A new small computer that won't limit you tomorrow

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  - additional memory
  - additional interfaces for telecommunications, data acquisition, etc.
- Small size

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Believe it or not, this new computer even offers multi-user capability when used with our advanced CROMIX* operating system option. Not only does this outstanding O/S support multiple users on this computer but does so with powerful features like multiple directories, file protection and record level lock. CROMIX lets you run multiple jobs as well.

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- Completely compatible file,
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- Extensive subsystem support

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hierarchical directories. It's a tree struc­
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directories, and device files. File,
device, and interprocess I/O are com­
patible among these file types (input and
output may be redirected inter­
changeably from and to any source or
destination).

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directories to be maintained for different
users or functions with no chance of
conflict.

PROTECTED FILES
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e of the file system, CROMIX maintains
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directory. All files can thus be protected
from access by other users of the
system. In fact, each file is protected by
four separate access privileges in each
of the three user categories.

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FAST ACCESS
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languages that operate under CROMIX.
These include a high-level command
process language and extensive sub­
system support such as COBOL, FORTRAN
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There is even our highly-acclaimed
‘C’ compiler which allows a program­
er fingertip access to CROMIX system
calls.

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generation of microcomputer operating
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touch with your Cromemco rep today.

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March 1982

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March 1982 © BYTE Publications Inc
In This Issue

Hard copy was once considered a luxury by computer hobbyists, but now the ability to record program listings and text on paper is seen as almost a necessity. And though you’re not likely to find a printer like the one Robert Tinney pictured on this month’s cover, you’re sure to find one from the many available that will fit your needs.

For a rundown on what’s around, see Curtis Feigel’s printer directory. For a look at a new approach to printers, see Ed Umlor’s review of the Prism Printer. We’ve also included a report on custom and standardized forms: where to get them and how to use them. And we have an article on programming your computer to fill in forms.

The Atari Tutorial continues with Part 7: Sound; William Barden Jr. discusses building a half-year clock for the Color Computer in the fourth article in his series on Radio Shack computers; in Part 2 of the “Input/Output Primer” Steve Leibson discusses interrupts and direct memory access; and Steve Ciarcia writes about using voiceprints to analyze speech. Don’t miss our quarterly games feature, “BYTE’s Arcade,” plus our regular items and reviews.

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BYTE, Product Review

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The Microprocessor's Tenth Birthday

by Chris Morgan, Editor in Chief

"... Intel introduces an integrated CPU complete with a 4-bit parallel adder, sixteen 4-bit registers, an accumulator, and a push-down stack on one chip. It's one of a family of four new ICs which comprise the MCS-4 microcomputer system—the first system to bring you the power and flexibility of a dedicated general-purpose computer at low cost in as few as two dual in-line packages..."

—from the first microprocessor advertisement in the November 15, 1971 issue of Electronic News

It's hard to believe, but the microprocessor celebrated its tenth birthday this past November. The event slipped by with little comment from the technical press. We nearly missed it ourselves in the rush to keep up to date in an industry that refuses to slow down and wait for anyone. Nevertheless, it's staggering to realize that ten years have gone by since the calculating powers of the computer were first squeezed onto a small square of silicon. The first microcomputer was actually a family of four integrated circuits known collectively as the "MCS-4 system." It consisted of the 4004 CPU (central processing unit) that featured a set of 45 instructions, the 4001 ROM, the 4002 RAM, and the 4003 shift register.

Ironically, it was a Japanese calculator company called Busicom (now out of business) that spurred the creation of the microprocessor. As Ted Hoff Jr., inventor of the 4004, put it, "The development came as all good ideas do. I looked at a customer's proposed design and said, 'There ought to be a better way.'"

The "better way" came about in 1971 when Busicom contracted the newly formed Intel company to develop a family of integrated circuits that Busicom could use in a proposed line of programmable calculators. The Japanese company had already designed the calculator with about a dozen proposed MOS chips, and it wanted Intel to complete the design. Intel had only two designers at the time, though, and probably would have been hard pressed to design the chips quickly enough if it had not been for Hoff's inspiration. It was all related to Hoff's admiration for the architecture of DEC's PDP-8, a mini-
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Editorial

computer he had been using for some time. “The PDP-8 was a nice machine: simple, yet it could do a lot. I looked at the PDP-8, I looked at the proposed Busicom, and I wondered why the calculator should be so much more complex.” Busicom was initially uninterested in the proposed microprocessor. Nevertheless, Hoff’s supervisors encouraged him to continue with the design, and Busicom finally relented.

As it turned out, the final configuration of the 4004 in the Busicom calculator was “pretty exotic,” as 4004 design team member Stan Mazor describes it. “Shima Masutashi [another member of the 4004 design team who was later to design the 8080] and I worked on the design of the calculator. He wrote a 19-byte interpreter in MCS-4 machine code for the calculator. It performed the relatively trivial task of fetching the next pseudo-byte and jumping to a subroutine. I laughed when I realized that what we had inside the desk calculator was a computer programmed as an interpreter emulating a pseudo-language.”

Intel didn’t realize at first what it had. An article in a recent issue of Intel’s house magazine, Solutions, points out that “Intel’s own board of directors could not agree on whether to proceed with the sale of the 4004. Their resistance was underscored by the company’s marketing department which, based on the belief that microprocessors would only be sold as minicomputer replacements, initially estimated the entire worldwide market at only a few thousand units per year.” Today, as we all know, Intel’s initial sales estimate was off by several orders of magnitude.

Situations like this are not uncommon in the technical world. A similar situation occurred at the Philadelphia Centennial Exposition of 1876. In a small pavilion at the fair, Alexander Graham Bell exhibited his newly invented telephone to a moderate number of politely interested people. Down the midway, though, thousands lined up to view the real technological hit of the show: the Corliss Steam Engine. I’ll refrain from saying which of these two gadgets ultimately became a household item. But I will say that I don’t have a princess model Corliss Steam Engine in my den.

Of course the microprocessor ultimately “made it” too, and it continues to affect our lives every day. The personal computer simply would not exist today without the microprocessor. In fact, it created a revolution. In his book Promise of Power, Carl Stokes said, “When you start dealing with change you are talking about interfering with those who are in possession of something.” This concept doesn’t apply to the microprocessor revolution, though, because microprocessors do not deny anything to anyone. Instead, they offer everyone a new tabula rasa. Not even the mainframe computer companies really suffered when the microprocessor appeared: they simply regrouped and continued marching (although it took some of them a long time to do it, and some of them haven’t started yet).
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- New features include full screen text editor, commands to drive optional equipment such as VTR's & voice response units.
- Currently used in many college and progressive high schools.
- Use for interactive applications—data entry, programmed instruction and testing.

Smith-Corona's new letter-quality printer, the TP-1.

We congratulate Intel on the tenth anniversary of the fortuitous invention that made personal computing possible, and we look forward to the day in 1992 when we can examine the second decade of the microprocessor.

An $895 Daisy-Wheel Printer

This month's theme is printers, and the most exciting news in the fast-changing printer market is undoubtedly Smith-Corona's new $895 (suggested retail) letter-quality printer, the TP-1. It features a plastic daisy wheel plus either an RS-232C serial interface or a Centronics-style parallel interface. Maximum speed of the TP-1 is between 14 and 15 characters per second, but the average speed is closer to 12 characters per second.

Smith-Corona makes no apologies for the fact that the TP-1 is a bare-bones system, and even though it lacks such niceties as proportional spacing, double-striking capability, and bidirectional printing, it's still a bargain. Price-wise, its closest competitor is in the $1500 range. The American-made unit accepts letter or legal-sized paper, and, in a new version, will soon be able to handle fanfold paper. The TP-1 has some competition in the form of add-on boards that convert the Olivetti Praxis typewriter into a letter-quality printer. They're manufactured by Vertical Data Systems Inc., Mississauga, Ontario, Canada (Converter TP3S); Williams Laboratories, Ithaca, New York (Bytewriter); and Systemed Corporation, Mountain City, Tennessee (Typrinter). We plan to review these units as soon as possible, for they herald the beginning of a new age of affordable word-processing computer systems.

Acknowledgments

Thanks to Donna Shuster and Intel for permission to reprint quotes and comments from the article "Tenth Anniversary of the Microprocessor" in the November/December 1981 issue of Solutions.
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For more details about these new boards, or any of SSM’s S-100 compatible boards (including various CPU, EPROM, video and development boards), just call your local dealer or SSM today.

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Letters

Apple's Decision Questioned

We use Apple computers for commercial machine-language program development and buy Apple IIs at frequent intervals, either as a service to our customers or in order to expand our office.

I have recently spoken to a mail-order distributor of Apples who told me that as of December 4, 1981, Apple was no longer wholesaling to mail-order houses. I could not believe this, so I called CALL-A.P.P.L.E. It's true, I was told.

I am outraged. How can Apple, with new, large, clever, powerful competitors just beginning to breathe down its neck, remove the only way for small, intelligent users to buy Apples inexpensively?

Apple is, in effect, forcing us to buy from retail stores, which are usually over-priced. Their personnel are insulting in their inexperience and knowledgeable only about the latest space games. We can not afford their arbitrary $700 markup on the Apple II. Our software systems, while cost-effective with mail-order firms' prices, are not with the retail stores' prices.

Apple will have to decide just who its friends are—the retailer who sits on his duff selling other people's ideas or the software innovator who takes a piece of hardware and makes it usable by the masses. While Apple may be trying to help out its dealers, it seems to have decided to do this at the expense of its serious customers—the people on whose success its own ultimate success depends.

Apple has succeeded so far because it provides a product which we (and others) can program without too much trouble and which our customers can afford. This new attitude of demanding that we submit to retailers' ridiculous prices will compel many to reconsider which personal computer we will use to develop our systems. I hope Apple discovers its error before its competitors profit too much from it.

Dennis Gerald Pratt
666 North Dearborn, Apt 3F
Chicago, IL 60610

The instruction transfers the value in PC (program counter) to register X. The value transferred is the location of the next instruction. The 6809 also allows:

LEAX n,PC

which adds “n” (8 or 16 bits) to PC and puts the result in register X. (LEA = Load Effective Address) This instruction, which may also be written:

LEAX label,PCR

can compute the address of any label (location) within the program without using an absolute address (PCR means use

Is Microfiche the Answer?

This letter is in response to the letter of Lew Merrick (October 1981 BYTE, page 10) regarding the storage bulk of advertising material in BYTE back issues.

The separation of advertising material into a separate removable section is undesirable because it would reduce the exposure of the advertising, reduce the value of the advertising, and ultimately degrade the quality of BYTE by reducing revenues.

An alternative is to convert to microfiche files at some loss of convenience but great savings in space. BYTE is now available from University Microfilms, Ann Arbor, Michigan, but you must be very patient with them because (1) back issues are available only in one-year blocks, (2) back issues are not produced until well into the following year, and (3) orders are not filled promptly.

My suggestion is that BYTE offer a microfiche option, just as is now done with the IEEE journals. The microfiche might actually be cheaper to produce and ship than the paper edition. A microfiche viewer can be found.

Back issues of BYTE are well worth preserving, as they enable me, after a session on my modest micro, to ponder what little was available only five years ago and to speculate what the future holds. The advertisements in a five-year-old BYTE issue contain some very interesting material.

Richard Schwartz
Electrical Engineer
Star Fleet Engineering
1328 North Santa Anita Ave
Arcadia, CA 91006

More on the WAI

Regarding Dr. S. S. Reddi's "Where Am I?" instruction (Technical Forum, November 1981 BYTE, page 413), I would like to point out that Motorola's 6809 has such an instruction. The simplest form is:

TFR PC,X

The instruction transfers the value in PC (program counter) to register X. (The value transferred is the location of the next instruction.) The 6809 also allows:

LEAX n,PC

which adds "n" (8 or 16 bits) to PC and puts the result in register X. (LEA = Load Effective Address) This instruction, which may also be written:

LEAX label,PCR

can compute the address of any label (location) within the program without using an absolute address (PCR means use

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Letters

PC-relative addressing). In these examples, the destination register could be Y, U, or S, instead of X, if desired. The destination for the TFR instruction could also be register D, which is accumulators A and B treated as one 16-bit register.

I question the usefulness of a WAI (Where Am I) instruction by itself, however. Apparently, Dr. Reddi would like to get the value of the 6502's program counter and then use this value to set up a table of addresses in page zero of memory, to be used with page zero indirect addressing (or, I shudder, to modify addresses within his program, such as jump and subroutine addresses). Adding a WAI instruction to the 6502 would help, slightly, with this rather clumsy method of making programs relocatable.

Much more is needed to make programs easily relocatable. The ideal situation would be to have code that runs at any address with no changes required. This is called position-independent code. The 6809 has the necessary instructions for such code. In addition to the LEAX (and LEAY, etc.) mentioned above, its instruction set includes branches (jumps), both conditional and unconditional, and subroutine calls with relative addressing. The relative address can be either 8 or 16 bits long, the latter allowing relative addressing anywhere within the 6809's address space. (Subroutine calls and unconditional jumps are also available with absolute addressing.) The presence of these instructions allows writing programs that can be run at any address with no changes (and with no need to set up a table of addresses or to modify the code at run time).

The WAI instruction by itself solves only a small part of the problem of being able to have position-independent code, code that will run unchanged at any address. Perhaps this is one reason it is not present in most computers. Most (or all) computers that have a WAI instruction, such as the 6809, PDP-11, 68000, and IBM 370, are also capable of position-independent code. I suspect that the 8086, Z-8000, and VAX 11/780 are also in this category.

Another reason for the absence of WAI in most microcomputers is that most 8-bit microprocessors were intended for use in dedicated controllers where there is no need for position independence or a WAI instruction.

One may note that the 6800 has a WAI instruction, namely:

```
NEXT    BSR NEXT
      EQU $1
```

This use of BSR (branch to subroutine), which uses relative addressing, pushes the address of the next instruction onto the stack, where it can be easily retrieved. (This is not to be confused with the 6800 instruction whose mnemonic is WAI. This WAI means "wait for interrupt").

Jim Howell
5472 Playa Del Rey
San Jose, CA 95123

The "Where Am I?" instruction is indeed useful. That is probably why it was included in the design of the Motorola 6809 as the Load Effective Address, or LEA, instruction, and its use is not restricted to finding the current PC content.

The LEA instruction loads the effective address of its operand into the specified 16-bit register, which may be either stack, either index, or the double accumulator. The operand must use the indexed addressing mode, which includes PC-relative. "Where am I?" could be coded:

```
HERE LEAX HERE,PCR
```

Assuming that you want HERE to be in the X register.

Other uses for the LEA instruction are addressing position-independent tables and adding constants to the indexable registers.

I recently read an article comparing the 6502 and the 6809 in which the author complained that he wasn't able to find much use for the LEA instruction. This caused some amusement among my friends. A close examination of some of my own code reveals that the LEA instruction is one of the most heavily used. I would venture the opinion that position-independent code would be much more difficult to write without it.

Howard Lee Harkness
Word's Worth
POB 28954
Dallas, TX 75228

Architecture Controversy

It was nice to see your article on higher-level machine-language constructs, "Should the DO Loop Become an Assembly-Language Construct?" by Glenn L. Williams (October 1981 BYTE, page 413). I would like to add a couple of comments to Mr. Williams's remarks.

Since Mr. Williams was including minicomputers in his article (he references the PDP-11 and VAX 11/780) he might also have included a reference to the HP3000 instructions MTBA, MTBX, TBA, and TBX. These four instructions each perform a variation of Mr. Williams's NXT function. All the instructions use a loop variable, a limit value, and a step value. TBA and MTBA use a variable address on the stack while TBX and MTBX use the index register for the loop variable. In all cases, the limit and step values are on the stack. MTBA and MTBX modify the variable by the step value, which may be any integer, positive or negative, and compare the result to the limit value. Positive step values cause a check to see if the limit has been exceeded, and negative step values cause the check to see if the result is less than the limit. TBA and TBX do not modify the variable but check only for the limit being exceeded. These allow compilers to implement more complex counting-loop structures while not being accomplished by adding or subtracting a step size. Also, functions similar to Mr. Williams's SRCH function are performed by SCU (Scan Until memory byte matches test byte or terminal byte) and SCW (Scan While memory byte matches test byte or until terminal byte is found) on character strings.

With the growing acceptance of modular, structured programming it has long been my feeling that high-level constructs should be imposed at the machine-instruction level. The only real need for assembly language these days is to utilize the machine architecture not available at the high-level-language level to produce quick, short code. Implementing higher-level functions in machine language and providing optimizing compilers should just about eliminate any need for assembly language. Code produced would be very short and quick, because a single complex machine instruction should run faster than the many simpler instructions put together needed to accomplish the same function. I would like to see both micro- and minicomputer processors developed with instructions to implement WHILE, IF... THEN... ELSE, CASE, DO... UNTIL, and other high-level constructs at the machine-instruction level.

Let's all keep pushing for advances in architecture to keep up with advances in software. And thanks, BYTE, for being among the leaders in this respect.

David B. Mears
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Santa Clara, CA 95051
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Glenn Williams is undoubtedly correct when he says that the instruction sets of microprocessors can be improved. For various reasons, however, I do not agree with his specific proposals.

It will always be necessary to write programs in assembly language, but if the "software crisis" can be solved at all it will only be by the efficient implementation of high-level languages. Processor designers have clearly realized this, but unfortunately their attempts at providing "features" that are supposed to help the compiler writer are often misguided. Consider, for example, two of the features mentioned by Mr. Williams: stack and condition registers.

There are two principal reasons for using stacks in the implementation of a high-level language. One is to save and restore environments when procedures are called, and the other is to provide fast temporary storage during expression evaluation. Typical PUSH and POP instructions do not help in either case: to save and restore an environment we need an appropriate addressing mechanism, and expressions can be evaluated faster using registers than stacks in memory.

If we were interested only in simple test-and-jump coding, condition registers would be fine, but in high-level language programming this is not always the case. The Pascal statements

\[
\text{finished} \ = \ \text{eof OR (lines > maximum)}
\]

and

\[
\text{total} \ = \ \text{total} + \text{width} \times \text{length}
\]

have the same structure. On a processor with condition registers, however, the first is coded by means of an elaborate sequence of jumps, while the second is a simple sequence of arithmetic operations. There is no reason why tests should not leave their results in ordinary registers, like other instructions.

The DO statement that Mr. Williams proposes would not be used by any but the most sophisticated optimizing compiler. First, it is inappropriate for loops in which a termination test is made on entry to, rather than on exit from, the loop body. This is not required for FORTRAN, but it is for Pascal. Second, the DO stack must be adjusted if an exit occurs before the loop is completed, and that is often, whatever the structured-programming zealots say. Third, a special addressing mode is required so that the code within the loop can access the DO index, because the DO index lives in the DO stack.

The real requirements have been accurately summarized by Professor William Wulf ("Compilers and Computer Architecture," Computer, July 1981): the compiler writer wants well-designed primitive instructions, not solutions to problems. A small set of efficient, useful instructions is better than a vast number of "clever" instructions that do the right thing in special circumstances but require elaborate analysis in the general case.

Peter Grogono
Metonomy Productions
4125 Beaconsfield Ave.
Montreal, Quebec
H4A 2H4 Canada

SR51A vs. HP-41C
Calculations Continued

I thank Mr. Kitchen (Letters, October 1981 BYTE, page 20) for another opportunity to discuss accuracy in Hewlett-Packard calculators. I fear he missed the point; please note my earlier statement regarding predictability (Letters, April 1981 BYTE, page 16). Then try this with an SR51A or a similar calculator:

1. Take the square root of 2. On both your SR51A calculator and my HP-41C, the display shows 1.414213562. Square this result. You get 2; I get 1.999999999. Subtract 2. Neither machine yields zero, but yours looks like it will, unless you "chisel out" the hidden digits first.

2. Enter 1.414213562 through the keyboard, then square it. If your display reads 2, feel free to be outraged: your machine does funny arithmetic. Indeed, the SR51A does not yield 2 as a result, but, considering what happened in (1), it looks like it will. How much work are you willing to do to discover how your calculator is going to behave? If it is really a 13-digit machine, why must you trick it to reap the benefits?

I could go on. At great length. And not just about SR51s and square roots.

In some cases, the SR51A yields better results than an HP-41C. But which cases? In chain calculations, digits 11, 12, and 13 can become numerical noise that creeps into the visible mantissa, causing mysterious results whose origins are very hard to isolate.

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Letters

digits is one reason. When unavoidable numerical errors occur, they are predictable, repeatable, and immediately apparent. Serious numerical analysis demands this; braggadocio does not.

Once again, a calculator is a tool, an extension of the mind. It must be understandable and understandable by the user. Consider what can happen if this is not the case for a variety of tools you may use (e.g., power saws, guns, automobiles). Then consider who uses calculators seriously, scientists, engineers, bankers, and doctors.

The designers at Hewlett-Packard keep such things firmly in mind.

Steve Abell
Research & Development Engineer
Hewlett-Packard Company
Corvallis Division
1000 NE Circle Blvd.
Corvallis, OR 97330

The Big Spelling Sweepstakes

The spelling-correction software review by Phil Lemmons ("Five Spelling-Correction Programs for CP/M-Based Systems," November 1981 BYTE, page 434) gives me new faith in the free-enterprise economic system of business. He has correctly pointed to the best value in a computer dictionary program: The Word from Oasis Systems.

When this program was released I compared it to the "high-priced spreads" and came to the conclusion that a big-budget ad campaign would always get results for the less-valorized product. The way that various magazine editors and writers were talking up certain overpriced spellers I thought that the big dollars would win over the underfinanced little organizations. I concluded I was wrong after reading your comprehensive review.

I'm sure there's a lot of egg on many a face this day—and rightly so. There are always some individuals willing to lend their names to products they don't fully understand. Furthermore, they let their names used without understanding the competitive positions they are taking. That seems to be a characteristic of our culture—if action is required, act even if you don't have the facts.

The time is rapidly approaching when the fast-track user can no longer get away with his "get-rich-quick" schemes, thanks in no small part to magazines like yours.

Frank Joseph
10925 Stonebrook Dr.
Los Altos Hills, CA 94022

We wish to inform BYTE and its readers that there is a sixth spelling-correction program on the market that, according to Mr. Lemmons' benchmarks, outperforms the others. This program is called the Disc-tionary.

We ran the Disc-tionary on Mr. Lemmons' 400-word benchmark text and it found all seven misspellings, yet failed to recognize only eight additional correctly spelled words. The total time to proofread and mark the file was only 47 seconds on a typical computer when the word review feature was skipped (1:12 with word review). A 3100-word file can be proofread in 1:12 without review. While it is impossible to make direct timing comparisons due to the use of two different computers, the Disc-tionary obviously combines a high level of accuracy with a large vocabulary. This gives the user a higher level of safety and convenience than the other programs.

We believe that the Disc-tionary presently provides the best combination of speed and accuracy. It is also very easy to use because of its menu-driven operation.

The Disc-tionary requires a Z80 and is available on an 8-inch CP/M disk for $79. This price includes a 54-page user's manual (available separately for $15) and two free "bug fix" updates.

David G. Hicks, Vice-President
Stellarsoft Corporation
841 Blanchette Dr.
East Lansing, MI 48823

Editor's Note: This program has not been tested by Mr. Lemmons. The times above have been provided by the manufacturer, and we cannot vouch for their accuracy.

An Avalanche of Answers

I have received some pretty strange and fascinating responses to a question I put to Steve Ciarcia that was printed in "Ask BYTE" (July 1981 BYTE, page 218).

Apparently, Steve didn't provide what the readers thought was the best answer and they quickly let us both know. The
Introducing the Enhancer II: a new Standard which is improving the relationship between Humans and Apples. The Enhancer II can help your Apple II's keyboard become more social by remembering words or phrases which can be entered into the Apple by the mere touch of a key. Life can become even easier because the Enhancer II can remember what you typed while your Apple was busy talking to your disc (or doing other things). Naturally, it knows the difference between upper and lower case letters and what shift keys are supposed to do. It even knows to auto repeat any key held down. The Enhancer II replaces the encoder board making installation simple.

Suggested retail price: $149.00.
day I got my magazine I also got a long-distance call asking if I was Dave Bower and if I owned a TRS-80 and if I had written to BYTE magazine. The caller then answered my question. The next day I got a letter answering the question. There's nothing strange about getting a letter, except that you didn't print my address, and neither did the person sending the letter! And it continued like that for the next couple of months—letters and phone calls from all over the United States. And just when I thought it was over I got a package from Steve Ciarcia containing the letters he had received!

So, needless to say, I got my question answered. And I got a lot more too. I think every person that contacted me also shared more hints and/or information or whatever. So even though they all called or wrote me about the same thing, not one exchange was a waste of time.

I just wanted to let you know what kind of readers you have and that I think Steve has a pretty good column, and a well-read one too.

Dave Bower
741 Lake Edward Dr., Apt. 104
Virginia Beach, VA 23462

Harry Saal's article on local networks ("Local-Area Networks, Possibilities for Personal Computers," October 1981 BYTE, page 92) did injustice to your readers with its narrow scope and omissions. Specifically:

1. Datapoint's local coaxial network-based ARC system was introduced and installed in 1977.
2. About 2000 ARCs are installed and in commercial service worldwide—more than all other networks, prototype or otherwise, combined. (I have heard no argument to estimates that Datapoint has a 95 percent market share of installed local networks.)
3. Tandy uses the local network portion of ARC, ARCNET, for its TRS-80 Model II personal computer network, announced in September—a step of major significance.
4. Three companies now use ARCNET—Datapoint, Inforex, and Tandy.
5. The only deliverable chip-based local network interface is manufactured by Datapoint.

Considering these omissions, I'm skeptical that the article was well researched.

Gerard Cullen
Vice-President Marketing
International Operations
Datapoint Corporation
9725 Datapoint Dr.
San Antonio, TX 78284

Harry J. Saal replies:

My article was not intended as a complete survey of local-area network products. Datapoint's offerings in the high-speed, serial, coax network were indeed quite early; it is unfortunate that Datapoint has not provided any in-depth technical information in the published literature by which its system can be evaluated for comparative study. In September 1981, several months after my article was completed, Datapoint announced its relationship with Tandy, a very exciting recent development.

Let me assure Mr. Cullen that there are substantially more than 100 installed, non-ARC local networks worldwide; hence the 95 percent market share claim is false.
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The Connector is designed to work with the Apple II, 48K of RAM and at least one disk drive. The Connector supports both 13 and 16 sector disk versions of VisiCalc. It also works with the Apple III in emulation mode.

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Far East: Microsoft Assoc., Tokyo, Japan, 03-403-2120.

Circle 132 on inquiry card.
Hardware Review

Commodore 4022 Printer

Joseph Holmes
13049 Broadway Terrace
Oakland, CA 94611

Some marriages are made in heaven—others are made in Japan. Commodore Business Machines has joined Epson to produce a fine, low-cost printer that combines the hardware features of the Epson MX-80 with the upgraded operating system of the Commodore CBM 2022 printer. Latest in a series of new products from Commodore, the CBM 4022 will handle most printing jobs where the 8½- by 11-inch paper size and dot-matrix output are acceptable.

The 4022 is totally compatible with all Commodore 2000, 4000, and 8000 series computers. The printer requires no special interface other than a cable. The 4022 prints the entire CBM/PET character set (256 characters), which means that listings and graphics programs come out just as they were entered (see figure 1). It is controlled by an internal microprocessor, which gives the 4022 versatile line-spacing and formatting capabilities. You can design your own business forms; you can even design and print special characters. The 4022 has both a replaceable line cord and an external, easily replaceable fuse.

In order to detail the other features of the CBM 4022, I will compare it to its cousin, the MX-80, and to its father, the CBM 2022.

CBM 4022 Versus Epson MX-80

Many of the 4022’s features overlap those of the MX-80. Both have a self-diagnostic print test and lowercase descenders (one-dot descenders with the 4022 and two-dot descenders with the MX-80). Line spacing defaults to 1/6 inch (six lines per inch) in the 4022 and to either 1/8, 1/6, or 7/72

At a Glance

<table>
<thead>
<tr>
<th>Name</th>
<th>Commodore Business Machines Dot-Matrix Printer Model CBM 4022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>General [listings, reports, business forms, graphics, draft-quality word processing, etc.].</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Commodore Business Machines and Epson</td>
</tr>
<tr>
<td></td>
<td>3330 Scott Blvd.</td>
</tr>
<tr>
<td></td>
<td>Santa Clara, CA 95051</td>
</tr>
<tr>
<td>Dimensions</td>
<td>10.7 by 37.3 by 33 cm [4¼ by 14¼ by 13 inches]; the weight is 6.6 kg [14.6 pounds]</td>
</tr>
<tr>
<td>Price</td>
<td>$795</td>
</tr>
<tr>
<td>Additional Hardware Needed</td>
<td>Cable [CBM to IEEE-488 or IEEE-488 to IEEE-488]</td>
</tr>
<tr>
<td>Features</td>
<td>Disposable heavy-duty 8-wire jeweled print head, cartridge ribbon, 80-column width capability, 5 by 8 dot-matrix characters (6 by 8 for graphics), true lowercase descenders, maximum print speed of 80 lines/minute for 20 columns (40 lines/minute for 40 columns), programmable line spacing, user-designed characters, paging with variable lines/page, enhanced (widened) characters, two character sets, and built-in error messages</td>
</tr>
<tr>
<td>Audience</td>
<td>Programmers, businesspeople, engineers, educators, students, writers, hobbyists, or others with Commodore 2000, 4000, or 8000 series microcomputers.</td>
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Character printed by the 4022 can be enhanced (widened). This can be done several times, if desired. Print enhancement with the MX-80 means emphasized print and/or double striking; both processes make the characters closer to correspondence quality. The 4022 is a tractor-feed printer that accepts paper in 4- to 10-inch widths. The print head is disposable, has a useful life of from 50 to 100 million characters, and costs less than $30. (Another disposable print head, which is longer lasting and 3 decibels quieter, sells for around $40.) The ribbon is housed in an easily changed cartridge, which needs replacing after about 3 million characters, that sells for around $14. Otherwise, the basic internal hardware of the two machines is virtually identical.

In printers, as in marriage, compromises of ten must be made. In order to accommodate the versatile CBM operating system, the 4022 has missed some of the juicier features of the MX-80:

- The MX-80 prints 10 characters per inch (cpi) at 46, 73, and 105 lines per minute for 80, 40, and 20 columns, respectively. The corresponding print speeds for 10 cpi with the 4022 are 30, 50, and 80 lines per minute.
- The MX-80 has its own set of 64 block-graphic characters. (I believe, however, that these graphics are far less interesting than the Commodore graphics.)
- The MX-80 has 12 printing modes that combine four character-width sizes: normal, 10 cpi; normal double width, 5 cpi; compressed, 16.5 cpi; and compressed double width, 8.25 cpi with four print densities: standard, emphasized, double strike, and emphasized plus double strike. Epson's MX-80 prints all these combinations of print sizes and print densities—except enhanced and emphasized plus double strike for the two compressed sizes.
- The four type sizes used by the MX-80 give a range of 40 to 132 characters per 8-inch line. The CBM
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4022 has one print mode and one type size giving 10 cpi or 80 characters per 8-inch line. Characters can be widened, however, for special effects.

- The character matrix of the MX-80 is 9 by 9 dots, whereas that of the CBM 4022 is 6 by 8 dots (5 by 8 for nongraphic characters). This allows two-dot lowercase descenders for the MX-80 versus one-dot descenders for the CBM 4022.
- The MX-80 has four indicator lights: Power On, Printer Ready, Paper Out, and On Line. The four switches on the MX-80 are Power On/Off, On Line, Form Feed, and Line Feed. In addition, a warning buzzer responds to paper-out and error conditions. The CBM 4022 has one indicator light (Power On), which also flashes for paper out, and two switches: an On/Off switch and a Paper Advance button that takes you to top-of-form or feeds continuously if held down.
- The MX-80 lists for $645; the CBM 4022 lists for $795. Since no additional interface board is needed to connect to PET/CBM computers, you could come out ahead with the 4022.

CBM 4022 Versus CBM 2022

How does the CBM 4022 stack up against its predecessor, the CBM 2022? Physically, they are quite different. The 4022 is lighter and far more compact. It is also much quieter—a plus for the families of nighttime programmers! The 4022 has true lowercase descenders; the 2022 does not.

Both printers share a slightly annoying bug. When in the lowercase mode, the backslash, the left arrow and up arrow, and the left and right brackets must be shifted to achieve their normally unshifted appearance. For their shifted versions, or graphics, you must type them unshifted. I have learned to live with this. The earlier model's paper advance couldn't find the top-of-form, but it was useful for advancing the paper short distances without turning the knob. The new model makes it more difficult to back up the paper without crinkling precious hard copy.

Both CBM printers have formatting and other features that are controlled by a system of secondary addresses (sa). These features are activated by opening files (channels) to one or more of the secondary addresses and then printing to the appropriate file. The earlier model 2022 had these seven secondary addresses:

- sa 0: Print exactly as received
- sa 1: Print according to an established format
- sa 2: Establish format field
- sa 3: Set number of lines per page
- sa 4: Activate error messages
- sa 5: Design custom character
- sa 6: Set spacing between lines

The later model 2022 added an eighth secondary address (sa 7) that switched the entire PET/CBM character set from uppercase/shifted

Photo 1: Manufactured in Japan by Epson, the new CBM 4022 combines the hardware features of the MX-80 with the upgraded operating system of the CBM 2022 printer.
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Let’s look at some of the 4022’s features in more detail. If a file (channel) has been opened to sa 1, all printing will be in a format that was previously established. This format was set up by opening file sa 2 and then assigning a format field (or image string) to a string variable, then printing that string variable to the file open to sa 2. The format field that governs output layout is similar to the image fields used in the PRINT USING command found in some versions of BASIC.

Here are a sample PRINT statement, a format field, and the formatted printout. (The values of the variables used are A$ = “OK”, A = 37, B = 86, C = 8.27, D = 1.28, E = 1.25, F = 26.51, G = -3, H = -3.) The PRINT statement is:

PRINT#1, “A$CHR$(29)CHR$(160)CHR$(29),A,B,C,D,E,F,G,H”

The format field for this PRINT statement is:

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Six diagnostic error messages can be accessed by opening a file to sa 4:

- *PE:L* Lines per page out of range
- *PE:C* Bad command (invalid secondary address)
- *PE:M* Data-format mismatch
- *PE:E* Exponent error
- *PE:F* Bad format
- *PE:T* Terminator error (change of sa before carriage return or other terminator detected)

This error channel can be turned off by opening a file to sa 9, printing to that file, and then closing the file.

The User's Manual gives a method for designing custom characters that should be changed to the following: Fill in a 6 by 8 matrix with dots where you like. Each row in this matrix is assigned a value that is a power of two from 1 (bottom row) to 128 (top row). The dot values are added for each of the six columns, assigned a CHR$ value, and then printed to a file open to sa 5. This character can be printed as CHR$(254).

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per inch (see figure 2). To do so, you must choose a divisor for 216 that will give a quotient that is the number of lines per inch that you want (default = 36 for 6 lines per inch): 18 yields 12 lines per inch and is nice for graphics that normally get too stretched out vertically when printed; 24 yields 9 lines per inch, but some graphics with this spacing are still too stretched out. If you want normally spaced text and somewhat compressed graphics, you can leave an extra space between text lines in your program and then change your spacing to 12 lines per inch. The User's Manual needs a revision on line spacing. The values given on page 31 are incorrect; they are left over from the model 2022. To correct them, change the 144 to 216, and change the divisors accordingly. You can use any divisor from 1 to 127. Dividing 216 by 1 will, of course, give a quotient of 216—the number of lines per inch (1/216, or 0.0046, inch spacing). Dividing 216 by 127 will give a quotient of 216/127, or approximately 1.7 lines per inch (127/216, or 0.5880, inch spacing).

The CBM 4022 and 2022 both have a set of special control characters. Their functions and equivalent keystrokes are listed in table 1.

To get more information on the use of these controls plus the other features of the CBM 4022, consult either the Commodore User's Manual or the appropriate sections of the Per-
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Four New Products from Radio Shack

by Chris Morgan

It was Christmas all over again on January 19 at Radio Shack in Fort Worth, Texas, where a quartet of major new products was unveiled during a day-long session. Some of the announcements were expected. Others were surprises.

The TRS-80 Model 16: Two Computers In One

The most significant announcement was for the new TRS-80 Model 16 computer, which contains a Motorola M68000 processor [see photo 1]. Externally, the unit looks like the TRS-80 Model II (in fact, the case is virtually identical to the Model II's), but the front bezel has been redesigned to accommodate either one or two slim-line 8-inch drives. Two of these drives fit into the same amount of space as a single, standard-width drive. The big surprise is that Model II owners will be able to convert their machines to Model 16s by adding two printed-circuit boards that together cost $1499. But there's one limitation: the maximum RAM (random-access read/write memory) on the upgraded Model II system is 256K bytes, whereas the Model 16 allows the user up to 512K bytes of RAM on board.

The Model 16's most important feature is its built-in Z80 coprocessor with 64K bytes of its own memory that allows the user to run all existing Model II software. Radio Shack's simple but clever idea is to free up the 68000 processor by using the Z80 for disk and I/O routines. This has to be one of the most elegant answers to the question of 8- and 16-bit compatibility. The operating system (Radio Shack's own design) boots up like the Model II, but automatically enters the 16-bit mode. A simple keyboard message from the user switches the system to the Z80 mode.

Floppy Disks and Hard Disks

The slim-line floppy-disk drives are double sided and double density, with slightly more than one megabyte capacity each (formatted). Normally, a user would get only one floppy-disk drive for operating the Model 16 with a Radio Shack 8-megabyte hard-disk unit. Such a configuration (with the maximum 512K bytes of RAM) costs $11,191—a bargain. By comparison, the least-expensive configuration, featuring 128K bytes of RAM and one disk drive [no hard disk], Costs $4999. This certainly gives the IBM Personal Computer some competition. (It should be kept in mind that the Model 16 lacks some of the IBM's features, such as color graphics.)

The announcement of the TRS-80 Model 16 gives the 68000 processor a firm footing in the 16-bit sweepstakes. (Can Apple be far behind with its 68000 design?) It's safe to say that the 16-bit era is underway.
An Updated Pocket Computer

The PC-2 Pocket Computer is an improved version of the current TRS-80 Pocket Computer, now known as the PC-I. Like the PC-I, the PC-2, shown in photo 2, is manufactured for Radio Shack by Sharp, in Japan, and features a built-in real-time quartz clock; a 7-by-156 dot-matrix liquid-crystal display; an 8-bit processor operating at 1.3 MHz; a new extended BASIC package with two-dimensional arrays, built-in arithmetic functions, and variable-length character strings; a four-color printer/plotter/dual-cassette interface (more about this later); and a 60-pin I/O con-

Photo 2: The PC-2 Pocket Computer from Radio Shack features an optional four-color PC-2 Printer/Plotter. The PC-2 contains 2.6K bytes of RAM and 16K bytes of ROM. Provision for a plug-In module allows an additional 16K bytes of RAM, ROM, or both. A 4K-byte RAM module is available for $69.95. PC-2 peripherals are intelligent and contain additional RAM and ROM. The Printer/Plotter can produce nine sizes of characters and plot graphs and charts with a resolution of 0.2 millimeter.

Photo 3: Though cosmetically similar to the Model III, the DT-1 video terminal uses the same monitor section as the Model II. Communication is through an RS-232C port, and both serial and parallel printer ports are provided. Transmission rates of from 75 to 19,200 bps are supported, all through keyboard commands.

Photo 4: The DT-1 video terminal achieves new heights in configurable systems. Not only does the DT-1 have built-in provisions for emulating four popular terminals, it can also be programmed from the keyboard to emulate most other terminals with similar capabilities. Emulation and transmission parameters are stored in an EEPROM, which means, in effect, that the DT-1 programs itself. Parameters can be changed on a more temporary basis as well, without being programmed into the EEPROM.
nect or that brings address data, interrupts, timing, and control signals to the outside world.

The basic PC-2, which retails for $279.95, contains 16K bytes of ROM (read-only memory) and 2.6K bytes of RAM. There is provision for one additional plug-in module which may be RAM, ROM, or a combination of both. A 4K-byte RAM module is available for $569.95, and an 8K-byte RAM will be introduced in the near future. The 8K-byte RAM is expected to cost almost as much as two 4K-byte modules. A 16K-byte RAM module is planned, but its introduction will depend on how quickly the price of 16K-byte CMOS RAMs drops.

Peripherals for the PC-2 will be intelligent and will contain their own RAM and ROM which will further extend the unit's memory capacity. An RS-232C interface plus software will also be introduced.

A Miniature Four-Color Printer/Plotter

The PC-2 Printer/Plotter is impressive. Packed into the unit's minuscule chassis is a four-color plotter that "draws" letter-quality characters in nine different sizes on standard 2½-inch adding-machine tape and creates four-color graphs and charts (see figures 1 and 2). A small circular barrel holds the four miniature solenoid-selectable pens.

The PC-2 Printer/Plotter is not a toy; it is capable of plotting with a resolution of 0.2 millimeter! It features a simple, yet sophisticated paper-drive system that anchors one side of the paper tape with a small rubbed wheel. This arrangement allows the plotter to move the paper tape back and forth repeatedly by as much as 10 centimeters as it creates an image. In the character mode, the printer's average speed is 12 characters per second (see photo 2).

The DT-1 Video Terminal

Radio Shack has done some unique things with its new terminal entry, the DT-1, shown in photos 3 and 4. For a suggested retail price of $599, you not only get an 80-by-24 character display, serial-communication port, and both serial- and parallel-printer ports—you also get the built-in capability of emulating a number of other terminals, including the Televideo 910, Lear Siegler ADM-5, ADDS 25, and Hazeltine 1410. This is accomplished by simple commands from the keyboard; no DIP switches to set. All emulation parameters as well as transmission protocols such as word length and data rate are then stored in an EEPROM (electrically erasable programmable read-only memory). Thus, the DT-1 actually reprograms itself. Even when power is turned off, the DT-1 retains its emulation and transmission parameters.

As if that weren't enough, you have the ability to change any or all of the emulation and transmission parameters, which allows you to emulate a number of other terminals in addition to those that are built in. The cursor is programmable from the keyboard and may be either a steady or blinking block or underline. The video attributes include normal, reverse, invisible, blink, underline, and half intensity. Data rates from 75 to 19,200 bps are available. The black-and-white monitor section of the DT-1 is identical to that of the Model II computer.

High-Resolution BASIC Graphics Package for the Model II

A $499 high-resolution BASIC graphics package that allows the user to create black-and-white graphics with a resolution of 640 by 240 pixels is now available for the TRS-80 Model II (see photos 5 and 6). The price includes a plug-in printed-circuit board with 32K bytes of on-board memory. Because the high-resolution graphics are generated from a separate memory, both text and graphics can be overlaid on the screen and each can be cleared separately.

The accompanying BASIC package features the same commands as the high-resolution BASIC for the TRS-80 Color Computer, except that only black and white can be chosen. Radio

---

**Figure 1:** The Printer/Plotter for the PC-2 Pocket Computer is capable of 0.2 millimeter resolution in four colors. Characters may be presented in nine different sizes. Charts and graphs are no problem for this machine.
Shack is including a library of commands that allow you to pass parameters from COBOL, FORTRAN, or assembly-language programs—a nice touch.

Yet to come is a printer dump routine that lets the user dump the screen to the Radio Shack Lineprinter VIII. Note: In order to use the high-resolution BASIC graphics package, your Model II must have the latest CPU (central processor unit) board, because the original Model II CPU board has a different set of wait states than the graphics board requires.

Radio Shack will retrofit any Model II with the latest CPU board if you bring your computer to a Radio Shack computer center. The upgrade, if needed, is included in the cost of installing the graphics package.

**Final Thoughts**

These four new products from Radio Shack indicate both a continuing commitment from the company to the furthering of the state of the art, and reaffirmation of the company's refreshing entrepreneurial approach to new computer products.

Random: Clear

```
RANDOM : CLEAR
: DIM A$(1)*56,
: DEGREE : WAIT 0
: 10. K=0: RESTORE 50
: FOR J=1 TO 10
: READ A$(1)
: PRINT A$(1)
: 15. FOR J=1 TO 60. A
: =$INKEY$ . IF A
$: = "": LET J=60
: 20. NEXT J
: 21. IF A$=" " THEN 3
: 5
: 25. FOR J=1 TO 10.
: IF MID$ ("1234
: ABCDEF", J, 1)=A
: LET K=J, J=12
: 30. NEXT J
: 35. IF KCLS : ON K
: GOSUB 100, 2000
: 600, 800, 4
: 00, 500, 700, 900
: 1000.GOTO 5
: 35. NEXT 11. IF RND
: (25)>THEN 10
: 40. K= RND (10). IF
: K<<THEN 31
: 45. GOTO 10
: 50. DATA "1 - LCD
display & grap
: hics", "2 - Fea
: tures Banner",
: "3 - Clock", "4
: Beeper"
: 55. DATA "A - 3-D
: Bar Chart", "B
: Pie Chart", "C - 2-D User 8
```

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**Photo 5:** A bar graph produced with the Model II high-resolution graphics package. Both text and graphics can be mixed on the screen and selectively erased.

**Photo 6:** Another example of what is possible using the Model II high-resolution graphics package.

---

**Figure 2:** Mixing text and graphics is easy with Radio Shack's new Printer/Plotter. Also shown is a partial BASIC listing.
Integral Data Systems’ Prism Printer

Integral Data Systems (IDS) has introduced an innovative printer called the Prism, whose modular design uses add-on options which let you upgrade the machine as needed.

The basic 80-column Prism is available for $899 and yields correspondence-quality print using an overlapping 24 by 9 dot matrix. Printing bidirectionally at 110 characters per second (cps) (up to 150 cps for proportionally spaced characters) the Prism printer is capable of 10, 12, or 16.8 character-per-inch densities, plus double-width characters.

Selectable standard features on the basic printer include automatic text justification, programmable horizontal and vertical tabbing, reverse paper feed, and “fine positioning” of characters to 1/120 inch. Up to four different 96-character sets can reside within the printer at the same time, although the basic unit is provided with only one 96-character set.

The Prism is microprocessor controlled, with true logic-seeking capability. It comes with a standard RS-232C serial interface as well as a Centronics-compatible parallel interface. Serial transmission rates from 110 to 9600 bits per second (bps) are switch selectable.

Six upgrade kits can be added to the printer at any time making it one of the faster printers in its price category. (As a comparison, an 80-cps printer drops to about 60 cps in enhanced mode and 40 cps in double-strike mode.) The Prism does not have a double-strike mode, although it is capable of providing it with the proper software. You can do reverse linefeeds.

External Controls

A slot on the top left side of the printer exposes the self-test switch and the power-up configuration switches—a

At a Glance

<table>
<thead>
<tr>
<th>Name</th>
<th>Prism Printer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>Dot-matrix printer</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Integral Data Systems</td>
</tr>
<tr>
<td>Dimensions</td>
<td>80-column: 9.1 by 15.75 by 12.4 inches (23.1 by 40 by 31.5 cm)</td>
</tr>
<tr>
<td></td>
<td>132-column: 9.1 by 21.6 by 12.4 inches (23.1 by 54.9 by 31.5 cm)</td>
</tr>
<tr>
<td>Features</td>
<td>80 and 132-column models. 24 x 9 dot matrix, bidirectional printing at 110 to 150 cps, true logic seeking, automatic text justification, programmable horizontal and vertical tabbing, 96-character ASCII set, up to four character sets resident, microprocessor controlled, RS-232C and Centronics-compatible interfaces.</td>
</tr>
<tr>
<td>Options</td>
<td>Cut Sheet Feeder, Dot Plot, Prism Color, Sprint Module, additional character sets, cassette for fully automatic sheet feed</td>
</tr>
<tr>
<td>Price</td>
<td>80-column, basic unit, $899; 132-column, basic unit, $1299; Options available now. Cut Sheet Feeder, $149, Dot Plot, $99; Prism Color, $399; Sprint Mode, $99. To come. Additional fonts, $99; cassette for automatic sheet feed, $399. Note: Until April 1, 1982 only—Special Option Package: Cut Sheet Feeder, Dot Plot, and Sprint Mode, $297.</td>
</tr>
<tr>
<td>Warranty</td>
<td>90-day limited</td>
</tr>
</tbody>
</table>
very nice touch in the design of the printer. Unlike most printers, you do not have to remove the cover or fumble with the unit to change the power-up parameters. Three switches located under this slot provide self-test on/off (a

A Closer Look
The Prism printer gave me several pleasant surprises. The early IDS Paper Tigers were some of the loudest printers I had encountered. When IDS engineers designed the 560—and now the Prism—they acoustically insulated the case and lowered the noise level to less than 63 dBA, a level suitable for most office environments. (By the way, the case for the Prism is identical to the one used on the 560.)

The print quality in the normal mode is excellent. Most other printers require an enhanced mode (move over ½ dot and strike again) or double-strike mode (reprint entire line) to achieve the same character quality. Furthermore, the Prism produces this type of print quality at 110 to 150 cps, and may be used in any combination. Cut Sheet Feeder, Dot Plot graphics, Prism Color, and Sprint Module upgrades are available now; special character sets and a cassette for fully automatic sheet feed will be available in the near future.

Control Line Form Length

<table>
<thead>
<tr>
<th>S3-1</th>
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<th>S3-2</th>
<th>Length (inches)</th>
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</tr>
<tr>
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<tr>
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<td>On</td>
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<td>7</td>
</tr>
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<td>On</td>
<td>14</td>
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Control Line Serial Data Rate

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<td>Off</td>
<td>2400</td>
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<td>Off</td>
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<td>Off</td>
<td>9600</td>
</tr>
<tr>
<td>On</td>
<td>On</td>
<td>1200</td>
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Selecting Parity

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<th>S3-7</th>
<th>Party</th>
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<tbody>
<tr>
<td>Off</td>
<td>Off</td>
<td>No parity, transmit space</td>
</tr>
<tr>
<td>Off</td>
<td>On</td>
<td>No parity, transmit mark</td>
</tr>
<tr>
<td>On</td>
<td>Off</td>
<td>Even parity</td>
</tr>
<tr>
<td>On</td>
<td>On</td>
<td>Odd parity</td>
</tr>
</tbody>
</table>

Table 1: DIP switch 3, located on the top left-hand side of the printer and accessible through a slot located there, controls form length, data rate for the RS-232C interface, and the parity. Although the switch sets the default values upon power-up, they can be overridden by software commands.

toggle switch), print-parameter controls (DIP switch S4), and form-length and serial-interface-parameter controls (DIP switch S3). The self-test switch is nonactive with the lever to the left and active (only in the off-line mode) when the lever is to the right. S4-1 and S4-2 set the character density and characters per inch (cpi), OFF-OFF sets the 5-cpi mode (double-width mode), OFF-ON sets the 16.8-cpi mode (condensed mode on most other printers). S4-3 selects 6 lpi (lines per inch) when OFF or 8 lpi when ON. S4-4 controls the automatic boundary skip (so the printer skips over the perforations on fan-fold paper) of one inch. When OFF, S4-4 disables the skip; when S4-4 is ON the skip is enabled. S4-5 is the switch TRS-80 users will be interested in. ON enables the auto linefeed on carriage return and OFF disables the auto linefeed. S4-6 controls the default setting of the Sprint Mode and is not used in the basic Prism. S4-7 controls the expanded functions (IDS's name for software control). Once again, ON enables and OFF disables software control. The functions of DIP switch 3 are shown in table 1.

On the right side of the top of the printer are two switches and a marker plate with several indicator lights. The left switch is a three-position switch labeled FS/OFL/ONL (Forms Set/Off line/On Line). The right switch is a spring-loaded, center return (off position), two-position switch labeled FF/LF (Form Feed/Line Feed). The indicators are for fault, on line, and power on.

Software Control
Many software commands are available with the basic unit. Here is a complete rundown. A line feed, Ctrl-J or CHR$(10), causes the paper/form to advance one line vertically. A form feed, Ctrl-L or CHR$(12), feeds the paper/form vertically to the next top of form. A carriage return, Ctrl-M or CHR$(13), causes the carriage to return without a linefeed (unless S4-5 is set to auto linefeed) after printing data in the buffer. These three controls will operate regardless of S4-7's position.

Now let's take the rest by the numbers:

Ctrl-A or CHR$(1): set expanded mode (double wide).
Ctrl-B or CHR$(2): reset expanded mode.
Ctrl-D or CHR$(4): set justify mode on (left and right margins are even).
Ctrl-E or CHR$(5): reset justify mode.
Ctrl-F or CHR$(6): set printer to fixed character space.
Ctrl-I or CHR$(9): tab to next set horizontal tab.
Ctrl-K or CHR$(11): tab to next set vertical tab.
Ctrl-N or CHR$(14): do two line feeds (double space vertical).
Ctrl-P or CHR$(16): print characters proportionally spaced.
Ctrl-Q or CHR$(17): reset the deselect mode.
Ctrl-R or CHR$(18): line feed without carriage return (S4-5's position makes no difference).
Ctrl-S or CHRS(19): deselect printer (causes it to ignore data from computer).
Ctrl-T or CHRS(20): do two line feeds without carriage return.
Ctrl-Y or CHRS(25): do three line feeds without carriage return.
Ctrl-Left bracket or CHRS(27): cause the printer to enter/exit the programming mode (This is called the escape code ESC).
Ctrl-Right bracket or CHRS(29): set printer to 10 cpi.
Ctrl-Uparrow or CHRS(30): set printer to 12 cpi.
Ctrl-Underscore or CHRS(31): set printer to 16.8 cpi.
ESC F or CHRS(27) + “P”: program horizontal tabs in increments of 1/120 inch (1 inch = 120, 2 inches = 240, ... etc). CHRS(27); “F,120,240,600,$” will set tabs at 1 inch, 2 inch, 5 inch points. You can set up to 8 tab points.
ESC B or CHRS(27) + “B”: set vertical tab 1 in increments of 1/48 inch. CHRS(27); “B,24” will set a 1/2-inch vertical tab with only one point allowed. This is ADV-1 and defaults to 8 or 6 as S4-3 is positioned.
ESC C or CHRS(27) + “C”: same as ESC B but with a default value of 8, which is a 6-1pi subscript value.
ESC D or CHRS(27) + “D”: same as ESC B but with a default value of -8, which is a 6-1pi superscript value.
ESC E or CHRS(27) + “E”: same as ESC F but for vertical tabs (1/48-inch increments) and up to 8 values can be set.
ESC G or CHRS(27) + “G”: set the absolute head position from the home position in 1/120-inch increments.
ESC H or CHRS(27) + “H”: set absolute head position from top of form.
ESC J or CHRS(27) + “J”: set margins—two values are required, left margin first, then the right margin (1/120 inch).
ESC L or CHRS(27) + “L”: set vertical form length—two values are required, form length first and then the printable space within that length. This instruction works within the form-length switch settings (1/48 inch).
ESC P or CHRS(27) + “P”: sets the intercharacter spacing in increments of 1/24 character width.

In all the above instructions, a “$” is required as the last character to terminate the instruction. Tabs may be cleared by setting a single tab to 0: CHRS(27); “E,0,$” clears the vertical tabs and CHRS(27); “F,0,$” clears the horizontal tabs. (I have deliberately not put the PRINT statement in these examples due to the variety of forms it can take. With the Apple computer you open the printer port and then use PRINT statements. With the TRS-80 you have to use LPRINT statements.)

Options
The $149 Cut-Sheet option (what I call letterhead) adds friction feed to the Prism printer. Most printers that have a friction option force you to feed the paper from the top and manually advance it to the position where you want...
Figure 1: Four examples of color graphics. These were produced on a 132-column Prism printer with the Dot Plot and Prism Color options and the process-color ribbon. Graphics are dot addressable.

to start printing. If you are good at it, you won't have to square up your sheet. It is also very difficult trying to print to the bottom of the page with other friction-feed printers. The Prism’s Cut Sheet option shows the same care in design as the rest of the unit. You can feed the paper from either the back or front of the printer. A photo sensor detects the paper being inserted. After a one-half- to one-second delay, the pinch rollers start to revolve, and if you have inserted the paper correctly it will feed and position the sheet to the first printable line on the paper. You might have to manually line feed past your letterhead, or you can handle that with your word-processing software. You will have to adjust the tractor on the printer to allow the paper to feed through them with the pins just to the outside of the paper. IDS has placed a set of pinch rollers into the tractors that are driven by the normal tractor-feed mechanism and continue to feed the paper after the bottom pinch rollers have been passed. With the out-of-paper sensor located at the printhead level, this allows the printer to print clearly and evenly right to the last line on the page. A simple form feed will eject the letter completely from the printer. Very nice indeed for the office that does a lot of letters on standard letterhead bond.

Dot Plot is a $99 dot-addressable graphics option package. The density is 84 by 84 dots per inch (dpi) for single-pass raster and 168 by 168 dpi for a four-pass raster. This option adds more control codes for you to play with. To enter the graphics mode you set switch S4-5 to ON and send a Ctrl-C (CHR$(3)). You can also select unidirectional (default) or bidirectional graphics by sending Ctrl-L or Ctrl-V, respectively. To exit you use a Ctrl-C + Ctrl-B (CHR$(3);CHR$(2);). In the graphics mode you have to be careful to always end your BASIC instruction line with a semicolon to prevent the automatic generation of carriage returns and linefeeds, as these would be printed as graphic characters and mess up your picture. Seven wires of the print head are used in the graphics mode and are bit controlled. Bit 0 controls the top wire and bit 6 controls the bottom wire. Bit 7 is ignored. You also have vertical and horizontal control if you use the previously given codes prefixed by CHR$(3).

Prism Color is a $399 color-capability option that adds color designator control codes to your instruction set. The printer that I reviewed did not have this option, so my assumptions are based on the color ribbons that I saw. You will have a choice of three ribbons: black plus process colors for mixing, black plus primary colors, and
INTRODUCING AFFORDABLE COLOR
The INTEGRAL DATA PRISM™ Printer

The PRISM COLOR PRINTER prints four basic colors:

COLOR #4 = BLACK
COLOR #2 = MAGENTA
COLOR #3 = CYAN
COLOR #1 = YELLOW

AND CAN MIX COLORS:
MIX #1 + #2, ORANGE
MIX #2 + #3, VIOLET
MIX #1 + #3, GREEN
MIX #2 + #4, BROWN

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- Correspondence quality print in a 24x7 matrix cell
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- 4 or 8 lines/inch spacing
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- Versatile features with programmable capabilities
- User definable function codes

Ease of Operation
- Switch selectable baud rates
- Auto line feed capability
- Hardware/software selectable forms length
- Fault/Paper-out indicator light

Ready Serviceability
- Simple mechanisms for easy service
- Modular design provides for low MTTR
- Built-in diagnostics and Self-test mode

Interfaces for All Configurations
- Parallel (Centronics compatible)
- RS-232c (up to 9600 baud) with Xon/Xoff protocol
- 115/230 volts, 50/60 Hz power, switch selectable

DotPlot Graphics Capability
- High resolution raster graphics
- 80x84 dots/inch
- Includes 1500 byte character buffer
- Long-life cartridge ribbon system

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Figure 2: Combining color with text. Color adds a new dimension to reports, manuscripts, and other documents. Combined with Dot Plot graphics, the possibilities are endless.
The last option (to be available soon) is a $399 cut-paper-feed cassette. Here the machine will really outdistance the field of friction/tractor printers in the $2000-and-under class, as it is the very first one to offer this option. By combining this printer, a word processor, and a mailing list that works with the word-processor files, you will be able to do individualized form letters to your mailing list on your letterhead. Now that is real class compared to most of the form letters that I get in the mail.

Examples of what can be done with the Dot Plot and Prism Color options are shown in figure 1. Figure 2 shows how text, color, and graphics can be combined.

Conclusions
Integral Data Systems has developed a new breed of printer. Its designers are to be congratulated for the quality of their product, the workmanship, and their innovative spirit.

- I like the design philosophy, execution, and price. For the money, it's hard to beat.
- You don't have to buy more printer than you need. Options can be added later.
- The documentation is excellent, providing complete setup, test, troubleshooting, and maintenance procedures, as well as complete schematics.
- IDS provides a 90-day limited warranty on all its products. It is presently expanding its service organization.
Use Voiceprints to Analyze Speech

Do you ever talk to your computer? I do. But it doesn’t understand a word I say. That’s just as well right now, because I talk to it mostly in moments of hardware-induced frustration.

Of course, the computer talks to me. If you’ve read my June and September 1981 Circuit Cellar articles, you know that my computers can talk using two different methods of voice synthesis. At present, a computer can synthesize speech much more easily than it can recognize speech.

Professional speech-recognition systems currently on the market can cost up to $100,000. Budget-priced systems for personal computers are available for about $500, but of course, they don’t perform as well.

My mail has been full of requests from readers for a speech-recognition circuit. Most correspondents point out that such a project is a natural follow-up to the two articles on voice synthesis. Unfortunately, designing a cost-effective voice-input speech-recognition system is a major project; it not only requires a complete understanding of the techniques involved but also necessitates skills in the design of filter networks and intricate data-comparison algorithms.

The basic concept of speech recognition is rather simple: have a computer digitize the analog voice waveform of each spoken word and compare it to a stored reference vocabulary. A basic block diagram is shown in figure 1.

First, the analog voice input is amplified, then it is digitized to form a word template. This template formatting can be done by various techniques that include bandpass filters, A/D (analog-to-digital) converters, zero-crossing detectors, or fast Fourier analyzers. The result, whatever the technique, is a digital representation of the word spoken into the microphone. In an inexpensive speech-recognition system, this word template might be 10 bytes long, whereas in a $100,000 system the template may have 10K bytes of data per word.

The input word template is then processed by a computer and compared to a series of templates stored in memory. The stored templates constitute the machine’s vocabulary. A spoken word is deemed to be recognized when there is an exact or reasonably close match with one of the stored templates.

In practical speech-recognition systems, the size of the word template must be traded off against the amount of available memory or storage and the computing power of the processor. With a small template, the
words are not very well defined, and there is a considerable possibility that the computer will confuse two different words. On the other hand, large templates, which more precisely define the words, take considerably more time for comparison as well as more storage space.

To achieve reasonably fast recognition with large templates, the computer must digest information at prodigious speed. In professional speech-recognition systems, a typical processor might perform 1 million 16-bit by 16-bit multiplications per second. Creating such a number cruncher is expensive.

To build a speech-recognition system on a low budget, using a microprocessor, we must make some compromise either in the time allotted for the computer to recognize a word or in the precision with which words are defined in the templates. There must be some amount of storage between 10K and 10 bytes that defines a word sufficiently well for our low-cost speech-recognition system to recognize it within a tolerable duration.

Preliminary Research
This article doesn't tell you how to build a speech-recognition system. We aren't ready for that yet. Instead, it describes a scheme to analyze the audible content of speech so that we can more accurately define a suitable template size.

A definition of just how much data is required can be determined only by carefully examining the spectral content of speech and analyzing the differences between the words we want to have the computer recognize. Just what is the audible difference between the numbers "six" and "eight"? Is there a unique set of data points that allows them to be easily differentiated?

In essence, the information we are looking for is a kind of fingerprint for speech, a voiceprint. (It may also be called a spectrogram.) By visually comparing the spectral voiceprints of words, we can perhaps come to understand details of definitive templates and the workings of comparison algorithms.

We may find that in a limited-vocabulary speech-recognition system the spectral differences between the words in the selected recognizable set may be so distinct that the template resolution can be reduced to perhaps less than 100 bytes. It is also possible that such an examination will demonstrate that a monumental effort must be exerted to distinguish between two words such as "seem" and "seen."

I hope to eventually write about a voice-response speech-recognition system. Such a project seems to lie within the scope of a Circuit Cellar article. For the present, however, I am still researching certain information about the significant differences between words, seeking to answer such questions as: Must data on amplitude as well as frequency be recorded? Must the input word be digitized in real time? Can the stored template data be compressed in some way? What frequencies are important and which can be ignored? Is there much variation between different utterances of the same word?

This month's hardware project, a spectral voiceprint display, should help answer some of these questions.

What Are Voiceprints?
When you speak, the sound that comes out of your mouth is composed of various frequencies blended together to create the tonal quality that is unique to your voice. If you attach a microphone to the input of an oscilloscope and speak into it, you can watch the frequency and amplitude changes. The bandwidth of meaningful sounds for most voices is about 4 kHz. (Not coincidentally, this is the passband of a voice-grade telephone line.)

Another method of looking at the various frequencies present in voices is to produce a graph of speech waveforms showing frequency as a function of time. An example of this is shown in figure 2 on page 52. As the word "eight" is spoken, the majority of the energy is between 1 and 4 kHz.

Figure 1: Block diagram of a computer speech-recognition system using word templates.
for the first 0.15 seconds, then a silent period is interrupted after another 0.15 seconds by a quick burst of energy at about 4 kHz. The first waveform group is the “eigh”, and the final burst is the “t”. A plot of the amplitude also provides significant information.

This sort of voiceprint or spectrogram shows a record of frequency and amplitude versus time.

Producing the graph shown in figure 2 requires an x, y plotter and a real-time spectrum analyzer. This equipment is costly and not generally available to the average experimenter, but with a little ingenuity we can obtain similar results with some simple bandpass filters and an oscilloscope.

**Economy Voiceprint Display**

The laboratory spectrum analyzer typically used to produce voiceprints often contains either a scanning filter or FFT (fast-Fourier-transform) processor. Such equipment has extremely high resolution (as well as cost) and allows the operator to resolve frequencies separated by only a few hertz (Hz). This is much more resolution than is required for our application, and a more cost-effective real-time spectrum analyzer can be substituted.

Figure 3 is a block diagram of the hardware I used to record voiceprints. It consists of an eight-octave bandpass filter connected to a microphone and some timing circuitry. The outputs of the circuit are connected to the x-axis, y-axis, and blanking (z-axis) inputs of an oscilloscope. The result is a three-dimensional view of the spoken word. The x axis represents time, the y axis represents frequency, and the z axis (brightness) represents amplitude.

The plot thus produced looks somewhat different from the spectrogram in figure 2, but it is equally representative of spectral content. The eight filter sections cover eight octaves from 31 Hz to 4 kHz. Concentrations of energy in the eight octaves appear as eight bands across the display.

For example, if there are any frequencies present around 1 kHz, the 1-kHz band on the display is illuminated, appearing as a stripe across the oscilloscope screen. The amplitude of these frequencies governs the intensity of the stripe. If this approximately 1-kHz signal is weak, the pattern will be dim; if it is strong, the pattern will be bright.

Figure 4 is an example of the kind of display produced by my interface circuit. This is approximately how the word “eight” appears when spoken. You’ll note the grouping of energies corresponding to “eigh” and “t” as before. (There is also a shift in frequencies due to the fact that this display was produced by a different

---

**Figure 3:** Block diagram of the Circuit Cellar voiceprint-recording system.
person speaking.) While unlike the ink-drawn spectrogram, it is equally detailed and unique.

On an 8- by 10-cm (centimeter) oscilloscope display, each frequency band occupies 1 cm on the vertical (y) axis. Time is recorded on the horizontal (x) axis where 1 cm corresponds to 0.05 seconds (all screen photos accompanying this article have these values). A complete word sample therefore represents sounds occurring during a one-half-second interval, consisting of 128 samples at each frequency. Changing the clock rate of the circuit can increase or decrease the scan time.

The scans appear as vertical lines on the screen. A full half-second sample consists of 128 vertical filter scans. Each vertical scan is divided evenly into eight sections corresponding to the eight filters. The bottom is 31 Hz, and the top is 4 kHz. The intensity of each segment of the scan line is determined by the output voltage of the particular filter: the more positive the output, the brighter the segment.

If there is no output from a filter section during a segment interval, that portion of the segment will not be illuminated (it will be blanked). As configured, a half-second sample period scans the filters every 3.9 ms (milliseconds).

How the Display Circuit Works

Figure 5 is a schematic diagram of the voiceprint-display system. It is basically divided into two sections: amplifier and filters (figure 5a on page 56) and the sample and scanning logic (figure 5b on page 58). A prototype of the sample and scanning logic is shown in photo 1 on page 50. The ribbon cable leads off to the amplifier and filter board.

Integrated circuit IC1 is a two-stage microphone preamplifier (you could substitute a much simpler circuit; this just happens to be the one I used) feeding output into IC2b, which has a sensitivity adjustment potentiometer and an additional stage of amplification. IC2a is an average level indicator. While each filter responds only to its preset frequency passband, this portion of the circuit passes all frequencies and produces a DC voltage output proportional to the average volume level. This output is fed to the voltage comparator IC9, which switches when the average input level is above a certain amplitude, thus triggering the sample period when pronunciation of the word begins.

The 3 least significant bits of the counter control the address lines of an 8-channel analog multiplexer, IC16. The other 8 bits of the 11-bit counter set the 256 positions of the x axis (128 displayed and 128 blanked positions).

(continued on page 58)
Photo 2: Voiceprints, or spectrograms, of various words being pronounced by a Micromouth voice synthesizer, as recorded by the circuit of figures 5a and 5b attached to a Tektronix model 2215 oscilloscope. Eight frequency bands are defined in the vertical y axis, while the horizontal x axis gauges time elapsed during the sounding of the word. The amplitude of energy in the various frequency bands is indicated by the brightness of the oscilloscope trace.
R-2R-ladder D/A (digital-to-analog) converter, which I discussed in my January Circuit Cellar article. With a count of 0, the output is 0 V (volts); with a count of 255, the output is +5 V. Therefore, each step is 19.5 mV (millivolts).

With a clock rate of 4096 Hz, the D/A converter increases its output voltage by an increment of 19.5 mV every 2 ms. With the scope set for x,y-vector display mode, the x-axis scope trace proceeds from the bottom left corner (0 V) to the bottom right corner (+5 V), taking half a second.

Initially I used a 3-bit D/A converter to increment the position of the y-axis beam. However, the 60-MHz bandwidth of the Tektronix scope was sufficient to cause each vertical scan to appear as eight dots rather than eight line segments. The scope was too fast. This was remedied by using a ramp-function generator configured from IC11 and IC17. IC11 is a positive-going integrator, and IC17 is a shorting switch connected across the integrating capacitor.

When the switch is closed, the output of IC11 is 0 V. This is the case during the odd-numbered scans, when the Q4 output of IC14 is high. On even scans the switch is open, and the capacitor is allowed to charge. As configured it charges linearly at a rate determined by the slope-adjustment potentiometer. This potentiometer should be set so that the output of IC11 (pin 6) goes from 0 V to 12 V during the 2-ms half period of the Q4 output. The clock rate affects this time period, so the slope will have to be readjusted if the clock frequency is changed.

**Recording Voiceprints**

After connecting the voiceprint-generating system to the scope, you can begin to experiment. Speak a word into the microphone. The beam will be triggered, and the trace will move from left to right across the screen. Slowly increase the input-sensitivity potentiometer until the background noise saturates the display. All filters will have some output, and the screen will be completely unblanked. Slowly back off
Figure 5a: Section of the schematic diagram of the spectral voiceprint circuit, showing the amplifier and bandpass-filter components. Eight passbands are selected by the filter stages, with the output sent to the scanning and display section of figure 5b.
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When performance must be measured by results.
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Figure 51: The scanning and display section of the workstation shown in schematic form. Input comes from the bandwidth filter and output is sent to an oscilloscope. Direct resistors may be used in place of the Allen Bradley 31202530 resistor package.
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Circle 179 for literature.
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the gain until the display appears to respond as you speak a word. Continue this adjustment until the display looks like the sample photos.

In bright ambient light the display will appear as a single vertical line moving across the screen. If you darken the room, the persistence of the phosphor screen will allow you to see the entire voiceprint.

To record the voiceprint for posterity you will need a camera. In a darkened room, simply set the camera on a tripod, open the shutter manually, allow one sample to scan on the screen, and then close the shutter. This is essentially the technique I used to produce the sample voiceprint photos that accompany this article. Unfortunately, since the Tektronix 2215 has no reticle illumination, no scale is reproduced in the photos. Keep in mind that there are eight vertical filter bands and that the x-axis is half a second.

Examples of my own voiceprints wouldn’t be especially helpful to you in trying to align your voiceprint system, so I have provided examples that can potentially be duplicated and compared. All the voiceprint photos here were produced using the output of a Micromouth voice synthesizer. The Micromouth, which I described in my June 1981 article, uses a National Semiconductor Digitalker speech-synthesis chip set. It has a limited vocabulary which is extremely intelligible and eminently reproducible. If you have a Micromouth, simply connect it up and compare your results to the various prints of words and numbers shown here.

