone, an arcade-type game. It's kill or be killed in this simulation of desert warfare. You must avoid the tanks and missiles that are trying to destroy you. For the Commodore PET/CBM; floppy disk, $8. Supersoft (see address above).

Typing Package. This touch-typing instructional program can be used alone or in a classroom. It includes a warm-up, type drill, and typing test. For the Commodore VIC-20; cassette, $12.75. MFJ Electro Enterprises (see address above).

VIC-20 Games Pack, a set of five arcade-type games that includes Alien Blitz, Invaders, Ground Attack, Storm, and Space Rocks. For the Commodore VIC-20; cassette, $14.95. Melbourne House Software Inc., 333 East 46th St., New York, NY 10017.

Word Search, an educational word game. You have 10 minutes to find 20 different words in any of three puzzles: Animals, Jumbles, or States and Capitals. For the Commodore VIC-20; cassette, $19.95. T & F Software Co., 10902 Riverside Dr., North Hollywood, CA 91602.

IBM PERSONAL COMPUTER

Buytel, several mathematical-analysis programs (see description under CP/M). For the IBM Personal Computer; floppy disk, $125 (Canadian funds). Software City, 35 Downview Cres., Nepean, Ontario K2G OA4, Canada.

Cosmic Crusader, an arcade-type game in which your mission is to prevent a fleet of alien ships from reaching Earth. You must track them down, dodge their torpedoes, and destroy each ship. For the IBM Personal Computer; floppy disk, $38.95. Fantastic Inc., 5-12 Wilde Ave., Drexel Hill, PA 19026.

Curvfit-3D, a polynomial surface-fitting program. High-resolution graphics permit 2-dimensional or 3-dimensional isometric plotting for visual analysis of statistical data. For the IBM Personal Computer; floppy disk, $90. Petrospec, POB 3122, Richardson, TX 75080.

Easywriter II. Different from the IBM-distributed Easywriter 1.1, this word-processing program allows you to type in and edit text in a page- and mode-oriented environment. A utility pro-

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gram is provided to transfer files to and from single-sided PC-DOS disks. For the IBM Personal Computer; floppy disk, $350. Information Unlimited Software Inc., 2401 Marinship Way, Sausalito, CA 94965.

Edix, a text-editing program to be used in conjunction with the Wordfix formatting program. Edix offers four-on-screen editing windows and online tutorial lessons that teach you how to use editing commands such as flexible pattern search. For the IBM Personal Computer with PC-DOS; floppy disk, $195. Emerging Technology Consultants Inc., 2031 Broadway, Boulder, CO 80302.

The Final Word, version 1.1, a word-processing program. A recent addition to a series of programs inspired by Richard Stallman's EMACS, this program offers multiple text buffers, two editing windows, and versatile formatting capabilities. A swap file on disk preserves text in the event of a system crash. For the IBM Personal Computer with PC-DOS; floppy disk, $300. Mark of the Unicorn Inc., POB 423, Arlington, MA 02174.

General Ledger, this accounting package is part of a series of accounting packages that helps you establish and maintain a general ledger. For the IBM Personal Computer; floppy disk, $199. Micro Architect Inc., 96 Dothan St., Arlington, MA 02174.

Pnate. Suitable for programs source-code-file and general text editing, this text-editing program offers a full selection of primitive functions that can be combined into macros to perform high-level tasks. For the IBM Personal Computer with PC-DOS; floppy disk, $225.


Powerwrite, version 1.8, a word-processing program. Based on the editing structure of the UCSF p-System, Powertwrite provides extensive capabilities for putting text into different formats. Form letter, document, and memo are a few of the possible files. For the IBM Personal Computer; floppy disk, $399. Beaman Porter Inc., Pleasant Ridge Rd., Harrison, NY 10528.

Newkeys, a utility program that lets you reconfigure the functions of your IBM PC keyboard by transforming it into a standard IBM Selectric or the Dvorak layout. For the IBM Personal Computer; floppy disk, $199.50. Magi Software, 564 Chiniquapin Dr., Eglin, FL 32542.

Nutritionist, a diet-analysis program (see description under Apple). For the IBM Personal Computer; floppy disk, $149.50. N-Squared Computing, 5318 Forest Ridge Rd., Silverton, OR 97381.

Versatext, a word-processing and database system that includes the modules PCWriter, PCProcessor, PCBase, and PCGiant. For the IBM Personal Computer with PC-DOS; floppy disk, $199.50. Texasoft, 1028 North Madison Ave., Dallas, TX 75228.

Volkswriter, version 1.2, a word-processing program. This program provides a variety of fast editing functions for beginners using word processing. Function keys are used for editing commands; other commands are invoked from on-screen menus. For the IBM Personal Computer with PC-DOS; floppy disk, $195. Lifetree Software Inc., Suite 342, 177 Webster St., Monterey, CA 93940.

Word Attack, an educational word game (see description under Apple). For the IBM Personal Computer; floppy disk, $49.95. Davidson & Associates, 6069 Groove Oak Place #12, Rancho Palos Verdes, CA 90274.

Word Wand, a word-processing program. This page-oriented program supports the French-language character set. For the IBM Personal Computer with Monochrome Display Adapter and PC-DOS; floppy disk, $340 ($400 Canadian funds). Tanda Software Inc., POB 244, Orleans, Ontario KIC 157, Canada.

Wordstar, version 3.2, a word-processing program. This well-known program has been adapted from its CP/M-80 version with few changes. It features a multi-menu command structure and on-screen text formatting. For the IBM Personal Computer with PC-DOS; floppy disk, $495. Micropro International Corp., 33 San Pablo Ave., San Rafael, CA 94903.

Texas Instruments

Digger Duck, an interactive maze game that requires strategy and patience. For the TI-99/4A; cassette, $13.99. Vaughn Software, 5460 Harlan #84, Arvada, CO 80002.

Mariner, a maze-type puzzle game. As a seafaring adventurer, you must navigate through waters of changing depths using sight and sonar. For the TI-99/4A; cassette, $16.99. Vaughn Software (see address above).

Submarine Warrior, an arcade-type game. You pilot a submarine through enemy waters diving and surfacing to avoid mines, whales, and depth changes. You can fire your missiles at targets for a high score. For the TI-99/4A; cassette, $11.95. J.W. Software, 814 West Main St., Urbana, IL 61801.

Timex/Sinclair

Catacombs, an adventure-type game. You are lost in one of several levels of the catacombs. In your struggle to survive you must locate food and gold while avoiding phantoms and monsters. For the Timex/Sinclair 1000 and XZ81; cassette, $14.95. Melbourne House Software Inc., 333 East 46th St., New York, NY 10017.

Gamestape 1, a set of 11 game programs that includes Klingons, Crash Landing, Simon, UFO, Code, Asteroids, Bomber, Guillotine, Breakout, and others. For the Timex/Sinclair 1000 and XZ81; cassette, $14.95. Melbourne House Software Inc. (see address above).

Gamestape 2, a set of three programs. Included are Starfighter, a space battle game; Pyramid, a strategy game; and Artist, a graphics-design program. For the Timex/Sinclair 1000 and XZ81; cassette, $14.95. Melbourne House Software Inc. (see address above).

3D Monster Maze, an arcade-type game. See if you can find your way out of the maze with a Tyrannosaurus Rex chasing you. For the Timex/Sinclair 1000 and XZ81; cassette, $14.95. Melbourne House Software Inc. (see address above).

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Software Received

3D Orbiter, an arcade-type game. You command the last surviving craft of your army. To defend your civilization you must battle against marauding invaders as you climb, bank, and dive in outer space. For the Timex/Sinclair 1000 and ZX81; cassette, $14.95. Melbourne House Software Inc. (see address above).

Videocalc, an electronic-spreadsheet program that lets you input data and mathematical formulas and immediately see the answers. The program uses Sinclair BASIC functions. For the Timex/Sinclair 1000 and ZX81; cassette, $9.95. F & B Software, 1155 East Malibu Dr., Tempe, AZ 85282.

ZXAD, an assembler/debugger. Assembler uses the entire Z80 instruction set and standard mnemonics. Source statements are entered as BASIC remark statements. Debugger displays or alters memory. For the Timex/Sinclair 1000 and ZX81; cassette, $14.95. Scientific Software, 6 West 61 Terrace, Kansas City, MO 64113.

TRS-80

Arachnid Plus, a set of three arcade-type games. In Arachnid you fight against a spider-like creature. In Warzone you must trap your opponent in a maze of squares. In Baja you race your dune buggy across a treacherous desert course. For the TRS-80 Models I and III; floppy disk, $24.95. Computer Shack, 1691 Eason, Pontiac, MI 48054.

Assault, an arcade-type game. You must struggle to prevent various creatures from stealing your bags of gold. For the TRS-80 Models I and III; floppy disk, $24.95. Computer Shack (see address above).

Cyborg, an arcade-type game. Try to collect all 12 signal modules in your complex while avoiding or killing threatening robots. If you succeed, you can move on to more difficult complexes. For the TRS-80 Models I and III; floppy disk, $24.95. Computer Shack (see address above).

Deadline, an interactive game. You are a detective who must solve a murder within 12 game hours. The program gives you all the clues you need. For the TRS-80 Model III; 5½- and 8-inch floppy-disk formats, $49.95 and $59.95, respectively. For information, contact Infocom, 55 Wheeler St., Cambridge, MA 02138.

Financial Planning for Visi-calc, a set of 17 templates for use with the Visi-calc electronic-spreadsheet system. For the TRS-80 Model II; floppy disk, $59.95. Howard W. Sams & Co. Inc., 4300 West 62nd St., POB 7002, Indianapolis, IN 46206.

Hexman, a disk-management system. The Hexman program runs under LDOS and can monitor file activity for easier storage and retrieval. It also makes daily backups of modified files. For the TRS-80 Models I and III; floppy disk, $169. Hexagon Systems, POB 397, Station A, Vancouver, British Columbia V6C 2N2, Canada.

Jovian, an arcade-type game. The Jovians are archenemies of Earth and must be stopped. If you can hit their space stations with your rapid-fire plasma bullets you will destroy them. For the TRS-80 Models I and III; floppy disk, $24.95. Computer Shack (see address above).

Liberator, an arcade-type game. Your robot has gone berserk and hidden your four assistants in a hazardous industrial park. Rescue your assistants while avoiding the robot. For the TRS-80 Models I and III; floppy disk, $24.95. Computer Shack (see address above).

Listmaker, a database-management program that can handle lists for business, home, or school; personalize and print form letters; and sort and search on one or multiple fields. For the TRS-80 Models I and III; floppy disk, $97.80. Reader's Digest Services Inc., Microcomputer Software Division, Pleasantville, NY 10570.

Starcross, an adventure-type game. Your ship has found a gigantic alien starship. In order to discover its treasures, you must dock and explore its mysterious interior. For the TRS-80 Model III; 5½- and 8-inch floppy-disk formats, $39.95 and $49.95, respectively. For information, contact Infocom, 55 Wheeler St., Cambridge, MA 02138.

Portfolio Manager, a stock-management program. Enter current stock prices and you receive a one-page report showing 19 classes of information about your stock. For the Heath/Zenith H-12-89; floppy disk, $25. RCK Associates, 640 Trehanny Lane, Wayne, PA 19087.

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 form 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.


The Power of Multiplan, Robert E. Williams. Portland, OR: Management Information Source (3543 Northeast Broadway), 1982; 168 pages,
51 by 64.6 cm, softcover, ISBN 0-13-687343-X, $14.95.


This is a list of books received at BYTE Publications during the 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.
Traveling Computers

Dear Steve,

We are considering buying a personal computer and have been looking for information in BYTE. We currently live in the Philippines, which makes comparison shopping difficult: information is limited and somewhat dated. We will be home on leave in the fall and hope to bring a computer back with us. We would appreciate any information, advice, or suggestions you might give us on computers, peripherals, and so on. We would like a computer for the following:

- Word processing, especially letter-quality printing. Is there a dot-matrix impact printer that would be satisfactory, or are formed characters necessary?
- We play complex strategy/tactics games, such as recreating World War II battles. Which computer has the best, most complex games of this type? Do you know any company besides Avalon Hill that makes this type of game?
- Educational programs for a ninth grader.
- Color graphics and color video monitor are a must. Is a color monitor suitable for word processing/designing needlepoint?
- We'd like to catalog a stamp collection, keep track of constantly changing titles in a small library, and have a typing tutor.
- What about future expansion?

Three of us have to bring it back on a plane. Reliability is most important; service here is nonexistent or of dubious quality. We will probably not be back in the States for at least two years.

In the Philippines, there are power fluctuations and outages. We have air conditioning, but with the power out, it's hot and humid. There are lots of insects and dust. If these conditions don't prohibit a computer, how do we protect it?

Finally, can an 8-bit computer have more than 64K bytes of user memory? Thank you for your help.

Ronald A. Alasin

Philippines

Choosing a computer for your applications is not half as difficult as determining the reliability of such a unit in the environment you describe. Let's address that aspect first.

Any computer that you purchase in the States will be designed to run off of 120 V (volts) at 60 Hz (hertz) AC. If your power in the Philippines is different than this, you will need a power converter and possibly a means to change the line frequency. One way around this would be to obtain a power inverter that would convert 12 V DC to 120 V AC at 60 Hz. This unit could then be powered by either battery or a 12-V DC supply designed for the local power requirements.

If power outages and fluctuations are frequent, you must assess the impact on your computing tasks. If you are greatly inconvenienced by fluctuations and outages (which cause the computer to crash), then an uninterruptible power supply may be required. This is a unit that instantly (for all practical purposes) switches from line to battery power in the event of an outage.

Insects and dust will be detrimental to your disks unless you take proper precautions. The heat may or may not be a problem, depending on the length of time that the computer is in use and whether or not it has a built-in fan.

As far as reliability is concerned, one must examine the record of the computers now on the market. Certainly, those that have been in production for awhile have had time to establish a reputation.

Because high-resolution graphics and color are requirements, and a large variety of software is suggested, I would lean toward either the Apple II or Apple IIe computer. You may need several accessory boards to drive a printer and an 80-column screen, but for your price range, it is a good choice. The Apple II has been around long enough to establish its reliability. One disk drive should suffice for most applications, but an extra drive adds convenience. Double-sided, double-density disks are not worth the extra price, in my opinion. Many disk manufacturers frown on using both sides of a disk because it adds extra abrasion to the data on the first side. In your dusty environment, it is not worth the chance.

For letter-quality printing, a high-quality dot-matrix printer should suffice, but this is a personal choice. Some pretty good letter-quality daisy-wheel printers costing less than $1000 are on the market. They are not terribly fast, but their reliability seems to be acceptable.

An 8-bit computer can have more than 64K bytes of memory, but it addresses only 64K bytes at any one time. A technique known as bank selecting is used to enable one of several 64K-byte blocks of memory.