### Experimental Results

What can we learn from studying the results of our simple testing? First of all, the voiceprints of speech synthesizers and people are very different. While the words sound much the same to the ear, the frequency content is rather different. This difference should not bother a computer speech-recognition system so long as the word templates are set to recognize either synthesized or natural voices. But because of its repeatable speech, the synthesizer might provide a good way to initially test a speech-recognition system.

In general, there seem to be considerable spectral differences between the words in the minimum useful vocabulary I chose as examples. Because of the great differences, a speech-recognition system could use minimally precise template data to differentiate between these words.

Consider how a computer could store these voiceprints as word templates. An A/D converter could be used to read the filter values. Storing the output values from 128 scans of eight filters requires 1024 (1K) bytes for each word, assuming the use of an 8-bit A/D converter. The amount of memory required can be reduced by eliminating the dead air time at the beginning of words and between the sounds contained within a word.

---

**Figure 6:** Timing diagram of the voiceprint-recording system.
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Five new Microboard computers with 1805 microprocessors and counter/timers.

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Perhaps storing the output amplitude of the filters is unnecessary, and a simple threshold detector would be sufficient. A logic 1 could indicate that there is some spectral content in that frequency range while a logic 0 indicates none. The eight instantaneous filter outputs could then be stored in a single byte rather than eight. This translates into a memory requirement of 128 bytes per sample period. This presumes that information about the frequency content of speech with respect to time is more important than information about the amplitude of the energy in the different frequency bands. I think it will depend a lot upon the vocabulary chosen.

Finally, I saw little activity in either the 31-Hz or the 4-kHz band in speech from my own voice and from the Micromouth. This may be a limitation of the hardware, but I think it would be safe to eliminate these passbands from any voice-response system. In my experience, the three frequency ranges that seem to always contain the most energy are about 60 Hz to 200 Hz, 200 Hz to 500 Hz, and 1 kHz to 2 kHz. I am at present unwilling to design a speech-recognition system with only three sampling passbands, but I’m still gathering data.

In Conclusion
I haven’t yet decided how I will configure my speech-recognition system. I have only one major design criterion so far: because writing comprehensive software algorithms isn’t among my greatest pleasures in life, I will attempt to do as much in hardware as I can.

Perhaps if I stall long enough a few inexpensive integrated circuits that can do it all will emerge from Silicon Valley. I have heard promising reports on a few such products. I know of the intense interest many of my readers have in the subject, and I intend to build a speech-recognition system as soon as I can make it cost-effective.

I hope that this article has at least helped you understand some of the first steps in speech recognition. If you are talented in software, you may have been inspired with an idea that will make the process easy. But at any rate, I hope to have helped allay any suspicions that computerized voice response is a black art.

Next Month:
New technological developments have made infrared light a convenient medium for remote-control or data transmission. We’ll explore how to use it.

References

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, 70 Main St., Peterborough, NH 03458. Garcia’s Circuit Cellar, Volume I, covers articles that appeared in BYTE from September 1977 through November 1978. Garcia’s Circuit Cellar, Volume II, contains articles from December 1978 through June 1980. Garcia’s Circuit Cellar, Volume III, contains the articles that were published from July 1980 through December 1981.

To receive a complete list of Garcia’s Circuit Cellar project kits available from the Micromint, circle 100 on the reader-service inquiry card at the back of the magazine.
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Personality—it's a major factor in distinguishing arcade best-sellers from the ones that lie around gathering dust in a corner. In coin-operated arcade games, it is not the only factor in determining success—anything with enough color, sound, and action will attract an adequate following. However, personality is a greater factor in microcomputer-based arcade games because they have fewer distracting frills. Of the many games I've seen in the past six months, Apple Panic has far more personality than any of several equally well-done games for the Apple II or II Plus microcomputers. Additionally, Apple Panic is an original game. It is not just a simplified copy of a coin-operated game. As a game that's available only for microcomputers, you can show it off to coin-op game snobs.

Like many successful arcade games, Apple Panic has a simple but eccentric premise. Your player is trapped in a world of walkways and ladders. The objective is to keep your player alive as long as possible. Of course, no arcade game is complete without a merciless enemy, and Apple Panic is no exception. Your enemies are a number of flattened "apples" (similar to Terrapin Turtle robots) that roam the walkways and ladders. They aren't terribly bright, but what they lack in intelligence they make up for in number. How do you fight back? By digging a hole in the walkway, waiting until an apple drops into it, and then knocking it through the hole to smash on the walkway below.

You control your player's movement by using the "I," "J," "K," and "M" keys. To dig a hole, hit the "A" key while your player is moving. (For some reason, your player does not always dig a hole when you want it to. Although this is probably the result of simplifying the game's algorithm to a manageable size, I look on it as a chance to develop my expertise in the game.)

Once an apple falls into the hole and sticks there, you have several seconds to return to that hole and knock the apple through by hitting the "S" key; if you line up two or more holes well enough for the apple to drop through all of them,
you get bonus points that increase with each extra hole used. When an apple falls through a hole, the walkway is mysteriously repaired; see photos 1a and 1b. (You didn't expect this to be easy, did you?) In addition, if you don't get to a stuck apple in time, the dumb but industrious critter pulls itself out of the hole and repairs the walkway.

Although the apples are slow, they don't waste any opportunities. If they get close enough, they pounce on and eat your player. The screen is then redrawn with a different arrangement of ladders and apples, and you start over. On successive screens, you usually get more apples on the screen. If you get good enough, two new predators, the Green Butterfly and the Mask of Death, appear; the latter appears only if you are very good. You get more points for killing them, but they are more difficult to kill. The Butterfly must drop through two holes before it is eliminated; if it drops from one hole to the walkway immediately below, it continues walking as if nothing had happened. (You get an extra player life when you kill a Butterfly.) The Mask of Death is even more difficult to kill; it must fall through three holes before it is destroyed.

One final note on the mechanics of the game: your player can fall through a hole without injury. This is sometimes useful as an escape route because the apples can't follow.

Strategy

Timing is very important in this game. It takes a certain amount of time to dig a hole or knock an apple through a hole. If you underestimate the amount of time needed when an apple is nearby, it may get you before you get it.

Another element of your strategy is the placement of holes with respect to ladders. On one hand, you like to have a hole between you and every apple. On the other hand, if an apple falls into a hole on the other side of the screen, those same holes may prevent you from getting to the trapped apple in time. After hastily digging a hole, you may find that it is now impossible to get to an entire section of the screen. Also, the strategy of going to the end of a walkway, digging a hole between you and the center of the screen, and waiting for an apple to come after you usually doesn't work—the apples aren't smart enough to sense you unless you are nearby.

Conclusions

Apple Panic is an interesting, playful game. It is interesting to note that, like Pac-Man (a game similar in spirit), it uses engulfment as the main form of destruction. This is very different from the majority of games, which have objects shooting projectiles at each other.

Apple Panic makes good use of both graphics and sound. When walking, the player does not flicker (as it would with less skillful animation). Nearly constant sound effects keep the ear entertained without assaulting it.

Even when played by a novice, this game usually lasts longer than most other arcade-style games. Although the apples will eventually overwhelm you, split-second reflexes are not as important here as they are in other games. A normal game of Apple Panic lasts from five to fifteen minutes; it lasts longer as you get better. Therefore, while still being entertaining and engaging, Apple Panic will not leave you a nervous wreck when the game is over. (Well, less of one, anyway.)

I do have a criticism, however. This game does not have the features that allow you to indefinitely pause while you turn the sound effects off. Granted, one game can't have everything, but these easily implemented features are becoming more common on Apple games. Game designers should take note.

Apple Panic is a copy-protected disk that boots directly on either 13- or 16-sector Apple computers. Broderbund Software pledges to replace the disk free of charge if it fails to boot and to replace it for a minimal charge if the disk is ever physically damaged. This is another policy that should be encouraged. It takes away many of the objections about copy-protected disks for programs of this nature.

It should be reemphasized that Apple Panic is an original game, not a copy of an arcade game. If the current trend away from microcomputer games adapted from coin-operated arcade games continues, the work of authors and companies that produce high-quality original games will become more important.
Missile Command

Stanley J. Wszola
Technical Editor

As your left thumb stab s at the fir ing button, your right hand spasmodically tries to control the cursor. You see flashes of light, hear bursts of sound, and finally it’s over. You’ve done it, racked up your best score ever playing Missile Command. Have you ever wondered why Missile Command is such a popular game? Despite the claims of Atari that its development was a long process, there are other reasons for its success. In this review, I’d like to touch lightly upon some of these reasons.

If you have never pumped a quarter into a video arcade game, or don’t own an Atari 400 or 800 microcomputer, I’ll briefly describe the game. The Missile Command game for the Atari 400 and 800 is an adaptation of the commercial arcade game. You become the commander of a missile base with armaments consisting of ABMs (antiballistic missiles). You must preserve your six cities and missile base from nuclear attack by destroying the incoming enemy missiles and bombs.

The enemy is armed with ICBMs (intercontinental ballistic missiles), MIRVs (multiple independently targeted reentry vehicle ICBMs), killer

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At a Glance

Name
Missile Command

Type
Arcade-type game

Manufacturer
Atari Inc.
1265 Borregas Ave.
Sunnyvale, CA 94086
(408) 745-2213

Price
$39.95

Format
Plug-in ROM cartridge

Language
6502 machine language

Computer
Atari 400 or 800 with 8K bytes of RAM and joysticks

Documentation
18-page booklet

Audience
Any Atari computer owner who enjoys a good game

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satellites that drop missiles, bombers, and smart missiles that can evade your ABMs and home in on their targets.

The enemy attacks come in waves. Each wave lasts from 30 to 45 seconds. The waves become increasingly more difficult as the game progresses, with the sixth wave introducing you to the smart missiles.

You are provided with 30 ABMs per wave. These are launched again by using the joystick to control a cursor on the screen. When a missile, bomber, or satellite appears, you position the cursor over or near the target and press the fire control button. Your missile base launches an ABM toward a detonation mark left by the cursor on the screen. The resulting atomic fireball, complete with the simulated sound of a nuclear explosion, will destroy the incoming missile or other target. That is, if your aim was true, if you allowed for a moving target, if you hadn't already used all your ABMs, and if the target wasn't smart enough to get out of your way (smart missiles).

The game allows you to select one or two players. The computer automatically keeps score and remembers the highest score while the game is continuing. You have the option of skipping the easier waves of enemy attacks. For example, you can practice shooting down nothing but smart missiles.

The object of all this nuclear mayhem is to accumulate points. Points are scored for every enemy weapon destroyed and for every city and ABM left at the end of each wave. Every two waves, a wave point multiplier increases the value of each point by as much as six times. Every time you earn 10,000 points, you get another city to replace one that was previously vaporized.

Why Is It Successful?

Though none of the editors on the BYTE staff advocate nuclear war, we all agree that Missile Command is a good game. Yet we agree for different reasons, and therein lies the reason for the game's success.

Some people enjoy the competitiveness of trying to better another person's score. Others enjoy the interaction between human and computer. And some enjoy the lights, noise, and the satisfaction of symbolically blowing things up. My enjoyment stems mostly from not having to pump quarters into the computer.

The Critics

There are those who object to the overt violence implicit in the game. After all, the destruction of cities is a very violent activity. A friend of mine once said that games of this type only encourage the acceptance of warfare as a viable solution to problems that could be settled peaceably. I asked if he ever played chess.
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For the first time, 8 and 16 bit processor intermixing.
When he said yes, I then asked if he thought his aggressive activities on the chessboard affected his actions in real life. A very spirited discussion then ensued, with neither of us convincing the other to change his views.

Whether the designers of Missile Command intended to or not, they have presented a game that reflects contemporary society. The game takes the threat of nuclear warfare and, simplifying the concept to the extreme, reduces that threat to a manageable human level. Whether this familiarity with nuclear warfare is good or not, I don’t know. However, it doesn’t seem to have affected the popularity of the game.

**Conclusion**

Missile Command is a great success, and Atari should be congratulated on producing such a high-quality product. However, it is only a temporary success. Programmers are constantly working on newer, better games. My advice to them is to carefully examine the current successes and determine why they work. Then, taking their own original games, incorporate those ideas in their own programs.

With the advent of new microcomputers and with the foundations for software development already well established, the potential for creative programming is greater than ever. I am excitedly awaiting what’s coming next.

---

**Dino Wars**

George Stewart
Technical Editor

If any computer game deserves the title “action game,” this one does. Dino Wars is a two-player game in which each player controls a ferocious dinosaur that attempts to bite the other player’s dinosaur until it cries uncle. Although there is no gore and the losing dinosaur always survives, the combat between the two creatures seems vicious at times.

The battle takes place on a desert plain decorated with several clumps of cactus. However, this is not your ordinary cactus. If a dinosaur mistakenly runs into one, the creature falls over and loses five units of fighting energy. Perhaps it’s fossilized.

Although the terrain is much larger than the field of view displayed on the screen, it is not infinite. If a dinosaur exits to either the left or the right, it eventually reemerges on the opposite side of the screen. Even if not visible on the screen, battles can rage in full force and dinosaurs can trip over unseen cacti.

The dinosaurs are chunky creatures (low-resolution is the term used outside of the prehistoric epoch) modeled after *Tyrannosaurus rex*. One is purple, the other blue. (An alternate color set is available for variety.) Although not the most graceful of animals, they can swing their tails menacingly, open their jaws to bite, and swagger around the screen in any direction.

The game is three-dimensional. As a dinosaur recedes into the background, it becomes smaller, eventually shrinking to the size of a dot. As it advances, its size increases to a stage where it consumes much of the screen.

Joysticks are used to control the combatants. Although these joysticks permit 360 degrees of apparent control, the dinosaurs can actually move in only six directions. As a result, they appear to hop from one stance to another.

The object of the game is to bite the

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**At a Glance**

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<thead>
<tr>
<th>Name</th>
<th>Dino Wars</th>
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<tbody>
<tr>
<td>Type</td>
<td>Animated dinosaur combat game</td>
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<tr>
<td>Author</td>
<td>Robert Kligus</td>
</tr>
<tr>
<td>Format</td>
<td>Plug-in ROM cartridge</td>
</tr>
<tr>
<td>Computer</td>
<td>TRS-80 Color Computer with two joystick controllers: 16K bytes of RAM recommended for best results</td>
</tr>
<tr>
<td>Audience</td>
<td>Game fans age 6 and up</td>
</tr>
</tbody>
</table>

---
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40 ch × 25 line
40 ch × 20 line
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Various Symbols, Hiragana, Kanji
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3 Copies

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510W × 600D × 505H mm (Green)
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other dinosaur while it is vulnerable, i.e., while it has its back turned or is recovering from a nasty fall over a cactus (the Marquis of Queensberry rules don’t apply in this primitive world). After sustaining an effective bite, a dinosaur falls to the ground with a resounding crash.

When two experienced players control the dinosaurs, the battle resembles an awkward ballet, with the dinosaurs constantly circling each other while vying for a shot at each other’s weak point. When beginners play, the action is more likely to resemble a pastoral scene in which the two dinosaurs wander around aimlessly, occasionally engaging one another with little effect and separating again.

To make a dinosaur bite, you press the joystick button. The dinosaur issues an awesome roar as it closes its jaws on air, cactus, or the opposing dinosaur. Generating this sound is one of the more satisfying aspects of the game.

Both dinosaurs start out with 100 units of energy. Each time a dinosaur is successfully bitten in a clinch, it loses 20 points; if bitten while recovering from a cactus fall, 10 points; falling over a cactus costs five points. The game ends when one of the dinosaurs loses all its points.

A prerequisite to enjoying this game at length is a sense of the ridiculous. Without that, you are apt to become frustrated by some of its limitations. For example, while either dinosaur is roaring, all action on the screen halts because the Color Computer’s microprocessor is totally preoccupied with the task of generating the sound (a hardware limitation).

Here are bite-by-bite reports from two noteworthy dino wars.

In the first battle, one player was an expert, the other a beginner. This quite typical case corresponds to computer owner and friend. The expert player used a sneak-attack strategy: his dinosaur stayed just off-screen until the beginner’s dinosaur presented a vulnerable back. Then the expert’s dinosaur lunged into view, bit effectively, and retreated again. Five such attacks were enough to send the beginner’s dinosaur into squeaking submission (a defeated dinosaur always runs off yelping toward the horizon).

In the second battle, two jaded players searched for a nonviolent use of the game. The cactus provided an answer. A dinosaur can become hopelessly entangled in a cactus; each time it gets up, it immediately falls down again, losing five points each time. Accordingly, the object of this absurd battle was to be the first to expend all one’s energy in mortal combat with a cactus.

Dino Wars is primarily a novelty, but a good one. It allows two players to work off all sorts of aggressions toward each other and plant life. However, it is not a game you can grow with; it doesn’t take long to “peak out.” It is not an intellectual game like Adventure, nor does it get your adrenaline going as does a fast-paced game of Star Raiders. Compared to one of these, you might say Dino Wars is prehistoric.
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Part 7: Sound

Bob Fraser
1639 Martin Ave.
Sunnyvale, CA 94087

The Atari 400 and 800 home computers have extensive hardware sound capabilities. Four independently controllable sound channels are able to play simultaneously. Each channel has a frequency register determining the note and a control register regulating the volume and the noise content. Several options allow you to insert high-pass filters, choose clock bases, set alternate modes of operation, and modify polynomial counters. This article will explain these options; next month, part 8 will show how to call these options from both BASIC and 6502 machine language.

Definitions

For the purposes of this discussion, a few terms and conventions need to be clarified:

1 Hz is 1 pulse per (hertz) second
1 kHz is 1000 pulses (kilo-)hertz per second
1 MHz is 1,000,000 pulses (mega-)hertz per second

A pulse is a sudden voltage rise followed somewhat later by a sudden voltage drop. If a pulse is sent to a television speaker, it will be heard as a single pop.

A wave, as used here, is a continuous series of pulses. Different types of waves exist, each of which is distinguished by the shape of the individual pulses. Waves created by the Atari computer are square. Brass instruments typically produce triangular waves, and a human voice produces sine waves.

A shift register is like a memory location (in that it holds binary data) that, when so instructed, shifts all its bits to the right by one position (i.e., bit 5 will get whatever was in bit 4, bit 4 will get whatever was in bit 3, and so on). Thus, the rightmost bit is pushed out, and the leftmost bit assumes the value on its input wire (see figure 1).

"AUDFn" is read "any of the audio frequency registers, AUDF1 through AUDF4." Their addresses are, respectively, hexadecimal D200, D202, D204, and D206 (decimal 53760, 53762, 53764, and 53766).

"AUDCr" is read "any of the audio control registers, AUDC1 through AUDC4." Their addresses are, respectively, hexadecimal D201, D203, D205, and D207 (decimal 53761, 53763, 53765, and 53767).

For the purposes of this discussion, frequency is a measure of the number of pulses in a given amount of time; that is, a note with a frequency of 100 Hz means that in one second exactly 100 pulses will occur. The more frequent (hence, "frequency") the pulses of a note, the higher the note. For example, a singer vocalizes at a high frequency (5 kHz), and a cow moos at a low frequency (100 Hz). The words "frequency," "note," "tone," and "pitch" are used interchangeably.

Noise and distortion are also used interchangeably, although their meanings are not the same. Noise is a more accurate description of the function performed by the Atari computer.

All examples are in BASIC unless
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otherwise stated. Type the examples exactly as they appear. If there are no line numbers, don't use any; if several statements are on the same line, type them as such.

**Sound Hardware**

Sound is generated in the Atari computer by the POKEY chip, a custom integrated circuit designed especially for the Atari 400 and 800; POKEY also handles the serial I/O bus and the keyboard. The POKEY chip must be initialized before it will work properly. Initialization is required after any serial bus operation (cassette, disk drive, printer, or RS-232C read/write). To initialize POKEY in BASIC, execute a null sound statement; that is, SOUND 0,0,0,0. In machine language, store a 0 at AUDCTL (hexadecimal 0208 = decimal 53768) and a 3 at hexadecimal 232 (decimal 562); this is the shadow location for the SKCTL register at hexadecimal D20F (decimal 53775).

**The Audio Frequency Registers**

Each of the four audio channels has a corresponding frequency register that controls the note played by the computer. The frequency register contains the number $N$ used in a divide-by-$N$ circuit. This is not a division in the mathematical sense, but something much simpler: for every $N$ pulses coming in, one pulse goes out. For example, figure 2 shows a divide-by-4 function.

As $N$ gets larger, output pulses become less frequent, making a lower frequency note.

**The Audio Control Registers**

Each channel also has a corresponding control register. These registers allow the volume and distortion content of each channel to be set. The bit assignment for AUDCn is given in table 1.

**Volume**

The volume control for each audio channel is straightforward. The lower 4 bits of the audio-control register (AUDCn) contain a 4-bit number that specifies the volume of the sound. A zero in these bits means zero volume; a fifteen means as loud as possible. The sum of the volumes of the four channels should not exceed thirty-two because this forces overmodulation of the audio output. The sound produced tends to actually lose volume and assume a buzzing quality.

**Distortion**

Table 1 also shows that each channel has three distortion-control bits in its audio-control register. Distortion is used to create special sound effects any time a pure tone is undesirable.

---

### Table 1: Bit usage in the AUDCn registers (AUDC1 through AUDC4)

<table>
<thead>
<tr>
<th>AUDCn Bit Number</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>distortion</td>
<td>volume-only bit</td>
<td>volume</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The computer's use of distortion offers great versatility and control. It is easy to synthesize an almost endless variety of sounds, from rumbles, rattles, and squawks to clicks, whispers, and mood-setting background tempos.

Distortion, as used here, is not equivalent to the standard interpretation. For example, intermodulation distortion and harmonic distortion are quality criteria specified for high-fidelity stereo systems. These types of distortion refer to waveform degeneration, where the shape of the wave is slightly changed due to error in the electronic circuitry. The computer's distortion does not alter waves (they are always square), but rather deletes selected pulses from the waveform. This technique is not adequately characterized by the word "distortion." A more descriptive and appropriate term for these distortion methods is "noise."

Before you can fully grasp what we

---

![Figure 3: An example of a poly counter. By letting the new leftmost bit be determined by some algorithm (here, an exclusive NOR of bits 3 and 5), a poly counter can produce a semirandom stream of bits. The pattern of the bits will eventually repeat, but the length of the pattern depends on the width in bits of the poly counter.](image)
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<table>
<thead>
<tr>
<th>Xerox 820</th>
<th>Hewlett-Packard 125—Model 10</th>
<th>IBM Personal Computer</th>
<th>Apple III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Memory</td>
<td>64K</td>
<td>64K</td>
<td>64K</td>
</tr>
<tr>
<td>Maximum Memory when fully configured*</td>
<td>64K</td>
<td>192K</td>
<td>256K</td>
</tr>
<tr>
<td>Expandability</td>
<td>No expansion slots</td>
<td>No expansion slots</td>
<td>No extra expansion slots in fully configured* 192K system</td>
</tr>
<tr>
<td>Diskette Storage (per drive)</td>
<td>92K</td>
<td>256K</td>
<td>160K</td>
</tr>
<tr>
<td>Max Storage (per drive)</td>
<td>1.16 megabyte Floppy Disk</td>
<td>5 megabyte Hard Disk</td>
<td></td>
</tr>
<tr>
<td>Display Graphics Capability</td>
<td>High resolution B/W</td>
<td>High resolution B/W</td>
<td>High resolution B/W or 4-color (color requires additional card)</td>
</tr>
</tbody>
</table>

* "Fully configured" means system includes at minimum, monitor, printer, 2-disk drives and RS-232 communications. NOTE: Chart based on manufacturers information available as of December 1981
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mean by distortion, you must understand polynomial counters (also called poly counters). Poly counters are employed in the Atari computer as a source of random pulses used in noise generation. The Atari computer's poly counters utilize a shift register working at 1.79 MHz. The shift register's contents are shuffled and fed back into the input; this produces a semirandom sequence of bits at the output of the shift register.

For example, in figure 3, the old value of bit 5 will be pushed out of the shift register to become the next output pulse, and bit 1 will become a function of bits 3 and 5.

The bit processor gets values from certain bits in the shift register (in figure 3, bits 3 and 5) and processes them in a way irrelevant to this discussion. It yields a value that becomes bit 1 of the poly counter's shift register.

These poly counters are not truly random because they repeat their bit sequence after a certain span of time. As you might suspect, their repetition rate depends upon the number of bits in the poly counter; in other words, the longer ones require many cycles before they repeat, while the shorter ones repeat more often.

On the Atari computer, distortion is achieved by using random pulses from these poly counters in a selection circuit. This circuit is actually a digital comparator, but the term "selection circuit" is more descriptive. The only pulses making it through the selection circuit to the output are those coinciding with a random pulse. Various pulses from the input are thereby eliminated in a random fashion. Figure 4 illustrates this selection method. A dotted line connects pulses that coincide.

The net effect is this; some pulses from the frequency-divider circuit are deleted. Obviously, if some of the pulses are deleted, the note will sound different. This is how distortion is in-

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introduced into a sound channel.

Because poly counters repeat their bit sequences, their output pattern of pulses is cyclic. And since the selection circuit uses this output pattern to delete pulses from the original note, the distorted note will contain the same repetitious pattern. This allows the hardware to create noises such as drones, motors, and other sounds having repetitive patterns.

The Atari computer is equipped with three poly counters of different lengths, which can be combined in many ways to produce interesting sound effects. The smaller poly counters (4 and 5 bits long) repeat often enough to create droning sounds that rise and fall quickly; the larger poly counter (17 bits long) takes so long to repeat that no pattern to the distortion can be readily discerned. This 17-bit poly counter can be used to generate explosions, steam, and any sound where random crackling and popping is desired. It is even irregular enough to generate white noise (an audio term meaning a hissing sound).

Each audio channel offers six distinct combinations of the three poly counters, which are listed in table 2. These upper AUDCn bits control three switches in the audio circuit as shown in figure 5. This diagram will help you understand why table 2 is structured as it is.

Each combination of the poly counters offers a unique sound. Furthermore, the distorted sounds can sound quite different at different frequencies. For this reason, some trial and error is necessary to find a combination of distortion and frequency that produces the desired sound effect. Table 3 gives you some rough guidelines with which you can begin your experimentation.

**Volume-only Sound**

Bit 4 of AUDCn specifies the volume-only mode. When this bit is set, the volume value in AUDCn bits 0 through 3 is sent directly to the television speaker; it is not modulated with the frequency specified in the AUDFn registers.

To fully understand the use of this mode of operation, you must understand how a speaker works and what happens to the television speaker when it receives a pulse. Any speaker has a cone that moves in and out. The cone's position at any time is directly proportional to the voltage it is receiving from the computer at that time. If the voltage sent is zero, the speaker is in the resting position. Whenever the cone changes position, it moves air that is detected by your ear as sound.

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If you sent the speaker a pulse, it would push out with the rising voltage and pull back with the falling voltage, resulting in a wave of air that can be detected by your ear as a pop. The following statements produce such a pop on the television speaker by sending a single pulse:

POKE 53761,31:POKE 53761,16
A stream of pulses (or wave) would set the speaker into constant motion, and a continuous buzz or note would be heard. The faster the pulses are sent, the higher the note. This is how the computer generates sound on the television speaker.

It is essential to note that in the volume-only mode the volume sent does not drop back to zero automatically, but remains constant until the program changes it. The program should modulate the volume often enough to create a noise. Now try the following two statements, listening carefully after each:

POKE 53761,31
POKE 53761,16

As before, you heard a pop the first time as the speaker moved back to its resting position, and you heard nothing the second time because the speaker was already in the resting position.

Thus, the volume-only bit gives the program complete control over the position of the speaker at any time. Although the examples given above are only binary examples (either on or off), you are by no means limited to this type of speaker modulation. You can set the speaker to any of 16 distinct positions.

For example, a simple triangle wave (similar to the waveform produced by brass instruments) could be generated by sending a volume of 8 followed by 9, 10, 11, 10, 9, 8, 7, 6, 5, 6, 7, and back to 8, then repeating this sequence over and over very rapidly. By changing the volume quickly enough, virtually any waveform can be created. It is feasible, for example, to perform voice synthesis using this technique, however, this requires the use of assembly language. There is more discussion of this bit in part 8 of this series.

AUDCTL

In addition to the independent channel-control bytes (AUDCn), an option byte (AUDCTL) affects all four channels. Each bit in AUDCTL is assigned a specific function, as shown in Table 4. AUDCTL is at location D208 hexadecimal, 53768 decimal.

Clocking

Before proceeding with the explanations of the AUDCTL options, a
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new concept must be explained: clocking. In general, a clock is a train of pulses used to synchronize the millions of internal operations occurring every second in any computer. The central clock pulses continuously, each pulse telling the circuitry to perform another step in its operations. You may remember that a divide-by-N frequency divider outputs one pulse for every Nth input pulse. You also may have wondered where the input pulses come from. One main input clock runs at 1.79 Mhz; it can provide the input pulses. Also, several secondary clocks can be used as input clocks. The AUDCTL register allows you to select the clock used as the input to the divide-by-N circuit. If you select a different input clock, the output from the frequency divider will change drastically.

The formula for the output frequency (from the divide-by-N) is quite simple:

$$\text{Output frequency} = \frac{\text{Clock}}{N}$$

Setting bit 0 of the AUDCTL register switches from the 64-kHz clock to the 15-kHz clock. Note that if this bit is set, every sound channel clocked with the 64-kHz clock will instead use the 15-kHz clock. Similarly, by setting bits 5 or 6, you can dock channels 3 or 1, respectively, with 1.79 MHz. This will produce a much higher note, as demonstrated by the following example:

SOUND 0,255,10,8
POKE 53768,64

The SOUND statement causes channel 1 to give a low tone, and the POKE sets AUDCTL bit 6 to 1, causing the pitch generated by channel 1 to jump to a much higher note.

**16-Bit Frequency Options**

The 8 bits of resolution in the frequency-control registers normally provide more than adequate resolution for the task of selecting any desired frequency. There are, however, situations in which 8 bits are inadequate. Consider what happens when you execute the following statements:

FOR I=255 TO 0 STEP -1:
SOUND 0,I,10,8:NEXT I

Initially, the sound rises smoothly,
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Listing 1: A program that uses a 16-bit divide-by-N register. When used with game paddles in part 1, this program produces a sound with a frequency that can be varied by paddles 1 and 2. Paddle 1 changes the sound in large steps; paddle 2 changes the sound between two adjacent large steps.

```
10 SOUND 0,0,0,0: REM
20 POKE 53768,80: REM
30 POKE 53761,160:POKE 53763, 168: REM
40 POKE 53760,POADDLE(0):POKE 53762,POADDLE(1)
50 GOTO 40: REM
```

but as it approaches the end of its range the frequency takes larger and larger steps that are noticeably clumsy. This happens because you are dividing the clock by smaller and smaller numbers: 15 kHz divided by 255 is almost the same as 15 kHz divided by 254; however, 15 kHz divided by 2 differs greatly from 15 kHz divided by 1. The only way to solve this problem is to use a larger number that allows you to specify frequency with greater precision. The means to do this are built into POKEY.

AUDCTL bits 3 and 4 allow two channels to be joined, creating a single channel with an extended dynamic-frequency range. Normally, each channel’s frequency-divider number can range from 0 to 255 (which results from 8 bits of divide-by-N capability). Joining two channels allows a frequency range of 0 to 65535 (16 bits of divide-by-N capability). In this mode, it is possible to reduce the output frequency to less than 1 Hz. The program in listing 1 uses two channels in the 16-bit mode and two paddles as the frequency inputs. Insert a set of paddles into port 1, then type in and run listing 1. The right paddle tunes the sound coarsely; the left paddle finely tunes the sound between the coarse increments.

This program first sets bits 4 and 6 of AUDCTL; this tells the Atari computer to clock channel 1 with 1.79 MHz and join channel 2 to channel 1. Once this happens, the 8-bit frequency registers of both channels are assumed to represent a single 16-bit number N that is used to divide the input clock. Next, the volume of channel 1 is set to 0. Since channel 1 no longer has its own direct output, its volume setting is meaningless to us and we zero it. The channel 1 frequency register is used as the fine-tuning or low byte in the sound generation; the channel 2 frequency register is the coarse-tuning or high byte. For example, poking a 1 into the channel 1 frequency register makes the pair of registers divide by 1. Poking a 1 into the channel 2 frequency register makes the pair divide by 256. Poking a 1 into both frequency registers makes the pair divide by 257.

Bit 3 of AUDCTL can be used to join channel 4 to channel 3 in the same way.

The following instructions demonstrate some interesting aspects of 16-bit sound (try poking other numbers into the last four locations):

```
SOUND 0,0,0,0
POKE 53768,24
POKE 53761,168
POKE 53763,168
POKE 53765,168
POKE 53767,168
POKE 53760,240
POKE 53764,252
POKE 53762,28
POKE 53766,49
```

High-Pass Filters

AUDCTL bits 1 and 2 control high-pass filters in channels 2 and 1, respectively. A high-pass filter allows only higher frequencies to pass through. In the case of these high-pass filters, high frequencies are defined as anything higher than the output of another channel selected by
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the AUDCTL bit combination. For example, if channel 3 is playing a cow’s moo and AUDCTL bit 2 is set, only sounds with frequencies higher than the moo will be heard on channel 1 (anything lower than the “moo...” will be filtered out). See figure 6.

The filter is programmable in real time because the filtering channel can be changed on the fly. This opens a large field of possibilities to the programmer. The filters are generally used to create special effects. Try the following statements:

SOUND 0,0,0,0
POKE 53768,4
POKE 53761,168:POKE 53765,168
POKE 53760,254:POKE 53764,127

9-Bit Polynomial Conversion

Bit 7 of AUDCTL, when set, turns the 17-bit poly counter into a 9-bit poly counter. The shorter the poly counter, the more often its distortion pattern repeats, or the more discernible is the pattern in the distortion. Therefore, changing the 17-bit poly counter into a 9-bit poly counter makes the noise pattern more repetitive and more discernible. Try the following demonstration of the 9-bit poly-counter option, listening carefully when the POKE is executed:

SOUND 0,80,8,8
POKE 53768,128

The first statement activates the 17-bit poly counter; the second changes the counter to a 9-bit poly counter.

Next Month

Now that we know about the various registers that control the sound-generating capabilities of the Atari 400/800, we will look at several BASIC and machine-language techniques to use sound within a program.

**Figure 6:** High-pass filtering in the Atari 400/800. At any given instant, the only frequencies in channel 1 that are passed by the filter are those greater than the frequency being played in channel 3.

---

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Build a Half-year Clock for the Color Computer

Fourth in a Series

William Barden Jr.
28122 Orsola
Mission Viejo, CA 92692

The ideal clock for a computer system, to my mind, would be an inexpensive, compact, accurate unit with a self-contained power supply that could be easily interfaced to the computer system. This article describes a clock for the Radio Shack Color Computer; it meets all of my goals at the expense of some software complexity.

The half-year clock (HYC) described here can provide the time with a resolution of ±10 seconds or better over a six-month period. Powered by a self-contained 9-volt (V) battery, it can be disconnected from the Color Computer at any time, set aside, plugged in later, and will continue reporting the time. It is a compact unit measuring 14 by 9 by 3.8 cm (5¼ by 3½ by 1½ inches).

The HYC uses seven integrated circuits (ICs) plus some discrete components. The project is built using wire-wrapping techniques. If you've never tried wire-wrapping, fear not: I'll provide detailed tips for easy construction.

Since the HYC communicates with the Color Computer via the serial interface of the computer, I'll start with a description of that interface.

Color Computer Serial Interface

The complete serial interface of the Color Computer is shown in figure 1. The four lines of the serial interface go to a 4-pin DIN plug on the rear of the system. These four lines are a subset of the 25 lines normally used in other computer systems, such as the Radio Shack Models I and III. The Color Computer uses asynchronous

Figure 1: The Color Computer RS-232C interface consists of two comparators and one op amp used as a comparator. The TD signal is generated from software by output to PIA (peripheral interface adapter) address FF20 hexadecimal. The RD is read into PIA address FF22 hexadecimal. The CD signal is not normally used and is an "edge trigger" signal generating a PIA interrupt.
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Data sent in asynchronous RS-232C format typically consist of a start bit, 8 bits of data, and one or two stop bits. The bits are evenly spaced with no inherent clock.

Asynchronous Communication

The EIA standard RS-232C defines the format for data communication. Therefore, serial communication is often called "RS-232C" or "RS-232" communication. A system channel designed for data communication is known as a serial or RS-232 port.

The standard format for asynchronous communication is shown above. In this example, 8 bits make up the actual data word. The data are asynchronous, that is, they are sent at unpredictable times, rather than at regularly spaced intervals. A good example of an asynchronous datum is a character transmitted from a keyboard to a communications system such as The Source or Compuserve. The host system does not know when to expect the next character—it may occur within 1/10 second or 10 seconds. Each character must be detected and handled as an independent "event."

The computer system or device receiving an asynchronous character can read either a logic 1 or logic 0 on the receive data (RD) line. Initially, the RD line is at logic 1, called "mark." The receiving system or device expects this high condition to exist initially. To signal the start of a data word, the transmitting system sends a start bit by bringing the RD line to a logic 0, called a "space," for a duration known as a "bit time." The length of the bit time depends on the data-transmission rate and may vary from about 9 milliseconds to 0.1 millisecond.

The receiving system or device detects the start bit, delays ½ bit time, and gets set to receive the rest of the data word at evenly spaced intervals of one bit time. The start bit is followed by eight data bits (one of which may be a parity bit) and one or two stop bits that are always at logic 1 (mark). The stop bits ensure that the RD line will be marking prior to transmission of the next data word.

The bit rate is the data-transmission rate of all data measured in bits per second (bps). Three hundred bps is typical for the Color Computer. Each character at this bit rate typically is made up of one start bit, eight data bits, and one stop bit, for a total of 10 bits. Thus, 300 bps yields 30 characters per second. The bit time is 1/300 second, or 3.33 milliseconds.

The standard logic levels for RS-232C communication are voltages above 3 V (logic 0) and below -3 V (logic 1). In the Color Computer, the voltages used are 12 V for logic 0 and -12 V for logic 1.

serial communication, which requires only three lines; the fourth line is available for special purposes. See the text box for background information on serial communication.

Interface operation. The Color Computer's serial interface is made up of one comparator (actually an operational amplifier) for controlling the transmit data (TD) line and two comparators for checking the receive data (RD) and carrier detect (CD) lines.

A comparator accepts two input voltages. If the "+" (plus) input voltage is higher than the "-" (minus) input, the comparator outputs a logic 1; if the "+" input voltage is lower than the "-" input, the comparator outputs a logic 0 (see figure 2).

In the following descriptions, I'll be referring to a few "memory" addresses in the Color Computer that function as I/O lines—part of the peripheral interface adapter (PIA).

TD line. The 741C operational amplifier compares the "-" input from bit 1 of port address FF20 hexadecimal with the "+" input from the voltage divider R23/R24. The "+" input is a constant +1.38 V. A logic 1 on port FF20 hexadecimal bit 1 will generate -12 V on the TD line; a logic 0 will generate +12 V on the TD line.

RD and CD lines. The two LM339 comparators have serial data as their input. Both have the same configuration. One is connected to the RS232IN line of port FF22 hexadecimal bit 0. The second is con-
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The half-year clock consists of a crystal oscillator, a divider producing 60-Hz pulses, a 9-digit BCD counter, a parallel/serial register, and comparator output to the Color Computer.

A block diagram of the HYC is shown in figure 3. It interfaces to the Color Computer via the RD, TD, and serial lines of the serial port. The clock count is sent via the RD line after a prompt by the Color Computer from the TD line.

At the heart of the HYC are three BCD (binary-coded decimal) counter chips. Each chip accumulates a three-decimal digit count of 0 to 999. Together, the three chips accumulate a count of up to 999,999,999.

The input to the three counters is a 60-hertz (Hz) signal from the oscillator/divider chip. This chip takes a 3.58-megahertz (MHz) signal from a "color burst" crystal and divides it down to 60-Hz signals.

At any given time, the count in the counter chips represents the number of 60-Hz pulses received. The maximum count of 999,999,999 represents 16,666,666 seconds—about 192 days.

The two "universal bus register" chips load 16 bits from the counters upon command from the Color Computer. The bits are then shifted out to the RD line at a rate of one every 66.66 seconds. It requires three transfers (48 bits total) to transmit the current time to the Color Computer. (Of course, the Color Computer has to decode it into a usable form.) The detailed logic diagram of the HYC is shown in figure 4.

Counters. The counters are Motorola MC14553B ICs. Each chip increments its count by one each time a 60-Hz pulse is received from the CLK input. To output its count, each chip presents one digit at a time over the Q3 through Q0 outputs. Q3 through Q0 represent a BCD digit of 0000 through 1001. For example, if the count in one of the MC14553B chips was "678," the outputs on Q3 through Q0 would be, in sequence, 0110, 0111, and 1000.

The chips are outputting their counts continually. The scan rate, the rate at which the three digits appear, is controlled by an external capacitor connected to C1A and C1B. A 1.0-microfarad (µF) capacitor generates a scan rate of about 3 Hz, or a new BCD digit every 333 milliseconds (ms). The scan frequency has no relation to the 60-Hz clock frequency. This scan frequency is applied to all three counters simultaneously so that the BCD digits of all sets of Q3 through Q0 change at the same time.

The DS3 to DS1 outputs indicate which BCD digit is being displayed on the Q3 through Q0 outputs. If DS3=0, the most significant digit is being output; if DS2=0, the next digit is being output; and if DS1=0, the least significant digit is being output.

To read the current count requires three reads of Q3 through Q0: at DS1 time, DS2 time, and DS3 time. When
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Figure 4: The half-year clock uses seven integrated circuits, most of which are CMOS devices. The counter information is multi
plexed and the count data are brought into the Color Computer in three segments of 2 bytes each.
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the outputs are shuffled around in the proper order, the nine digits represent the current count.

The OF signal is the "carry" output to the next counter. This appears on the thousandth count when the counter recycles to 000. The disable (DIS) and latch enable (LE) lines are not used in this application configuration. MR, "master reset," is used to zero the counters when a momentary switch is pulsed.

**Bus registers.** The bus-register chips are Motorola MC14034 B ICs. They contain two 8-bit registers and can operate in a number of different modes, depending upon the configuration of the A/E, P/S, A/B, and A/S inputs. The two modes being used here are "synchronous parallel data input" and "synchronous serial data input."

In the first mode, parallel data are strobed in by the clock input. In our circuit, 14 bits of data from the counter chips are strobed in. Twelve of these bits are the current BCD digits from each counter chip. Two of the bits are the DS3 and DS2 scan signals. (The third scan signal, DS1, is not needed, since we can infer that it is active when DS3 and DS2 are inactive.)

Setting the P/S signal to logic 1 selects the parallel data input mode. The 14 lines are continuously strobed in on the rising edge of every C (CLK) input. Since the clock runs at 60 Hz, the 14 lines are recorded 60 times per second.

When signal P/S is a logic 0, the bus registers are in the serial data input mode. This is something of a misnomer because this mode not only shifts in new data, but also shifts out previously recorded data; in this case, the 14 bits recorded earlier. The 14 "old" bits are shifted out at a 60-Hz rate. To allow synchronization of the serial bit stream, a leading 0 and 1 are prefixed to every 14-bit group.

**RS-232 interface.** The Color Computer's RD line is driven by the least significant bit of the HYC's lower-order bus register. The output is about 0 V if the data bit is a 1, or about +5 V if the data bit is a 0. The "bit time" of this output is ½ second, or about 16.66 ms. This RD output goes into the RS232IN bit of port FF22 hexadecimal.

The Color Computer's TD line drives the HYC's mode-select signal P/S. The level at the P/S pin changes from 0 V to close to +9 V for a positive or negative input, respectively. The P/S signal is logically equivalent to the status of the RS232OUT bit in port FF20 hexadecimal.

**CMOS circuitry.** All chips except the LM339s are CMOS (complementary metal-oxide semiconductor). CMOS is characterized by low power consumption. The HYC requires less than 4 milliamperes (mA) of current. The optional power switch shown in figure 4 lets you extend battery life when the HYC is not connected to the system or when the Color Computer is not in use. It shuts off power to all
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3 15 KO, 1/4 W, 10%
4 100 KO, 1/4 W, 10%
5 20 MO (use two 10 MO), 1/4 W, 10%

Capacitors
1 4.7 nF disk
2 47 nF disk
2 1.0 µF electrolytic, 25 V

Miscellaneous
1 3.58-MHz crystal
2 SPDT momentary switch, miniature
1 SPST or SPDT switch, miniature (optional)
1 N4000 series diode (not critical)
1 4-pin male DIN connector
1 9-V battery, alkaline
2 prototype board
1 case
1 ribbon cable, 3- or 4-conductor wire-wrap wire, solder, #14 wire, battery connectors

Table 1: Parts list for the half-year clock. All parts, except those starred, are available from Radio Shack.

Construction of the HYC
All the parts in the HYC are easy to obtain. The 3.58-MHz crystal, oscillator/divider, counter chips, and LM339 are stocked by Radio Shack. The bus-register chips are available from any well-stocked parts supplier (see the ads in any issue of BYTE). The cost of all parts should be under $20. See the parts list in table 1.

The HYC is housed in a project case (Radio Shack 270-219 or equivalent). This plastic case has a built-in compartment large enough to hold a 9-V battery.

A 7- by 9.5-cm (23/4- by 33/4-inch) grid board is used to hold the components. Two #14 bus wires run down the center of the board. One is used for the VDD bus (+9 V); the other is ground (see figure 5).

The board has printed-circuit pads on one side. Mount the IC sockets, resistors, capacitors, and crystal on the side of the board without the foil. Solder two diagonally opposing pins of the IC sockets. Leave the resistor, capacitor, and crystal leads uncut for wire-wrapping.

Wire-wrap the IC pins according to table 2. All detailed connections are shown, but obvious power-supply connections are not indicated.

Components not involved in maintaining the half-year count.

A typical alkaline battery has a capacity of about 0.5 ampere-hours, making the HYC functional for about 250 hours of continuous use in the low-power mode, or about 125 hours of continuous use without the optional power switch. This 5/10-day life can be extended by paralleling a number of 9-V batteries or by using a larger battery, such as the NEDA 1603 size, which will not fit in the case used here, but which will last a good deal longer—over 1000 hours in the low-power mode.

CMOS operates on a power supply of from 3 to 18 V. The voltage of the supply can be degraded quite far before the HYC will stop operating. The limiting factor is the RD output, which must swing from 0 to at least +2.6 V for proper comparator operation in the Color Computer.
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recommend buying precut wire in lengths of 1, 2, and 3 inches. It is inexpensive and will cut the wire-wrap time in half.

The **V** and ground leads can be connected directly to the two buses. No power switch is used. The three leads to the serial port can be made from three-conductor ribbon cable routed into the battery compartment of the case and between the compartment cover (see figure 6). The opposite end of the ribbon cable connects to the 4-pin male DIN plug (see figure 7).

**Testing the Hardware**

After you've assembled the board, test the interconnections, referring to table 2 and figure 4. Invariably, there will be one or two miswires. (I once wired 10 chips in mirror-image fashion—pin 1 to 24, 2 to 23, etc.; you should be in better shape than this!)

Use two common straight pins, clip leads, and an ohmmeter or continuity tester to check all connections before installing the ICs in their sockets. When you're confident that all the connections are proper, plug in the ICs. CMOS is not as intolerant of static electricity as it once was, but avoid handling the chips more than necessary.

Plug in the 9-V battery, and you should be in operation. If you have an oscilloscope, check between pin 3 of IC4 and ground. The scan clock

![Figure 6: The ribbon cable can be brought out between the cover of the battery compartment and the project case.](image)

![Figure 7: A 4-pin male DIN connector is used to link the half-year clock to the Color Computer's RS-232C jack on the rear of the computer.](image)
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HYC Software

The HYC, in keeping with the traditions of the Color Computer system, is largely software dependent. Listing 1 shows a 6809 assembly-language program that reads data from the HYC. It resides in the upper 256 bytes of RAM (in a 16K Color Computer system). Protect this area by a CLEAR 200, &H3EFF when running the program with BASIC. Key in the 97 bytes of the program or use POKEs and DATA statements in your BASIC program.

With the exception of 2 bytes, the program is relocatable. Change the second and third bytes of the second instruction (locations 3F05 to 3F06 hexadecimal in listing 1) if you should be operating at about 3 Hz. If it's slower than 3 Hz, try lower values than the 1-µF capacitor connected between pins 3 and 4 of IC2. Also, check the oscillator/divider output. You should see a clean 60-Hz square wave.

How the HYC Program Works

The Clock I/O Handler (listing 1) is divided into three parts: the DELAY subroutine, the INPUT subroutine, and the main loop CLOCK.

The DELAY subroutine delays in multiples of 0.8333 second. One 60-Hz pulse has a duration of 16.666 milliseconds. This subroutine can be conveniently used for delaying in multiples or submultiples of one 60-Hz bit time.

The INPUT subroutine makes a single read of 16 bits of data from the counters. The BSR instruction at INPUT calls INPUA, resulting in the code from INPUA through the RTS instruction being executed twice. Eight bits of data are read on each pass through the section of code.

The loop at INP010 reads in eight data bits from port FF22 hexadecimal. Bit 0 is shifted right into the carry condition code and then rotated into the byte pointed to by the user stack pointer. The byte is initially cleared to 0. At the end of the second pass through INPUA, 2 bytes of data have been stored in the user stack, representing one complete read of three digits.

The main loop at CLOCK performs consecutive calls of the INPUT subroutine until three samplings of DS1, DS2, and DS3 have been compiled in the 6 bytes of the buffer. First, a 1 is output to bit 1 of port FF20 hexadecimal, bringing the HYC's P/S signal to a 1 (parallel data input mode). A delay of 1.9 cycles is provided so that the data can be clocked into the bus registers.

After the delay, the serial output is started by outputting a 0 to bit 1 of port FF20 hexadecimal, bringing P/S to a 0 (serial data input mode). Immediately after the output, the serial datum is checked by reading port FF22 hexadecimal bit 0. If the datum is a 1, the first clock occurred too close to the initialization of the process, and the process is repeated from CLK010. If the datum is a 0, a delay of 1/10 cycle is done and a test for 0 is done again; if the datum is not 0, the clock occurred within 1/10 cycle (close to the edge of a bit time), so the process is repeated.

If the first bit is a 0, the loop at CLK020 delays until the appearance of a 1. At this point, the second clock has just occurred. A delay of 1½ cycles is then done to position the next read in the middle of the third data bit time. The INPUT subroutine is then called to read in the next 16 bits. The last two of these are always zeros.

Now, the scan number of the first 16 bits is tested. If not equal to binary 11, or DS1, the process is repeated from CLK010. If equal to DS1, the user stack pointer is adjusted, the scan number is adjusted to 2, and another read from CLK010 is done to read the DS2 cycle. A third iteration reads the last cycle, DS3.

The short subroutine at GETSER gets the serial bit and tests it, changing the Z condition code to zero or nonzero.
relocate the program. These 2 bytes should hold the address of a 6-byte buffer.

A simple BASIC test program is shown in listing 2. This program defines the location of the program by the DEFUSR0 statement. (Change this statement if you have relocated the machine-language code.) The assembly-language program is entered by the USR0 call and returns with 6 bytes of the current clock count in locations 3F00 through 3FF5 hexadecimal. These six locations represent the BCD digits and scan numbers as shown in figure 8. Sample outputs are shown in figure 9.

Text continued on page 122

Listing 2: This short BASIC program calls the clock I/O handler and displays the 6 bytes of data that were read.

```
100 DEFUSR0=63H3FF0
110 A=USRO(0)
120 FOR I=63H3FF0 TO 63H3FF5
130 PRINT PEEK(I),
140 NEXT I
150 PRINT:PRINT:GOTO 110
```

Listing 1: The clock I/O handler is a three-section, assembly-language program that reads in 6 bytes of the count into a buffer at location 3FF0 hexadecimal.
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Figure 8: The 6 bytes of count data from the half-year clock contain nine BCD digits and three scan numbers. The order is based on the functional layout of the hardware and the data must be rearranged by the interface software.

Figure 9: These are typical data samples. Sample 1 represents a count of 000289457, or 4824.XX seconds. Sample 2 occurred after sample 1 and represents the next count of 000289525, or 4825.XX seconds.
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LISTING 3: This BASIC program interfaces to the assembly-language clock driver. It converts the 6 bytes of clock data into a count of days, hours, minutes, and seconds, and checks for error conditions.

```
100 INPUT "TIME IN GOTHIS";T2
110 CLS
120 DEFUSR=0:WSFBS
130 T0=1
140 A=USRK(0)
150 B=INT(PEEK(#2FSF);4)
160 C=INT(PEEK(#2FSF);4)
170 D=INT(PEEK(#2FSF);4)
180 E=INT(PEEK(#2FSF);4)
190 F=INT(PEEK(#2FSF);4)
200 G=INT(PEEK(#2FSF);4)
210 H=INT(PEEK(#2FSF);4)
220 IF (G+H) MOD 2 = 1 THEN FB=T3
230 J=INT(PEEK(#2FSF);4)
240 IF (J+3) MOD 2 = 1 THEN TB=T1
250 IF T1+T0 THEN GOTO 140 ELSE IF T1+T0 THEN GOTO 140 ELSE T0=1
260 T3=T1+T2: IF T3=999999999 THEN T3=1
270 T2=INT(T2/60)
280 D=INT(T3/3600)+INT(T3-D-B/3600)/36000 M=INT(T3-DB/3600-H/36000/60 B=S=T3-DB/3600-H/36000/60
290 PRINT "DAY","HOURS"/1HMS","SEC"
300 GOTO 140
```

Text continued from page 117:

A general-purpose BASIC driver is shown in listing 3. This program displays the actual number of days, hours, minutes, and seconds represented by the count in the HYC. This count can be held in a Color Computer BASIC variable, which allows nine decimal digits of precision.

A "bias" count can be input to the program before sampling the HYC. This bias may be positive or negative to adjust the current count to a previous starting point or to "trim" the time. The unit of bias is 1/6 second. Thus, use a value of 60 for every second, 3600 for every minute, 216,000 for every hour, or 518,400 for every day. The momentary-contact RESET switch resets the entire count to 0.

The tests of the current count (T1) with the previous count (T0) require some explanation. In most cases, the sampling process reads count data in a "nonchanging" state. However, because the scan clock occurs at unpredictable times, the count may be sampled in the middle of a scan clock "edge," yielding invalid data. Because of this, T1 (current) is compared to T0 (old). If T1 is less than T0, T1 is invalid and another sample is made. If T1 is greater than T0 by 999 counts (16.65 seconds), T1 is considered invalid and another sample is made.

The typical display generated by the program shows the time changing every 2 seconds, with occasional lapses of up to 4 seconds.

Tests run over several days showed less than one (detected) invalid read per minute with a maximum delay of 5.5 seconds. No invalid times appeared.

If the HYC is to be called at random times, make three calls and test for ascending counts with a difference of less than 10 seconds or so. Using this method, the resulting time will be accurate to within 10 seconds of the counter time.

The crystal used should provide an excellent time base. It can be fine-tuned, however, by substituting a 5 to 50-picofarad (pF) "trimmer" capacitor in place of the 4.7-pF capacitor connected to the crystal.

In operation, the HYC can be disconnected from the system at any time (without turning off the Color Computer) and left running. It can be reconnected at any later time. (Stop the BASIC program above if this is done to prevent a hang-up caused by T1-T0 being greater than 999.)

If Rip van Winkle had owned a Color Computer, he would have loved the half-year clock. If you have nothing to do for the next 192 days, why not check this project out with your Color Computer to test its accuracy? Or count clock pulses instead of sheep: 999,998,767; 999,998,768; 999,998,769 (yawn) . . .
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Last month we left the computer waiting patiently for the printer to signal its readiness to receive another character. If you think it's wasteful to make a machine as expensive as a computer spend most of its time waiting on slower equipment, you are definitely thinking ahead. Later in this month's article, I'll explore a communication mechanism that lets the computer work on another task after transmitting a piece of information. This mechanism, known as the interrupt, enables the computer to go about its business until the printer is ready for more data. First, though, you need to know how a computer selects a peripheral device to communicate with; you also need to know about interfaces—the hardware that connects computers and peripherals.

Creating subaddresses ensures that information of different kinds can be directed to the proper section of the device.

Picking and Choosing
In the first article of this series, I briefly discussed peripheral address lines. Computers, which generally have several peripheral devices attached, select a particular device in one of two ways. One method is to have a separate I/O connection for every device connected. Selecting a particular device is merely a matter of sending information on the proper bus. This technique, however, rapidly creates a rat's nest of wires, something that's impractical to manufacture.

An I/O bus has a set of peripheral-address lines that the processor uses to specify a device. This greatly simplifies wiring the system and results in major cost savings, although it does limit the computer to communicating with one peripheral at a time. For most computer processors, though, one is the limit anyway.

Multiplexing Peripherals
Peripheral-address lines allow the I/O bus to be shared or multiplexed by many devices. Each device must have a unique address on the bus. Otherwise, conflicts will arise when two devices try to use information on the bus simultaneously. For instance, plotters are useful for graphing data but are terrible for listing programs.
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When the computer is accessing the disk storage device, everything will run more smoothly if the plotter ignores transactions on the I/O bus.

Clearly, each peripheral device must have its own unique address. It's more advantageous, however, for each device to have several unique addresses. Think of the peripheral device as an apartment building having a single, unique street address. Apartment One gets the local daily newspaper, which covers general information, while Apartment Two gets The Wall Street Journal, which reports on economic events. Each apartment gets information but of a different kind.

A peripheral device also requires information of different kinds. Not only do printers receive characters to print, but they also get control information such as line spacing, number of characters to print per line, type font, and other functions. Creating subaddresses within the peripheral device ensures that information of different kinds can be directed to the proper section of the device.

Peripheral address lines are split into a select code that specifies a particular peripheral and a register code that specifies the subaddress. (A register is a hardware device that holds the information until the peripheral can use it.)

Setting up Subaddresses

To illustrate, I'll create four subaddresses within each select code. Being obstinate, as computer designers often are, I'll call these subaddresses 1, 4, 5, 6, and 7 (nobody starts at zero any more). These four subaddresses are registers that serve as portals to the peripheral.

Four subaddresses require two wires for selection because two wires can assume four binary states. These states are:

<table>
<thead>
<tr>
<th>State of line #1</th>
<th>State of line #2</th>
<th>Register addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>7</td>
</tr>
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Assume one of two states: on or off, "1" or "0."

Although four registers could do the job, there's a complication: the data lines are bidirectional, and bi-directional registers are complex to construct. It's easier to use eight registers—four for input and four for output. The I/O line will specify from which group of four the register address lines will select. Remember that the I/O line specifies the direction of data flow on the data lines and so is ideal for selecting between the input and output registers.

I've now constructed a simple I/O bus that can convey information between the computer and external devices. This I/O bus isn't the most advanced, but it will satisfy present needs. I'll upgrade this "bunch of wires" later, but first let's confront a more pressing problem.

Introduction to Interfaces

The I/O bus discussed above is a subset of the bus used in the Hewlett-Packard desktop computers, model 9825 and Systems 35 and 45. It would be convenient if all peripherals came with circuitry that directly interfaced to the I/O bus.

Unfortunately, present interfacing methods are far from ideal. The bus constructed above is parallel-oriented, which means that every binary digit (bit) of a piece of information (such as a character) is available simultaneously on the 16 data lines.

Not all peripherals use 16 data lines; some peripherals don't have any parallel interfaces but instead send information one bit at a time in a time-serial fashion. No peripherals use the eight-register scheme discussed above, while several use incompatible voltage levels to represent "1" and "0." This appears to be quite a problem. In fact, there isn't a single peripheral that can talk to our I/O bus in its present state.

Interfaces as Translators

It's necessary to interpose some specialized circuitry between the I/O bus and the peripheral device to adapt the signals from the computer to those used by the peripheral. This
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specialized circuitry is called an interface. The interface, which actually plugs into the I/O bus, acts as an intermediary, translating voltages, signal formats, and whatever else is required to establish communications between the computer and the peripheral.

If every peripheral manufactured in the last decade required a different interface, it would be impossible for the computer to communicate with even a small fraction of them. Computer manufacturers simply cannot make products for that many different interfaces. Fortunately, several devices require only one of four basic types of interface: parallel I/O, serial I/O, GPIB (GPIB), and BCD (binary-coded decimal).

To connect with a peripheral, the parallel interface uses a set of wires much like those of the I/O bus. This interface is the most common among current peripherals because it's the simplest to build and usually transfers data the fastest. Major variations involve (1) the connector used between the peripheral and the interface circuitry and (2) the sense of the data and control lines. Does zero volts mean logic zero (positive true logic) or logic one (negative true logic)?

A flexible parallel interface should be available with several connectors and an unterminated cable so that a custom connector can be installed. The logic sense of the data and control lines and even the logic levels used can all be adjusted to suit the needs of a particular device.

A serial interface takes data from the I/O bus and serializes it into a stream of bits. Incoming serial data is converted into parallel data and sent to the computer. Only two wires are required for serial communications—transmit data and receive data—however, control lines exist in serial interfaces because serial I/O dominates the special environment of long-distance data communications.

Interrupts force the processor to leave the part of the program it's executing and start executing the code in a different location in memory.

HPIB, a relatively new interface, is standardized. HPIB stands for Hewlett-Packard Interface Bus. Due to standardization, it's also known as the General Purpose Interface Bus (GPIB). Formally known as IEEE-488-1978, HPIB has well-defined signals, connector, logic sense, and logic levels. This interface allows simple connection to multiple devices over a bus structure. Since the connector and signals are standardized, you just bolt the connecting cable to the peripheral for the computer to begin communicating. You then can concentrate on the software needed to run the peripheral. A single HPIB interface can connect a computer to 14 peripheral devices.

Older instruments use a different type of interface known as binary-coded decimal (BCD). Data is transferred in 4-bit chunks, and each group of 4 bits represents a numeral (0 through 9). BCD interfaces are generally used for transmitting numeric information.

In the third and fourth installments of this primer, I'll examine these types of interfaces in depth. For now, though, let's turn to this month's main topic, interrupts and direct memory access (DMA).

Getting the Processor's Attention

What do you think is the most important part of a telephone? The dial? The receiver? The cord? I submit that it's the bell. If the telephone had no way to summon you when a call came in, you'd have to check it periodically to see if there was someone on the line. Having to lift the receiver every few minutes would make the instrument a maddening inconvenience. Fortunately, telephones do have bells that interrupt you when someone calls.

Earlier I discussed the relative speeds of computer processors and peripheral devices. The mismatch in speeds forced the creation of handshaking lines the processor could check to determine the peripheral's availability. Without these lines, the speedy processor would inundate the poor peripheral with data. Using these handshake lines is the simplest form of I/O. The computer spends much of its time patiently waiting for the peripheral to signal readiness for

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Interrupting
Waiting for peripherals is tolerable if the computer has nothing else to do. Often, however, there are many other things the computer could be doing, making the handshaking I/O highly inefficient. Fortunately, most computers now offer an alternative called interrupt I/O.

Let's first make clear exactly what will be interrupted. The computer is continuously executing a program in its memory. If there's no user program running, then at least the operating system will be. Thus there are at least two program levels in the computer, with the higher level being the user program, usually written in a language such as BASIC.

Because microprocessors can't run a BASIC program directly (although that day isn't far off), they use a lower-level program called an interpreter, which is written in a machine language the processor can run directly. The interpreter takes the BASIC program and interprets it by deciding which machine-language routines to call to perform the tasks requested in the BASIC program. Another type of lower-level program, a compiler, can translate a high-level language program into machine code. I'll consider only interpreters here.

Interrupts are hardware mechanisms that force the processor to leave the part of the program it's executing and start executing the code in a different location in memory. Figure 4 shows the I/O bus with an interrupt request line added. That's the only change the bus needs in order to add interrupt capability.

Interrupts take place at the machine-code level. It's helpful in synchronizing external events with the computer program but must be used carefully. Let's take an example.

Suppose a user program asks the computer to calculate the value of 2.5 + 2.5, produce the resulting value on a printer, then calculate the value of 3 + 3. The computer will first execute the BASIC interpreter's routine for floating-point addition and produce the first sum: 5.00. Then there will be six characters to print: 5, . , 0 , 0 , <CR> , and <LF>. <CR> and <LF> are carriage return and linefeed characters usually sent to advance the printer to the next line on the paper.

Handshake I/O requires the computer to wait the full 0.6 seconds before calculating the second sum because the computer is waiting to send the printer another character during that time.

Interrupt I/O's alternative is to place characters to be printed in a buffer somewhere in memory. Interrupt routines can then withdraw characters from this buffer whenever the printer can accept them, and the computer can push on through the program.

Interrupting Machine Code

The first character to be printed is removed from the buffer and sent to the printer, the printer interface "goes busy," transferring the character to the printer and waiting for a signal that indicates completion of the printing. Meanwhile, the computer can proceed to the next BASIC statement. When that first character has finally been printed, the processor will "go ready" for the next one. At that time, the printer interface will interrupt the processor and request another character.

Note that the machine code interpreter is interrupted, not the BASIC program. The flow of execution of the BASIC statements is not changed but merely halted while the interruption is serviced. The interpreter, however, does branch to a different routine. This special routine, also in machine code, is called an interrupt service routine. The author of the BASIC program doesn't have to write interrupt service routines for Hewlett-Packard desktop computers, as needed routines are provided in the interpreter. This is convenient because interrupt service routines must handle many factors.

An interrupt forces a branch to the location in memory where the interrupt service routine is stored. If the processor doesn't remember where it was before the interruption, the processor will be unable to return to that location. In fact, the processor will be "lost" and unable to continue processing. Most microprocessors automatically save the address of the location being executed before the interrupt, and a return from the interrupt is sufficient to store that address.

If the interrupt routine uses any of the internal registers in the processor, the routine must carefully save the contents of these registers before using them. This procedure is called context switching because the registers will be used for a different purpose in the interrupt service routine than in the main program. Upon completion of the interrupt service routine, the routine must restore the saved values of the registers.

Interrupting BASIC

Occasionally, the buffered I/O routines for servicing interrupts are not sufficient for handling a problem. Some interrupts are more complex than those needed for data transfer. Maybe the computer is monitoring a water system and the dam bursts. Such crises require the processor's immediate attention; a simple data transfer will not suffice. A branch is needed in the high-level program to a special high-level routine written to handle the interrupt. You did write the "Dam Burst" routine, didn't you?

Interrupting a program in BASIC or another high-level language is considerably more complex than inter-
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rupturing a machine-language routine for data transfer. High-level statements can affect large portions of memory through the use of variables, arrays, and strings. If a variable is not logged in, but it will not be serviced until the end of the current program line.

Machine-code or low-level interrupts are generally called hardware interrupts because the processor hardware grants the interrupt request and performs the subsequent branching. Interrupts to the BASIC or high-level program are called software interrupts because several instructions in the operating system are required to log in the interrupt, request an end-of-line branch, then take control of program flow at the end of the line.

A Misunderstanding
A classic example of a misunderstanding occurs whenever a first-time writer of interrupt service routines tries to use an interrupt for input. The typical programmer will enable the interface to interrupt and expect that when the interrupt comes, the interface will have the desired data. Unfortunately, the interface interrupts when it isn't busy. This may happen when the interface wasn't told to do anything or when an operation has completed. Since the interrupt routine didn't originally make the interface busy by requesting a data input operation before the interrupt was enabled, the interface interrupts immediately but has nothing to offer. Such a miswritten interrupt routine always produces incorrect information on the first data transfer. Remember, to use interrupts properly, you must see that data transfer is started before interrupts are enabled. That way, the first interrupt will occur when the first data transfer is complete.

End of the Line
To prevent such problems, Hewlett-Packard desktop computers allow the BASIC program to be interrupted only at the completion of program line execution. This feature is called end-of-line branching because the branch to a BASIC interrupt service routine is allowed only when the end of a line is reached. The interrupt may occur at any time and will be

DMA: The I/O Superhighway
Thus far, I've covered the hardware within a computer and the interfacing circuitry necessary to interface peripheral devices with computers. All the discussions have assumed that the computer processor is in control of the data-transfer process, which is true for many peripheral devices. The processor is usually fast enough so that the peripheral determines the data-transfer rate.

Some devices, however, are too fast for processor-controlled I/O. These devices can handle data at rates approaching the speed of the computer memory and therefore require a different I/O technique. One technique for interfacing these fast peripherals is called direct memory access.

If the peripheral device is slightly slower than the computer processor, the processor may be able to execute only the few machine instructions needed for the I/O transfer before the peripheral is ready for another transfer. In that case, there's a good match between the I/O software and the peripheral speeds, and programmed I/O will suffice for the task.

Some peripherals, however, are too fast for the processor to execute even the few instructions needed to perform programmed I/O. As long as these peripherals are not faster than the computer's basic memory cycle, direct memory access can perform the required I/O.

In order to discuss DMA and how it works, we must return to the model of the processor/memory/I/O sys-
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Figure 5: A computer system with an added DMA (Direct Memory Access) machine. The DMA machine, which parallels the processor, can generate the signals necessary for controlling both the memory bus and the I/O bus.

The effective memory bandwidth, are not needed.

By placing this special circuitry so that it bridges the I/O and memory buses and also by giving it the capability of generating the address and control signals required by these buses, you then have a machine that can perform I/O at the full speed of memory. Such special circuitry is called a direct memory access machine. Figure 5 shows how one might add a DMA machine to the I/O bus.

All that remains is to decide which device will have control of the buses: the processor or the DMA machine. Normally, the processor will have control of the buses, since the DMA I/O must be infrequent enough to allow some processing to get done. The DMA machine must therefore have a way to acquire bus control from the processor whenever necessary. The processor can enable the DMA machine to request bus control, but the interface must actually request service through the DMA machine because only the interface knows when an attached peripheral requires DMA service. Thus some connecting signals must exist between the interface and the DMA machine and between the DMA machine and the processor. To give the interface a means of requesting service from the DMA machine, let's add a signal called DMA Request (DMAR) to the collection of signal lines on the I/O bus.

Upon receipt of a DMA Request, the DMA machine must request bus control from the processor. If the processor decides that the request comes at an inopportune time, it can temporarily withhold transfer of control. This is a job for the ever-present handshake! Let's create two handshake lines, Bus Request and Bus Grant. The DMA machine will ask for bus control with Bus Request and will take control after receiving a signal on Bus Grant. As a result, the processor can maintain control of the memory and address buses as long as required.

The kind of DMA I've been discussing is called burst DMA because the data transfer is done in a burst during which the DMA machine totally controls the memory and I/O buses. This provides the I/O with the full speed of the memory bus at the expense of completely halting processor activity. If half the memory bus bandwidth were sufficient to solve the high-speed I/O problem, we could use another type of DMA called cycle-steal DMA. In the cycle-steal arrangement, the DMA machine alternates control of the buses with the processor, each using every other memory cycle. Cycle-steal DMA allows the processor to operate at 50 percent efficiency while still providing relatively high-speed I/O.

Summary

It would simplify matters greatly if all devices could agree on data representation, format, signal levels, timing, or even the number of wires used for interconnection. Attempts at standardization have been made, but the swift pace of computer technology renders some standards obsolete before they're published. In addition, the need for compromises seems to arise with every new system. Older equipment also needs to be interconnected; otherwise, replacement of a computer would dictate replacement of the entire system.

Fortunately, present technology can reach backward as well as forward. The computer itself can make adaptations, since computers excel at changing one value into another. Furthermore, interface circuitry that links the computer's memory or I/O bus to the I/O of the peripheral device can overcome hardware incompatibility. Next month I'll discuss two basic types of hardware interface presently used in computer systems: the parallel and HPIB (GPIB) interfaces.

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A BASIC Plotting Subroutine
Sophisticated Plotting with Your MX-80

Since the introduction of the MX-80 printer, several articles have described most of its outstanding features, including the remarkable print quality for the price. I'd like to showcase another great feature of this printer: its ability to plot data curves. By combining its features with simple software routines, the MX-80 can emulate sophisticated plotters.

Plotter Criteria
Several features constitute a good plotting routine. First, it should be a subroutine that, when called, plots data generated in the main program and, if needed, returns to the main program with the data unmodified for further processing. Second, the plot routine should be automatically scaling so that the operator of the main program doesn’t have to worry about keeping tabs on all the maximum and minimum values sent to the plotting routine. Last but not least, the hard-copy output should have enough resolution to allow interpretation of the data. After all, that’s why a plot was deemed necessary in the first place.

Once a linefeed is generated, there’s no turning back.

The MX-80 printer easily meets these criteria, as evidenced by figure 1. The plot is a straight line of the form \( y = mx + b \). Note that the plotting routine provides its own graph paper by inserting horizontal and vertical grid lines; legends for both axes are included. Ah, you say, any print routine could handle a straight line with ease. Figure 2 is a better test of the printer and plotting routine. Here, concentric circles are plotted with radii of 1 and 0.5. Note that the auto-scaling routines in this case must handle both positive and negative values, and that, although the circles are not perfect, they have enough resolution for most plotting applications.

Resolution of these plots is set by the maximum number of data points allowed by the plotting routine. In the plots shown, the number of points was limited to 101 X,Y pairs. The number of points chosen was based on several criteria. First, the maximum number of print positions that can be set in the horizontal direction is 132. Using 101 of these positions for data plotting leaves 31 positions for printing the Y-axis scale values and the Y-axis title. In the vertical direction, the MX-80 can be set so that every linefeed increment moves the paper up by as little as \( \frac{1}{2} \) inch. Therefore, resolution to a single printed dot can be obtained. I chose only 101 points in the vertical direction for several practical reasons. In most cases, this is all the resolution needed to obtain a smooth fit of the data. Most important, though, each data point plotted takes time to print, and the increased printing time is not warranted in most cases.

About the Program
The program for generating the plots, shown in listing 1, was written in Microsoft MBASIC 5. The size of the program can be cut down considerably by removing the REM statements and by combining several program lines into one multiple-statement line. As written, the program doesn’t need a main program to gen-

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Lawrence J. Bregoli has a bachelor's degree in electrical engineering and is currently employed as a research engineer working on electrochemical aspects of fuel cell research at UTC in South Windsor, CT.
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Fig. 2: The program generates X, Y data sets. It was written this way so that it could be tested immediately for errors using data generated in lines 5120 through 5200. In normal operation, the DIM statement in line 5160 would be in the calling program, and the entry point to the plotting routine would be at line 5250. Line 5670 would also be changed from END to RETURN.

Lines 5250 through 5310 allow the user to enter the graph’s title and legends for the X and Y axes. These strings are then centered in 50-character strings so they are printed at the center of the X and Y axes, independent of the title or legend length. Manual or automatic scaling can then be selected by answering the prompt in line 5320.

The main body (lines 5460 to 5670) and its subroutines are where the real plotting action occurs. Most dot-matrix printers print from the top of the page down and do not allow this top-down mode to be reversed. The MX-80 also fits into this category. The resulting limitation forces special handling of the data to be printed so that all the data of a given Y value is printed on a line before the next linefeed occurs. Once a linefeed is generated, there’s no turning back to print another data point on the line above it.

In the main body, the first few lines set up the printer for 132 characters per line and 7/8 inch per linefeed. With these settings, a plot size of somewhat over 5½ inches in both directions is obtained when two linefeeds are performed for each of 101 data positions in the Y direction. Line 5520 performs a very important function in that it converts the line number position presently being pointed to on the plot to a numeric value proportionate to the total span of the data, which is set by the maximum and minimum scale values. (I didn’t even understand that!) In other words, consider line number 100 to be at the top of the plot and line number 0 at the bottom; also suppose that \( Y_{\text{MAX}} = 1 \) and \( Y_{\text{MIN}} = -1 \) as shown in figure 2. Then, if the present line number were 20 lines down from the top, the value of \( Y_1 \) would be:
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Listing 1: Program listing of MX-80 plotting routine, written in Microsoft MBASIC 5.

5000 REM
5010 REM ^*
5020 REM * 30 REH
5030 REM * PLAYOUT PROGRAM FOR MX-80
5040 REM * BY
5050 REM * LAWRENCE J. BREEDLI
5060 REM *
5070 REM *
5080 REM * USE THE FOLLOWING SPACE TO CALCULATE A 101 BY 101
5090 REM * DATA ARRAY IN X(I) AND Y(J).
5100 REM * ENTER PROGRAM BELOW THIS SECTION IF ARRAY EXISTS
5110 REM *
5120 REM *
5130 REM * SAMPLE ARRAY->CONCENTRIC CIRCLES
5140 REM *
5150 REM *
5160 REM * ENTRY TITLE OF PLOT AND AXIS LEGENDS
5170 REM *
5180 REM *
5190 REM *
5200 REM *
5210 REM * MAIN BODY OF PROGRAM STARTS HERE
5220 REM *
5230 REM *
5240 REM *
5250 REM *
5260 REM *
5270 REM *
5280 REM *
5290 REM *
5300 REM *
5310 REM *
5320 REM *
5330 REM *
5340 REM *
5350 REM *
5360 REM *
5370 REM *
5380 REM *
5390 REM *
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5840 REM *
5850 REM *
5860 REM *
5870 REM *
5880 REM *
5890 REM *
5900 REM *
5910 REM *
5920 REM *
5930 REM *

YN = 1 - (((1 - (-1)) / 100) 
   x (100 - 80))
   = 0.6

This value is subsequently tested against the data in the PLOT DATA subroutine. If a match with any data in the Y array occurs, a point is plotted at the proper X position as determined by the value in the corresponding X array.

The overall action performed on any given line can be summed up as follows:

1. The value of YN is calculated.
2. A character in the Y-axis title is printed.
3. The vertical grid line segments are printed.
4. The data is plotted for that line, if any.
5. If a horizontal line is called for, it's printed along with the scale.
6. The cycle is repeated for the next line down.

A special precaution must be taken to ensure exact horizontal indexing on printers like the MX-80, as they use bidirectional printing. Because the print head doesn't physically return to the left-hand stop each time a new line is printed, a slight but distracting misalignment occurs in the vertical grid lines. To overcome this, lines 5500 and 5590 were inserted to force the print head to the left prior to each new line printed. If you take a close look at the left-hand vertical grid lines in figures 1 and 2, you can see this slight misalignment. If your particular printer is perfectly aligned or if you can put up with a slight misalignment error, then remove these line numbers. Removal of these lines will save a lot of time in actually plotting the data.

While I'm on the subject of time, it takes about eight minutes to complete a plot using the program shown in listing 1. This may seem a bit long to some users, but consider plotting 101 X, Y points by hand from a table of data. I'd rather sip my coffee and watch the MX-80 go about that agony. Later, I'll discuss a way to take about two minutes off this time.

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**Listing 1 continued:**

5940 G0DBUS BS850
5950 NEXT I
5960 RETURN
5970 REM
5980 REM ******************************************************
5990 REM # PLOT DATA SUBROUTINE
6000 REM ******************************************************
6010 REM
6020 CHAR=S"0"
6030 FOR I=1 TO 100
6040 IF Y(I)>YHIN THEN YHIN=Y(I)
6050 IF X(I)<XHIN THEN XHIN=X(I)
6060 IF X(I)>XHAX THEN XHAX=X(I)
6070 IF Y(I)<YHIN THEN YHIN=Y(I)
6080 NEXT I
6090 REM
6100 REM ******************************************************
6110 REM # PLOT Y SCALE AND HORIZONTAL LINE SUBROUTINE
6120 REM
6130 REM
6140 IF YHAX<100 THEN RETURN
6150 PRINT CHAR(13):PRINT "**BUS BS850"
6160 PRINT USING "**BUS BS850"
6170 PRINT CHAR(13):PRINT "**BUS BS850"
6180 PRINT CHAR(13):PRINT "**BUS BS850"
6190 PRINT CHAR(13):PRINT "**BUS BS850"
6200 REM
6210 REM ******************************************************
6220 REM # PRINT Y AXIS TITLE
6230 REM
6240 REM
6250 IF YHAX<100 THEN RETURN
6260 PRINT CHAR(13):PRINT "**BUS BS850"
6270 PRINT USING "**BUS BS850"
6280 PRINT CHAR(13):PRINT "**BUS BS850"
6290 PRINT CHAR(13):PRINT "**BUS BS850"
6300 PRINT CHAR(13):PRINT "**BUS BS850"
6310 REM
6320 REM ******************************************************
6330 REM # PRINT X SCALE SUBROUTINE
6340 REM
6350 REM
6360 REM # PRINT DATA SUBROUTINE
6370 REM
6380 REM
6390 REM
6400 REM
6410 REM
6420 REM
6430 REM # PRINT X AXIS TITLE
6440 REM
6450 REM
6460 REM
6470 REM
6480 REM # AUTO SCALING SUBROUTINES
6490 REM
6500 REM
6510 REM
6520 REM
6530 REM
6540 REM
6550 REM
6560 REM
6570 REM
6580 REM
6590 REM
6600 REM
6610 NEXT I
6620 RESTORE 4830 REM
6630 MSD=(YMAX-YMIN)/10 REM
6640 FIX I=-2 TO 4
6650 FOR K=1 TO 31 READ J
6660 IF MSD=310 THEN MSD=310.1;GOTO 6680
6670 NEXT K:RESTORE 4830 NEXT I
6680 FOR I=10 TO -10 STEP -1
6690 IF MSD=10/MSD THEN MSD=10/MSD
6700 MSD=(YMAX-YMIN)/10 REM
6710 MSD=(YMAX-YMIN)/10 REM
6720 RESTORE 4830 REM
6730 PRINT USING "**BUS BS850"
6740 PRINT USING "**BUS BS850"
6750 PRINT USING "**BUS BS850"
6760 PRINT USING "**BUS BS850"
6770 PRINT USING "**BUS BS850"
6780 PRINT USING "**BUS BS850"
6790 PRINT USING "**BUS BS850"
6800 NEXT I
6810 PRINT USING "**BUS BS850"
6820 RETURN
6830 DATA 1,2,5
6840 REM
6850 REM ******************************************************
6860 REM ******************************************************
6870 REM # LIST OF VARIOUS NAMES USED IN PROGRAM
6880 REM ******************************************************
6890 REM ******************************************************
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may be difficult to interpret occurs in the PLOT DATA subroutine. Line 6040 compares a data value in the Y array with the value of YN discussed above. If the value in the Y array equals YN plus or minus 51 percent of the value between lines, it’s printed on the plot at an X position determined by the corresponding value in the X array. This value (XP) is calculated in line 6050. The PLOT DATA subroutine checks every data value in the Y array each time the subroutine is called to make sure that all data corresponding to YN is plotted before a new value of YN is calculated and a new linefeed occurs.

**Automatic Scaling**

The type of automatic scaling used in a plot program can be one of the most critical factors in determining usefulness of the resulting plot. I’ve run programs containing auto-scaling features that actually make the resulting plot worthless. These programs seem to be written so that the highest data point falls on the top line and the lowest falls on the bottom line—without any consideration of the intermediate scale values. This type of scaling is the easiest to implement but makes data interpretation extremely difficult. One of the problems in developing auto-scaling routines involves individual preference regarding the scales selected. Some people may prefer the type of scaling mentioned above, some may choose scale deltas that vary in the 1-2-5 sequence which many analog plotters have adopted, and others may accept any sequence as long as it has integer values. Because of this, I’ve written auto-scaling routines in which you can tailor the scaling sequence simply by inserting a new DATA statement with user-selected values.

The auto-scaling subroutines start at line 6550. The extreme values in both the X and Y arrays are determined in lines 6550 through 6610; then the X and Y scales are determined. Determination of the scales starts by restoring the DATA statement in 6830. Then the minimum scale delta.
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Listing 2: Additional software to sort data prior to plotting.

```plaintext
5450 REM
5452 REM # SPEED UP MODIFICATIONS USING SORT ROUTINE
5454 REM
5456 REM 5458 REM
5460 REM T'|E|P=100:TEMPTOP=100
5462 REM GOSUB 6890REM
5970 REM
5990 REM # PLOT SORTED DATA SUBROUTINE
6000 REM
6010 REM
6020 CHARS="0"
6030 FOR 1=TOP TO 0 STEP -1
6035 IF Y(1) < YN-.5 THEN 6080
6040 TEMPTOP=1
6050 XP=FIX((XN)-YMIN/1000)/MAX-XMIN
6060 IF XP < 1 OR XP > 100 THEN 6080
6070 LPRINT CHR(13):RSTOP=XP+20:GOSUB 5850
6080 NEXT 1:TCP=TEMPTOP:RETURN
6990 REM
6992 REM SHELL SORT OF DATA
7000 REM 1:100
7010 1=INT(H/2):F=0-1:0 THEN RETURN
7020 J=0:K=100-M
7030 L=1:1M:IF Y(I)<Y(L) THEN 6970
7040 T=Y(I):I=K:K=K+1:10:GOTO 6970 ELSE 6940
7050 J=J+1:K=K+1:10:GOTO 6930 ELSE 6910
7060 REM
7070 REM # SHELL SORT OF DATA
7080 REM
7090 REM M=100
7100 M=INT(M/2):IF M=0 THEN RETURN
7120 J=0:K=100-M
7130 L=1:1M:IF Y(I)<Y(L) THEN 6970
7140 T=Y(I):I=K:K=K+1:10:GOTO 6970 ELSE 6940
7150 J=J+1:K=K+1:10:GOTO 6930 ELSE 6910
```

( MSD) is determined, based on the data extremes. This value is the smallest that can be used between major scale divisions yet still fit all the data on a plot with ten major divisions. Line 6640 starts a FOR...NEXT loop which selects the multiplier for the scale divisions; the nested FOR...NEXT loop beginning at line 6650 selects the value of the major scale divisions using the DATA statement in line 6830. Lines 6660 through 6710 then use this information to determine new maximum and minimum scale values which in turn are used in the data plotting routines. Scaling of both the X and Y axes is handled in the same manner.

Although the logic of these routines would become quite clear with some study, you don’t have to understand these routines at all to select your own personalized auto-scaling factors. Simply change the DATA statement in line 6830 and the limit of the FOR...NEXT loops in lines 6650 and 6750. For example, suppose you like any even integer scaling. Change the DATA statement from 1, 2, 5 to 1, 2, 3, 4, 5, 6, 7, 8, 9, and change the upper limits in the READ loops from 3 to 9. I don’t like scales with increments of 3, 6, 7, 8, or 9 and typically use a scaling of 1, 2, 3, 4, 5. As I’ve stated, though, this depends strictly on your esthetic values. The program uses 1, 2, 5 scaling as an example.

Figure 3 is a plot of EXP(X) versus X using 1, 2, 2.5, 4, 5 auto-scaling values. Exponential curves such as the language that is based on the past but looks to the uses of the future.

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the one shown are particularly difficult for any linear plot routine to handle because of the wide range of values usually involved. It's obvious from figure 3 that much of the data falls below the Y value of 200 and below the X value of 5. With this type of data, it's sometimes desirable to have a higher-resolution plot of this section of the data. You can accomplish that by now replotting this section of data using the MANUAL feature of the program. Figure 4 shows a plot of the same data with the Y scale manually set from 0 to 200 and with the X scale manually set from 0 to 5. Use of auto-scaling to present all of the data and manual scaling to expand features of the overall plot can provide a very powerful tool for those who have to handle data regularly.

**Speeding It Up**

As I mentioned before, this plotting routine isn't very fast and has never been optimized to make it faster. One obvious method to decrease the overall time is to presort the data prior to plotting it so that the PLOT DATA routine doesn't have to scan every bit of data each time through. Listing 2 shows the lines that have to be added or modified to sort and plot the data with the sort routine given. Inserting these lines will cut almost two minutes off each plot, but there's no free lunch here either. What price is paid for this speed-up feature? The data isn't the same as when it entered the routine, since the array numbers have been altered. You could save the arrays in other arrays to maintain the integrity of your data, but this will cost you variable space. Again, use of these options is strictly up to the user and the particular application.

I've written the software for a standard MX-80 without the Graftrax-80 option. Those of you having this option should delete the last part of line 5780, since the CHRS(27)"2" is no longer needed.

Please feel free to write and let me know of any features of the MX-80 or of the program I've missed that would reduce the plot time—my mailman will love it!
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Modify Your Paper Tiger for Different Paper Thicknesses

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Are you tired of removing the printer cover of your Paper Tiger to adjust for different paper thicknesses? A simple modification can change all that.

The various Paper Tiger models produced by Integral Data Systems (IDS) are popular with microcomputer owners because they're rugged, reliable, extremely flexible in operation, and well supported by the manufacturer. That tremendous flexibility, however, is marred by one "bug" in the IDS 460. I use my high-speed printer to generate business reports (using both single- and multiple-part copy paper), form letters, and address labels. This necessitates a change from thick address labels to thin fanfold paper to single sheets in holders to carbonless multiple-part copy-forms, and back again.

The paper-thickness control knob is located inside the cover. In order to adjust it, you must remove the cover, adjust the control, replace the cover (try not to snag the ribbon or damage the circuit board), and then run the printer to see if it's adjusted correctly.

If it isn't, you have to start all over again.

A simple modification solves this problem, making it easy to adjust to the proper paper thickness from outside the printer. All you have to do is drill a hole in the cover and cut a slot in the adjusting rod for a screwdriver. (Editor's Note: IDS says that this modification isn't necessary for the newest version of the model 460, as there is a lever attached to the paper-thickness control knob which allows it to be adjusted from outside the printer. You can purchase this lever and knob by contacting Customer Support Group, Integral Data Systems Inc., Milford, NH 03055. If you choose to make the modifications described in this article, IDS says it will still repair its printers no longer under warranty, as long as the printer mechanism itself has not been modified.)

The first step is to locate the position for the hole. Put the printer on a light-colored table or piece of paper and remove the cover. Set a drafting triangle or a small carpenter's square on the table (see photo 1) and make a mark on the table or paper directly below the center of the paper-thickness control knob. Then mark on the triangle the height of the center of the control knob from the table. Without moving the printer, carefully replace the cover. Using the marks on the table and on the triangle, find the spot on the cover where the two marks intersect (see photo 2). Mark

Photo 1: Use a square or a drafting triangle to mark the table directly beneath the center of the knob. Measure the height of the shaft above the table and mark the triangle.
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**CENTRONICS**

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<td>739 PARALLEL</td>
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<td>ANADEX DP-9501</td>
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**ACCESSORIES**

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<td>$178.00</td>
</tr>
<tr>
<td>VIDEOM VIDEOTERM</td>
<td>$290.00</td>
</tr>
</tbody>
</table>

*Prices and specifications subject to change without notice.
After replacing the cover, we take a square to mark the hole location on the cover. This is the location for the hole you will drill.

Next, remove the cover from the printer. As you begin to drill the hole, let the drill bit turn slowly (I used a sharp \( \frac{1}{8} \)-inch drill and a drill press for an accurate hole). Make the hole large enough to allow a screwdriver to be inserted easily.

Use a fine-tooth hacksaw to cut a slot in the shaft (see photo 3), and watch out for the circuit board and the wires attached to it. I chose to make a slot that is horizontal when the print head is at its closest setting so that I could use it as a reference point. Once the shaft was marked, however, I turned it 45 degrees clockwise to cut it, making it less awkward to work on. Saw through the knob and the shaft until you have a screwdriver slot about \( \frac{1}{16} \)-inch deep. Then clean out all the shavings from the printer.

Replace the cover, erase any pencil marks, and adjust your printer from the outside (see photo 4). I find that the screwdriver blade on my jackknife fits perfectly. It’s easy to set the proper adjustment while the Paper Tiger is printing its test pattern on the type of paper you will be using. I also marked the positions of the slot for various paper thicknesses on the cover of the printer, so that I can quickly set the different adjustments.

---

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How often would you like to have the results of a computation printed in a selected format? Unlike FORTRAN or Extended BASIC, a minimal BASIC such as TI BASIC does not usually have FORMAT statements. Listing 1 shows a routine that I developed to obtain printer output in any desired format with my BASIC programs. The routine, written in TI BASIC (although it can easily be adapted to other BASICs), is simple to use because the PRINT statement can directly access the user-defined format functions without any conditional transfers.

To use the format routine in a program, you must include the statements in lines 230 through 320 in your program before the first PRINT statement. Line 510 is a typical example of such a PRINT statement. Titles and string variables are printed using a PRINT statement like that shown in line 490.

An example of the formatted output is shown in figure 1b. The results would have been printed as in figure 1a if a regular PRINT statement with semicolon print separators (line 470) was used. (Figures 1a and 1b are on page 164.)

The formatting routine takes advantage of the string variables used in TI BASIC. To print a real variable, say X, print the formatted string RF$(X). Similarly, use IFS$(I) to print an integer, I. To obtain print titles, use RFT$(X$) to print X$ as the title associated with the real numbers. IFT$(I$) is a similar function for titles of integer fields. RFT$(X$) and IFT$(I$) can, of course, be used like RF$ and IFS to print any string variables.

The format field is controlled by the variables FL, FD, and IL (see the DATA statement on line 250). FL and IL represent the total length of the field for real and integer variables, and FD is the number of decimal places chosen for the real numbers. The real numbers are rounded off to the desired digits. (The effect of the two format descriptors is similar to using the FORTRAN statements FORMAT(F,FD) for real numbers and FORMAT(I, IL) for the integer numbers.)

The program prints right-justified entries in the user-selected field in both real and integer formats. When the value of the variable is larger than can be accommodated in the allocated field, a starred output is printed as shown in figure 1b.

<table>
<thead>
<tr>
<th>Listing 1: The format routine embedded in this program (lines 230 through 320) allows control of printer output without the use of FORMAT statements.</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 REM FORMAT PRINTING</td>
</tr>
<tr>
<td>110 REM IN TI BASIC</td>
</tr>
<tr>
<td>120 REM</td>
</tr>
<tr>
<td>130 REM PROGRAM BY</td>
</tr>
<tr>
<td>140 REM MALLADI SUBBAIAH</td>
</tr>
<tr>
<td>150 REM</td>
</tr>
<tr>
<td>160 REM FL PRINT LENGTH</td>
</tr>
<tr>
<td>170 REM FOR REAL NUM.</td>
</tr>
<tr>
<td>180 REM FD DECIMAL DIGITS</td>
</tr>
<tr>
<td>190 REM IL PRINT LENGTH</td>
</tr>
<tr>
<td>200 REM FOR INTEGER NUM.</td>
</tr>
<tr>
<td>210 REM ***************</td>
</tr>
<tr>
<td>220 REM</td>
</tr>
<tr>
<td>230 REM END FORMATTING</td>
</tr>
<tr>
<td>240 REM PRINT FD,FL,IL</td>
</tr>
<tr>
<td>250 DATA 10,5,6</td>
</tr>
<tr>
<td>260 RF$=FL-FL*FD-1</td>
</tr>
<tr>
<td>270 IFS$= ***************</td>
</tr>
<tr>
<td>280 IFS$(I)=IF$(I)$</td>
</tr>
<tr>
<td>290 RF$(X$)=RFTS$(X$)</td>
</tr>
<tr>
<td>300 IFT$(I$)=IFT$(X$)</td>
</tr>
<tr>
<td>310 REFT$(X$)=RFT$(X$)</td>
</tr>
<tr>
<td>320 IF$(X$)=IFS$(X$)</td>
</tr>
<tr>
<td>330 REM END FORMAT ROUTINE</td>
</tr>
<tr>
<td>340 REM</td>
</tr>
<tr>
<td>350 REM DIM N(10),X(10),Y(10)</td>
</tr>
<tr>
<td>360 REM READ N(1),X(1),Y(1),X(2),Y(2),X(3),Y(3),X(4),Y(4),X(5),Y(5),X(6),Y(6)</td>
</tr>
<tr>
<td>370 REM READ N(7),X(7),Y(7),X(8),Y(8),X(9),Y(9),X(10),Y(10)</td>
</tr>
<tr>
<td>380 REM Y(1)=Y(1)$</td>
</tr>
<tr>
<td>390 REM Y(2)=Y(2)$</td>
</tr>
<tr>
<td>400 REM Y(3)=Y(3)$</td>
</tr>
<tr>
<td>410 REM Y(4)=Y(4)$</td>
</tr>
<tr>
<td>420 REM Y(5)=Y(5)$</td>
</tr>
<tr>
<td>430 REM Y(6)=Y(6)$</td>
</tr>
<tr>
<td>440 REM Y(7)=Y(7)$</td>
</tr>
<tr>
<td>450 REM Y(8)=Y(8)$</td>
</tr>
<tr>
<td>460 REM Y(9)=Y(9)$</td>
</tr>
<tr>
<td>470 REM Y(10)=Y(10)$</td>
</tr>
<tr>
<td>480 REM PRINT FD,FL,IL</td>
</tr>
<tr>
<td>490 REM FOR REAL NUM.</td>
</tr>
<tr>
<td>500 FOR 1 TO N</td>
</tr>
<tr>
<td>510 PRINT RF$(X$)</td>
</tr>
<tr>
<td>520 NEXT 1</td>
</tr>
<tr>
<td>530 CLOSE 1</td>
</tr>
<tr>
<td>540 STOP</td>
</tr>
</tbody>
</table>

The program prints right-justified entries in the user-selected field in both real and integer formats. When the value of the variable is larger than can be accommodated in the allocated field, a starred output is printed as shown in figure 1b.■
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Figure 1a: Sample of printer output from the program in listing 1 without the format routine.

Figure 1b: Using the format routine, the printer output can be formatted to suit your needs. If a number exceeds the length available for a variable, the program in listing 1 will print a string of stars, as shown in lines 3, 4, and 8.
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How many times have you, after buying a new "toy" for your computer, installed the hardware, read the manual carefully, and played with the equipment until its functions become familiar, only to go back to your regular activities and forget much of what you've learned?

This is what happened after I bought my Epson MX-80 printer. I studied the manual conscientiously and learned all the printer-control codes. For weeks thereafter, I did nothing with the printer except turn it on and off. By the time my Epson Graftrax-80 bit-plot graphics option arrived, I had forgotten how the printer worked.

This time I entrusted the information to the Apple's memory instead of my own. I wrote a print-control program in Applesoft BASIC, called MX-80 (see listing 1), that I keep on disk with my Applewriter text editor.

When the program is run, the screen displays a menu of available printer options (see figure 1). The on-screen display has some of the instruction codes highlighted as black on white. The highlighted options are the choices transmitted to the printer when one of the three termination codes (EDITOR, PRINTER, or QUIT) is entered. To review the inventory of (nongraphics) printer signals, I can choose the INVENT option.

There is no way to query the printer about its current status, so the program records a status file, called MX.STATUS, that recalls the last instructions sent to the printer. This status file is used to initialize the program the next time it is run. The status file is especially convenient when a given typeface is used repeatedly. So that there will be a file for the print-control program to read

Text continued on page 170

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>STANDARD</td>
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<tr>
<td>ITALIC</td>
<td>ITALIC FONT</td>
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<td>STRIKE1</td>
<td>SINGLE STRIKE</td>
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<tr>
<td>STRIKE2V</td>
<td>TWO VERTICAL STRIKES</td>
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<tr>
<td>STRIKE2H</td>
<td>TWO HORIZONTAL STRIKES</td>
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<tr>
<td>STRIKE4</td>
<td>QUADRUPLE STRIKES</td>
</tr>
<tr>
<td>SMALL</td>
<td>SMALL LETTERS, UP TO 132/LINE</td>
</tr>
<tr>
<td>NORMAL</td>
<td>NORMAL LETTERS, UP TO 80/LINE</td>
</tr>
<tr>
<td>SPACEN</td>
<td>NORMAL SPACING BETWEEN LINES</td>
</tr>
<tr>
<td>SPACET</td>
<td>TIGHT SPACING BETWEEN LINES</td>
</tr>
<tr>
<td>SPACEO</td>
<td>NO SPACE BETWEEN LINES</td>
</tr>
<tr>
<td>INVENT</td>
<td>INVENTORY OF MX-80 SIGNALS</td>
</tr>
<tr>
<td>EDITOR</td>
<td>SHIFT TO APPLEWRITER'S EDITOR</td>
</tr>
<tr>
<td>PRINTER</td>
<td>SHIFT TO APPLEWRITER'S PRINTER</td>
</tr>
<tr>
<td>QUIT</td>
<td>QUIT</td>
</tr>
</tbody>
</table>

ENTER INSTRUCTION CODE;

Figure 1: Menu from the MX-80 print-control program. The menu offers 36 combinations: 24 with normal letters (two fonts by four strikes by three spacings); 12 with small letters (two fonts by two strikes by three spacings). You can also choose INVENT, an inventory of the control signals for the Graftrax-80 function codes, and one of three program-termination options—EDITOR, PRINTER, and QUIT.
Percom's DOUBLER II tolerates wide variations in media, drives

GARLAND, TEXAS — May 22, 1981 —
Harold Mauch, president of Percom Data Company, announced here today that an improved version of the Company's innovative DOUBLER™ adapter, a double-density plug-in module for TRS-80® Model I computers, is now available.

Reflecting design refinements based on both theoretical analyses and field testing, the DOUBLER II™, so named, permits even greater tolerance in variations among media and drives than the previous design.

Like the original DOUBLER, the DOUBLER II plugs into the drive controller IC socket of a TRS-80 Model I Expansion Interface and permits a user to run either single- or double-density diskettes on a Model I.

With a DOUBLER II installed, over four times more formatted data — as much as 364 Kbytes — can be stored on one side of a five-inch diskette than can be stored using a standard Tandy Model I drive system.

Moreover, a DOUBLER II equips a Model I with the hardware required to run Model III diskettes.

(Ed. Note: See "OS-80™: Bridging the TRS-80® software compatibility gap" elsewhere on this page.)

The critical clock-data separation circuitry of the DOUBLER II is a proprietary design called a ROM-programmed digital phase-lock loop data separator.

According to Mauch, this design is more tolerant of differences from diskette to diskette and drive to drive, and also provides immunity to performance degradation caused by circuit component aging.

Circuit misapplication causes diskette read, format problems.

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CRC ERROR-TRACK LOCKED OUT

The problem is most severe on high-number (high-density) inner file tracks.

As reported earlier, the click-data separation problem was traced by Percom to misapplication of the Internal separator of the 1771 drive controller IC used in the Model I.

The Percom Separator substitutes a high-resolution digital data separator circuit, one which operates at 16 megahertz, for the low-resolution one-megahertz circuit of the Tandy design.

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Installation involves merely plugging the SEPARATOR into the Model I E1 disk controller chip socket, and plugging the controller chip into a socket on the SEPARATOR.

The SEPARATOR, which sells for only $29.95, may be purchased from authorized Percom retailers or ordered directly from the factory. The factory toll-free order number is 1-800-527-1222.

Ed. note: Opening the TRS-80 Expansion Interface may void the Tandy limited 90-day warranty. Circle 309 on inquiry card.

All that glitters is not gold

OS-80™ Bridging the TRS-80® software compatibility gap

Compatibility between TRS-80® Model I diskettes and the new Model III is about as genuine as a gold-plated lead Kruger.

True, Model I TRSDOS® diskettes can be read on a Model III. But first they must be converted and re-recorded for Model III operation.

And you cannot write to a Model I TRSDOS® diskette. Not with a Model III. You cannot add a file. The write-protect method will modify a Model I TRSDOS diskette with a Model III computer.

Furthermore, your converted TRSDOS diskettes cannot be converted back for Model I operation.

Operation of the Model I computer over two years after it is installed as it was then — and there’s no re-writing. A point to consider before switching the company’s payroll to your new Model III.

Real software compatibility should allow the driver software interchangeability of Model I and Model III diskettes. No read-only limitations, no conversion/re-recording steps and no chance to be left high and dry with Model III diskettes that can’t be read on a Model I.

What’s the answer? The answer is Percom’s OS-80™ family of TRS-80 disk operating systems.

OS-80 programs allow direct, immediate interchangeability of Model I and Model III diskettes. You can run Model I single-density diskettes on a Model III, install Percom’s plug-in DOUBLER™ adapter in your Model I, and you can run double-density Model III diskettes on a Model I.

There’s no conversion, no re-recording.

Slip an OS-80 diskette out of your Model I and insert it directly in a Model III.

And vice-versa.

Just the right OS-80 disk operating system — OS-80, OS-80D or OS-80/III — in each computer.

Moreover, with OS-80 systems, you can add, delete, and update files. You can read and write diskettes regardless of the system of origin.

OS-80 is the original Percom TRS-80 DOS for BASIC programmers.

Even OS-80 utilities are written in BASIC. OS-80 is the Percom system about which a user wrote. In Creative Computing magazine, “...the best $30.00 you will ever spend.”

Requiring only seven Kbytes of memory, OS-80 disk operating systems reside completely in RAM. There’s no need to dedicate a drive exclusively for a system diskette.

And, unlike TRSDOS, you can work at the track sector level, defining and committing data formats in BASIC — to create simple or complex data structures that execute more quickly than TRSDOS files.

The Percom OS-80 DOS supports single-density operation of the Model I computer — price is $29.95; the OS-BOD supports double-density operation of Model I computers equipped with a DOUBLER or DOUBLER II; and OS-80/III — for the Model III of course — supports both single- and double-density operation. OS-80D and OS-80/III each sell for $49.95. Circle 310 on inquiry card.

Prices and specifications subject to change without notice.

P.RICES DO NOT INCLUDE HANDLING AND SHIPPING.

PERCOM DATA COMPANY, INC. 11220 Pagemill Road Dallas, Texas 75243 (214) 340-7081

Listing 1: MX-80, an Applesoft program that controls the print of an Epson MX-80 printer equipped with the Graftrax-80 option.

1 REM LISTING 1
10 REM MX-80
20 REM THIS PROGRAM SETS THE
30 TEXT : A$ = CHR$(4) : D$ = CHR$(27) : PRINT A$"NMOMON C, I, O": PRINT
40 REM TYPEFACES OF THE EPSON
50 REM MX-80 PRINTER EQUIPPED
60 REM WITH GRAFTRAX-80.
70 PRINT A$"OPEN MX.STATUS": PRINT A$"READ MX.STATUS": INPUT A:
80 PRINT A$"CLOSE MX.STATUS"
90 PRINT A$"PR# 0": HOME : IF A = 1 THEN INVERSE
100 PRINT "STANDARD": NORMAL : PRINT A$ = STANDARD FONT": IF A = 2 THEN INVERSE
110 PRINT "ITALIC": NORMAL : PRINT A$ = ITALIC FONT": IF B = 1 THEN INVERSE
120 PRINT "STRIKE": NORMAL : PRINT A$ = SINGLE STRIKE": IF B = 2 THEN INVERSE
130 PRINT "STRIKE2": NORMAL : PRINT A$ = TWO VERTICAL STRIKES": IF B = 3 THEN INVERSE
140 PRINT "STRIKE3": NORMAL : PRINT A$ = TWO HORIZONTAL STRIKES": IF B = 4 THEN INVERSE
150 PRINT "QUADRUPLE STRIKES": PRINT TAB(15)"*" ONLY WITH NORMAL
160 PRINT "SMALL": NORMAL : PRINT A$ = SMALL LETTERS, UP TO 1
170 PRINT "SPACE": NORMAL : PRINT A$ = NORMAL SPACING BETWEEN
180 PRINT "SPACE": NORMAL : PRINT A$ = TIGHT SPACING BETWEEN LINES": IF D = 2 THEN INVERSE
190 PRINT "SPACE": NORMAL : PRINT A$ = NO SPACE BETWEEN LINES": IF D = 3 THEN INVERSE
200 PRINT "NO SPACE": PRINT A$ INVENTORY OF MX-80 SIGNAL": PRINT
210 PRINT "EDITOR": SHIFT TO APPLEWRITER'S EDITOR"
220 PRINT "PRINTER": SHIFT TO APPLEWRITER'S PRINTER": PRINT
230 PRINT "QUIT": PRINT INPUT

Circle 408 on inquiry card.
170 IF B$ = "INVENT" GOTO 440
180 IF B$ = "STANDARD" THEN A = 1: GOTO 40
190 IF B$ = "ITALIC" THEN A = 2: GOTO 40
200 IF B$ = "STRIKE1" THEN B = 1: GOTO 40
210 IF B$ = "STRIKE2" THEN B = 2: GOTO 40
220 IF B$ = "STRIKE2H" THEN B = 3: GOTO 40
230 IF B$ = "STRIKE2H" GOTO 330
240 IF B$ = "STRIKE4" AND C = 2 THEN B = 4: GOTO 40
250 IF B$ = "STRIKE4" GOTO 330
260 IF B$ = "SPACE8" THEN D = 1: GOTO 40
270 IF B$ = "SPACE2" THEN D = 2: GOTO 40
280 IF B$ = "SPACEO" THEN D = 3: GOTO 40
290 IF B$ = "SMALL" AND B = 2 GOTO 330
300 IF B$ = "NORMAL" THEN C = 1: GOTO 40
310 IF B$ = "NORMAL" THEN C = 2
320 GOTO 40
330 HOME: VTAB 12: PRINT "SMALL LETTERS CANNOT BE", PRINT "COMBINED WITH TWO HORIZONTAL STRIKES": PRINT "GOTO 490"
340 PRINT A$;"PR1 1": IF D < 3 THEN PRINT D$; (4 - 2 * D); GOTO 360
350 PRINT D$;"1";
360 IF E = 80 THEN E = 81
370 PRINT D$; CHR$(84); D$; CHRS(E); PRINT D$; IF B < 3 THEN PRINT CHR$(70); GOTO 390
380 PRINT CHRS(69);
390 PRINT D$; IF B = 1 OR B = 3 THEN PRINT CHRS(72); GOTO 410
400 PRINT CHRS(71);
410 PRINT D$; (4 - A); PRINT A$;"OPEN MX.STATUS B": PRINT A$;"WRITE MX.STATUS B": PRINT A$: PRINT B$: PRINT C$: PRINT D$: PRINT A$:"CLOSE MX.STATUS": IF B$ = "PRINTER" THEN PRINT A$:"BRUN PRINTER"
420 IF B$ = "EDITOR" THEN PRINT A$:"BRUN TEDITOR"
430 END
440 HOME: PRINT TAB(9);"* DENO TES CHR$(27)="ESC": PRINT "ST ANDARD FONT": SPC(24);"*5": PRINT "ITALIC FONT": SPC(2 6);"*4": PRINT "SINGLE STRIK "ENTER INSTRUCTION CODE: ": B$; IF B$ = "QUIT" OR B$ = "PRINTER" OR B$ = "EDITOR" GOTO 340

Listing 1 continued on page 170

Circle 409 on inquiry card.
Listing 1 continued:

```
E": BPRC (22) "@FH"
450 PRINT "TWO VERTICAL STRIKES"
" BPRC (15) "@FSB": PRINT "TW
O HORIZONTAL STRIKES": BPRC
(13) "@H"": PRINT "QUADRUPLE
STRIKES": BPRC (18) "@EBS": PRINT
"SMALL LETTERS (16.5/INCH,13
2/LINE)": BPRC (19) "@2"
460 PRINT "NORMAL LETTERS (10/
INCH,80/LINE)": BPRC (10)
"WIDE LETTERS (8.25/INCH,66
/LINE)": BPRC (10) "@2": PRINT 
"DOUBLE LETTERS (5/INCH,40/LINE)
@BS": PRINT ": RETURN PRINT
HEAD LEFT W/O LINEFEED": BPRC
(19) "@2"
470 PRINT "SPACE 8 LINES/INCH": BPRC
(19) "@2": PRINT "SPACE @/72
/INCH (0\(256)): BPRC (10) "@2
A": PRINT "PRINT SPACE @/216/IN
CH (0\(255)): BPRC (9) "@3 "
PRINT "FORMFEED": BPRC (23)
"CHRk(12)": PRINT "FORM LEN
6TH = @ LINES (0\(256)): BPRC
(C)": PRINT "SET HORIZONTAL
TAB": BPRC (6) "@D @1 @2 ... 
0"
480 PRINT "HORIZONTAL TAB MOVE": BPRC
(8) "POKE 49296,9": PRINT
"SET VERTICAL TAB": BPRC (8)
"@D @1 @2 ... 0": PRINT "VE
RTICAL TAB MOVE": BPRC (14) "
CHRk(11)
490 INPUT "PRESS 'RETURN' TO CON
TINUE.": IC\@: BOTO 40
```

Text continued from page 166:

the first time it is run, I've included a brief program, shown in listing 2, that creates a status file. (Listing 2 also

Listing 2: This program creates a disk file, called MX.STATUS, that is accessed by the program in listing 1. You must run this short program prior to running the MX-80 printer program for the first time.

```
10 REM THIS PROGRAM CREATES
20  A = 13: A# = CHR\(4): PRINT A#
30 "OPEN MX.STATUS": PRINT A#a
40 RITE MX.STATUS": PRINT A# PRINT
50 PRINT A# PRINT A# PRINT A# "CLOSE MX.STATUS"
```

shows the italic font that is available with the Graftrax-80.)

The print-control program is designed for the Apple­writer word processor, but can be adapted to other text editors by modifying lines 150, 160, 410, and 420. To use the program with AppIewriter:

1. Enter S to save the text file.
2. Enter Q to quit Applewriter.
3. Enter RUN MX-80.
4. Turn on the printer.
5. Enter choices from the menu.
6. Enter Printer to quit the MX-80 program.
7. Enter L to load the text file.
8. Enter P to print.

Do not turn the printer off between running the print­control program and the actual printing because your choices will be lost as the printer resets to its default options (STANDARD, STRIKEI, NORMAL, SPACEN).

You may switch the printer offline and manually advance the paper by pressing the formfeed or linefeed buttons without affecting the typeface settin gs.
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Circle 77 on inquiry card.
Graphics II by Selanar
High-Resolution Hard Copy from a DECwriter

A picture, a thousand words, or both—that's what you can print out on a DECwriter II terminal outfitted with the Selanar Graphics II attachment. This versatile modification provides a host of features for the DECwriter (by Digital Equipment Corporation): high-resolution graphics, bidirectional linefeed, multiple character sets, the ability to print standard, boldface, and double-width characters that can be rotated in any one of four directions, and several other useful options that cost extra if purchased from DEC.

Our interest in this unit began when we saw it featured in the new-products section of a digital-electronics trade magazine. We were especially interested in the claim that, with this attachment, a dot could be printed anywhere on a standard DECwriter page and that up to 1,045,440 points could be addressed. For $850 (less a 5 percent educational discount), this seemed like a low-cost way to high-resolution graphics, so we ordered a Graphics II modification from Selanar Corporation.

In less than three weeks the unit arrived. The box contained the Graphics II circuit board, a power cable consisting of three wires: blue, black, and orange (the same color-coding used by DEC), six #8 nylon screws and nylon washers (already attached to the circuit board), and a user's manual.

Installation and Testing
With the help of the user's manual, installing the Graphics II board was simple and straightforward. First, we examined the board for any damaged or loose components. (The manual provides a list of likely sources of trouble.) In our case, we found the ground connection of the TTL (transistor-transistor logic) interface socket (J4) to be loose and had to touch it up with a bit of solder; otherwise, everything was in order.

Next, the board was prepared for installation by selecting from the several available jumper options (i.e., parity, bell, serial interface, and data-transfer rate). Step-by-step instructions are accompanied by two full-page photographs that show the inside of the DECwriter before and after installation of the Graphics II board. The photos are invaluable for locating and identifying the various components important to the installation.

Following the instructions given in the user's manual, the original DECwriter board was removed. (A screwdriver is all that is necessary for this and the following operations.) The Graphics II board was attached to the...
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Circle 271 on inquiry card.

**At a Glance**

**Name**
Graphics II

**Use**
Enhancement to the DECwriter II printer

**Manufacturer**
Seilhan Corporation
3054 Lawrence Expressway
Santa Clara, CA 95051

**Dimensions**
48.3 x 26.7 cm (19 x 10.5 inches)

**Price**
$895

**Hardware Needed**
DECwriter LA35 or DECwriter LA36

**Software Needed**
None

**Hardware Options**
Precision tractors, $50 extra

**Documentation**
50-page manual, includes schematics

**Audience**
DECwriter owners desiring high-resolution hard-copy graphics

**Features**
Print speed: character mode average 36 cps—graphics mode average 1 ips; transmission rates: selectable to 1200 bps, with X-on and X-off interfaces; 20 mA current loop, EIA RS232, TTL (for modern); line length: character mode, 132 characters—graphics mode, 120 dots; spacing: character mode, horizontal; 10 cps—vertical, 6 cps; graphics mode: horizontal, 100 dots per inch—vertical, 72 dots per inch; four complete character sets including upper case and lowercase: ASCII character set; APL character set; Math/Greek character set; user-defined character set (load from keyboard or computer into memory), boldface: all characters; four rotations: all characters, double width: all characters

**Paper**
Variable width 7.6 cm (3 inches) to 37.8 cm (14 ¾ inches), up to 6-part forms 0.020 in maximum thickness: tractor drive line feed

**Power Requirements**
120 V AC 50/60 Hz

---

six mounting points on the DECwriter back panel using the attached nylon hardware. The cables provided with the DECwriter were then connected to the new circuit board and the three-wire cable was connected to the terminal’s power supply. This completed the assembly of the unit.

Sufficient warnings are included at each step to insure a virtually foolproof installation. Total installation time was about 30 minutes. After verifying that all connectors to the Graphics II board and all components on the board were secure, and that there were no loose parts, tools, or other items left on the circuit board or in the internal cabinet area of the terminal, the unit was ready for testing.

The testing procedure is straightforward and can be done without sophisticated test equipment. By switching the DECwriter to local operation, the user can run through the various features, including graphics, and verify that everything is working properly. Once everything is operational, the I/O (input/output) interface is checked and the printer is ready to use.

**Printer Adjustment**

Our unit worked immediately and we were soon printing out the different character sets in boldface and double-width; however, some characters did not seem well formed. In addition, the tractor drive had a tendency to slip. The character problem, we were told, was caused by minor variations in parts such as the drive and stepper motors used in different DECwriters; this can result in different levels of performance depending on the user's specific terminal. To compensate for these variations, the Graphics II unit has built-in adjustments that can be set to obtain optimum performance. An oscilloscope, preferably one with dual-trace capability, is necessary for making these adjustments. The procedure outlined in the user's manual gives two types of adjustments: print columns and print-speed control. In our case, we simply adjusted the forward and reverse print-speed controls and the characters printed out perfectly.

In operation, the enhanced DECwriter can function as an unmodified terminal, as a terminal featuring many of the options offered by DEC at extra cost, and in the graphics mode (a completely new feature). System commands are selected by...
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Control Code Name Description

CL  Form feed  Advance paper to beginning of next form (top of page).

CN  APL character set  Selects second character set (factory set with APL characters). Once selected, all characters printed are as defined from this PROM.

CO  Normal character set  Selects normal character set.

ESC  Print entire character set  Test mode.

ESC7 Upside-down print mode  Rotates characters 180°.

ESC8 Sideways I print mode  Rotates characters 90°.

ESC9 Sideways II print mode  Rotates characters 270°.

ESC0 Double-width characters  Prints double-width characters.

ESC A Boldface characters  Prints each character in boldface.

ESC C Special reset  Returns DECwriter to normal configuration.

ESC F Power-up reset  Resets all modes, character styles, tabs, and top of form (also occurs at power-up).

ESC G Up 1/4 line  Moves paper up 1/4 line at a time.

ESC H Down 1/4 line  Moves paper down 1/4 line at a time.

ESC N Third character set  Selects third character set (factory set for mathematics symbols and selected Greek letters).

ESC P Fourth character set  Selects fourth character set as defined in programmable memory.

ESC O Load-memory character set  Defines fourth character set to be loaded into programmable memory.

ESC B Enter graphics mode  Enters graphics mode. All characters ignored except "(" " " " " ")", and digits 0 through 9 in graphics mode, prints all seven dots instead of one at a time.

ESC C Exit graphics mode

Table 1: Command codes used by the LA36 DECwriter II with the Selenar Graphics II modification. Codes in the table preceded by a lowercase "c" are entered by holding down the Control key while entering the indicated code (similar to the standard procedure for typing any uppercase letter by using the shift key). Other codes are entered by typing ESC (escape) followed by the indicated letter.

---

either a Control code or an ESC (escape) code. The Control code is obtained by simultaneously pressing the Control key and another key to select a given function. The ESC code is a two-step operation: first the ESC key is pressed, then the key that selects the desired function. Pressing ESC a second time cancels this command sequence. Table 1 is a list of some of the more important ESC and Control commands that function in the normal (nongraphics) and graphics modes.

Other system commands that can be implemented with Graphics II are horizontal tab control (advances the print head to the next column position with a set tab); vertical tab (advances the paper vertically to the next line with a vertical tab); set horizontal tab (sets a tab where the head is positioned, up to 16 tabs may be set); reset horizontal tab (resets the individual horizontal tabs at each desired head position); set vertical tab (sets a tab to any one or all of 16 vertical tab positions); and reset vertical tab (resets an individual vertical tab at the present position of the print head).

In addition, you can activate the bell, reset the top-of-form position, enable the automatic linefeed with carriage return, backspace, and issue a special Here-is message where up to

---

$495 64K-256K Error Correcting Memory

Table 1: Command codes used by the LA36 DECwriter II with the Selenar Graphics II modification. Codes in the table preceded by a lowercase "c" are entered by holding down the Control key while entering the indicated code (similar to the standard procedure for typing any uppercase letter by using the shift key). Other codes are entered by typing ESC (escape) followed by the indicated letter.

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Be sure to inquire about our new Vision 40, a softscreen programmable character generator for Apple II™ computers. It's great for graphics and perfect for foreign language applications.
32 characters encoded in PROM (programmable read-only memory) are transmitted as if from the keyboard (e.g., for an automatic password sign-on to a remote computer).

"Normal" Printing Operations

In the printing mode the Selanar Graphics II acts as a normal DECwriter printer with enhanced capabilities. We can select any one of four character sets: standard, APL, mathematical, and user-defined. The first three sets are encoded in PROM, the fourth is stored in programmable memory. The fourth character set may be loaded from the host computer or entered manually from the keyboard; once loaded, it remains in memory until the DECwriter is turned off.

The programmable character set can contain up to 94 printable characters. Each of these is represented as a 7-by-7 dot matrix with the top dot corresponding to the most significant bit and the bottom dot to the least.

Seven bytes are required to define each character: one for each column of the matrix. For convenience in entering characters from the keyboard, each byte can be entered as an ASCII (American Standard Code for Information Interchange) character.

Using the boldface character option, we are able to emphasize words and headings, or even print out an entire document in this type style for a more pleasing appearance. Figure 1 shows the first three character sets and the various type styles available with the Graphics II enhanced DECwriter. The one-quarter-up and one-quarter-down linefeed option is invaluable for printing the superscripts or subscripts that are often necessary when writing chemical or mathematical equations (see figure 1), as well as printing chemistry manuscripts, examinations, and writing computer-assisted instruction units.

Data Buffer

The Graphics II unit also has a 1000-character buffer for serial I/O. In this mode, the printer will automatically print characters as fast as it can. Data not ready for printing will be temporarily stored in the buffer; however, the programmer must be careful not to overflow the buffer. To prevent this, an X-off character is sent to the host computer when the buffer is filled to within 100 bytes of overflow; an X-off character is then sent for every additional character received. When the buffer is emptied to fewer than 100 characters, an X-on character is transmitted. Thus, the programmer does not have to worry about overflowing the buffer or other timing considerations, and data transfer rates of up to 1200 bps (bits per second) are possible. The X-on/X-off option need not be used if the programmer is careful to take into account the time needed to execute a carriage return and line feed, horizontal tab, vertical tab, graphic vectors, and Here Is, to avoid overflowing the buffer.

GRAPHICS II CHARACTER SETS

**STANDARD**

<table>
<thead>
<tr>
<th>Character Set ID</th>
<th>Characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>A-Z a-z 0-9</td>
</tr>
<tr>
<td>02</td>
<td>A-Z a-z $ @</td>
</tr>
<tr>
<td>03</td>
<td>A-Z a-z # %</td>
</tr>
<tr>
<td>04</td>
<td>A-Z a-z * /</td>
</tr>
</tbody>
</table>

**MATHEMATICS**

<table>
<thead>
<tr>
<th>Character Set ID</th>
<th>Characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>05</td>
<td>( a )</td>
</tr>
<tr>
<td>06</td>
<td>( b )</td>
</tr>
<tr>
<td>07</td>
<td>( c )</td>
</tr>
<tr>
<td>08</td>
<td>( d )</td>
</tr>
<tr>
<td>09</td>
<td>( e )</td>
</tr>
<tr>
<td>10</td>
<td>( f )</td>
</tr>
<tr>
<td>11</td>
<td>( g )</td>
</tr>
<tr>
<td>12</td>
<td>( h )</td>
</tr>
<tr>
<td>13</td>
<td>( i )</td>
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<td>14</td>
<td>( j )</td>
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<td>15</td>
<td>( k )</td>
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<td>16</td>
<td>( l )</td>
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<tr>
<td>17</td>
<td>( m )</td>
</tr>
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<td>18</td>
<td>( n )</td>
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<tr>
<td>19</td>
<td>( o )</td>
</tr>
<tr>
<td>20</td>
<td>( p )</td>
</tr>
<tr>
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**APL**

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<tr>
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</tbody>
</table>

**CHEMICAL EQUATIONS**

(2) \( \text{Ca}^{2+} + 2 \text{OH}^- \rightarrow \text{Ca} \text{(OH)}_2 \)
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DRIVE NO 4 355.00

DUAL HEAD 40 TRACK EXTERNAL DRIVES
DRIVE NO 3 499.00
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BYTE March 1983 179
**THE GRAPHICS MODE**

<table>
<thead>
<tr>
<th>ACCUMULATOR</th>
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</thead>
<tbody>
<tr>
<td>X2</td>
</tr>
<tr>
<td>Y2</td>
</tr>
<tr>
<td>X1</td>
</tr>
<tr>
<td>Y1</td>
</tr>
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</table>

**GRAPHICS COMMANDS**

- X2 TO X1, Y2 TO Y1,
- CLEAR ACCUMULATOR
- ACCUMULATOR TO X2, AND CLEAR
- ACCUMULATOR TO Y2, AND CLEAR
- DRAW LINE FROM X1, Y1 TO X2, Y2
- POSITION PRINT HEAD TO X1, Y1

**EXAMPLES USING GRAPHICS COMMANDS**

**LOCAL** - (800,200,(900),(1000,150.)

**BASIC** - LPRINT (";STR$(800);";STR$(200);");";STR$(150);"

**LOCAL** - (900,500,(1000,450.)800,450.)800,550.)1000,550.)

**Figure 2:** Graphics-mode sample output. Figure 2a gives a summary of the graphics command procedures, as printed in the graphics mode. Figure 2b shows straight lines are drawn.

---

**ACT-85**

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- 32 terminals per line

**MONITOR**
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- 24 lines of 80 characters
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- highlighting
- blinking
- underlining
- separate keyboard
- 38,400 baud effective speed

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    - 400, 410, 450
    - 460, 801, 851
  - FLOPPIES
    - 8", 10, 20, 30 or 40 Megabyte

**COMPUTER**
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- 10 mhz crystal
- 64 K ram
- two RS-232 ports
- 32 terminals per line

**WINCHESTERS**
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---

**Graphics Operation**

The graphics mode is entered at any time with an ESC B and exited with a ESC C command. Graphics are done a page at a time, with each page consisting of 792 lines with 1320 dots per line. The origin (0,0) is located at the upper left-hand corner of the page; the bottommost right-hand corner corresponds to the point (1319,791).

In the graphics mode, the system responds only to the digits 0 through 9, parentheses, the right bracket, the comma, and the period; all other characters are ignored.

The comma transfers the previously entered number from the accumulator to the X2 register and then clears the accumulator. A left parenthesis copies X2 into X1 and Y2 into Y1 and also clears the accumulator; a right parenthesis is the command for drawing a line between X1,Y1 and X2,Y2. This sequence of operations is summarized in figure 2a. Examples of lines drawn using these commands are shown in figure 2b. Also illustrated is a BASIC print statement that shows the method of drawing lines under program control. Note that a comma indicates that the number preceding it is an ordinate value and a period indicates that the preceding number represents an abscissa.

Thus, (A,B,(C,D,)) will draw a line between A,B and C,D; (A,B,(C,)) draws a horizontal line between A,B

---

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---

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Figure 3: Typical acid/base titration curve. Data points are drawn as short bars, the curve is enclosed by a border, and the heading and labels are printed double width.

The Use of Precision Tractors

Another modification of the DECwriter, which is particularly useful in graphics mode, is the installation of a set of precision paper-feed tractors in place of the standard tractors supplied with a conventional DECwriter. (These can be obtained from the Selanar Corporation for $50.) Their purpose is to insure that lines originating from the same point (such as in a radial pattern) begin at that point every time a new line is drawn—otherwise the pattern shows a distinct discontinuity. The improvement in the printed results due to the use of the precision tractors can be seen in

and C; (A,B,1) prints a single dot; and the right bracket, as in A,B,[] positions the print head at location A,B without printing. Two examples are illustrated in figure 2b where, in the top example, a horizontal line is drawn between the points 800,200 and 900,200 and then a line from 900,200 to 1000,150. The intersecting lines in the bottom example are purposefully drawn in the same manner. First, a line is drawn between the points 900,500 and 1000,550. The intersecting lines are drawn in the same manner. Finally, a line between 900,500 and 1000,550.
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Why this operating system? Ask the leading independent software vendors. They know Intel's iRMX 86 well enough to know it's an industry standard; that it allows them to plug into VLSI technology, and to design in a heap of high-performance features.

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Incidentally, all these features are available for $130/unit in OEM quantities. Plus all are backed by extensive documentation, development tools, workshops, field support, software maintenance, and a company name that’s liable to turn up anywhere.

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EXAMPLES OF HERSHEY CHARACTER ALPHABETS

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz

USE A 2-D ROTATIONAL ALGORITHM

\[
\begin{bmatrix}
X_1 & Y_1 & 1 \\
X_2 & Y_2 & 1 \\
X_H & Y_H & 1
\end{bmatrix}
\begin{bmatrix}
\cos(q) & -\sin(q) & 0 \\
\sin(q) & \cos(q) & 0 \\
0 & 0 & 1
\end{bmatrix}
= \begin{bmatrix}
X_1 & Y_1 & -1 \\
X_2 & Y_2 & -1 \\
X_H & Y_H & -1
\end{bmatrix}
\]

EXAMPLES

Figure 4: Various type fonts produced by the program of listing 1 from data stored on disk. The rotation feature is shown in figure 4b.

Figure 2b, where the lines all originate from the point 900,500. The precision tractors are no trouble to install and otherwise perform exactly like the original tractors.

Figure 3 shows a typical acid/base titration curve. Note the use of the double-width characters to label the graph, the box enclosing the curve, and the use of the bar-print mode to emphasize the individual data points. This graph was generated with a FORTRAN program and is a good example of the combined use of printing characters and graphics. The four character sets, double-width, boldface, and character rotation options all make the Selanar Graphics II board a powerful addition to any DECwriter.

Generating Character Sets

The excellent resolution available with the Graphics II and the fact that it prints vector-generated graphics prompted us to explore the use of graphics to draw characters as well as plot curves. Normally, we would have to do this by developing tables of coordinates for each alphanumeric character. But fortunately, there is an invaluable reference work that provides all the information needed: A Contribution to Computer Typesetting Techniques: Tables of Coordinates from Hershey's Repertory of Occidental Type Fonts and Graphic Symbols. (Published by the U.S. Department of Commerce, the book is now out of print, although many libraries have a copy.)

This document lists the coordinates used to generate 1377 different alphabetic and graphic characters on either a video terminal or a hard-copy digital plotter. The tables were originally developed by Dr. A. V. Hershey of the Naval Weapons Laboratory in Dahlgren, Virginia. Dr. Hershey's assiduous digitization of these many character sets and symbols is as much a work of art as it is a scientific achievement, and it includes symbols from mathematics, engineering, music, and other disciplines. The typeset quality of the characters and symbols is certain to enhance any graphics display.

Figure 4a presents several examples

Text continued on page 196
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Figure 5: Three-dimensional plotting in the graphics mode. Figures 5a and 5b show the same function but with differing detail; figure 5c (on page 190) is a "two-dimensional particle in a box."
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Circle 41 on inquiry card.
Listing 1: Program used to print characters in the various type fonts from data stored on disk. The program (written in Microsoft BASIC-80, Version 5.0) produces output, such as that shown in the figures, on the modified DECwriter.

```basic
10 REM *************************************************
20 REM DANIEL S. HOLMES
30 REM CHEMISTRY DEPARTMENT
40 REM SYRACUSE UNIVERSITY
50 REM *************************************************
60 REM THIS PROGRAM OUTPUTS ANY OF A NUMBER OF MERSHEY
70 REM CHARACTERS AS TEXT. THE TEXT AND NUMBER OF LINES
80 REM ARE USER SELECTED, ALONG WITH THE MAGNIFICATION
90 REM FACTOR, AND THE ANGLE OF ROTATION (0-360 DEGREES).
100 REM
110 REM ENTER GRAPHICS MODE
120 LPRINT CHR$(27); "*"
130 REM
140 REM ENTER PART OF THE PROGRAM IS TO INPUT ALL USER SELECTED DATA
150 REM
160 PRINT ** CHARACTER SETS $REC/CHARACTER**
170 PRINT * CROWN 1*
180 PRINT * STHAT 2*
190 PRINT * THORAN 3*
200 PRINT * GOTHICD 4*
210 PRINT * LOOOTH 5*
220 PRINT **PRINT** INPUT * WHICH CHARACTER SET DO YOU WANT *IC*
230 OPEN "R";1,08
240 PRINT ** OF RECORDS / CHARACTER **IREC
250 PRINT 100
260 PRINT ** ENTER TEXT**SPRINT
270 INPUT ** OF LINES (UP TO TEN) **I02
```

Listing 1 continued on page 192
The important plus in matrix printers:

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The full standard ASCII 96 character set, with descendents and underlining of all upper and lower case letters, is printed bidirectionally, with up to 5 crisp copies, at speeds up to 200 CPS. Models DP-9500 and DP-9501 offer 132/158/176 and 132/165/198/220 columns respectively. Print densities are switch- or data-source selectable from 10 to 16.7 characters/inch. All characters can be printed double-width under communications commands.

**Interface Plus**
Standard in all models are the three ASCII compatible interfaces (Parallel, RS-232-C, and Current Loop). Also standard is a sophisticated communications interface to control Vertical Spacing, Form Length and Width, Skip-Over Perforation, Auto Line Feed, X-On/Off, and full point-to-point communications.

**Features Plus**
As standard, each model features forms width adjustment from 1.75 to 15.6 inches, shortest-distance sensing, full self-test, 700 character FIFO buffer (with an additional 2048 characters, optional), and a quick-change, 6 million character life ribbon.

**Quality Plus**
Beyond the built-in performance of the grafixPLUS series printers, the engineered-in quality and support are equally important. The result? Approval of both UL and FCC, Class A; operating noise levels under 65dB(A); and a nationwide service organization second to none.

To see for yourself why the grafixPLUS printers offer more pluses for your printing dollar, contact us today.

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Are you faced with having to spend $3000 and up for a letter-quality printer?

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For only $500 the **Mediamix ETI** lets you connect the IBM Electronic Typewriter Models 50, 60, or 75 to any computer. Why invest in two separate machines? Your office typewriter can do both jobs, yielding better type quality, a consistent corporate image and renowned IBM service.

The **ETI** is no simple black box, either. It is a sophisticated microcomputer with 2000 characters of memory, over 39 special commands and the option of doing typesetting on the IBM Model 50.

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Los Angeles, California 90067
(213) 475-9949

Listing 1 continued:

```
220 PRINT : PRINT "USE CONTROL-H TO BACKSPACE"
230 FOR J=1 TO 82
240 PRINT "------------------------LINE \"J\"------------------------" : PRINT
250 X=1
260 X*(J+X) = INPUT$(1)
270 IF ASC(X*(J+X))=0 THEN X=X+1 : PRINT CHR$(B) : GOTO 310
280 IF X*(J+X)=CHR$(13) THEN 320
290 PRINT X*(J+X)
300 X=X+1
310 GOTO 260
320 PRINT
330 D(J)+X=1
340 NEXT J
350 PRINT : PRINT "IS THIS THE STRING YOU WANTED \"YES\"?"
370 IF Y=-"YES" THEN 390 ELSE 170
390 INPUT "WHAT MAGNIFICATION POWER \"INAG\""
400 PRINT
410 PRINT "WHAT ROTATION ANGLE (-360) \"IT\"
420 T2=IT/57.295B
430 PRINT
440 INPUT "WHAT IS THE STARTING POINT ON THE PAGE \"IN\""
450 A1=IN 1 B1=IN B
490 REM
495 REM
500 REM THE COORDINATE PAIRS ARE STORED IN A RANDOM ACCESS FILE
505 REM THE RECORD NUMBER IS DETERMINED BY THE ASCII VALUE OF
510 REM THE LETTER TO BE WRITTEN. NOTE: THE CHARACTERS ARE
515 REM NOT STORtED IN SEQUENTIAL ASCII FORMAT.
516 REM
517 REM
520 FOR J=1 TO 82
530 FOR D=1 TO D(J)
540 IF ASC(X*(D-J))=96 THEN 600
550 IF ASC(X*(D-J))=64 THEN 610
560 IF X*(D-J)="*" THEN C=27*REC-REC+111:BOTO 620
570 IF X*(D-J)="*" THEN C=28*REC-REC+111:BOTO 620
580 IF X*(D-J)="*" THEN C=29*REC-REC+111:BOTO 620
590 C=(ASC(X*(J-D))-10)*REC-REC+1:BOTO 620
600 C=(ASC(X*(J-D))-47)*REC-REC+1:BOTO 620
610 C=(ASC(X*(J-D))-64)*REC-REC+1:
620 PRINT "THE RECORD \"IS \"" :C
630 REM
635 REM
640 REM HERE WE GET THE COORDINATE PAIRS,
645 REM SOME OF THE CHARACTER SETS TAKE UP MORE
650 REM THAN ONE RECORD/CHARACTER.
660 REM
665 REM
670 FIE LD #1,1 AS M$2 AS L$2 AS R$2 AS H$2
680 Z=0
690 FOR J=0 TO 59 STEP 2
700 FIELD #1,2#7 AS D$2 AS A$(B)+2 AS A$(G+1)
710 Z=Z+1
720 NEXT G
730 GET #1,C
740 L=CVI(L$)
750 R=CVI(R$)
760 H=CVI(H$)
770 I=1
780 A(I)=CVI(A(I))
790 A(I+1)=CVI(A(I+1))
800 IF A(I+1)=-64 THEN 1100
810 IF I=59 THEN 850 ELSE I=I+2 : GOTO 780
840 GOTO 1100
850 H1=60
860 FOR Y=1 TO REC-1
870 I=0
880 FOR X=H1+1 TO H1+59 STEP 2
890 FIELD #1,1#4 AS D$2 AS A$(X)+2 AS A$(X+1)
900 I=I+1
910 NEXT X
920 C=C+1
930 GET #1,C
940 FOR X=H1+1 TO H1+59 STEP 2
950 A(X)=CVI(A(X))
960 A(X+1)=CVI(A(X+1))
970 IF A(X+1)=-64 THEN 1100
980 NEXT X
990 H1=H1+60
1000 NEXT Y
1050 REM
1055 REM THIS IS THE PART OF THE PROGRAM THAT OUTPUTS
1065 REM THE LETTER TO THE DECWRITER. THE DECWRITER
1070 REM ACCEPTS THE STRING REPRESENTATION OF EACH CHARACTER.
1075 REM A (-64,8) IS A LIFT PEN INSTRUCTION.
```
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Z-80A™ CPU, Floppy Disk Controller, 64K of Memory, Serial & Parallel I/O Ports...all on a SINGLE S-100 BOARD!

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Circle 9 on Inquiry Card.
Fill this space with a GRAFTRAX graphic and win a trip to Japan.

The Epson "Softwear" Sweepstakes.

We're looking for the Picasso of programming. So we drew up an art contest for people who don't know a painting pallet from a PROM.

If you've got an Epson printer, a computer and a little imagination, you could win a week-long trip for two to Japan. Or our top-of-the-line 136-column MX-100 printer. Or his and hers Seiko Quartz Watches. Or a whole lot of honorable mention prizes. And you'll get a T-shirt with the winning graphic just for entering.

All you have to do is program a GRAFTRAX graphic — abstract, landscape, still life, whatever — using an Epson MX-70, MX-80, MX-80 F/T or MX-100 printer. We'll not only put it on our T-shirts, we'll be displaying the winning entries for all to see in June at the National Computer Conference in Houston.

Why, you may ask, are we being so generous? It's simply because GRAFTRAX is the most incredible graphics capability made for micros. And we want to see it used to its full potential.

All entries will be judged on originality, creativity and best use of computer equipment. They must be postmarked no later than May 1, 1982, and be accompanied by the software program, so we can recreate the winning entries for verification. Make sure the graphic is no larger than 8" x 10" and no smaller than 4" x 6". And remember, if you digitize art or a photograph, it must have been originally created by you.

So get busy and enter. You might be a winner.

And your software could be your "softwear."

EPSON
EPSON AMERICA, INC.

3415 Kashiwa Street • Torrance, California 90505
EPSON
"SOFTWARE" SWEEPSTAKES RULES

1) Any computer equipment may be used to format the entry, but the graphics output must have been printed on an Epson MX-70, MX-80, MX-90, EC-77, or MX-100 printer with either built-in or optional GRAFTAX. Winning entries will be re-created by Epson for verification.

2) Each entry must be accompanied by the software program used to create it. All entries and software and the rights to use them become the property of Epson America, Inc.

3) All entries must be at least 6" x 4" and no larger than 8" x 10" in size.

4) Art photographs, if used, must have been created by the entrant.

5) All entries will be judged by an independent panel of judges on their creative merit, originality and best use of computer equipment. Decision of the judges is final.

6) This contest is valid from January 1, 1982 until May 1, 1982. Entries must be postmarked not later than May 1, 1982.

7) Participation in the Epson "Software" Sweepstakes is open to anyone except the following: employees of Epson America, Inc., its service agencies, or their families.

8) Winners will be notified by mail no later than June 1, 1982. A list of winners will be made available by sending a stamped, self-addressed envelope to Epson America, Inc., 345 Kashuba Street, Torrance, CA 90710.

9) Entries will be maintained on file at Epson America, Inc. until January 1, 1983.

10) Prizes are as follows: First prize includes round-trip economy air transportation for two to Tokyo, from the airport nearest the winner's place of residence, and six nights standard hotel accommodations, double occupancy. Trip does not include airport departure taxes, hotel service charges, cost of transportation or other expenses incurred before leaving the airport of initial departure, returning to Tokyo airport and returning home from the airport of initial departure; nor does it include meals or gratuities. Second prize consists of one Epson MX-100 Printer. Third prize consists of a pair of Siskiyo Quartz Watches. Additional prizes include 25 Microsoft Printbooks, 50 Epson Digital Watches, and 100 Epson Ribbon Cartridges.

11) You may enter more than once, but each entry must be accompanied by the official entry coupon below.

12) Void where prohibited by law.

---

Attach this form firmly to the back of each graphic you enter.