Finally, Strategic Simulations (Suite 108, 465 Fairchild Dr., Mountain View, CA 94043) has a variety of complex strategy/tactic games for the Apple II. I hope that this gives you some guidelines on your purchases. Buy before you leave and run all units for as long as possible then so that any premature failures can be corrected. ... Steve

Inside Level II ROMs

Dear Steve,

I have a TRS-80 Model I Level II. I presently write 99% of my programs in machine language. As you know, there are a lot of programs in the Model I's ROM (read-only memory) that handle, for example, the keyboard. I called Radio Shack to get a source-code listing of those programs, but they are not available. Can you tell me where I can get those listings?

Francois Paquin

Sarnia, Ontario, Canada

Mumford Micro Systems has a book that explains the inner workings of the Radio Shack TRS-80 Models I and III Level II ROMs. It contains information on set-ups, calling sequences, and variable passage for number conversion, arithmetic operations, etc. In addition, it is a very useful reference manual with information on RAM usage, relocation of BASIC programs, USR call expansion, and creating system tapes of your programs. The book, Inside Level II—The Programmer's Guide to the TRS-80 ROMs, costs $15.95 (plus $2 postage) and can be ordered from Mumford Micro Systems, POB 400-D, Summe-
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land, CA 93067, (805) 969-4557... Steve

Colorful Computer Questions

Dear Steve,
I'm wondering if you, or some of your readers, could answer a couple of questions regarding the Radio Shack Color Computer.

1. Is there any way to get more than 32 characters per line? I bet someone is working on it, but I haven't seen any solutions except that achieved by Cognitex in its Teletext word-processing program.

2. Have you any information on a BASIC compiler for the Motorola 6809 in the Color Computer (or does the type of processor make very much difference anyway)? It sure would be handy.

Thanks,
Duft Kennedy
Santa Barbara, CA

The video-display format for the Radio Shack Color Computer is controlled by the Motorola 6847 Video Display Generator chip, and the number of characters per line that are displayed on the screen is a function of the font mode that the chip is in. For example, if a 5 by 7 font is used with one blank dot between characters, then 256/64 = 42 characters per line. See "What's Inside Radio Shack's Color Computer," by Ahrens, Browne, and Scales (March 1981 BYTE, page 90).

I'm sorry but I don't have any information on a BASIC compiler for the 6809... Steve

More Colorful Questions

Dear Steve,
In the May 1982 BYTE, you answered a question about video-display problems on the TRS-80 Color Computer (see "TV Jitter Bugs," page 398). You did not comment on one proposed solution to the problem of interference: is it possible to remove the RF (radio-frequency) modulator and go directly to a video monitor? What about the sound? Because most monitors have a sound input, is it possible to tie that output directly to a monitor?

Thanks for the help.
Mark Oesoki
Mount Clemens, MI

If the interference problem referred to in that Ask BYTE letter was caused by the vertical synchronization signal being slightly off frequency, removing the RF modulator will not solve the problem. The modulator only takes the composite-video signal (video, horizontal synchronization, and vertical synchronization) and superimposes a carrier signal upon it so that the video may be received on a television set.

The RF modulator can be removed from the Color Computer. The composite-video signal is then available at pin 1 of the modulator unit and the sound is at pin 3. These outputs can then be fed into the sound and video inputs of a monitor. Of course, the standard caution of voiding the warranty by tampering with the computer applies... Steve

ZX81 Power Backup

Dear Steve,
One rainy day, when just finishing a perfect program on
my ZX81, the power went out and I lost my program. I want to prevent this from happening again. Do you know of any way to add battery backup to the ZX81 without spending a lot of time and money?

The ZX81 requires 9.75 V (volts) at 650 milliamperes (mA); however, my multi-tester indicates that the AC line adapter puts out 15 V without the computer connected. Also, what is the amperage available from a common 9-V battery?

Z. Smith
West Grove, PA

One way to prevent power loss to your Sinclair ZX81 is to use a 12-V DC supply with an automotive storage battery in parallel across it. The ZX81 has a 5-V regulator inside to drop the input voltage to the necessary 5 V, and with a 12-V input, only a little extra heat will be generated. If this is undesirable, a series-dropping resistor between the power supply and the ZX81 will restore original conditions. In the event of a power failure, the computer will continue to run from the storage battery. When power is restored, the DC supply will take over and also recharge the battery.

A common 9-V battery has a current output of 20 to 40 mA; many would need to be paralleled to drive the computer. The AC line adapter output measures 15-V because there is no load in the circuit. If you put a load (such as the computer) across the supply, the voltage will drop to the specified range.

Dear Steve,

Have briefcase computers been tested in variable temperature situations? Going from a 75° F house to the car in the winter at -25° F might cause some type of electronic damage or damage to the floppy disks that are stored in the units (as in the Osborne). I live in Wisconsin. Considering the wide temperature range, should I buy a portable computer?

Paschal A. Frigo
Green Bay, WI

You raise an interesting question. Shugart, for example, specifies an ambient operating temperature range for its Model SA 400 floppy-disk drive of 40° to 115° F. As the temperature drops, the potential for mechanical sluggishness increases and this may result in erratic data transfers.

Floppy disks have a storage requirement of 50° to 125° F. One can only guess as to the flexibility of a disk at extremely low temperatures. If there is valuable data on the disk, I would not leave it exposed to low temperatures.

The electrical functioning should be less sensitive, but a general rule would be to allow the unit to warm to approximately room temperature before powering up. The thermal change in going from a warm building to a cold car should cause no problem, assuming that the car has a heater which will be in use. The short time at the temperature extremes will not markedly affect the unit's internal temperature.

Follow-up and Music to His Ears

Dear Steve,

This letter is a follow-up to my letter about adding lower-case display characters to a Lear Siegler ADM 3A terminal. (See "ADM 3 Lower-case Conversion," October 1982 BYTE, page 453.) You kindly referred me to an article published in the March

Software

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DATASMITH
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Circle 156 on inquiry card.

May 1983 © BYTE Publications Inc
I get the 2513 ROM (read-only memory) from Active Electronics. I tried to do this, but they were back ordered.

I then noticed a ROM sold by Advanced Computer Products in Santa Ana, California, called the 2513-ADM. When I called the company, the only information I could get was that it was made by General Instrument. Upon calling that company, I received a firm denial that General Instrument ever made a ROM with inverted outputs as needed by the ADM 3A. I decided to take a chance and ordered the chip for $14.95, along with the specification sheet.

The specification sheet sent with the chip was for a 2513-RO-3, not for the 2513-102 as labeled on the chip. Thoroughly confused, I boldly put the chip in the socket in the ADM 3A and... and behold—lowercase characters appeared without any soldering or tinkering!

I have gone into such detail on this issue because I thought your readers might be interested in knowing about this orphan chip that no one claims (although it is marked as being made by General Instrument) and that no one knows anything about.

I'd like to ask you another completely unrelated question. I would imagine that many people engrossed in computers are like me in that they started out with electronics as a result of an interest in high-fidelity and music. A few years back, all my spare cash went for buying high-fidelity equipment; now all of it goes for buying computer equipment. I would love to have my high-fi controlled by my computer (e.g., changing music sources from tape to tuner, adjusting the volume, switching speakers). The first and last are relatively easy, but I have not seen any-

thing on the control of an analog circuit by a computer—especially one sensitive to noise. Could you suggest a circuit, or point me in the direction of one? I am a neophyte when it comes to electronics.

Thank you for your time and help. It's greatly appreciated.

Rich Bucholz
Hamden, CT

Thanks for the follow-up.

Controlling audio devices by means of a microcomputer is a relatively easy process, requiring the use of D/A (digital-to-analog) converters. A unit made by Analog Devices, the AD 7110 is a CMOS (complementary metal-oxide semiconductor) digitally controlled audio attenuator with an attenuation range of 88.5 dB (decibels), plus full muting capability. Its 6-bit digital input covers the attenuation range in 1.5 dB increments. Such a unit could control the audio amplitude in your stereo system.

The ADG201 is a CMOS-protected quad SPST (single-pole, single-throw) analog switch that can be toggled by a TTL- (transistor-transistor logic-) or CMOS-level logic input. It features a make-before-break switching action and has overvoltage protection to 25 volts above the supply voltage. In its "ON" state, it looks like a 100-ohm resistor. This can switch low-level signals in your system.

The data sheets for both these devices give an indication of their use. Handle them with extreme care because they are static sensitive. I have no circuits immediately available as the application of these devices to audio control is usually unique to each user. Write Analog Devices for further information and data sheets. The address is Analog Devices, Route One Industrial Park, POB 280, Norwood, MA 02062, (617) 329-4700.

Home Security 6502 Style

Dear Steve,

I am trying to implement that neat home-security system you outlined. (See "Build a Computer-Controlled Security System for Your Home," Part 1, January 1979 BYTE, page 56; Part 2, February 1979 BYTE, page 162; Part 3, March 1979 BYTE, page 150). Not being familiar with the 8080 series of processors, I am using a SYM-1 single-board computer, which is based on the 6502 microprocessor.

Because the flowcharts in the article are so clear and easy to program from, it occurred to me that there must be some literature describing in more detail the development of such "event processor" programs. If you could steer me toward some books or articles about this type of programming, I would be most grateful.

Eric A. Lowhar
Venice, CA

An excellent book on programming the 6502 microprocessor, with emphasis on interfacing and controlling applications, is Programming & Interfacing the 6502. With Experiments, by Marvin L. DeJong (Howard W. Sams & Co., Inc., 4300 West 62nd St., POB 7092, Indianapolis, IN 46206). It costs $16.95. This book specifically addresses the SYM-1, AIM-65, and KIM-1 single-board computers. It should be in your reference library.

An article in the October 1977 issue of Kilobaud (page 84), "Dedicated Controllers" by Michael J. Myers, describes a specific application of a KIM-1 computer as a process controller. The software is described and should be of some help to you... Steve

Upgrading Homebrew to CP/M

Dear Steve,

I have an 8080A-based microcomputer that I designed and built. I am redesigning it with a Z80 and several refinements. It occurred to me that machine language was perhaps going to be a bit of a drag once I was past the development stage (are we ever!). What sort of hardware/bootstrap configuration would I need so that I could eventually add floppy-disk drives and run CP/M? I know that the boot-loader program must be limited to 256 bytes, and I'm familiar with the term BIOS, but that is about it.

I'm in Korea, and there is an acute lack of serious material on microcomputers. Can you give me any clues as to where to look? I would like to find out about necessary design changes before I wire-wrap the whole thing. Any help would be appreciated.

Sergeant Dale L. Botkin
South Korea

I would suggest that you configure your computer around the S-100 bus so as to take advantage of this simple means of adding a disk controller and CP/M to your system. Many of the S-100 disk-controller boards on the market are designed for CP/M and include a bootstrap PROM (programmable read-only memory) as part of the package or as an option.

Some of the disk-controller cards with this feature are the CCS Model 2422 (California Computer Systems), the Versa Floppy (SD Systems), the Double-D (Jade), and the Disk 1 (Computro).

These units can be obtained from Jade Computer Products, 4901 West Rosecrans Ave., Hawthorne, CA 90250,
and Priority 1 Electronics, 9161 Deerin Ave., Chatsworth, CA 91311. Write for their catalogs. They also carry an extensive selection of books on microcomputers. . . . Steve

Rounding Off Square Roots = Gray Hairs

Dear Steve,

A friend called me and asked me to do a short program on my Apple II Plus. He wanted a program that printed out the Pythagorean triplets between 1 and 20. After some work, I found that my Apple has some trouble calculating square roots.

The program shown in listing 1 should work, but it doesn’t. The problem is in line 40. I found that the Apple has trouble with IF, THEN, and SQRT functions when they are used together.

I went through a test program and I found something very unusual. First, I typed in LET X = SQR(100). We all know that X should equal 10, but just in case, I entered PRINT X. The computer responded with 10, but then came the problem. I entered print X = 10. If that statement is true, the computer should respond with 1, but it doesn’t, it prints 0 (i.e., the statement is false). Now computers are likely to make some errors, but even my little brother knows that one!

I was wondering if you could tell me what was the cause of this. This error has kept me from doing quite a few programs for algebra and other classes of mine. Is it a flaw in the Apple, or is it just that my particular computer is messed up?

Joel Kozikowski
Indianapolis, IN

The problem that you have with the SQRT function is not an error in Applesoft BASIC. In fact, it is not an error at all. You are correct in assuming that the problem is in line 40 of your program, but for the wrong reason. After taking the square root, you test for those values that are integers. The problem is that none of the square roots are integers due to the way that square roots are calculated.

Remember the pocket calculators that would give you 1.999999999 for the square root of 4? This is exactly what is happening in the Apple II. The algorithm that calculates square roots rounds off to a fixed number of significant digits. Because line 40 branches to line 60 if not an integer, your program just runs the nested loops and then ends.

Change line 40 to what’s shown in listing 2, and your program will run correctly. This line tests to see how close C is to an integer value. If the difference between C and the integer C is very, very small, then it is an integer and will be printed. Otherwise, your computer will look for the next set of values.

Also, when you apply the test PRINT X = 10, the answer is false because X does not equal 10. It may equal 9.999999999 or 10.0000001 etc. and not 10.000000000. This is a subtle mistake that creates lots of gray hairs for programmers. . . . Steve

FCC Requires Testing Lab’s Approval

Dear Steve,

I am an avid reader of yours. Your projects really seem to hit home with my interests. I enjoyed listening to you speak at the Trenton Computer Festival last year and your comments concerning answering letters has prompted me to write.

I have experimented with adding devices to the telephone line. My interface, for the most part, consists of a 1-megohm resistor in series with the phone line and a 100k-ohm and 0.1 microfarad (µF) capacitor tied in parallel.

How can I get FCC approval for a device that connects to the phone? I would really like to sell these designs to a company that would be interested in building and marketing my prototypes.

Mark Kantrowitz
Rockaway, NJ

FCC approval requires the passage of tests that are best conducted by an independent testing laboratory. These laboratories are also familiar with the paperwork that must accompany such testing. One testing lab that I have used and can recommend is Art Schulze, 8807 Mobud Dr., Houston, TX 77036. . . . 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
do 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.

May 1983 © BYTE Publications Inc 519
IBM recently unveiled its top-of-the-line microcomputer: the IBM Personal Computer XT. The XT, an extended version of the popular IBM PC, comes with a 10-megabyte hard-disk drive, 128K bytes of RAM (random-access read/write memory) that’s expandable to 640K bytes, one 360K-byte floppy-disk drive, an asynchronous communications adapter, and eight expansion slots. It lists for $4995. Externally, it looks the same as its predecessor, and it still uses the 8088 microprocessor, but the XT is not the radical new computer that rumors had predicted. Nonetheless, it’s a fine, conservative machine.

At the same time that the IBM Personal Computer XT was announced, company spokesmen also took the wraps off several optional accessories and enhancements for the Personal Computer line. IBM now offers expansion units for both the PC and the XT (with a hard disk and eight input/output slots), a high-resolution color display, and an enhanced version of Microsoft’s disk operating system, DOS 2.0.

The basic XT provides a roomy storage area with its 10-megabyte hard-disk drive, allowing you to work with large data files and eliminating the need to swap around disks and programs. The availability of the IBM hard disk sets the stage for software developers who want to create new applications that require the greater storage capacity and faster access time of a hard disk.