NAME ____________________________

STREET __________________________

CITY ___________ STATE ZIP ________

PHONE (_____) _________________

COMPUTER EQUIPMENT USED

PRINTER MODEL AND SERIAL NUMBER

T-SHIRT SIZE S M L XL ______

Mail entries to:
"SOFTWARE" SWEEPSTAKES
Epson America, Inc.
345 Kashuba Street
Torrance, California 90710

Listing 1 continued:

1000 REM A (-64, -64) IS AN END OF CHARACTER INSTRUCTION.
1090 REM
1095 REM
1100 A=A-L*SA*COS(T2)
1110 B=B-L*SA*SINT2
1120 DOSUB 2000
1130 IF H=1 THEN 1300
1140 LPRINT '*'&STR$(INT(A(1)*SA)+A)+'*'+STR$(INT(A(2)*SA+B))'
1150 FOR B=1 TO H-2 STEP 2
1160 IF A(SH)=64 THEN 1300
1170 IF A(SH)=64 THEN 1270
1180 A(0)=A(0)*SA
1190 A(0)+1=A(0)+1+B
1210 A(0)+1=A(0)+1+B
1220 LPRINT '*'&STR$(INT(A(0)))+'*'+STR$(INT(A(0)+1))'
1230 IF H=1 THEN 1250
1240 LPRINT '*'
1250 U=0
1260 GOTO 1290
1270 LPRINT
1280 U=1
1290 NEXT D
1300 A=A+R*SA*COS(T2)
1310 B=B+R*SA*SINT2
1320 NEXT D
1360 REM
1370 REM NOW WE GO BACK TO THE START OF THE NEXT LINE
1380 REM
1390 REM
1400 IF REC<1 THEN 1440
1410 A(0)=A(0)+15*SA*SINT2
1420 B(0)+1=B(0)+15*SA*COS(T2)
1430 GOTO 1465
1440 A(0)=A(0)+30*SA*SINT2
1450 B(0)+1=B(0)+30*SA*COS(T2)
1465 A(0)=A(0)+15*SINT2
1470 NEXT J
1472 REM
1475 REM
1480 REM CHECK FOR ANYTHING ELSE TO PRINT OUT
1490 REM
1495 REM
1500 INPUT "DO YOU HAVE MORE TEXT "
1510 IF YS="YES " THEN 1550
1520 PRINT
1530 INPUT "DO YOU WANT TO CHANGE CHARACTER SETS "
1540 IF YS="YES " THEN CLOSE 1 GOTO 70
1542 REM
1543 REM
1545 GOTO 190
1547 REM
1548 REM
1550 LPRINT CHR$(27)$"C"
1560 END
2000 REM
2010 REM
2020 REM THIS IS THE ROTATIONAL ALGORITHM USED TO ROTATE THE
2030 REM CHARACTERS ANY ANGLE FROM 0-360 DEGREES.
2050 REM THE COORDINATE PAIRS ARE STORED IN A 3x3 MATRIX AND
2060 REM MULTIPLIED BY THE ROTATION MATRIX (ROTATION ABOUT
2065 REM THE POINT 0,0).
2070 REM
2080 REM
2090 REM
2095 REM
2100 IF T1>0 THEN RETURN
2060 FOR I=1 TO H
2070 S(I,1)=A(I#2-1)
2080 S(I,2)=A(I#2)
2090 S(I,3)=I
2100 NEXT I
2110 T(I,1)= COS(T2)
2120 T(I,2)=COS(T2)
2130 T(I,3)=SINT2
2140 T(I,4)=SINT2
2150 T(I,5)=0
2160 T(I,6)=0
2170 T(I,7)=0
2180 FOR Y5=1 TO H
2190 IF A(Y5)=64 THEN 2250
2200 FOR X5=1 TO 5
2210 A(X5,Y5)=S(I,5)*T(X5,1)+S(I,6)*T(X5,2)+S(I,3)*Y5+T(X5,3)
2220 NEXT X5
2230 A(Y5)=$1=INT(A($1)+Y5)
2240 A(Y5)=INT(A($1)+Y5)
2250 NEXT Y5
2260 RETURN

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of Hershey-character alphabets. Starting from the top of the figure, these are: simplex Roman, simplex script, complex italic, triplex Roman, and Gothic English. At our laboratory, we now have the coordinates of these various character-printer sets stored on disk and can send them to the DECwriter under program control in any size desired. The coordinates for the simplex Roman characters occupy approximately 7K bytes of disk storage space, while the Gothic English files require more than four times that amount.

In addition to being able to vary the size of the displayed Hershey character sets, we also included in our program the ability to rotate characters to any angle. The effects of this routine, adapted from *Mathematical Elements for Computer Graphics*, by D. F. Rogers and J. A. Adams (see references), are shown in figure 4b, which displays several examples of character rotation; also shown is the rotational algorithm that does the calculations necessary for the individual rotations. The BASIC program that outputs the Hershey coordinates as letters, starting at any location on the page, with any magnification and any degree of rotation, is given in listing 1.

Figure 5a is a three-dimensional plot of an exponential function showing the use of the graphics mode to display the lettering as well as the mathematical function itself. Figure 5b is a three-dimensional plot of the same function with certain lines hidden, with cross hatching, and labeled with graphically generated Hershey characters. Finally, shown in figure 5c is the three-dimensional representation of the quantum-mechanical wave function for a two-dimensional particle in a box.

**Conclusion**

The Selanar unit has been in operation in our laboratory for over a year and has performed flawlessly during that time. The illustrations of the various graphs shown, especially the three-dimensional plots, with or without hidden lines, coupled with the development of programs to encode and output the different Hershey character sets, has made our DECwriter a truly versatile and low-cost generator of high-quality, high-resolution hard copy.

**References**

WHILE OUR COMPETITORS TALK ABOUT PRINTER RELIABILITY, DATAROYAL PROVES IT.

Many printer companies talk about how reliable their products are. But very few can publish hard evidence supporting those claims. Dataroyal knows that every printer breakdown, service call, or extra maintenance procedure increases the cost of owning and operating your system. So we don’t make claims we can’t prove. Dataroyal tests our IPS-5000 printers non-stop at 100% duty cycle and page density. These printers have now surpassed an MTBF (mean time between failure) figure of 2000 hours-without failure, maintenance, or any special treatment. Under normal conditions, this performance rating means years of reliable operation between service calls. And our printhead life now exceeds 500 million characters. All of this reliability spares you the time and expense you might now be spending on your existing printers. This superior performance has made Dataroyal the intelligent choice for major domestic and international OEM systems manufacturers. Want to see our proof? Contact us, and we will send you our latest test results. And that’s not just talk.

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(937) 284-6426

3150 EAST LAPALMA AVENUE, SUITE D, ANAHEIM, CA. 92806
(714) 632-9310
To help you find forms for your software, we are offering this brief account of the current marketplace of forms for microcomputer users.

Some microcomputer users have written their own software; others have bought one or more commercial programs. Many microcomputer users run both software of their own and commercial programs.

A number of companies stand ready to help you with various stock, custom, or standardized forms. Table 1 (page 200) lists companies active in this market. Table 2 (page 202) summarizes the product offerings of these companies and the minimum orders required for custom and standardized forms. I have also included brief information about these companies' offerings, if any, of continuous custom letterheads.

While stock forms are of several common types, they are not written specifically for one company's computer or software. Nevertheless, stock forms do, in fact, work with many commercial programs. Companies offering stock forms are too numerous to list. If stock forms will work with your commercial programs, or if you can write software that uses stock forms, you will be able to get the forms you need at an economical price. Some companies make the use of stock forms easier by providing programmer's guides for use of the form, e.g., a grid with rows and columns numbered and data fields highlighted.

But the focus of this article is on custom and standardized forms. Custom forms, of course, are designed to go with unique, user-written software. What I am calling standardized forms are designed to go with specific pieces of commercial software. If you buy an accounting program from the fictitious Ersatz Software, for example, and you know someone who sells forms for the Ersatz programs, you won't need to spend any time adapting the software to your forms or spend any legwork looking for stock forms that happen to be compatible with the software.

Custom Forms

If you absolutely must do things your own way down to the last detail, custom-designed and printed forms are for you. Many companies produce custom forms. These companies are found under "Business Forms" in the Yellow Pages. Minimum order quantities vary greatly. The companies listed in table 2 that do custom forms accept orders for minimums ranging from 1000 to 5000. Pricing varies with the com-

Philip Lemmons

c/o BYTE Publications Inc.

POB 372
Hancock, NH 03449

198 March 1982 © BYTE Publications Inc
Inexpensive doesn't have to mean incomplete, and the quiet, dependable Centronics 739 is the classic example. It's complete in capability and because it's from Centronics you can expect it to perform just like the workhorse printers that have made Centronics a leader in the business for more than a dozen years. So when you shop for a desk-top printer and compare features, here's what you can expect from a 739:

CORRESPONDENCE QUALITY - Clear, high density characters plus right justification and proportional spacing that produce correspondence, direct mail, and other important documents that demand a "custom" quality appearance.

BUSINESS GRAPHICS - What good is a printer that can't print your technical business/management information? The 739 produces a range of graphics - from bar charts and curves to illustrative material - almost anything your computer can produce.

3-WAY PAPER HANDLING - Cut sheets for correspondence; roll paper for day-to-day operations; fan-folded forms for normal data printout.

DEPENDABILITY - You depend on your printer for hard copy of timely information and that means it must operate dependably. With Centronics reputation behind the 739, reliability is a foregone conclusion. More than 350,000 Centronics printers sold worldwide is the proof.

SERVICE - Someday you may need it. Where do you find it? With Centronics worldwide network of service locations it's not very far. And now, there are authorized Centronics sales and service dealers, and "walk-in" service centers in an expanding number of key cities throughout the U.S.

When it comes to printers, Centronics is the leading independent printer manufacturer - chosen by computer professionals in major industry brand preference studies. So when you look for an inexpensive printer don't settle for incomplete. Choose the Centronics 739. It comes complete with a commitment - to performance, dependability and service. See it at your Centronics dealer. Or write for information.

CENTRONICS PRINTERS

Circle 70 on inquiry card.
plexity of the form. Many companies stress that it makes little sense to buy only 1000 custom forms because 5000 cost relatively little more—much of the cost lies in the unique design of the form.

**Standardized Forms**

A few companies are now offering forms to go with standard, commercial software packages for microcomputers. NEBS, Checks-to-Go, DFS, Moore, and Trinity are all active in this market. Your choice of a company might depend on whether you want to buy forms by telephone or mail, from your local computer or software dealer, or (with Moore, at least) from the company's own local office.

More likely, however, your choice will depend on which company has the forms for your commercial programs. Table 3 (page 204) lists the kinds of software for which the companies shown sold forms. Note that not all these companies identify forms the same way. Some companies list their standardized forms primarily by reference to software houses. Others refer primarily to computer companies: you tell them what kind of computer you use, and they tell you what forms they have for it. Some companies list standardized forms by a combination of software house and computer company. Since many computer companies sell software as well as hardware, you can't always be sure which forms company has exactly what you need.

Perhaps the wisest course is to contact all the companies or their local dealers and ask about your specific needs. Although table 3 lists the kinds of microcomputers and software for which various companies offer standardized forms, some of the companies have only recently entered the field. By the time you read this, the new entrants in the microcomputer forms market are likely to have added many new forms to their product lines.

---

**Check-Mate**
POB 103
Randolph, MA 02368
(617) 963-7694
Comments: Check-Mate sells only by direct mail and telephone. Its custom forms are limited to checks; its standard computer forms are for Radio Shack and Libra software only.

**Checks-to-Go**
8384 Hercules St.
La Mesa, CA 92041
(800) 854-2750
(800) 552-8817 (California residents only)
Comments: Checks-to-Go sells only by direct mail and telephone. Tell Checks-to-Go what kind of computer you have and you will receive a sample kit of its forms for your computer.

**DFS Computer Forms**
POB 643
Townsend, MA 01469
Comments: DFS has an extensive line of forms for existing microcomputer software and sells only through local dealers.

**Moore Business Forms Inc.**
1205 North Milwaukee Ave.
Glenview, IL 60025
(800) 447-4700
(800) 322-4400 (Illinois residents only)
Comments: Moore sells forms through more than 600 of its own local sales offices around the United States. Check the Yellow Pages or call Moore's toll-free numbers to find out the name of your local dealer.

**NEBS Computer Forms**
78 Hollis St.
Groton, MA 01471
(800) 225-9550
(800) 922-8560 (Massachusetts residents only)
Comments: NEBS sells only by direct mail and telephone. On request, NEBS sends a helpful, cross-indexed Forms Selector Guide and a catalog with programmer's guides for each form.

**Trinity Forms Company**
Micro Computer Forms Program
Carrollton, TX 75006
(800) 527-0625
(800) 492-5232 (Texas residents only)
Comments: Trinity sells through local dealers only. Contact Trinity on a toll-free number for the name of your local dealer. Trinity plans to introduce a large line of standard forms for many different microcomputer software packages.

**Table 1:** Some companies selling standardized or custom forms for micro-computers.
3.7 million reasons why the ATARI Home Computer is something to see.
The display screen used with our computers is composed of 192 horizontal lines, each containing 320 dots. Delivering color and luminosity instructions to each dot for a second requires 3.7 million cycles...a lot of work for the normal 6502 processor.

That's why the ATARI computer has equipped its 6502 with its own electronic assistant. It's called ANTIC, and it handles all the display work, leaving the 6502 free to handle the rest. What this means to you is uncompromisingly spectacular display capabilities without loss of computer power needed to carry out the demands of your program.

That's a quality you just don't find in ordinary personal computers. And it's one of the reasons some computer experts say that ATARI computers are so far ahead of their time.

There's more... which is what you'd expect from ATARI.

Language. The ATARI Personal Computer uses several programming languages to give the user maximum control of its extraordinary capabilities. PILOT, Microsoft BASIC, and ATARI BASIC are understood and spoken by the ATARI computer. You'll also find our Assembler Editor cartridge indispensable for machine language programming.

Sound. An ATARI computer has four sound generators, or voices, activated by a separate microchip. This leaves the principal microprocessor chips free to perform other tasks. And you can take full advantage of this capability which is designed for easy programming.

Change. ATARI Home Computers have been designed to make change and expansion easy. The ATARI computer has a modular operating system that can be easily replaced as new technology develops. If you need it, memory expansion requires no more than inserting additional RAM modules. And the ATARI ROM cartridge system also makes it easy to change languages. In short, your ATARI computer won't be obsoleted by future developments... because it already incorporates the future.

Sharing. To learn more about the amazing capabilities of ATARI computers, visit your local computer store for a demonstration. Or send for our Technical User's Notes, intended for the serious programmer. They are only $27 and contain a lot more information about our computers' special capabilities than most companies could tell.

See your ATARI dealer or send $30 ($27 plus $3 postage and handling), payable to ATARI, to Technical User's Notes, c/o ATARI Customer Service, 1340 Bordeaux Avenue, Sunnyvale, CA 94086.

© 1981 Atari, Inc.
Table 2: Information about how six companies sell custom and standardized forms for microcomputers. Important considerations include minimum order quantities and sales methods—whether through a company’s own local offices, through local dealers, or by mail and telephone.
Financial Planning... from Supersoft

SCRATCHPAD: SUPERSOFT’S ELECTRONIC WORKSHEET

ScratchPad is a user-interactive data modeling program suitable for financial planning or any general purpose modeling. Whether you are an executive, a researcher, or planning the family budget; you will find ScratchPad an invaluable tool in giving you the numeric correlations you need for sound decision making.

ScratchPad provides for labels and corresponding numeric data entries cross-referenced by row and column. Data entries are then defined as dependent variables in a user-created algebraic formula. You can now quickly see how changes in one or more variables affects all others.

STATS-GRAF: SUPERSOFT’S STATISTICAL DISPLAY PACKAGE

Stats-graph performs statistical analyses on user data and displays the results in graphic form.

Graphic formats include:
- Pie Graph
- Bar Graph
- Scatter Graph

Statistical Analyses include:
- Mean
- Median
- Minimum and Maximum values
- Standard Deviation
- Regression Analysis

ScratchPad includes the following
- Multiple screen splitting which allows two or more sections of the worksheet to be viewed simultaneously.
- Both immediate and deferred calculation modes allowing calculations to be either made as data is entered or deferred until later.
- Flexibility in entry and editing functions so that data can be entered or changed easily.
- Column widths are variable.
- Portions of the worksheet not currently being viewed can be quickly brought to the screen for either single or split screen viewing.
- Any portion of the worksheet can be printed as hardcopy at the user’s discretion.

DATA-VIEW: THE EXECUTIVE ORGANIZER

Data-view is an easy-to-use, free formatted system for organizing information. It can be used as an electronic filing cabinet, an automated date book, or a computerized listing device. Insertion and retrieval of information is both simple and quick. Data may be retrieved by file, string, or key word, and any type of information can be stored.

ScratchPad: $200.00
Stats-graph: $200.00
Data-view: $200.00
Total Package: $500.00
Manuals only: $15.00

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Table 3: Hardware and software sources for which these companies produce standardized forms. Keep in mind that a company that produces forms for one program from a particular software house may not produce forms for all programs from that house. Furthermore, a company that produces forms for one computer from a certain manufacturer may not produce forms for every computer from that manufacturer. In addition, since some of these forms companies entered this market shortly before the research was done for this article, they may by now offer forms for more computers and more software.
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<td>The Systems Shop</td>
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Recently, after considering it for quite awhile, I added a printer to my system. My choice was the Base 2 printer, which I use with an Exidy Sorcerer with 32K bytes of RAM (random-access read/write memory). I bought the printer used for $470, complete with most of its options (tractor feed, graphics option, and expanded character buffer). Parts of this article may not apply to Base 2 printers that lack these options.

**Construction**

This compact printer measures 7.5 by 24.5 by 35.6 cm (3 by 11 by 15 inches) and is constructed of aluminum, which makes the printer surprisingly heavy for its size. The aluminum chassis acts as a heat sink for the large-scale integrated (LSI) circuits, making a fan unnecessary if the printer has an unimpeded airflow. Designed around the 8085 microprocessor and other LSI chips, the printer has few components but great flexibility. Behind the tractor mechanism is a removable panel that provides access to two erasable programmable read-only memories (EPROMs).

One EPROM contains the printer's program and the standard character set, consisting of 96 ASCII characters. The other EPROM can contain auxiliary character sets; it does not come standard with the printer. The paper inlet is located in the bottom of the printer, and the friction feed mechanism is located inside. In the upper left-hand corner of the printer's back panel is the power switch. Also on the back panel are the three interface connectors, power inlet, mode switches, and the reset/self-test switch. On the front panel are the formfeed (FP) and unit-select switches.

**Interfaces**

The Base 2 printer has three interface connectors that support four popular interfaces: RS-232, 20-milliampere (mA) current loop, Centronics parallel, and IEEE-488. You select the interface mode by using two switches of an eight-position miniature DIP (dual-inline package) switch located under the power switch. The next four switches set the default line length from any of the five of the six line densities. The remaining two switches determine the "pinout" (lines assigned to the socket pins) for the serial interfaces. Also on the back panel is the data rate/unit-number switch, which consists of a 16-position thumb-wheel switch. In the serial mode this switch determines one of 15 data rates ranging from 75 to 9600 bits per second. In the IEEE-488 interface mode this switch acts as the unit-number switch. In the parallel mode this switch is not used.

An additional mode recommended for the TRS-80 uses the parallel interface and a line length of 80
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When performance must be measured by results.

Circle 178 on Inquiry card.
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<th>Decimal</th>
<th>Code</th>
<th>Operation</th>
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<td>CTL I</td>
<td>09</td>
<td>09</td>
<td>HT</td>
<td>Horizontal Tab</td>
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<td>CTL J</td>
<td>0A</td>
<td>10</td>
<td>LF</td>
<td>Linefeed</td>
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<td>CTL K</td>
<td>0B</td>
<td>11</td>
<td>VT</td>
<td>Vertical Tab</td>
</tr>
<tr>
<td>CTL L</td>
<td>0C</td>
<td>12</td>
<td>FF</td>
<td>Formfeed</td>
</tr>
<tr>
<td>CTL M</td>
<td>0D</td>
<td>13</td>
<td>CR</td>
<td>Carriage Return</td>
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<tr>
<td>CTL N</td>
<td>0E</td>
<td>14</td>
<td>SO</td>
<td>Elongated Characters</td>
</tr>
<tr>
<td>CTL Q</td>
<td>11</td>
<td>17</td>
<td>X-ON</td>
<td>Selects unit online</td>
</tr>
<tr>
<td>CTL S</td>
<td>13</td>
<td>19</td>
<td>X-OFF</td>
<td>Deselects unit offline</td>
</tr>
</tbody>
</table>

Table 1: The control codes of the Base 2 printer.

Power Supply
My printer came wired for 110 volts of alternating current, but it can easily be rewired for 210 volts. Written directions and diagrams are in the operator’s manual. Since the stepping motors are direct current (DC) and independent of the line frequency, the printer does not need to compensate for frequencies of 50 or 60 hertz (Hz).

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Manual Control
The Base 2 printer's front panel consists of a unit-select switch and a formfeed switch. When the unit-select switch is on, the formfeed switch causes the printer to eject paper to the top of the next form (default form length is 66 lines per page). When the switch is off, the formfeed switch causes the paper to advance at a rate of 1.5 inches per second.

In the upper right-hand corner of the printer's back panel is the reset/self-test switch. When toggled to the left, this switch resets the printer to its default mode. When the reset/self-test switch is toggled to the right, the printer prints a line of characters using the present mode. The self-test switch allows testing the printer independently of the host computer.

Software Control
Two sets of software controls have functions that overlap to a slight degree. One set consists of "control codes" (table 1); the other set consists of "function codes" (table 2). To take effect, the function codes must be prefixed by an ESC (ASCII 27). Some of the function codes must be followed by data, as when setting tabs.

The Base 2 printer supports six character densities (64, 72, 80, 96, 120, and 132 characters per line), as well as elongated characters (10 dots wide rather than 5) in all character densities.

The standard character set contains 96 ASCII characters in a 5 by 7 dot-

<table>
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<th>Function</th>
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<td>J</td>
<td>4A</td>
<td>74</td>
<td>General printer reset</td>
</tr>
<tr>
<td>H</td>
<td>48</td>
<td>72</td>
<td>Unit select</td>
</tr>
<tr>
<td>I</td>
<td>49</td>
<td>73</td>
<td>Unit deselect</td>
</tr>
<tr>
<td>k</td>
<td>6A</td>
<td>106</td>
<td>Enable unidirectional printing</td>
</tr>
<tr>
<td>R</td>
<td>6B</td>
<td>107</td>
<td>Enable bidirectional printing</td>
</tr>
<tr>
<td>S</td>
<td>55</td>
<td>83</td>
<td>Enable 1920 character buffer</td>
</tr>
<tr>
<td>5</td>
<td>35</td>
<td>53</td>
<td>Disable 1920 character buffer</td>
</tr>
<tr>
<td>6</td>
<td>36</td>
<td>54</td>
<td>Disable print on buffer full</td>
</tr>
<tr>
<td>7</td>
<td>37</td>
<td>55</td>
<td>Enable print on buffer full</td>
</tr>
<tr>
<td>B</td>
<td>42</td>
<td>66</td>
<td>Enable auto LF following CR</td>
</tr>
<tr>
<td>C</td>
<td>43</td>
<td>67</td>
<td>Disable auto LF following CR</td>
</tr>
<tr>
<td>D</td>
<td>44</td>
<td>68</td>
<td>Enable CR recognition</td>
</tr>
<tr>
<td>E</td>
<td>45</td>
<td>69</td>
<td>Disable CR recognition</td>
</tr>
<tr>
<td>V</td>
<td>56</td>
<td>86, n1..n16</td>
<td>Enable LF recognition</td>
</tr>
<tr>
<td>V</td>
<td>58</td>
<td>88</td>
<td>Disable LF recognition</td>
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<tr>
<td>X</td>
<td>59</td>
<td>89, n1..n10</td>
<td>Set horizontal tabs</td>
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<tr>
<td>@</td>
<td>61</td>
<td>97</td>
<td>Reset horizontal tabs</td>
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<td>A</td>
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<td>Set vertical tabs</td>
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<td>T</td>
<td>54</td>
<td>84, n</td>
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<td>s</td>
<td>39</td>
<td>57, n</td>
<td>Enable elongated characters</td>
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<td>3A</td>
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<td>Disable elongated characters</td>
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<td>g</td>
<td>46</td>
<td>70, n</td>
<td>Set form length to n lines</td>
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<td>47</td>
<td>71</td>
<td>Set auto FF count</td>
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<td>Enable auto FF</td>
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<td>Disable auto FF count</td>
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<td>Set eject to n lines</td>
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<td>Eject</td>
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<td>52</td>
<td>Set line length to 64 chars.</td>
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<td>b</td>
<td>35</td>
<td>53</td>
<td>Set line length to 72 chars.</td>
</tr>
<tr>
<td>c</td>
<td>36</td>
<td>54</td>
<td>Set line length to 80 chars.</td>
</tr>
<tr>
<td>K</td>
<td>4B</td>
<td>75, data</td>
<td>Set line length to 96 chars.</td>
</tr>
<tr>
<td>L</td>
<td>4C</td>
<td>76</td>
<td>Set line length to 120 chars.</td>
</tr>
<tr>
<td>M</td>
<td>4D</td>
<td>77</td>
<td>Set line length to 132 chars.</td>
</tr>
<tr>
<td>O</td>
<td>4F</td>
<td>78</td>
<td>Set vertical line density</td>
</tr>
<tr>
<td>P</td>
<td>50</td>
<td>80</td>
<td>Enable and send graphics</td>
</tr>
<tr>
<td>Q</td>
<td>51</td>
<td>81</td>
<td>Load user-defined characters</td>
</tr>
<tr>
<td>E</td>
<td>65</td>
<td>101</td>
<td>Enable user-defined chars.</td>
</tr>
<tr>
<td>f</td>
<td>66</td>
<td>102</td>
<td>Enable Standard ASCII chars.</td>
</tr>
<tr>
<td>g</td>
<td>67</td>
<td>103</td>
<td>Enable optional chars. 1</td>
</tr>
<tr>
<td>h</td>
<td>68</td>
<td>104</td>
<td>Enable optional chars. 2</td>
</tr>
<tr>
<td>i</td>
<td>69</td>
<td>105</td>
<td>Enable optional chars. 3</td>
</tr>
</tbody>
</table>

Table 2: The function codes of the Base 2 printer. All function codes must be preceded by an ASCII <ESC> (escape, hexadecimal 1B, decimal 27) in order to take effect.
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</tr>
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<td>CX13 Microsoft Basic</td>
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</tr>
<tr>
<td>CX4101 Invitation To Programming</td>
<td>$17.00</td>
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<tr>
<td>CX4102 Kingdom</td>
<td>$17.00</td>
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<td>CX4103 Statistics</td>
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<tr>
<td>CX4104 Mapping List</td>
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<tr>
<td>CX4105 Blackjack</td>
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<tr>
<td>CX4106 Invitation To Programming 2</td>
<td>$20.00</td>
</tr>
<tr>
<td>CX4107 Bolythm</td>
<td>$17.00</td>
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<tr>
<td>CX114 European Countries &amp; Capitals</td>
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<td>CX116 Invitation To Programming 3</td>
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</tr>
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</tr>
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<td>CX1075 Stock Analysis</td>
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<td>$20.00</td>
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<tr>
<td>CX1036 Assembler Editor</td>
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<td>$649.00</td>
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<tr>
<td>Diablo 630 Special</td>
<td>$1799.00</td>
</tr>
<tr>
<td>Epson MX70</td>
<td>$350.00</td>
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<tr>
<td>MX80</td>
<td>$489.00</td>
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<td>MX85</td>
<td>Call</td>
</tr>
<tr>
<td>MX100</td>
<td>Call</td>
</tr>
<tr>
<td>NEC 8023</td>
<td>$530.00</td>
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<td>7720</td>
<td>Call</td>
</tr>
<tr>
<td>7730</td>
<td>Call</td>
</tr>
<tr>
<td>7740</td>
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matrix font. With software, you can define 96 other characters as an alternate character set. Up to eight other character sets can be contained in a 2732 EPROM, or four in a 2716 EPROM. A function code selects each of the 10 character sets. These extra character sets, especially the user-defined set, allow for special character sets, for example, APL characters, math symbols, and foreign alphabets.

The expanded buffer allows storage within the printer of a full screen (1920 characters). The buffer contents are printed either when the buffer is full or the print-buffer function code is received. The print on buffer full option is disabled with a function code.

The graphics feature provides six horizontal densities up to 99 dots per inch and a constant vertical density of 72 dots per inch. Table 3 shows the character set in different densities. To use the graphics mode, you send the graphics-mode-enable function code followed by a full line of graphics data. The graphics data consist of bytes in which the lower 7 bits control the seven wires in the print head. The printer automatically prints the line of graphics upon receiving a full line of data. Since the printer does not linefeed automatically in the graphics mode, you must send an LF after each line of data. Figure 1 shows a printout of my name in script, produced by using the graphics mode.

Documentation

The documentation for the Base 2 printer is well done. It consists of a single 74-page Operator's Reference Manual that is divided into five sections plus appendixes. The sections cover installation, operation, internal specifications, and software control. Each control code and function code has a complete written description followed by a demonstration program in BASIC. The appendixes cover the hardware, providing full schematic diagrams and component layouts for the logic boards, as well as the parts lists.

Disaster and Recovery

After I wrote the first draft of this article, disaster struck at a most inconvenient time (couldn't Murphy have waited?). I had used my computer to write my term papers in school and had saved the papers on tape. When the time came to print the papers and pass them in, the printer blew a fuse. Okay, I thought, no problem. Just a fuse. Having noticed that the lights had flickered earlier, I thought it was probably just a power surge. I made sure that none of the mechanical parts had stuck, and then I inserted a new fuse. That blew immediately. My printer was not under warranty. Besides, I needed the printer now; I could not afford to wait six weeks for the company to fix it. Well, everything was not against me. With the help of the Operator's

| 64 characters per line. | 0123456789 0123456789 | \@ABCD \@ABCD |
| 32 characters per line. | 0123456789 0123456789 | \@ABCD \@ABCD |
| 80 characters per line. | 0123456789 0123456789 | \@ABCD \@ABCD |
| 48 characters per line. | 0123456789 0123456789 | \@ABCD \@ABCD |
| 120 characters per line. | 0123456789 0123456789 | \@ABCD \@ABCD |
| 172 characters per line. | 0123456789 0123456789 | \@ABCD \@ABCD |

Table 3: Printouts of the Base 2 printer character set. The densities range from 64 characters per line to 132 characters per line.
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We live in a paper-mill world with a form for just about everything. And someone has to fill out all those forms. A computer can make form handling easier because it can be programmed to do the complete job, but if there are many forms then you'll need many programs to fill out these forms—right? Wrong. You can do it with three programs.

The Fill Forms System is composed of three CP/M-based programs. The first, FFGRID-1, is used to determine the line and column position for each data field. The next, FFTABL-1, is used to build a control table that is used by the third program, FFORM-1, for data entry and forms printing. These programs are relatively simple and, best of all, easy to use.

Form designers have been known to ignore the fact that typewriters and printers are generally unable to handle forms with unusual line spacing.

Each of these programs is written in Microsoft BASIC and is designed for use on a CP/M-based system (CP/M versions 1.4 through 2.2).

Determining Field Positions

The idea behind the system is to establish the line and column position for each data field to be printed on the form, then enter the data and print it in the proper position.

Field positions may be determined by measuring the number of lines in the form and finding the width by counting the spaces from the left side of the form (see figure 1). Once line position 1 and column position 1 are established as reference points, all other field locations can easily be determined—if you count correctly.

This method works fine for a form with a few fields, but when there are a number of fields, it is better to draw a grid on the form and then determine the field positions from the intersections of the horizontal and vertical lines of the grid.

Gridding the Form

The FFGRID-1 program is used to produce a grid on a form (see listing 1). The program prints a row of col-

---

Editor's Note: Copies of these programs, on either 8-inch single-density CP/M disks or 51/4-inch single-density disks for North Star CP/M users complete with instruction manual can be obtained for $20 from Elliam Associates, 24000 Bessemer St., Woodland Hills, CA 91367. Programs with the enhancements mentioned in the article are also available.
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APPLESCOPE-HRSS High Resolution and High Speed. Circuit consists of two 16 bit flash analog to digital converters to give a 10 bit dynamic range. The 10 bit converter resolution may be increased by sampling rates up to 7 MHz maximum for signal slew rates less than 5 volts per microsecond. Larger inputs slew rates will reduce the converter resolution to 6 bits unless the signal amplitudes within the 5.5 Volt per microsecond limit. Requires Apple II with disk drive. Software provided on disk includes the basic SCOPE DRIVER package. Price per channel $595

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- Disk Storage: Allows data storage and recovery of acquired data on floppy disks
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BUS RIDER

LOGIC ANALYZER for the Apple II

The BUS RIDER circuit card simply adds the Apple II peripheral bus and allows real time tracking of program flow. Software provided on EPROM allows setup of trace parameters from the keyboard and read back of dissected state after a program has been traced.

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The BUS RIDER is an invaluable development tool for anyone working with Apple II or Apple II+ computers.

Price $295

Listing 2: Using the positions determined from the gridded form, the FFTABL-1 program can develop a control table that displays the field name for each piece of data, sets the maximum field length, and enters the exact line and column position for each data field.

```
10  "**********************************
20  "# Variable Definitions#
30  "**********************************
40  PRINT: "FFTAB1-BAS"
50  PRINT: "FillForm Table Program"
60  PRINT: "Copyright 1983 by Ellem Associates"

70  "* This program builds or updates a
80  "* control table file that is used
90  "* with FFORM-1.BAS
100  "*  "MICROSOFT BASIC"
110  "*  "Set for 100 records

510  "#  "Dimension arrays, Set flags and Initialize#
520  "#  "variables#
530  "#  "**********************************
540  "#  "**********************************
550  "#  "**********************************
560  "DIM LCS(3),LNS(100),COLS(100),LNS(100),FDWNAS(100)
570  "PALSET=0: TRKS=1
580  "NORCD=0:
590  "CPYFLO-PALSER
600  "RFIL=5,FSER
610  "DFP+PALSER
620  "EKPLO+PALSER
630  "DEF PROM(0:2)=LEFTS(A$1)
640  "COLS="No No No Len Field Name"
650  "LCLS(1):""Line No.":" LCLS(2):"Column No.": LCLS(3):"Length"
660  "INV$="Invalid": PFLS=""""= "
670  "CHDDS(1)="VALID COMMANDS": CHDDS(2)="
680  "CHDDS(3)="DF = deletes item no. 6"'
690  "CHDDS(4)="II = allows record to be inserted at item no. 4"
700  "CHDDS(5)="SH = allows new item to replace item no. 6"
710  "CHDDS(6)="L = Lists all items"
720  "CHDDS(7)="L = Lists item no. 6"
730  "CHDDS(8)="L - Lists Range of Items"

1000  "**COMMAND MODE**
1010  "# This section directs the control of the
1020  "# program."
1030  "#  "**********************************
1040  "#  "**********************************
1050  "#  "**********************************

1060  "PRINT
1070  "INPV "Build Table, Update Table, List Table or END (B, U, L or E): ",AS
1080  "IF FMLS(0):="B" GOTO 1130
1090  "IF FMLS(0):="U" GOTO 1140
1100  "IF FMLS(0):="L" GOTO 1160
1110  "IF FMLS(0):="E" GOTO 7050
1120  "GOTO 1050
1130  "GOSUM 2190: GOTO 1050
1140  "GOSUM 1560: IF AS="E" GOTO 1050
1150  "GOSUM 4090: GOTO 1050
1160  "GOSUM 4750: IF AS="E" GOTO 1050
1170  "GOSUM 5860: GOTO 1050

1060  "#READ CONTROL TABL FILE"
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- Provision to expand to 256K using 846 by 1 chip.

32K Static RAM 'Uniselect: 3'

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- Fully Static using 72 by 8 NMOS chip.
- 10 or 24 bit address
- 8/18 bit wide data
- Bank Select by port and bit in 32K block.
- Two 16K block addressing with window capability in 2 increments.
- EPROM can be mixed with RAM.
- Fast access - 250ns from address valid - will run with 260, 2600 to 4mhz, 8080, 8086, 8088 or 80286 in static without West States.
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- 16US-32 32000 A11 A21 2579
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- 16US-128 128000 A11 A21 2579
- 16US-256 256000 A11 A21 2579
- 16US-512 512000 A11 A21 2579
- 16US-1024 1024000 A11 A21 2579
- 16US-2048 2048000 A11 A21 2579
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- 16US-1048576 1048576000 A11 A21 2579
- 16US-2097152 2097152000 A11 A21 2579
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- 16US-8388608 8388608000 A11 A21 2579
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- 16US-33554432 33554432000 A11 A21 2579
- 16US-67108864 67108864000 A11 A21 2579
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- 16US-268435456 268435456000 A11 A21 2579
- 16US-536870912 536870912000 A11 A21 2579
- 16US-1073741824 1073741824000 A11 A21 2579
- 16US-2147483648 2147483648000 A11 A21 2579
- 16US-4294967296 4294967296000 A11 A21 2579
- 16US-8589934592 8589934592000 A11 A21 2579
- 16US-17179869184 17179869184000 A11 A21 2579
- 16US-34359738368 34359738368000 A11 A21 2579
- 16US-68719476736 68719476736000 A11 A21 2579
- 16US-137438953472 137438953472000 A11 A21 2579
- 16US-274877906944 274877906944000 A11 A21 2579
- 16US-549755813888 549755813888000 A11 A21 2579
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Listing 2 continued:
4050 "** Item No. The "L" (list) by itself will
4060 "** list the whole CONCTRL Table. "Lj<" lists
4070 "** item #. "Li<" lists a range of item Nos."
4080 "**
4090 "**
4100 "**
4110 PRINT: PRINT "<UPDATE MODE>:" PRINT
4120 INPUT * Replace, Delete, List, END or ?: |Ig, R, D, L, R or P |?: "A$"
4130 EOD $?PiDS(K)=' THEN RETURN
4140 IF PLD(|Q<)="?" THEN RETURN
4150 EDPL*TONK, DBPC="O"
4160 CRDS+PLD(|S|)=' AS$HID$(AS, Z)
4170 FOR K=1 TO 5
4180 IF LHEDA)-=IND""+(KI, L), GOTO 4190
4190 "Valid entry?
4200 NEXT: GOTO 4110
4210 IN{ REP LELI LIST ?
4220 NEXT: GOTO 4110
4230 "LIST COMMANDS"
4240 "FOR K=1 TO 8: PRINT CRDS(K):"
4250 "NEXT"
4260 "RETURN"
4270 "INSERT ITEM"
4280 /*---------------------------*/
4290 "** Records are always inserted ahead of the **
4300 "** item number used. Records are moved up to
4310 "** room to insert the new record. The Max
4320 "** record counter is incremented.
4330 "**---------------------------*/
4340 /*---------------------------*/
4350 IF LHENA)=1 OR LHEDA)=0 GOTO 4500
4360 "** Test for valid Rec #
4370 GOTO 4550
4380 IF LHENA)=1 OR LHEDA)=0 GOTO 5570
4390 "** Get record number
4400 "** Set Rec # & display
4410 "** Increment Rec count
4420 "**---------------------------*/
4430 "DELETE ITEM"
4440 /*---------------------------*/
4450 "** Records are moved down to overlay the item#
4460 "** being deleted. The Max record counter is #
4470 "** decremented.
4480 "**---------------------------*/
4490 IF LHEDA)=1 OR LHEDA)=0 GOTO 5570
4500 "** Get record number
4510 "** Set rec # & display
4520 "** Record changed
4530 "** Move all records down
4540 "** Line number
4550 "** Set Counter
4560 "**---------------------------*/
4570 "REPLACE ITEM"
4580 /*---------------------------*/
4590 "** The new record replaces the old
4600 "**---------------------------*/
4610 IF LHEDA)="A$"
4620 "** Test for valid Rec #
4630 GOTO 5560
4640 "** Get record number
4650 "** Set rec # & display
4660 "** Set Counter
4670 "**---------------------------*/
4680 "LIST ITEMS IN UPDATE MODE"
4690 /*---------------------------*/
4700 "** Lists All items, Single item or a range of #
4710 "** Items depending on the parameters entered
4720 "**---------------------------*/
4730 PRINT: DBPS="O"
4740 IF AS<=" ?" THEN DBPS="O":TOPS+NOREC:
4750 GOTO 4850
4760 "** Test for "
4770 IF AS<="?" THEN LHEDA)=IND""+(KI, L), GOTO 4850
4780 "** Set low rec number
4790 IF TOPS+<1 THEN TOPS+1:
4800 "**---------------------------*/
4810 IF TOP$HID$(AS, Z)="?" THEN RETURN
4820 "** Set hi record number
4830 IF TOPS+<1 THEN TOPS+1:
4840 "**---------------------------*/
4850 IF TOPS+<1 THEN TOPS+1:
4860 "**---------------------------*/
4870 IF LHEDA)="A$"
4880 "** Test for "
4890 IF AS<="?" THEN LHEDA)=IND""+(KI, L), GOTO 4850
4900 "** Set low rec number
4910 IF TOPS+<1 THEN TOPS+1:
4920 "**---------------------------*/
4930 IF TOPS+<1 THEN TOPS+1:
4940 "**---------------------------*/
4950 IF LHEDA)=1 OR LHEDA)=0 GOTO 5570
4960 "** Get record number
4970 "** Set Rec # & display
4980 "** Record changed
4990 "**---------------------------*/
5000 "LISTS OR PRINTS RECORDS IN COMMAND MODE"
5010 /*---------------------------*/
5020 "** Lists or Prints the complete Control Table
5030 "**---------------------------*/
5040 "**---------------------------*/
5050 "**---------------------------*/
the program issues only a carriage return and waits for a response. If your printer includes a line feed, you will have to crank the form back one line before repositioning. When the form is aligned satisfactorily, the program prints the grid on the form. Figure 2 shows a sample standard purchase-order form that has been gridded with the FFGRID-1 program.

Building a Forms-Control Table

Using the gridded form, you can determine the line and column positions to be used in building a control table (see listing 2). At the same time, the maximum length for each field can be specified.

Listing 3 shows the control table created with the FFTABL-1 program for the purchase-order form. This control-table file will also be used by the FFORM-1 program to display the field names for data entry, determine the maximum field length, and provide the line and column position for each data field.

FFTABLE-1, like the other programs, scrolls up from the bottom of the screen, so no cursor positioning is required.

When the FFTABL-1 program comes up in the command mode, you are given the choice of building a new control table, updating or changing an existing control table, listing an existing control table to the screen or printer, or ending the program and writing out the control table to disk. The program always returns to the command mode after each mode is finished.

Build Mode: When the Build mode is entered, a column heading is displayed, and the user is prompted for the heading (Item Pg Col Fld No No No Len). The program issues only a carriage return, so no cursor positioning is required.

Text continued from page 222:
played with item number 1 on the next line. After each entry is made, the item number is incremented by one. An entry consists of the line number, the column position, the maximum field length, and a field name (see figure 3). The field name is displayed by the FFORM-1 program for data entry. Commas are required as delimiters between fields.

While in the Build mode you may reenter the previous field by entering a < or go back to any previously entered item by entering < N, where N is the item number. The program issues an error message if N is less than 1 or greater than the largest item number. The Build Mode is terminated by entering the word END.

List Mode: After the Build mode is ended, you may list the control table on the screen or print the table. The program lists 18 lines on the screen and requests a carriage return before listing the next 18 lines. If printed, the program takes care of column headings for a 66-line page. A previously prepared control table can also be read and listed.

Update Mode: In the Update mode you can:

• Insert: Enter the code IN, with N being the item number of the record to be inserted. If 19 is used, item 9 will be renumbered to 10, 10 will be moved to 11, etc. The inserted record becomes item 9. All previous records are moved up to make room for the insertion. Item numbers greater than N will be incremented. To append records to the end of the file use L to insert an item number greater than the highest item number in the file or return to the Command mode and use the Build mode.
• Replace: The entry of RN will allow a new entry for item N. This entry replaces the existing record with the new record.
• Delete: DN causes item N to be deleted. All records will be moved down. Item numbers greater than the N used will be decremented.
• List: The list commands allow you to L all items, L # a single item, or L # - # a range of items (# is the number of an item).
• End: END terminates the Update mode and returns the program to the Command mode.

Valid Entries
The fields that make up a record are entered as a string, then broken up into individual fields. This allows use of < and END, which would never work in BASIC if the line-number field was a numeric field. The program edits each record to make sure it is valid by

• Checking for commas as delimiters between fields
• Checking for line or column positions less than 1
• Checking to make sure that line numbers increment (for example, you cannot insert line number 20 ahead of line number 15)
• Checking to make sure that fields on a line do not overlap (a field starting in column position 20 that is 20 characters long cannot be followed by a field starting in column 30)
• Issuing error messages when the record is not valid and displaying the same item number again for a correct entry

Once a control table is built, it can be changed by running the control-
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Circle 217 on inquiry card.
table file through the FFTBAL-1 program. Use the Update mode to insert, delete, or replace the line and column positions that need adjusting so that the data fields will fit properly on the form.

Filling in a Form
After building a control table, the FFORM-1 program is used to enter the data to be printed on the form (see listing 4). When the program is loaded it goes into the Command mode and gives you the following options:

- **Build**: Build new data arrays; these may be printed or written to disk.
- **Change**: Change the data in the data array or data file (fix errors).
- **List**: List the data-array file, showing the line and column position and data for each field. The listing may be displayed or sent to the printer. You can specify that the whole file, a single field, or a range of fields be listed.
- **Print**: Print the form on the printer or display the data on the screen as it would look on the form.

While in the Command mode, the FFORM-1 program functions the same as the other two programs. User options include:

- **Build**: The control table that provides the line and column positions and field names is first read into an array. The program then displays the first field number and field name, together with underscores corresponding to the maximum field length. You enter the data for that field and hit the carriage return. The program will display the field number and field name for the second field. For blank fields, a carriage return is entered. The use of the < and <N for reentering data is the same as in the FFTBL-1 program. If you want to stop before reaching the end of the file, enter <END to go back to the Command mode.

Form designers have been known to ignore the fact that typewriters and printers are generally unable to han-

---

**Listing 4: The FFORM-1 program prints out the form or allows you to enter or change data in the form.**

```
10 "**************************************************************************
20 **
30 ** PRINT: PRINT
40 PRINT "FORM-1.BAS" "**
50 PRINT "Filling Form and Print Program" **
60 PRINT "Copyright 1981 by Elliam Associates" **
70 **
80 ** This Program Builds a Form File **
90 ** and/or Fills Out a Form - uses **
100 ** a control table built with **
110 ** FFBL1 **
120 *
130 **
140 "Program set for 100 fields"
150 **
160 **INITIALISATION**
170 **
180 ** Dimension arrays, Set flags and Initialize **
190 ** variables **
200 **
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2020 **
2030 **
2040 **
2050 **

Text continued on page 236

Listing 4 continued on page 234

---

232 March 1981 © BYTE Publications Inc
Look What Apparat has for your IBM Personal Computer.

Apparat announces our initial line of add-on boards for your IBM Personal Computer. We are committed to further product introductions to enable you to build on your new IBM system.

**Add Functionality and Capability with These New P.C. Boards**

Apparat has the following products available for delivery in the first quarter 1982:

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IBM Personal Computer is a trademark of IBM.
BASIC B+™ is!

Delphic Systems has merged its 280 BASIC with FairCom's MICRO BASIC™ to produce BASIC B+,™ the first all purpose interpreter featuring a B-TREE file structure implemented using NEW commands. No more messy CALLS or difficult assembly language interfacing! Instead, use the following BASIC B+™ functions to manage an index without ever reorganizing the file:

BOPEN BCLOSE NEWB
KILL FINDB GETB
NEXB PREVB STATS

In addition, BASIC B+™ was written using 280 code in order to minimize size and enhance speed performance.

Features & Requirements
- Search a 10,000 entry index in one second
- No index reorganization needed
- Uses fast and compact 280 code
- CP/M® Versions 1.4 or 2.2
- 12 Digit precision
- Program Chaining
- Read only file protection
- Sequential and random files

Listing 4 continued:

2060 "** number by entering "<N" where "N" is the **
2070 "** field number. Each field name is display**
2080 ed followed by a number of underscores.
2090 "** The number of underscores corresponds to **
2100 "** maximum length of the field. If the **
2110 "** entry is to long an error message is dis-**
2120 "** played and the field name in displayed. **
2130 "** if no data is to be entered in a field **
2140 "** then enter a c/r. To escape before all **
2150 "** fields are filled enter "END".
2160
2170 -
2180 GDUB 1270
2190 PRINT "<C" "" C R E L " " N D U L M " " G " " N " " T A D " " C • " "
2200 IF FUNC THEN C=NOHDRAT: GOTO 2220
2210 C=Cl+1: C=c
2220 RFL=FALSE: CTPLGR=FALSE
2230 PRINT TAB(1)("FUSSING (C1) (+) *): CHR(13): *="FILE NO.
2240 PRINT ""CIRC" ++ ""*STRS(C1,A) ++ ": "FILE MARK(C1) ++ """
2250 LINE INPUT ""N": AS
2260 IF AS=""END"" THEN NOHDRAT=C-1: RETURN
2270 IF AS=""COSTD:" GOTO 2400
2280 IF LEFTS(A$)=""<"" THEN CTPLGR=TRUE: GOTO 2380
2290 "Ck for new- or
2300 IF LEE(A$)=""<""+1 THEN GOTO 2340
2310 IF LEE(A$)=A$ THEN GOTO 2340
2320 IF C=Cl THEN GOTO 2340
2330 GOTO 2340
2340 C=VAL(MIDS(A$)): IF C<1 THEN C=1
2350 IF UDD=""TRUE"" AND C>NOREC THEN C=NOREC
2360 IF URDD=""FALSE"" AND C>Cl THEN C=Cl
2370 RFL=TRUE: GOTO 2240
2380 IF LEN(A$)=VAL(LNS(C)): GOTO 2400
2390 PRINT ""CIR<"++L: C=": GOTO 2420
2400 FINES(C1)=LNS(C1): FCOL(C1)=COLS(CB)
2410 PUT C="): =F
2420 FUC=TRUE: IF C>NOREC THEN RETURN
2430 IF RFL THEN C=C-1: RFL=FALSE
2440 IF EXPLOD THEN RETURN ELSE GOTO 2220
2450
4000 CHANGE
4010 ""***************
4020 ** This routine allows a user to change the **
4030 ** in an existing file by file number. If **
4040 ** no file number is supplied from the **
4050 ** Command mode the program requests a field **
4060 ** number. The old data is displayed so the **
4070 ** user can see what was in the field. Also **
4080 ** the line and column position are displayed**
4090 **
4100 -
4110 GDUSB 9050: IF A$="•" THEN RETURN
4120 GDUSB 1570: IF A$="" THEN RETURN
4130 EDPLUS=FALSE
4140 A$=MIDS(CMD$),2)
4150 IF VAL(A$)=0 OR VAL(A$)>NOREC THEN INPUT "Record #: ": AS
4160 IF A$="" THEN RETURN
4170 IF VAL(A$)=0 AND VAL(A$)<NOREC GOTO 4150
4180 "Range test field no. 
4190 IF A$="" THEN RETURN
4200 GDUSB 4850: GDUSB 2240: RETURN
4210 "List control
4220 "** This section sets up the parameters for a **
4230 ** listing. All fields, single field or a **
4240 ** range of fields depending on the **
4250 ** entered.
4260 -
4270 GDUSB 9050: IF A$="" THEN RETURN
4280 GDUSB 1570: IF A$="" THEN RETURN
4290 EDPLUS="": DFBH="")
4300 A$=MIDS(CMD$),2)
4310 IF A$="" THEN BOTS=1+TOPA=NOHDRAT: GOTO 4660
4320 "No prame - All **
4330 IF A$="": IF JB=0 THEN LENDH=VAL(A$): GOTO 4660
4340 BOTS=VAL(LEFTS(A$),JB=11): IF BOTS<1 THEN BOTS=1 **
4350 "Read column number 1 **
4360 IF TOPS=VAL(LEFTS(A$),JB=11): IF TOPS<TOPA THEN TOPS=TOPA
4370 "Read column number 1 **
4380 IF BOTS<TOPS THEN GDUSB 4770: RETURN **
4390 "Go list
4400 GOTO 4670
4410 IF LENDH=0 AND LENDH=NOHDRAT GOTO 4680
4420 "Range test of fields **
4430 PRINT: PRINT "Line No. Out of Range": RETURN **
4440 "Error message **
4450 BOTS=LENS: TOMP=LENS: GDUSB 4770: RETURN **
4460 "Set Rec & Display **
4470 "** List data file. **
4480 "** Displays or prints the selected part of **
4490 "** the data file. Field numbers, line nos. **
4500 "** column numbers and data are output. A **
4510 "** Column heading is visible when printing. **
4520 -
4530 PRINT "Display, Print or both (D, P or B) ": AS
4540 PRINT: DFBH="": IF A$="" THEN RETURN
4550 IF A$="" THEN PRINT CMD$: PRINT CMD$: GOTO 4650
4560 IF A$="" AND A$="": GOTO 4700 **
4570 "Position paper: c/r ": AS
4580 GDUSB 8510: "Reading
4590 SCRD: FOR T=TOPS TO TOPA **
4600 A$="" RIGTHS: "** RIGTHS(T4),4): **
4610 "Field number **
Listing 4 continued:

4840 IF DPBS="P" GOTO 4940
4850 PRINT AS;FDESC(1);TAB(15-LEN(FCOLS(1))); 
4900 PRINT FCOLS(1);TAB(20);FPDTAS(1)
4910 IF DPBS="Y" GOTO 4950
4920 LCDTM=LCNTM+1: IF SCNTK<=18 GOTO 5000 "Screen line count 
4930 INPUT "c/t" A6: SCNTK=0: GOTO 5000
4940 IF DPBS="G" GOTO 5000
4950 LPRINT AS;FDESC(1);TAB(15-LEN(FCOLS(1))); 
4960 LPRINT FCOLS(1);TAB(20);FPDTAS(1)
4970 LCDM=LCNTM+1: IF LCNTM<=62 GOTO 5000 "Test for end of page 
4980 FOR %=LCNT TO 66: LPRINT "End of page spacing 
4990 NEXT: LCNTM=0: GOSUB 8910 "Ending
5000 NEXT RETURN
7000 "WRITE DATA FILE 
7010 "This routine writes the data in the arrays. 
7020 "* to a sequential file. 
7030 
7040 
7050 
7060 GOSUB 1560 "Get control tab 
7070 INPUT "Write File (Y or N): ",AS 
7080 IF AS="Y" GOTO 7100 
7090 IF AS="N" GOTO 7070 ELSE GOTO 8090
7100 INPUT "Write to: Drive A or B", AS 
7110 PRINT AS: IF AS="A" GOTO 7070 
7120 IF DRVS="A" AND DRVS="B" GOTO 7100 
7130 INPUT "Enter File Name: ",FILS 
7140 IF FILS="" THEN FILES=FILE 
7150 OPEN ",I,MODE="FIL$". FILE 
7160 PRINT "Writing ([""HOTAS(1) "] Records"
7170 FOR %=1 TO HONTM 
7180 PRINT "$$.LINES(1);",CH$COLS(1)); ": Line 
7190 WRITE "$$.LINES(1): Data field " 
7200 NEXT 
7210 CLOSE 
7240 
8090 "AGAIN " 
8020 "This section allows the user to: 
8030 1. Build another data file. 
8040 2. Print another data file. 
8060 4. Without leaving the program. 
8070 
8080 
8090 INPUT "Again (Y or N): ",AS 
8100 IF AS="N" THEN END 
8110 IF AS="Y" GOTO 8090 
8120 INPUT "Same Control Table (Y or N): ",AS 
8130 IF AS="N" GOTO 8090 
8140 IF AS="Y" GOTO 8090 
8150 IF AS="Y" GOTO 8130 
8160 INPUT "Same Data File (Y or N): ",AS 
8170 IF AS="N" THEN FDTS=FALSE: GOTO 1060 
8180 IF AS="Y" GOTO 8110 ELSE GOTO 1070
8200 "PRINT CONTROL 
8300 "This routine uses a line counter LNCM. 
8400 "when the line number C1N in the record. 
8500 "matches LNCM the data is printed at TAB 
8600 "position C1N. After the first data field 
8700 "is printed the program allows the user to: 
8800 "1. Realign the Form if necessary. 
8900 
9000 GOSUB 9050: IF AS="Y" THEN RETURN 
9010 PRINT 910 
9200 INPUT "Display, Print or Both (D, P or B): ",AS 
9300 IF DPBS="A": IF AS="Y" THEN RETURN 
9310 IF DPBS="Y" THEN LPRINT "Clear Printer Buffer 
9320 IF DPBS="D" THEN INPUT "Position Form: ",AS 
9330 IF C1N=LNCM, C1N=SPACN, CNTR=PRINT LINE COUNTER 
9340 CNTRM=CNTRM: CNTRM=PRINT LINE COUNTER 
9350 CNTRM=-CNTRM: ORCH=ORCH: 
9360 IF LNCM(FPDTAS(CNTRM)); C1N=VAL(FCOLS(CNTRM)) 
9370 IF LNCM(FPDTAS(CNTRM)); GOTO 8750 
9380 IF C1N=LNCH1 1 GOTO 8640 
9390 LNCM=LNCM1 
9400 IF DPBS="D" OR DPBS="B" THEN PRINT: GOTO 8600 
9410 IF DPBS="P" OR DPBS="B" THEN LPRINT: GOTO 8600 
9420 GOSUB 8460 
9430 PRINT Field 
9440 ON ORCH GOTO 8750 
9450 PRINT 9460 IF DPBS="Y" THEN AS="Y": GOTO 8730 
9470 INPUT "Alignment OK, Ck Next Field or Quit (Y, C or Q): ",AS 
9480 IF AS="Y" GOTO 8730 
9490 IF DPBS="Y" THEN PRINT 
9500 IF DPBS="P" THEN LPRINT RETURN 
9510 IF DPBS="Y" THEN AS="Y": GOTO 8730 
9520 "Test valid entry 
9530 ON ORCH=ORCH: 
9540 IF C1N="Y" THEN ORCH=1: 
9550 IF CNTRM=CNTRM=1: IF CNTRM=CNTRM GOTO 8580 
9560 PRINT: IF DPBS="D" THEN LPRINT: RETURN 
9570 PRINT 9580 
9700 "PRINT FIELD 
9790 Listing 4 continued on page 236
Listing 4 continued:

8800 ** Check for "STOP to allow for repositioning"
8810 ** the form. Print data field at line number**
8820 ** and column Position.
8830 ****************************************
8840 IF FDDAS(CNT)="<STOP" GOTO 8870 ' Test for reposition
8850 IF FDDAS="*" THEN PRINT TAB(C28);FDDAS(CNT); 'Display field
8860 IF FDDAS="*" THEN PRINT TAB(C28);FDDAS(CNT); 'Print field
8870 RETURN
8880
8890 "HEADING
8900 LPRINT "LPRINT "Data File Name=":LPRINT Ch01$; LPRINT "Form File" Print column heading
8910 LCNT=7: RETURN 'Set line counter
8920
8930 "READ DATA FILE
8940 **************
8950 ** This routine reads a data file and places **
8960 ** the data in appropriate arrays.**
8970 **
8980 **
8990 IF FDDAS THEN RETURN
9000 INPUT "Form File Drive (A or B):",AS: DRVS=AS
9010 IF DRVS="*" THEN RETURN
9020 IF DRVS="A" AND DRVS="B" GOTO 9070
9030 INPUT "Enter Form File Name=":FILS
9040 IF FILS="<" GOTO 9070
9050 OPEN "A:".DRVS">-1;FILE="">FILS">-1;FILE=">
9060 PRINT: PRINT "Reading )*FILS">-1;FILE="> Form File"
9070 FOR I%=1 TO 1000
9080 IF EOF(I%) GOTO 9300
9090 INPUT J$;FILS$ (I%)
9100 LINE INPUT 1$ .AS
9120 AS=HID$(AS;2) ANDAS=LEFT$(AS;LEN(AS)-1) 8 Strip quotes from string
9130 NEXT
9140 NEXT J%
9200 NODTA=1=1-1
9210 PRINT: PRINT NODTA$ "Form File Entries Read": PRINT "File"
9220 FDTAS=TRUE
9230 CLOSE 1
9240 RETURN

Text continued from page 232.

If the print program can be stopped so the form can be repositioned, you will enter <STOP for field name and the program will stop on the selected line at the selected column. Reposition Form will be displayed on the screen.

Once back in the Command mode the data can be changed, listed, written to disk, displayed on the screen, or sent to the printer.

Change: If the change command is used when the program starts up, you will be requested to enter the file name for a previously saved data file and control table. If you enter C while using the FFORM-1 program, it will request the field number to be changed. If you enter C, the program will display the current data for field N. You can then change the data for that field and the program will be ready for the next command.

List: The list command, like the change command, can be used with a
Introducing The FinalWord!

Word processing that goes beyond the stars.

How could anyone call their word processor The FinalWord? Take the best features of the most popular word processors, combine them and add a few more in one text editor/formatter and you'd be off to a good start. Then, write the program in C to allow user customization and make it capable of supporting any printer on the market and you'd be ahead of everybody else. If you went one step further and made your word processor transportable from one terminal to another you'd have—The FinalWord.

Supports multiple printers: The FinalWord allows you to produce high-speed draft copies on one printer, and letter-quality on another. It also means you'll never need another version just because you bought a new printer.

User-installable on different hardware: With The FinalWord you can upgrade your system and still have a familiar screen display. And since we've written The FinalWord in C, new versions are available almost as soon as new computers.

Features that go beyond the stars: Look at what you get with The FinalWord: automatic generation of Table of Contents, Index, footnoting and chapter/section numbering; enhanced command sets (delete/move a letter, word, sentence, paragraph, page); multiple buffers and windows, deletion recovery, true proportional spacing and more. And because we wrote The FinalWord to be easily reconfigured for different systems, our price can be lower.

<table>
<thead>
<tr>
<th>Features</th>
<th>The FinalWord</th>
<th>WordStar</th>
<th>Magic Wand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-Screen Editing</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Directory Access while Editing</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Simultaneous Printing while Editing</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>External Commands while Editing</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Video Highlighting</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Automatic Footnotes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<tr>
<td>User-Defined Commands</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<tr>
<td>Multiple File Editing</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Deletion Recovery</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Supports Multiple Printers</td>
<td>Yes</td>
<td>No</td>
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</tr>
<tr>
<td>Crash Recovery</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Dynamic Include Files</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Suggested Retail Price

<table>
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<tr>
<th>The FinalWord</th>
<th>WordStar</th>
<th>Magic Wand</th>
</tr>
</thead>
<tbody>
<tr>
<td>$300</td>
<td>$495</td>
<td>$395</td>
</tr>
</tbody>
</table>

The FinalWord requires a 56K CP/M system and video terminal with cursor positioning character sequences. It is presently available in 8" standard format for the TRS-80 Model II, Vector Graphics and A-series Systems. There are compatible versions for the HP-125, Xerox 820, Cromemco, Micropolis, Ohio Scientific and Dynabyte Systems, and there are 5¼" versions for the Heath/Zenith Z-89, Northstar, Apple and Superbrain. Coming Soon: The FinalWord for the IBM Personal Computer.

The FinalWord is available through leading retailers, Westico, and Discount Software, or directly from:

Mark of the Unicorn
PO BOX 423
Arlington, Massachusetts 02174
(617) 489-1387

Dealer and OEM inquiries invited. Call for delivery schedule. Reserve yours now!
Listing 5: A sample data file developed with the FFORM-1 program. The data is also shown in the completed form in figure 4.

Data File [MODE]

<table>
<thead>
<tr>
<th>Item Line</th>
<th>Col No</th>
<th>No. No.</th>
<th>Field Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>4</td>
<td>10</td>
<td>Easyoff Riding Stables</td>
</tr>
<tr>
<td>2.</td>
<td>4</td>
<td>44</td>
<td>Contacts</td>
</tr>
<tr>
<td>3.</td>
<td>4</td>
<td>57</td>
<td>Fred Horsesman</td>
</tr>
<tr>
<td>4.</td>
<td>5</td>
<td>10</td>
<td>133 Pony Lane</td>
</tr>
<tr>
<td>5.</td>
<td>5</td>
<td>57</td>
<td>(555) 123-4567</td>
</tr>
<tr>
<td>6.</td>
<td>6</td>
<td>10</td>
<td>123 Pony Lane</td>
</tr>
<tr>
<td>7.</td>
<td>9</td>
<td>10</td>
<td>Havlink Supply Company</td>
</tr>
<tr>
<td>8.</td>
<td>9</td>
<td>58</td>
<td>Easyoff Riding Stables</td>
</tr>
<tr>
<td>9.</td>
<td>11</td>
<td>10</td>
<td>456 Whitehorse Blvd.</td>
</tr>
<tr>
<td>10.</td>
<td>11</td>
<td>58</td>
<td>Back Gate</td>
</tr>
<tr>
<td>11.</td>
<td>12</td>
<td>10</td>
<td>376-9</td>
</tr>
<tr>
<td>12.</td>
<td>12</td>
<td>10</td>
<td>Quarters, AZ 1002</td>
</tr>
<tr>
<td>13.</td>
<td>13</td>
<td>58</td>
<td>Mustang, AZ 10001</td>
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<tr>
<td>14.</td>
<td>17</td>
<td>2</td>
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</tr>
<tr>
<td>15.</td>
<td>17</td>
<td>20</td>
<td>376-9</td>
</tr>
<tr>
<td>16.</td>
<td>17</td>
<td>37</td>
<td>Livery Wagon</td>
</tr>
<tr>
<td>17.</td>
<td>17</td>
<td>51</td>
<td>Y'esterday</td>
</tr>
<tr>
<td>18.</td>
<td>17</td>
<td>70</td>
<td>Ho/Da/Yr</td>
</tr>
<tr>
<td>19.</td>
<td>17</td>
<td>70</td>
<td>12</td>
</tr>
<tr>
<td>20.</td>
<td>20</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>21.</td>
<td>20</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>22.</td>
<td>20</td>
<td>20</td>
<td>Soft Pillow</td>
</tr>
<tr>
<td>23.</td>
<td>20</td>
<td>64</td>
<td>2.75</td>
</tr>
<tr>
<td>24.</td>
<td>20</td>
<td>74</td>
<td>each</td>
</tr>
<tr>
<td>25.</td>
<td>22</td>
<td>5</td>
<td>each</td>
</tr>
<tr>
<td>26.</td>
<td>22</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>27.</td>
<td>22</td>
<td>20</td>
<td>Saddle Glue</td>
</tr>
<tr>
<td>28.</td>
<td>22</td>
<td>64</td>
<td>37.50</td>
</tr>
<tr>
<td>29.</td>
<td>22</td>
<td>74</td>
<td>case</td>
</tr>
<tr>
<td>30.</td>
<td>24</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>31.</td>
<td>24</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>32.</td>
<td>24</td>
<td>20</td>
<td>Saddle sore liniment</td>
</tr>
<tr>
<td>33.</td>
<td>24</td>
<td>64</td>
<td>27.80</td>
</tr>
<tr>
<td>34.</td>
<td>24</td>
<td>74</td>
<td>box</td>
</tr>
</tbody>
</table>

Figure 4: The result of the FFORM-1 program. The information on this form is the same as that in the data file in listing 5.

data file or used to list the fields just completed. All the fields may be listed by entering L; a single field can be listed using L1; a range of fields can be listed using LN, where N is the field number (see listing 5 for a sample data file).

The listing of the sample data file created with the FFORM-1 program contains the item number, line position, column position, and data to be printed at that location.

Print: The print command allows you to display either the array data (created by FFORM-1) or field data, formatted as it would look on the form, or the field data can be used to fill in the form on the printer.

When a printout of a form is requested, the program first asks you to position the form, then prints the first field and allows you to reposition the form. If the needed field is more than 100 data fields, the program will stop to allow you to reposition the form. Figure 4 shows the completed purchase order that was printed using sample data fields.

Saving the Data: In the Command mode, the program can be ended by entering E. You then have the option of writing the data arrays to a disk file for future use or rerunning the program.

Depending upon your needs, you can add a number of enhancements to these programs that will make them easier to use, for example:

- Special editing and range checking of data
- Use of the INP statement instead of INPUT to eliminate the need of the carriage return for completely filled fields
- Making a mask that looks similar to the form to be filled in and placing it over the screen—then filling in the data in the mask fields (this enhancement requires the use of a display that has an addressable cursor)

Most of these enhancements could be implemented by expanding the number of fields in the control table, then adding more code to support them.

Summary

The Fill Forms System is a relatively simple set of programs that can be used in a wide variety of situations. They work particularly well in situations where a standard form is required—for insurance agencies, application forms, or government documents. The more complex the form and the more frequently it is used, the more time you'll save by using this system.
"Okay, which entry-level, single-user microcomputer should I own?"
The BOS M System.

"Which multi-user system should I own?"
The BOS M System.

"If I want a larger system with the ultimate in performance and capacity, what should I own?"
The BOS M System Multiprocessor.

"How much more does it cost to own a single-user set-up and upgrade it, than to start with a larger system?"
Not a penny more.

"Can I have diskette, tape, and large rigid disk storage?"
Yes.

"How about really good accounting software?"
The MBSI* package (GL, AR, AP, PR, OE/INV, Sales Analysis — all in COBOL) is probably the best available on any system...this is one you have to see to believe.

"How about Word Processing?"
WordStar®, and others.

"Can I run all the other software I've seen?"
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"Will I have to change the operating system when I expand?"
No, with BOS/TURBODOS****, just upgrade it.

"Well, this is important...will service be available when I need it?"
Yes, with a large dealer network, strategically placed maintenance depots, and fast factory repair turn-around.

"Sounds great! But isn't it too good to be true?"
No...and it's not even expensive! So, why take a chance with somebody else?

"Okay, how can I get one?"
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2835 East Platte Avenue
Colorado Springs, Colorado 80909
In Colorado Call: (303) 634-1541
Toll Free Number: 1-800-525-3898

Inquiries Welcome

Dealer and OEM

APPLICABLE INDUSTRY STANDARDS: S-100 IEEE 696 • RS 232, HDLC, SDLC, Async, Sysx • CP/M** TURBODOS**** • 8"" soft sectored diskettes • ANSI X3/89/15 Tape Cartridge

A really good modem takes a telephone number stored in your computer's memory, dials it, selects the appropriate originate/answer frequencies, and starts communicating at 9600 bits per second (bps). Unfortunately, a really good modem can also cost as much as a good used car.

If you are willing to dial your own telephone, set a manual switch to select originate/answer frequencies, and settle for 300 bps, Commodore's new modem may be an inexpensive solution. In fact, for the price of a moderately good 1200-bps modem, Commodore will sell you its modem and a VIC-20 home computer to go with it.

The modem is the VICMODEM. It is contained in a slim plastic case with an edge connector at one end and a modular telephone jack (for the handset cord) at the other. The edge connector attaches directly to the VIC-20, which has a special telecommunications slot to accept this modem or Commodore's RS-232 interface (see photo 1). (The VIC-20 is named for the Video Interface Chip, which provides the necessary interface between the computer and a television set. The VIC-20 has built-in connectors for a television (RF) and a video monitor. It also has a type-

writer-style keyboard, which is unusual for a computer in this price range.)

The modem is compactly designed on a single circuit board and conforms to the Bell 103 modem frequencies. It uses Motorola modem integrated-circuit chips and has a crystal to ensure frequency stability. Selection of originate or answer frequencies is accomplished manually by setting a small slide switch on the side of the unit. A carrier-detection LED (light-emitting diode) is also provided.

A cassette contains the object code for the interface program VICTERM I. The features included in this software are impressive. They include:

Word wrap: If the word at the end of a line is too long to fit on that line, it

Photo 1: This low-cost modem for Commodore's VIC-20 home computer takes a modular plug from a telephone handset and plugs directly into VIC-20's telecommunications slot. The modem shown here is a prototype with a provisional model number.
Announcing
A Media Event From IMS

The New 8000 SX Micro Computer System With Winchester And Floppy And Tape

Winchester technology brought a tremendous increase in capacity, but it also dumped a big problem in your lap.

How to dump all that data?

Trying to transfer 10 to 40M bytes of data between Winchester and floppies takes an armload of diskettes and a lot of time.

Cartridge tape is fast, but not efficient for random file handling.

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Choose from 10, 20 and 40M byte Winchester subsystems, with error detection and correction, capable of loading a 20K byte system program in less than a second.

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The bulk memory subsystem, an incremental cartridge tape drive, stores up to 17M byte on a single cartridge.

And, of course, the computer itself offers proven IMS top performance and reliability. Compare its full 2-year warranty.

Operating systems include CP/M, MP/M, and the incredibly powerful TurboDOS.

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Telex: 913-386-6051

Circle 186 on Inquiry card.
Product Description

is whisked to the beginning of the next line. This feature is particularly useful for the VIC-20 with its maximum line length of 22 characters. Without this word-wrap feature, the screen would quickly become cluttered with many word fragments at the beginnings and ends of lines. (A 40-character-line software option for the VIC-20 is under consideration. However, it would use a 3 by 5 dot matrix to form the characters and might be difficult to read.)

Half or full duplex: Half duplex means that the "echoplex" used by some data networks is not utilized. Communication still takes place in two directions on two frequency-multiplexed "channels," but the host computer no longer echoes what the user types. Instead, the VIC-20 displays what the user types directly on its own screen. This feature is also menu-selectable.

Color separation: In the half-duplex mode, the software can display what the user types in one color, while displaying the host computer's output in another color. This feature makes user-computer dialogues easier to read.

Data rate: This selection on the menu goes from 0 to 300 bps. Some data-communications aficionados may turn up their noses at a data rate of 300, but most economy modem users do not exceed it. Three hundred bps translates into 300 five-letter words per minute. This is faster than most of us type and faster than a radio announcer can read.

Five parity settings: These are also menu-selectable. They are: even parity, odd parity, parity set to one (mark), parity set to zero (space), and no parity (eighth bit treated as data). This feature goes a long way toward assuring that the modem will make the VIC-20 compatible with most 8-bit-byte transmission schemes.

More on this feature later.

By now, a cartridge with even more features should be available, priced around $50.

If you decide not to buy the VICTERM I software, Commodore provides a free printed copy of a short BASIC program with the modem (see listing 1). You key this program in before dialing and eventually record it on your own cassette. It has none of the features listed above for the VICTERM I software.

What do engineers at large data networks recommend when using an inexpensive modem to connect to their expensive computers? Mike Marburger, Tymnet's Eastern Region Technical Manager, recommends setting parity to zero (space) on the modem and typing control-H immediately after the Terminal Identifier (TID) to disable Tymnet's

At a Glance

<table>
<thead>
<tr>
<th>Name</th>
<th>VICMODEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>Telecommunications for the VIC-20</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Commodore Business Machines Inc. 681 Moore Rd King of Prussia, PA 19406</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Approximately 15 by 10 by 3.75 cm (6 by 4 by 1 1/4 inches)</td>
</tr>
<tr>
<td>Price</td>
<td>$109 95 (includes $9.95 VICTERM I cassette software)</td>
</tr>
<tr>
<td>Hardware Needed</td>
<td>VIC-20, modular telephone, television set or video monitor, cassette recorder</td>
</tr>
<tr>
<td>Software Needed</td>
<td>VICTERM I cassette software or cartridge equivalent</td>
</tr>
</tbody>
</table>

Hardware Options

If you already own an acoustic coupler, it can be used with Commodore's RS-232 interface.

Features

Direct connection to VIC-20 and telephone crystal control, carrier-detect LED, originate/answer switch. With VICTERM I: word wrap, color separation [see text], menu-selectable data rate, parity options, cursor on/off.

Documentation


Audience

Anyone desiring an inexpensive telecommunication device
IMP Debuts
A Generation Beyond MuMath and FORTRAN
Penn Yan-
Programmer/Engineer John Clarke has released his IMP (Instant Mathematical Programming) for use with all UCSD p-System machines, as well as for CP/M users with Pascal/M. The program, which was introduced at $225, permits anyone (yes, a non-programmer) to generate sophisticated Pascal programs to solve complex linear and non-linear equations.

IMP Writes It
The software first simplifies an algebraic problem statement (entered in simple text form), then writes a Pascal source program which, when compiled, gives the user a solution. The compiled program then permits the user to interactively redefine constants or variables, or to maximize given parameters. Reviewers claim this system may replace FORTRAN as the software tool for solving complex linear and non-linear equations.

RADIO SHACK II, III
GET p-SYSTEM
Now Can Share Programs with Apple, DEC and IBM
Penn Yan- PCD Systems, who originally installed the p-System on the TRS-80 Model II have announced release of the complete system for the TRS-80 Model III. The p-System requires a 48K Model III with 2 disk drives. Now Radio Shack users can write programs compatible with Apple, Commodore, IBM (Personal Computer) and DEC machines (and vice versa). A spokesman from the company noted that p-System software for DEC, Atlas, Terek and Apple are already available from PCD Systems, Inc.

Chapin Refuses to Reveal True Meaning of CPR
Penn Yan- Chip Chapin, who recently released his CPR “text formatter” refuses to reveal the true meaning of his new program’s title. CPR, which was designed for use with the UCSD p-System operating system software, takes raw text files produced from the Editor and formats them for printing. At $195, CPR provides sophisticated word processing capabilities for a fraction of the cost.

20% Off List
Penn Yan: PCD Systems is giving purchasers 20% off SoTech Microsystems suggested list price for those who buy a complete UCSD Development System by July 1st. Operating System, File Handler, Screen Editor (with word processing capabilities), system Library, Assembly Code Linker, Pascal Compiler and full documentation is only $800 complete. Compare other systems of this power and capability at three times the price.

UCSD p-System To Burst CP/M’s Balloon
Experts predict 8-Bit to 16-Bit Portability Crucial
Support from IBM, Texas Instruments, Philips, Hewlett Packard, Commodore Announced
San Diego- Sources close to the battle predict that recent release of the master design that allows programs compiled on an 8-bit machine to run unchanged on the new 16-bit micros will give the p-System the “industry standard” status presently enjoyed by CP/M. They say that SoTech and PCD Systems have come up with the most viable system for the 80’s.

Structured Programming lowers Maintenance Costs
P-System structured languages give developers powerful tools. A complete implementation of Pascal (plus many useful extensions) is available, as is FORTRAN-77, which supports the ANSI-77 subset for that language. A new BASIC compiler and a full range LISP interpreter round out the high level languages available. The structured approach to programming eliminates maintenance headaches which plague present users of standard BASIC and FORTRAN systems.

Speed No Longer an issue
Linkage of Code segments in assembly language and/or use of the NATIVE CODE generators give compact code without the sacrifice of speed expected from p-Code interpretation. One can have one’s cake and eat it too!

Dynamic Memory Management
Virtual operating system characteristics with nearly unlimited overlaying of program segments allows the user to run larger programs than other microcomputer operating systems. Program chaining, print spooling, 128K addressing capability and efficient use of system library units, universal screen control coding, and many peripherals configurations are fully supported. Command files, asynchronous I/O processing, p-Code debugger, procedural cross reference and more capabilities are being hailed by thousands of users.

LOGICALC (TM)
moves “Calc” Software to UCSD Environments
LOGICALC (TM) gives spreadsheet capability to all those other micros. Does-Does Regression Analysis-Accepts Database In-Out
Penn Yan- LOGICALC (TM) has swept the Pascal world by storm. Only $295 a complete package.

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For a Catalog of UCSD p-System and Applications Software
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The ADVANTAGE™ desktop computer from North Star is better in every category than either the IBM Personal Computer or the Apple III. Compare for yourself!

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The ADVANTAGE has twice the diskette capacity of either the IBM PC or the Apple III. This means you have twice as much information at hand.

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The ADVANTAGE gives you a higher precision display. A revolutionary software package called BUSIGRAPH™ is provided at no extra charge for preparing graphs, bar charts, and pie charts.

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TWX/Telex (910) 366-7001.

Incredible Advantage Computer Comparison Chart

<table>
<thead>
<tr>
<th></th>
<th>North Star Advantage</th>
<th>IBM Personal Computer</th>
<th>Apple III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microprocessor(s)</td>
<td>8086, 80286</td>
<td>8088 processor</td>
<td>68024 processor</td>
</tr>
<tr>
<td>Graphics Display Resolution</td>
<td>640x240 pixels</td>
<td>640x200 pixels</td>
<td>560x182 pixels</td>
</tr>
<tr>
<td>Dual Floppy Disc Capacity</td>
<td>720K bytes</td>
<td>320K bytes</td>
<td>288K bytes</td>
</tr>
<tr>
<td>Government Desktop Package</td>
<td>Yes, all-in-one enclosure</td>
<td>No, 3 enclosures</td>
<td>No, 3 enclosures</td>
</tr>
<tr>
<td>Business Graphics Software Included?</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<tr>
<td>CP/M Compatible?</td>
<td>Yes</td>
<td>Not Available</td>
<td>No</td>
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<tr>
<td>Languages Supplied by Manufacturer</td>
<td>Basic, PASCAL, DOS, FORTRAN, C</td>
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<td>BASIC, PASCAL</td>
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<tr>
<td>Applications Software Packages Supplied by Manufacturer</td>
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<tr>
<td>Break-Fast Diagnostic</td>
<td>Yes</td>
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<tr>
<td>National On Site Service</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Manufacturer Supplied Printers</td>
<td>Letter quality/medium (186 columns)</td>
<td>Matrix (90 columns)</td>
<td>Letter quality/medium (80 columns)</td>
</tr>
<tr>
<td>Retail Price Per Kilo-Byte of Disk Storage</td>
<td>$25.55</td>
<td>$41.17</td>
<td>$50.57</td>
</tr>
</tbody>
</table>

* Professional configuration: 120K Floppy Disks, Monochrome Display, Keyboard, CPU, 64K bytes (or minimum) RAM Memory, and Printer Interface.


FOLLOW THE STAR
NorthStar
Circle 281 on Inquiry card.
Product Description

Listing 1: A simple BASIC program that allows the Commodore VIC-20 to communicate using the modem. VICTERM I, a more sophisticated program, is available at extra cost.

```
100 OPEN5.2,3,CHR$(6);DIMF(255);T(255)
210 FORJ=37:T064:R(J)="";PT(J)=0:CT=0
220 FORJ=1:T026:R(J)="";PT(J)=0:CT=0
230 FORJ=37:T064:R(J)="";PT(J)=0:CT=0
240 FORJ=1:T013:R(J)="";PT(J)=0:CT=0
```

Here’s 256K Performance At an Economy Price!

InterSystems has done it again! The new Series III operates at 6 MHz and includes software to fully utilize the 256K high speed memory. You can buy it from BRIDGE for $5545—check out these features.

- Operating system software that effectively utilizes the 256K RAM
- CP/M 2.2 and Cache BIOS™ that speeds operation up to 4 times
- 6 MHz CPU with powerful 1 MByte memory management system
- 256K memory—6 MHz with parity and 8/16 bit transfers
- S-100 Bus follows IEEE 696 Standards
- Two serial ports and four parallel ports with two interrupt controllers
- Dual double-density soft-sectored SJ,4" drives (0.8 MByte total)
- Easily upgraded to 6-user MP/M system.

But we are sure that you want turnkey operation, so we have packaged a system that includes:

- InterSystems Series III Computer P/N CB-256/625
- BMATE™ screen oriented text editor/word processor
- Zenith Z-19 or Televideo 950 Terminal.

INTRODUCTORY OFFER

<table>
<thead>
<tr>
<th>ORDERING INFORMATION</th>
<th>List</th>
<th>Special Offer</th>
</tr>
</thead>
<tbody>
<tr>
<td>InterSystem CB-256/625 Computer with software</td>
<td>$6545</td>
<td>$5545</td>
</tr>
<tr>
<td>As above with BMATE™ and Zenith Z-19 Terminal</td>
<td>7590</td>
<td>6495</td>
</tr>
<tr>
<td>As above with BMATE™ and Televideo 950 Terminal</td>
<td>7935</td>
<td>6725</td>
</tr>
</tbody>
</table>

For something still more powerful, ask about the BRIDGE enhanced systems, including the FORTRAN Development and the Compiler systems, based on InterSystems computers.

Call to order, or send for complete information. Dealer inquiries invited.

InterSystems

Authorized Distributor

General Electric Information Services Company operates a network similar to Tymnet, although GE’s is much larger. In fact, it is the largest international data-communications network in the world. Robert McCalley, manager of the communications and distribution system, recommends setting the modem to half duplex and no parity (treating the eighth bit as data) before logging on.

Keith Boyer, a spokesman for Compuserve’s technical services, noted that although any parity setting will put ASCII characters on the screen, the eighth bit must be sendable and receivable as data in order for Compuserve’s A and B file-transmission protocols to work properly. These protocols are used for important functions such as downloading programs to user memory. Also, transmission of some graphics characters requires the eighth bit. The "no parity" selection on the VICTERM I menu should be selected when using the A and B protocols or graphics programs.

As this article was being completed, The Source had some information for VIC users in its Commodore Business Machines database.

The VICMODEM was developed under the watchful eyes of Michael Tomczyk. The development process took four months from start to finish, he said in a recent interview. The toughest part was getting it in at the right price. Tomczyk, who has an astute sense of the marketplace for home computers, assessed the future of the modem this way: "We think this modem may sell as many VICS as the game cartridges."

With a growing number of giant publishing firms gearing up to supply electronic newspapers, videotex, and other home data products, he may well be right.
NEW HIGHER PRINTING SPEED,
NEW LOWER PRINTER PRICE

High-speed printer
The Heath/Zenith 25 Printer is a heavy-duty, high-speed dot matrix printer that gives you sharp, clear printouts. It prints crisp, clear copy at speeds over 150 characters per second with quiet smoothness.

Baud rates from 110 to 9600 are user-selectable.

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The 25 prints the entire 95-character ASCII set in upper case and lower case with descendents, in a 9 x 9 matrix. Also, 33 block graphic characters - which are compatible with the Heath/Zenith 89 All-In-One Computer and the 19 Smart Video Terminal - let you create graphs and charts. All functions and timing are microprocessor-controlled.

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The 25 has all the features you've been looking for in a high-quality, high-speed dot matrix printer - for only $1095 in kit form, or for only $1595 assembled and tested.

Free demonstration awaits you at your Heathkit Electronic Center†
Pick the store nearest you from the list below. And stop in today for a demonstration of the new Heath/Zenith 25 Printer. If you can't get to a store, send $1.00 for the latest Zenith Data Systems Catalog of assembled commercial computers. We'll also send you a free copy of the latest Heathkit® catalog. Write to Heath Company, Dept. 334-874, Benton Harbor, MI 49022.

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El Cerrito, CA
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714-461-9110

Los Angeles, CA
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213-749-9281

Pomona, CA
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714-629-9343

Redwood City, CA
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415-365-8150

Sacramento, CA
5960 Paton Ave
916-488-1737

Woodland Hills, CA
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213-883-0501

Denver, CO
5604 W. 36th Ave.
303-422-3408

Avon, CT
385 W. Main St (Rt. 44)
203-878-0035

Hialeah, FL
4750 W. McArthur Blvd
305-929-2260

Plantation, FL
7173 W. Broward Blvd
305-791-7800

Tampa, FL
4019 W. Hillsborough Ave
813-888-2041

Atlanta, GA
5293 Howell Rd
404-252-4341

Chicago, IL
3483 N. W. Devon Ave
312-583-3500

Dowlers Grove, IL
224 Ogden Ave
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Lowercase Descenders for the Epson MX-70

Bruce Piggott
35 Beverley Rd.
Stevenage, Hertfordshire
SG1 4PR, England

Like most home-computer owners, I wanted a printer and, like most, couldn't afford one. But as prices began to fall, I gradually realized I could afford the Epson MX-70.

The MX-70 uses ordinary paper and has a graphics mode, but unfortunately it does not do lowercase descenders. This didn't worry me too much because most of the printing I wanted to do was program listings.

However, after working with the printer, I realized that although the MX-70 has eight print wires, it uses only seven in text mode. That meant lowercase descenders would be possible by switching to the graphics mode at the right time and using all eight print wires to create the lowercase letters.

Strangely enough, the MX-70 can print true descenders mechanically, but electronically the option was not available. I decided to write a machine-language program to modify the output.

The technique is to have a small program that examines the output of a printing routine. It looks at the ASCII (American Standard Code for Information Interchange) character in the microprocessor's A register to see if it is a lowercase letter with descender (e.g., g, j, p, q, or y). If one of those letters is not in that register, then the program jumps to the standard output routine and prints the character in the normal way.

If, however, the letter requires a lowercase descender, the program switches the printer into the graphics mode and outputs a string of data that drives the printing pins to construct the improvised character (see listing 1).

The program assumes that the printer controller card is in slot 1. The equates (EQU) in lines 19, 20, and 21 must be changed for other slots: for slot 2, add hexadecimal 100 to the numbers, for slot 3, add hexadecimal 200, and so on.

If the character style is not to your liking, it can be changed by modifying the appropriate data string. The format is 5 dots wide and 8 dots deep, with the first byte defining the left side of the character and with the most significant bit at the top. The data string must end in a zero, as this is the delimiter for the program.

The program can also be extended to modify other characters or create some that are not in the standard ASCII set, for example:

- to change the number sign (#) to the English pound sign (£)
- to intercept normally unprintable codes (0 through 7) and print graphics
- to print Chinese characters

Plan the character you wish to design on graph paper. Convert the vertical columns into hexadecimal values using the tables in the MX-70 operation manual (remember the top bit is most significant). Then insert the resulting string into the source code in the DATA1 file (line 93), and insert the representative ASCII code into the "match" string (line 87). If you add a string at the end of the DATA1 file, you must also place the matching ASCII code at the end of the match string.

The program resides at hexadecimal 300 (decimal 768) and this address will have to be entered into the printer driver program.

Anyone planning to use this technique should expect that the operation of the MX-70 will seem a little strange at first. Whenever the MX-70 enters the graphics mode, it completes printing whatever is in the buffer up to that point, then backsteps to print the graphics. Consequently, the speed of the printer will slow down proportional to the number of lowercase letters with descenders. For this reason, I use the routine only for the final copy.

But the combination of the MX-70 and this program has saved me over $150 compared to the price of the MX-80. And now I also have the use of the graphics mode.
Listing 1: The Lowercase Descender program for the MX-70 and Apple II. Not only can you get true lowercase descenders, but you can program your own characters.

SOURCE FILE: MX-70

00001: ** lists continue on page 254 **
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Listing 1 continued from page 249:

032E: 60 *
032E: 61 * NOW OUTPUT CHARACTER DATA
032E: 62 *
032E: 63 PLA : GET OFFSET TO CHAR.
032E: 64 TAX : PUT IN X AS INDEX
032E: 65 LOOP3 LDA DATA1,X : GET NEXT CHAR. DATA
032E: 66 CMP #0 : DELIMITER?
032E: 67 BEQ EXIT : IF DONE
032E: 68 STA POUT : SEND TO PRINTER
032E: 69 JSR SENSE : WAIT TILL PRINTER DONE
032E: 70 IMX .
032E: 71 BPL LOOP3 : IF NOT DONE
032E: 72 *
032E: 73 * ALL DONE SO EXIT VIA RESTORE ROUTINE
032E: 74 *
032E: 75 EXIT JMP RESTORE
032E: 76 *
032E: 77 ****************************************************
032E: 78 * SUB ROUTINE TO SENSE THAT PRINTER HAS
032E: 79 * FINISHED PRINTING LAST CHARACTER.
032E: 80 ****************************************************
032E: 81 *
032E: 82 SENSE LDA PSENSE : GET PRINTER STATUS
032E: 83 CMP #$FE : STILL BUSY ?
032E: 84 BEQ SENSE : IF YES
032E: 85 RTS : IF PRINTER READY
032E: 86 *
032E: 87 *
032E: 88 ****************************************************
032E: 89 * DATA GROUPS
032E: 90 *
032E: 91 DATA0 DFB 0,6,$4B,$1B : CONT.K,6 IN REV.ORDER
032E: 92 *
032E: 93 DATA1 DFB $18,$25,$25,$25,$5A,0 : G DATA
032E: 94 DATA2 DFB 2,1,$21,$BE,$20,0 : J DATA
032E: 95 DATA3 DFB $3F,$24,$24,$24,$18,0 : P DATA
032E: 96 DATA4 DFB $18,$24,$24,$24,$3F,0 : Q DATA
032E: 97 DATA5 DFB $39,5,5,5,$3E,0 : Y DATA
032E: 98 *
032E: 99 SUM DFB 0 : SCRATCH DATA
032E: 100 *
032E: 101 MATCH DFB $E7,$EA,$F0,$F1,$F9 :G,J,P,Q,Y
032E: 102 *
032E: 103 * END OF SOURCE
032E: 104 ****************************************************
032E: 105 * TEST ABOVE ROUTINE
032E: 106 ****************************************************
032E: 107 TEST LDA #$54 : 'T'
032E: 108 JSR PRINTER
032E: 109 LDA #$F9 : LOWER CASE "Y"
032E: 110 JSR ENTER
032E: 111 LDA #$9A : LINEFEED
032E: 112 JMP PRINTER : EXIT VIA PRINTER
032E: 113 *****************************************************

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The Sinclair ZX80 keyboard has several obvious limitations. After only a short period of use, the user will begin to realize that the keyboard is awkward and doesn't really allow any degree of speed. Another limitation is not so obvious: the lack of a true reset button. This may not be apparent when running BASIC programs, as the break key works well, but a reset button is necessary when running machine-code programs or subroutines. Thankfully, all of these limitations can be eliminated (see photo 1).

Adding the Keyboard

The ZX80 decodes its keyboard by software. To the processor, the keyboard appears as a block of I/O (input/output) ports. The upper 8 bits of the address bus, A8 through A15, are apparently used to strobe the keyboard sequentially, and the resulting values on the data bus are decoded. Figure 1 shows this interconnection as it appears from the back (solder side) of the ZX80 printed-circuit board. If software makes address line A9 high while the A key is pressed, D1 will be high, but D0
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AH-HA! EUREKA! ALL-RIGHT!
Figure 1: The connection of keys on the Sinclair ZX80 keyboard. The black lines represent actual traces on the "solder side" of the printed-circuit board. The red lines are connections made on the other side of the board. The ribbon-cable connection to the new keyboard is made to the points labeled A8 through A15 and D0 through D4. When wiring the new keyboard, all connections should follow this diagram.

Photo 2: The standard-sized keyboard shown in photo 2a is made of a metal plate into which the keyswitches are pressed. Photo 2b shows the solder lugs to which connections will be made.

Photos 3a and 3b: Wiring the new keyboard. Photo 3a shows the first set of installed jumpers. The wire is standard 30 AWG wrapping type, wrapped once around each post before soldering. Photo 3b shows the completed jumper system.
and D2 through D4 remain low.

Photo 2a shows the keyboard I used, consisting of a metal base with holes into which the keyswitches are pushed. Two solder lugs on the back of each keyswitch make the connections (see photo 2b). Many of the symbols that are unshifted on a normal keyboard are obtained by using the shift key on the ZX80; consequently a number of keys on the new keyboard will not be used.

The first step is to wire the keys together (use figure 1 as a guide). Keys do not have to be arranged as they are on the ZX80, as long as the connections remain the same, and two or more keys may be used for the same function by wiring them in parallel (i.e., wire one as shown, then wire the two posts of the second key to the corresponding posts on this first key—I did this with the shift key to use the second shift key on the keyboard). Photo 3 shows how to wire the keys together. I used striped Kynar (wire-wrap) wire to make the connections and insulating tape to shield the wires where necessary. A connector may be added to the free end of the ribbon cable.

The second step involves the connection at the ZX80 end. The ribbon cable should be carefully soldered to the points shown in photos 4a through 4c, then extra solder added to obtain a good connection. Avoid applying too much heat as it can damage the board or solder pads. Again, a connector can be added to the ribbon cable.

Once the final connection is made, you're ready to test the keyboard. If you have problems, recheck your wiring on the new keyboard for a short circuit or broken connection. I had no such problems—the keyboard worked perfectly from the start. One potential problem, key bounce, never arose. Apparently the touch-sensitive keys on the ZX80 aren't as prone to this phenomenon as other keyboards. A constant worry was that the technique the ZX80 used to handle key bounce would not allow sufficient time for the key bounce on the new keyboard to settle down. In practice, however, this was not a problem.

Adding the Reset Key

To reset, simply connect the reset pin of the Z80A processor, pin 26, to ground. There are two ways of doing this. The first uses the expansion bus. Pin 21A on the component side is the reset line, and pins 4B and 5B on the solder side are ground. All that is required is to connect a momentary contact switch between these two pins.

The second technique involves making these connections closer to the processor. I chose this approach because connections had already been made on the

Photos 3c and 3d: Extra insulation is added in photo 3c, and photo 3d shows the installed ribbon cable.

Figure 2: Diagram of the reset system used in the ZX80. Figure 2a is a schematic representation of the reset circuitry. Figure 2b is a sketch of the solder side of the circuit board where the connection to the reset key is made.
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System Notes

(4a)

Photos 4a and 4b: Ribbon-cable connections to the ZX80. Photo 4a shows the solder pads to which the data-bus connections should be made (labeled 0 through 4). Photo 4b is the completed ribbon-cable connection.

underside of the board for the keyboard, so two more didn’t matter.

Pull-up resistor R21 and capacitor C10 on the ZX80 are connected to the reset pin of the processor (see figure 2a). Thus, the reset switch can be connected between pin 26 of the processor and the grounded side of the capacitor (see figure 2b). I ran two lines with the ribbon cable to the keyboard I had added and connected two spare keys in series such that both have to be pressed together for a reset. This minimizes the chance of an accidental reset.

These simple modifications greatly increased the accuracy, speed, and ease of use of the Sinclair ZX80, and neither process is beyond the ability of anyone who has used a soldering iron on printed-circuit boards.
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Text Editing with Compuview's VEDIT

H. Bradford Thompson
Department of Chemistry
University of Toledo
Toledo, OH 43606

VEDIT is a fast, friendly, adaptable, full-screen editor for use with CP/M and compatible operating systems. It is the first software product from Compuview, based in Ann Arbor, Michigan. If you’re writing programs on the editor that came with CP/M, and particularly if you’ve never used a full-screen editor, then what follows will probably be of interest to you. With VEDIT, you always have a full screen of text in front of you. To add or change, you just type. If this review gives you an appetite for simplicity while editing, then VEDIT, at $130, is well worth considering.

If you already own a word processor or a full-screen editor, you might still be interested in VEDIT. It’s very adaptable to your video-display terminal, to your preferences in assigning special keys, and to the task at hand. I keep three versions: one for general text writing, one for BASIC programming, and one for assembler programming. (More about this under Customization.) VEDIT performs best as a programmer’s editor. You can write notes, letters, and even manuscripts on it, but VEDIT is not a word processor.

What It’s Like to Use VEDIT

VEDIT has two operating modes: a command mode (which works like a conventional command editor) and a visual mode. In visual mode, the screen is filled with a portion of the text. Most work is done in visual mode, so I’ll describe that first.

The portion of text on the screen is called the window. I began the final version of this article by giving CP/M the command:

```
VEDIT BYTVEDIT.REV
```

If the file BYTVEDIT.REV had not existed, the message NEW FILE would have appeared briefly, after which the screen would have been cleared, with the cursor at upper left ready for entry of text. Until you have a change or correction to make, you just type in your text. In this case, the file already existed, so the window filled with the first lines of the file, with the cursor at upper left. You can move the cursor over the window at will, adding, changing, or inserting text. If the cursor rests on existing text, what you type normally overwrites the old text. With one key, however, you can switch to an insert mode.

At a Glance

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<td>Manufacturer</td>
<td>Compuview Products Inc.</td>
</tr>
<tr>
<td></td>
<td>618 Louise</td>
</tr>
<tr>
<td></td>
<td>Ann Arbor, MI 48103</td>
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<tr>
<td></td>
<td>(313) 996-1299</td>
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<tr>
<td>Price</td>
<td>$130; order directly from Compuview</td>
</tr>
<tr>
<td>Format</td>
<td>5.1/4- or 8-inch floppy disk</td>
</tr>
<tr>
<td>System needed</td>
<td>An 8080- or 280-based computer with a video-display console and CP/M or CDOS operating system</td>
</tr>
<tr>
<td>Documentation</td>
<td>65 pages punched for 3-ring binder; approximately 15 pages of assembly-language listing also provided in two disk files</td>
</tr>
<tr>
<td>Audience</td>
<td>Programmers and anyone else who writes text on a video-display device</td>
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</tbody>
</table>
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mode, where the new text is inserted and everything to the right is shifted to make room.

Old text can be deleted by typing spaces over it (which leaves blanks), by backspacing (which moves the cursor left, deletes that character, and closes up the line), or by hitting Delete (which does the same without moving the cursor). In addition to the usual moves up, down, left, and right, VEDIT's cursor commands include single-key moves to the start or end of the current line, to the beginning of the next line, or to the next tab stop.

Once you've mastered on-screen maneuvers, how do you move the window? VEDIT has one-key instructions that page up or down a little less than one screen-height; others move the window and cursor to the beginning or end of the text. If you want to move up or down just a few lines, move the cursor up until it reaches the third line (or fourth or fifth, the value is set during customization). From that point on, additional Up Cursor keystrokes move the text down through the window (unless, of course, you're already at the beginning). Moving the cursor close to the bottom also scrolls the text up through the window.

An editor should be able to perform functions in addition to these on-screen manipulations. VEDIT handles these via an adequate command mode, which is designed to work nicely in tandem with the visual mode. For example, to replace every occurrence of the word OLD with the word NEW, the command string is:

$$\#<S \text{ OLD } $> $>$$

The $#$ means "do the contents of $>$ as often as necessary." is the substitute command, and $>$ is echoed when the escape key is used. By adding a V command,

$$\#<S \text{ OLD } $ NEW $ V>$ $$

VEDIT enters the visual mode after each substitution, with the cursor marking the point where the change was made. If the substitution is satisfactory, you press one key to return to command mode. Since the V command is inside the $<$, you're immediately back in visual mode, with the cursor marking the next substitution. Of course, you may discover that you set up the substitute command incorrectly. VEDIT's author has provided another escape from visual to command mode, which jumps out of the $>$.

Command mode has an adequate set of editing commands, considering you'll spend most of your time in visual mode. It also provides file-handling commands and a means for changing disks and escaping from write-error and full-disk situations. I made up a full disk for testing and VEDIT did indeed let me off the hook in two ways: by deleting a file to make space or by changing disks.

Customizing VEDIT

For those of us tinkering with new systems, VEDIT's strongest point may be its adaptability. The process is versatile, simple, and well documented.

VEDIT comes in versions for 8080 or Z80 processors and for serial interface or memory-mapped video displays. I've tested only the Z80, videodisplay version. You set up VEDIT by running a customization program called VEDSET, which leads you stepwise through the required choices. VEDSET first presents a list of nineteen popular terminals, including the Lear-Sieghler ADM-3A, Heath H-19/Z-19, DEC VTS2, Hazeltine, and Televideo, from which you identify your own. This lets VEDSET install the display-control escape sequences unique to your terminal, unleashing the speed made possible by those expensive features. If your terminal isn't included or if you've built your own, VEDSET provides special instructions and even an assembly listing of the terminal-dependent routines and tables.

I've done most of my testing of VEDIT on a North Star Horizon with 51K bytes of memory, two disk drives, and a Zenith Z-19 (alias Heath H-19) terminal. I've also used a Cambridge Development Labs Graphics Display plus a homebrew character

---

<table>
<thead>
<tr>
<th>TO START OF BUFFER</th>
<th>PAGE UP</th>
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<tr>
<td>Switch insert mode</td>
<td>Cursor up</td>
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<table>
<thead>
<tr>
<th>TO START OF THIS LINE</th>
<th>NEXT TAB</th>
<th>TO END OF THIS LINE</th>
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<tbody>
<tr>
<td>Cursor left</td>
<td>Cursor right</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>TO START OF NEXT LINE</th>
<th>PAGE DOWN</th>
<th>TO END OF BUFFER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indent</td>
<td>Cursor down</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COPY TO TEXT REGISTER</th>
<th>MOVE TO TEXT REGISTER</th>
<th>INSERT TEXT REGISTER</th>
</tr>
</thead>
</table>

Figure 1: Suggested keypad layout for Heath H-19 terminal. Shading (shifted keys) indicates large cursor movement and accompanying window movement as required. The H-19 should be set to Heath mode, the keypad shifted using internal switches and also set to Alternate keypad mode by including the sequence ESC = in the terminal initiation routine in the BIOS section of CP/M.
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generator and terminal emulator, which provided a pretty rigorous test of those special instructions. VEDIT makes good use of smart terminal features when they're available. However, unforeseen questions may arise. For example, H-19 users should be aware that VEDSET assumes your terminal has special instructions. VEDIT makes good use of smart terminal features. You can also use any control character (except CTRL-M) or ESC followed by any letter. The assignment process is simple: VEDSET names the function, and you strike the key(s) you want to use. VEDIT will reject unsuitable choices. A sample layout for a keyboard without special keys is provided. My package included a suggested layout for the H-19, but I devised one I like better; its third revision is shown in figure 1. The instructions encourage you to try one of the sample setups and then revise it to suit yourself.

In the final segment of customization, you enter your screen size in characters, the number of lines up and down that you want the window to move when paging, and similar parameters. You can also set up two features of special convenience to programmers. First, there's a selective lowercase-to-uppercase conversion that operates on each line of text until some particular character is encountered. This lets you leave the caps lock off when entering programs, type your code in all caps, and type your comments in lowercase. VEDIT switches modes when it crosses the ; (semicolon) in 8080/Z80 code, the ' (apostrophe) in Microsoft BASIC, or the ! (exclamation point) in DEC BASIC Plus. This feature can be set up during customization and then altered during use from command level.

Second, there's Indent/Undent. You define a special key for Indent and another for Undent during setup and also specify an indent increment (say, 5 spaces). Each time you press the Indent key, it changes the position the cursor goes to when you press Return. One Indent and you return to position 6 instead of position 1; press Indent again and you now return to space 11, and so on. Each tap of the Undent key undoes one Indent. Even if the language you're writing doesn't require specific indents, this makes it easy to improve the readability of your code.

Other Special Features

A feature highly touted in VEDIT publicity is the Undo key. Whatever you've done on the line you're editing, one stroke on Undo and the whole line is restored—you're back
VEDIT also has a text register for moving or copying a block of text. Place the cursor at the beginning of the block, hit the Move key, move the cursor to the end of the block, and hit Move again. The block, now placed in the text register, disappears from the screen. You then move the cursor to wherever you want the text and hit the Insert key. Copy works the same way but doesn't delete the copied text from its original location. The Move key can also be used to delete a block of text.

One of VEDIT's best features is its speed in visual mode. VEDIT rarely rewrites the screen when it isn't necessary, and even when it does, the time required is not excessive. On the Z-19 at 9600 bps (bits per second), most operations seem instantaneous. Command mode, however, is another matter. A loop I set up to remove the first six characters from each line of a 200-line file took about 30 seconds.

VEDIT and Large Files
On my 51K-byte system, VEDIT's text buffer holds 35,786 bytes. (For comparison, Microsoft's EDIT80 holds 32,974, and Digital Research's ED holds 28,589.) That's almost 900 40-character lines. I rarely write single program modules that long, so I have limited experience with VEDIT's disk buffering for large files. On a 32K byte system, the buffer would hold about 17K bytes or over 400 lines.

Like most simple editors, VEDIT processes long texts by reading lines from an input file into the text buffer, where editing can take place, then writing into an output file. Progress is instantaneous, where editing can take place, then writing into an output file. Progress is instantaneous. Operations could hopelessly scramble files on my disks. I've tried all the combinations that usually cause trouble, but VEDIT seems to handle them flawlessly.

What VEDIT Doesn't Do
I haven't found any serious bugs in VEDIT. A minor problem arises when you use the terminal's Repeat button to move the cursor around quickly or to delete a long string of characters. This works until VEDIT is required to do more than a simple operation. For instance, a repeated Up Cursor works until the cursor reaches the line where VEDIT must scroll down and write a new top line for each incoming Up Cursor. If Up Cur-

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Conclusions

**VEDIT** is a convenient, friendly, full-screen editor available at a reasonable price. It has several features specifically designed for program preparation and, for that purpose, has distinct advantages over command editors. It's readily adaptable to a wide variety of terminals and takes advantage of smart-terminal features. Special function keys can be assigned whatever functions you wish. If you don't have special function keys, substitute control characters and escape sequences of your own choice. The well-documented customization process is easily accomplished.

In addition to its screen mode, **VEDIT** has an adequate command mode. The command mode is useful in setting up string searches and substitutions; it also allows iteration macro commands that include transfers into visual mode and back. You won't spend much time in command mode. As part of a word-processing system, **VEDIT** has several limitations. You can't underline or even insert control characters in visual mode, and you can't send text to a printer.
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Add a Cassette Interface to Your VIC-20

William R. Hale
3309 June St. NE
Albuquerque, NM 87111

During the time I've owned a Commodore VIC-20, I've found it to be an excellent home computer. You really get a lot for your money. With so many excellent peripherals being introduced recently, the VIC-20 will be a great addition to the home computer market. I do feel, however, that the price (almost $100) Commodore is asking for a cassette recorder is a little high. Thus, I decided to design my own interface.

Figure 1 (on page 274) is a schematic of an interface that allows use of an ordinary, portable audio-cassette recorder to store programs from a VIC-20. The cost of the few parts needed, including a plastic case, runs about $10; the parts are available at Radio Shack and other electronic parts stores. The audio tape needed to store programs need not be of high quality due to the tones the VIC-20 uses. The cassette "shell" itself should not be so cheap that it causes the tape to drag.

Most of the components I used were already in my home stock, including the 6-pin connector to the VIC-20 motherboard. (See figure 1 for part numbers.) The VIC-20 outputs 0 to +4 volts (V) and prefers an input a signal of an amplitude between 0 and −4 V. (Later testing has shown that the VIC-20 will accept a 0- to +4 V input if the signal consists of true square waves and does indeed range from 0 to +4 V.) Capacitor C1 allows the recorder to receive a normal AC input; the combination of C2 and CR1 allows DC restoration for the VIC-20 input. R2 is merely a fuse to protect the VIC-20.

L1 is an LED used to indicate that data is coming into the interface and is of sufficient level to properly operate IC1, which is being used as a wave-shaping circuit. L1 isn't a necessary part of the interface, but since the SN7404 has extra inverters, you might as well use one for the indicator. Switch S1 is also unnecessary because you can tie the line coming to it low. However, if you do this, be sure your recorder is in PLAY for the load and verify operations and in RECORD for any save operations before pressing the return key. Switch S2 is needed to rewind the tape. Always return this switch to REMOTE immediately after using it in MANUAL.

My particular recorder, Superscope Model C-76, uses +6.7 V to drive its motor, so I was able to use the VIC-20's motor-power line directly. Figure 1 also illustrates an alternate method for controlling the recorder using the VIC-20's +6.7 V motor line as a control signal.

Notice that the shield on the AUX input of the recorder is not connected to the VIC-20 system ground. I found that if I tied this line to the VIC-20 ground, noise would appear on the external speaker output of the recorder while I was attempting to load a program from the recorder. This noise was of sufficient level to trigger the input of inverter IC1 prematurely and cause an error message to be generated by the VIC-20.
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Figure 1: Interface between the VIC-20 and a standard cassette recorder. Although the VIC-20 outputs 0 to +4 V, it seems to prefer a 0 to −4-V input. Switch S1 could be eliminated (see text), but it’s safer to include it. Alternate sources for the connector to the VIC-20 are listed; an alternate motor control circuit is also shown.
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To say that the printer market has blossomed is to make an apt analogy. An immense crop of printers with exciting features has flourished in the last few years. Unfortunately, a handful of thorns is waiting for those who make a hasty grab without carefully examining the field. Only an understanding of the present state of the art and knowledge of the printers available will help the personal-computer user choose the best printer for an application.

The printer provides an important and common man-machine interface. Recent advances in printer technology allow the use of personal computers in many new ways: producing letters, checks, and even pictures. However, a printer still represents a large investment to most people—sometimes as much as the rest of the computer system. BYTE provides this list of printers and their features to help you get the necessary information.

The newest printers offer standard features that illustrate the progressive thinking of designers and manufacturers, at a low cost that would have been impossible two years ago. Through the use of dedicated microprocessors, new printers provide bidirectional printing, short-line seeking, and multiple-font capability—features that are difficult to implement with mechanical printers. The presence (or absence) of these features is the key to selection of the proper printer.

Understanding Printers

Although a variety of printing technologies is available, the traditional impact printer is still the most common. The other printing concepts find favor in special applications (e.g., if copy must be produced at high speed, an ink-jet system might be used) where special attributes are used to advantage. The following is a description of the printing technologies you will discover in the microcomputer printer market:

Impact: Uses a type element with a raised character that strikes an inked ribbon against the paper, thus transferring the outline of the character to the paper. This is the same concept used in the common typewriter, but manufacturers have added several twists to the idea. In daisy-wheel or thimble-type printers, the complete set of type elements can be removed and replaced as a single unit. This makes it possible to change type fonts (the style of the letters) or install characters not commonly available.

The typical small-computer owner usually opts for an impact printer that uses a dot-matrix type element. This device prints characters made from dots in a closely spaced grid. It is popular because of its flexibility. In many units, the characters' form is stored in memory and can be changed easily. The presence or absence of dots can be controlled by the computer (in some fashion) so that graphs and pictures can be printed.

A rather unusual printer that might be classed with impact types uses a stylus to form the characters (an idea analogous to having a machine that draws with a pencil). The theory is that this system should provide the flexibility of a dot-matrix design with the fully formed characters of a daisy-wheel-type printer.

Thermal and Electrostatic: Both use a form of the dot-matrix print head, but depend on special paper to create the image, rather than ink from a ribbon. These printers are usually small, allow only 20 or 40 characters on a line, and have few extra features.
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Ink-Jet: This is actually a controlled spray of ink directly onto paper. Small droplets of ink formed at a nozzle are directed by electrostatic fields to cover the proper areas on the paper. This is a fast way to print whole pages because the inertia of the droplets is far smaller than that of mechanical systems. The system is flexible because the form of each character is computer-controlled.

Laser: Uses a raster-scan system similar in idea to a video display. The laser moves across a sensitized drum, "burning" a row of dots; as each row is completed, the beam moves down to begin the next row. The image is then transferred to paper, just as in a photocopier. Obviously, laser printers contain precision optical and mechanical parts, so they cost tens of thousands of dollars; but they are very flexible and fast.

Because many of these systems are relatively new, manufacturers have not been able to bring down their cost. Because of this money factor, we will mainly consider the impact, electrostatic, and thermal types. Even the least expensive of today's impact printers has features that set it apart from the teletypewriter that was the common hard-copy appliance 10 years ago. Here is an explanation of the concepts behind these features:

Print Quality: An obvious consideration for most people and small businesses. The quality of the characters that appear on paper is mostly determined by the printer technology used. Daisy-wheel and thimble-type printers produce fully formed characters that look similar to those produced by typewriters or typesetting equipment. Dot-matrix printers, although usually faster, are not as a rule capable of producing high-quality printing (the exception is multipass types that allow their dots to overlap, giving a fully formed look). In dot-matrix printers, the number of dots in the matrix is a good guide to the visual quality of the printing (i.e., a 9-by-14-dot character will probably look far better than a 5-by-7-dot one).

Character Sets: They can be an overriding factor if special characters are required. Although the type elements of daisy-wheel and thimble-type printers can be changed manually, many dot-matrix printers can be programmed with alternate character sets; some come with several preprogrammed sets. Almost all printers follow the ASCII (American Standard Code for Information Interchange) convention that assigns each standard character with a 7-bit binary number. Few printers, however, allow all 128 ASCII characters.

A related concern is the font, or style of type, used by the printer. This governs whether parts of the lowercase letters g, j, p, q, and y actually descend below the print line, whether the vertical lines of the characters are slanted, and whether or not the characters have serifs (short lines that extend at an angle from the ends of the main strokes of the letter). Many dot-matrix printers provide a feature to condense or expand the characters horizontally; some even slant or rotate the characters.

Although most printers produce characters that all take the same amount of space, an important feature on high-quality units is proportional spacing. (Perhaps you have noticed that typesetting—such as is used in magazines, newspapers, and books—produces characters that have a variety of widths.) This contributes much to the look of a printed page.

Speed: Many printers include features that allow them to print characters at a high rate. This may be as simple as a character set that is draft-quality (the printer doesn't spend much time making the character look pretty).
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- list structure, allowing easy manipulation of words (strings) and lists
- user defined procedures which can be used exactly as if they were part of the language.
- fully integrated screen editor for procedures and text
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- a total of 120 primitives (commands) including 30 graphics commands
- recursion
- assembly-language interface capability

The Terrapin Logo language was developed by the Artificial Intelligence lab at the Massachusetts Institute of Technology. Terrapin now authorized by MIT to distribute the results of its 12 years of research to you. To provide quality support for the language, Terrapin has assembled a team that includes two of the three authors who developed the Logo language for the Apple II at MIT, as well as Dr. Feurzeig, the originator of the Logo language.

Every copy of the Terrapin Logo language comes with complete documentation. To run the language, a 48K Apple II with a 16K RAM card or a language card, and one disk drive is required.

Terrapin also offers the robot Turtle, and the following books: Turtle Geometry, Special Technology for Special Children, Mindstorms, Katie & the Computer, and Apple Logo from Byte Books.

Suggested retail price: $149.95
To order or for more information, call or write:

Terrapin, Inc.
678 Massachusetts Avenue
Cambridge, MA 02139
(617) 492-8816

"Logo" trademark under license from R.C.I. Botanik & Newman, Inc.
However, two logical concepts are important to the speed of any printer: bidirectional printing and short-line seeking. A printer that does bidirectional printing does not waste time moving the print head from the end of one line, at the right of a page, to the beginning of the next line at the left. It simply prints the next line backward, beginning at the right. A short-line-seeking printer skips over multiple spaces at a higher than normal speed and slows when the print head is located at the first printable character.

Forms: Paper that the printer will accept is usually limited to one or two types. A large amount of computer printouts are done on fanfold paper. However, cut sheets are preferred for correspondence and reports. Some printers accept only roll paper, as used on adding machines. Forms controls that allow the printer to automatically find the top of the next fanfold page, and feeding mechanisms that load the printer with a single sheet of paper, are also available.

(Fanfold continuous paper is separated into sheets by perforations along the top and bottom of each "page." A series of holes is provided along each margin for a tractor to move the paper vertically through the printer. Fanfold paper is available in a variety of styles and widths, including preprinted forms such as invoices and checks.)

Following is a listing of printer manufacturers and their products. Where possible, the information has been taken directly from the maker's literature. But please remember this caveat: a manufacturer may emphasize one feature and neglect to mention other features. Although we have made every attempt to keep the specifications accurate and up-to-date, errors do occur. Also, keep in mind that manufacturers reserve the right to alter specifications without notice.

A D Data Systems Inc.
200 Commerce Dr.
Brookster, NY 14623
(716) 334-9649
Addmaster Corporation
416 Juniper Serra Dr.
San Gabriel, CA 91776
(213) 285-1121
170: impact, 5 by 7 dot matrix; 18 or 21 char/line; 50 cps; 6 line/inch; ASCII or Baudot characters; time-of-day clock with battery backup; self test; friction feed; 2.25 inch wide roll paper; RS-232, 63 char buffer; Centronics or Apple II parallel; 8.25 by 12 by 5; 7 lbs; $299
180: impact, 5 by 7 dot matrix (9 by 7 optional); 34 or 40 char/line; 48 cps; 6 line/inch; ASCII or Baudot characters; time-of-day clock with battery backup; self test; friction or tractor feed; 4.5 inch wide roll paper or labels; RS-232, 40 char buffer; Centronics parallel; $399
Alphacom Inc.
3051 Tisch Way
San Jose, CA 95128
SprINTER 40: thermal, 5 by 8 dot matrix; 20 char/line; 96 char ASCII; graphics; rotated printing; roll paper; RS-232, 110 to 9600 bps; parallel; $175
SprINTER 46: thermal, 5 by 8 dot matrix; 40 char/line; 96 char ASCII; graphics; rotated printing; roll, fanfold paper; RS-232, 110 to 9600 bps; parallel; $330
Alps Electric Inc.
100 North Center Ave.
Rockville Center, NY 11570
(516) 766-3636
1200: stylus; 15, 18, 24, or 36 char/line; 6 cps; four colored ballpoint pens; graphics; all characters created under software control of the host computer; friction feed; 2.25 inch wide roll paper; 8.5 by 5.9 by 1 lb; $65.50
1100: same as 1200 except: one color only; $325
Amperex Electronics Corporation
230 Duffy Ave.
Hicksville, NY 11802
GP300: impact, 9 by 9 dot matrix; 120 or 144 char/line; 80 or 300 cps; vertical tab; paper out indicator; graphics; self test; two character sets; friction feed and tractor feed; sheet or fanfold paper; RS-232, 300 to 9600 bps; parallel; 20.5 by 17.5 by 7.4; 44 lbs; $3165
Anacom General Corporation
Computer Products Division
1116 Vallencia Dr.
Fullerton, CA 92631
(714) 992-2023
150: impact, 9 by 9 dot matrix; 136 char/line; 150 cps; 6 or 8 line/inch; 96 char ASCII; lowercase characters; double-width characters; bidirectional printing; short-line seeking; self test; graphics optional; paper-out indicator; top-of-form control; tractor feed adjustable to 15 inches wide; fanfold paper; RS-232, buffer optional; parallel; 34 lbs; $1495
150Z: impact, dot matrix; 40 or 220 char/line; 180 cps; four selectable character sets; graphics; tractor feed; fanfold paper; RS-232; parallel; $1650
160: impact, 9 by 9 dot matrix; 80 char/line; 150 cps; 6 or 8 line/inch; 94 char ASCII; graphics; lower-case descendents; paper-out indicator; top-of-form control; tractor feed adjustable to 10 inches wide; fanfold paper; RS-232 with hand-shaking, 110 to 9600 bps; 256 char buffer (1K to 4K char buffer optional); parallel; 17.5 by 18.5 by 7.9; 34 lbs; $1450
160Z: same as 160 except: 96 char ASCII, 2 pass high-quality mode; preprogrammed and programmable character sets; 70 by 70 dot graphics; self test; 4K char buffer
Anadex Inc.
9825 De Soto Ave.
Chatsworth, CA 91311
(213) 998-8010
DP9000: impact, 9 by 9 dot matrix; 80 char/line; 150 cps; 6 or 8 line/inch; 96 char ASCII; bidirectional printing; graphics; 72 by 60; compressed characters give 106 char/line at 200 cps; self test; tractor feed; fanfold paper; RS-232; Centronics parallel; 22 by 15.4 by 8.3; 30 lbs; $1550
DP9500: impact, 9 by 9 dot matrix; 80 char/line; 120 cps; 96 char ASCII; compressed characters give 132 char/line at 200 cps; tractor feed; fanfold paper; RS-232; Centronics parallel; $1550
DP1000: impact, 9 by 9 dot matrix; 80 char/line; 112 cps; 6 line/inch; 96 char ASCII; bidirectional printing; vertical tabs; double-width characters; compressed characters give 176 char/line at 200 cps; underlining; graphics; bidirectional printing; short-line seeking; paper-out indicator; self test; tractor feed adjustable to 15.6 inches wide; fanfold paper; RS-232, 800 char buffer; Centronics parallel; 35 lbs; $1650
DP9501: impact, 11 by 9 dot matrix; 80 or 132 char/line; 120 cps; 96 char ASCII; 6 or 8 line/inch; lowercase descendents; double-width characters; compressed characters give 176 char/line at 200 cps; underlining; graphics; bidirectional printing; short-line seeking; paper-out indicator; self test; tractor feed adjustable to 15.6 inches wide; fanfold paper; top-of-form control;
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An Underline Filter for Matrix Printers

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Although matrix printers such as Digital Equipment Corporation's Decwriter III have the advantages of relatively high speed and fairly low cost, they do have an important disadvantage when it comes to printing manuscript copy. By convention, some items in manuscripts (the names of cited journals, for example) are underlined in the text. Matrix printers, if they underline at all, do so by overprinting the bottom line of each "underlined" character. Besides being slow and aesthetically unappealing, this type of "underlining" makes the text nearly illegible.

Fortunately, many matrix printers, including the Decwriter, can achieve half-line vertical spacing. The program in listing 1 sets this option, converts the underline characters to minus signs (which are the same length as underline characters on most matrix printers, including the Decwriter), then moves them onto a separate line to be printed under the corresponding line of text. The result is clear, fast, legible underlining. At the end of the text file, the program restores the Decwriter to normal vertical spacing.

The program in listing 1 is written in C to act as a "filter" under the Unix operating system. Its input is a text file with standard underlining, and its output is the input to the matrix printer. It can be translated readily into other languages, such as BASIC or FORTRAN, for use with other operating systems and matrix printers.

Listing 1.

1 /* This program improves Decwriter underline handling by using a line buffer */
2 /* and may also be used to change, temporarily, the dw3's horizontal pitch. */
3
4 #include <stdio.h>
5 #include <csetty.h>
6 #include <signal.h>
7
8 int dwreset();
9
10 main(argc, argv) int argc; char *argv[]; {
11
12 register char c, h, *p;
13 int b, n;

Listing 1 continued on page 302
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Ashton-Tate
Listing 1 continued:

char opstrin[256];
char *option = opstrin;
char *pmax, *plast;
static char buf[256];
setbuf(stdout, (char *)malloc(BUFSIZ));

/* Make sure to reset decwriter if interrupted */
signal(SIGHUP, dwreset);
signal(SIGINT, dwreset);
signal(SIGQUIT, dwreset);
signal(SIGKILL, dwreset);
signal(SIGPIPE, dwreset);
signal(SIGALRM, dwreset);
signal(SIGTERM, dwreset);

/* Get the option from the command */
strcat(option, argv[1]);
if (*option == NULL) c = '2';
else {
    c = *option++;
    if (c == '4' || c == '-') c = *option++;
    if (c == '1') c = *option++;
    if (c == 'p' || c == 'P') c = '0';
    if (c == 'n' || c == 'N') c = '6';
    if (c == 'w' || c == 'W') c = '8';
}

/* Then, initialize the Decwriter */
putchar(27); printf('[3z');
putchar(27); printf('[132t');
putchar(27); printf('[1,132r');
putchar(27);
if ((c == '0') || printf('[1w');putchar(27);printf('[1;84s']);
else if (c == '6') printf('[4w');putchar(27);printf('[1;140s']);
else if (c == '8') printf('[8w');putchar(27);printf('[1;70s']);
else {
    printf('[2w');putchar(27);printf('[1;102s']);
}

/* Then process the file */
c=getchar();
while (c != EOF) {
    /* Main loop: process each line in turn */

    h=b=0;
    plast=pmax = &buf[255];
p=buf;
    while (p<plast) p++ = 32; /* clear under line buffer */
    plast=pmax;
    while (c!=10 && c!=EOF && c!=13 && p<pmax ) {
        /* loop for processing characters */

Listing 1 continued on page 304
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<tbody>
<tr>
<td>&quot;Starting FORTH&quot; by Brodie, Prentice Hall. Best user's manual available. (soft cover)</td>
<td>$19.00</td>
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<tbody>
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<td>Installation Manual for fig-FORTH, contains FORTH model, glossary, memory map, and instructions</td>
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<td>$150.00</td>
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<td>6809 by Taibol Microsystems fig-FORTH, editor, assembler, disk I/O, FLEX* 5% or 8</td>
<td>$100.00</td>
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<tr>
<td>6809 Enhanced 2nd screen editor, macroassembler, tutorial, tools and utilities, FLEX</td>
<td>$250.00</td>
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<td>280 by Laboratory Microsystems. Editor and assembler, CPIM, 8</td>
<td>$50.00</td>
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<td>280 with floating point</td>
<td>$150.00</td>
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<td>280 with AMD 5911 support</td>
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<td>280 by Inner Access. Editor, assembler, and manual, CPIM, 8</td>
<td>$100.00</td>
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<td>8080 by Inner Access. Editor, assembler, and manual, CPIM, 8</td>
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<td>8088 with AMD 9511 support CPIM-86</td>
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- CPIM (NS) $200
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Circle 268 on Inquiry card.
Listing 1 continued:

```c
71 if ( c== 3 ) dwreset(); /* catch interrupt signals */
73 if ( c=='\t' ) { /* tab both text and ul line */
74     putchar ( '\t' );
75     *p++ = '\t';
76     if ( plast<P) plast=P;
77 }
78 else if ( c==' ' ) { /* underline, backspace? */
79     if ((c = getchar()) == '\b') {
80         b=2;
81     } else {
82         *p++ = '-';
83         if (plast>P) plast=P;
84         putchar(32);
85         h=1; /* a character is waiting */
86     }
87 }
88 else if ( c=='\b' ) { /* backspace, underline? */
89     if ((c = getchar()) == '\b') {
90         if (plast<P) plast=P;
91         *(p-1) = '-';
92     } else {
93         h = 1 ;
94         putchar('\b');
95         --p;
96     }
97 }
98 else { /* ordinary char */
99     putchar(c);
100     ++p;
101     if ( b==2 ) { /* previously underlined char */
102         b = 0 ;
103         if (plast<P) plast=P;
104         *(p-1) = '-';
105     }
106 }
107 if ( h==1 ) h=0; /* character read already */
```

Listing 1 continued on page 306
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Listing 1 continued:

```
110    else c = getchar();
111
113    putchar(10);
114    p = buf;
115    while ( p < last ) {
116        putchar(*p);
117        *p++ = 32;
118    }
119    last = buf;
120    putchar(10);
121    if ( c != 10 && c != 13 ) break; /* any c other than LF or CR */
122    /* at end-of-line indicates error */
123    c = getchar(); /* otherwise set first c in new line */
124    /* or EOF */
125
126    /* after EOF the end is near, so reset decwriter to normal mode */
127    alarm(120);
128    dwreset();
131 }

133    dwreset() { /* Subroutine to reset the decwriter to normal mode */

135    signal(SIGINT, SIG_IGN);
136    putchar(27); printf("[1z");
137    putchar(27); printf("[66t");
138    putchar(27); printf("[1,66r");
139    putchar(27); printf("[2w");
140    putchar(27); printf("[1,102s");
141    exit();
143 }
```
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SPACE TILT

APPLE II

Amiga

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ENCAPSE THOM VANDYKIN

PET

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PET

A new adventure game for the PET computer. The Rush of the Empire is a challenging and exciting game that you must pilot through the galaxy by jumping over obstacles and avoiding your enemy. The game is a fast-paced one that will keep you coming back for more!

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PET

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WAY](car

PET

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PET

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APPLE

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GAME PACK II (available for all computers)

APPLE

This NEW GAME PACK is now available for all computers. It contains new software including

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APPLE II

The program is both a mental training tool as well as a relaxing educational game. Based upon recent scientific studies relating to the mental training of the brain, the program offers a mental activity that is both challenging and exciting.

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SPACE EVACUATION (available for Apple and TRS-80)

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MONEY (available for TRS-80 and PET)

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SILVER (available for PET)

PET

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SPACE LANE (available for all computers)

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AVAILABILITY

DYNACOMP's software is available with complete documentation covering each application and use. Unless otherwise stated, all programs are run with IBM compatible hardware (TRS-80 compatible) and come with a 24-hour order time. The programs are available for the following computers:

- TRS-80
- PET
- IBM PC
- Apple II
- Apple II
- Apple II
- Apple II
- Apple II
- Apple II
- Apple II

Note: Programs marked with an asterisk (*) are available for the specific computer line only.

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MISCELLANEOUS

CRYSTALS

PET

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The Diablo Model 1620 and 1640 daisy-wheel printers have a lot of nice graphics features that aren't generally used. After working with high-resolution graphics shape tables on the Apple II computer, I decided to write a shape-list generator for the Diablo in BASIC. (We call this construct a "shape list" to distinguish it from the binary-coded Apple shape tables....RSS).

The program I devised permits the definition of a variety of shapes and the printing of these shapes at any chosen size. No attempt has been made to write a complete graphics package, but the shape-list generator could easily be incorporated into a larger program. Changing the position of printing on the paper and rotating the shapes could also be added.

Each shape is defined in terms of the instructions needed to print it on the paper. The move and print instructions are coded into character strings that are interpreted by a series of subroutines. The program can be used on any BASIC interpreter that supports string variables and permits dissection of strings into substrings.

The details of the Diablo codes for graphics can be found in the Diablo user's manual. The printer is placed into graphics mode by sending to it an Escape, "3" sequence and is taken out of graphics mode through an Escape, "4" sequence. When in graphics mode, carriage movement is not tied to character printing, but space and backspace cause carriage movements of 1/60 inch forward and backward, respectively. Also the linefeed character causes paper-feed movement of 1/48 inch, and "negative linefeed," initiated by sending an Escape, linefeed sequence, causes paper movement of 1/48 inch in the opposite direction. Other paper-movement commands such as vertical tab, formfeed, and margin control remain unchanged.

Thus, to print a horizontal line, it is necessary to send an alternating sequence of periods (decimal ASCll code 46) and spaces or backspaces; the length of the line in inches will be 1/60 times the number of periods printed. To print a vertical line one sends an alternating sequence of periods and linefeeds, or negative linefeeds: the length
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Listing 1: *Diablo printer shape-table program in BASIC for the Apple II computer.*

```basic
1 REM DIABLO SHAPE TABLE GENERATOR
2 REM BY THOMAS D. BROCK, MADISON, WI.
3 REM FIRST DEFINE CODES FOR DIABLO. $E$=ESCAPE.$S$=SPACE.
5 REM B$=BACKSPACE.$N$=NEGATIVE LINE FEED.
10 $E$=CHR$(27)$.SP$=CHR$(32)$.LF$=CHR$(10)$.G$=CHR$(51)
11 TX$=CHR$(52)$.PE$=CHR$(46)$.BS$=CHR$(8)
12 NF$=CHR$(27)+CHR$(10)
19 REM SHAPE TABLE REFERENCES
20 INPUT "SHAPE#?”;N
22 INPUT "SCALE?”;S
28 REM TURN ON PRINTER.INITIALIZE GRAPHICS MODE
30 PR# 3: PRINT ""; $E$; $G$;
40 ON N GOSUB 1000,1100,1200,1300
45 GOTO 200
48 REM MOVE AND PRINT ROUTINES
50 FOR I = 1 TO M * S
52 PRINT SP$;PE$;
54 NEXT I: RETURN
60 FOR I = 1 TO M * S
62 PRINT LF$;PE$;
64 NEXT I: RETURN
70 FOR I = 1 TO M * S
72 PRINT BS$;PE$;
74 NEXT I: RETURN
80 FOR I = 1 TO M * S
82 PRINT NF$;PE$;
84 NEXT I: RETURN
198 REM RETURN TO TEXT MODE
200 PRINT $E$;TX$;: PR# 0: END
998 REM LINES 1000,1200 DEFINE SHAPES
999 REM ANY SHAPES MAY BE INSERTED HERE
1000 SH$ = "L3D3R2XL2D3R3"
1001 GOSUB 5000: RETURN
1100 SH$ = "XD3L2U4R4D4L2"
1101 GOSUB 5000: RETURN
1200 SH$ = "XD3L2XL1UX1UX1XR1R1X1D1D3XD1XL1L2"; GOSUB 5000: RETURN
1998 REM TEST FOR PRINT DIRECTION
2000 IF MS$ = "R" THEN GOSUB 50
2010 IF MS$ = "D" THEN GOSUB 60
2020 IF MS$ = "L" THEN GOSUB 70
2030 IF MS$ = "U" THEN GOSUB 80
2040 RETURN
4998 REM INTERPRET STRING AS SHAPE
5000 FOR J = 1 TO LEN (SH$)
5020 IF MID$(SH$ , J , 1) = "X" THEN PE$ = CHR$(0);J = J + 1
5030 MS$ = MID$(SH$ , J , 1); J = J + 1:M = VAL (MID$(SH$ , J , 1)); GOSUB 2000
5100 PE$ = CHR$(46); NEXT J
5200 RETURN
```

of the vertical line in inches will be 1/40 times the number of periods printed. To move the print head without printing a line, the print-head-motion command is sent without the corresponding periods. The program in listing 1 is fairly self-explanatory. The shapes are stored as character strings in lines 1000 to 1200, and could, of course, also be input just before starting execution by a change in line 20.
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Figure 1: Sample printout produced on a Diablo printer of the 1600 series with the program of listing 1

The shape string selected is interpreted in the subroutine at line 5000. If an X is present, it means move without printing, an R means move right, an L means move left, a U means move up, and a D means move down. The number after the move instruction provides the relative amount of movement, which is stored in the variable M.

The actual amount of movement depends upon the size of the shape, selected at line 22. The whole shape is quickly printed by the program. Printing is then stopped so that another instruction can be fetched, if desired. A typical printout is shown in figure 1.

Although the Diablo printer has several different ways by which graphics can be created, the shape-list program provides a simple means to make nonnumerical drawings. By permitting the selection of any desired size (and position on the paper, with routines easily added) some useful tasks can be performed. Because of the simplicity and shortness of the program, it can be run with virtually any BASIC interpreter that supports string functions.
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2 USNDA Annually computation program
3 DATE Time between dates
4 DASYEAR Day of a year a particular date falls on
5 LEDAYT Interest rate on lease
6 B BREKEN Breakeven analysis
7 DEPRESS Straightline depreciation
8 DEPRIV Sum of the digits depreciation
9 DEPRST Declining balance depreciation
10 DEPVEBA Double declining balance depreciation
11 TAYN P Cash flow vs. depreciation tables
12 CHECKP Print NFS checks along with daily register
13 CHECKA1 Checkbook maintenance program
14 MORTGAE/M Mortgage amortization table
15 MULTPM Computes time needed for money to double triple, etc.
16 SALVAGE Determines salvage value of an investment
17 RAVIAB Rate of return on investment with variable inflows
18 RAINSTA Rate of return on investment with constant inflows
19 EFFECT Effective interest rate of a loan
20 PVV Future value of an investment (compound interest)
21 PVN Present value of a future amount
22 LOANPAY Amount of payment on a loan
23 REGWIT Equal withdrawals from investment to leave 0 over
24 SIMPSON Simple discount analysis
25 DATEVAL Equivalent & not equivalent dated values for obligations
26 ANNDEF Present value of deferred annuities
27 MARKUP % Markup analysis for items
28 SFUND Software fundraising program
29 BONDBAI Value of a bond
30 DEPLETE Depletion analysis
31 BLACKSH Black's Scholastic options analysis
32 STOCKVAL Estimate current value stock via discounts dividends
33 WARVAL Value of a warrant
34 BONDVAL2 Value of a bond
35 ESPEST Estimate of future earnings per share for company
36 BETDELH Computes alpha & beta variables for stock
37 SHAPPE Portfolio selection model e. what stocks to hold
38 OPTWRITE Option writing computations
39 RIVAL Value of a right
40 EXPVIA Expected value analysis
41 BAYES Bayesian decisions
42 VALPINT Value of perfect information
43 VALADIN Value of additional information
44 UTILITY Derives utility function
45 SIMPLEX Linear programming solution by simplex method
46 TRANSP Transport program method for linear programming
47 EQOA Economic order quantity inventory model
48 QUEUE1 Single server queuing (waiting line) model
49 CMP Cost-volume-profit analysis
50 CPNSPRO Conditional profit tables
51 OPTLOSS Opportunity loss tables
52 FCOQEO Fixed-quantity economic order quantity model
53 FCOQBI As above but with shortages permitted
54 FCOQBOA As above but with quantity price breaks
55 QUEBFCB Cost-benefit waiting line analysis
56 QUEBFCF Cost-benefit waiting line analysis
57 PROFIND Pet cash flow analysis for simple investment
58 PROFIND Profitability index of project
59 CAPJ Cap. Asset Pr Model analysis of project

NAME DESCRIPTION
59 WACT Weighted average cost of capital
60 COMPSAL True rate on loan with compensating bal. required
61 DIST BAL True rate on discounted loan
62 MARGANAL Merger analysis computations
63 FINRAT Financial ratios for a firm
64 NPV Net present value of project
65 PRINDAS Language price index
66 PRINPDA Peach price index
67 SEASIND Constructs seasonal quantity indexes for company
68 TMORR Time series analysis moving average trend
69 TIMEMOV Time series analysis moving average trend
70 FURRINF Future price estimation with inflation
71 MAILPAC Mailing list system
72 LETNRT Letter writing system links with MAILPAC
73 SORTP Sorts list of names
74 LABEL1 Shipping label maker
75 LABEL2 Home label maker
76 RUSHOR DOMF business bookkeeping system
77 TIMECLK Computes weeks total hours from timeclock info
78 INCOME Computes income accounts payable and storage permitted
79 INVOICE Generate invoice on screen and print on printer
80 INVENTY In memory inventory control system
81 TEDOR Computes telephone directory
82 RMUSAN Time use analysis
83 ASSIGN Use of assignment algorithm for optimal job assign
84 ACCURE In memory accounts receivable system-storag
85 PROFSPAY Computes 3 methods of repayment of loan
86 PAYNET Computes gross pay required for given net
87 SELLPA Computes selling price for given tax amount
88 ARBASV Computation of Asbash computations
89 DEPSPF Sinhing fund depreciation
90 UPSIZE Finds UPS zones from zip code
91 ENVELOPE Types envelope including return address
92 AUTOEXP Automobile expense analysis
93 INSUR Policy
94 PAYROLL2 In inventory payroll system
95 DLANIAL Dilution analysis
96 LOANAFD Loan amount a borrower can afford
97 PNLHPR Purchase price for rental property
98 SALELEAS Sale leaseback analysis
99 RRCNVD Investor's rate of return on convertible bond
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The programming language Pascal was developed in the late 1960s and early 1970s by Niklaus Wirth. According to Wirth, principal aims were to create a language suitable for teaching and facilitating disciplined and systematic programming and to develop reliable and efficient implementations of the language on computers then available. Here, we review four implementations of Pascal designed for today’s microcomputers. Three of these—Pascal/M, Pascal/MT+, and Pascal/Z—are designed to operate under the CP/M operating system; the fourth, Softech’s UCSD Pascal, is an entire operating system designed to run on a variety of microcomputers, including Z80-based machines.

Wirth’s Pascal, or standard Pascal, is defined in the Pascal User Manual and Report (K. Jensen and N. Wirth, New York: Springer Verlag, second edition, 1974) and is the common basis for the implementations considered. Each implementation is essentially a superset of this standard and incorporates features of the proposed International Standards Organization (ISO) draft proposal for the language, ISO/DP 7185. The ISO proposal extends Wirth’s Pascal.

Differences in Implementations

The four implementations of Pascal described here differ chiefly with respect to these kinds of features:

- Nature of code generated, whether machine code that can be directly executed in the target processor, or P-code (pseudo-machine code, also called intermediate code) that must be translated into machine code by an interpreter when the program is run.
- Types and variety of input and output primitives (intrinsic procedures for input and output).
- Support for separate compilation of modules or libraries of procedures and data structures (so that the separate modules can be called and used by other programs, eliminating the need to rewrite commonly used procedures).
- Support for memory overlays (an overlay is a section of code brought into main memory in an area previously occupied by another section of the same program). An overlay reduces the amount of main memory necessary for a program to run.
- Ease of use. The nature of the code generated and the steps required to generate it do much to determine ease of use.

We will describe each of the four implementations of Pascal and then examine the way they handle some of the Pascal features just mentioned. Some of the terms used to describe programming languages are defined separately in the text box “Programming Language Terms” on page 354.
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Pascal/Z

Ithaca Inter systems' Pascal/Z is a compiler for the Z80 processor and is designed to run under Digital Research's CP/M Version 2.2 operating system. Pascal/Z requires 56K bytes of RAM (random-access memory), including the space used by the operating system and at least one disk drive. According to the developer, the Pascal/Z compiler generates optimized macro-assembler code that is capable of being written into a read-only memory device (ROM-able) and capable of being interrupted and later reentered at the point of interruption (reentrant).

To execute a Pascal program with Pascal/Z, you must compile the source text, assemble the resulting Z80 assembler code, and link the resulting code file to a runtime library. The linked code is then ready for execution under CP/M.

The Pascal/Z compiler, assembler, and linker are all part of the Pascal/Z package, retailing for $395.

Pascal/M

The Pascal/M compiler, made by Sorcin of Santa Clara, California, is a one-pass compiler that produces a P-code file as output. Pascal/M was designed to run under CP/M 2.0, MP/M, Cromemco CDOS, and Oasis operating systems on Z80 or 8080/8085 machines. Pascal/M requires 56K bytes of memory and one disk drive. The Pascal/M package includes the compiler, a run-time library, and a run-time interpreter. It costs $225. (Our thanks to Digital Marketing of Walnut Creek, California, for making a copy of Pascal/M available to us.)

Pascal/M is identical to UCSD Pascal—in all its extensions to standard Pascal—with two important exceptions. The similarity includes the naming and definition of strings and the built-in procedures for handling them, along with low-level, byte-oriented procedures for moving information from one part of memory to another.

The important differences between Pascal/M and UCSD Pascal are in the operating system and library facilities. Pascal/M operates under CP/M, but UCSD Pascal is an independent operating system. Pascal/M has no apparent facility for separate compilation of libraries of procedures; UCSD Pascal is well endowed in this regard. Pascal/M allows memory overlays.

UCSD Pascal

UCSD Pascal, originally developed at the University of California, San Diego, is supplied by Softech Microsystems Inc. of San Diego. The UCSD Pascal system requires at least 48K bytes of contiguous RAM (64K bytes are recommended) and at least 175K bytes of disk storage.