The 360K-byte floppy-disk drive provides an easy way to transfer programs and data to or from the hard-disk system. Why IBM chose this new floppy-disk format with 180K bytes (single-sided) or 360K bytes (double-sided) per disk is somewhat perplexing because it doesn’t offer much more space than the 160K- to 320K-byte-per-disk format on the PC. IBM DOS 2.0 supports this new disk format with nine sectors instead of eight. It is upward-compatible with PC-DOS 1.0 and 1.1 and can read and write all previous disk formats.

Backing up the hard disk to floppy disks is supported by a couple of new commands. A menu of several options lets you choose between copying the entire disk, selected files (via a wildcard format), all files created after a certain date, or only the files changed since the last backup.

Eight system expansion slots are an improvement over the IBM PC’s five slots, but three slots are already taken up by adapters for the hard disk, the floppy disk, and asynchronous communications. If you get the expansion unit, a fourth slot will be used for an attachment card to link the two units together.

Only six of the eight slots in the IBM PC XT are for full-sized accessory cards. Because of space limitations, two slots are behind the disk drives. These slots accept smaller cards, such as the asynchronous communications, game controller, and printer adapters, or the attachment cards. The IBM PC XT includes an asynchronous communications adapter that can be used to connect a serial printer or to communicate with IBM PCs, larger IBM mainframe systems, or other information sources via a modem.

The optional expansion unit with a 10-megabyte hard disk and eight more I/O slots comes in two configurations: one for the IBM PC and the other for the IBM PC XT. The expansion unit for the regular IBM PC differs only in that it contains a hard-disk adapter and is therefore more expensive. A single hard-disk adapter can handle two hard-disk drives, but each drive has to be in the same unit because of cabling requirements. One of the full-sized slots will be used by the hard-disk adapter when it is moved from the IBM PC XT system unit to the expansion unit to handle the two hard disks. The expansion unit has an automatic, power-on self-test of the components, like the system unit does, and is not available without the hard disk.

For the first time, IBM is offering a color display monitor for its personal computers. This 16-color 12¼-inch display is aggressively priced at $680 and provides resolution of up to 640 by 200 dots. Text can be shown in 25 lines of either 40 or 80 characters. A separate color/graphics monitor adapter controls the monitor.

A version of MS-DOS 2.0 for IBM’s personal computers was also released. The IBM DOS 2.0 disk includes BASIC 2.0, which supports some of the new functions available under DOS 2.0, such as the hierarchical file directories and new graphics, music, and function-key enhancements.

Immediate price reductions on the IBM Personal Computer averaging 15 percent were also disclosed. The only items actually lowered in price are the system unit, disk drives, memory card, color/graphics monitor adapter, and asynchronous communications adapter. The IBM PC with 16K bytes of memory has been discontinued, and now 64K bytes of memory is the minimum configuration.

To make communications with corporate IBM mainframe computers easier, synchronous data-link control (SDLC) and binary synchronous communications (BSC) adapters are available. These adapters allow the IBM Personal Computers to emulate common IBM terminals.

For those companies that already have IBM 3270-type terminals and would like to add personal-computer capabilities, IBM has come out with the 3270 Personal Computer attachment. This allows you to use the 3270 keyboard and display as a terminal to a central computer, then switch to using the 3270 as a terminal to an IBM Personal Computer compatible with other IBM microcomputers.

By typing the alternate key with another key, you can jump back and forth between the two modes. You can even get data from the host computer and analyze it locally in the personal-computer mode.

The 3270 Personal Computer attachment consists of the 3278 Personal Computer adapter (an IBM PC system unit with disk drives), which is installed by an IBM service representative, and the Personal Computer 3278 attachment option, a card that you can plug into one of the unit’s slots. If you have both a 3278 terminal and an IBM Personal Computer, you only need to purchase the attachment option to hook the two together.

IBM is making swift strides to integrate all of its lines of computers and bring the IBM Personal Computers into the corporate fold.—Bruce Roberts
Clubs and Newsletters

News from Budapest, Hungary

Members of a Hungarian home computer club meet to develop low-cost systems, lecture on computer techniques, and assist beginners with construction projects. Club members exhibit homebrew computers, programs, and peripherals at microcomputer symposiums held each year in Budapest, Hungary. For details, write to Dr. Endre Simonyi, 19 Trencsenyi, Budapest H-1125, Hungary.

Design and Manufacturing

CAD/CAM Alert is a monthly newsletter containing news, checklists, reviews, and recommendations in the computer-aided design and manufacturing field. A one-year subscription is $95. Sample issues are available on request. For further information, write to CAD/CAM Alert, POB 404, Newton, MA 02161.

Electronic Opportunity

Each monthly issue of the Micro Moonlighter Newsletter contains features on how to profit from home-based businesses using personal computers. An annual subscription is $25 in the U.S. and $29 in Canada. For details, write to the Micro Moonlighter Newsletter, 2115 Bernard Ave., Nashville, TN 37212.

Memorable Optics

Optical Memory Newsletter including Interactive Videodisks is a bimonthly publication that features book and software reviews, articles, and a conference calendar. A one-year subscription (six issues) is $295. Discounts are available with multiple subscriptions. For details, write to Optical Memory Newsletter, POB 14817, San Francisco, CA 94114, or call (415) 621-6620.

Telecommunications in Engineering

The monthly newsletter produced by M/A-COM contains news and updates of recent developments in telecommunications engineering. For more information, write to M/A-COM, 11717 Exploration Lane, Germantown, MD 20874.
Pruning the Family Tree

Genealogical Computing, a bimonthly periodical produced by Data Transfer Associates Inc., specializes in hardware and software applications to lineage research. It also contains news, reviews, programs, and services. Subscriptions are $14 a year in the U.S.; Canadian and foreign subscribers pay $19. For further information, write to Data Transfer Associates Inc., 5102 Pommeroy Dr., Fairfax, VA 22032.

Notes from North Star

North Star Notes is a newsletter designed to keep users of North Star Computers informed about the latest developments in hardware, software, and corporate activities. North Star Notes is free to anyone who wants to be on the mailing list. Send your requests to North Star Computers Inc., 14440 Cattail St., San Leandro, CA 94577, or call (415) 357-8500.

Spread the Word

The Spreadcalc News contains listings, applications, reviews, and news releases about getting the most from your VisiCalc investments. The annual subscription rate is $25 (six issues). For details, write to Spreadsoft, POB 192, Clinton, MD 20735, or call (301) 856-1128.

In Terre Haute

The Wabash Valley Computer Society meets every fourth Wednesday of the month at 7 p.m. at the Vigo County Public Library in Terre Haute, Indiana. Family dues are $10 a year and include a subscription to the Journal of the Wabash Valley Computer Society. Contact the Wabash Valley Computer Society, 203 Briarwood Dr., Terre Haute, IN 47803, or call (812) 877-3269.

TRS-80 Color Computer Club

A TRS-80 Color Computer Club in Durham, North Carolina, is welcoming new members. The club produces a monthly newsletter that contains features on the Color Computer. Membership is $10 and the newsletter is 85 cents. For more details, write to Donald DeHart, 3632 Check Rd., Durham, NC 27704.

LNW Information from Nebraska

The LNW User, a bimonthly newsletter for LNW-80 enthusiasts, is produced by the LNW User Group and contains programming news, hardware and software reviews, and a question-and-answer section. Subscriptions are $12 a year and back issues are available. For further information, write to The LNW User, 4345 Manchester Rd., Grand Island, NE 68801.

Central Ohio Amateurs Meet

The Amateur Computer Society of Central Ohio (ACSCO) meets on the first Wednesday of each month at 7:30 p.m. at the Barnett Rec. Center in Columbus, Ohio. Membership dues are $10 a year and include a subscription to the newsletter, the L/O. To swap newsletters, send yours to TRS-80—ACSCO, c/o Cramer, POB 28355, Columbus, OH 43228. For additional information about the club's activities, write to Joel Sampson, 3009 Calmvet, Columbus, OH 43202, or call (614) 262-2955.

Winnipeg PET Users Group

The Winnipeg PET Users Group (WPUG) meets on the first Wednesday of every month to exchange news about Commodore computers. Meetings include hardware and software demonstrations, speakers, and question-and-answer sessions. The $15 membership fee entitles you to receive the WPUG newsletter and provides access to more than 3000 programs in the WPUG disk library. For more information, write to Larry Neufeld, WPUG, 9-300 Enniskillen Ave., Winnipeg, Manitoba R2V 0H9, Canada.

File From Canada

File, a newsletter that examines ideas, processes, and technology in the publishing and direct-mail marketing industries, is produced six times a year by Creative Data Processing of Brauch & Neville Associates Ltd. For further information, contact Brauch & Neville Associates Ltd., 3390 Midland Ave., POB 351, Agincourt Post Office, Scarborough, Ontario M1S 3B9, Canada.

If you would like BYTE readers to know about your club or newsletter send the details accompanied by no more than one newsletter to Clubs and Newsletters, BYTE Publications, POB 372, Hancock, NH 03449. Overseas groups are encouraged to participate. Please allow at least three months for your announcement to appear.

BYTE's Bits

Porsche Will Go to Contest Winner

Seeq Technology of San Jose, California, will award a 1983 Porsche 944 to the person who comes up with the best application for one of its electrically erasable read-only memory (EE ROM) chips. This chip, the 16K-bit 5-volt 5213, can be purchased for $9.95 at Schweber Electronics stores with a limit of two to a customer until May 31. Possible applications include a remotely programmable private branch exchange (PBX) for telephone systems or even jukeboxes that tell you when to replace worn records.

To be eligible, you must come up with a good idea, build it, test it, and send the schematic to Seeq by May 31, 1983. Complete rules and entry forms are available from local Schweber Electronics stores or from Seeq Technology, 1849 Fortune Dr., San Jose, CA 95131, (408) 942-1990.

North American Book Distributor

In Dr. Michael Carter's review of Personal Documentation for Professionals, the North American distributor of the book was not mentioned. (See the October 1982 BYTE, page 385.) It can be ordered from Elsevier Science Publishing Co., 52 Vanderbilt Ave., New York, NY 10017.
Specials of the Month

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Micro Sci

Apple II Disk Drives Available Call

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Singletabene w/Power Supply $99
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Apple II Disk Drives Available Call

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S/2 Cabinet w/Power Supply $129

MONITORS

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12" Green Screen, 20MHz $107

SMC

12A (15MHz) Composite $129
12/20 (20MHz) Composite $179
9/16 Color Composite $279

Taxan

12" Green 1/16 Horse Composite $129
12" Amber 1/16 Horse Composite $189
6/8 Color $249

Zenith

ZUM 12" Green 15MHz $94
USI $139

CABLES

IBM to Printer $32
Osborne to Printer $32
Keypro to Printer $32

DISKETTE STORAGE

Mini Files-100 Disk $16.50
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What's New?

ELECTRONIC OFFICE

Portable Computer
with Networking Potential

Up to 15 battery-powered Athena I portable computers can be connected in a local-area network. This 15-pound machine carries 512K bytes of solid-state storage, dual low-power NSC-800 processors running CP/M, 64K bytes of main memory for computation, 4K bytes of communications memory, and a full-sized keyboard. Its 4-line by 80-character display performs as a window because it's backed by 24 lines of 80 characters held in memory. A 5¼-inch floppy-disk drive, two RS-232C ports, and a printer port are standard. Expansion capabilities include up to 1 megabyte of internal memory and space for two additional circuit boards.


DMS-15 Can Serve as Master Station

The DMS-15 can serve as a master in a Hinet local-area network. Hinet can support up to 32 users and address as many as 255. Manufactured by Digital Microsystems, and said to be an enhanced version of the portable Fox, DMS-15 comes with CP/M 2.0 and 15 megabytes of built-in Winchester-disk storage (formatted). It features DSC-3 (Z80A) architecture, 64K bytes of RAM (random-access read/write memory), a 9-inch display, one double-sided double-density 5¼-inch floppy-disk drive (614K bytes), a Hinet interface, and four RS-232C serial ports.

A list price of $7495 has been set for the DMS-15. The software to run the system as the Hinet master station costs $500. Quantity discounts are offered. Contact Digital Microsystems, 1755 Embarcadero, Oakland, CA 94606, [415] 532-3686.

Network to Connect Dissimilar Hosts

Tri-Data's Netway Family is designed to create a cohesive network using a variety of hosts and workstations, regardless of the local or remote protocols employed. The family comprises distributed-communications-oriented hardware and a multitasking/multiprogramming network DOS, called NCOS.

NNET networking software provides automatic alternative routing, online configuration from any workstation, and the ability to manage up to 254 processors. The NCOS operating system gives network and host transparency and has a user-friendly interface with help messages. It allows CP/M Plus to run as a task for applications development.
QT 5¼" MAINFRAME

- Provisions for any 2 - 5¼" drives (hard or floppy) 15 ea DB 25 cutout + 2 ea 50 pin + 2 ea 34 pin = 1 ea Centronics + EMI filter (fused) + 2 AC outlets = Avril with 6-8 or 12 slot motherboard + Power supply (+ 18VDC / +12VDC / +5VDC)

**Prices**
- OTC-MF - $185.00
- OTC-MF - $175.00

QT 8" MAINFRAME

- Provisions for any 2 - 8" drives (hard or floppy) 15 ea DB 25 cutout + 2 ea 50 pin + 2 ea 34 pin = 1 ea Centronics + EMI filter (fused) + 2 AC outlets = Avril with 6-8 or 12 slot motherboard + Power supply (+ 18VDC / +12VDC / +5VDC / +24VDC)

**Prices**
- OTC-MF - $260.00
- OTC-MF - $240.00

QT STANDARD MAINFRAME

- Provisions for any 2 - 5¼" drives (hard or floppy) 15 ea DB 25 cutout + 2 ea 50 pin + 2 ea 34 pin = 1 ea Centronics + EMI filter (fused) + 2 AC outlets = Avril with 6-8 or 12 slot motherboard + Power supply (+ 18VDC / +12VDC / +5VDC / +24VDC)

**Prices**
- OTC-MF + 12" - $495.00
- OTC-MF + 12" - $475.00

**Miscellaneous**

- Desk Top Version - $400.00
- Rack Mount Version - $400.00
- OTC-RMF-008 - $260.00
- OTC-RMF-012 - $240.00

**QT S-100 CARD CAGES**

- Made of anodized steel + Card guides for MB - 1 = Indicates w/MB + 2 = Indicates w/MB + 1 = 1 ea + 3 = Indicates w/MB + 2 = 2 slots

**Prices**
- OTC-CC4 - $32.00
- CC4 - $15.00
- CC4-1 - $10.00
- CC4-2 - $15.00
- CC5-1 - $20.00
- CC5-2 - $20.00
- CC5-25 - $20.00
- CC5-26 - $20.00
- CC5-27 - $20.00
- CC5-28 - $20.00

**QT S-100 MOTHERBOARDS**

- Silence Plus + Built in Terminator = EE99 + Terminal strip for easy power connection

**Prices**
- 4 Slot Motherboards - $60.00
- 8 Slot Motherboards - $60.00

**Miscellaneous**

- OTC-M6BK - $45.00
- OTC-M6BK - $50.00
- OTC-M6BK - $55.00
- OTC-M6BK - $60.00
- OTC-M6BK - $65.00
- OTC-M6BK - $70.00
- OTC-M8BK - $100.00
- OTC-M8BK - $110.00
- OTC-M8BK - $120.00
- OTC-M8BK - $130.00
- OTC-M8BK - $140.00
- OTC-M8BK - $150.00
- OTC-M8BK - $160.00
- OTC-M8BK - $170.00
- OTC-M8BK - $180.00

**OTC DISK DRIVE CABINETS**

- All in One Vertical Disk Drive Cabinet
  - For 1) 2 ea or 4 ea 8" thinline drive
  - 2) 2 ea standard 8" drive
  - 3) 1 ea hard disk + 1 ea standard 8" drive
  - Power supply (+ 5VDC / -5VDC / +12VDC / +24VDC)
  - Power supply 18VDC for any 8" drive
  - Power interface cable for any 8" drive
  - OTC-DCCMKB - For 2 standard 8" drives
  - OTC-DCCMKB - For 2 thinline 8" drives
  - OTC-DCCMKB - For 1 8" drive
  - OTC-DCCMKB - Horizontal Disk Drive Cabinet
  - Power supply (+ 5VDC / -5VDC / +12VDC / +24VDC)

**Prices**
- OTC-DCCMKB - $300.00
- OTC-DCCMKB - $325.00
- OTC-DCCMKB - $325.00
- OTC-DCCMKB - $275.00

**DISK DRIVES**

- 8" Disk Drives
  - 50 I/0 Shugart SS/00
  - 55 I/0 Shugart DS/00
  - 65 I/0 Shugart DS/00
  - M-2694-3 MT DS/DD
  - M-2694-6 MS 6" thinline DS/DD

**Prices**
- OTC-DG5-0 - $355.00
- OTC-DG5-1 - $400.00
- OTC-DG5-2 - $400.00
- OTC-DG5-3 - $475.00
- OTC-DG5-6 - $575.00

**GT DISK DRIVE SUB ASSEMBLY**

- Vertical or horizontal disk cabinet - 11" h x 17" w x 20" d
- Power supply (+ 5VDC / -5VDC / +12VDC / +24VDC)
- OTC-DG5-D - 0 or 2 x 8" SS/DD Siemens drives
- OTC-DG5-1 - 1 or 2 x 8" DS/DD Siemens drives
- OTC-DG5-2 - 2 x 8" DS/DD Siemens drives
- OTC-DG5-3 - 3 x 8" SS/DD Siemens drives
- OTC-DG5-4 - 4 x 8" DS/DD Siemens drives

**Prices**
- OTC-DG5-D - $565.00
- OTC-DG5-1 - $650.00
- OTC-DG5-2 - $755.00
- OTC-DG5-3 - $850.00
- OTC-DG5-4 - $950.00

**TERMINALS**

- Telsavideo 2912C
- Telsavideo 970

**Prices**
- Telsavideo 2912C - $725.00
- Telsavideo 970 - $1095.00

**MONITORS**

- BAC20A (15 MHz)
- BAC120V (20 MHz)
- BAC120V (20 MHz)
- Color CRT Color 9191
- Color CRT 12" Green (15 MHz)

**Prices**
- BAC20A - $125.00
- BAC120V - $125.00
- Color CRT Color 9191 - $275.00
- Color CRT 12" Green - $80.00

**PRINTERS**

- Star-Gem
- OKI-23A (120 cps) Serial - $355.00
- OKI-23A (120 cps) Serial - $385.00
- OKI-23A (200 cps) Serial - $1075.00
- OKI-92A (150 cps) Serial - $395.00
- OKI-92A (150 cps) Serial - $395.00
- NEC-222A - $475.00
- BEST BUY
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**BOARD SETS**

- Best Bare Board Set Available
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- OTC-SBC-9/F A + T
- OTC-2308 BB
- Telekalt FDC-I A + T
- Telekalt Systemmaster A + T

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- DYNAMIC (54K/256K or 1 MEG)
- OTC-EXP+III 8K A + T
- OTC-EXP+III 8K A + T
- STATIC
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- S-RAM 128 K A + T
- S-RAM 128 K A + T

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- OTC-I/O = B + 2 SER 3 PAR
- OTC-I/O = A + T
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**DISKETTES**

- 5¼" standard (for Apple)
- 17.00 for 10
- 1 yr warranty with hub ring
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- 24.00 for 10
- 5¼" standard (for Apple)
- 25.00 for 10
- Floppy disk storage case (store 70 diskettes)
- 19.00 ea

**APPLE CORNER**

- Micro-Sci Drive
- Enetwriter
- Rana Elite I
- Rana Elite II
- Rana Elite III
- Rana Controller
- OTC Apple Compatible Drive

**We accept cash, checks, credit cards, or Purchase Orders from qualified firms and institutions. Minimum prepaid order $15.00. Export customers outside the U.S. or Canada please add 10% to all prices. Prices and availability subject to change without notice. Shipping and handling charges vary based upon UPS. Up to $1.00/pb. Minimum charge 3.00.**
NCOS is standard; NNET costs $500.

Netway hardware is built around the Netway 200 communications processor. It supports up to 32 workstations and host ports and renders remote and local networking facilities. System architecture includes multiple-DMA, an 800K-byte floppy-disk drive, a Centronics parallel printer port, and six serial I/O ports that support asynchronous, bisynchronous, and bit-oriented protocols. The single-unit price is $6680. Integrated 10- or 15-megabyte Winchester drives are available.

Additional hardware elements include a Z80-based device-interface processor with 64K bytes of memory and a local network interface, composed of a shielded cable and an RJ-11 connector. Prices range from $200 to $420.

A host of other hardware and interface modules are available as options. For details on possible configurations, contact Tri-Data, 505 East Middlefield Rd., Mountain View, CA 94043. [415] 969-3700.

Circle 603 on inquiry card.

CDI Creates Office Systems Environments

Computer Development Inc. (CDI) will design and support an office communications system to your specific needs. Major components of CDI's modular approach to electronic communications include the Electronic Telecommunications (ET) System 3000 family of portable microcomputers and the Voice Com software package.

The System 3000 has a built-in microprocessor-controlled modem that comes with full communications software, software-controlled answer/originate modes, TouchTone and rotary-pulse auto-dialers, variable 300-to 1200-bps (bit-per-second) data rates, half-and full-duplex operation, interactive vocal and data communications abilities, and an error detection/correction protocol that automatically detects and corrects mistakes occurring during transmission.

Unlimited voice and data communications over ordinary telephone lines are achieved by Voice Com, which features single-keystroke operation and permits a document to be created, discussed, and edited simultaneously on all terminals online. It's part of the Commail electronic mail system. Commail also includes a communications systems management program and a call handler/telephone link controller.

Basic ET System 3000 hardware is made up of dual Z80 processors. 64K bytes of RAM (random-access read/write memory), a 12-inch nonglare green phosphor display, and a 72-key keyboard with a separate numeric/cursor control pad and 8 user-programmable function keys. Built-in diagnostics, CP/M, and a Help key are supplied. Software includes BASIC, COBOL, Supercalc, and applications packages.

Many options can be added to the System 3000, including intelligent modems, mathematics and high-speed processors, and floppy- and hard-disk drives. For complete details on available systems and services, contact, CDI, Suite 200, 6700 Southwest 105th, Beaverton, OR 97005, (800) 547-1831; in Oregon, (503) 646-1599.

Circle 604 on inquiry card.

Database System Has Unique Zoom Function

Powerbase is an easy-to-use relational database management system from GMS Systems Inc. Powerbase has a unique Zoom feature that lets you zero in on any information within the database and show the detailed components of that information up to 16 levels deep. Designed for IBM Personal Computers running PC-DOS, Powerbase offers a fast search, sort, and select feature, user-defined screens for data entry, user-specified reports, special keys for "sounds like" retrieval, a front-end editor, and the ability to handle arithmetic expressions written in algebraic form. As many as 65,000 records of 1760 bytes each can be accommodated, and each record can hold up to 32 fields of 80 characters. All files are random access by means of B-tree structure.

This system comes with a daily planner, financial/insurance record inventory, and a 132-column printer. Each module is sold separately, and prices range from $298 to $398. A 25% discount is allowed after the first module is purchased. For ordering information, contact Micro Architect Inc., 96 Dothan St., Arlington, MA 02174, [617] 643-4713.

Circle 605 on inquiry card.
The Avalonche is a
distributed
multitasking
system, which offers
real-time capabilities and
file protection with password
access. Accounting,
word processing, text
editing, utilities, and
electronic mail programs come
standard.

Two thousand feet
of cable can support up to
32 cluster boxes for a total
of 128 systems.

Applenet will employ
baseband bus architecture
with carrier-sense multiple
access with collision
detection (CSMA C/D) to avoid
data loss during communi-
cation. All network com-
ponents are located on an
interface card that plugs
into the computer. The
Applenet, which will use
the Xerox Network Sys-
tems (XNS) protocol, will
be sold through Apple
dealers and Apple's Na-
tional Accounts program.
For full details, contact
Apple Computer Inc.,
20525 Mariani Ave., Cu-
pertino, CA 95014, (408)
973-3019.
Circle 608 on inquiry card.

SYSTEMS

HP's First 16-Bit
Personal Computer

The HP Series 200
Model 16 is Hewlett-Pack-
ard's first 16-bit personal
computer. The Model 16
will be sold through direct
sales and retail computer
stores. Based on the
Motorola MC68000 micro-
processor, the Model 16
offers an 8-MHz system
clock and a choice of
3½-inch micro-floppy-disk
drives. It has a 9-inch
display, a detached ASCII
keyboard, 128K bytes of
main memory, graphics
capabilities, and built-in
parallel and serial inter-
faces. The video screen
features an 80-character
by 25-line display format
with a resolution of 300
by 400 pixels. Its keyboard
is outfitted with five user-

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What's New?
Low-Cost Network
EXO Corporation re-
ports that a fully functional
network system can be
achieved at a low cost
with its Avalanche com-
puter and EXO/Net, an
enhanced version of
CP/Net. The EXO system
is a distributed network
with sharing of disks, pro-
grams, databases, and
printers, as well as full
communications abilities.
It supports up to 31 sta-
tions and one file server
per channel. Individual
computers in the network
operate under CP/M
when equipped with local
disk storage. Stations are
connected to a single
twisted-pair cable up to
4000 feet long. The data
rate is 800,000 bps (bits
per second). Interfaces for
other protocols to allow
users access to main-
frames and external data-
bases are under develop-

Apple Nets Local
Network Scheme
Apple Computer plans
to market the Applenet,
which will electronically
link Lisa and Apple II/Ill
computers so that they
can exchange information
and share central files.
Network connections will
be a drop cable and a
cluster box supporting up
to four computers. For
large networks, cluster
boxes can be connected
to a twin axial network
cable capable of 1 million-
bit-per-second transmis-

expense reporting, and
telephone/mailing list di-
rectory applications pro-
gams. It requires 128K
bytes of memory, PC-
DOS, two 160K-byte
floppy-disk drives or a hard
disk, a cursor-addressable
terminal, and an 80-col-
umn printer. It costs $475,
including user and refer-
ence manuals. Contact
GMS Systems Inc., 12
West 37th St., New York,
NY 10018, (212) 947-
3590.
Circle 606 on inquiry card.

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The file server runs the
multitasking MP/M II oper-

The HP Series 200
Model 16 is Hewlett-Pack-
ard's first 16-bit personal
computer. The Model 16
will be sold through direct
sales and retail computer
stores. Based on the
Motorola MC68000 micro-
processor, the Model 16
offers an 8-MHz system
clock and a choice of
3½-inch micro-floppy-disk
drives. It has a 9-inch
display, a detached ASCII
keyboard, 128K bytes of
main memory, graphics
capabilities, and built-in
parallel and serial inter-
faces. The video screen
features an 80-character
by 25-line display format
with a resolution of 300
by 400 pixels. Its keyboard
is outfitted with five user-
definable softkeys (ten with shift) and a rotary control knob for rapid program editing, cursor positioning, and analog control of instruments. The Model 16 can be linked in a network that shares disk drives and printers.

Three languages are available for the Model 16: BASIC, HPL, and Pascal. HP BASIC includes such enhancements as subprograms, multidimensional arrays, unified I/O and mass storage, labeled common blocks, and external program control. Application packages cover computer-aided engineering tools, mathematics modules, and business aids. The company is investigating the possibility of offering Digital Research's CP/M operating system on the Model 16 and plans to provide its own version of the Unix operating system in the future.

Among the Model 16 options are a tilt-and-swivel display accessory and a dual micro-floppy drive. Including the processor, display, keyboard, and 128K bytes of memory, this system costs $3650. Contact your local Hewlett-Packard sales office for complete details.

Circle 609 on inquiry card.

What's New?

68000 Unix-based System Uses Multibus Architecture

The Codata 3300 is an MC68000 Unix-based microcomputer from Codata Systems Corporation. This system comes with 320K bytes of parity-protected RAM (random-access read/write memory), expandable to 1.5 megabytes with memory management. Its Multibus architecture supports a variety of mass-storage configurations. Backup data storage is available through quad-density floppy disks, cartridge tape, or 9-track tape drives.

All the software and programming languages developed for the Codata CTW-300 computer are fully compatible with the 3300. These include APL68000, a BASIC-Plus-compatible interpreter, and Unixis, Codata's Unix superset. Standard implementations of FORTRAN 77, RM/COBOL, Pascal, and SMC BASIC are supported. Business applications software to run with the 3300 includes a database-management system, an electronic spreadsheet, and word-processing packages.

The standard eight-user 3300 comes with an integral 5½-inch 33-megabyte Winchester hard-disk drive and lists for $9600. A two-user version with 12 megabytes of Winchester storage costs $7800. For multitasking, multiuser applications, the Codata 3300 can be purchased with an 8-inch 84-megabyte Winchester drive for $13,500. Contact Codata Systems Corp., 285 North Wolfe Rd., Sunnyvale, CA 94086, (800) 521-6543; in California, (800) 221-2265. Circle 610 on inquiry card.

16-Bit Computer Costs Less Than $100

The TI-99/2 Basic Computer from Texas Instruments is the first 16-bit computer for less than $100. Targeted at the technical enthusiast, engineer, and student, the TI-99/2 has a standard typewriter-like keyboard, 4.2K bytes of RAM (random-access read/write memory) that can be expanded to 36.2K bytes, a built-in RF (radio frequency) modulator, and monochrome display capabilities. For expansion, this system is equipped with a rear-panel peripheral interface connector for a variety of units especially designed for it, including an RS-232C interface, a digital tape drive, and a four-color printer/plotter. Later this year, Texas Instruments plans to release other peripherals, such as modems, printers, a wand input device, and a black-and-white monitor.