UCSD Pascal comprises an entire operating system and can run on a variety of machines. The operating system includes a file handler, a character-oriented editor, a one-pass compiler that generates P-code, a conditional macro assembler, a linker, and a librarian utility. The operating
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system is written in Pascal and supported by a run-time interpreter written in the language of the host processor. The interpreter is part of the package, which retails for $500. A separate FORTRAN compiler is available for the system.

An important trade-off to be noted by CP/M users who are considering purchase of the UCSD system is its portability versus its incompatibility with CP/M. The UCSD system is portable because versions of the interpreter have been developed for a variety of microprocessors. Softech supports the system well, and this support will probably be extended to more processors in the future. The considerable advantage to the software developer is that UCSD Pascal programs can be transferred without modification from one hardware system to another.

Conversely, UCSD Pascal is incompatible with CP/M. Data files are not automatically transferable between CP/M and the UCSD system. This causes problems in maintaining the integrity of databases. The problems are only partially offset by the availability of programs to convert files from one system to another.

Pascal/MT+

Pascal/MT+ is a product of MT Microsystems of Cardiff-by-the-Sea, California. This Pascal includes a compiler, a linker, a disassembler, a debugger, and a run-time subroutine library. Pascal/MT+ requires an 8080 or Z80 processor running CP/M with at least 140K bytes of disk storage and 52K bytes of RAM, including space for CP/M. For developing large programs, a minimum of 300K bytes of disk storage and 60K bytes of RAM are suggested. The compiler generates relocatable, optimized Z80 code, or 8080 code (if desired) that must be linked to the run-time library. The Pascal/MT+ package costs $450.

Pascal/MT+ is an interesting and powerful tool. Alone among the four implementations, it supports passing of procedures and functions as parameters to other procedures and functions and supports "conformant" arrays—both features required by the ISO standard. In fact, Pascal/MT+ is the only implementation that claims full compatibility with the ISO standard.

The conformant-arrays scheme is important because there are no dynamic arrays in Pascal. The programmer must change the declaration of an array in the source program to change the bounds of the array at run time. This restriction imposes a burden on the programmer. The conformant-array scheme provides greater flexibility. For example, you can pass bounds derived by the source program to a library program, provided the array in the library program is of the same type as the array originally declared and the bounds passed are within those originally declared.

Pascal/MT+ provides several facilities for machine-level programming from Pascal and also makes possible the use of interrupts. Also, several non-standard data types are built in. For example, Pascal/MT+ provides two types of real data: fixed-point binary-coded and floating-point.

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### At a Glance

<table>
<thead>
<tr>
<th>Name</th>
<th>PasclZ, Version 3.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Software</td>
<td>Package implementation of Pascal programming language</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Ithaca Intersystems Inc</td>
</tr>
<tr>
<td></td>
<td>1650 Hanshaw Rd.</td>
</tr>
<tr>
<td></td>
<td>Ithaca, NY 14850</td>
</tr>
<tr>
<td></td>
<td>(607) 257-0190</td>
</tr>
<tr>
<td>Price</td>
<td>$395</td>
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<tr>
<td>Format</td>
<td>8-inch standard CP/M floppy disk</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Compiler</th>
<th>True Z80 compiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Needed</td>
<td>Any Z80-based computer running CP/M Version 2.2 with 54K bytes of RAM (64K preferred) and at least one disk drive (two drives preferred)</td>
</tr>
<tr>
<td>Documentation</td>
<td>A 198-page loose-leaf bound manual</td>
</tr>
<tr>
<td>Audience</td>
<td>Applications software developers, Pascal users</td>
</tr>
</tbody>
</table>

Pascal are the WHILE...DO, REPEAT...UNTIL, IF...THEN...ELSE, the FOR...DO loop, the CASE statement, and the GOTO statement. All of these constructs are supported in the four implementations. All the implementations but UCSD Pascal have provided for an OTHERWISE clause in the CASE statement—an addition included in the ISO standard. A restricted form of GOTO (which precludes exiting the body of a procedure) is supported in all versions except Pascal/MT+, which provides unrestricted GOTOS.

The primitive data types defined in standard Pascal include integers, reals, Boolean data, user-defined scalars and subrange types, and character data. The defined, structured types include arrays, sets of scalars, pointers, record types, and files of records. Wirth's Pascal calls for text files and permits packing of structured types to conserve memory space.

All these data types and structuring techniques except packing are available in each of the four Pascals. Packing is not explicitly available in the native-code compilers Pascal/Z and Pascal/MT+. These two allocate memory in bytes, whereas the other two allocate in words; that is,
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the native-code compilers always pack data. Generally speaking then, the native-code compilers are more conservative in terms of memory needed for data than are the other two implementations, although similar and sometimes even greater conservation can be achieved by packing data in the other two.

All the versions extend standard Pascal to include a predefined string type. Strings of length N may be defined up to a maximum length of 255, and the actual length of a string may vary from 0 to N during program execution. The next section discusses built-in procedures for manipulating strings.

Pascal/M and UCSD Pascal have provided long (32-bit) integers as a predefined data type. The operations permitted with long integers are addition, subtraction, and comparisons. Pascal/MT+ has provided two types of reals: floating-point reals and fixed-point, binary-coded decimal reals with 18 digits, four decimal. Pascal/Z provides floating-point reals and fixed-point reals with user-declared precision.

**Built-in Procedures and Functions**

Standard Pascal includes a number of intrinsic procedures and functions, including transcendental-arithmetic functions, memory-management procedures, and several

---

**At a Glance**

**Name**

UCSD Pascal, Version 2.0

**Type of Software**

Implementation of Pascal programming language, including the UCSD operating system

**Package**

Manufacturer
Softech Microsystems
9494 Black Mountain Rd.
San Diego, CA 92126

**Price**

$500. Note: price is for Version 4.0. We tested Version 2.0

**Format**

B-1nch IBM 3740-compatible disk

**Type of Compiler**

Pseudo-code compiler supported by a run-time interpreter

**Computer Needed**

Any Z80, 8080/8085, 6502, or 6800-based computer with 48K bytes of continuous RAM (64K recommended) and a floppy-disk system with at least 175K bytes of online storage, or any Digital Equipment Corp. LSI-11 or PDP-11 computer

**Documentation**

A 450-page, paper-bound manual includes documentation for the UCSD operating system

**Audience**

Applications software developers. Pascal users

**Comments**

The UCSD system has its own file handler and operating system, including compiler, linker, assembler, editor, and librarian utility. When the system is used on machines already equipped with CP/M, only the BIOS routines from CP/M are used. Non-CP/M users will need to write their own simplified basic input/output subsystem (SBIOS) and boot-strap module. Documentation for how to write the SBios is included.
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input/output (I/O) procedures. We will consider the I/O procedures in a later section; for now, we will concentrate on other intrinsics and built-ins.

In standard Pascal you are permitted to dynamically allocate and deallocate memory for user-defined data types on a variable-by-variable basis. Only Pascal/MT+ fully implements this standard. In the other versions, you can allocate space on a variable-by-variable basis, but you can only deallocate blocks of memory cells at a time. In these cases, memory is a heap of indistinguishable cells; the programmer can mark the top of the heap, dynamically allocate memory to variables, and then deallocate memory back to the old top of the heap.

A useful function for dynamic-memory management is one that returns the amount of memory available at the time the function is called. Such a function can inform the programmer that allocating more memory may clobber some portion of the current program. All but Pascal/Z provide this function.

All the versions have provided built-in functions for manipulating the string types just described. Pascal/Z provides functions for appending one string to another, determining the length of a string, and finding the position of a substring within a string. The other versions have these three built-in functions, and functions for inserting, deleting, and copying substrings from a string.

UCSD Pascal, Pascal/MT+ and Pascal/M have provided several high-speed, built-in procedures for moving bytes between memory locations. You can move data between packed arrays of data and similar data structures, initialize packed arrays, and search arrays for specified bit patterns on a byte-by-byte basis.

Pascal/M, Pascal/MT+, and UCSD Pascal have a procedure called EXIT that permits clean exits from procedures, functions, and programs. A typical application would be to exit a program after flagging an egregious user error, such as bad input from the keyboard.

Pascal/M and UCSD Pascal support random screen-cursor addressing through the built-in function GOTOXY(X,Y). Pascal/M also has built-in procedures that permit homing the cursor, clearing to end of line, and so on. UCSD Pascal supplies the utility program SETUP that matches the operating system to the characteristics of the user's terminal.

Pascal/MT+ has several built-in procedures and operators for byte and bit manipulation. For example, you can perform an "OR" operation on two integers that is a logical OR on their bit representations, and you can test bits, shift bits, and swap bytes in 16- and 8-bit variables. There are also built-in primitives for handling interrupts at the Pascal level. The programmer can enable and disable interrupts and designate up to seven Pascal proce-
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dures as interrupt procedures. The programmer assigns a vector number to an interrupt procedure and the compiler generates code to load the vector number with the procedure address.

Only Pascal/Z permits functions to return structured data values. In the other Pascals, functions can return only unstructured types.

Input-Output Procedures

Not surprisingly, there is significant variation in the I/O procedures that these four Pascals provide. The versions differ in adherence to standard Pascal and in their extensions to the standard.

Standard Pascal specifies four primitive file-handling procedures—GET(F), PUT(F), RESET(F), and rewrite(F), where F is an arbitrary file type—and certain procedures for reading and writing text files. PUT(F) appends data to F, GET advances the file-position pointer and retrieves the next record, RESET resets the file-position pointer to the beginning of the file, and rewrite initializes a file for writing. The text-file procedures are READ and READLN, which reads to the end of a line, and their counterparts WRITE and WRITELN. Left to the Pascal implementer is the way that an external disk file is associated with the internal file. Standard Pascal makes no provision for random access I/O.

Pascal/MT+, Pascal/M, and UCSD Pascal all supply the standard procedures; Pascal/Z subsumes the operations of GET and PUT under general-purpose READ and WRITE procedures. All four Pascals have simple methods for assigning disk files and external devices to internal file variables. All versions provide some form of random access for non-text files.

All four versions have built-in facilities for purging files from disk directories. All but Pascal/Z have an added procedure for closing an open file; in Pascal/Z, files are automatically closed on exit from the procedure block in which the file is declared, but there is no way to close a file explicitly.

Pascal/M, Pascal/MT+, and UCSD Pascal all provide a built-in function IORESULT that returns an integer value to indicate the result of the last I/O operation. The function can trap fatal execution-time I/O errors, such as failure to find a required disk file.$\text{UCSD Pascal, Pascal/M, and Pascal/MT+ all provide low-level procedures to perform I/O on untyped files. These procedures transfer memory-image bytes with no interpretation. In addition, Pascal/M and Pascal/MT+ provide built-in primitives for manipulating Z80 input-output ports.}$

Modules, Overlays and Chaining

Programmers developing large application programs face several problems that can become acute on microcomputers. Among these are limitations on memory size, the time-consuming need to recompile large programs when only small changes are made, and the need to link high-level programs to low-level routines for speed or convenience in special applications. The four Pascals reviewed here are reasonably well equipped with tools to solve these problems.

Two techniques for mitigating limitations on memory size are overlays (program segmentation) and chaining (calling one program from another). For the overlay approach, the programmer declares segments within a host program, with the segments either procedures or functions. A segment is brought into memory from disk when needed and remains active in memory only as long as needed; control returns to the host program. Segment procedures can access global data and procedures in the host program, just as they do ordinary procedures. With chaining, the currently active program calls the next link in the chain, which is then loaded from disk. There need be no host program per se and no relationship between the global declarations of chained programs.

UCSD Pascal and Pascal/M support overlays. In UCSD Pascal, a program can have a maximum of 16 segments, while Pascal/M can support as many as 10 segments. Both versions count the host program as one segment. Pascal/Z and Pascal/MT+ allow chaining. Both provide mechanisms for sharing global data between chained programs, but not for sharing global procedures. Pascal/Z, UCSD Pascal, and Pascal/MT+ support the ability to divide large programs into separately compil-
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UCSD Pascal offers UNITS, which consist of three major syntactical pieces: an INTERFACE portion, an IMPLEMENTATION portion, and initialization code. The INTERFACE portion contains the declarations (data, procedures, and functions) accessible to a host program. The IMPLEMENTATION portion contains the code for the procedures declared in the INTERFACE and any additional data structures and code required to perform the tasks of the unit; the latter declarations are not accessible to the host program. The initialization code is used to initialize the UNIT and is unknown to the host.

UCSD UNITS come in two varieties: intrinsic UNITS and regular UNITS. An intrinsic UNIT must be stored in the system library, which must be online when a program using the unit is executed. Intrinsic UNITS are prelinked to their hosts and do not have to be relinked if either the host or the UNIT is changed. Regular UNITS must be linked to the host by the programmer. Once linked, they need not be online, since the UNIT's code is duplicated in the host's code file. Regular UNITS count against the number of segments allowed in a program; intrinsic UNITS do not.

Pascal/MT+ provides what it calls modular compilation. When combined with a certain compiler option, this feature is comparable to the UCSD regular UNIT except for the initialization code. Pascal/MT+ modules may be somewhat more convenient to use than UCSD UNITS because the former can be broken into as many modules as desired at any time, while the latter require more forethought for effective use.

Pascal/Z provides a somewhat more limited version of modular compilation than Pascal/MT+. First, the number of modules is held to 10, including the host program. Also, there can be no hidden portions to a Pascal/Z module; in the language of UCSD UNITS, Pascal/Z modules consist of only an INTERFACE block. Finally, a Pascal/Z module cannot contain any global data declarations; it can only contain procedures and functions with local (private) data structures.

Like UCSD UNITS, Pascal/Z and Pascal/MT+ modules must be linked explicitly to their hosts. Unlike UCSD Pascal, Pascal/Z and Pascal/MT+ make the programmer responsible for insuring that data and procedures used by the host and its modules are declared consistently across modules.

Modules in Pascal/Z and Pascal/MT+ can freely use procedures declared in other modules. Procedures can be similarly cross-referenced by UCSD UNITS, but this requires more planning than in the other two Pascals.

Pascal/Z, Pascal/MT+, and UCSD Pascal all allow the user to link Z80 assembly-language programs to Pascal programs. Pascal/MT+ features a special declaration INLINE whereby the programmer can include hexadecimal code for machine-language programs in the body of a Pascal program without using externally assembled routines.
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Ease of Use

Ease of use of any given language implementation lies mainly with the user. Ease of use may be defined as a measure of how quickly and reliably an implementation can help a programmer accomplish a given programming task.

The main advantage of Pascal is the ease with which the programmer can express the control and data structures that seem to arise naturally when designing a program. Beyond the standard Pascal, however, there is much that the language implementer can do to simplify the programmer's job. Since the programmer spends (or should spend) a great deal of time designing and writing programs, the relevant question is whether the language implementation helps or hinders the programming process. String functions, for example, have proved very useful in manipulating character data of arbitrary length, and all the Pascals we examined had string functions in one form or another. We feel that other additions to standard Pascal can be of great help, as long as they do not detract too much from the resulting program's portability to other systems. We previously discussed most of these useful features.

In addition to programming ease, there is debugging ease that reduces the time necessary for the programmer to sit in front of the video display. The sequence of commands that the user types to compile, link, and run a program can be simple (e.g., with UCSD Pascal, in the simplest case, you can execute a source program just by typing an "R") or complex (e.g., Pascal/Z, which in the simplest case requires three separate CP/M commands to transform a source file into a runnable program). Fortunately, CP/M commands can themselves be gathered into a file and executed using the SUBMIT feature.

Finally, the documentation can be a source of either help or frustration. The manuals that accompany these packages are uniformly poor; unfortunately, they were probably written by the programmers who developed the packages. Any user who expects to learn Pascal from these will be bitterly disappointed. (Although to be fair, the manuals do not claim to be tutorials.) We also found the manuals disorganized, with poor indexes and tables of contents. Finding the answer to any specific question was a challenge, and the clarity of the English in the documentation is best left without critique.

We mentioned earlier that UCSD Pascal comprises an entire operating system, but failed to express the grief we experienced in getting the system configured for our machine, compounded by the confusing and contradictory documentation. The configuration process per se is simple. The difficulty is in reaching the point at which you can start the configuration process.

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We point this out not to dissuade the reader from using UCSD Pascal, but to inform you of what to expect. If you are interested in UCSD Pascal, it may be worthwhile to seek out a configuration matched to your machine. Some preconfigured versions are available.

**Benchmarks**

To test each version of Pascal for speed, ease of use, and other features, we wrote and ran a series of benchmark programs. We did all testing on a Cromemco System III computer, which has 64K bytes of memory and two 8-inch floppy-disk drives capable of handling more than a million bytes of data each. The CP/M-compatible versions of Pascal were run under CP/M version 2.2 (from Intelligent Terminals Corporation). We timed the programs using Mountain Computer's 00,000 Day Clock. The results appear in table 1.

A few words of caution: the results of these (or any other) benchmarks should not be taken as absolute indicators of any Pascal’s inherent quality. Our programs are necessarily simple and relatively portable between the different implementations. We certainly do not represent these programs as the “best” programming solutions available for the problems they solve.

Our first benchmark, PRIMES (see listing 1), is a program to calculate the first 1000 prime numbers, using a method from Donald Knuth’s *The Art of Computer Programming, Volume I: Fundamental Algorithms* (Reading, MA: Addison-Wesley, 1968), pages 143-144. The only statements that needed change, as we moved from one version of Pascal to the next, were in the routine to read the time from the Mountain Computer clock board, which required Z80 hardware port input. Pascal/M and Pascal/MT+ had intrinsic routines to do such input; for UCSD Pascal and Pascal/Z, we wrote small assembler routines to do the job. To minimize rewriting, we isolated the version-dependent code in a function that was different for each implementation.

We also made two ease-of-use measurements while we were compiling and running the program. First, we measured the time needed to transform the Pascal source file into a running program. For the CP/M Pascals, we used a SUBMIT file containing the necessary commands...
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Listing 1: PRIMES, a Pascal program that calculates the first 1000 prime numbers, based on an algorithm from Donald Knuth's The Art of Computer Programming, Volume I: Fundamental Algorithms.

```
PROGRAM PRIMES;
CONST
  maxvec=14; (* used by the timing routine *)
  np=1000; (* number of primes *)
TYPE
timevec=ARRAY[0..maxvec] OF INTEGER;
VAR
  Junk, large:REAL;
  t:timevec;
  Pr:ARRAY[1..np] OF INTEGER;
  J, k, n, q, r:INTEGER;

FUNCTION Portin (Port:INTEGER):INTEGER; (* Pascal-M version *)
VAR
  i:INTEGER;
BEGIN
  import(Port, i);
  Portin:=i;
END;

FUNCTION tick(VAR t:timevec):REAL;
CONST
  basePort=32;
VAR
  i:INTEGER;
  prev:timevec;
BEGIN
  FOR i:=0 TO maxvec DO
    prev[i]:=t[i];
  FOR i:=0 TO maxvec DO
    t[i]:=Portin(basePort+i);
  tick:=0.0001*(t[0]-prev[0])+ (* 100 microseconds *)
    0.001*(t[1]-prev[1])+ (* milliseconds *)
    0.01*(t[2]-prev[2])+ (* 10 milliseconds *)
    0.1*(t[3]-prev[3])+ (* 100 milliseconds *)
    1.0*(t[4]-prev[4])+ (* seconds *)
    10.0*(t[5]-prev[5])+ (* 10 seconds *)
    60.0*(t[6]-prev[6])+ (* minutes *)
    600.0*(t[7]-prev[7])+ (* 10 minutes *)
    3600.0*(t[8]-prev[8])+ (* hours *)
    3600.0*(t[9]-prev[9])+ (* 10 hours *)
    86400.0*(t[10]-prev[10])+ (* days *)
    86400.0*(t[11]-prev[11])+ (* 10 days *)
    864000.0*(t[12]-prev[12])+ (* 100 days *)
    8640000.0*(t[13]-prev[13])+ (* 1000 days *)
    86400000.0*(t[14]-prev[14])+ (* 10000 days *)
END;

BEGIN
  writeln('The first ', np, ' primes: ');
  Junk:=tick(t);
  Pr[1]:=2;
  Pr[2]:=3;
END.
```

Listing 1 continued on page 338
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to eliminate variation due to typing speed. We started timing when the compilation of the program began and stopped when the program’s message “The first 1000 primes:” was displayed. Then we counted the number of keystrokes that would have been necessary for compilation.

As expected, we found that the execution time of programs produced by the native-code compilers was much less than that of programs produced by the P-code compilers. On the other hand, the compilation time and the number of keystrokes necessary to run the program were much greater for the native-code compilers; there is a trade-off between calculational speed and ease of use. Perhaps the ideal situation would have P-code used for software development and native code employed for the final version.

Our second benchmark is PRECISION (see listing 2). It is an attempt to determine the precision of floating-point calculation for each Pascal. We calculated two numbers, BIG and SMALL. BIG was defined to be the largest number such that:

\[(\text{BIG} + 1.0) > \text{BIG}\]

given the limitations of floating-point arithmetic. Similarly, SMALL was defined to be the smallest number such that:

\[(1.0 + \text{SMALL}) > 1.0\]

Here we found that all our Pascals had approximately seven digits of precision, some slightly more and others slightly less. (Note that all four versions include some means of doing extended-precision arithmetic.)
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A specification sheet and price list are available, free. Your check or money order for $75 will purchase the AMX Reference Manual for immediate evaluation (specify 8080, 8085, 8086 or 6809 processor). Add $25 for postage and handling outside USA and Canada. The standard AMX Multitasking Executive package, including source code, is available for $800 after signing our liberal license agreement.

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Our third benchmark, BLOWUP (see listing 3), was designed to measure the amount of memory each implementation had available for dynamically allocated variables. The program successively allocates 100-byte blocks of memory until a run-time error occurs due to lack of additional memory. The program continuously prints out the number of blocks it has successfully allocated; the last number it prints (before the run-time error), divided by 10, is the approximate dynamic-memory space in kilobytes. All the versions of Pascal except for Pascal/MT+ generated such an error; running the program with Pascal/MT+ eventually caused the system to "hang," apparently due to overwriting the memory containing the program or the operating system. Pascal/MT+ does not check for such memory overflow; the programmer must do it with one of the built-in procedures. (For many programmers, this may be a desirable feature.)

From this program we found that the native-code compilers have more space for program code and dynamic variables than do the P-code versions. This is probably because of the extra memory required for the P-code interpreters, which results in less memory available to user programs. This test is somewhat misleading, however, since for larger programs this situation could be reversed. P-code should be more compact than native code, and the compactness should atone for the interpreter overhead in large programs. (We did not test this hypothesis.)

The final benchmark is called BENCHMARK (see listing 4), which is an attempt to measure the different Pascals’ performances in the more realistic applications of sorting, disk I/O, and data-structure generation. The program first generates a pseudorandom array of 1024 integers, then writes it to disk. (Pascal allows writing the entire array as a single entity, which turns out to be infinitely faster on our system than writing each element of the array individually.) The array is sorted using the Shell-Metzner algorithm. The random array is then read back into memory from disk (again, as a single entity) and sorted using the Quicksort algorithm. (Both sorting algorithms are adapted from Algorithms Plus Data Structures.)
Softlights

By Fred Huntington

We are proud to introduce our first major piece of software, Understand Yourself. Written by Mike Taylor, this series of programs based on the Chicago Review Press book, The Test Yourself Book by Dr. Harry E. Dunn.

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Circle 181 on inquiry card.

BYTE March 1983 341
Listing 3: BLOWUP, a program that measures the amount of memory available for dynamically allocated variables. The program successively allocates 100-byte blocks of memory until a run-time error occurs.

```pascal
PROGRAM blowup;
CONST
  blocksize=100;
TYPE
  byte=0..255;
  block=PACKED ARRAY[1..blocksize] OF byte;
  block ptr=^block;
VAR
  r:block ptr;
  i,j:INTEGER;
BEGIN
  i:=0;
  WHILE TRUE DO
    BEGIN
      new(r);
      FOR j:=1 TO blocksize DO
        r^[j]:=0;
      i:=i+1;
      writeln(i);
    END;
END.
```

Listing 4: BENCHMARK, a program that measures performance in tasks that occur commonly in applications programs. The program generates a random array of integers; writes the array to disk; sorts the array with the Shell-Metzner algorithm; reads the random array back into memory from disk; sorts the array with the quicksort algorithm; reads the unsorted array into memory yet again, using the integers as keys by which dummy data are stored in a binary tree; and writes the tree elements individually to disk. Along the way, the program displays the array elements on the terminal screen to insure that the disk input/output and the sorts are done correctly, as well as to see how fast each version of Pascal can output text.

```pascal
PROGRAM benchmarks;
CONST
  maxlength=1024;
  maxvec=14; (* Part of timing package *)
TYPE
  index=0..maxlength;
  vector=ARRAY[index] of INTEGER;
  link=^node;
  dummydata=RECORD
    key:INTEGER;
    frequency:index;
    datafield:STRING[16];
  END;

  node=RECORD
    dd:dummydata;
    left,right:link;
  END;

  timevec=ARRAY[0..maxvec] OF INTEGER; (* Part of timing package *)
VAR
  v:vector;
  root:link;
  nodecount:INTEGER;
```

Listing 4 continued on page 344
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Listing 4 continued:

Junk: REAL; part of timing package
timevec

(* define 'portin' and 'tick' as in PROGRAM Primes; *)

FUNCTION portin(port: INTEGER): INTEGER;
BEGIN
...
END;

FUNCTION tick(VAR t: timevec): REAL;
BEGIN
...
END;

PROCEDURE randomen(VAR v: vector);
VAR s: INTEGER;
  i: index;

FUNCTION random(VAR seed: INTEGER): INTEGER;
CONST
  multiplier = 3;
  increment = 5;
  modulus = 8192;
BEGIN
  random := seed;
  seed := (multiplier * seed + increment) mod modulus;
END;

BEGIN (* randomen *)
  s := 3;
  FOR i := 1 TO maxlen DO
    v[i] := random(s);
END;

PROCEDURE writearray(VAR v: vector);
VAR
  f: FILE OF vector;
BEGIN
  rewrite(f, 'vector.dat');
  f^ := v;
  put(f);
  close(f, lock);
END;

PROCEDURE readarray(VAR v: vector);
VAR
  f: FILE OF vector;
BEGIN
  reset(f, 'vector.dat');
  set(f);
  v := f^;
END;

Listing 4 continued on page 346
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Listing 4 continued:

```pascal
PROCEDURE shellsort(VAR v: vector);
VAR jump, m, n, index:
  temp: INTEGER;
  done: BOOLEAN;
BEGIN
  jump := maxLen - 1
  WHILE jump > 1 DO
    BEGIN
      jump := jump DIV 2
      REPEAT
        done := TRUE
        FOR m := 1 TO (maxLen - jump) DO
          BEGIN
            n := m + jump
            IF v[n] > v[n + jump] THEN
              BEGIN
                temp := v[n]
                v[n] := v[n + jump]
                v[n + jump] := temp
                done := FALSE
              END;
            END;
          END;
        UNTIL done;
      END (* FOR *);
    END (* WHILE *);
END; (* shellsort *);
```

```pascal
PROCEDURE quicksort(VAR v: vector);
PROCEDURE sort(left, right, index:
  pivot, temp: INTEGER);
REPEAT
  i := left; j := right;
  pivot := v[left + (right - left) DIV 2]
  REPEAT
    WHILE v[i] < pivot DO i := i + 1;
    WHILE v[j] > pivot DO j := j - 1;
    IF i < j THEN
      BEGIN
        temp := v[i]
        v[i] := v[j]
        v[j] := temp
        i := i + 1
        j := j - 1
      END;
    UNTIL i < j;
  IF left < j THEN sort(left, j);
  IF i < right THEN sort(i, right);
END;
BEGIN
  sort(1, maxLen);
END;
```

Listing 4 continued on page 348
Are you keeping up with computer salaries?

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Two Northfield Plaza, Suite 227
Northfield, Illinois 60093
PROCEDURE treegen(VAR root:link;VAR v:vector); 
VAR
  nodecount:INTEGER;
  i:index;

PROCEDURE insert(VAR ref:link;VAR nodecount:INTEGER;newkey:INTEGER); 
BEGIN
  IF ref=nil THEN
    BEGIN
      new(ref);
      nodecount:=nodecount+1;
      WITH ref DO
        BEGIN
          left:=nil;
          right:=nil;
          WITH dd DO
            BEGIN
              datafield:='0123456789ABCDdef';
              key:=newkey;
              frequency:=1;
            END;
        END;
    END;
  ELSE WITH ref DO
    BEGIN
      IF newkey<dd.key THEN insert(left,nodecount,newkey)
      ELSE IF newkey>dd.key THEN insert(right,nodecount,newkey)
      ELSE (*duplicate key! update frequency.*)
        dd.frequency:=dd.frequency+1;
    END;
  END;

BEGIN
  root:=nil;
  nodecount:=0;
  i:=0;
  REPEAT
    i:=i+1;
    insert(root,nodecount,v[i]);
  UNTIL i=maxlen;
  writeln('nodecount,' distinct nodes created.');
END;

PROCEDURE writetree(root:link); 
VAR
  dummyfile:FILE OF dummydata;
  counter:INTEGER;

PROCEDURE traverse(ref:link;VAR counter:INTEGER); 
BEGIN
  IF ref<>nil THEN
    BEGIN
      traverse(ref^.left,counter);
      dummyfile^:=ref^.dd;
      put(dummyfile);
    END;
  END;

Listing 4 continued on page 350
More performance than you ever imagined — for $1995. If you're considering a DEC* terminal, C. Itoh now has two reliable alternatives that could easily change your mind.

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Before you order a VT100, think twice.
Listing 4 continued:

```
counter:=counter+1;
traverse(ref^.right, counter);
END;
END;

BEGIN
rewrite(dummyfile,'dummy.dat');
counter:=0;
traverse(root, counter);
close(dummyfile, lock);
writeln(counter,' records written. ');
END;

PROCEDURE disarray(VAR v:vector);
VAR
i:index;
BEGIN
FOR i:=1 TO maxlength DO writeln(v[i]);
END;

PROCEDURE dispreee(ptr:link);
BEGIN
IF ptr<>nil THEN BEGIN
  dispreee(ptr^.left);
  writeln(ptr^.dd.key);
  dispreee(ptr^.left);
END;
END;

BEGIN
Junk:=tick(t):
random(v);
writeln('Random array generation took ',tick(t)," sec.");

disarray(v);
writeln('Displaying array took ',tick(t)," sec.");

writearray(v);
writeln('Writing array to disk took ',tick(t)," sec.");

shellsort(v);
writeln('Shell sort took ',tick(t)," sec.");

disarray(v);
writeln('Displaying array took ',tick(t)," sec.");

readarray(v);
writeln('Reading array from disk took ',tick(t)," sec.");

disarray(v);
writeln('Displaying array took ',tick(t)," sec.");

quicksort(v);
writeln('Quick sort took ',tick(t)," sec.");
```

Listing 4 continued on page 352
Listing 4 continued:

disparray(v);
writeln("Displaying array took ",tick(t)," sec.");
readarray(v);
writeln("Reading array from disk took ",tick(t)," sec.");
disparray(v);
writeln("Displaying array took ",tick(t)," sec.");
treeseen(root,v);
writeln("Generating binary tree took ",tick(t)," sec.");
dispreee(root);
writeln("Displaying tree took ",tick(t)," sec.");
dispreee(root);
writeln("Writing tree to disk took ",tick(t)," sec.");
END.

Text continued from page 340:

Tures Equals Programs by Niklaus Wirth, Prentice-Hall, 1975.) After this, the unsorted array is again read into memory, and the integers are used as keys by which dummy data are stored in a binary tree. The tree elements are then written individually to disk. The array elements are displayed on the monitor along the way to insure that the disk I/O and the sorting are done correctly. Displaying the array also measures how fast the Pascal can output textual information.

The incompatibilities between the Pascal implementations for this program only involved the way the disk data were accessed. Slight changes in the program were made for opening, closing, reading, and writing to the disk files. (Obviously, the changes described for reading the clock also had to be made.)

Again, native-code compilers were faster in the computation-intensive tasks such as sorting and were also noticeably faster in output to the terminal. All Pascals took about the same time to write and read from the disk.

The four Pascals reviewed here defy classification as good or bad; they seem almost to represent different philosophies of language implementation. We cannot recommend one Pascal over another or say that you would find any of them unacceptable for your purposes. We only hope that you now have enough information to decide for yourself.

Updates seem to be published faster than magazines are. Some information on new versions of the Pascals tested in this article is given on page 356. . . . G.W.
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- IBM System 34 drives
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**Product Specifications**
- Capacity: Unformatted: 1.6M bytes/disk; IBM Format: 1.2M bytes/disk
- Recording Density: 6816 BPI
- Track Density: 48 TPI
- Cylinders: 77
- Tracks: 154
- Recording Method: MFM
- Rotational Speed: 360 RPM
- Transfer Rate: 500K bits/second
- Latency (avg.): 83 ms
- Access Time: Track-to-track 3 ms; Settling 15 ms;
- Average 91 ms
- Head Load Time: 35 ms
- Disk: 20" or equivalent
Programming Language Terms

Machine language, also called object code, is binary; it consists entirely of zeros and ones. Words made of zeros and ones represent both op codes, which define basic operations in the processor, and addresses of the data on which an operation is to be performed. The accurate reading and writing of machine language is difficult.

Machine-language statements that use the correct op codes for a specific processor are said to be the native code for that processor.

Intermediate between machine language and higher-level languages like Pascal is assembly language. Assembly language substitutes standard mnemonics—more easily remembered names—for machine-language instructions. Statements in assembly language are not directly executable. An assembler is a program that translates assembly-language code into machine code; a macro assembler allows the programmer to use a single name to represent a sequence of assembly-language instructions. Assembly-language mnemonics vary from one processor to the next, and an assembly-language program written for one processor will not run on another.

A compiler is a program that translates the programmer's statement in a source language or higher-level language (such as BASIC or Pascal) into machine language. The resulting machine-language code needs no support software to run (except an operating system). Compilers process an entire program at one time; the resulting machine-language code can be executed only after the whole program is compiled.

Single-pass compilers complete the translation of a program in source language into machine language in a single, continuous operation. Multiple-pass compilers divide the process of translation into different stages. The advantage of multiple-pass compilers is that they usually reduce demands on main memory, though single-pass compilers work faster.

An interpreter is a program that translates each source-language statement into machine language as the statement is read and then immediately executes the machine-language translation of the statement.

Some higher-level language implementations such as CBASIC (from Compiler Systems) and Pascal/M compromise between the compiler approach and the interpreter approach. These implementations compile source code into a noneexecutable intermediate code; a separate interpreter must then be run to execute the intermediate code. The intermediate code produced by a Pascal compiler is called P-code. Unlike assembly language, P-code is the same for different versions of Pascal that use the intermediate-code approach.

A linker is a program that combines into a single module two or more program segments that have been separately compiled.

A program library is a set of programs distributed with a program language to provide code to perform frequently used operations. Programmers save time and labor by incorporating code from the library in programs under development. A linker can incorporate library program segments into a program whose other segments were written by an applications programmer and separately compiled.

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Pascal Updates

Each Pascal has been revised and improved in the past few months. All of the vendors claim bug fixes, increased speed for low-level support routines, and better user interfaces. We were unable to test the new versions. Version numbers and prices were current as of October 1981.

Pascal/Z Version 4.0

An interactive debugger and the ability to segment programs are the major additions to Pascal/Z. The debugger is fully symbolic. Among other things, you can symbolically display and modify local and global variables (including record fields), trace program flow, and display run-time memory requirements.

Overlays, or segments, are compiled separately like modules. They are then processed by a system program that prepares the memory maps and relocation information needed by a host that uses the overlay. Finally, they are linked to the host.

Version 4.0 costs $395. The cost of updating from Version 3.3 is $50; new manuals are included in the update.

Pascal/M Version 4.02

Major enhancements to Pascal/M are an interactive symbolic debugger, the ability to perform 16-digit BCD arithmetic, and an increase from 10 to 40 in the number of program segments permitted.

Pascal/MT+ Version 5.5

Several changes have been made to Pascal/MT+ to increase its power and compatibility with other CP/M software. The compiler has been reduced in size by 7K bytes, substantially adding to the amount of symbol table space for compiling user programs. Users can compile larger programs than were heretofore possible.

A converter program has been added to the collection of utility programs. The new program converts code files produced by the compiler to a format acceptable to Microsoft linkers. Overlays are now allowed. A program is permitted 16 overlay “areas” with up to 16 overlays per area. The programmer is burdened with supplying code address information to the linker before the overlays can be used by a host program.

The new version can be purchased with a speed programming kit that consists of a menu-driven program whose operations include a screen-oriented character editor, a Pascal syntax scanner for preprocessing program texts, and an identifier frequency counter. The latter can be used, for example, to spot identifiers referenced only once in a program, such as uncalled procedures or unconnected variables.

The manuals have been rewritten with improved indexes. Version 5.5, including the speed programming kit, is $475.

UCSD Pascal Version 4.0

(Note: Version 3.0 is specially designed for Western Digital's Microengine.)

Major enhancements to UCSD Pascal include an increase in the number of segments and units allowed to 255 and easier compilation and cross-referencing of units, facilitating the development of very large application programs. Programmers can also control the residency of segments and units in memory through calls to intrinsic procedures. Overlay segments can be protected from being overwritten by other segments until the programmer permits, and potentially time-consuming, annoying disk I/O (due to repeated calls to a segment) can be defeated. Chaining is also permitted in Version 4.0.

Procedures for memory management have also been augmented. One of these permits a form of dynamic arrays and should considerably increase the ease of development for libraries of procedures operating on arrays.

Concurrent processes have been implemented in Version 4.0. Concurrent processes, or tasks, are controlled by "semaphores" (a term coined by E. W. Dijkstra), which synchronize tasks and control access to critical code sections and resources. Semaphores can be associated with hardware interrupts so that interrupt handlers can now be written in UCSD Pascal.

Intrinsic procedures for redirecting program and system I/O have been included. Redistribution of system I/O means that the system can be driven from a script in a manner similar to CP/M's SUBMIT facility. Redirection of program I/O enables the programmer to collect the input to (or output from) a program from any peripheral device or disk file.

Additions to the system's utilities include an interactive debugger, a procedural cross-referencer, and a console screen control unit. The documentation has also been completely rewritten.

Version 4.0 costs $500. Preconfigured versions are available for a variety of machines.
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Circle 80 on inquiry card.
Microsoft's BASIC Compiler for the TRS-80

Mahlon G. Kelly
268 Turkey Ridge Rd.
Charlottesville, VA 22901

At a Glance

Name
BASIC Compiler

Type
A BASIC compiler package, including a compiler, linker, routine library file, and run-time package

Manufacturer
Microsoft Consumer Products
400 108th Ave., Suite 200
Bellevue, WA 98004

Price
Model I, $195

Format
Model I, 5-inch floppy disk; also available for the TRS-80 Model II

Language
280 machine language

Computer needed
TRS-80 Model I, minimum of 48 K bytes of memory and one disk drive

Documentation
More than 200 pages in a three-ring binder

Audience
TRS-80 BASIC programmers who want to increase the speed of their programs

Do you have friends who tell you that BASIC is a toy language or that it's only for beginners and those too lazy to learn more "sophisticated" languages? Such snobs seem to fall into one of three categories: the machine- or assembly-language fan who wants to commune directly with the hardware and keep track of where every bit goes; the structured-program maven who feels that the machine must force a person to write well-organized programs; and the traditionalist who still thinks that the only "real" higher-level languages are FORTRAN, COBOL, and ALGOL.

Machine and assembly languages are essential when you need fast execution that can't be accomplished with a higher-level language. Structured languages like Ada and Pascal make it much easier to monitor long, convoluted programs.

But we should listen carefully to the traditionalists; they probably learned to program on an IBM 650 in 1956 and have sage minds. Most of them will tell you that FORTRAN, COBOL, and the like are superior because they are compiled languages that use a computer much more efficiently. They forget that BASIC—originally written at Dartmouth College as a simple beginner's language for easy interaction with the computer—is now at least as sophisticated and as easily compiled as older languages.
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Listing 1: A small BASIC program used to demonstrate the compiler.

10 DEFNSNG A-Z
20 FOR I = 1 TO 2000
30 A = I + 2
40 NEXT I
50 PRINT CHR(7)

What It Does
A compiler is a machine-language program that translates a higher-level language, such as FORTRAN or BASIC, into machine code. This compiled program can be stored on disk and run as if originally written in machine language. On the other hand, an interpreter, used in many microcomputers with BASIC, "translates" each line of a program while the program is running. If a line is executed many times, it must be "translated" many times.

A compiled program is therefore much faster than an interpreted one and uses the computer more efficiently despite the lengthy compilation time (which need only be done once). Compilation also allows more flexibility and offers options unavailable with interpretation. Conversely, an interpreted program can be run immediately, without waiting for compilation, and thus is much easier to debug, edit, and modify. Although this may be a poor practice, it is a good way to learn programming and is usually necessary to refine a moderately long program.

Microsoft's BASIC compiler gives you the best of both worlds. It is now possible to debug and modify a program using the TRS-80's built-in interpreter. Then, when it's doing just what you want, it compiles the program to get rapid execution.

I've often wished I could do that with FORTRAN on our university's Cyber 172; in fact, I have been known to write and rewrite a program in interpreted BASIC until it did what I wanted, then translate it "by hand" into FORTRAN for fast execution.

We can evaluate the Microsoft compiler in five ways: ease of use (and quality of documentation); compatibility with TRS-80 disk BASIC; speed; added features compared to interpreted BASIC; and any special quirks, bugs, or problems that may get in the way.

This compiler has many versions; the one I review here is the latest available for the TRS-80. It is much improved over that machine's first version, and anyone with the earlier version can obtain an update from Microsoft for a nominal charge.

Procedures for Use
The compiler is very easy to use, although that's not conveyed in Microsoft's documentation. The compiler is really a package of four software modules: the actual compiler (BASCOM/CMD); a library file (BASLIB/REL); a linker (L80/CMD) that links machine code from the library file to the program as compiled by BASCOM; and a "run-time package" (BRUN/CMD)
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Listing 2: The compiled version of the program shown in listing 1.

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0014 0007 10 DEFSNG A-Z
** 0014' CALL $4.0
** 0017'L00010:

0017 0007 20 FOR I = 1 TO 2000
** 0017'L00020: CALL $FASA
** 001A' DW II
** 001C' DW ,CONST.
** 001E'L00000:

001E 000B 30 A = I + 2
** 001E'L00030: CALL $FADA
** 0021' DW II
** 0023' DW ,CONST.
** 0025' CALL $FASO
** 0028' DW AI

002A 000F 40 NEXT I
** 002A'L00040: CALL $FADA
** 002D' DW II
** 002F' DW ,CONST.
** 0031' CALL $FASO
** 0034' DW II
** 0036' CALL $LEIA
** 0039' DW II
** 003B' DW ,CONST.
** 003D' DW 100000

003F 000F 50 PRINT CHR$ (7)
** 003F'L00050: CALL $PROA
** 0042' LD HL.0007
** 0045' CALL $CHR
** 0048' CALL $PV2D

004B 000F ** 004B' CALL $END

005C 0019

0000 FATAL ERROR(S)
08219 BYTES FREE

Listing 3: The same compiled version of the program, except with two errors inserted to show the response of the compiler.

BASCOM 5.23 - COPYRIGHT 1979, 80 (C) BY MICROSOFT - 13512 BYTES FREE

0014 0007 10 DEFSNG A-Z
** 0014' CALL $4.0
** 0017'L00010:

0017 0007 20 FOR I = 1 TO 2000
** 0017'L00020: CALL $FASA
** 001A' DW II
** 001C' DW ,CONST.
** 001E'L00000:

001E 000B 30 A = I + 2
** 001E'L00030: CALL $FADA
** 0021' DW II
** 0023' DW ,CONST.
** 0025' CALL $FASO
** 0028' DW AI

002A 000F 40 NXT 1
** 002A'L00040:
** error pointer, syntax error SN

Listing 3 continued on page 364
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*Data Source: Epson MX-80 Operation Manual

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Tekwriter-2 is especially well suited to handle word processing applications because of its data buffer expansion capabilities to 25K. This ability makes it an efficient graphics generator.

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with additional machine code accessed by the linked program while it is running.

Compilation is best understood by following a program through the whole process. Programs are compiled in many ways, but the following procedure is used in almost all cases. (Other options, invaluable when needed, are rarely used.) First, write and debug a BASIC program (see listing 1). The program is then saved as an ASCII file, using the command:

```
SAVE "TEST1/BAS", A
```

(My most common error is forgetting to save it as an ASCII file; also, the BAS extension is needed for recognition by the compiler.) After returning to the DOS with CMD "S", the program is compiled by typing the command:

```
BASCOM TEST2=TEST1
```

This will produce a listing file (called TEST3/LST) of the compiled code in assembly language (see listing 2) and a partially complete and relocatable machine-language program (called TEST2/REL) that must be linked to other machine code using L80.

```
TEST1/BAS was the BASIC source program.
```

Error diagnosis is excellent—any errors in the BASIC source code will be listed on the screen and shown in the listing file (see listing 3). The command:

```
L80 TEST2,TEST4=N=E
```

will link machine code from BASLIB/REL and produce the file TEST4/CHN (for chain) from TEST2/REL. The "N" and "E" are "switches" that in turn tell L80 to write the /CHN file to disk and exit to DOS. A variety of other switches are available for L80 and BASCOM. Again, errors will be listed to the screen. TEST4/CHN can then be run as a machine-language program with the command:

```
BRUN TEST4
```

Obviously BRUN/CMD must be available any time the program is run, but the other programs are unnecessary. Other names could have been used for any file, and disk drive numbers could have been specified. Usually, all of the names are the same (e.g., TEST/XXX). In that case, we create files called TEST/BAS, TEST/LST,
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Circle 432 on Inquiry card.
TEST/REL, and TEST/CHN. If the compiled program runs correctly, the /LST and /REL files can be deleted.

Although the procedure I describe is used with three disk drives, the sequence is very similar using one or two drives, though disk swapping is necessary. Actually, the process is so cumbersome with one drive that Microsoft doesn't recommend it. (Microsoft also points out that, for almost all purposes, 48 K bytes of memory are needed.) Three double-density drives are ideal. I can use drive 0 for the operating system, drive 1 for the compiler software and Microsoft's FORTRAN and macro assembler, and drive 2 for the various programs.

At this point, the compiler may seem awkward. With practice, it's simple to use and any program needs compilation only once if interactively debugged. Also, the compilation time is very short in relation to the run time if the program is to be run several times. There are some cases, however, when compilation is superfluous. For example, a program that spends most of its time with disk I/O (input/output) will gain little speed by compilation. On the other hand, a program that does a lot of iterative number crunching with little I/O will be greatly quickened. If you use short programs or those that wait a long time for I/O, a compiler won't help much.

### Flexibility and Documentation

The compiler is designed to be very flexible; in fact, I can't fully describe its tremendous range of options. For example, subroutines written in Microsoft FORTRAN can be called from BASIC by using the command:

```
CALL SUBR (A, B, C)
```

where SUBR is the name of a subroutine in a compiled (but not linked) FORTRAN program and A, B, and C are variables to be passed to the subroutine as sequentially declared in the FORTRAN subroutine statement. You can write a personal subroutine library in FORTRAN that can be called from BASIC. The ability to write a user library of language-independent subroutines is usually found only on mainframe computers or very large minicomputers. Working with the compiler on a microcomputer is much less awkward than it would be on a large computer system. This means, however, that L80 must have a provision for specifying a FORTRAN program that will be searched for subroutines. In other words, flexibility means some complexity in compilation, and there are a wide variety of different procedures for compilation. For example, typing BASCOM and then after a prompt:

```
TEST2, *PR = TEST1
```

sends the listing to a line printer. Many other features are too complex and lengthy to be described here.

Unfortunately, this flexibility and complexity mean rather unclear documentation. Microsoft has tried to describe all of the options, special features, and peculiarities of the system before a user becomes acquainted with the rudiments. In some instances, the system's complexity seems to have confused even the writer of the manual.

For example, in one section a COMMON statement is described in great detail, while another section tells us that it's not implemented. In another case, it gives an excellent table comparing Level II BASIC, disk BASIC, and "standard" Microsoft BASIC (BASIC-80) with compiled BASIC, but several statements and commands that are available in compiled BASIC (and BASIC-80) are omitted.

The manual is very complete and includes an introductory section (confusing); a technical section (also confusing) detailing the features of compiled BASIC; and the BASIC-80 manual that gives the syntax of statements not found in either Level II or TRS-80 disk BASIC, but with (distractingly) almost everything in the TRS-80 lan-

### Table 1: Execution speeds with the above statements substituted for line 30 in Listing 1.

<table>
<thead>
<tr>
<th>TIMES (seconds)</th>
<th>Integer</th>
<th>Single Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Interpreted</td>
<td>Compiled</td>
</tr>
<tr>
<td>PRINT(i)</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>A = PEEK(i)</td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>A = LEFT$(&quot;ABC&quot;, i)</td>
<td>37</td>
<td>6</td>
</tr>
<tr>
<td>A = SQR(3.14159)</td>
<td>149</td>
<td>50</td>
</tr>
<tr>
<td>A = 1 + 2</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>FORJ = Y100+NEXT</td>
<td>169</td>
<td>4</td>
</tr>
</tbody>
</table>

---

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guages described as well. I spent several days trying to decipher some simple features (like the CALL statement mentioned above), but everything I needed to know was eventually found within the several different sections. The software is easily used, but the simplicity is obscured by very confusing documentation. In fairness to Microsoft, I have seen much worse obfuscation in documentation from CDC, DEC, and IBM.

Compatibility
The package is compatible with TRS-80 disk BASIC. Disk BASIC is more forgiving in some things, like FOR . . . NEXT loops, but if you use legal disk BASIC the compiler will recognize everything (except, of course, things like EDIT and CLOAD). CLEAR is not needed by the compiler, but if it's in the source program it will be ignored and a nonfatal error message will be given (which may be ignored). Also, there's no provision for data I/O with tapes. There are a few other minor differences, but almost any program written in standard TRS-80 BASIC will compile successfully. The reverse, however, is not true. The compiler recognizes many statements and commands not used by TRS-80 BASIC.

Speed
All compiled programs are much faster, but the compilation process itself takes some time. The trivial program in listing 1 took less than two minutes to compile and link. A game using 11K bytes took one minute and 46 seconds to compile and two minutes and 50 seconds to link without a listing file. With a BASIC listing file but no object code between the lines, compilation took two minutes and 11 seconds, and the listing file required about 14K bytes or 13 "grans." It was impossible to compile the program with object code; the listing file needed more than 100 grans of disk space. This is a problem with the compiler that's not mentioned in the documentation; object code listings may need more storage than is available on any blank disk. However, it's probably never necessary to get a complete listing file with object code. A "-N" switch after the BASCOM line will inhibit the object code.

Some differences in run times for various interpreted and compiled programs are given in table 1, which shows the execution times for statements placed in line 30 of listing 1. Speed increases vary from more than 40 times, with integer variables in simple functions, to less than three times faster using SIN, COS, and similar functions. Nevertheless, there's always a speed increase that varies depending on the program.

Special Features
Compiled BASIC has many features unavailable in interpreted TRS-80 BASIC. In fact, they're not all listed in the documentation. Table 2 gives the additional statements and commands, although they are too numerous to fully describe. For example, SWAP( A,B ) exchanges the value assigned to the two variables, and transcendental functions will return double precision. Perhaps the most important are WHILE and WEND statements; they allow writing structured program code. Variables may be of any length; that is, the compiler will consider J, JOS, and JOSEPH to be different variables. This may pose a problem when compiling a program that uses variable abbreviations; the compiler may recognize more variables than were originally intended.

Microsoft's original BASIC compiler had many defects, but all of the problems seem cured in this new version. I have some BASIC programs that will not compile using BASCOM, but that's always because standard TRS-80 conventions were not used. For example, Radio Shack's backgammon game will not compile because it branches to subroutines from within a loop; that is disallowed but forgiven by interpreted BASIC. Also, some things may be mistaken for bugs. For example, I thought there were problems with linking because L80 is different for Microsoft FORTRAN and BASIC. But the two act the same if a "-R" switch is used with the BASIC version.

Table 2: Some statements, commands, etc., supported by Microsoft's compiled BASIC, but not by TRS-80 disk BASIC.

<table>
<thead>
<tr>
<th>OPTION BASE</th>
<th>SWAP</th>
<th>WAIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHILE</td>
<td>WEND</td>
<td>WIDTH</td>
</tr>
<tr>
<td>FRE</td>
<td>HEX$</td>
<td>OCT$</td>
</tr>
<tr>
<td>INP$</td>
<td>INPUTS</td>
<td>LPOS</td>
</tr>
<tr>
<td>POS</td>
<td>SPACES</td>
<td>$PC</td>
</tr>
<tr>
<td>CHAIN</td>
<td>NINCLUDE</td>
<td></td>
</tr>
</tbody>
</table>

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I've yet to find any "real" bugs—only things that I either misinterpreted or didn't understand.

If you have code that you want to run faster, or if you need any of the features like a FORTRAN library, this is definitely a worthwhile product. If you're not accustomed to a compiler, compilation may be annoying. But this is a professional package, just as flexible and much easier to use than some compilers on mainframe computers.

Conclusions

Microsoft’s BASIC compiler allows compilation of any BASIC program written for a disk-based TRS-80. This results in a three to 30 times increase in execution speed. The system includes a compiler (BASCOM), linker (L80), routine library (BASL8), and run-time package (BRUN). For most purposes, 48K bytes of memory and two disk drives are needed. The package is nearly identical to the interpreter that Microsoft designed for the TRS-80.

The software is readily used by those familiar with a compiler and compilation is quick. The documentation is confusing but complete, and a novice should be operating the system within an hour. Full use of its very flexible and extensive special features will require several days' study, which would be reduced with better documentation.

There are more than 20 features in the package that are not available in disk BASIC, including structured loops and calls to FORTRAN subroutines. Because of ambiguities in documentation, full use of the features requires long study and experimentation.

This is a very professional software package that gives the TRS-80 features found only on much larger systems. Except for the documentation, the package is superlative in all respects.

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The TRS-80 microcomputer has evolved from a rather simple, cassette-based experimenter's delight to a complex and powerful disk-centered system. With disks came the necessity of a DOS (disk operating system) for control and communication with the computer. The first DOS came from Radio Shack, but independent vendors have since released others. The latest of these is LDOS from Logical Systems Inc.

LDOS was created out of need. Lobo Drives International wanted to market a new disk interface for the TRS-80 Model I that supported not only 5¼-inch floppy disks, but 8-inch and hard disks as well. Additionally, the floppy-disk interface supported both single- and double-density operation. At the time of the hardware design, no existing DOS could support this diversity of hardware. Therefore, LDOS was created. Originally, it started as a debugged and enhanced version of VTOS 4.0. However, the present version is essentially all new code. VTOS users will be quite comfortable with LDOS because the command structure and syntax of VTOS have been largely maintained. The present version of LDOS supports both the Radio Shack expansion interface and the Lobo LX-80 interface. It is compatible with TRSDOS 2.3. Also, it supports both the Percom Doubler and double-sided operation. A version of LDOS is also available for the TRS-80 Model III.

It is always difficult to review a software product of this magnitude. I hope I have successfully avoided the tendency to get lost in infinite detail. I will stress the highlights of the system based on extensive use of LDOS 5.0.2 on a Model I and limited use of LDOS 5.1 on a Model III. The features discussed reflect primarily LDOS 5.1. As this is being written, this latest version, called 5.1.1 for the Model I, has just been released. Therefore, the operating features of both Model I and Model III LDOS are identical.

The LDOS Command Library

TRSDOS 2.3 could be viewed as a subset of LDOS. Every TRSDOS command has been implemented, and most have been significantly enhanced. LDOS also provides many new commands never previously available on any one TRS-80 DOS. Table 1 contains a brief listing and descriptions of the major enhancements and extensions found in LDOS. The major features are described below.

If you do any assembly-language programming, you will find the LDOS extended DEBUG a tremendous tool. All of the old commands are included, but many new ones have been added, too. Some of the extensions are:

- enter data directly into entire sections of memory
- fill a block of memory with a specific byte
- jump over a byte in program execution
- locate first occurrence of a specific byte or word in memory
- print a block of memory
- send or display a byte to or from any I/O (input/output) port
- type ASCII (American Standard Code for Information Interchange) characters directly into memory
- compare two blocks of memory

There is also a disk read/write utility that allows reading or writing to any sector of any disk, even the directory sectors!

The fact that LDOS supports hard disks and 8-inch floppy disks is evident in the changes to the DIR (directory) command. An unconditional call for a disk directory on a 10-megabyte hard disk would be a messy proposition. LDOS allows directories...
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by class and date. For example, a directory of only files with the extension "/TXT" could be shown. Or all files created on, before, or after a specific date could be shown. This is a real time-saver when you are trying to find a specific file in a full disk. Any DIR command also shows the amount of free space in kilobytes on a specific disk, as well as the usual disk name, creation date, and drive number.

The LINK and ROUTE commands are very sophisticated and offer features normally found only on minicomputer and mainframe operating systems. LDOS is a device-independent operating system. Each peripheral is seen by the operating system as a DCB (device control block) in memory independent of the actual hardware. This means that data can be transferred between peripherals (called devices) in any manner you want. Additionally, so-called dummy-devices can be created so that data intended for one destination can be made to go elsewhere (a disk file, for example). In essence, device-independence allows you to redirect I/O any way you like without having to rewrite the machine-language I/O drivers. This may sound terribly complicated, but it is extremely easy to use and offers unbelievable versatility.

The ROUTE command allows you to change the destination of data. For example, routing the video to the line printer forces anything normally displayed on the screen to be printed on the printer. Another application for ROUTE is to send anything from the RS-232 serial port to a disk file, instead of the screen, when the computer is unattended. LINK is similar to ROUTE in function. However, instead of redirecting data to another device, it simultaneously adds a second (or third, or fourth . . . ) destination device. This would allow you to send anything appearing on the screen to the printer, too, or vice versa. I have a disassembler that only goes to the screen. By linking the video display to the printer, the assembled code appearing on the screen is simultaneously sent to the printer, thus providing hard copy. The LINK command takes 10 seconds to type in; writing a new I/O driver could have taken days.

The SPOOL command has many uses, but its greatest application is when long printouts are required. Rather than tying up the computer completely while printing, SPOOL sends the data to be printed to a buffer located in memory or on a disk. Then, as the computer has time (in between keystrokes, for example), the data are sent to the printer. You can choose the size of the buffer, as well as whether to spool to memory or the disk. When using SPOOL, it seems that the TRS-80 is doing two things at once. However, it's just using time much more efficiently! Small-business users will love this feature because you can print a long report or a general ledger and use the computer for other things at the same time.

A final highlight of the LDOS library is the SYSTEM command. This allows you to customize LDOS for a particular installation. The disk-drive stepping rate, blinking cursor, keyboard type-ahead, and break key disable are but a few of the many features that can be configured. The final configuration can then be saved. Each time that LDOS system disk is booted, the configuration is also loaded. SYSTEM will be a real favorite with a single-drive user because it allows you to load many of the "/SYS" files into memory. This in turn frees a great deal of disk space for data. It also has the effect of speeding up disk I/O since overlays are not being called from the disk. Potentially, you could have the full operating system at your disposal, and about 60K bytes of disk space in a single-drive, single-density, 35-track system. Finally, SYSTEM allows you to reallocate physical drive, or logical drive 0. You must load LDOS the usual way, but after that anything goes. This will find application among Model III users who have a 35-track drive left from their Model I. By making this external drive the system drive, the two higher-capacity 40- or 80-track drives in the Model III

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPEND</td>
<td>Can ECHO to screen while appending, and can back up 1 byte in destination file to merge script files.</td>
</tr>
<tr>
<td>ATTRIB</td>
<td>Can make files VISible and INvisible.</td>
</tr>
<tr>
<td>AUTO</td>
<td>Can disable BREAK key.</td>
</tr>
<tr>
<td>BOOT</td>
<td>Software reset &quot;button.&quot; Reloads LDOS.</td>
</tr>
<tr>
<td>BUILD</td>
<td>Creates ASCII or HEX files for PATCHing, JCL, etc.</td>
</tr>
<tr>
<td>COPY</td>
<td>Simplified syntax. Can specify LRL, CLONE attributes of source file. ECHO characters to screen while copying. Single-drive copy from non-system disk.</td>
</tr>
<tr>
<td>CREATE</td>
<td>Preallocate disk space for a file in either kilobytes or number of records.</td>
</tr>
<tr>
<td>DEBUG</td>
<td>Extended significantly (see text).</td>
</tr>
<tr>
<td>DEVICE</td>
<td>Shows all important disk-configuration data.</td>
</tr>
<tr>
<td>DIR</td>
<td>Extended significantly (see text).</td>
</tr>
<tr>
<td>DO</td>
<td>Used to execute JCL file.</td>
</tr>
<tr>
<td>DUMP</td>
<td>Will dump in ASCII. End of text marker can be specified.</td>
</tr>
<tr>
<td>FILTER</td>
<td>Modify I/O flow.</td>
</tr>
<tr>
<td>FREE</td>
<td>Shows amount of space used and available, creation date, disk name, number of directory entries used and available, free space in K, and space map. Can be sent to printer.</td>
</tr>
<tr>
<td>LINK</td>
<td>Change I/O flow (see text).</td>
</tr>
<tr>
<td>LIST</td>
<td>Can number lines, dump in HEX, expand tabs, begin at specific record or line number, specify LRL, and output to printer.</td>
</tr>
<tr>
<td>LOAD</td>
<td>Can load from a non-system disk in single-drive systems.</td>
</tr>
<tr>
<td>MEMORY</td>
<td>Can show or modify top of memory. Can display, jump to, or modify specific memory locations.</td>
</tr>
<tr>
<td>PURGE</td>
<td>Multiple kill of files.</td>
</tr>
<tr>
<td>RESET</td>
<td>Reconnect peripherals to standard I/O drivers.</td>
</tr>
<tr>
<td>ROUTE</td>
<td>Modify I/O flow (see text).</td>
</tr>
<tr>
<td>RUN</td>
<td>Execute file from non-system disk on a single-drive system.</td>
</tr>
<tr>
<td>SET</td>
<td>Connect device to new I/O driver routine.</td>
</tr>
<tr>
<td>SPOOL</td>
<td>Data spooler (see text).</td>
</tr>
<tr>
<td>SYSTEM</td>
<td>Configure system parameters (see text).</td>
</tr>
</tbody>
</table>

**Table 1:** The major enhancements of LDOS as compared to TRSDOS 2.3. Not all library features are listed here.
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are free to handle data disks.

LDOS Utilities
LDOS includes the familiar BACKUP and FORMAT utilities, which have been greatly enhanced, plus several new utilities. As with the command functions, BACKUP and FORMAT provide support for larger disk drives. BACKUP by class can be invoked, for example, to back up only nonsystem files. FORMAT provides the necessary functions to format disks of various sizes, densities, and single- or double-sided usage. As with most sophisticated operating systems, LDOS requires that a disk be formatted before a backup is allowed.

CMDFILE is a utility that allows the transfer of files stored on tape to disk, or vice versa. Where necessary, the utility will offset program locations from the tape version to insure that there is no conflict with the operating system is encountered. Disk-to-disk transfers are also supported. The PATCH utility allows modification of disk files to make minor changes or repairs without having to rewrite the entire file. Model III LDOS comes with a CONV utility to convert Model III TRSDOS disks to LDOS.

A final utility of interest is LCOMM. It provides communications software compatible with both the Radio Shack and the Lobo LX-80 serial ports. This is not a "dumb-terminal" program, but a full-blown communications package with features like file transfers and downloading.

LDOS Filters and Drivers
One of the unique features of LDOS is its ability to "filter" data. By loading an appropriate program, it is possible to modify data before they are sent to a particular device. Three such filters are provided with LDOS, but documentation is provided to help the assembly-language programmer write others. The KEYSTROKE MULTIPLY filter allows you to program any key to generate a phrase when pressed. I programmed some commonly used BASIC phrases into my keyboard. By pressing CLEAR and G together, the phrase GOTO is generated. Another possible application for this filter would be to reduce complicated DOS commands to a single keystroke. LDOS does provide abbreviation for certain commonly used library commands such as FREE and DIR by means of the MINIDOS filter. The third filter is the PRINTER filter. Its features include adding a linefeed after a carriage return, specifying the number of characters to be printed on a line, and setting the left margin of the printed page.

Logical Systems is also releasing an entire disk of filter routines to be used with LDOS. This disk will sell for $60. It has many extended features, such as redefining every ASCII character. This would allow, for example, translation from ASCII to another data code such as EBCDIC. Another filter on this disk allows decimal and hexadecimal arithmetic while in another program (EDTASM, for example).

LDOS has a provision for loading custom I/O drivers as well. With one command, it is possible to change peripheral control from the LDOS drivers to one you have written. An RS-232 driver is provided for applications involving the serial port.

Job Control Language
It is impossible to do justice to the Job Control Language (JCL) feature short of writing a separate review of it. This is essentially a way of writing programs using LDOS library commands. Let's say you want to load a disk, and then on have hands-off operation while the computer updates your mailing list, realalphabizes it, and prints labels. Normally, you would have to type in four separate DOS and BASIC commands:

BASIC
RUN "NEWDATA"
RUN "ALPHABET"
RUN "LABELS"

In LDOS, you simply create a file with these commands in it (using the LDOS BUILD command or a text editor such as Scripsit). Then tell LDOS to DO this file and sit back! Program execution is automatic. JCL
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also has the capability of prompting the user for input from the keyboard, to make decisions, to wait for a specific time on the clock before executing, and many other features. One application could be running long business programs unattended at night. This feature alone is worth the entire package price.

**LBASIC**

As with Disk BASIC 2.2, LBASIC is an adjunct to the BASIC interpreter in the TRS-80. It is compatible with programs written in Radio Shack BASIC, but has extended features that significantly enhance the language.

LBASIC adds many new random and sequential file controls. One of the best is the implementation of the Blocked File mode. In this mode of operation, an LRL (logical record length) between 1 and 256 bytes per record may be selected. This means that although the physical record size is still 256 bytes per record, you can deal with logical records that are less than this. Let’s say you wanted to write a random-access file that contained nothing but names up to 32 characters long. Rather than FIELディング the buffer for eight separate data fields and writing 256-byte records, LBASIC allows you to have records that are exactly 32 bytes long as far as you are concerned, while maintaining actual physical records that are 256 bytes. Another random-access file control, OPEN, has been modified to allow the opening of a file only if it already exists or, conversely, only if it does not already exist.

The sequential file controls have been enhanced as well. It is now possible to write to the end of (append) a sequential file directly without having to first load the file into memory, modify it, and write it back to disk. As with the random files, OPEN can be made dependent upon whether the file does or does not already exist.

LBASIC implements some features that greatly enhance writing and debugging programs. The more commonly used BASIC commands such as AUTO, EDIT, and LIST have been reduced to a single-letter command, and it is possible to single-step through a BASIC program. To facilitate program documentation and debugging, LBASIC includes a powerful line-renumber command and a cross-reference generator.

Several totally new BASIC commands have been added. RESTORE lets you go to a specific line of a program rather than always to the first DATA statement. When chaining programs, it is possible to specify at what line of the next program execution is to begin. Variables can also be passed from program to program while chaining. Thus, it is no longer necessary to save the variables in a file and read them back in when the next program has been loaded. A final addition is the ability to reset the EOF (end-of-file) marker in a random file, effectively allowing you to make random files smaller at will.

A final enhancement in LBASIC is the extended use of the CMD com-
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mand. Any legal LDOS command that does not affect protected memory can be executed from within LBASIC. To do a directory, for example, simply type in CMD "DIR". You can also load "/CMD" files from LBASIC by typing in CMD "filespec".

Documentation

It is claimed that of the approximately $100,000 spent on the LDOS project, the manual alone cost more than $25,000 to develop. This is not difficult to believe because LDOS has the best, most comprehensive documentation and manufacturer support I've ever seen for a microcomputer. In excess of 250 pages, the LDOS manual is plainly the work of professionals. It will bring particular joy to assembly-language programmers because all major system entry vectors are thoroughly documented and all old documented TRSDOS vectors have been maintained. (I gained a great deal of insight into TRSDOS by reading the LDOS technical section.)

The non-technical user is by no means left out though. The manual is extremely readable and full of good examples.

The documentation is further supported by a toll-free telephone number, an excellent update policy, a Micronet bulletin board, and a quarterly news magazine. The phone-in customer service is available for four hours daily. The magazine is free for the first year. New releases of LDOS can be obtained by sending $5 and the original master disk to the manufacturer. If you prefer, you can update LDOS by logging in to Micronet and copying the updated version at no charge. As newer versions of LDOS become available, existing owners will be able to upgrade to the new version for a nominal fee (depending on the nature of the new revision). In short, the LDOS documentation and support system have no peers. They can be expected to become the standard by which all others are measured.

Benchmarks

LDOS boots quickly and seems to operate quite efficiently. One of its nicer features is the fact that the real-time clock is kept on during disk I/O operation. While this keeps the clock much more accurate than other systems, it can lead to a rather mysterious problem. If the disk drive is turning at exactly 300 rpm (revolutions per minute), the interrupt for the clock can occur at the same time the directory track becomes available to be read. This can result in long waits during disk I/O. The problem is remedied by reducing disk-drive speed by several rpm. The first quarterly magazine includes a BASIC program that indicates drive speed allowing you to see if your drives need a slight readjustment. The 15 minutes it takes to do this minor correction is a small price to pay for the added clock accuracy, though, and the problem is intermittent and minor at most.

Listing 1 is the Benchmark program used to compare the speeds of TRSDOS and LDOS.
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and TRSDOS. Table 2 is a summary of the results of that benchmark. For the Model III, TRSDOS 1.3 was used. The Model I benchmark presented a problem since TRSDOS 2.3 does not officially support variable LRLs (i.e., logical record lengths less than 256 bytes). The latest version, TRSDOS 2.3B, does support variable LRLs on the Radio Shack Compiler BASIC package, but not with the interpreter. Variable LRLs are partially implemented in TRSDOS 2.3 and 2.3B, but they cause errors to occur. In investigating this, I discovered that it was possible to write records in this file mode, but not to read them. Furthermore, the write procedure appeared to work fine, except that when the file was to be CLOSED an error message appeared. Consequently, the timings given for TRSDOS on the Model I should not be treated as true benchmarks. They are included here only as a point of interest. It is interesting to note that, even with the errors being generated, the figures for the Model I and Model III are remarkably similar. This seems to indicate that, if Radio Shack ever implemented variable LRLs on the Model I, no significant improvement in efficiency could be expected unless the entire procedure was rewritten.

Summary and Conclusions

It is probably apparent that I really like LDOS. It is by far the most sophisticated piece of systems software available for the TRS-80 (and probably for any computer priced under $5000). It offers unprecedented features, giving the TRS-80 new applications previously impossible without a massive programming effort. I had been considering selling my Model I and upgrading. After using LDOS, it became apparent that, while I might improve the hardware, I would be hard-pressed to come up with a more usable and better supported system in an affordable price range.

Specifically, LDOS offers these unique features:

- A level of documentation and technical support almost unheard of in anything but minicomputers and mainframes.
- Virtually problem-free operation.
- The possibility of true portability between members of the TRS-80 family, as well as some S-100 computers. Versions of LDOS for the Model II and certain S-100 computers are planned. These will probably be CP/M-compatible to some extent and will allow transporting data disks between any machines running under LDOS (provided the media are compatible).
- An exceptional bargain! If the individual features of LDOS were bought separately, the price would be near $1000. The SPOOL feature alone would cost almost as much as the complete LDOS package.

It is difficult to conceive of a TRS-80 user who would not benefit from LDOS. In fact, the overall programming efficiency should at least double. Even if you are using another advanced DOS, it would be worthwhile to look into LDOS because its advanced features are yet to be rivaled in any one competitive operating system. If you are about to purchase a disk system or a new DOS, you'll find LDOS to be a professional, debugged, and efficient tool that will free your time and talents to write better applications software.