The TI-99/2 uses software on solid-state cartridges and cassettes. Initially, two cartridges are available: "Learn to Program" and "Learn to Program BASIC." In addition, 20 cassette-based programs covering education, personal management, and entertainment are scheduled for introduction this quarter. The suggested retail price of each cartridge is $19.95, and most cassette-based programs cost $9.95.

The TI-99/2 comes with a video cable and antenna switch for connection to any television, an interface cable that hooks directly to a cassette-tape player, an AC adapter, a user's manual, and a demonstration cassette. It costs $99.95. For details, contact Texas Instruments Inc., Consumer Relations Department, POB 10508, MIS 5828, Lubbock, TX 79408, (800) 858-4565. Circle 611 on inquiry card.
Color Monitor with Headset for Privacy
A color monitor for personal and business computers featuring a non-glare screen, the Color-I Plus is manufactured by Amdek Corporation. The 13-inch Color-I Plus has a line resolution of 260 (horizontal) and 300 (vertical). It accepts a composite-video signal and comes with front compartment controls, a built-in audio amplifier, and a carrying handle. The Color-I Plus is supplied with a headset for private operation. The unit's speaker automatically shuts off when the headset is connected.

The Color-I Plus costs $449. For more information, contact Amdek Corp., Marketing Department, Elk Grove Village, IL 60007, [312] 364-1180. Circle 612 on inquiry card.

Video Board Displays
Uppercase/Lowercase in 80 by 25 Format
The 82-018 stand-alone video-terminal board from John Bell Engineering displays 80 columns by 25 lines of uppercase and lowercase characters. This video board uses a 6502 microprocessor and has RS-232C I/O lines for direct connection to a computer or modem. The 82-018 transfers data at rates ranging from 110 to 9600 bps (bits per second) through switch-selectable RS-232C lines. An onboard UART (universal asynchronous receiver/transmitter) is controlled by a five-position DIP (dual-inline pin) switch. Hardware features include 4K bytes of 6116-type RAM (random-access read/write memory), 2716 EPROMs (erasable programmable read-only memories) for character generation and video program control, a 6545-1 display controller, an interrupt-driven serial input port, and a 1500-character buffer. Power requirements are +5 V (volts) at 700 mA (milliamperes), +12 V at 50 mA, and −12 V at 50 mA.

The 82-018 requires a parallel ASCII keyboard, a standard NTSC (National Television Standard Code) monitor, and power supply. It can be purchased fully assembled and tested for $199.95 or as a bare board with EPROMs and crystal for $89.95. Shipping and handling fees are additional. Complete source listings are included in the documentation. Both versions are available directly from John Bell Engineering Inc., 1014 Center St., San Carlos, CA 94070, [415] 592-8411. Circle 613 on inquiry card.

Hard Disk for APC
NEC Information Systems is marketing a 12-megabyte hard-disk subsystem for its Advanced Personal Computer. This high-performance 5¼-inch drive stores 9.27 megabytes of formatted data and transfers data at a rate of 500K bytes per second. Track-to-track head movement time is 120 ms (milliseconds) and the access time averages 130 ms. The rotation rate is 3000 revolutions per minute. This system's hardware features a direct-drive DC spindle motor, microprocessor controls, and LSI (large-scale integration) circuits. Mean time between failures is 12,000 power-on hours. It measures 6½ inches high by 9% inches wide by 15 inches deep.

The APC hard-disk subsystem costs $2798. The 16-bit APC computer is 8086-compatible and supports CP/M-86, MS-DOS, and the UCSD p-System. Address inquiries to NEC Information Systems Inc., 5 Militia Dr., Lexington, MA 02173, (617) 862-3120. Circle 614 on inquiry card.

Combination Cards for IBM PC
The XPR Series of Multi-function Combination Cards for the IBM Personal Computer can be equipped with a parallel port, a serial RS-232C port, a clock/calendar with battery back-up, or all three functions. The parallel port comes with required hardware and connectors for use as either a printer or as a SASI (Shugart Associates Standard Interface) hard-disk interface. The serial port, with a DB25 connector, can be used as COM1 or COM2. Both ports can be individually disabled. The clock/calendar option, coupled with its companion software, automatically provides current time and date information to the PC. The XPR comes on a single printed-circuit
board and with up to 256K bytes of memory.

The XPR is supplied with installation and reference manuals, internal cabling, connectors, mounting hardware, and a diagnostic disk. Prices range from $350 to $650 for one option and 64K to 256K

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What's New?

Supertalking IBM Personal Computers

Mountain Computer's Supertalker II gives your IBM Personal Computer a vocal outlet. Sound enters the Supertalker through a microphone and is then digitized and stored on a floppy disk for playback through a loudspeaker or the PC's speaker. This plug-in board is said to reproduce a human voice in a manner similar to an audio tape recorder, providing inflection not possible with voice synthesizers. A single floppy disk can record up to 2 minutes of phrases or sentences, and voice output can be accessed with Supertalker's software or by user-developed BASIC programs.

A data-compression technique minimizes disk-storage requirements. Three digitizing rates, ranging from 2K to 4K bytes per second, control the quality of reproduction, and the volume is controlled by software or with a built-in control knob. Frequency response is 300 to 3000 Hz.

Supertalker requires a 64K-byte IBM PC and a single disk drive. It comes with menu-driven software for creating and editing phrases. 32K bytes of RAM (random-access read/write memory), a loudspeaker, and a microphone. Supertalker II costs $565 and is available at Mountain Computer retail stores. Mountain Computer Inc. is located at 300 El Pueblo Rd., Scotts Valley, CA 95066, (408) 438-6650.

Circle 615 on inquiry card.

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Winchester Storage for Apple and PC

Xiren Systems is offering an 11.3-megabyte Winchester-disk subsystem for Apple II/IIIe and IBM Personal Computers through a select network of IBM and Apple dealers. The Gallium 10 stores 14.4 megabytes of unformatted data and can be partitioned for DOS 3.3, CP/M, and Pascal when used with Apple computers. For the PC, it can operate under PC-DOS or CP/M-86. Its cabinet and power supply can support two Winchester-disk drives (28.8 megabytes total storage), and its controller can handle four drives in two cabinets (57.6 megabytes total).

For the location of the dealer nearest you, or for more information, contact Xiten Systems, 16815 Hawthorne Blvd., Lawndale, CA 90260, (213) 370-3966.

Circle 618 on inquiry card.

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Voice-Response Unit with Modem

A low-speed modem now complements the single-board interactive voice-response unit for Apple II from Vynet Corporation. The basic element of the response unit, the V101-A Interactive Telephone Interface board, is designed to plug into an Apple peripheral slot and connect directly to the telephone network. It can answer on ring and dial and detect Touch-Tone signals. With this unit, users can call or be called by a computer and respond with Touch-Tone signals to computer inquiries for modifying program flow or updating the database, without terminals or dedicated lines. A set of 20 routines, resident in ROM (read-only memory), preprograms all functions to control interface hardware. Voice-response capabilities are provided by the V200-VSM (voice-synthesizer module). The V200-VSM, an LPC (linear-predictive coding) based unit, comes with a 300-word vocabulary on disk; a 1300-word option is available.

The modem option consists of the V103-A.
motherboard and the V200-LSM (low-speed modem). The V103-A fastens into a slot on the Apple and is cable-connected to the V101-A. The V200-LSM provides 300-bps (bit-second), Bell 103-compatible half- or full-duplex data-communications abilities. In systems equipped with both the V200-VSM and the V200-LSM, the V101-A permits voice and data communications to share a single telephone line.

System software comes in Applesoft, Pascal, or CP/M formats. The V101-A costs $295, and the V103-A is $199.95. Both the V200-VSM and the V200-LSM are $149. Contact Vynet Corp., 1608 Albright Way, Los Gatos, CA 95030, (408) 370-0555. For an online demonstration, call (800) 538-7002 or (408) 370-9764.

Circle 619 on inquiry card.

**PUBLICATIONS**

Timex/Sinclair Sourcebook

The Timex/Sinclair Sourcebook is a directory of more than 600 programs, hardware accessories, add-on memories, and books for Timex and Sinclair computers. Produced by Micro Design Concepts, the Sourcebook lists and describes mail-order products from almost 160 sources. Each listing provides such facts as program highlights, type of media, minimum system configuration, price, and ordering information. The entries are organized by category: games, education, business, home/personal use, hardware, and books/catalog.

The 96-page Timex/Sinclair Sourcebook costs $6.95, plus $1.25 postage and handling; $2.50 postage and handling outside the U.S. It's available from Micro Design Concepts, Department F, POB 280, Carrollton, TX 75006.

Circle 620 on inquiry card.

Report Studies Electronic Typewriters

Seybold Publications has released a comparative study entitled Electronic Typewriters: Getting Started for Less Than $2000. This analysis of the major products on the electronic typewriter market covers such manufacturers as IBM, Xerox, Exxion, Olivetti, Olympia, and Royal. A discussion of the role of the electronic typewriter in the automated office, a summary of functions available, a glossary of terms, and a comparison chart of model features are included.

For subscribers of the Seybold Report on Office Systems, this report costs $75; nonsubscribers pay $100. Order it directly from Seybold Publications Inc., POB 644, Media, PA 19063, (215) 565-2480.

Circle 621 on inquiry card.

Directory Covers Products for IBM

The Directory of Independent IBM Personal Computer Hardware and Software from Infopro is a comprehensive buyer's guide of software and hardware developed for the IBM Personal Computer. It contains descriptions and evaluations of more than 400 products and provides the addresses and telephone numbers of all the vendors profiled. All the software in the directory runs under the PC-DOS operating system.

This directory costs $29.95. It's available at participating dealers or directly from Infopro Inc., POB 22, Bensalem, PA 19020, (215) 750-1023.

Circle 622 on inquiry card.

Win at Home Video Games

How to Win at Home Video Games analyzes 70 home-video games step by step so that you can develop game-winning strategies. It covers such games as Adventure, Donkey Kong, and Utopia designed for Atari, Intellivision, Odyssey 2, and Colecovision game systems. Descriptions and buying guide information are included.

This 4-color, 64-page book by the editors of Consumer Guide magazine costs $3.98. It's published by Beekman House and distributed by Crown Publishers, One Park Ave., New York, NY 10016.

Circle 644 on inquiry card.

Guide Spans Databases

The current edition of the Directory of Online Information Resources covers more than 720 databases up and running in North America. This guide has subject, vendor, and producer indices, address and telephone information for all database producers and vendors, and database price information. It's completely revised semiannually.

Single copies of the directory cost $22.50, plus $1.50 postage and handling. A subscription price of $60 (four issues) is available. To order, contact the CSG Press, 11301 Rockville Pike, Kensington, MD 20895, (301) 881-9400.

Circle 623 on inquiry card.

SOFTWARE

Suspended Joins Interlogic Line

Infocom has announced Suspended, the sixth game in the Inferlogic product line. Suspended joins such adventure games as Deadline, Starcross, and the Zork trilogy. Inferlogic games are highly interactive and feature a programming language that permits complete sentence communication between player and computer. The games run on virtually any computer, including DEC Rainbow, TI Professional Computers, Osborne 1, NEC APC, and 8-inch CP/M-based systems.
What's New?

In Suspended, you and your six robot assistants must rescue the population of a planet deep in outer space. While in a limited state of cryogenic suspension, you must repair damage to the planet with your robots. The robots, which can act for you independently of one another, can be sent to different locations and make subsequent moves. Suspended is the first Interlogic game to have a functional game board with movable pieces. Estimated playing time is 30 hours.

Suspended, which was released early last month, is the brainchild of Michael Berlyn. It costs $49.95 and is marketed through software distributors, major retail stores, and personal-computer manufacturers. Info-Designs Inc. has its headquarters at 55 Wheeler St., Cambridge, MA 02138, (617) 492-1031. Circle 624 on inquiry card.

Access 8086 Development Software

Genesis Microsystems' Access lets you run Intel Series-III 8086 development software on your Compaq or IBM Personal Computer at a substantial cost savings. A version for systems running CP/M-86 is also available. With Access, your computer can run such software as PL/M-86, FORTRAN-86, and Pascal-86. Access provides you with an operating system adapter program and a data link program for transferring files between your computer and Intel Series-III systems. A program that connects your computer to Intel's 957A debugger for downloading programs to your system is also available. It costs $450.

For a complete 8086 development system, the manufacturer recommends a 128K-byte computer with MS-DOS, two 320K-byte floppy-disk drives (or a hard disk), a monochrome display, and a text editor. Access costs $950 and can be ordered directly from the manufacturer. For benchmark and price comparisons, contact Genesis Microsystems, POB 70280, Sunnyvale, CA 94086, (408) 241-3727. Circle 626 on inquiry card.

High-Quality Text Processor

The print quality of the incredible Text Printer (ITP) from Datamed Research Inc. is said to be equivalent to the best stand-alone word processors and to exceed that of any other text processor. ITP has extensive, built-in automatic text-formatting capabilities and a series of menus to help you set up printing formats. Among its text-formatting options are underlining, boldface, subscript, superscript, variable character widths, tab and line drawing, and table and figure relocation. ITP automatically hyphenates words at the end of the line, creates indexes and tables of contents, and numbers sections, tables, and figures. It gives you extensive control over headings, subheadings, and footers, including centered and left and right justified fields. With this system, you can insert files from within other files, add pages, and generate personalized form letters or customized text from name and address files or entered from the console. Other features include run-time entry of text or instructions from the console.

ITP runs on UCSD Pascal-compatible systems. It requires 56K bytes of memory, two floppy-disk drives or a hard disk, an external text editor, and a 24-line by 80-character display monitor. It costs $249, which includes six months of free updates. A demonstration disk can be purchased for $60, and the manual alone is $30. Dealer terms are available. Datamed Research Inc. is located at 1433 Roscomare Rd., Los Angeles, CA 90077, (213) 472-8825. Circle 627 on inquiry card.

User-Friendly Spreadsheet

The Timberline Spreadsheet is said to be a user-friendly system designed for small businesses with no prior computer experience. Timberline features an array of statistical calculation capabilities and six conditional statements for developing reports based on changing financial parameters. Conditional statements allow almost any set of conditions to be entered into the spreadsheet in an if...then format. While it offers traditional financial calculations, Timberline is also flexible enough to calculate such equations as net present value and internal rate of return. Statistical calculations include linear regression, correlation coefficients, dependent vari-

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able, analysis independent variable, and standard deviation.

The Timberline Spreadsheet's double-window display lets you view separate areas on the worksheet. Its editing function, based on user-definable commands, permits rows and columns to be inserted, deleted, or moved. Rows can also be sorted by alphanumeric or numeric information, and blocks of data can be moved.

This package will run on computers using the UCSD p-System with a minimum of 64K bytes of memory and two floppy-disk drives. The Timberline Spreadsheet costs $395 and can be purchased factory-direct from Timberline Systems Inc., 10550 Southwest Allen Blvd., Beaverton, OR 97005, (503) 643-9461.

Circle 628 on inquiry card.