<table>
<thead>
<tr>
<th>Function</th>
<th>TRS DOS 1.3</th>
<th>Real Time</th>
<th>Clock Time</th>
<th>LDOS 5.1</th>
<th>Real Time</th>
<th>Clock Time</th>
<th>TRS DOS 2.3B</th>
<th>Real Time</th>
<th>Clock Time</th>
<th>LDOS 5.0.2</th>
<th>Real Time</th>
<th>Clock Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write New File LRL = 2 2000 Records</td>
<td>13:23</td>
<td>2.09</td>
<td>1.28</td>
<td>1.28</td>
<td>13:36</td>
<td>-----</td>
<td>1.37</td>
<td>1.38</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Write To Existing File LRL = 2 2000 Records</td>
<td>1.21</td>
<td>0.13</td>
<td>0.09</td>
<td>0.09</td>
<td>1.23</td>
<td>-----</td>
<td>0.11</td>
<td>0.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read Existing File LRL = 2 2000 Records</td>
<td>6.37</td>
<td>1.54</td>
<td>0.49</td>
<td>0.49</td>
<td>-----</td>
<td>1.05</td>
<td>1.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Write New File LRL = 128 200 Records</td>
<td>1.52</td>
<td>0.26</td>
<td>1.05</td>
<td>1.05</td>
<td>1.42</td>
<td>-----</td>
<td>1.28</td>
<td>1.30</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Write New File LRL = 256 100 Records</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>0.45</td>
<td>0.20</td>
<td>0.55</td>
<td>0.55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read Existing File LRL = 256 50 Records</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>0.10</td>
<td>0.11</td>
<td>-----</td>
<td>-----</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: The results from the Benchmark program. Times given are in minutes and seconds. Blank spaces indicate tests not run on the Model III, or not possible with the Model I.
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</thead>
<tbody>
<tr>
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</tbody>
</table>

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COBOL for the TRS-80 Models I and III

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COBOL on a TRS-80 Model I? Yes, I was skeptical myself. Visions of COBOL’s notoriously verbose source code rapidly filling memory and floppy disks led me to believe that Radio Shack had probably exceeded the limitations of the TRS-80 this time. I have been surprised in the past by some things people have converted from mainframes and minicomputers to microcomputers, but COBOL seemed like too much. Now, after substantial use of the system, I can happily report that Radio Shack’s COBOL package is professionally done and well suited to the TRS-80.

COBOL is the most widely used programming language in the world. Over the years, the American National Standards Institute (ANSI) CODASYL committee has overseen the evolution of COBOL into a powerful language highly suited for business applications. It is particularly strong in its file-handling capabilities. Also, Radio Shack has announced that all the business-application software it develops in the future for the TRS-80 Model II will be done in COBOL.

Radio Shack COBOL (RSCOBOL) is a complete COBOL program development system. It implements a substantial portion of the ANSI X3.23-1974 COBOL Standard (the most recently approved standard). The package contains two 5¼-inch floppy disks for the TRS-80 Model I and one for the Model III. My report is based on the use of the Model I system. The Model III version is supposed to be functionally identical.

The disks contain:
1. CEDIT, a line-oriented text editor for preparing COBOL source programs. This editor is similar to the one provided with the Model I EDTSAM (Editor-Assembler) package, with tab settings for COBOL and several additional commands.
2. The RSCOBOL compiler supplied in Z80 machine-language format. It produces an object file, listing file, and cross-reference list in a single pass over the source code.
3. The RUNCOBOL run-time package, including an interactive COBOL debugger. The output of the RSCOBOL compiler can be run immediately with no need to go through a linking/loading phase, such as the one required by Radio Shack’s FORTRAN package.

At a Glance

<table>
<thead>
<tr>
<th>Name</th>
<th>RSCOBOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>TRS-80 COBOL development system</td>
</tr>
<tr>
<td>Author</td>
<td>Ryan-McFarland Corporation Software Products Group Aptos, CA 95003</td>
</tr>
<tr>
<td>Distributor</td>
<td>Tandy Corporation One Tandy Center Fort Worth, TX 76102 (817) 390-3583</td>
</tr>
<tr>
<td>Price</td>
<td>$199</td>
</tr>
<tr>
<td>Software</td>
<td>All software needed to run COBOL on both Model I and Model III TRS-80s, provided on three 5¼-inch floppy disks. This includes a line-oriented text editor, an overlayed COBOL compiler, interactive COBOL debugger, and run-time package.</td>
</tr>
</tbody>
</table>

Software Format
Model I version requires TRSDOS 2.3B, which is provided with the package; Model III version requires TRSDOS 1.1, which is also provided.

Computer
TRS-80 Model I or III with 48K bytes of RAM and at least two disk drives

Documentation
Concise but complete explanation of system operation, lengthy and thorough description of language, written in the style of a reference manual, not a tutorial: 368 pages.

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BYE March 1982 385
A New TRSDOS
TRSDOS 2.3B is being provided with RSCOBOL, the new RBASIC Model 1 BASIC Compiler, and the Series 1 Editor/Assembler. Each of these packages requires TRSDOS 2.3B and will not run under older versions of TRSDOS or other disk operating systems from alternate vendors (at least not at the time of this writing; the alternate DOS vendors will probably do something to remedy this situation).

Because of its dependence on certain features of TRSDOS 2.3B, the RSCOBOL package cannot be used without modification on systems that support double-density disk storage on the Model I, such as LDOS and NEWDOS/80, although the extra disk storage would certainly be useful for this package.

A utility, UPGRADE, is provided to convert a disk made with older versions of TRSDOS to run under 2.3B. However, once the disk is upgraded it cannot be used with an older TRSDOS. UPGRADE also deletes any system (TRSDOS) files that happen to be on the disk being upgraded. Therefore, make sure you really want this to happen before you run the program.

The major change to TRSDOS is in the way it maintains the end-of-file (EOF) information in a disk's directory. The old systems maintained a 2-byte count of sectors in use by the file, plus a 1-byte offset of the last byte in use in the last sector. The new system maintains these 3 bytes differently. Together, the 3 bytes comprise a true total byte length of the file; if the EOF offset byte is not zero, the sector-count byte is one less than it was under the old system.

New TRSDOS
One of the biggest surprises of this package was the introduction of a new version of DOS (disk operating system) for the Model I, TRSDOS 2.3B. I had seen no mention of this upgrade when I purchased RSCOBOL. Although this new release is only slightly different from TRSDOS 2.3, one of its changes is significant enough to make 2.3B disks incompatible with any other TRS-80 disk operating system, including NEWDOS, LDOS, TRSDOS 2.3, and its predecessors. This raises many "interesting" (read "painful") problems with file sharing between the various systems.

System Overview
The RSCOBOL system is heavily disk oriented. It requires two disk
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drives. Since the compiler and the run-time module both use overlays, these disks must always be online during compilation and execution.

During compilation, the files in table 1 must be online. During execution of COBOL programs, the files in table 2 must be online. The best way to set up the disks in a two-drive system is to have the disk in drive 0 containing TRS-80 Monitor and either of these all the files needed to compile a program or all the files needed to run one. This allows the disk in drive 1 to be formatted as a "data disk," with all its space available for COBOL source code, object code, and/or the files used by applications programs. In fact, the disk containing both TRS-80 Monitor and the run-time system has enough space for a sizable COBOL object program, allowing drive 1 to be used entirely for data.

Unfortunately, Radio Shack didn't see it this way and its disks are set up differently. Only the run-time disk contains the TRS-80 Monitor system files. This disk does not contain the run-time debugger overlay, RSCBLD13/OBJ. That file is on the disk that must go in drive 1. The second disk contains the COBOL compiler, all overlays, and the COBOL editor. Even if this disk does not contain TRS-80 Monitor, you must have a disk containing TRS-80 Monitor in drive 0 while you are compiling. Where should you put your COBOL source code and object code? Take your pick, but you must share space on the same disk with either TRS-80 Monitor or the compiler and its overlays.

Why the fuss about file placement? After all, can't you just use COPY to move the files around to achieve more logical placement? Due to an inexplicable move on Radio Shack's part, you can't. Although the disks as a whole can be copied freely, the BACKUP utility, all the COBOL system files are password protected and can't be copied individually. Frankly, the logic of this escapes us. There is no protection against piracy as both disks may be copied freely without restrictions. But the license owner of the system is prevented from moving individual files around to increase the usefulness of the system. Does anyone in Fort Worth care to explain this policy? It is either a slip-up or Radio Shack is trying...
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Radio Shack replied saying that they have been using this same method of protecting their application software program files on all Model II software. They stressed that this does not represent a change in Tandy policy and emphasized that there are no restrictions on backups, only on copying individual files. . .[SJW]

For those who own disk editors such as Apparat's Superzap and are familiar with the disk-directory structure, it is a simple matter to overcome this problem by zapping the passwords. However, sensible use of the system should not be restricted to those with this knowledge.

One of the biggest surprises was the Introduction of a new version of DOS for the Model I.

On the positive side, all components of the RSCOBL system appear to honor the high memory pointer address stored at location hexadecimal 4049. This is not documented, but by using a disassembler I found code referencing hexadecimal 4049 during the start-up phase of both the compiler and the run-time package in a manner that suggested it was using hexadecimal 4049 as a pointer to the top of available memory. I have also been using a serial printer driver that protects itself by storing the last available address below itself at hexadecimal 4049. I have experienced no difficulties with the use of this driver during compilation and execution of COBOL programs. If you have an application for this, I recommend careful testing to make sure that it works.

In case you haven't seen a reference to this before, most Model I DOS systems, including TRSDOS 2.3B, store a pointer at location hexadecimal 4049 to the last byte of available memory. Anything stored after the address contained in hexadecimal 4049 is "protected"; programs that follow this protocol, as RSCOBL appears to, are careful not
A Sample RSCOBOL Program

The sample RSCOBOL program shown in listing 1 prompts the user to type in a selection key (a string of up to five characters); it then reads through a sequentially organized disk file and compares the first five characters of each record in that file against the string typed in at the keyboard. All records whose first 5 bytes match the specified string are listed on the screen. This process is repeated until the user types Q, instead of a key value.

The IDENTIFICATION DIVISION of the program, lines 1 through 7, is treated as a comment by the compiler. It tells the program’s name, its author, and the date it was written.

The ENVIRONMENT DIVISION contains a CONFIGURATION SECTION. This identifies the SOURCE COMPUTER, or the system on which the program was compiled, as RMC (Ryan-McFarland COBOL). The OBJECT COMPUTER is the system on which the program will run; this is also RMC.

The INPUT-OUTPUT SECTION serves to establish connections between real disk file names and program identifiers for files. In this instance, line 17 logically connects the program file identifier INF/LE with the TRSDOS file INF/LE/DAT:1. A program variable could have been specified instead of the literal string INF/LE/DAT:1, which would have allowed the file name to be specified at run-time rather than compile-time. The keyword INPUT specifies that this file is to be used for INPUT only.

The DATA DIVISION contains declarations for all program variables. Program variables in COBOL are referred to as “data items.” The FILE SECTION contains a description of the disk records that will be read from the sequentially organized file INF/LE. The WORKING-STORAGE SECTION contains declarations for all the program data items. IN-RECORD is the name for the “group” data item comprising RECORD-KEY and REST-OF-RECORD. The clause PIC X(5) on RECORD-KEY declares that data item to be a 5-byte long string of alphanumeric characters. (PIC stands for PICTURE; X stands for a number or an alphabetical character.)

The data item USER-QUITS-FLAG in line 32 illustrates one of COBOL’s powerful tools for enhancing program readability. This flag is a 3-byte character string (PIC XXX) that initially has the value “NO”. USER-QUITS in line 33 is a “Level 88” item: it gives a name to a possible value of USER-QUITS-FLAG. In line 54 of the program, the statement PERFORM GET-KEY-AND-SEARCH-FILE UNTIL USER-QUITS serves to repeatedly perform the code paragraph labeled GET-KEY-AND-SEARCH-FILE until the USER-QUITS-FLAG assumes the value named by USER-QUITS, in this case the string “YES”.

MORE-DATA-REAINS-FLAG is another example of the use of “Level 88” data items.

REQUEST-KEY-MSG and WAIT-MSG are data items containing prompts to be printed on the screen using the DISPLAY statement. The VALUE clause gives them initial values.

The PROCEDURE DIVISION of a COBOL program is where the work gets done. It is divided into “paragraphs,” each labeled by a name starting in the second column. The first paragraph is named RECORD-Seleccion-AND-DISP/:LAY. It contains only two statements: one that has been explained already, and STOP RUN, which halts program execution and returns control to TRSDOS.

The next paragraph, labeled GET-KEY-AND-SEARCH-FILE, is the one PERFORMed repeatedly by the first paragraph. It clears the screen (ERASE) and puts the REQUEST-KEY-MSG on the second line of the screen. It then ACCEPTs a user response from the keyboard, which goes into the data item called SELECT-KEY. POSITION 0 means leave the cursor where it is; PROMPT puts out a prompt of underscores the size of the data item SELECT-KEY; ECHO sends what is typed at the keyboard to the screen. The user is not allowed to type in more characters than will fit in the data item (one per underscore prompt character).

The IF statement in line 61 tests the value of SELECT-KEY typed by the user; if Q is typed, it puts the value “YES” in the USER-QUITS-FLAG. This causes termination of the program because the UNTIL USER-QUITS test in line 55 now evaluates as true.

If the user types anything other than Q, the ELSE part of the IF statement is executed starting at line 64. The file IN-FILE is opened for INPUT, and the paragraph SEARCH-FILE-AND­DISPLAY-RECORD is performed for each record in the file. When the file has been completely processed, it is closed in line 67, the flag MORE­DATA-REAINS is reset to “YES” for the next time through the loop, and a message is displayed telling the user to hit the ENTER key to continue (lines 69 and 70).

The SEARCH-FILE-AND-DIS­PLAY-RECORD paragraph reads the next record from INFILE into the data item IN-RECORD. When the end of the file is reached, the word “NO” is put into the MORE-DATA-REAINS-FLAG. This makes the test UNTIL NO-MORE-DATA-REAINS in line 66 evaluate as true. If the end of the file is not reached, the RECORD-KEY field of the record read in from the file is compared to the SELECT­KEY typed in by the user. If they match, the entire record is displayed on the screen by the DISPLAY statement in line 77.

To create a COBOL source program, some type of text editor must be used. If you are accustomed to full-screen editors, you will be disap-
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pointed with RSCOBOL’s editor. Until there is a version of Scripsit or another full-screen editor that works with TRSDOS 2.3B, your only option is to use the line-oriented editor included with the RSCOBOL package. This editor, CEDIT, is written in assembly language. It is very similar to the original Model I EDTASM (Editor-Assembler) package, which in turn bears a close resemblance to the Level II BASIC editor. CEDIT does have a few enhancements, most noticeably the inclusion of a global “replace text” command. All CEDIT commands can be abbreviated to a single letter.

If you are accustomed to full-screen editors, you will be disappointed with RSCOBOL’s editor.

CEEDIT loads all the text to be edited into memory and saves everything to disk at once. It is not a memory buffer editor, such as the one supplied with Radio Shack’s FORTRAN package. Thus, you are restricted to editing files that will fit in memory all at one time. CEDIT saves COBOL source programs on disk in a plain ASCII format; blanks and line numbers are not compressed in any way.

If you look through the CEDIT portion of the RSCOBOL manual, do not be misled by the section titled “Source File Format” on page 3. It implies that each line of source code takes up its own 256-byte disk record. Fortunately, this is not true. Source code lines are packed together and terminated by carriage returns, as in most other TRS-80 editors. The entire file is terminated by a hexadecimal 1A byte.

When you are ready to use CEDIT to create a COBOL source program, you must decide which disks to put online. I have a disk that contains TRSDOS, CEDIT, and the RSCOBOL compiler. This disk goes into drive 0, and a blank disk in drive 1 holds the COBOL source code being edited. Decide in advance which disk
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will hold your COBOL program; once in the editor, you cannot go back to TRSDOS to look at the disk directory without losing what is in memory.

Since the COBOL language requires much similar information at the start of every program, I recommend that you create a "skeleton" or "template" file that contains this information. Then, when you create a new program, load this file and edit it as needed, rather than having to type in all the header information every time. Referring to listing 1, my skeleton file contains the IDENTIFICATION DIVISION, the ENVIRONMENT DIVISION, and part of the DATA DIVISION seen in this listing. My DATA DIVISION skeleton includes a FILE SECTION with a couple of FDs and the WORKING-Storage section with some often-used identifiers. Experience will help you decide which things are frequently repeated.

Line numbers are provided by the editor during the text creation process. The INSERT command, abbreviated I, is used much like BASIC's AUTO command; it automatically enters a line number, then you type the line. During text insertion, if the line number of a new line is the same as that of an existing line, the entire text is automatically renumbered from the current line to prevent overwriting the existing line. This gives you the advantage of never running out of room during text insertion. However, the disadvantage is that automatic renumbering causes the line numbers of existing lines to change. INSERT does not notify you that this has happened. This makes it more difficult to find and correct a line that was the cause of a compilation error, since error messages use the old line numbers. However, the offending line's contents are printed along with the error message. Therefore, you can use the editor's FIND command to locate the line.

FIND lets you search a range of source text for any string of characters. Another "new" command is CHANGE, which lets you change any string of characters to a different
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RSCOBOL Compiler

All the files in Table 1 must be online before compilation begins. Several versions are available at compile-time. I used the command:

RSCOBOL SAMPLE
(P X L = 1 0 = 1)

string in as many places as you want. This is useful if you discover that a data item name is a COBOL reserved word, e.g., KEY. KEY can be changed to RECORD-KEY in all lines of a program with the CEDIT command:

C/KEY/RECORD-KEY/*

The "*" means change KEY to RECORD-KEY everywhere it occurs in the program. A number N, instead of "*", means change it the next N times it occurs. The 'X' command behaves like CHANGE, but it asks you if the change should be made every time it finds a match for the search string.

Another useful command is MEMORY, which tells how big your program is in bytes and how much free memory is left.

CEDIT's remaining commands have counterparts in the Level II BASIC and EDTASM editors. These include commands to list a range of lines to the screen or printer, delete a range of lines, replace a range of lines, renumber the lines, and move to the top or bottom of the program file. The EDIT command provides editing of a single line; character insertion, deletion, and replacement; extension of the line, etc., in a manner nearly identical to Level II BASIC's EDIT command.

Once a program is completely typed in, it is saved to disk with the WRITE command. A default file name extension of /CBL is automatically provided. For example, typing W SAMPLE:1 saved the sample program's source file on drive 1 with a file name of SAMPLE/CBL.
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example is listing 1. The X option generates a cross-reference of PROCEDURE and DATA DIVISION names. This appears at the end of listing 1. The L=1 option sends a copy of the listing to a disk file on drive 1. O=1 means put the object file on drive 1. If O=N had been selected, no object file would have been created.

RSCOBOL provides a COPY statement that allows COBOL source files to be included directly from disk in the compilation of a program. For example, a common record definition could be kept in a file called RECDEF, and the source program statement COPY RECDEF would open that file and compile its contents just as if it were part of the main source file being compiled.

One problem with the implementation of COPY is that all COPY files must be online during compilation. If one of them is not, the compilation aborts with an error message. It would have been simple to have the compiler pause if the file were not found and ask the user to mount the disk containing the file instead of aborting the compilation. This would have extended the size of source files that could be compiled for users with only two disk drives.

A couple of other options are available that were not used in the sample compilation. The D option compiles all the "debug" lines. Simply stated, any program line starting with D is ignored during compilation unless the D option is specified. Therefore, you can write your program with as much extra code as you want to help during debugging, and then have it all eliminated from the final version of your program by simply compiling without the D option. Debug code is commonly used to DISPLAY the value of some data item while testing a program. However, there is no restriction on the type of source code line that can be flagged in this way.

If the compiler finds any errors in your program, they are clearly marked with a pointer to the offending word and an error message in English. More than 70 error messages are possible, and I have never had a problem figuring out what they meant. Each error message has a brief explanation in the manual.

This listing is followed by the size of the read-only portion of the program (presumably the code block) in bytes, the size of the read/write portion (the data area) in bytes, and the
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total size in bytes. The total size for the sample program and its data is hexadecimal 0264 (612 decimal) bytes, which is fairly compact for this COBOL program.

For the sample program, a cross-reference table was requested. All PROCEDURE and DATA DIVISION names are listed in alphabetical order. For each entry, the line numbers in which it is declared and referenced are given. The line numbers in which a data item is declared are surrounded by slashes. Lines in which the value of a data item may be altered are marked with asterisks, e.g., *0073* for the variable IN-RECORD. In line 73, IN-RECORD is the destination of a record read from INFILE.

The COBOL compiler resides from hexadecimal locations 5200 to AAFF in memory. This leaves hexadecimal 5500, or 21,760, bytes of memory free. The compiler is so large that it had to be split into overlays as shown in table 1. Different overlays are loaded from disk to compile different divisions of a COBOL program. It is not documented whether these overlays eat into the 21,760 bytes of free storage. A couple of internal error messages tell when the compiler's working storage has been exceeded. This could happen, for example, if a program has too many symbols to store in the compiler's symbol table.

If this should happen, the subroutine CALL can be used to alleviate the problem. A program can be split into a main program and subroutines, each separately compiled. At runtime, when the main program CALLs a subroutine, it is loaded dynamically from disk. This also provides a method for controlling memory usage at runtime. But it is not the only method. A single program can be broken into overlays. A program

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segmented in this manner is compiled in one piece, but the overlays are loaded into memory dynamically at run-time when they are entered via a GOTO or PERFORM statement. These two options, CALL and overlays, combine to provide the most dynamic memory-management system that I have seen in any TRS-80 language.

A word on compiler performance. With both the input of source text and the output of object code involving disk I/O (input/output), and the compiler itself requiring several disk overlay loads during the course of a single compilation, this compiler is no speed demon. The sample program, with the options shown, took 135 seconds to compile. This works out to about 35 lines per minute. This includes printing a listing and creating a listing file on disk, both including cross-reference lists. Choosing options of T and E (create an object file on disk and print any errors on the screen), sped things up to about 50 lines per minute. It then took 95 seconds to compile the sample program.

Testing a Program

The RSCOBOL system provides a simple run-time interactive debugger. This debugger allows you to test many aspects of a COBOL program without having to program in a lot of special debugging statements. Combined with the compiler's D option described earlier, RSCOBOL provides a decent debugging environment.

To make full use of the interactive debugger requires a current printed listing of the program under test. A printer is not a prerequisite for use of RSCOBOL, but I strongly recommend having one.

The command RUNCOBOL invokes the RSCOBOL run-time module. The debugger is invoked by specifying the D option. Once in the debugger, a COBOL program can be single-stepped a sentence or group of sentences at a time. This is achieved by typing S, optionally followed by N (where N is the number of sentences to execute). To execute all the way up to a particular sentence, type A followed by the address in the DEBUG column preceding the sentence at which execution should stop.

The final debugger command is D. It is used to DUMP the contents of different data items in a readable format. For the sample program, by typing D 54, 5, ANS, the current value of the data item RECORD-KEY is displayed on the screen. It is permissible to request the display of a data item in other than the default format; a hexadecimal dump is available, for example.

Some important features that this debugger lacks include:

1. The capability to alter data item values.
2. A way of setting program breakpoints. The current system lets you specify that execution should proceed to a particular COBOL sentence; it is desirable to be able to specify a number of points in the code at which execution should halt, passing control to the debugging monitor.
3. A way to reference data symbolically rather than requiring the use of hexadecimal values representing actual data-storage locations.
4. A way to step through the statements of a COBOL sentence. In listing 1, there is only one value in the DEBUG column for the entire range of program lines from 61 to 71. This value represents the beginning of the COBOL sentence starting with "IF". You cannot step partially through this sentence; you must execute it in full.

If you are not using the debugger, the RSCBLD13/OBJ file need not be present during run-time.

Run-Time Environment

The RSCOBOL package includes a substantial run-time module that must be resident during the execution of any COBOL program. The run-time code resides from locations hexadecimal 5200 to B1FF, leaving about 20K bytes of user program space. This is respectable for a small machine.

There is a trade-off in using a standard run-time module rather than linking in only those pieces specifically required by each program. Use of a run-time module allows much faster program development; the linking phase otherwise required is usually very time-consuming. It involves a lengthy search of a large library module to find those pieces required by a particular program. A run-time module also cuts down on the size of user programs; without one, every user program must contain a lot of the code that is otherwise in the run-time module, resulting in much duplicated code on a disk holding several user programs.

The disadvantage is that, in most cases, not all of the run-time code is needed for a particular program. Therefore, some memory space is taken up unnecessarily. RSCOBOL compensates for this somewhat with its overlay and CALL statements for memory management.

Two options besides D (invoke interactive debugger) are available at run-time:

1. S=nn..n: This option allows the setting of "switches" at run-time. A COBOL program can test for the value of these switches and make decisions accordingly. The eight switches each can assume the value 0 or 1.
2. T=hhhh: This sets the top memory address that will be used by RSCOBOL at run-time. It is used to protect user machine-language programs from the run-time system. As discussed previously, it appears that if your assembly-language program stores this value in location hexadecimal 4049 (for the Model I), the same effect is achieved.

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messages can appear at run-time. They are carefully documented in the RSCOBOL manual.

My overall impression of run-time performance is favorable. Every program I have written which reads from the disk, computes something, and writes the results to the printer has managed to keep the printer moving at full speed (60 characters per second bidirectional). Interpreted BASIC programs I have written, which perform similar formatted I/O with the PRINT USING statement, pause noticeably between the output of formatted data items. By comparison, RSCOBOL is quite snappy and moves right along.

Language Implementations

RSCOBOL is based on the ANSI X3.23-1974 COBOL Standard. The ANSI Standard defines "levels" of implementation for different aspects of the language. Table 3 lists the levels of implementation provided by RSCOBOL. The more advanced the implementation, the higher the level number. The Federal Information Processing Standard (FIPS) lists 2 as a relatively "high" level of implementation for most language components. RSCOBOL's implementation does quite respectably.

Table 3 is somewhat misleading in that there are exceptions to the levels of implementation stated, i.e., certain features defined by ANSI as part of a level are not implemented. A complete list of these exceptions is in the back of the RSCOBOL manual. Notable exceptions include:

- Multiple results are not supported in arithmetic statements. For example, you cannot state ADD A TO B C; you must state ADD A TO B and ADD A TO C.
- REMAINDER is not supported in the DIVIDE statement.
- INSPECT data items are restricted to a single character.
- Compound TALLYING and REPLACING clauses in the INSPECT statement are not supported.
- Exponentiation to a noninteger power is not supported.
- Abbreviated combined relation conditions are not supported. You cannot say IF A EQUALS 1 OR 2; you must say IF A EQUALS 1 OR A EQUALS 2.
- The STRING and UNSTRING statements are not supported.

Some extensions to the stated levels of implementation are available, mostly nonstandard. One that struck me as quite interesting was the inclusion of several statements having to do with the locking and unlocking of disk records. These statements allow simultaneous access to a disk file by multiple users in a controlled fashion.

It is worth mentioning that the rather powerful MOVE CORRESPONDING statement is implemented. This lets you move all like-named fields from one record to another with a single statement. MOVE CORRESPONDING is frequently left out of small-machine implementations of COBOL. Also implemented are ADD CORRESPONDING and SUBTRACT CORRESPONDING.

The ACCEPT and DISPLAY statements provide good capabilities for interacting with the display and keyboard. In listing 1, the ACCEPT statement in line 60 puts out a field of underscore characters the size of the data item SELECT-KEY, and allows only that many characters to be input. DISPLAY is a programmatical simple way of printing a data item contents on the screen.

Assembly-language programs can be called from RSCOBOL. They are dynamically loaded from disk and must be in standard TRSDOS load format. An arbitrary number of parameters can be passed to an assembly-language program via the USING clause of the CALL statement. Parameters are passed by reference, i.e., the address of the data item itself is passed. This is a very flexible system. Loading assembly-language programs from disk at run-time gives the same flexibility in managing memory used by assembly-language programs as for that used by COBOL subroutines.

File I/O

COBOL probably has the most complete set of commercial file handling statements of any language. It is a substantial challenge to implement them for a 48K-byte RAM, using a floppy-disk Model I. RSCOBOL provides three major COBOL file types: sequential, relative, and indexed sequential.

Sequential files can have fixed-variable-length records. Variable-length records contain a byte at the beginning of each record telling the length of that record. Lengths vary from 2 to 255 bytes. Fixed-length records do not contain any bytes telling the length. Sequential files, containing records of either type, must be accessed in order, that is, one record after the other in the order they were stored.

Relative or random files contain fixed-length records. Any particular
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Record can be accessed "at random" by specifying its record number. The first record is number 1, the second number 2, etc. The maximum length of a relative record is 253 bytes.

Indexed sequential access method (ISAM) files are the most powerful ones provided by RSCOBOL. Records in an ISAM file are fixed-length, but can be up to 4096 bytes long. When creating an ISAM file, one or more "keys" must be specified. A key is simply a field of the record that is used later as a search argument over the file.

For example, an employee record may contain a Social Security number field. If this field is specified as a key when the file is created, you can later retrieve a particular employee's record by specifying the Social Security number. Such a method is usually easier to program than relative files, which require that you provide a record's number in order to directly retrieve it.

When an ISAM file is created, records are stored in sorted order on their "primary keys." The primary key must be guaranteed unique; the Social Security number is a good example of such a field. Secondary keys can also be specified for a record. A record can be retrieved by specifying the value of any secondary-key field. Secondary keys can have duplicates, that is, two or more records can have the same value in a field designated as a secondary key.

The sample program in listing 1 uses a sequential-type file, not ISAM. It does a sequential search of the file when looking for a record whose key field matches the value typed in at the keyboard. If an ISAM file had been used, the record desired could have been located directly by its key value.

In summary, the records of an ISAM file can be sequentially retrieved in the ordered order of any key field, and directly retrieved by specifying the value of a particular key field. This powerful access method reduces the amount of user programming required for many data-storage applications.

ISAM files do pay a space penalty for this generality in retrieving
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records. An index structure is stored in the file for each field specified as a key. The manual states that the use of secondary (ALTERNATE) keys causes a geometric growth in the time required to create a file. However, the time required to access a record by its key is relatively uniform throughout the file.

The RSCOBOL manual gives the following formula for estimating the number of 256-byte sectors required for an ISAM file with the specified parameters:

\[
N_{RECS} = \text{INT} \left( \frac{(S+33)/32 \times R/8 + (R\times 2)/\text{INT}(252/(Kn+8))}{8} \right)
\]

where 
- \( R \) = maximum number of records desired
- \( S \) = size of records in bytes
- \( Kn \) = size of key n in bytes
- \( D \) = number of keys that allow duplicates

I created an ISAM file containing one hundred 61-byte records, each containing a 5-byte primary key and no secondary keys. The input records used to create the file were read from a sequential file on disk. The ISAM file took 3 minutes and 40 seconds to create (2.2 seconds per record), and it used 37 sectors on the disk (8 granules). Since the formula predicts 35.5 sectors, it appears to be fairly accurate. A record file created by Disk BASIC would take 25 sectors (four records per sector) to hold this same amount of data. Therefore, the indexes do produce some overhead. Of course, you could not access the Disk BASIC records by key value, and this is the function you are buying with this extra disk space.

Performance wise, the disks kept spinning the whole time the ISAM file was being generated. An interpreted BASIC program creating a record file usually leaves the disks idling at intervals while it is performing computations. Two factors could further speed up the file creation process. First, TRSDOS 2.3B steps my MPI disk-drive heads at a slow 40 milliseconds (ms) per track; they are capable of 5 ms per track. Second, I had the file of input records used to create the ISAM file on the same drive as the ISAM file itself. By placing these two files on separate drives, less disk-head movement would occur and the files would be accessed faster.

Documentation

The manual accompanying RSCOBOL is a substantial one. It comes in a 3-inch-thick loose-leaf binder containing 368 offset-printed pages in a readable dot-matrix font. This is definitely not a beginner's guide; a good COBOL textbook is a necessity if you have not used the language much. If you are already familiar with COBOL, however, you will find complete information about every aspect of RSCOBOL, written in the style of a reference manual.
Ciarcia's Circuit Cellar, Volumes I, II, & III by Steve Ciarcia

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Conclusions
Radio Shack has provided a very complete, professionally done COBOL package. The memory-management options do almost everything possible to compensate for the inherent limits of the Model I and III machines — a small main memory of 48K bytes and limited floppy-disk storage. The most powerful features of this system, especially the multitykeyed ISAM files, are limited by the floppy-disk system for anything but the smallest applications. Use the formula given earlier for computing disk-space requirements and make sure your application will fit before you invest in this software. However, if you just want to learn how to program in COBOL and you already have the hardware, this is an excellent package.
Inversions

An "inversion" is a word that has been written so that it reads symmetrically.

For instance, words that are the same upside down and right side up are inversions. A few words exist in the English language that do this naturally, such as "SWIMS" and "NOON." But alas, the great majority of words, when turned upside down, don't do anything interesting at all.

Fortunately for lovers of inversions, letters are quite flexible. Look around you and you will see the letter "a" written in hundreds of different ways. And all of them we have learned to read as the same letter.

By bending and stretching the shapes of letters, we can turn ordinary asymmetrical words into symmetrical inversions. Not all words will work, but when they do, the results are inevitably fascinating.

Scott Kim's new book *Inversions: a Catalog of Calligraphic Cartwheels,* published by Byte Books, is a collection of more than 60 inversions, exploring a wide range of ideas and lettering styles.

In the accompanying text, Scott explains how inversions are created, so that you may try your hand at them.

"Scott Kim's *Inversions... is one of the most astonishing and delightful books ever printed... Over the years Kim has developed the magical ability to take just about any word or short phrase and letter it in such a way that it exhibits some kind of striking geometrical symmetry."
—Martin Gardner,
*Scientific American*

Infinity

In this design, Scott Kim mixes idea and image, art and technology, in a swirling evocation of infinity. This intricate design was created with the aid of a computer program, which took a basic hand-drawn design, repeated it symmetrically, then bent it into a continuously expanding spiral.

As you look at the design, you'll discover that it can be read in two different ways. Notice that the letters "fi" when turned upside down become the "y" at the end of "infinity." And so the spiral can be read as either "infinity" going in or "infinity" coming out! Which do you see?

Infinity is the first in a series of wearable wordplays from the book *Inversions: a Catalog of Calligraphic Cartwheels* by Scott Kim. The book is available through your local bookstore, or by calling Byte Books toll-free at 800-258-5420.

Give the Infinity shirt as a gift, wear it while doing double back somersaults, take one on your next space flight. The possibilities are infinite.
One reason I bought an Apple II was the potential for expansion on its motherboard. I'd planned to add a parallel I/O (input/output) port, a real-time clock, and a couple of other items I was going to design and build. After working with the board for two years, though, I concluded that buying one that already had these features would put me ahead of the game.

Fortunately, I discovered that John Bell Engineering produces an Apple II parallel interface board—actually a multifunction module. It contains two 6522 Versatile Interface Adapters (VIAs) and can function as a parallel interface, clock, or counter. To explain the capabilities of the card, I need only elaborate on the capabilities of the 6522 chip.

The 6522 VIA
The 6522 is a 40-pin support chip compatible with the 6502 microprocessor family. The chip is designed for connection to the data and address bus of a 6502 microprocessor, and it provides two bidirectional, 8-bit I/O ports (where the direction of each bit is programmable). In addition to the parallel ports, each 6522 has two 16-bit, fully programmable clocks that can be used as counters or interval timers. The chip also includes a shift register for use with one of the timers to clock serial data into or out of the 6522. Each 6522 fully supports the 6502 interrupt structure, finally allowing you to constructively use

<table>
<thead>
<tr>
<th>At a Glance</th>
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<tbody>
<tr>
<td><strong>Name</strong></td>
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<td><strong>Use</strong></td>
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<td><strong>Manufacturer</strong></td>
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<tr>
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<tr>
<td><strong>[415] 367-1137</strong></td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
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**Features**
Board contains two 6522 Versatile Interface Adapters with a total of four 8-bit, bidirectional I/O data ports; eight I/O control lines; four independent, 16-bit timers; and two 8-bit serial-to-parallel/parallel-to-serial shift registers. User can choose the I/O or NMI interrupt lines

**Software Needed**
All user-written—no software provided

**Documentation**
A 16-page booklet containing a circuit board description and a 6522 data sheet

**Audience**
Assembly-language programmers and others with some hardware experience

---

**About the Author**
Ned Rhodes earned a BEE from the University of Minnesota and a master's in computer science from George Washington University. He presently develops minicomputer-based distributed processing systems for the MELPAR division of E-Systems Inc. in Falls Church, Virginia.
the Apple interrupts.

All communication with the 6522 occurs through 16 internal registers. Two of the 16, IRB/ORB and IRA/ORA, are used as I/O registers for the two 8-bit parallel ports. Two others, DDRB and DORA, are data-direction registers that define the direction of each bit (either input or output) of the parallel ports. Four registers are set aside to control the two programmable counter/timers, and one I/O register controls the serial-shift register. Two registers select the operating mode of the timers and shift register; they also determine whether the chip will recognize positive- or negative-going control pulses.

The 6522 has a dedicated interrupt flags register that allows the chip to generate interrupts upon detection of

1) a positive- or negative-going edge on any of the four control lines, (2) a timeout (overflow) condition on either of the timers, or (3) the completion of a shift-register shift cycle. One register selectively enables and disables interrupt generation, while the last register is reserved for special forms of I/O through port A. Figure 1 is a block diagram of the 6522 chip's internal layout.

6522 on the Apple

Due to a design limitation in the Apple II, the 6522 can't work properly if it's merely attached to the bus; the 6522 requires a phase 2 clock pulse that isn't available on the Apple. The Apple 6502 processor generates the phase 2 clock signal, but that pin is unavailable at the expansion slot connectors.

Therefore, the I/O board must generate its own phase 2 clock signal. The phase 2 clock pulse is simulated by delaying the phase 0 clock signal by 80 nanoseconds. I must point out that simply delaying phase 0 may not match the duty cycle specification of the phase 2 clock, but that doesn't seem to matter. The 6522s accept the simulated phase 2 clock signal and work just fine.

The Circuit Board

The board may be purchased in three different forms. For those of you with no hardware experience, it's available as a fully assembled and tested card. It may also be bought as a complete kit or as a bare board for which you supply the parts. I chose the bare board, then ordered the sockets and 6522 chips from a mail-order supplier.

The board is very simple to build.
All you do is mount two 40-pin sockets, four 16-pin sockets, one 14-pin socket, and two bypass capacitors. Then plug in the chips and you’re ready to go. The documentation suggests that you use “standard assembly and soldering techniques.” I guess that means you shouldn’t lift the solder donuts by applying excessive heat and that solder bridges between pins are taboo. I managed to avoid both perils.

Connections are made through the four 16-pin DIP (dual in-line package) sockets; each socket handles eight bits. If interrupts are used, two jumper wires must be installed to enable them. One of the 6522s can be attached to the IRQ (interrupt-request) line, while the other can be attached to the NMI (nonmaskable interrupt) line. Note that the interrupt lines cannot be shared—you can have only one 6522 attached to an interrupt line.

Documentation accompanying the board is sparse, and the unadventurous user may get lost. The board comes with a two-page circuit diagram and register identification list, a two-page circuit description, and a two-page list of all possible board addresses (whose availability depends upon which slot is used on the Apple). A ten-page 6522 data sheet is also provided.

If you can read the data sheet, you can use the 6522. If you find the data sheet difficult to understand, chances are this product isn’t for you. The manufacturer has provided no software examples because of “the numerous uses of the board,” I believe that limits the board’s usefulness. Hold on, though; I’ve provided two software routines to demonstrate the capabilities of the parallel interface board and the 6522s.

**Software**

I was unable to write software that would test all of the 6522 functions, so I chose two of the more common applications: parallel I/O and clock.

**Parallel Printer Routine.** The first software example, in listing 1, is a parallel output routine for a printer such as the Epson MX-80. Two basic sections comprise the routine. In the first section, the output routine “hooks” through DOS, so that any character output to the screen will also appear on the printer. The horizontal-tab counter and the screen-echo flag are initialized at this time. The 6522 is then set up for output, and a Control X is sent to the printer, clearing its internal buffer. The routine’s second section is characters are output, one at a time to the printer.

The 6522 initialization is unique. First, you enable port A for output, placing a hexadecimal FF in the direction register (DDRA) for port A. Then set up the data-output strobe and the data-ready flag, which are handshaking signals required for parallel communications. When the printer is ready to receive data, it indicates this with a pulse. With the MX-80, a negative-going pulse indicates ready, so you tie it to the C line (one of the control lines for port A). The other signal, the data strobe...
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Listing 1: Parallel printer output routine for the John Bell Engineering parallel board. Written in 6502 assembly language, this program is designed to drive an Epson MX-80 printer.

```
1000 LDX #80-80 PRINTER DRIVER
1020 JSR 3/69
1040 JSR 3/69
1060 JSR 3/69
1080 JSR 3/69
1100 JSR 3/69
1120 JSR 3/69
1140 JSR 3/69
1160 JSR 3/69
1180 JSR 3/69
1200 JSR 3/69
1220 JSR 3/69
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1900 JSR 3/69
1920 JSR 3/69
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1980 JSR 3/69
2000 JSR 3/69
2020 JSR 3/69
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Listing 1 continued:

0345: AD 70 05 2030 DMA ACC GET CHAREACTER AGAIN
0363: 09 80 2040 DBA #EO GET ASCII FROM SCREEN
0365: 4C F0 FD 2050 TV JMP SCR SCREEN OUTPUT TO SCREEN
0366: 60 20 RET RTS NORMAL RETURN
0368: 00 80 LOAD SUBROUTINE
0370: 29 0D 2170 ECP POUT HD IO/0 WATT
0375: AD 79 05 2180 LDA ACC GET CHARACTER TO PRINT
0377: 1D 01 06 1370 STA ORA BUMP CHAR COUNTER
0379: 60 20 RTS RETURN

SYMBOAL TABLE

0577: ACC
0579: BCC
0580: CAR
0585: CHA
0586: DEX
0587: ENB
0588: FBC
0590: HLT
0592: IMQ
0595: MUL
0599: ORA
059C: PCH
059D: PCE
059F: PCL
05A4: PSE
05A6: RET
05A7: RMP
05A9: SBR
05B0: SLT
05B1: SNE
05B5: TAB
05B7: TV

Listing 2: This routine uses the parallel board as a real-time clock. The time will be continuously displayed on the screen.

### SYNTAX ERROR

IASH

1000
1020
1050
1070
1090
1110
1130
1150
1170
1190
1210
1230
1250
1270
1290
1310
1330
1350
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1390
1410
1430
1450
1470
1490

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<td>Input/Output, 12 RS-232 Control Signals</td>
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<td>TNW-103</td>
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Pier also works with acoustical couplers and other modems interfaced to the PET with the TNW-2000 or TNW-232D Electronic mail and TNW Terminal programs also available. All units are addressable IEE-488 devices, complete with power supply cabinet, full documentation and one year warranty

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Text continued from page 418

clocks data into the printer's internal buffer. Again, the MX-80 requires a negative-going pulse for the data strobe; use control pin CA2 for this function.

The 6522 allows you to choose a negative- or positive-going pulse for either of two signals; inform the 6522 of the desired polarity by loading the Peripheral Control Register (PCR). With the MX-80, hexadecimal 0A is the proper code. This bit pattern is determined by consulting the coded values on the data sheet. We enable the printer by sending it a Control Q (hexadecimal 11) and then a Control X to clear the internal buffer.

The actual output routine is quite simple. First, check the horizontal character position and compare it with the current character position in the output line. If they differ, output spaces until reaching the proper character position. To print characters, check bit 2 in the Interrupt Flag Register (IFR) to see if the printer has sent its data-ready flag. This bit will be set if the 6522 has detected a negative edge on control pin 1 (CA1), which is the ready line.

If the printer is busy or has yet to send the ready pulse, keep testing the bit until the printer is ready. When the printer is ready to receive data, store the character to be printed in the output register for port A. As you place the character in the output register, it's clocked into the printer's internal register because pin CA2 goes low and acts as the data strobe. The printer becomes busy while accepting the character. Once it's processed, the ready pulse is given and the printer will accept another character.

Time-of-Day Clock. Listing 2's routine is a time-of-day clock that continuously displays the time on the screen. The routine uses interrupts so that the clock runs while you develop and run BASIC programs. The routine is compatible with DOS 3.3; DOS disables the IRQ interrupt while it does I/O and then re-enables the interrupt when finished. (I haven't tried

Listing 3: This BASIC routine will load and initialize the clock. It will also protect the time display.