CP/M Graphics Conforms to GKS, VDI Standards

Digital Research designed CP/M Graphics architecture with standard interfaces at the programmer and device levels. The programmer interface conforms to the emerging ANSI and ISO Graphical Kernel System standard, which provides source-code portability. The device-level interface addresses ANSI VDI (Virtual Device Interface) to provide object code portability. The CP/M Graphics line is comprised of six products: GSX, GSS-4010, GSS-Kernel, GSS-Plot, GSS-Graph, and GSS-Draw.

GSX is required by all the packages in the line. It's the graphic system extension to the CP/M operating system. It provides graphic output through standard operating-system calls. Three components make up GSX: GDOS (Graphics Device Operating System), GIOS (Graphics Input/Output System), and the Gengraf utility, which configures a graphics application to run in the GSX environment.

Other programs let you use graphic software that currently exists only on mainframe computers, create portable graphics applications programs, produce programs for typical business, engineering, and scientific representations, and create and edit presentation-quality charts and diagrams. For complete details on the CP/M Graphics product line, contact Digital Research, POB 579, Pacific Grove, CA 93950, (408) 649-5500.

Circle 629 on inquiry card.

Speachware: Software with the Gift of Gab

Centigram Corporation and Peachtree Software have teamed up to produce a line of talking software, known as Speachware. This speech-synthesis system works with hardware devised by Centigram and with speech files created and edited by Peachtree Software, maker of the Peachpak 8 Accounting Series and other software packages. It's reported that this combination produces user-friendly software that's suitable for teaching people with limited computer knowledge how to process information.

Speachware will provide voice capabilities to existing or forthcoming Peachtree software.

Centigram's Voiceware Development System is the hardware heart of Speachware. It offers bit rates averaging 3000 bps (bits per second), which reduces the amount of host processor overhead as well as the amount of mass storage needed to hold messages. Voiceware digitizes and compresses analog waves using a proprietary coding technique known as PWC (parametric waveform coding). Analyses of waveforms are done at variable-length intervals, with frame rates determined by the voiced or unvoiced events in the original speech. This results in a synthesized waveform that's nearly identical to the original. Voice output is achieved by means of Centigram's Sybil synthesizer board, which uses the General Instrument SPO250 chip. Sybil is compatible with the IBM Personal Computer.

For further details, contact Centigram Corp., 1153 Bordeaux Dr., Sunnyvale, CA 94086, (408) 734-3222.

Circle 630 on inquiry card.

OEM Applications Sought for Image-Recognition System

Sirius Software is seeking OEM (original equipment manufacturer) applications and will consider a variety of licensing agreements for its stand-alone, Multibus-based image-recognition system, called Floyd. This system uses a custom-designed video processor and an NSC 16032 central processor. The video processor demodulates and digitizes an incoming NTSC [National Television Standards Code] color signal, then it fits two 64K-byte memory planes 60 times a second. The central processor can access this memory continuously for real-time image analysis. Floyd's color resolution is 510 by 213 pixels through a 4-bit gray scale. Color is demodulated to red/yellow, blue/yellow format.

Floyd offers softswitch-selectable code conversions for linear, log, or inverse storage, and it has 8-bit color storage (256 colors) as red/yellow, blue/yellow vectors with softswitch-selected code conversion for hue correction. Video memory is 128K bytes, expandable to 256K bytes using 150-nanosecond RAMs (random-access read/write memories).

For complete technical specifications, contact Sirius Software, Research and Development Department, 10364 Rockingham Dr., Sacramento, CA 95827, (916) 366-1195.

Circle 631 on inquiry card.
Hard-Disk Subsystem Has Error-Correcting Controller

Advanced Digital Corporation has unveiled a 5½-inch Winchester harddisk subsystem for S-100 microcomputers. This system is built around the company's HDC-1001 error-correcting hard-disk controller board, which features an onboard microprocessor, multiple burst detection, up to 9-bit single burst correction, and data rates approaching 5 megabytes per second. A built-in 32-bit computer-generated polynomial is said to be able to detect and correct errors before the user is even aware of them. The HDC-1001 can control up to four drives and as many as eight read/write heads and is IEEE 696 [S-100] compatible.

The Winchester subsystem comes with the HDC-1001 controller board, connector cable, CP/M BIOS disk, and drive mechanisms. It's available in 5-, 10-, 20-, and 40-megabyte versions. The 5-megabyte model uses Seagate Technology's ST506 drive, and the 10- and 20-megabyte units feature the miniscribe ST506 drive. Prices begin at $1800; quantity discounts are offered. Contact Advanced Digital Corp., 12700 B Knott Ave., Garden Grove, CA 92641, (714) 891-4004. Circle 632 on inquiry card.

Tomorrowhouse Today

Tomorrowhouse is a turnkey home monitoring and control system from Compu-Home Systems. It's based on the Apple II computer and is made up of a plug-in circuit board, a junction box, hardware for hooksups, all the programs needed to set up and control your house, and installation and user manuals.

Tomorrowhouse lets you schedule heating and cooling systems up to nine weeks in advance with as many as 48 changes per day. You can automate your lights, appliances, and hot tub for maximum energy conservation. Complex heating and cooling and light/appliance schedules for different circumstances can be stored and recalled for execution whenever necessary. Verbal warnings and an easy-to-read graphics display of your home's floorplan with status information presented both graphically and verbally are provided by Tomorrowhouse. Convenience features include an appointment calendar, a voice wake-up call, and a record-keeping system that tracks each time Tomorrowhouse is boosted or an alarm detected.

Tomorrowhouse is available in kit form or dealers can provide turnkey installation. For individuals with Apple computers, kit prices start at less than $1000. For full details, contact Compu-Home Systems Inc., 3333 East Florida Ave., Denver, CO 80210, (303) 777-6600. Circle 633 on inquiry card.

Computer Camps

The following is a list of computer camps and where to send for complete information.

Camp Compuquest, POB 8161, Lexington, KY 40533, (606) 278-9933.
Champlain College Computer Camp, Shelley Richardson, Room #4A, Box 670, 163 South Willard St., Burlington, VT 05402, (802) 658-0800.
Computer Camp, Registrar, J. Hamilton Welch Academy, 3049 McGregor Blvd., Fort Myers, FL 33901, (813) 334-6044.
Computer Experience, Performance Designs Inc., 1411 North Main St., POB 124, Bluffton, IN 46714.
Hockaday Computer Camp, 11600 Welch Rd., Dallas, TX 75229, (214) 363-6311.
Lake Forest Computer Camp, Lake Forest College, Sheridan and College Roads, Lake Forest, IL 60045, (312) 234-3100.
Long Acres Computer Camp, Route 1, Box 320, Spotsylvania, VA 22553, (703) 582-5382.
National Computer Camp, POB 585, Orange, CT 06477, (203) 795-9677.
Tar Heel Career Camps Inc., POB 2328, Chapel Hill, NC 27514, (919) 967-6996.
Timbertech Computer Camp, 1287 Lawrence Station Rd., Sunnyvale, CA 94086, (408) 745-1110.
What's New?

Bulk Eraser Works Without Batteries, External Power
Nortronics' Model CMP-230 Computer Tape Bulk Eraser is a handheld unit with two strontium-ferrite magnets for quick erasures of standard-size cassette tapes. The magnets are divided into four quadrants of north and south poles and are positioned so that a cassette encounters 16 different flux fields as it passes through. This unit operates without batteries or external power supplies.

Circle 634 on inquiry card.

Tecmar Markets IBM PC Packages
Tecmar manufactures more than 60 peripherals and software packages for the IBM Personal Computer. Its hardware includes a high-speed, 5-megabyte removable-cartridge Winchester disk drive, a 15-megabyte Winchester system, high-resolution graphics, an Ethernet network interface, and a voice-recognition unit with a 100-word vocabulary. Tecmar's software includes such offerings as the Coherent DOS (a Unix look-alike with real-time extensions and multitasking capabilities) and support packages for laboratory hardware, an IEEE-488 interface, and an EPROM (erasable programmable read-only memory) gang programmer.

For information, contact Tecmar Inc., 23600 Mercantile Rd., Cleveland, OH 44122, (216) 464-7410.
Circle 635 on inquiry card.

Apple-Compatible Keyboard
The Model KB-200 detached keyboard is plug-compatible with the Apple II computer. Available directly from Key Tronic Corporation, the low-profile KB-200 has 83 keys, a combination cursor and standard numeric keypad, and an extra Return key for use as an Enter key. Cursor controls include diagonal movements. Eleven functions keys are provided for easy multiple-key functions, and a movable jumper causes the keyboard to output lowercase characters if the Apple is equipped to accept them. Standard features include sculptured, non-glare keytops with double-shot molded keys, full key travel with positive tactile feedback, N-key rollover, microprocessor electronics, solid-state capacitance, and a flexible cable.

With postage, the Model KB-200 costs $298. Contact Key Tronic Corp., POB 14687, Spokane, WA 99214. For ordering information, call (800) 262-6006; in Washington state, or for technical information, call (509) 928-8000.
Circle 636 on inquiry card.

Cursor-Positioning System Has Cordless Mouse
The Datawafer cursor-positioning system from Display Interface Corporation consists of an ultra-thin position detector and a cordless mouse. The mouse is powered by a self-contained recharge-
What's New?

able battery and is available with 1, 3, 4, 12, or 16 keys for inserting instructions and data. The Datawafer, only 0.2 inch thick, detects and transmits position information any time the mouse is within 3 inches of its surface. It comes with passive position-detecting elements, or it's available with electronic circuitry for signal conversion and for interfacing with data-processing systems. The optional electronics package can be supplied as a separate plug-in card, or it can be mounted on the bottom of the Datawafer, increasing its thickness to 0.75 inches.

Cursor and stylus versions of the positioning device are being developed, each of which will be completely interchangeable with the mouse. Complete information can be obtained from Display Interface Corp., 525 Post Rd., Milford, CT 06460, (203) 877-7661.

Circle 637 on inquiry card.

From the New England Woods

New England Wood Designs has introduced a line of handcrafted computer furniture, all in a variety of hardwoods and native pine. This line includes computer desks, printer stands, file drawers, and accessories.

The computer desk is available in two heights (26 or 29 inches) and can accommodate a disk drive and a number of accessories. It has adjustable shelves and a multiple-output AC-power bar. It measures 42 inches long and 30 inches wide. The printer stand features a paper-feed slot and paper storage shelf. Its dimensions are 26 by 16 inches and 26 or 29 inches high.

Desk prices begin at $350. The printer stand starts at $160. For further information, contact New England Wood Designs, RFD 1, Box 53, Greenfield, NH 03047, (603) 924-7367.

Portable Gold-Plating System

A compact, portable gold-plating system suitable for quick and safe replating of edge connectors or gold-plated surfaces has been introduced by Pace Inc. The PEP-220 Gold-Plating System is a self-contained package that includes noncontaminating electrode assemblies, conductive and plating tape, power cord, case, tray, and gold-plating, electro-cleaning, and nickel-plating solutions. The unit comes with the PPS-76 power source, which provides precise DC outputs for each solution.

The PEP-220 is being marketed through Pace representatives. For further details, contact Pace Inc., 9893 Brewers Court, Laurel, MD 20707, (301) 490-9860.

Circle 638 on inquiry card.

FOREIGN

Bimonthly Lists Published Programs

The Small Computer Program Index is a bimonthly index of printed program listings from a wide range of United Kingdom and American magazines and books. Subjects covered include science, social science, business and management, education, games, home applications, text and word processing, mathematics, statistics, and utilities. Most of the programs are in BASIC but are said to be equally applicable to mainframe computers that support BASIC, FORTRAN, and ALGOL.


Circle 639 on inquiry card.
**First 32-Bit Business Computer Unveiled**

Mitsubishi Electric Corporation has announced the availability of the Model 500. Japan's first small-business computer using 32-bit architecture. System hardware includes 16 megabytes of logical space using a virtual storage-control system, a main-memory capacity of up to 8 megabytes, a magnetic disk drive capable of accommodating a large-capacity file of up to 4.8 gigabytes, and a 12-megabyte-per-second transfer time. Up to 128 terminals (64 inline workstations and 64 online circuits) can be connected to the Model 500. For office automation, the Model 500 has Japanese word processing and business graphics capabilities. When running the DPS 10 processing system and relational database, the Model 500 is said to have the performance of a medium-sized general-purpose computer. DPS 10 enables five-dimensional multiprocessing: workstation, timesharing, transaction, remote-batch processing, and local-batch processing. High-level language support includes Mitsubishi's Duet conversational user language, COBOL, and FORTRAN.

Options include an 8K-byte cache memory. For details, contact Mitsubishi Electric Corp., 2-3, Marunouchi 2-chome, Chiyoda-ku, Tokyo. 100 Japan; tel: Tokyo (218) 2171; Telex: J24532. Circle 640 on inquiry card.

**128K-Byte Computer Packed on Eurocard**

The Quark/100 from Megatel is an 8-bit, 128K-byte CP/M-compatible computer packed onto a single Eurocard. Megatel based the Quark/100 on the 6-MHz Zilog Z80B processor and used three PAL (programmable array logic) circuits and gate-array technology to squeeze all memory, disk, display, and I/O functions onto a standard 100 mm by 160 mm Eurocard.

The Quark/100 has a dual-mode alphanumeric/graphic video-display interface with a software-programmable character set. The display operates in an 80-column by 28-line format that's backed by a bit-mapped graphics mode using 24K bytes of dedicated RAM (random-access read/write memory).

You can connect the Quark/100 to any standard display with its direct-drive and composite video outputs, and it has inputs for encoded or wire-only keyboards. Standard features include single- and double-density 5¼- or 8-inch floppy-disk interfaces, full-duplex and simplex RS-232C serial ports, a parallel port for a printer, and 22 general-purpose I/O lines for applications flexibility. For special-purpose peripherals, access to the central processor's address, data, and control buses is provided.

The Quark/100 is $595 (U.S.). A complete package with a transition board, connector, installation software, CP/M 2.2, and BIOS source listings costs $995. A version with a color video-display interface with red/green/blue video outputs can be ordered. A 1-megabit-per-second network interface can be added to the Quark/100. Contact Megatel Computer Corp. Inc., 150 Turbine Dr., Toronto, Ontario M9L 2S2, Canada, (416) 745-7214. Circle 642 on inquiry card.
What's New?

Energy-Management Module
An IEEE 696 (S-100) compatible energy-management module, the Model 100-EMM, is available from Fulcrum Computer Products Ltd. The module provides temperature-sensing facilities at four remote locations, relay or optoisolator on/off control for six external devices, and an eight-source fire or intruder alarm. Battery backup of the 100-EMM enables the alarm to operate independently of the host computer. The alarm has a 50-millisecond dwell period and three operating conditions. Temperature-sensing functions are provided by means of four pairs of contacts connected to thermistor-sensing transducers. Six relays, rated at 28 amperes, operate independently under software control and can handle air conditioners, water heaters, and so on.

The 100-EMM will verify the condition of up to eight sensors for fire alarm or intruder systems. Sensor inputs are equipped with protection circuits that will withstand transient switching voltages. It's suitable for use in industrial-control applications. RFI (radio frequency interference) suppression circuits are included to eliminate false triggering from nearby radio sources.

For further details on the 100-EMM module, contact Fulcrum Computer Products Ltd., Fulcrum (Europe), Valley House, Purleigh, Essex CM3 6QH, England; tel: (0621) 828763; Telex: 995411. Circle 643 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.
### IBM PC
- IBM PC System includes 64K IBM-PC with 320KB Floppy Disk Drive, Controller, Color Graphics Card, Monochrome Monitor. All for only $2490

### LOTUS 1-2-3 Software
- Call

### HARD DISKS FOR APPLE AND IBM
- DAVONG
  - 5 MB $1790
  - 10 MB $1990
  - 15 MB $2790

### MEMORY BOARDS
- AST
  - Full 512K $590

### EPSON (W/GRAFTRAX PLUS)
- MX 80 FT $490
- FX 80 FT $575
- MX 100 FT $690
- FX 100 FT $790

### OKIDATA
- 82A $440
- 93A $690
- 84A $975
- 92A $575

### BROTHER HR-1
- $760

### SMITH CORONA
- TP 1 $560

### STAR MICRONICS
- Gemini III $370
- Gemini IV $540

### SPINWRITER
- 7710-1 Call 3510 Call
- 7715-1 3515
- 7720-1 3520...
- 7725-1 3525...
- 7730-1 3530...
- 3550
- PC 8023A

### PRINTERs
- C-ITOH
  - 8000 (60 CPS) Matrix $240
  - 6900 $460
  - 12110 1/4" $690
  - 14100 (40 CPS) Letter Quality $1390
  - 14100 (60 CPS) Letter Quality $1690

### EPSON (W/GRAFTRAX PLUS)
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- Gemini III $370
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What's the Creator of the Walkman® Doing Now?

Getting ready for another smash hit, of course. Toshiaki Kamijo, creator of the Walkman®, has teamed up with the SORD Corporation, Japan's 2nd largest manufacturer of desktop computers, to develop an exciting new personal computer. So small it could rest on this magazine, light enough to tuck in your briefcase, and designed with an attention to quality that is unique, the M5 computer is a joy to own. Connect to a color TV or color monitor and enjoy instant BASIC, spreadsheet calculations (with optional FALC cartridge), or video games.

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Uses industry standard 4116 RAMs. All 64K is available to the user, our VIDEO and EPROM sections do not make holes in system RAM. Also, very special care was taken in the RAM array layout to eliminate potential noise and glitches.

Z-80 CPU
Running at 2.5 MHz. Handles all 4116 RAM refresh and supports Mode 2 INTERRUPTS. Fully buffered and runs 8580 software.

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Full 2 channels using the Z80 SIO and the SMC 8116 Baud Rate Generator. FULL RS232. For synchronous or asynchronous communication. In synchronous mode, the clocks can be transmitted or received by a modem. Both channels can be set up for either data-communication or data-terminals. Supports mode 2 int. Price for all parts and connectors: $39.95

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Consists of separate parallel port (220 PIO) for use with an ASCII encoded keyboard for input. Output would be on the 80 x 24 Video Display.

BLANK PC BOARD – $119
The blank Big Board PC Board comes complete with full documentation (including schematics), the character ROM, the PFM 3.3 MONITOR ROM, and a diskette with the source of our BIOS, BOOT, and PFM 3.3 MONITOR.

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With a crisp, flicker-free display that looks extremely sharp even on small monitors. Hardware scroll and full cursor control. Composite video or split video and sync. Character set is supplied on a 2716 style ROM, making customized fonts easy. Sync pulses can be any desired length or polarity. Video may be inserted or true 5 x 7 Matrix – Upper & Lower Case.

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LEARN 16 BIT TECHNOLOGY IN EASY LOW-COST STEPS. This 2-board system features (1) a ROM-based board with a 5-hour expansion bus that can accept any hardware designed for the IBM AT and (2) a 2-board system (expandable to 5 boards) memory board that allows features on IBM compatible RS/232 communications ports. All circuits are functionally equivalent to the IBM AT and can be used for the IBM AT. This means that all programs written in basic designed to run in an IBM can be compiled to run in this system and be run on any IBM AT. This system requires a little extra programming for these modifications, but not only does it allow ease of debugging and ease of use, but also ease of programming for those who want to learn or who already know how to program.

The EXPLORER 88-PC STARTER'S KIT includes a mouse board, memory I/O board, all components needed, schematics for I/O board, user manual, and complete assembly instructions. Instructions are included in the manual on how to set up the Explorer 88-PC system so you can start programming and debugging your programs. The commands include modify memory... modify display registers, input output data to I/O ports. The EXPLORER 88-PC is a truly portable system that allows you to program and debug your programs on your desk or on the go.

The EXPLORER 88-PC is fully IBM compatible. These items require only additional power supplies and are only available and tested as follows:
- IBM compatible keyboard: $99.95 + $10.00 shipping
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<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
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<tr>
<td><em>Kangaroo</em> (w/brary case) SS/DD</td>
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<td>DS/DD</td>
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<td>Elephant SS/DD</td>
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**MODEMS**

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<td>Hayes: MicroModem II</td>
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<td>with Terminal Program</td>
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<tr>
<td>Hayes Smartmodem: 300 Baud</td>
<td>$199.00</td>
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<tr>
<td>1200 Baud</td>
<td>$505.00</td>
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<tr>
<td>Novation: J-Cat</td>
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<td>Applecat II</td>
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<td>Smartcat 1200 Baud</td>
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<td>Hayes Chronograph</td>
<td>$179.00</td>
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</tbody>
</table>

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|----------------|--------------|
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| 300A Amber     |              | $155.00 |
| 310G Green     |              | $175.00 |
| 310A Amber     |              | $175.00 |
| Zenith: 12" Green |              | $99.00 |
| US: Amber      |              | $159.00 |
| *Tarmac: Amber* |              | $139.00 |
| PGS: RGB Monitor |            | $CALL |
| BMC: Green 12" |              | $80.00 |

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| Make           | Model        | Price |
|----------------|--------------|
| Apple:         | Fourth Dimension: w/o controller | $250.00 |
|                | w/ controller | $319.00 |
| Rana Elite I:  | w/o controller | $270.00 |
|                | w/ controller | $339.00 |
| IBM:           | *Tandon TM-55* | The New Thin-Line | $235.00 |

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SAVE ON WABASH DISKETTES
Product Description

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Part #</th>
<th>CE amount $ per disc</th>
</tr>
</thead>
<tbody>
<tr>
<td>8” SSSD IBM Compatible (128 B/S, 26 sectors)</td>
<td>F111</td>
<td>1.99</td>
</tr>
<tr>
<td>8” Same as above, bulk pack w/o envelope</td>
<td>F111B</td>
<td>1.79</td>
</tr>
<tr>
<td>8” SSSD Shugart Compatible, 32 Hard Sector</td>
<td>F131</td>
<td>2.49</td>
</tr>
<tr>
<td>8” SSSD IBM Compatible (128 B/S, 26 sectors)</td>
<td>F14A</td>
<td>3.79</td>
</tr>
<tr>
<td>8” DSDD Soft Sector (Unformatted)</td>
<td>F144</td>
<td>3.19</td>
</tr>
<tr>
<td>8” DSDD Soft Sector (256 B/S, 26 sectors)</td>
<td>F145</td>
<td>3.19</td>
</tr>
<tr>
<td>8” DSDD Soft Sector (512 B/S, 15 sectors)</td>
<td>F147</td>
<td>3.19</td>
</tr>
<tr>
<td>8” DSDD Soft Sector (1024 B/S, 15 sectors)</td>
<td>F147</td>
<td>3.19</td>
</tr>
<tr>
<td>5w” SSDD Soft Sector with Hub Ring</td>
<td>M11A</td>
<td>1.58</td>
</tr>
<tr>
<td>5w” Same as above, bulk pack w/o envelope</td>
<td>M11AB</td>
<td>1.39</td>
</tr>
<tr>
<td>5w” SSDD 10 Hard Sector with Hub Ring</td>
<td>M41A</td>
<td>1.58</td>
</tr>
<tr>
<td>5w” SSDD 16 Hard Sector with Hub Ring</td>
<td>M51A</td>
<td>1.50</td>
</tr>
<tr>
<td>5w” SSDD Lanier No-problem compatible</td>
<td>M51F</td>
<td>2.99</td>
</tr>
<tr>
<td>5w” SSDD Soft Sector with Hub Ring</td>
<td>M13A</td>
<td>1.89</td>
</tr>
<tr>
<td>5w” Same as above, bulk pack w/o envelope</td>
<td>M13AB</td>
<td>1.69</td>
</tr>
<tr>
<td>5w” SSDD Soft Sector Flippy Disk (use both sides)</td>
<td>M18A</td>
<td>2.79</td>
</tr>
<tr>
<td>5w” SSDD 10 Hard Sector with Hub Ring</td>
<td>M43A</td>
<td>1.88</td>
</tr>
<tr>
<td>5w” SSDD 16 Hard Sector with Hub Ring</td>
<td>M51A</td>
<td>1.89</td>
</tr>
<tr>
<td>5w” DSDD Soft Sector with Hub Ring</td>
<td>M14A</td>
<td>2.79</td>
</tr>
<tr>
<td>5w” DSDD 10 Hard Sector with Hub Ring</td>
<td>M44A</td>
<td>2.79</td>
</tr>
<tr>
<td>5w” DSDD 16 Hard Sector with Hub Ring</td>
<td>M54A</td>
<td>2.79</td>
</tr>
<tr>
<td>5w” SSDD Soft Sector with Hub Ring (56 TPI)</td>
<td>M15A</td>
<td>2.68</td>
</tr>
<tr>
<td>5w” DSDD Soft Sector with Hub Ring (66 TPI)</td>
<td>M16A</td>
<td>3.79</td>
</tr>
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8" FLOPPY DISK DRIVE CABINET

Compare these features listed and you'll see why this cabinet is our FINEST DISK CABINET

- Positive Pressure Filter Filing
- Power Supply-4V @ 5.5A or 24V @ 4A
- Each output individually fused
- Hinged top for easy access
- Heavy duty 990 aluminum cabinet
- Modular power connectors

STANDARD UNIVERSAL DISK ENCLOSURE

List Price: $695.00

With augmented power supply and case cost, the reliable operation...

MP10 5 1/4" DISK DRIVES

MP10801 Single-Sided Double-Density 43 990.00
MP10802 Double-Sided Double-Density 990.00
MP10803 Single-Sided Double-Density 790.00
MP10804 Double-Sided Double-Density 1490.00

The first 5 1/4" drive disk drive allows for mounting under the keyboard or on the desk. NO AC required. 43V to 24VDC only.

MP10805 (Shipping Weight: 0 lbs.)

TANDON

8-INCH THIN LINE

Exactly one-half the height of any other model. Proprietary, high-resolution, read-write heads patented by Tandon.

TANDON 6" DRIVES

TANDON 1050 Single-Sided 2400K 990.00
TANDON 1051 Single-Sided 2400K 990.00
TANDON 1052 Double-Sided 4800K 990.00
TANDON 1053 Double-Sided 4800K 990.00

TANDON 5 1/4" DRIVES

TANDON 1000 Single-Sided 2000K 990.00
TANDON 1001 Single-Sided 2000K 990.00
TANDON 1002 Double-Sided 4000K 990.00
TANDON 1003 Double-Sided 4000K 990.00

TANDON 8" HALF HEIGHT FLOPPY CABINET

- 4V @ 4A 990.00
- Fan cooled 990.00
- Socketed power connections 990.00
- All supplies regulated 990.00

TANDON 8" Half Cabinet (2400K) $165.00

RETAIL STORE PHONE NUMBERS: (Chatsworth) (213) 709-5464 - (Irvine) (714) 660-1411
**IBM MULTICARD**

**Vise**™ **MEMORY & I/O CARD**

- 64K RAM Expandable
- Real Time Clock
- Calendar with Battery Backup
- One Parallel Printer Port

**SALE PRICE:** $299.00

- 40 columns x 25 lines
- Parallel interface
- Serial interface
- Keyboard interface
- Turbo Processor
- Dual Processor
- One Processor

**LIMITED EDITION**

**IBM MAXICARD**

**Vise PERSONAL COMPUTER RAM CARD**

- Runs at full speed with no wait states
- Parity can be disabled at User's option
- On board parity bit on each Byte
- Fully expanded, a full 576K on one card
- One board 668 MHz primary RAM address space available
- Full Vista 120 Day Warranty

**SALE PRICE:** $199.00

**IBM**

**MEMORY 6 I/O**

**MULTICARD**

**16 PIN GOLDB and TIN DIP SOLDELSocket**

**SALE PRICE:** $99.00

**EIA/RS232 WALL PLATES**

(Does not include connectors)

**SALE PRICE:** $299.00

**TEXAS INSTRUMENTS**

**13 PIN GOLDB and TIN DIP SOLDELSocket**

**SALE PRICE:** $99.00

**DIRECT CONNECT MODEM**

**MURA**

**SALE PRICE:** $195.00

**AXOIM CORPORATION**

**5 1/4" FLOPPY DISKETTES**

**SALE PRICE:** $395.00

**STAR MICROS**

**Circuit Board 100CPS**

**DOUBLER DENSITY!**

- Features:
  - Includes replacement ring
  - Wires protect with tabs
  - 100% Surface tested
  - Lifetime warranty

**SALE PRICE:** $395.00

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**ORDER TOLL FREE (800) 425-5922 - CA, AK, HI CALL (213) 709-5111**

Terms: U.S. Visa, MC, BC, Check, Money Order, U.S. Funds Only. CA residents add 9.25% Sales Tax. MINIMUM SHIPPING & HANDLING OF $3.00 for the first 10 lbs plus 40¢ for each additional pound. Orders over $50 lbs must be freight collect. If not specified, please include your telephone number. All sales subject to change without notice. We will do our best to maintain prices through May, 1983. Credit Card orders will be charged approximate weight. If you have a return receipt, you will receive your Refund of 10% of the price of the item. If you have a return receipt with 10% of the price of the item.
PURE SPEED
That's what you get when you operate this subsystem. Imagine data access virtually without wait! By using DMA technology, the actual time required to send and retrieve data is greatly reduced. With the additional speed and high density of the 5¼” Winchester disk drive from COMPUTER MEMORIES, you will have enormous files at your fingertips without the frustration of searching for the right floppy disk! The throughput of this subsystem is further increased by having all low level disk drive routines resident on the DMA controller, thus relieving the computer for other tasks.

COMPATIBILITY
MORROW DESIGNS engineers have invested thousands of man-hours to assure that this M16 hard disk subsystem will be compatible with almost all S-100 IEEE/696 computer systems. Each M16 hard disk subsystem is supplied with CP/M 2.2™, and MICROSOFT BASIC V5.2™. MORROW DESIGNS has even included an INSTALL program on 8” disk so you can easily custom configure your M16 subsystem to operate flawlessly with any system that is fully IEEE/696 compatible and has no other DMA devices on line. North Star compatible INSTALL package available by special order.

EXPANDABLE
The M16 subsystem can grow with your needs. The DMA controller can operate up to four drives at one time. Just imagine — 64 MBytes on line! Also, as technologies progress, you will be prepared with a controller designed with the future in mind.

KEY FEATURES:
- DISCUS M16: Computer Memories CM15616, 16Mb formatted capacity
- Same physical size and mounting as the minifloppy
- Same DC voltages as the minifloppy
- Band actuator and stepper motor head positioning
- 5.0 megabits/second transfer rate
- Same track capacity as a double density 8 inch Floppy
- 170 milliseconds random average access time, reducible to 95 ms via a simple software algorithm

CONTROLLER:
- Fully compatible with high speed 6MHz and 8 MHz CPUs of today and tomorrow
- DMA bus arbitration as outlined by the IEEE 696 standard
- Controls 1 to 4 soft sectored Winchester drives
- Variable sector length (256, 512, 1024, or 2048 byte sectors)
- Automatic CRC generation and checking
- Addresses 1 to 16 heads
- Addresses an infinite number of tracks
- 24-bit address burst DMA transfers
- Due to the high transfer rate, a minimum CPU speed of 2.5MHz is required

There are price barriers to be broken, and then there are PRICE BARRIERS TO BE S-H-A-T-T-E-R-E-D!! Priority One Electronics prides itself on breaking price barriers — but never like the one you see here! We're talking about 16 M-E-G-A-B-Y-T-E-S FOR ONLY $1595.00!! That's the storage capacity of THIRTY TWO Shugart SA801Ts — at one tenth the price! And there can be no comparisons between the performance of this system and floppy disk drives!

WITH CP/M 2.2™ AND MICROSOFT BASIC V5.2™
NO KIDDING!
16,000,000 BYTES FOR
ONLY $1595.00
LIST PRICE: $2995.00 (Shipping Weight 20 lbs.)
SAVE $1400.00!!

DON'T WAIT!!!
WE HAVE PURCHASED ANOTHER PRODUCTION RUN — AS WE SOLD OUT THE LAST ONE IN LESS THAN A MONTH!!
BKP1535 SPECIFICATIONS:
- 35MHz response, usable beyond 50MHz
- 2 mV/cm vertical sensitivity
- Signal delay line for accurate view of high frequency pulse train edge
- Alternate trigger capability
- Automatic or manual selection of CHOP AND
- ALTERNATE dual-trace display
- Variable hold-off for accurate pulse train display
- Video sync separators
- Built-in triggering filters
- A/D CRT with P31 phosphor
- DC and direct probes included
- Differential input capability

35 MHz DUAL TRACE - TRIGGERED
BKP1535 List Price: $950.00
$695.00
(SHIPPING WEIGHT 20 lbs.)

SAVE $255.00!
INCLUDING REBATE

BKP1535 SPECIFICATIONS:
- Delayed sweep operation for sweep expansion up to 1000V
- 5 mV division sensitivity selectable
- 2 mV to 20MHz
- Variable hold-off pulse train display
- Single-sweep for nonrepetitive waveforms
- Built-in triggering filters
- Video sync separator standard
- DC and ALTERNATE display
- Differential Input capability
- 11.7 nS rise time for short duration pulses
- Alternate trigger capability
- Front panel x-y operation
- 0.1:1 reference/direct probes included

30 MHz DUAL TRACE - DELAYED SWEEP
BKP1535 List Price: $950.00
$625.00
(SHIPPING WEIGHT 20 lbs.)

SAVE $325.00!
INCLUDING REBATE
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**STATIC RAMS**

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**DYNAMIC RAMS**

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**EPROMS**

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**DISC CONTROLLERS**

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**CART CONTROLLERS**

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**EPROM ERASERS**

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**EARLY AVM-1014**

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**CONNECTORS**

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**FUNCTION**

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**594 BYTE May 1983**

Circle 245 on inquiry card.
NEW UN-USED ISOLATORS

MUFFIN FANS

DIODES

OPTO-ISOLATORS

CAPACITORS

TANTALUM

DISC

ELECTROLYTIC

RADIAL

ANIAL

0.1uF-mono 50V .18 47uF-mono 50V .25

COMPUTER GRADE

25,000uf 30V 3.35 6000 16V .65

2732 32K EPROM $495

2764 64K EPROM $995

WIREWRAP CARDS

FR-4 Epoxy Glass Laminate
With Gold-Plated Contact Fingers

S-100 BUSS

P100-1 Bare No Foil Pads ................. 15.95
P100-2 Horizontal BUSS ................. 22.95
P100-3 Vertical BUSS ................. 22.95
P100-4 Single Foil Pads Per Hole ........ 23.95

APPLE

P500-1 Bare No Foil Pads ................. 15.95
P500-3 Horizontal BUSS ................. 22.95
P500-4 Single Foil Pads Per Hole ........ 23.95

IBM

IBM-PR BUSS Lines + Pads ................. 55.00

GENERAL PURPOSE

22/44 PIN (.156" SPACING)
P441-3 Vertical BUSS, 4.5" x 6" ........ 13.95
P442-3 Vertical BUSS, 4.5" x 9" ........ 14.95
36/72 PIN (.1" SPACING)
P721-3 Vertical BUSS, 4.5" x 6" ........ 13.95
P722-3 Vertical BUSS, 4.5" x 9" ........ 14.95

IF YOU CAN FIND A PRICE LOWER ELSEWHERE,
LET US KNOW AND WE WILL MEET OR BEAT
THEIR PRICE! (SEE TERMS BELOW)

OPTO-ISOLATORS

M4301 1.00 MCA-7 1.59
M4271 1.10 MCA-255 1.75
M4131 .95 ITO-47 3.57
M4431 .95 ITO-155 1.25
MCT-2 1.00 T1L-111 1.00
MCT-3 1.50 T1L-113 1.75

DIODES

1N3711 .51 roll zener ....... 25
1N3713 .52 roll zener ....... 25
1N4148 (1N4148) switching 25.00
1N4144 404PIV rectifier 10.00
KB2200 200PIV 1.5amp bridge .45
KB2300 400PIV 1.5amp bridge .55

MUFFIN FANS

NEW-UNUSED

4.68" Square 14.95
3.125" Square 14.95

SWITCHES

SPDT mini-toggle 1.25
DPDT mini-toggle 1.50
SPDT push-button 1.49

HEAT-SINKS

DIP SWITCHES

4 POSITION .95
2 POSITION .95
10 POSITION .95

RESISTORS

1/4 WATT 5% CARBON FILM ALL
STANDARD VALUES
FROM 1 OHM TO 10 MEG OHM
50 PCS SAME VALUE .025
100 PCS SAME VALUE .015
1000 PCS SAME VALUE .005

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HOURS: M-W-F, 9-5 T-Th, 9-9 Sat. 11-3

PLEASE USE YOUR CUSTOMER NUMBER WHEN ORDERING
TERMS: For shipping include $1 for UPS Ground or $2 for UPS Blue Label Air. Items over 5 pounds require additional shipping charges. Foreign orders, include sufficient amount for shipping. There is a $10 minimum order. Bay Area and Los Angeles Counties add 6% Sales Tax. Other California residents add 6.5% Sales Tax. We reserve the right to substitute manufacturer. Not responsible for typographical errors. Prices subject to change without notice. We will match or beat any competitor's price provided it is not below our cost.
### DISK DRIVES

**TANDON**
- TM100-1 5½" (FOR IBM) $229.00
- TM100-2 5½" (FOR IBM) $295.00

**SHUGART**
- SA 400L 5½" (40 TRACK) $199.95
- SA 400 5½" (55 TRACK) $189.95

**SIEMENS**
- FD100-6 8" $105.00 (NOT REPLACEMENT) $259.00
- FD-200 5½" $179.95
- FD-250 5⅝" $199.95

**MPI**
- MP-52 5½" (FOR IBM) $295.00

**CABINETS FOR 5¼" DISK DRIVES**

- CABINET #1 $29.95
  - Dimensions: 8⅝ x 5½ x 3⅞" in.
  - Color matches Apple
  - Fits standard 5¼" drives, incl. Shugart
  - Includes mounting hardware and feet

- CABINET #2 $79.00
  - Complete with power supply, switch, line cord, fuse & standard power connector
  - Dimensions: 11½ x 5⅝ x 3½" in.
  - +5V @ 1 AMP, +12V @ 1.5 AMP
  - Fits standard 5¼" drives
  - Please specify gray or tan

**RIBBON CABLE**

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**D-SUBMINIATURE**

**IDC CONNECTORS**

**POWER SUPPLY**

**MODEL 2 $39.95**

- Mounted on PC board manufactured by Conver
- 5V VOLTM 4 AMP +12V 1 AMP

**JDR SPRING SPECIALS**

**SA400 $189.95**

- 35 Tracks
- Repeat of a Sellout
- Limited Supply (Again)
- Modify for use in Apple (experienced technicians only)
- Use with cabinet #1 to make a beautiful Apple Compatible drive

**MEMORY SALE**

- 2114 400NS (TMS4040) $8.95 ea.
- 2120L-4 low power 400NS $5.55 ea.
- 4164 200NS $5.95 Z80A-CPU 11.95
- HM6116-4 200NS $4.75 8085 3MHZ 3.95
- TMM2016 200NS $4.15 8085 5MHZ 5.95
- 2732 400S $4.95 8085 7MHZ 7.95
- TMS2532 420NS $5.95 68000 3.95
- 2764 400NS $9.95 68000 5MHZ 9.95

**COMPONENTS**

- LM1488 or LM1489 .69 ea. 780ST or 7812T .75 ea.
- 16 pin low profile IC sockets 100/8.00
- 16 pin toed wire IC sockets .49 EA.

**FOR ORDERING INSTRUCTIONS:**

Spring specials are good only until May 31, 1983.

**BEST SELLING BOOKS**

- Apple II User's Guide
- CRT Controller's Handbook
- 6800 Assembly Language Programming
- CBASIC User's Guide
- SYBEX

**TRANSFORMERS**

- Frame Style
  - 12VAC 2amp $4.95
  - 12VAC 5amp $5.95
  - 12VAC 1amp $7.95
- Plug Case Style
  - 12VAC 350ms $3.95
  - 12VAC 500ms $4.95
  - 12VAC 1amp $5.95
  - 12VAC 3amp $6.95
- DC Adapter
  - 9, 12 VDC selectable with universal adapter $8.95

**RIBBON HOODS**

- Male female $1.25
- Male male $2.05
- Female female $3.75

**CONTACTS 9**

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Insert the number of contacts in the position marked "# of" of the "order by" part number listed.

Example: A 10 pin right angle solder style header would be IDH10SPL.
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FOR SALE: AM6485, 28R of state RAM, plus assemble and PLUS PROMS, all documents, one year old 1425 Ron Dai, 63 Maplewood Ave., Cranston. R 02920

FOR SALE: Doublevision 8-column card for Apple II with Doublevision version of Apple II 2.0 word-processing software, 1200 Alia Integra BASIC firmware card 550 Dr. Steven Sight, Department of Physics and Astronomy. Washburn Col­lege, Waukesha, WI 53186

FOR SALE: Inteligent Systems Corporation color-graphic computer systems: Compaq II with 12K memory, 5 1/4-inch disk drive, and 72-key keyboard. Integ ertion 16K with 32K memory, 8-inch disk drive, and 177-key keyboard. Compaq II with 16K memory, 72-key keyboard. Color graphics display, BASIC/COM (in ROM). RS-232 interface, full software, and documentation will pay in 10%-down shipping U.S. (Daryl Nadonshock, 1840 4th Ave, Carrollton, PA 15108)

WANTED: 425 ZDS 140 Development system number 05-561-63. Please send price and details. Billy Adams, 52 Boeroldtstraat, B 8300 Herstal, Belgium. Tel. 056/223317

FOR SALE: OS/24 Superboard computer, 4 5A power supply, KIT 204 computer and programs. 1900 Studio II disk card and cartridge. 320 Tom Realsch, 6337-820 ro S. Cottage Grove, MN 55010

FOR SALE: Two Heilman-Nelson Lazer, 2-mW laser visible red output, 1100 each or will trade Electronic Systems and laser knowledge required for sale operation Jim Bonner, 1025 North Dickson St., Tuscaloosa, AL 35401, (205) 343-1894

FOR SALE: IBM Selectric printer purchased as a Date 1035 terminal. It includes a printer (which also doubles as a Selectric typewriter), complete Dan and IBM documentation, and an IBM set and documentation to convert IBM to a Selectric typewriter code to parallel ASCII. M. Gene Nelson, 74 Bran St. Ph. 207-728-2121

FOR SALE: Apple IIe. Evidently these new products generated just as much interest among BYTE readers. Gregg Williams won first place in the February BOMB contest for his Product Description of “The Lisa Computer System.” As a staff member he is ineligible for the $100 prize. Second place goes to Robin Moore for his review of “Apple’s Enhanced Computer. The Apple IIe.” He will receive the $50 award. Chris Morgan, Gregg Williams, and Phil Lemmons earned third place for their interview with three key members of Apple’s engineering team: “An Interview with Wayne Rosing, Bruce Daniels, and Larry Tesler.”
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<td>Paul McPherson Jr</td>
<td>(617) 262-1160</td>
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<td>McAuliffe-Hill Publications</td>
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<td>ATLANTIC</td>
<td>Eugene Dunn</td>
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<td>McAuliffe-Hill Publications</td>
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<td>Dick Maguire</td>
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<td>SOUTH</td>
<td>Jack Anderson</td>
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<td>McAuliffe-Hill Publications</td>
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<tr>
<td>Italy</td>
<td>Mrs. Maria Sarmento</td>
<td>E: <a href="mailto:mail@italy.com">mail@italy.com</a></td>
</tr>
<tr>
<td>Spain</td>
<td>Pedro Telles M.</td>
<td>P: +34 12345678</td>
</tr>
<tr>
<td></td>
<td>Iberia Mart 1</td>
<td>E: <a href="mailto:mail@spain.com">mail@spain.com</a></td>
</tr>
<tr>
<td>Madrid</td>
<td>Mr. Andre Karr</td>
<td>E: <a href="mailto:mail@madrid.com">mail@madrid.com</a></td>
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<tr>
<td>Southern CA, AZ, NM, LAS VEGAS</td>
<td>Karen Niles</td>
<td>(415) 586-2222</td>
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<td></td>
<td>Pacificcoast Publishing Co</td>
<td>E: <a href="mailto:mail@ca.com">mail@ca.com</a></td>
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<td></td>
<td>McAllister-Allen</td>
<td>P: +1 213</td>
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<td></td>
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<td>E: <a href="mailto:mail@ca.com">mail@ca.com</a></td>
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<td></td>
<td>Larry Allen</td>
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<tr>
<td>Tom Harvey</td>
<td>(808) 586-2222</td>
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<td></td>
<td>3463 State St.</td>
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