```
10 REM ROUTINE TO LOAD AND START THE DOSCLOCK
20 REM
30 REM "LOAD DOSCLOCK.BEL" - "LOAD DOSCLOCK.BEL"
40 REM
50 REM "PRINT "LOAD DOSCLOCK.BEL",OBJ"
60 REM "POKE 3461 CALL 656"
70 REM "POKE THE CURRENT TIME IS ->" "POKE 34+2
80 REM VOB 10
90 REM "INPUT CENTER HH-MM-SS -> HH-MM-SS"
100 REM "POKE 125-HH, REN HOURS"
110 REM "POKE 125-MM, REN MINUTES"
120 REM "POKE 125-SS, REN SECONDS"
130 REM "CALL 1400, REM START THE CLOCK"
140 REM "POKE 1919+11, REM DISPLAY TIME"
150 END
```

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<td>DWC-1-1600</td>
<td>$68.80</td>
<td>$48.30</td>
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**TRS-80 COLOR COMPUTER**

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- The board is available fully assembled, as a kit, or alone. The kit is easy to build, but you must be able to read a circuit diagram.
- Documentation is sparse, though all required information for use of the 6522 is included. The manufacturer does not hold your hand, relying instead on the user community to publish software that uses the board.
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**Books Received**


Programs for Beginners on the TRS-80, Fred Bleichman.


Real Time Programming—Neglected Topics, Caxton C. Foster.


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**BYTE'S Bugs**

Joe Hadlamean’s inflation calculator program in the July 1981 BYTE has a bug in line 440, page 302. (See “Computing Inflation with the Consumer Price Index,” page 300.) If:

\[
\text{STR$(P2-INT(P2))}
\]

is less than 0.01 (in other words, if the rounding error is less than a penny), the calculation is handled in scientific notation and the output is garbage. To correct this, insert:

\[
\text{OR IF (P2-INT(P2)) < .01}
\]

before the “THEN” of line 430.

Michael D. Decker, MD
5869 North Glenwood #1
Chicago, IL 60660
**BYTE LINES**

**News and Speculation about Personal Computing**

Conducted by Sol Libes

**Random Rumors:** IBM is rumored to be increasing production of its personal computer system, with 175,000 units expected to be sold before Christmas 1982. IBM will probably soon announce a graphics package and X.25 communications options for the personal computer. Epson America is expected to introduce several video terminals, including one with a flat screen. The rumor is that they will be shown at the NCC (National Computer Conference) in June; look for Sinclair, Sony, and Hitachi to introduce similar products at NCC. Also due at NCC are 80- and 160-megabyte 8-inch Winchester disk drives from Micropolis and 16- and 30-megabyte 5¼-inch Winchester from Control Data Corp. Reportedly, a 15-inch flat-screen monitor is due from Japan shortly. DEC (Digital Equipment Corporation) is expected to introduce a PDP-8 replacement, a 16-bit version of its recently introduced personal-computer board for the VT-100 terminal, and a complete personal computer. Incidentally, DEC is budgeting $500 million for research and development, with half going to software development and its 2000-member software development team. Hearsay has it that Centronics is working on a ribbonless dot-matrix printer. NEC, Toshiba, and Okidata Corporation are currently supplying samples of 256K-bit dynamic memory devices and expect to start volume delivery in June. These ICs should begin shipping in equipment by the middle of 1983. The S-D Systems will introduce yet another local-network system called MARS/NET. Mitsubishi is supplying samples of its 5¼-inch Winchester disk drives and half-wide floppy-disk drives; Toshiba is also considering sale of its 5¼-inch Winchester in the U.S. Shugart's half-height 5¼-inch 5A210 floppy-disk drive will make its first appearance in Xerox's new Sabre line of electronic typewriters. WD (Western Digital) is expected to shortly introduce a single-chip Winchester controller that replaces 25 TTL (transistor-transistor logic) parts. Also due from WD is a new floppy-disk drive controller IC that incorporates the data separator, comparator, and write-precompensation circuits missing from current controllers. IBM recently opened its tenth computer store; more are in the works. Seagate has introduced a 6-megabyte, 5¼-inch Winchester with removable media. Emuloog of Fremont, California, has introduced a full-feature video terminal with a $465 list price. HP (Hewlett-Packard) has separated its personal-computer operation from the calculator division and created a Personal Computer Group. HP has also increased dealer discounts on models 80, 85, and 125 systems by as much as 25 percent over previous discounts. Radio Shack has beaten Apple into the 16-bit market with the introduction of its new Model 16, 68000-based microcomputer. For more details on this machine and other new products, see page 40. Radio Shack has also established an online videotex-information data-base system for subscribers in the Forth Worth area.

**Random Bits:** At the recent Comdex show held for dealers, emphasis changed from the hobbyist to a business orientation, with Apple and TRS-80s all but replaced by integrated business systems. This change should be reflected in computer stores shortly. NEC, Toshiba, and Okidata Corporation are currently supplying samples of 256K-bit dynamic memory devices and expect to start volume delivery in June. These ICs should begin shipping in equipment by the middle of 1983. S-D Systems will introduce yet another local-network system called MARS/NET. Mitsubishi is supplying samples of its 5¼-inch Winchester disk drives and half-wide floppy-disk drives; Toshiba is also considering sale of its 5¼-inch Winchester in the U.S. Shugart's half-height 5¼-inch 5A210 floppy-disk drive will make its first appearance in Xerox's new Sabre line of electronic typewriters. WD (Western Digital) is expected to shortly introduce a single-chip Winchester controller that replaces 25 TTL (transistor-transistor logic) parts. Also due from WD is a new floppy-disk drive controller IC that incorporates the data separator, comparator, and write-precompensation circuits missing from current controllers. IBM recently opened its tenth computer store; more are in the works. Seagate has introduced a 6-megabyte, 5¼-inch Winchester with removable media. Emuloog of Fremont, California, has introduced a full-feature video terminal with a $465 list price. HP (Hewlett-Packard) has separated its personal-computer operation from the calculator division and created a Personal Computer Group. HP has also increased dealer discounts on models 80, 85, and 125 systems by as much as 25 percent over previous discounts. Radio Shack has beaten Apple into the 16-bit market with the introduction of its new Model 16, 68000-based microcomputer. For more details on this machine and other new products, see page 40. Radio Shack has also established an online videotex-information data-base system for subscribers in the Forth Worth area.

**Unix Royalty Fees Cut:** Western Electric recently introduced its Unix System III update which combines Version 7 Unix and the PW8 (Programmer's Workbench) into a single system. Some enhancements have also been added. They raised the source code license fee to $43,000 but lowered the distribution deposit from $50,000 to $25,000 against royalties. The royalty fees have been reduced to $100 for a single user and $250 for systems for 2 to 16 users. [Previously, a license cost $1500 plus $250 per user.] Royalties prepaid under the old rates will not be refunded. Licensees will, in effect, start with a clean slate. Hence, Microsoft will lose the $200,000 it had prepaid to obtain a discount advantage, an advantage it no longer has. The reduction in royalty fees removes what has been a significant deterrent for people wishing to use Unix, namely that it was very expensive. This should increase competition among Unix and its look-alikes. More important, it puts Unix in a much better position to compete with other single- and multi-user operating systems such as CP/M-86 and MP/M-86. Microsoft's president, Bill Gates, indicated that despite his unhappiness about the lost royalty payment, the royalty change would help his company sell copies of Xenix, its version of Unix.

**Ada Update:** Ada is finally becoming available as a working language. Telesoft Incorporated of San Diego, California, released its Ada package for 68000 systems last August, and RR Software of Madison, Wisconsin, in November released I anus.
version for Z80 computers running CP/M. Both compile subsets of the Ada language. The Telesoft Ada compiler retails at $2400, while Janus sells for $250.

The DOD (Department of Defense) holds the trademark on the name "Ada" and stipulates that commercial companies can use the name only if they have or are developing a full-language compiler. To acquire legal access to the name "Ada," a company must submit its product to a DOD Ada-validation office for approval. Validation will ensure that programs written with the compiler will be fully portable between computers. Portability of that type doesn't exist for system-oriented languages such as Pascal, FORTH, and C.

Western Digital, based in Irvine, California, has also demonstrated its microAda and expects to be the first company to submit a complete Ada compiler to the DOD for validation. WD plans to submit it within the next 3 to 4 months. The WD Ada will run only on WD's new PAL 16-bit computer, a WD microAda license will cost $2000.

SuperSoft Associates of Champaign, Illinois, has demonstrated its Ada compiler for Z80 systems, also expected to be ready for submission to the DOD for validation sometime this year. SuperSoft intends to release Intel 8086/8088, Motorola 68000, and Zilog Z8000 versions, with the Z80 version to sell for under $300.

Telesoft is developing versions of its Ada compiler to run on the 8086, DEC VAX, and IBM 370 machines. Intel has developed an Ada compiler for its (APX432 32-bit microcomputer currently running at beta test sites. Intel is preparing to submit the compiler for DOD validation.

And Ethernet’s Fate?
A report issued by Strategic Incorporated, a market-research firm in San Jose, California, predicts Xerox Corporation’s Ethernet local-area network will be a total failure within two years. According to Strategic’s president, Michael Killen, “Xerox is headed for the worst failure in the company’s history.” He believes that Ethernet’s technical and price advantages, sales force, and customers interested in buying large systems. Further, he contends that Ethernet’s baseband approach to local networking will prove inferior over the long haul to the broadband approach taken by Xerox’s competitors. He points out that broadband systems are better suited to carry video, heavy voice and data transmissions, among other applications.

In response to the report, Xerox issued the following statement: “Based on the level of customer satisfaction with our existing network installations, the backlog of orders for network products and service, and the interest in Ethernet on the part of major accounts, we are confident that Xerox will be a leading vendor in office automation.”

Bell Set to Move Into Computer-Related Markets
AT&T (American Telephone and Telegraph) is undergoing a major management reorganization to comply with the FCC-required separation of regulated and deregulated activities. As a result, look for the Bell System to become an unbridled competitor in computer-related markets. It will probably begin marketing terminals and business computers soon, competing directly with companies such as IBM, Wang, Xerox, and DEC in the intelligent-terminal and work station markets and with Tymnet and Telenet in the communications-processing field. It is unlikely that Bell will compete directly with IBM in the mainframe business.

The Bell System itself presents a large, captive market for computer products. Actually, the Bell System is IBM’s biggest customer outside of the U.S. government. Bell is expected to sell business and personal computers through its many Phone Center stores.

AT&T has also agreed to provide CBS (Columbia Broadcasting System) with home-computer terminals, data-entry equipment, and transmission facilities for a joint teletex experiment scheduled to begin this fall in New Jersey.

A National Amateur Computer Society
The Japan Microcomputer Club is well organized, registers close to 4000 members, and has chapters in every major city in Japan. Hobbyists in England also work together through one central organization, providing an excellent base for the computer industry.

Computer hobbyists have long been the backbone of technological growth, but in the U.S., the hobbyist community is fragmented into several hundred independent clubs. A handful of clubs have over 1000 members, but most include fewer than 100. While some attempts have been made to found a national organization, none has succeeded.

Personal computing as a hobby is a breeding ground for computer professionals of tomorrow. Therefore, it’s vital that we organize a national amateur computer society while we are still the world’s technological leader in computing.

CP/M Goes Into Firmware
Digital Research has signed an agreement with Intel which will allow the latter to sell ROMs encoded with the CP/M-86 operating system. The ROM will also contain timers and some logic; it should be available by mid-year. The ROM is intended for use in a CP/M system where systems containing CP/M in firmware don’t have any disk but must communicate with a CP/M or MP/M server.

Intel will also sell CP/M-86 and MP/M-86 on disk for its single-board and 86330 system. Intel has contracted with Microsoft for its MS-DOS (used on the IBM personal computer). Intel will sell its own RMX-86 DOS and plans to acquire Unix from Western Electric. Hence, Intel users and systems houses will be able to select among a wide variety of operating systems. Intel also expects to market applications software.

Digital Research Buys MT Microsystems
Digital Research has acquired its second software company in less than three months by purchasing MT MicroSystems Incorporated of San Diego, California, supplier of Pascal/MT. Previously, Digital Research had purchased Compiler Systems Incorporated, supplier of CBasic.

Exxon Buys Out Zilog:
Over the years, Exxon Corporation has moved from a minor investor in Zilog Incorporated, supplier of the Z80, to a major investor, owning
90 percent of the stock. Zilog has bought the remaining 10 percent and will become a wholly owned Exxon subsidiary. One result is that Exxon will no longer be required to break out Zilog's quarterly earnings for shareholders. Zilog, incidentally, has yet to report a profit. In fact, the Exxon Enterprises operation, which includes all of Exxon's electronics subsidiaries, incurred a loss of $51 million in the first nine months of 1981.

Microprocessor Trends: Did you know that there are currently 51 different general-purpose microprocessors in production, that 17 are 4-bit devices, 14 are 8-bit devices, 6 are 16-bit devices, 4 are 32-bit devices with 16-bit I/O, 4 are bipolar, and 5 are microframe or special (e.g., Intel 8043/2)? Further, did you know that seven more have been announced but are not yet in production, and that 42 companies currently manufacture microprocessors? The microprocessor recently celebrated its tenth birthday. Credit for creating the microprocessor goes to Intel. (See this month's Editorial on page 6.) Ten years ago, the companies that designed micros were mostly small, freewheeling organizations employing a great deal of ingenuity. Today, it is a totally different ballgame. Most of those early pioneers were either swallowed up by large companies (e.g., Zilog and MOS Technology) or are now very large companies (e.g., Intel, AMD, and National Semiconductor). Furthermore, leadership in design and production appears to be passing to the Japanese.

The microprocessor scene has changed a lot over these ten years. The question now is: what are the current trends and directions of the new micros? First of all, suppliers are making micros easier to program. National and Zilog already have micros with software-in-silicon. They each provide single-chip computers that execute BASIC statements directly in an interpretive mode. Furthermore, Intel is developing one micro with the capability to execute MP/M and another with a sophisticated on-board operating system. Also, there are rumors of a one-chip FORTH computer. There's no doubt that both National and Zilog have been successful with BASIC-processing ICs.

Second, microcomputer ICs are getting more sophisticated, having floating-point capability, multiply/divide functions, enhanced interrupt handling, and the like.

The most glamorous changes will occur in the 16/32 bit micros. All of these devices are getting coprocessors to extend their capabilities into the minicomputer field. Incidentally, Zilog has disclosed that it's working on a 32-bit micro. If the 8-bit unit is a Z80, the 8/16-bit device is a Z800, and the 16-bit micro is the Z8000, what will its 32-bitter be called? You guessed it! The Z80000! Maybe Zilog would be better off calling it the Z8 × 10^4.

Memory Trends:... or, What Is Turbo and Parity? I occasionally look back with fondness to my first micro. It had 256 bytes of memory and used an Intel 8008. That was only 8 years ago. The next year, I graduated to an Altair 8800 that had an 8080, six printed-circuit cards containing 4K bytes of RAM, an I/O channel, and a huge power supply. How times have changed! The most significant change has been in memory. Today the 16K-bit, single-voltage RAMs dominate the marketplace, providing cost savings (mostly by shrinking power-supply requirements), yielding faster operation, and making the 64K-byte computer memory nearly standard. The 64K-bit RAM ICs are just starting to appear, and we find that computer memory sizes of 128K bytes and 256K bytes are becoming more common and will probably become the standard microcomputer memory size by the end of 1983. The 256K-byte RAM chips are now going into production. I expect that by 1985 1 megabyte will probably be the typical microcomputer memory size. Also, as the volumetric memory space decreases, the associated access time decreases, resulting in increased system performance.

Some of the most interesting changes in memory design are improving memory reliability and speed. Memory manufacturers are beginning to introduce multifunction memory systems that perform parity or error-checking and correction functions previously handled by a computer's processor, if they were done at all. In fact, National
Semiconductor has introduced an IC (the OP8400) that performs all the memory error checking and correcting so that the processor is not bothered with this task. Error checking and correction is particularly important with dynamic RAM since these devices are prone to soft (transient) errors due to noise and radio-frequency interference, alpha particles, cosmic rays, and voltage fluctuations.

Manufacturers are also introducing on-board batteries to protect RAM during power failure. With the use of CMOS RAM, an on-board battery can protect data for over a hundred hours, and lithium-iodine batteries have been shown to be able to provide as much as one year of data retention.

The demand for faster computer access to disk drives has generated new cache techniques to reduce seek time and rotational latency delays that account for about 60 percent of throughput bottlenecks. This technique is called the "turbo disk file cache" or "turbo" for short. The turbo eliminates disk seeks by frequently used data by transferring such data to a cache memory (typically 128K bytes) and accessing the data from the cache instead of the disk. The data in the cache is kept current using an algorithm such that the block of data that has gone unaccessed the longest is replaced by the next nearest-in-use block of data. The turbo algorithm considers past use and the probability for future use. Software 2000 Incorporated of Arroyo Grande, California, for example, sells TurboDOS, which it claims runs CP/M software three to five times faster. The company has adapted its software to run on most of the popular S-100 systems, the Xerox 820, TRS-80 Model II, and others.

**Quote of the Month:**

"By the end of the century, analysts predict, computers and information processing will be the world’s biggest business after petroleum."


**APOLOGY DUE:** I regret that in my November 1981 column I erroneously reported that Canon was marketing the CX-1 computer via distributors responsible for software support. Canon has informed me that it markets the CX-1 directly to dealers and provides software support.

** 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**
**POB 1192**
**Mountainside, NJ 07092**
Clubs and Newsletters

Apple Group in Little Rock

The Little Rock Apple Addicts publish a newsletter and hold meetings and program swaps. Guest speakers have shown members how to diagnose ailing Apples and have demonstrated programs and peripherals. Contact Little Rock Apple Addicts, POB 55215, Little Rock, AR 72205.

Free Newsletter

The Software Newsletter is a free bimonthly publication of the Software Store in Los Angeles, California. It features news about personal and business CP/M software. Also included are reviews of microcomputer books, magazines, and games. Contact the Software Store, 11768 West Pico Blvd., West Los Angeles, CA 90064, (213) 473-1136.

Llano Estacado Computer Club

Llano Estacado Computer Club would like to exchange ideas with other computer clubs. Members are interested in all microcomputers. Write to John L. Peters, Llano Estacado Computer Club, 1509 Fairway Terrace, Clovis, NM 88101.

Computer Association in Central Texas

The Central Texas Computer Association (CTCA) meets on the fourth Monday of the month at the Farm & Home Savings Building in Austin, Texas. Club meetings include short demonstrations or informal talks on a variety of subjects relating to personal computers. A monthly journal, PRINT-OUT, has information on hardware and software, new equipment critiques, and a classified ad section free to members. The CTCA is active in community service, with a number of projects underway for the deaf. Membership dues are $15. Contact CTCA, POB 179303, Austin, TX 78760.

HUGs in Pittsburgh

The Pittsburgh Heath Users Group (HUG) meets the third Tuesday of every month at the Heathkit store (3482 William Penn Hwy.) from 7 to 9 p.m. For more information, call (412) 624-3564.

Computer Dealers Society

The American Society of Computer Dealers (ASCD) is a new group devoted to promoting sound business practices in the used-computer industry. ASCD intends to cooperate fully with the Computer Dealers and Lessors Association in promoting ethical conduct standards. A code of ethics for ASCD members has been adopted. Meetings will be held twice a year, in February and July. For further details, contact ASCD, 3500 Southland Center, Dallas, TX 75201, or call Jerry Roberts at (313) 689-6200.

Dental Computer News

The Dental Computer Newsletter is a publication serving an international group of dentists, physicians, and office-management personnel who share a common interest in office computers. Members also have access to a software exchange and a computer bulletin board. Dues are $15 domestic, $23 overseas. Contact Dental Computer Newsletter, c/o E. J. Neiburger, 1000 North Ave., Waukegan, IL 60085.

Magazine for War Gamers

The War Machine is a bi-monthly magazine dedicated to fans of computer war games. It features news, reviews of complex games for all microcomputers, and advice for independent software writers. The latest issue can be obtained for $3 from Emjay, 17 Langbank Ave., Rise Park, Nottingham NG5 5BU, England.

Two New Groups in Munich

Two new microcomputer groups have been organized in Munich, West Germany. The European Branch of the Pascal Z Users Group has been formed in association with the American Pascal Z Users Group. And the second, the Ithaca Intersystems/S-100 Users Group plans to coordinate Ithaca users' efforts in Europe and to form a program exchange. Both groups can be contacted by writing George Brooke, Sebastian Bauersstrasse 20c, 8000 Munich 83, West Germany.
Software Received

Apple
Adventure in Time, an adventure game for the Apple II. Floppy disk, $29.95. Phoenix Software Inc., 64 Lake Zurich Dr., Lake Zurich, IL 60047.

Birth of the Phoenix, a tutorial adventure for the Apple II. Floppy disk, $14.95. Phoenix Software Inc. (see address above).


Comma Usage/Semicolon and Colon Usage, a punctuation usage tutorial for the Apple II. Cassette, $20; floppy disk, $25. LARA Software, 980 Hunting Valley Pl., Decatur, GA 30033.


DataLink, a telecommunications package in Pascal for the Apple II. Floppy disk, $100. Link Systems, 1655 26th St., Santa Monica, CA 90404.

Linkdisk, a disk-utility package in Pascal for the Apple II. Floppy disk, $70. Link Systems (see address above).

Linkindex, a rapid key data-file retrieval system in Pascal for the Apple II. Floppy disk, $150. Link Systems (see address above).

Quickscreen, a screen-formatting program for the CP/M operating system. 8-inch floppy disk, $19.50. The Information People, 443 Hudson Ave., Newark, OH 43055.

Visicalc utility program for the Apple II. Floppy disk, $70. Link Systems (see address above).

Zap Grafix, a graphics/printer control package for the Apple II. Floppy disk, $39.95. Phoenix Software Inc. (see address above).

Atari
Easytext Word Processor, a word-processing system for the Atari 800. Floppy disk, $50. Datatworks Inc., 97 Jackson St., Cambridge, MA 02140.

The I Ching, a program for casting and displaying hexagrams for the Atari 800. Floppy disk, $44.95. Alternate Reality Software, 2111 West Arapahoe Dr., Littleton, CO 80120.

Shadow Hawk One, an arcade-style game for the Atari 400/800. Floppy disk, $49.95. Horizon Simulations, 107 East Main #2, Medford, OR 97501.

CP/M
Office System 80, a utility system for the CP/M operating system. 8-inch floppy disk, $19.50. The Information People, 443 Hudson Ave., Newark, OH 43055.

Quicktext, a screen-formatting program for the CP/M operating system. 8-inch floppy disk, $149. Fox and Geller Associates Inc., POB 1053, Teaneck, NJ 07666.


XLT86, an assembly-language conversion utility to convert CP/M programs to CP/M-86. 8-inch floppy disk, $150. Digital Research Inc., 801 Lighthouse Ave., POB 579, Pacific Grove, CA 93950.

TRS-80
LOG, a simple database management program for the TRS-80 Models I and III. Floppy disk, $44.95 (Model I), $49.95 (Model III). KSoft, 318 Lakeside Dr., Brandon, MS 39042.

Modern 80, a telecommunications software package for the TRS-80 Models I and III. Floppy disk, $39.95. The Alternate Source, 1806 Ada St., Lansing, MI 48910.

Smart Terminal, a telecommunications software package for the TRS-80 Models I and III. Cassette, $69.95.

This is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. All software received is considered to be on loan to BYTE and is returned to the manufacturer after a set period of time. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

BYTE's Bugs

Closer Look Spies Bug

PC: The Independent Guide to the IBM Personal Computer is a bimonthly publication, not a monthly as stated on page 60 of Gregg Williams' article "A Closer Look at the IBM Personal Computer" (January 1982 BYTE). Subscriptions to the magazine cost $12 for six issues.

Please note that the new address for PC: The Independent Guide to the IBM Personal Computer is 1239 21st Ave., San Francisco, CA 94122, (415) 753-8088.
Speech Synthesizer Application

Dear Steve,

I read with great interest your article, "Build an Unlimited-Vocabulary Speech Synthesizer" (September 1981 BYTE, page 38), and have found a possible use for it. I have a Perkin-Elmer 3220 computer and would like to use the synthesizer to answer telephone calls into the computer, mainly to respond to salesmen who have phoned orders into the computer. The synthesizer would respond with appropriate messages, telling the salesmen if transmission was successful or what problem occurred. Could you say the synthesizer feasible be used in this capacity on my computer, with or without modifications, and what modifications would be necessary, if any?

Derek Pitcher
Highland Park, NJ

The speech synthesizer requires only a Centronics-compatible parallel output port commonly used for printers. The port comprises 9 output lines and 2 input lines. If your computer has this capability, then the synthesizer can be easily interfaced as described in the article.

Your application is an excellent one. Many companies, including Ma Bell, use speech synthesizers on the telephone. Listen carefully the next time you dial a phone number that has been changed. . . . Steve

Problems with EPROM

Dear Steve,

I was very glad to see your article, "Build an Intelligent EPROM Programmer," in the October 1981 BYTE (see page 36). For the past several months, I have been trying to build a circuit to program EPROMs (erasable-programmable read-only memory) using my homebrew 6809 computer and three output ports from 6820 Peripheral Interface Adapters. It was a bit of a surprise to see that my circuit is almost the same as yours. Mine does not work, however, and I can't figure out why.

I am using the 5-volt-only version of the 2716 EPROM, and my timing is done by a wait loop in software rather than by the one-shot TTL (transistor-transistor logic) device that you used. When I try to program a "known-good" 2716, it comes out with about one-fourth the bytes programmed (the rest are hexadecimal FF), and those bytes that are programmed are not necessarily right.

I checked all the address lines and data lines over and over again. I even single-stepped through the program, monitoring all the voltages as I went. Every pin is what it should be, but it just doesn't work right. I was wondering if you knew of any little idiosyncrasies of the 2716 that may cause such a symptom. Did you run into any such trouble with your circuit?

Matthew G. Cimbala
State College, PA

It sounds as if you have a software problem in which the addresses are not being placed on the EPROM in the right sequence. Perhaps your address-incrementing routine is resetting too soon.

The fact that you are getting data into the EPROM (assuming that all bytes were hexadecimal FF prior to programming) indicates that the program timing loop is okay. The 2716 is a very reliable EPROM and I am not aware of any idiosyncrasies that would cause this problem. I suggest you leave it alone for a few days and then walk through the software, paying close attention to your indexing instructions. . . . Steve

High-speed Printers

Dear Steve,

I would like to build a 16-bit microcomputer system to drive a 600-line-per-minute printer. Printers like that advertised in BYTE, but I have my doubts that anything can actually print at that speed. What do you think?

Colin Morris
New York, NY

Six-hundred-line-per-minute printers do indeed exist. Your doubts as to anything printing that fast are natural, especially if you are used to seeing a dot-matrix or daisy-wheel printer printing one character at a time. The higher-speed printers print a whole line at a time (like the old mechanical adding machines) and can be driven much faster.

I think the ultimate in printers is the IBM laser printer. It is capable of 1800 lines per minute. It works by having the laser, acting like the electron beam of a TV screen, scan a metal plate. The plate becomes charged, and the image is transferred to paper much like a xerographic copier. The problem with this type of printer is the manpower necessary to load and unload the boxes of paper that are used. . . . Steve

Level I Tape Format

Dear Steve,

I wrote a program that brought data from the tape and stored them in memory of my TRS-80 Model I so that I could examine them. But the data format did not match any listed in my refer-
ences. Part of the problem was that I was using a Level I BASIC machine and reading programs like Eliza, Micro­movie, and Pyramid 2000.

So I modified my program to read Level II tapes and sure enough, the formats were correct. Can you tell me where to find the format for Level I tapes?

Bob Fabiano
El Cajon, CA

Radio Shack has machine­language programs for con­verting your Level I BASIC programs and data files into the Level II format. They are called CONV and DCONV, respectively, and are furnished free of charge when a Level I machine is upgraded to Level II. See your local Radio Shack dealer.

The Level I cassette­tape format can be found in The Custom TRS-80 and Other Mysteries by Dennis Kitzs.

...Steve

Computer Lab Essentials

Dear Steve,

I am a sometime practition­er of simple chip and micro­processor designs. I am approach­ing retirement in a few years and I'd like to build more ambitious projects. To do that I'd like to set up a lab of sorts. Accordingly, I would value your recommenda­tions about the kinds of test instruments I should be thinking about getting. I should tell you also that I have a 35-year-old degree in electrical engineering and, in the mid­fifties, I worked in hardware. The point being I'm not worried about my ability to use dual­trace scopes, voltmeters, and the like.

I'll probably try to build a computer from scratch. I was particularly intrigued by your article, "Build a Computer­Controlled Tank," in the February 1981 BYTE, page 44. Maybe I'll try to tie a specially built computer to a complex model railroad layout. I tell you this to give you an idea of what I think I'd like to do. I'm not especially worried about the price of the test instruments, but naturally I'd like to avoid buying the fanciest Tektronix scope. I'm an experienced kit builder, so if you think a particular Heath scope is a good value and desirable, that might be best.

B. H. Kramer
St. Louis, MO

The two instruments that are absolute musts for a com­puter lab are an oscilloscope and a DVM (digital voltmeter). The scope should have a 15 to 25 MHz bandwidth with dual trace and a time­base range between 200 nanoseconds and 0.5 seconds (without having to use the time­base magnifier). Vertical sensitivity should be at least 10 millivolts per division. Delayed sweep and trigger view are not necessary. I just purchased a Tektronix 2215 ($1400), and it is very good for the money. As for the DVM, any 3½ digit model should suffice.

Other useful equipment would be a function generator and variable­voltage power supply with short­circuit and overload protection. The above recommendations should suffice for the application that you describe. In any event, this represents the foundation of a good lab system and will require only a modest investment. Enjoy your retirement. ...Steve
Micro Manufacturing Systems has been developing and supplying manufacturing software directly to manufacturers for several years and is now offering its MCS-2 system to dealers and OEM's. MCS-2 is the most comprehensive manufacturing control system designed for the CPM based micro computer. MCS-2 consists of nine separate modules which can be purchased as a complete system or individually as required.

For more information contact:

Micro Manufacturing Systems

1670 Norma Rd. • Columbus, Ohio 43229
Phone: (614) 885-0738

Dear Steve,

I have been unable to find any information on programming the RS-232C serial port on the Radio Shack Color Computer. A call to the "hot line" indicated that Radio Shack consultants were somewhat in the dark, although they tried to be helpful. Can you shed any light on this topic?

Martin F. Rooney
Troy, NY

The RS-232C serial port on Radio Shack's Color Computer consists of 3 bits of 3 addresses of a Motorola MC6821 Peripheral Interface Adapter (PIA). At address hexadecimal FF20, bit 1 represents the RS-232C Data Output and is brought out to pin 4 of connector P2. Address hexadecimal FF21, bit 1, is the Status Input line, connected to pin 1 of P2. Address hexadecimal FF22, bit 0, is the RS-232C Data Input and is connected to pin 2 of P2; pin 3 of P2 is ground.

In software, the only RS-232C device supported by the 8k-byte BASIC is a serial printer, so pin 1 of P2 is not used. Pin 2 is intended to be connected to the printer status or busy line, and pin 4 is the output to the printer. To program the MC6821, a rather elaborate discussion must ensue. An article from EDN magazine, September 20, 1980, "Understanding PIA Operations Increases Your Design Options" by Randy Hutcheson, explains this rather well.

The TRS-80 Color Computer Technical Reference Manual (Cat. No. 26-3193) explains all the input/output ports and has a complete memory map. It is available through any Radio Shack store... Steve

Ask BYTE

Programming the RS-232C Serial Port

Dear Steve,

I have read some of your articles and especially liked "Build the Disk-80" (see the March 1981 BYTE, page 36), but I was sorry that it was not designed to work with 8-inch disk drives. I would like to build a computer, perhaps based on Zilog's Z80, with provisions for four 8-inch disk drives and with the ability to directly address 128K bytes of nonvolatile memory. Do you have any suggestions?

W. Edward Kelsey
New London, NH

I'm glad to see that there are still some people who enjoy building computers rather than buying them. Your idea of a Z80-based system sounds fine, but I don't plan anything like it in the near future. Below are a few suggestions that may help.

You don't say what your experience level is, but at the risk of sounding like a commercial I would recommend my book, Build Your Own Z80 Computer (a McGraw-Hill publication available from BYTE Books, Peterborough, NH 03458). It contains the necessary information to build a complete computer and configure it any way that you wish.

As for the disk controller and memory, I would suggest that you buy them either as bare boards or assembled and tested. Configure your Z80 to an S-100 bus and save yourself a lot of grief. You will have your fun building the Z80 and you will save a lot of headaches by using prewired boards for the rest of the system.

You then can use bank-selectable memory boards and can easily have your 128K bytes of memory... Steve

Build Your Own
Radio Frequency Interference

Dear Steve,

I have been reading your column in BYTE since I first picked up an issue about four months ago. I am writing this on my newly acquired Vector Graphic System B and would deeply appreciate a reply to a nagging question.

The Vector System B installed for word processing in my home is about 15 feet from our TV antenna (located on rafters in the garage—our elevation precludes an external antenna). The system kills channel 2 and distorts 5 and 7. The dealer suggested a Radio Shack filter, which did nothing. I learned from another dealer that the System B uses a crystal oscillator with a frequency near television channel 2.

Please suggest what course of action I should take or what remedies I might initiate myself, such as a radio-frequency filter a novice could install in or around the computer case.

Jacob D. Pottingen
New Lenox, IL

Plotting with the TRS-80

Dear Steve,

I would like to find a program that will allow me to make x-y plots of graphs of linear and logarithmic equations and data points. I have a TRS-80 Model III and an IDS-560 printer with graphics capability. I don’t need to see the plots on the screen; I only need to be able to print them out on the IDS-560.

Any help you could give me would be most appreciated. Thanks a lot.

Donald M. Lammers
Wexford, PA

Programs for x-y plotting are available at your local Radio Shack store. The following two books are quite thorough in the explanation of equations and data points and are directed, naturally, toward Radio Shack BASIC: TRS-80 Programs, Cat. No. 62-2064, and TRS-80 Graphics, Cat. No. 62-2063.

... Steve

A Matter of Environment

Dear Steve,

I’ve taken instructions from a page from your recent book, Build Your Own Z80 Computer, and modified them to “Build Your Own Z8000,” which is the source of my problem. The S-100 system I’m designing uses a Zilog Z8001 segmented microprocessor with a 4 MHz 8511 arithmetic processor. Hardware design is a snap so far. (I plan to purchase the Disk-1 floppy-disk controller from Godbout and build all other boards that I need.) The problem will be software; specifically, I need an operating system such as Unix or Unix-compatible Coherent. But Coherent is written in unsegmented code.

... Steve
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Ask BYTE—

Where can I get an operating system?

This sort of operating system is not the type usually advertised in BYTE; and you know how much good my beautiful hardware is going to be without it. (I'd prefer Unix if available.) The computer is intended as a multiuser, multitasking system, preferably with a FORTRAN compiler, as well as an assembler/editor/debugger.

Frank Barresi
Woodhaven, NY

Your problem is somewhat sticky. The problem is not altogether in the operating system. Unix, like CP/M, does not contain the primitives (software subroutines) for any I/O (input/output). Like CP/M's BIOS (basic input/output subsystem), these are totally hardware dependent.

In other words, you might be able to use Unix if you can write the subroutines for the I/O primitives. Be wary, however; Unix may use some strange hardware-dependent software, but I'm not an expert on Unix and can't be sure of this.

Two good sources of information about Unix are: The July-August 1978 issue of the Bell System Technical Journal devoted to Unix, available for $2.98 from the Bell Laboratories Circulation Group, Whippiny Road, Whippany, NJ 07981; and Using the Unix System by Richard Gauthier, Reston Publishing Co., Reston, VA, 1981.

Get as much information on Unix as you can and study the various implementations of Unix. Pay special attention to system environmental requirements and I/O requirements.

What it all boils down to is this: if you can make your hardware as much like the proper environment for Unix as possible, it should work. By the way, I'll let you know when I do anything with the Z8000. Remember what happened to Colossus in the sequel? Good luck in any event... Steve

Feasibility Study

Dear Steve,

I am presently studying electronics at a technical school. I have a technical writing course in which we are assigned to do some sort of feasibility study. I have chosen to do mine on the feasibility of purchasing a microcomputer for home use.

I am hoping that you could give me some references and, if possible, pass along some information which would help me in my study. This would be most appreciated.

Douglas E. Sprague
Hancock, ME

There is a wealth of information available on purchasing a computer for home use. The field of home computing is rapidly expanding and makes an excellent choice for a feasibility study.

The following are some references that should be quite helpful: Popular Computing, November 1981; Personal Computing—Home Professional and Small Business Applications by Daniel R. McGlynn, John Wiley and Sons, 1979; and Your Own Computer by Mitchell Waite and Michael Pardee, Howard W. Sams & Co. Steve

VIP Expansion

Dear Steve,

I have an RCA COSMAC VIP with the 20K-byte memory upgrade so that I can use the VIP Floating Point (VIP 711). What I would like is to add a printer. Is it possible to do this with the VIP 711? I
know very little about the 1802 microprocessor.

I also have a TRS-80 with 48K bytes of memory, one disk drive, and a printer, and I have a Quick Printer 2. I would like to hook up the Quick Printer 2 to the VIP, but I don’t even know how to start. I have no knowledge of electronics at all. Is this project possible? If so, where would I get the driver for the printer? (I have looked for 1802-based software to drive a printer, but so far, no soap.) Can you help me?

Nicholas Mulchin
Meadville, PA

The RCA COSMAC VIP is a powerful single-board computer. Unfortunately, there is little support for it in the computer magazines. It does, however, have expansion capability in the form of a 44-line I/O (input/output) interface that will allow almost anything to be added, including up to 32K bytes of programmable memory. It requires a fair amount of technical skill to accomplish the interface.

I doubt if there exists a printer interface such as you are looking for that would simply “plug in” to your VIP. The two manufacturers listed below make interface boards for the 1802 processor, and they may have the necessary information to connect with the VIP: Netronics Research & Development, Ltd., 333 Litchfield Road, New Milford, CT 06776, (203) 354-9375; and RCA Solid State, Box 3200, Somerville, NJ 08876.

Any software must first test the “printer busy” signal. If it is active, the computer must not send data to the printer, or it will not be seen. When the busy signal is low, the 8-bit data character may be sent from the output port which will cause the printer to print it. When the next character is ready, the process must begin again. . . . Steve

TTL Data Books

Dear Steve,

I am looking for a TTL (transistor-transistor logic) data book that has descriptions and pinouts for the majority of the manufactured ICs (including the special and less frequently used ICs). Your suggestions are appreciated.

Paul Russo
Naples, FL

Every manufacturer of integrated circuits publishes a data book for its product line. One of the most readily available data books is published by National Semiconductor and is available at your local Radio Shack store or through Jameco Electronics, 1355 Shoreway Rd., Belmont, CA 94002, (415) 392-8097. Price lists for various data books can also be obtained by writing directly to the manufacturers. . . . Steve

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March 1982

March Courses and Seminars from George Washington University, Amsterdam, Netherlands; and Washington, DC. Among the courses and seminars to be presented are "Microcomputers in Control Systems," "Comparative Database Management Systems," and "Structured Programming and Software Engineering." For further information, contact The Director, Continuing Engineering Education, George Washington University, Washington, DC 20052, (800) 424-9773; in Washington, DC, (202) 676-6106.

March Course in Structured Systems, various sites throughout the U.S. Courses in "Structured Systems Design" and "Structured Requirements Definition" are being offered by Ken Orr and Associates. For information on meeting times, places, and fees, contact Ken Orr and Associates Inc., 715 East 8th, Topeka, KS 66607, (800) 255-2459; in Kansas, (913) 233-2349.

March-April Fundamentals of Data Processing for Administrative Assistants and Office Support Staff, various sites throughout the U.S. The American Management Associations (AMA) has designed this three-day course for secretaries, assistants, supervisors, and other personnel desiring to learn the fundamentals of data processing and its use in offices. Computer hardware, software, programming languages, and technology will all be covered. The team fee for AMA members is $470 per individual and $550 for nonmembers. Individual fees are $550 for AMA members and $630 for nonmembers. For a schedule of dates and locations, contact the AMA, 135 West 30th St., New York, NY 10002, (212) 586-8100. To register by phone, call (212) 246-0800.

March-May Courses from Boeing Computer Services, various sites throughout the U.S. Boeing Computer Services is offering a wide variety of computer-related courses at its regional service centers. Course topics range from "Introduction to Data Processing" to "Structured Program Development in FORTRAN." For a complete schedule of times, locations, and fees, contact Boeing Computer Services Co., Education and Training Div., POB 249346, Seattle, WA 98124, (206) 575-7700.


March-June One- and Two-day Professional Development Seminars, various sites in the greater Boston area. Among the courses being offered by Boston University are "Business Writing for Results," "Improving Customer Service," and "Assertive Management." Registration fees range from $295 for a one-day program to $445 for a two-day program. These seminars can be conducted within your company. For details, contact Ms. Joan Merrick, Center for Management Research, 850 Boylston St., Chestnut Hill, MA 02167, (617) 738-5020.

March-May Seminars and Conferences from Datapro Research, various sites throughout the U.S. Among the topics to be presented are "IBM's Systems Network Architecture," "Data Dictionary/Directory Systems," and "Data Processing: Fundamental Concepts." Enrollment fees are $640 for Datapro subscribers and $690 for nonsubsribers. For a complete catalog with descriptions, dates, and locations, contact Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075, (800) 257-9406; in New Jersey, (609) 764-0100.

March-June Datamation Institute Seminars on Information Management, various sites throughout the U.S. Databases and communications, systems performance, data-processing management, word processing, office automation, computer graphics, and topics of general interest are among the areas to be covered by these two-day seminars. Fees range from $495 to $595. For schedules of times and places, contact Karen Smolens, c/o the Center for Management Research, Datamation Institute Seminar Coordination Office, 850 Boylston St., Chestnut Hill, MA 02167, (617) 738-5020.
March-June

Courses and Seminars from Sira Institute, various sites throughout England. Sira Institute is sponsoring seminars on a wide variety of subjects ranging from microprocessor familiarization to design and development of microprocessor-based equipment. For details, contact Conferences & Courses Unit, Sira Institute Ltd., South Hill, Chislehurst, Kent BR7 5EH, England.

March-July

Technical Classes from Zilog, Campbell, CA. Zilog is offering a series of one- to five-day technical classes at its California-based training facility. Topics range from "Microprocessors: A General Introduction" to "Zeus/System 8000 User." Contact Zilog, Training Dept., 3315 Dell Ave., Campbell, CA 95008, (408) 446-4666.

March 9-11

The 1982 International Zurich Seminar on Digital Communications, Zurich, Switzerland. The theme of this seminar is "Man-Machine Interaction." Its aim is to present recent advances in theory and application of digital-communication systems. Services, facilities, ergonomics, and their impact on peripheral equipment, systems architecture and design, as well as I/O (input/output) concepts and principles will be covered. For details, contact Secretariat 82 IZS, Ms. M. Frey, EAE, Siemens-Albis AG, POB CH-8047, Zurich, Switzerland.

March 9-12

Understanding and Using Computer Graphics, Dallas Hilton Inn, Dallas, TX. This seminar is designed for those needing information about interactive computer graphics, including hardware, software, and applications. Headed by Carl Machover, the seminar provides a comprehensive overview of the state of the art in graphics systems. For details, contact Bob Sanzo, c/o Frost & Sullivan Inc., 106 Fulton St., New York, NY 10038, (212) 233-1080.

March 9-12

Digital Image Processing and Analysis, San Diego, CA. Integrated Computer Systems' course in digital-image processing is designed for engineers, scientists, technical managers, and other professionals responsible for the specification, design, implementation, or application of digital-image processing systems. Among the topics to be covered are image acquisition, image-processing software and database structures, interactive two- and three-dimensional image processing and display, and real-time arrays. Some of the applications examples to be presented are quality assurance and robot vision. The course fee is $795; on-site courses can be arranged. Contact Ruth Dordick, c/o Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (800) 421-8166; in California (800) 352-8251.

March 10-12

Cincinnati Business Show, Cincinnati Convention Center, Cincinnati, OH. The Cincinnati Business show features the latest in business technology, office systems, and products. Seminars will also be presented. For information, contact Ray G. Nemo, 5679 Creek Rd., Cincinnati, OH 45242, (513) 531-5959.

March 10-12

The Fifth Annual Computers in Education Conference, Seattle Pacific University, Seattle, WA. Sponsored by Seattle Pacific University and the National Council for Computers in Education, this conference features concurrent talks, workshops, and discussions. Special emphasis will be placed on curricular uses of microcomputers in kindergarten through 12th grade. Contact Tony Jongejan, Everett High School, Everett, WA 98201.

March 12-14

VIO-Voice Input/Output for Computers, Los Angeles, CA. This four-day course is designed for product development and design engineers, systems analysts, programmers, and technical managers involved in the planning, design, and implementation of voice input/output systems. The topics to be covered include voice-processing algorithms and software, evaluating VIO hardware components and systems, utilizing speech-synthesis techniques, and designing voice-recognition techniques. Participants will have the opportunity to work with devices that permit online generation of computer-voice output, data entry by means of voice input, and voice input for system control. The course fee is $795; on-site courses can be arranged. For information, contact Ruth Dordick, c/o Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (800) 421-8166; in California (800) 352-8251.

March 13-15

Digital Filters and Spectral Analysis, Boston, MA. Integrated Computer Systems (ICS) is presenting this four-day course for project and design engineers, programmers, and technical managers responsible for implementing

March 15-17

Microprocessor Background for Management Personnel, Albuquerque, NM. This course is sponsored by the Electrical and Computer Engineering Department of the University of New Mexico. The course fee is $375. For details, contact Dr. Martin Bradshaw, Engineering Continuing Education, University of New Mexico, Albuquerque, NM 87131, (505) 277-4354.

March 15-19

Software expo-West, Anaheim Convention Center, Anaheim, CA. This conference and show is devoted to packaged software. Exhibitors will display a wide range of software products. For additional information, contact Software expo-West, Suite 400, 222 West Adams St., Chicago, IL 60606, (312) 263-3131.

March 16-19

Microprocessor Background for Management Personnel, Albuquerque, NM. This course is sponsored by the Electrical and Computer Engineering Department of the University of New Mexico. The course fee is $375. For details, contact Dr. Martin Bradshaw, Engineering Continuing Education, University of New Mexico, Albuquerque, NM 87131, (505) 277-4354.

March 16-17

Short Course from UCLA, Boelter Hall, University of California-Los Angeles (UCLA), Los Angeles, CA. "Mechanical Reliability, Design by Reliability, Probabilistic Design—The Stress/Strength Interference Approach to Reliability Prediction" is a short course being presented by UCLA. The course fee is $795, which includes comprehensive course notes. For details, contact Dr. Dimitri Kececioglu, Aerospace and Mechanical Engineering Dept., University of Arizona, Tucson, AZ 85721, (602) 626-2495 or (602) 626-3901. In California, call Robert Rector at UCLA, (213) 825-1295 or (213) 825-3334.

March 16-18

Software expo-West, Anaheim Convention Center, Anaheim, CA. This conference and show is devoted to packaged software. Exhibitors will display a wide range of software products. For additional information, contact Software expo-West, Suite 400, 222 West Adams St., Chicago, IL 60606, (312) 263-3131.

March 16-19

Digital Filters and Spectral Analysis, Boston, MA. Integrated Computer Systems (ICS) is presenting this four-day course for project and design engineers, programmers, and technical managers responsible for implementing
Event Queue

advanced digital signal-processing systems and for others who must understand them and their potential. Fundamentals of digital signal processing, fast Fourier transform (FFT) algorithms, and special- and general-purpose LSIS/LSI (large-scale and very large-scale integration) devices are among the topics to be addressed. The course fee is $795; on-site courses can be arranged. Contact Ruth Dordick, c/o ICS, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (800) 421-8166; in California, (800) 352-8251.

March 17

Evaluating Decision Support Software: A Managerial Perspective, Suffolk University School of Management, Boston, MA. This conference is sponsored by the local chapters of six management and computer associations. It will examine the managerial issues involved in choosing decision-support software. The focus will be on end-user characterization, problem diagnosis, needs assessment, and the implications of the evaluation and selection process. Industry experts will speak. Contact DSS Conference, 215 First St., Cambridge, MA 02142, (617) 547-5061.

March 19

The Eleventh Annual International Computer Programs Awards Ceremony and Executives' Conference, Savoy Hotel, London, England. The annual International Computer Programs (ICP) awards ceremony honors super software salespeople, advertising agencies, public relations firms, and achievements in the industry. The executive conference is one and a half days of discussion of the major issues and concerns of the industry. The fee for the executive conference is $250. For information, contact Carol Stumpf, c/o ICP, 9000 Keystone Crossing, POB 40946, Indianapolis, IN 46240, (800) 428-6179; in Indiana, (317) 844-7461. In England, contact International Computer Programs Inc., 2 Deeney St., Park Lane, London WY 5LH, England, Tel: 01 499 6621.

March 19-21

The Seventh West Coast Computer Faire, Civic Auditorium and Brooks Hall, San Francisco, CA. Attendance this year is expected to reach 35,000. More than 300 exhibitors and a wide assortment of seminars make this one of the largest annual computer shows. For more information, contact The Computer Faire, 333 Swett Rd., Woodside, CA 94062, (415) 851-7075.

March 22-23

Oasis Level Two Training Seminars, Phase One Systems, Oakland, CA. Using a step-by-step approach to developing applications software with the multiuser Oasis operating system, this seminar begins with program design and proceeds to a careful study of the Oasis system. Topics to be covered are the Oasis BASIC interpreter and compiler, program segments, file structures and I/O (input/output), matrices and matrix I/O, multiline branching structures, and subroutine and error handling.

The registration fee for this three-day session is $350. Some background in BASIC programming is recommended. Contact Phase One Systems, Suite 800, 7700 Edgewater Dr., Oakland, CA 94621, (415) 562-8085.

March 22-23

Interface '82 Conference and Expo, Dallas Convention Center, Dallas, TX. Cosponsored by McGraw-Hill's Business Week and Data Communications magazines, Inter-
face '82 is aimed at users of data-communication equipment, distributed-data processing, and various networks. For details, contact The Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

March 22-25
Computers/Graphics in the Building Process, Washington, DC. This international conference is sponsored by the Advisory Board on the Built Environment (ABBE) of the National Academy of Sciences and by the World Computer Graphics Association (WCGA). The conference features tutorials, technical paper sessions, and exhibits that reflect the state of the art of computers and computer-graphics technology in the building industry. Sessions on case studies, current achievements, and research and development of computer hardware, software, and database programs will be presented. Conference topics include computer aids to management, computer technology, and computer-aided analysis in design development and construction documents. For further details, contact the WCGA, Suite 250, 2033 M St. NW, Washington, DC 20036, (202) 775-9556.

March 22-26
Tutorial Week East '82, Orlando Marriott Inn, Orlando, FL. Tutorial Week East is sponsored by the Institute of Electrical and Electronics Engineers (IEEE) and Engineers (IEEE) Computers and Communications Networking Conference topics include computer aided to manage, computer technology, and computer-aided analysis in design development and construction documents. For further details, contact The Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

March 23-25
Southcon '82, Sheraton Twin Towers Hotel, Orlando Hyatt Hotel, and Holiday Inn International Drive, Orlando, FL. Among the topics to be presented at Southcon '82 will be artificial intelligence and robotics, office automation, computers and microprocessors, and software. For complete details, contact Robert Myers, c/o Electronic Conventions Inc., Suite 410, 999 North Sepulveda Blvd., El Segundo, CA 90245, (213) 772-2965.

March 26-28
The 1982 Computer Showcase Expo, Atlanta, GA. The Computer Showcase is designed for small-business owners, independent professionals, and corporate managers. Admission is $7.50. For further details, contact The Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

March 27-28
Amateur Radio and Computer Hobbyists (ARCH) Convention, Chase Park-Plaza Hotel, St. Louis, MO. This convention features exhibits, workshops, forums, and a flea market. For details, contact Gateway Amateur Radio Association, POB 8432, St. Louis, MO 63132, (314) 361-4965.

March 29-30
Information Utilities '82, Rye Town Hilton Hotel and Conference Center, Rye, NY. The Information Utilities conference will focus on videotex, transactional services, electronic publishing, online database services, cable advertising, and regulations concerning copyright, censorship, and communications. More than 60 speakers are scheduled. For details, contact Online Inc., 11 Tannery Ln., Weston, CT 06883, (203) 227-8466.

April 29-April 1
INFOCOM '82, Las Vegas, NV. INFOCOM '82 is sponsored by the Institute of Electrical and Electronics Engineers (IEEE) Computer and Communications Societies. The conference theme is "Data Processing—Data Communications: The Illusory Boundary." Focusing on the convergence of computer and communication technology, this conference will attempt to bridge the boundary between the two disciplines. Discussions on programming-language and operating system design, performance evaluation and analysis of computer-communication networks and protocols, standards, and the design of distributed computing and database management systems will be held. Exhibits and tutorials are planned. Write to INFOCOM '82, POB 639, Silver Spring, MD 20901, (301) 589-3386.

March 30-April 2
Digital Image Processing and Analysis, Washington, DC. For details, see March 9-12.

April 1982

Courses from George Washington University, Hampton, VA; Salem, NH; Washington, DC; London, England; and Berlin, West Germany.

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Your IBM Model 50, 60, or 75 Electronic Typewriter can be an RS232C PRINTER or TERMINAL

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CALIFORNIA MICRO COMPUTER
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April

April
Knowledge Engineering in the 1980s, Boston, MA. Expert Systems are computer programs that reason in tasks that require considerable human expertise, such as locating computer malfunctions, monitoring intensive-care patients, analyzing noisy signal data, and diagnosing medical problems. This one-day executive briefing provides an introduction to the potential benefits and costs of Expert Systems. For further information, contact Dina Barr, c/o Teknowledge, 151 University Ave., Palo Alto, CA 94301, (415) 326-6827.

April 1-2
The Eleventh Annual International Computer Programs Awards Ceremony and Executive Conference. Marriott Mountain Shadows Resort, Scottsdale, AZ. The annual awards ceremony honors super software salespeople, advertising agencies, public relations firms, and microcomputer software achievements. The executive conference discusses the main issues and concerns of the industry, such as productivity through proper use of people and machines, new software piracy solutions, and how to get the most out of advertising dollars. The fee for the executive conference is $250. For detailed information, contact Carol Stumpf, c/o ICP, 9000 Keystone Crossing, POB 40946, Indianapolis, IN 46240, (800) 426-6179; in Indiana, (317) 844-7461.

April 2-3
Educational Computing—The Future Is Now, Anchorage, AK. The Educational Computing Conference is sponsored by the Alaska Association for Computers in Education. Invited speakers, exhibits, and demonstrations of microcomputer products for educational purposes will be featured. Admission to the exhibition area is free of charge. For further details, contact Pat Stewers, '82 Educational Computing, Drawer 129, Healy, AK 99743, (907) 683-2278.

April 2-4
The Second Annual Eighty/Apple Computer Show, New York Statler Hotel, New York, NY. The Eighty/Apple Computer Show features products and services for TRS-80 and Apple computer systems. More than 100 exhibitors of hardware, software, books, magazines, supplies, services, and accessories will attend. For more information, contact Kengore Corp., 3001 Rte. 27, Franklin Park, NJ 08823, (201) 297-2526.

April 4-7
The Seventh Annual Deltek International Training Conference, Access 82, Hyatt Regency, Chicago, IL. More than 1000 training and electronic data-processing professionals are expected to attend 35 workshop sessions. Former president Gerald R. Ford will deliver the keynote address. The registration fee is $925. Information is available from Gail Bohan, c/o Deltek Inc., 1220 Kensingon Rd., Oak Brook, IL 60521, (312) 920-0700.

April 5-7
The Third Annual Office Automation Conference, George R. Moscone Convention Center, San Francisco, CA. This conference is sponsored by AFIPS (American Federation of Information Processing Societies). Exhibits and workshops will be featured. For details, contact Betty Lou Cooke, c/o AFIPS, 1815 North Lynn St., Arlington, VA 22209, (703) 558-3612.

April 6-8
The Sixth Annual Computerized Office Management Expo-Midwest '82, O'Hare Expo Center, Chicago, IL. This conference and exhibition features business-oriented equipment for word and data processing, information management, record storage and retrieval, and micrographics. A three-day high-technology symposium, "Business Automation and Communications" will highlight Midwest '82. For details, contact Cahners Exhibition Group, 222 West Adams St., Chicago, IL 60606, (312) 263-4856.

April 13-16
Digital Image Processing and Analysis, Boston, MA. For details, see March 9-12.

April 14-18
Electronic Home Entertainment Show, Arlington Park Race Track Exposition Hall, Arlington Heights, IL. This show will feature audio and video equipment, video games, home computers, and citizen-band radio systems. It will run concurrently with the Fourth Annual Energy & Home Improvement Fair. Contact Expo Management Inc., Suite S2-132, Arcade, The Apparel Center, Chicago, IL 60654, (312) 329-1191.

April 15-17
The 1982 Computer Showcase Expo, St. Louis, MO. For details, see March 26-28.

April 15-18
The Second Southwest Computer Show and Office Equipment Exhibition, Market Hall, Dallas Market Center, Dallas, TX. This features mini- and microcomputers for business, education, government, industry, home, and personal use. Data- and word-processing equipment, office machines, computer peripherals, and office supplies will be displayed. General admission is $5. Contact National Computer Shows, 824 Boylston St., Chestnut Hill, MA 02167, (617) 739-2000.

April 16-17
The Twelfth Annual Virginia Computer Users Conference, Marriott Hotel, Blacksburg, VA. This conference is sponsored in cooperation with the ACM (Association for Computing Machinery). Topics of interest are artificial intelligence, office automation, and database management. Contact Deidre Maskateris or Wesley Braudaway, 562 McBryde Hall, Virginia Polytechnic Institute & State University, Blacksburg, VA 24061, (703) 961-6931.

April 19-21
Open Systems Interconne-
tion with X.25 and Other Related Protocols, Denver Marriott Hotel-City Center, Denver, CO. Sponsored by Data Communications, a McGraw-Hill publication, this seminar will present a thorough treatment of the basic OSI (Ohio Scientific) Reference Model, describing the seven-layer structure, service definitions, and emerging protocols. Detailed presentations of the X.25 packet protocol will be included. The seminar fee is $690. For further details, contact the McGraw-Hill Conference & Exposition Center, Rm. 3677, 1221 Avenue of the Americas, New York, NY 10020, (212) 997-4930.

April 20-23
VIQ—Voice Input/Output for Computers, Boston, MA. For details, see March 9-12.

April 21-28
Hanover Fair '82, Hanover, West Germany. The annual Hanover Fair is one of the world's largest industrial and trade exhibitions. More than 330 American firms are expected to exhibit products, services, and technology at the Fair. Contact M.A. Delia, Hanover Fairs Information Center, POB 338, Whitehouse, NJ 08888, (800) 526-5978; In New Jersey, (201) 534-9044.

April 22
California Computer Show, Hyatt Hotel, Palo Alto, CA. This show is for OEMs (original equipment manufacturers), knowledgeable users, distributors, and dealers. More than 60 computer manufacturers will be exhibiting mainframes, mini- and microcomputers, and peripherals. Contact Carol Reimer, c/o Norm De Nardi Enterprises, 289 South San Antonio Rd. #204, Los Altos, CA 94022, (415) 941-8440.

April 22-25
New York Computer Show and Office Equipment Exposition, Nassau Coliseum, Uniondale, NY. For details, see April 15-18.

April 23-25
The 1982 Computer Showcase Expo, Miami, FL. For details, see March 26-28.

April 24
Computer Swap America, Santa Clara County Fair Grounds, San Jose, CA. This high-technology flea market features everything from home satellite-receiving stations to floppy disk ads. Admission is $3. Contact Computer Swap America, POB 52, Palo Alto, CA 94302, (415) 494-6862.

April 27-28
The Eighth Annual National Computer Security and Privacy Symposium: Top Secret '82, Washington, DC. Sponsored by Honeywell, approximately 22 national authorities on computer security and
privacy will speak on a varie-
ty of topics. Training work-
shops in security planning and
computer fraud investigation
will be held. The fee for the symposium is $525; dis-
counts on multiple regis-
tations are available. Contact
the Security Symposium
Registrar, Honeywell Inc.,
M/S T-99-4, POB 6000,
Phoenix, AZ 85005; or call
Jerome Lobel, (602) 249-5370.

May 1982

May 1-3 Sensors & Systems '82, var-
rious sites throughout the cen-
tral and western regions of
the U.S. This series of three-day
conferences will cover all
aspects of sensor technology
from temperature sensors
through to displacement,
velocity, acceleration,
magnetic field, and moisture.
Other topics to be covered
include signal conditioning,
digital interfaces, and system
interfaces. Contact Network
Exhibitions, 785 Harriet Ave.,
Campbell, CA 95008, (408)
370-1661.

May 6-9 The Southern California
Computer Show & Office
Equipment Exposition, Los
Angeles Convention Center,
Los Angeles, CA. This show
features mini- and microcom-
puters for business, education,
government, industry, home,
and personal use. Word- and
data-processing equipment,
office machines, and com-
puter peripherals will be
displayed. Admission is $5.
For details, contact National
Computer Shows, 824
Boylston St., Chestnut Hill,
MA 02167, (617) 739-2000.

May 7-9 The 1982 Computer Showcase
Expo, Anaheim, CA. For de-
tails, see March 26-28.

May 10-12 Despo 82, Marriott Hotel,
Atlanta, GA. This exposition
features DEC- (Digital Equip-
ment Corporation) compat-
ible hardware, software, and
services. Contact Expoconsul
International Inc., 19 Yeger
Rd., Cranbury, NJ 08512,
(609) 799-1661.

May 10-14 The Twentieth Annual Con-
vention of the Association
for Educational Data Systems
(AEDS), Sheraton Twin
Towers, Orlando, FL. This
conference includes presenta-
tions on the state of the art in
educational computing. Ad-
ministrative and instructional
computing applications will
presented, and new ways of
improving educational pro-
cesses will be explored. Con-
tact Shirley Easterwood, c/o
AEDS, 1201 Sixteenth St.
NW, Washington, DC 20036.

May 14-15 The Second Annual Southern
California Computers-in-Edu-
cation Conference, University
High School, Irvine, CA. This
conference covers the applica-
tion of computers in educa-
tion from kindergarten
through two-year college. All
areas of curriculum will be
touched upon, including read-
ing, mathematics, science,
language, and special educa-
tion. Hands-on workshops
and field trips are planned.
Contact Craig Walker, Ar-
rowview Intermediate School,
2299 North G St., San Berna-
dino, CA 92405, (714)
886-9118.

May 14-16 Applefest/Boston, Hynes
Auditorium, Boston, MA. This
show will feature more
than 200 displays and booths
of Apple-compatible products
and accessories. Seminars and
panel discussions will be held.
Ticket prices are $6 per day or
$15 for a three-day pass. Con-
tact National Computer
Shows, 824 Boylston St.,
Chestnut Hill, MA 02167,
(617) 739-2000.

May 15-16 The North American Com-
puter Othello Championship,
Learning Resources Center,
Andersen Hall, Northwestern
University, Evanston, IL. This
two-day tournament is spon-
ored by the United States
Othello Association. Cham-
ions will be determined in
three categories: microcom-
puter systems (located on
site), mainframe systems (tele-
phone hookup), and special-
purpose Othello machines.
For complete tournament de-
tails, write to Professor Peter
W. Frey, Dept. of Psychol-
ogy, Northwestern Univer-
sity, Evanston, IL 60201.

May 18-20 Microcomputers—A New
Tool for Foresters, Purdue
University, West Lafayette,
IN. Sponsored by Purdue
University's Department of
Forestry and Natural Re-
sources and by the Inventory
and Systems Analysis Work-
ning Groups of the Society
of American Foresters, this con-
ference seeks to advance the
professional forester's knowl-
edge of microcomputers and
to introduce currently avail-
able microcomputer applica-
tions in forestry. Session
themes include hardware and
software considerations as
well as information-process-
ing and forest-inventory sys-
tems. Contact John W. Moser
Jr., Dept. of Forestry and
Natural Resources, Purdue
University, West Lafayette,
IN 47907, (317) 494-3596.

May 19-21 Computer Hong Kong 82,
Regent Hotel, Hong Kong. This
tree-day program, which
embraces the Fifth
Hong Kong Computer Con-
ference, will focus on the elec-
tronic data-processing mar-
tet. For further details,
contact Kallman Associates, 5
Maple Court, Ridgewood, NJ
07450, (201) 652-7070.

May 21-23 The 1982 Computer Showcase
Expo, Boston, MA. For de-
tails, see March 26-28.

BYTE's Bits

Computer Camps

The 1982 National Com-
puter Camp for boys and
girls ages 10 to 18 will be held
July 11 to August 6 in
Simsbury, Connecticut, and
Atlanta, Georgia. The kids
will learn on mini- and micro-
computers in small groups
with ample hands-on time.
The camp director, Professor
Michael Zabinski of Fairfield
University, is assisted by ele-
mentary and secondary
school teachers. For more in-
formation, contact Michael
Zabinski, POB 624, Orange,
CT 06477, (203) 795-3049.
Collector Edition
BYTE COVERS

The Byte covers shown below are available as beautiful Collector Edition Prints. Each full color print is 11" x 14", including 1½" border, and is part of an edition strictly limited to 500 prints. The artist, Robert Tinney, has personally inspected, signed and numbered each print. A Certificate of Authenticity accompanies each print guaranteeing its quality and limited number.

The price of a Collector Edition Byte Cover is $25, plus $3 per shipment for postage and handling ($8 for overseas airmail). Collector Prints 9, 10, 11 and 12 can be purchased as a set for $80, as can Prints 13, 14, 15 and 16.

Collector Edition Byte Covers are also available in the beautiful mat and frame shown above for $60 each (if Set 9-12 or Set 13-16 is ordered framed and matted, the price per set is $200). The mat is a neutral gray which blends with most decors, and the black 12" x 16" frame is trimmed in silver. The print is mounted under non-glare glass.

Framed and matted prints are shipped UPS—no delivery to P.O. boxes. Because of expense and breakage, no framed prints are shipped overseas. Please allow 4-6 weeks delivery for framed prints.

To order use the coupon below; Visa and Master Charge orders may call Toll Free.

 ALSO AVAILABLE are the prints shown at left. "Computer Chess" is an 18" X 22" full color poster. "Through the Trap Door" and "Breaking the Sound Barrier" are limited editions of 750 prints each, signed and numbered by the artist. Each print is 18" X 22", and is accompanied by its own Certificate of Authenticity. If both "Door" and "Barrier" are ordered, a special price of $55 applies.

All three prints shown at left are shipped first class in heavy duty mailing tubes.
Scientists everywhere are learning to detest small computers. They hate the things with a special passion reserved for anything that interferes with their research. Although researchers were among the first to embrace the promise of small, inexpensive computers, many now avoid using microcomputers in their labs.

It oughtn't to be so. Scientists need computers to monitor, coordinate, and control their experiments. Communicating rapidly and reliably with many different instruments, a computer can read and record data while responding swiftly to any problems that develop. The computer cannot grow bored or tired, nor will it object to uncomfortable or dangerous working conditions.

Above all, experimenters need the flexibility and adaptability that computers promise. Labs are exciting, disorganized, chaotic places. Cables run everywhere to connect instruments piled on tables and stacked on the floor. New equipment and new procedures are commonplace; ideas and plans are in continual flux. Even when everything works perfectly, the results of a few hours' work may call for a complete redesign of the entire experiment.

The modern microcomputer is easy and inexpensive to reprogram, so it ought to be a superbly flexible lab assistant. But it is this promise that small computers have betrayed. Microcomputers, expected to help scientists manage the constantly changing laboratory environment, implacably oppose every change and trivial modification.

Each change in the experiment calls for new software. Every new instrument needs new software. Every modification of hardware or technique demands new software. The computer's constant hunger for new and revised programs may be so daunting that promising experiments aren't even attempted. Laboratory computers have to be intimately involved with many aspects of the experiment, but this intimacy demands that they change and adapt constantly. Unfortunately, common programming techniques often produce programs that are obscure to read and tedious to modify.

The Computer Toolbox
Rather than design an inflexible computer for a specific job, our research group has tried to build a general-purpose laboratory assistant that can be carried, like a toolbox, from one experiment to another. It is an integrated, consistent package of hardware and software tools for the experimenter, who should be able to patch together a working system in a few days.

Just as a regular toolbox includes many wrenches and screwdrivers of various sizes, the computer toolbox contains many different "inlets" and "outlets" for information and a collection of interfaces of various sorts. Few experiments use every part in the toolbox; we tried to provide enough interfaces of each type for any experiment we expect to do.

The toolbox includes not only many types of interfaces but also

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Useful For</th>
<th>Relative Cost</th>
<th>Suggested Quantity and Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>parallel input port</td>
<td>reading digital devices</td>
<td>inexpensive</td>
<td>many</td>
</tr>
<tr>
<td>parallel output port</td>
<td>controlling digital devices</td>
<td>inexpensive</td>
<td>many</td>
</tr>
<tr>
<td>keyboard</td>
<td>input from people</td>
<td>moderate</td>
<td>1</td>
</tr>
<tr>
<td>video display</td>
<td>output to people</td>
<td>expensive</td>
<td>use extra displays for graphics</td>
</tr>
<tr>
<td>serial interface</td>
<td>interface printers, printers,</td>
<td>moderate</td>
<td>1-5</td>
</tr>
<tr>
<td>printer</td>
<td>permanent records</td>
<td>moderate</td>
<td>1</td>
</tr>
<tr>
<td>plotter</td>
<td>permanent records</td>
<td>moderate</td>
<td>1 if experiment must run untended</td>
</tr>
<tr>
<td>telephone interface</td>
<td>report emergencies</td>
<td>moderate</td>
<td>some</td>
</tr>
<tr>
<td>analog-to-digital converter</td>
<td>analog input</td>
<td>inexpensive</td>
<td>some</td>
</tr>
<tr>
<td>digital-to-analog converter</td>
<td>analog output</td>
<td>moderate</td>
<td>some</td>
</tr>
<tr>
<td>sound generator</td>
<td>alarms and warnings</td>
<td>inexpensive</td>
<td>many distinct noises can be invaluable if required</td>
</tr>
<tr>
<td>digitizing tablet</td>
<td>input from charts and graphs</td>
<td>expensive</td>
<td>sometimes convenient very useful</td>
</tr>
<tr>
<td>joystick</td>
<td>moving things</td>
<td>inexpensive</td>
<td>several for demanding calculations</td>
</tr>
<tr>
<td>stepping motor</td>
<td>power control</td>
<td>inexpensive</td>
<td></td>
</tr>
<tr>
<td>AC controller</td>
<td>arithmetic</td>
<td>inexpensive</td>
<td></td>
</tr>
<tr>
<td>arithmetic processor</td>
<td>arithmetic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Widely useful equipment for computer toolboxes.
many interfaces of each different type (see table 1). Redundant facilities add little to the cost or complexity of the toolbox and greatly enhance its usefulness. Because several interfaces of each type are available, adding new apparatus to an experiment is easy. Scientists will not be forced to choose between one instrument and another, because they are free to connect lots of instruments at once.

If an interface circuit is accidentally damaged, redundant interfaces allow work to continue. The computer need not be repaired immediately, and the damaged interface can be fixed at the scientist’s convenience. Redundancy makes the system robust, despite the hazards of the laboratory environment.

Software Design in the Lab

Most laboratory programs live only a few weeks or months. Indeed, many programs are modified so often that they are really never “finished.” To make matters worse, laboratory software is written by scientists, i.e., by ingenious, amateur, and relatively unschooled programmers. The lab computer must emphatically encourage clean, comprehensible, modifiable programming.

Lab programmers face a diverse and confusing array of complicated devices, each posing distinct programming problems. Although the procedures for each instrument may be simple, the entire repertoire of communications methods for a complete experimental setup can easily baffle and dismay the programmer. Programs degenerate to an ill-structured network of procedure calls, timing loops, and code conversions, as a profusion of detail overwhelms the program’s overall design.

Debugging these tangled, baroque routines is terribly frustrating. The toolbox restores clarity and explicitness to program structure by treating all devices on an equal footing. Toolbox programs never talk directly with any outside instrument. Instead, they communicate with small programs called device drivers that, in turn, communicate with the experiment’s instruments and sensors.

Device drivers make programs...
Programmers can concentrate on the experiment without undue distraction from the computer's idiosyncrasies. Device drivers clarify program structure, since irrelevant details need not be represented explicitly. Programs are easier to understand, use, and revise. Documentation is easier to write, and its completeness is less crucial.

Communications between the programmer and the various device drivers are simple and standardized; all device drivers "look" pretty much the same. The device driver, in turn, understands and accommodates the special requirements of each device or instrument. Device drivers shield and protect the toolbox programmer from his confusing and ill-behaved array of instruments (see figures 1 and 2).

For example, different printers may require different character codes, signal levels, and control signals. Nevertheless, all printers are logically equivalent—they all accept characters from a computer and print them on paper. A toolbox program that uses a printer need not consider the details of the printer's interface or timing. Whenever a number must be printed, the program invokes the device driver \{PRINT!\}. If I replace the printer with a different model, I just revise \{PRINT!\}. All my programs will still work. If, on the other hand, every program communicated directly with the printer, I would have to modify every program. Indeed, I might need to modify every printer command in every program!

Device drivers help adapt the computer to the changing needs of its peripherals. To plot results on a chart recorder instead of printing them, for example, we need to make only slight changes. Chart recorders are logically equivalent to printers; they just accept numbers from the computer and
put them onto paper. So, to use the chart recorder we simply replace \{ PRINT \} with \{ PLOT \} and, instead of printing a list of numbers, the computer will draw a graph of the experiment's results.

Device drivers can exchange data with instruments, other toolboxes, even with other computers. In fact, the (still hypothetical) device driver \{ TELEPHONE \} could connect an experiment to thousands of printers and computers throughout the world.

Programmers don't need to know all the details of every device's design and operation. Of course, the author of the device driver must understand these details, but, since device drivers are all used in pretty much the same way, anyone else can use the device driver.

Tables 2 and 3 describe several device drivers. Drivers that send a single number or character to an instrument have names that end in an exclamation point (!), like \{ PRINT! \}. Drivers that receive a single number or character have names followed by an at sign (@). Device drivers that receive data from an instrument and display it immediately have names ending in a question mark (?), while device drivers that test an instrument's status, and that abort if an error has been detected, have names that begin with a question mark.

In fact, knowing the name of the device driver is often all that a programmer needs to know to use an instrument.

The FORTH Language

Many computer languages might be suitable for use in the toolbox. The language chosen must be implemented efficiently, especially because small computers tend to be slow and their memory space is often restricted. Invocation, the ability to execute a subprogram by naming it, is required for implementing the device drivers. Other features are convenient, but efficiency and invocation are not expendable.

These considerations exclude the two methods most commonly used to program small computers. BASIC does not support invocation, except...
in a most primitive and unsatisfactory manner. Common BASIC interpreters, moreover, are too slow for many laboratory situations. Assembly language does not intrinsically support invocation either, although macroassemblers (which support invocation quite satisfactorily) are now available for many machines. Unfortunately, extensive use of macroinstructions only exacerbates the propensity of assembly language to produce very long programs. Few microcomputer assemblers can com-

---

**Table 2: The hardware complement of the author's computer toolbox.**

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Quantity</th>
<th>Total Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td>parallel port</td>
<td>6</td>
<td>96 data bits</td>
</tr>
<tr>
<td>serial port</td>
<td>1</td>
<td>12 control signals</td>
</tr>
<tr>
<td>AC power control</td>
<td>4</td>
<td>4 100-W channels</td>
</tr>
<tr>
<td>DAC</td>
<td>1</td>
<td>2 bipolar inputs</td>
</tr>
<tr>
<td>IEEE-488 control bus</td>
<td>1</td>
<td>2 100-W channels</td>
</tr>
<tr>
<td>sound controller</td>
<td>1</td>
<td>4 resistor inputs</td>
</tr>
<tr>
<td>graphics display</td>
<td>1</td>
<td>8 unbuffered inputs</td>
</tr>
<tr>
<td>scratchpad memory</td>
<td>1</td>
<td>128 bytes</td>
</tr>
<tr>
<td>plotter</td>
<td>1</td>
<td>1 (uses DACs)</td>
</tr>
<tr>
<td>motor controller</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

---

**Table 3: Some typical device drivers, based on the author's system.**

<table>
<thead>
<tr>
<th>Driver</th>
<th>Device</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRINT1</td>
<td>memory</td>
<td>stores number in specified location in memory</td>
</tr>
<tr>
<td>EMIT1</td>
<td>printer</td>
<td>sends number to printer</td>
</tr>
<tr>
<td>DAC1</td>
<td>DAC</td>
<td>sends number to digital-to-analog converter</td>
</tr>
<tr>
<td>VID1</td>
<td>TV camera</td>
<td>sends instruction to camera</td>
</tr>
<tr>
<td>PLOT1</td>
<td>plotter</td>
<td>moves pen to specified coordinate</td>
</tr>
<tr>
<td>THUMB@</td>
<td>thumbwheel</td>
<td>retrieves current thumbwheel setting</td>
</tr>
<tr>
<td>VID@</td>
<td>memory</td>
<td>retrieves current TV camera programing instructions</td>
</tr>
<tr>
<td>ADC@</td>
<td>ADC</td>
<td>requests measurement from analog-to-digital converter</td>
</tr>
<tr>
<td>POINT@</td>
<td>digitizer</td>
<td>requests one coordinate-pair from the digitizer</td>
</tr>
<tr>
<td>TALK</td>
<td>IEEE bus</td>
<td>transmits &quot;talk&quot; to an instrument</td>
</tr>
<tr>
<td>UNTALK</td>
<td>IEEE bus</td>
<td>transmits &quot;untalk&quot;</td>
</tr>
<tr>
<td>LISTEN</td>
<td>IEEE bus</td>
<td>transmits &quot;listen&quot; to an instrument</td>
</tr>
<tr>
<td>UNLISTEN</td>
<td>IEEE bus</td>
<td>transmits &quot;unlisten&quot;</td>
</tr>
<tr>
<td>IEEE@</td>
<td>IEEE bus</td>
<td>receives data byte from bus</td>
</tr>
<tr>
<td>IEIEEE</td>
<td>IEEE bus</td>
<td>transmits data byte over bus</td>
</tr>
<tr>
<td>R/W</td>
<td>disk</td>
<td>reads and writes disk files</td>
</tr>
<tr>
<td>MOVE</td>
<td>memory</td>
<td>moves blocks of data in memory</td>
</tr>
<tr>
<td>EDIT</td>
<td>disk/screen</td>
<td>creates and modifies disk files</td>
</tr>
<tr>
<td>HOME</td>
<td>screen</td>
<td>returns cursor to top of screen</td>
</tr>
<tr>
<td>FORWARD</td>
<td>motor</td>
<td>advances stepping motor</td>
</tr>
<tr>
<td>ON</td>
<td>AC control</td>
<td>supplies power to outlet</td>
</tr>
<tr>
<td>OFF</td>
<td>AC control</td>
<td>disconnects outlet</td>
</tr>
<tr>
<td>TIME1</td>
<td>clock</td>
<td>sets the clock</td>
</tr>
<tr>
<td>TIME@</td>
<td>clock</td>
<td>reads the clock</td>
</tr>
</tbody>
</table>
FORTH was originally designed for makes just this application. FORTH interpreters, its easy implementation subsets of FORTH in only a few commercial implementations of significant commercially available for many computers. While FORTH is now commercially available for many computers, its easy implementation makes it a practical choice even if a commercial version is not available.

Several higher-level languages are suitable for programming the toolbox. APL’s extraordinary facility for array and matrix calculation easily outweighs its handicaps. Pascal, C, or Ada might also be attractive. Even FORTRAN would be adequate, especially since many scientists already know FORTRAN; this consideration also applies to ALGOL-60 and its descendants.

Unfortunately, currently available microcomputers are rather slow, and thus they demand exceptional efficiency from the toolbox language. Compilers and interpreters for common languages do not now produce sufficiently fast programs and cannot be used. This situation will change as the power and speed of microcomputers improve.

We have used the FORTH language in our toolbox, with very satisfactory results. FORTH has been described in several articles in the August 1980 BYTE, in Ronald Loeliger’s Threaded Interpretive Languages (BYTE Books, 1981), and in FORTH Inc.’s Using FORTH. More advanced but invaluable information is available from FIG (the FORTH Interest Group), which publishes assembly-language implementations of FORTH for many common microprocessors.

The FIG implementation of FORTH is extremely efficient in both space and speed. Although some common programming tasks are difficult to express clearly in FORTH, the language adapts unusually well to laboratory programming. In fact, FORTH was originally designed for just this application. FORTH interpreters are uniquely simple to test and to modify. Several writers report successful implementations of significant subsets of FORTH in only a few weeks. While FORTH is now commercially available for many computers, its easy implementation makes it a practical choice even if a commercial version is not available.

FORTH procedures communicate with each other by using a first-in, last-out stack (see figure 4). Toolbox routines use the stack to exchange information. For example, the routine ADC@ measures the input to the analog-to-digital converter, leaving the result on the stack. DAC! sends the number on top of the stack to the digital-to-analog converter, which produces a corresponding voltage. ADC@ can talk to DAC! by using the stack; the program

```
ADC@ DAC!
```

reads a voltage at the analog input and transmits it to the analog output. Other programs transform data on the stack, accepting information from one routine, transforming it, and leaving the results for another routine. LOG, for instance, takes a number off the stack, calculates its logarithm, and leaves the result on the stack. The sequence

```
ADC@ LOG DAC!
```

sets the output voltage to the logarithm of the input signal.

In FORTH, numbers are simply procedures that put their value onto the stack. “273” is the name of a procedure that leaves the value 273 on top of the stack. FORTH can work in any common base; the procedure HEX instructs FORTH to treat numbers as hexadecimal quantities, DECIMAL tells FORTH to use base ten, and BINARY makes FORTH use base two.

Building Toolbox Commands
A scientist controls an experiment by typing commands into the toolbox. Consider, for example, the simple problem of turning equipment on and off during the course of an experiment.

In Harvard’s picosecond laser facility, toolbox hardware includes four 117-V AC outlets controlled by the computer. An experimenter might plug an oscilloscope into socket number 1, a meter into outlet 2, a signal generator into outlet 3, and a laser into outlet 4. At various times during the experiment, the computer must supply and remove power to these devices.

The device drivers for the AC power controller are named ON and OFF. ON and OFF connect and disconnect power to a specified outlet; the command

```
1 ON
```

supplies power to socket number one.

For flexibility and convenience, we might define a new command called SCOPE:

```
: SCOPE 1 ;
```

Whenever SCOPE is invoked, it leaves the value 1 (the scope’s socket number) on the stack, so the command

```
ADC@ SCOPE 1 ;
```

allows the experimenter to turn power off and on simply by typing SCOPE 1 ;

A Note About FORTH
FORTH uses punctuation in some of its words, which makes representing them in text a difficult problem. For example, one FORTH word is (“”), which could be taken to mean one of several character combinations. (For your information, the word has three characters and is made from a left parenthesis followed by a double quote mark and a right parenthesis.)

To decrease the chance of confusion while trying not to clutter text unnecessarily, we have used pairs of braces, { }, to isolate the character string within as a FORTH word or phrase. For example, the above word would be written { “”). Braces have been used only in the following situations:

1. when the material being quoted is a phrase of FORTH words (e.g., | 26 LOAD | or | 35 + |)
2. with the FORTH words (period), { }, “comma”, { : }
3. (colon), { ; } (semicolon), { , } (question mark), { ) } (exclamation point), { ' } (single quote mark), and { " } (double quote mark)
4. with any word using the above punctuation marks (e.g., | & | or | ) |

All other FORTH words are set apart by a space on either side of the word. So, in this article, braces always signal a FORTH word or phrase. The braces are not part of the word or phrase, and FORTH words never use braces within the body of a figure or listing.
energizes the oscilloscope. If we decide to plug the oscilloscope into some other socket, we simply change the definition of SCOPE. This "informs" all our programs of the change, so we don't have to hunt through every procedure, looking for references to socket number 1.

Commands can be issued singly or in a large burst. Several commands can be put on one line, or a single command can spread over many lines. Extra spaces, carriage returns, and tabs are harmless and make program listings more attractive and easier to follow. Part of an experimental session might read:

```
METER ON  SCOPE ON
LASER ON
5 MINUTES
LASER OFF
```

This set of commands turns on the meter, oscilloscope, and laser, waits for five minutes, and then turns off the laser.

If I need to perform this sequence often, it is simple and convenient to group these commands into a single command:

```
: TEST
  METER ON  SCOPE ON
  LASER ON  5 MINUTES
  LASER OFF
```

Typing TEST tells the computer to perform the entire sequence. This particular sequence might be used to check whether all the instruments are working, and procedures called ALIGN, COLLECT-DATA, and SHUT-DOWN could be used for other parts of the experiment. In fact, TEST can be included as a part of another procedure.

Toolbox commands are easy to create. New commands cost only a few bytes of memory. Powerful and subtle commands can be built up from simpler ones. The toolbox actually encourages programmers to write convenient and comprehensible programs. Toolbox programs that are easy to write and modify are in-

---

**Figure 3:** In conventional environments, replacing one hardware device can require many software changes. If the plotter is replaced, many programs must be altered. In figure 3a, John and Jeanne must rewrite parts of their programs, and Mark has to rewrite the assembly-language subroutine Steve and Jeanne both use. If Mark leaves for a new job, Steve and Jeanne may be in serious trouble! As shown in figure 3b, the toolbox insulates users from software changes. If the plotter is replaced, the device driver has to be rewritten, but user programs don't need to be changed.

---

**Figure 4:** Reverse Polish notation and the computation stack. Reverse Polish makes arithmetic look strange but can be perfectly natural for controlling machines.
herently easy to use; man-machine dialogue is intrinsic in the program's structure, not lacked on as an afterthought.

Amenities

Scientists work in a number-filled world. Contrary to popular myth, though, most scientists have no special facility for arithmetic. In one Cambridge poker game, the regular players include three chemists, a physicist, a stockbroker, and a lawyer. To rapidly count and split pots, all defer to the seventh player—an artist.

Since scientists generally can't do arithmetic any better than other people, lab computers should be able to do it for them. When an unexpected question comes up, the lab computer ought to double as a pocket calculator. Our tool box provides this facility within the FORTH language, because FORTH can do arithmetic very much like any reverse-Polish calculator.

For example, to add 3 to 7 and print the result, we can simply type

```
3 7 + .
```

to which FORTH responds

```
10 OK
```

{} is the FORTH command to display the top value from the stack. FORTH's ability to use any common base is often very useful; to translate, say, hexadecimal 4AF to base ten, we simply type

```
HEX 4AF DEClMAl .
```

Clocks and timers are often useful. The command SECONDS instructs the toolbox computer to pause for a specified period. The time-of-day clock may be used (through its device drivers) to ascertain or set the current time. For example,

```
5 47 TIME!
```

sets the clock to 5:47. The command TIME@ reads the time, leaving the

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<table>
<thead>
<tr>
<th>CP/M Compatibility</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load and execute as a normal program under CP/M, installing itself under the CP/M operating system.</td>
<td></td>
</tr>
<tr>
<td>Other CP/M programs — editors/word processors/applcation program/documenters</td>
<td></td>
</tr>
<tr>
<td>Assemblers — they then run using all MicroShell features.</td>
<td></td>
</tr>
<tr>
<td>FORTH compatibility is generally not affected by MicroShell’s presence.</td>
<td></td>
</tr>
<tr>
<td>Adds Unix Power without losing CP/M Compatibility.</td>
<td></td>
</tr>
</tbody>
</table>

| Console Input/Output Redirection |
| Send Console Output to a File instead of or in addition to the screen. |
| Example: stat 1 " > status sends "status" output to file "status": |
| Take Console Input from a File instead of the Keyboard. |
| Example: ad items < script takes "ad" commands from the file "script": |
| Implementable for: graphic debugging, saving exact Screen Output for documentation, etc. |

| Automatic Command File Execution |
| MicroShell finds your program, User concentrates on the big tasks, MicroShell does the details. |
| Permits development or data files on one drive and all programs on another |
| User-specified Search Path. Example: Current Drive 1st, then Drive A, etc. |

| Multiple Commands Per Line |
| User types a logical group of commands to be executed. |
| Example: execute file, link file file |
| MicroShell executes the commands one at a time. |

| Direct Command File Execution |
| Files of CP/M or MicroShell commands are executed by MicroShell simply by typing the file name. |
| User-specified Command Filetypes. Examples: "com", "bat", etc. |
| Argument substitution (B1, B2, etc) as with CP/M SUBMIT/RESP |

| Additional Features |
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| Install program to customize MicroShell to user's needs & system |
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The Toolbox Development System

The toolbox approach lets scientists apply computers to laboratory problems that tend to resist conventional design and programming methods. Moreover, developments in computer technology will substantially augment the potential of the toolbox in the next few years. Trends in microprocessor architecture favor designs that emphasize the toolbox virtues of modularity and invocation. A microprocessor designed specifically for efficient FORTH implementation, for example, is now under development. The toolbox relies heavily on its abundant input and output devices, and these, too, are subject to constant improvement.

Computer toolboxes are also uniquely suited to incorporate new advances in integrated-circuit technology. New parts can be plugged into the toolbox, often simply by connecting their pins to the appropriate signals on the system bus. New device drivers are easy to write and can use all the existing toolbox facilities.

For example, our toolbox currently includes programs to calculate logarithms. This job could be performed more effectively by an integrated-circuit arithmetic processor. Physically
installing such a device would require only a few additional integrated circuits. To install the processor in the toolbox software, we would write device-driver programs to control the math processor’s operations. These programs could be written on the toolbox, using the existing toolbox software, and tested by comparing the results of the new and old logarithm routines.

Once a new device has been tested, existing toolbox programs may be modified to take advantage of the toolbox’s new capabilities. This unusual flexibility suggests that the toolbox, designed to apply small computers to the scientific laboratory, may be a useful tool for developing computer systems! The toolbox makes no distinction between devices that happen to be inside or outside its box; everything is handled by device drivers. The toolbox, designed specifically to control many external devices, can also configure and control its own internal structure.

The toolbox may, like a snake, shed its skin of peripheral controllers, using them in the end only to create and test a new set of more powerful devices. If a better terminal becomes available, the old terminal can be used to write the new terminal’s device drivers. An instrument designed this way could design and test its own successor—in fact, the new model could retain many of the old machine’s parts and programs!

The toolbox is easy to customize and simple to modify. It can revise its own language and extend its vocabulary to meet the requirements of its user. It can be connected to many devices and can help test new interfaces and new instruments. In short, the toolbox is a very personal computer.

Acknowledgments
I’d like to express my gratitude and appreciation to Professor Kevin S. Peters, who patiently supported this work, and to the Merck Corporation for the honor of a Merck Corporation Foundation Fellowship.

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Skip Sequential: A New File Structure for Microcomputers

I still remember that fall day almost three years ago at Ecosoft, when we got our first floppy-disk drive up and running. Compared to the cassette system we had been using, it was the greatest thing since fire. It was at that point we began to think that the use of a microcomputer in serious business and research applications was a viable concept. It wasn't much longer before we were sure of it.

Like most disk systems, ours supported both random-access and sequential file structures. Depending upon the intended function, each has certain advantages and disadvantages. Sequential files use disk space very efficiently (an important consideration even with the increased storage capacity of double-density drives), but they are progressively slower on disk accesses as the file size grows. Random-access files are much faster on disk access, regardless of file size, but they require a fixed record length set to the maximum anticipated (i.e., "worst case") size. This often results in a considerable amount of wasted disk space.

The purpose of this article is to discuss a "new" file structure that we developed to help overcome some of the disadvantages associated with random-access and sequential files. Although the text discusses Skip Sequential and its use in terms of North Star BASIC, we have also included listings for Microsoft's BASIC-80. Those familiar with BASIC-80 should have little difficulty implementing Skip Sequential.

An Example Using Sequential Files

The program in listing 1 is an example of storing data with sequential files. It is assumed that the values of the variables were determined elsewhere in the program. (If these were actual subroutines, the END statements would be RETURNs.) Line 230 opens the file to be read, while line 240 looks for an end-of-file mark using the TYP command. In North Star BASIC, a unique type will be associated with the data: if it is a string variable, TYP returns a value of 1; if it is a numeric variable, TYP will equal 2; and, if it is an end-of-file mark, TYP returns with a 0. If line 240 finds that TYP is not equal to 0, it falls through to line 250 and reads the data in the file into a set of dummy variables. (Dummy variables must be used so that we don't destroy the new data that we want to add to the file.) Once the end-of-file is found, the branch in line 240 is executed and we write the new data to the file (line 270).

Note that as new transactions are entered, more and more time is spent in the loop formed by lines 240 through 260 looking for the end-of-file mark. Because sequential files require that the entire data file be read before any new data can be written, the time lost looking for the end-of-file is a major limitation of sequential files. On the other hand, a sequential file is a "dense" file (i.e., there are no
wasted gaps in the file). Each new piece of data is tightly packed against the previous piece of data, so disk space is used very efficiently. However, the programmer must decide between optimal use of disk space or faster operation: a choice that usually dictates use of random-access files.

An Example Using Random-Access Files

Listing 2 presents the same type of program as that shown in listing 1, but using random-access files. A major difference between the two programs is that random-access files must use a fixed record length (i.e., each transaction will use exactly the same number of bytes in all instances). The programmer must decide this length, and in making that determination needs to know the following: how many bytes are required to store a numeric variable; how many bytes should be allocated to store string data (including any "overhead" bytes associated with such string variables); and how many numeric and string variables will be used in each record.

In our example, we use four numeric variables (D, N, A, and F) and one string variable (N$).

The first task is to determine how many bytes are needed for each floating-point number stored in the numeric variables. For North Star BASIC, this can be determined by the following equation:

$$B = \left(\frac{P}{2}\right) + 1$$

where:

- \(B\) = the number of bytes in a floating-point number
- \(P\) = the precision of the BASIC

For the standard version of North Star BASIC (8-digit precision BASIC), each floating-point number requires 5 bytes.

To determine the requirements for the name field, the programmer must decide on a string length that will be long enough to hold most customer names, but not so long as to waste unnecessary disk space. In our example, we selected 30 bytes for the name string (N$). It should be noted that North Star BASIC requires 2 overhead (or housekeeping) bytes for each string that is less than 255 bytes long (3 bytes are required if the string is longer than 255 bytes). We can now determine the fixed record length for the random-access file, as shown in table 1.

Having determined the fixed record length, the programmer can proceed to write the program (see the example shown in listing 2). We have assumed that the programmer has written a 0 (zero) to the file for R (the variable that informs the program of how many previous transactions have been written to the disk). Since R is a floating-point number, the file has 5 bytes in it before it is even used. The
percent sign (\%) in line 250 of listing 2 is interpreted to mean "jump the following number of bytes" and write the new record. If this is the first entry, the program will jump over 0 X 52 bytes, plus 5 more bytes. Since 0 X 52 is 0, the program jumps over 5 bytes (jumps over the R variable) and writes the new data. Line 260 increments the record count in R and writes the new value of R at the beginning of the file (the %0 says to jump over 0 bytes, hence rewriting R). The NOENDMARK command informs the interpreter not to write an end-of-file mark after updating R. If the end-of-file mark was written after R, the program would think that the file ended after the first 5 bytes.

The advantage of random-access files is that we don't have to read through the entire file to perform a write operation. By simply reading R and jumping the correct number of bytes (lines 240 and 250 in listings 2), we know exactly where the new data should be written. There is a price to pay for the increased speed, however. If a customer's name is "W. Oz", which is only 5 bytes long including the blank, we must still allocate 30 bytes because of the fixed record requirement of random-access files. We have wasted almost 50% of the record space, a circumstance that is of particular importance when working with the smaller capacities of 5-inch floppy disks. Even the end user might get a little cranky if he knew that half of his disk space was going to waste.

**Skip Sequential: The Best of Both Worlds**

The main advantage of a Skip Sequential file is that it has the same speed as a random-access file, but does not require the use of fixed record lengths. This means that it can write data to the disk with the same speed as random access, but does so without wasting disk space. If a customer's name is 5 bytes long, it will use only 5 bytes. We've been using Skip Sequential for almost three years and have virtually eliminated sequential files from our programming choices. In all but the most trivial cases, Skip Sequential beats sequential files, hands down.

Listing 3: Initializing a Skip Sequential file requires that a single number be written to the file. Since this number will serve as the file byte counter, and is itself 5 bytes long, it is set to 5 on initialization.

```
100 REM Initialization routine for Skip Sequential prior to use
110 REM
120 REM
130 REM
140 REM
150 REM
160 REM
170 REM
180 REM
190 REM
200 REM
210 REM
220 REM
230 REM
240 REM
250 REM
260 REM
270 REM
```

<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>210 REM</td>
<td>We're assuming 5-digit precision</td>
</tr>
</tbody>
</table>

Skip Sequential is easy to use and requires little programming overhead. Essentially, it is a random-access file with a fixed record length of 1 byte; all we have to do is keep track of the number of bytes already written to the file. To this end we must provide a byte counter when the file is initialized (before using Skip Sequential). The program in listing 3 illustrates this process.

When preparing a file for Skip Sequential, you must first write a single number to the file. The value of that number depends upon the number of bytes required for a floating-point number. North Star BASIC, for example, uses 5 bytes for such numbers, so X in line 240 of listing 3 is set to 5. Line 250 writes the number 5 to the file, and the program ends. Why do we have to write this number? Since we must keep track of the number of bytes written to the file, and the counter is a number which is 5 bytes long, 5 bytes are written to the file when we write the byte counter in line 250. The program in listing 3 has done what it's supposed to do: keep track of the number of bytes in the file—exactly 5. Having initialized the byte counter, we are now ready to use the file.

The program in listing 4 can be used to implement the sample program discussed earlier. Line 240 reads the byte counter, while line 260 says to "skip over" B bytes and then write the new data to the disk. The first time through, B will equal 5 bytes, since only the byte counter is in the file. Note that North Star BASIC "skips" with respect to the beginning of the data file; some operating systems may do this with respect to the disk head after reading B. If this is true, the byte counter must be initialized to 0 in listing 3. Once the skip is performed in line 260, the new data is written to the disk in the conventional manner.

Disk space is saved through line 270, which sets L equal to the length of NS. Line 280 increases the byte counter to reflect the number of bytes written to the disk. Since there are four numbers of 5 bytes each, this is added to B, plus the length of the string, L, plus the 2 overhead bytes associated with each string. If the name were "W. Oz", L would equal 5, and the total number of additional bytes would be 27. The byte counter would reflect 32, the total number of bytes in the file (27 new bytes plus 5 for the byte counter itself). Line 300 then writes the new value of the byte counter to the beginning of the file.

Note what happens in listing 4 when a second entry is made to the file. Line 240 returns with 32 in B. The program then skips over 32 bytes in line 260 and writes the new transaction in the proper place in the file. The disk-write operation is actually performed faster than the random-access example given earlier, since B does not have to be calculated. Fixed record lengths are not used, so we save the difference between the actual string length and the worst case string length that would have been used with random-access files. As the file grows longer, the savings can be substantial.

It is quite simple to read the file...
Listing 4: New records may be added to a Skip Sequential file with this routine. The length of each record varies with the length of NS, the string variable containing a customer name.

Listing 5: Each record of a Skip Sequential file is read by calculating the individual record lengths as they are read and adding this value to the current byte count.

Using sequential techniques. An example is given in listing 5. Note that E is equal to 5 in line 230. By using this variable in the same manner as B in listing 4, a comparison of E and B (as in line 310) is equivalent to testing for an end-of-file mark. Since E is updated in line 300, we know that we have read all of the data in the file when E is equal to B.

The program in listing 5 does point out one potential problem. In those cases where NS might be empty, line 270 expects to see an NS in the file. The simplest way to avoid a type error on a read operation is to set NS equal to one blank before writing it to the disk in listing 4. While this does waste 3 bytes, the loss is trivial compared to the other savings of the Skip Sequential method.

Updating a Skip Sequential File

Another advantage of Skip Sequential over sequential files is that they can be updated as easily as random files. Suppose that we want to use the flag variable (F) to reflect whether or not the transaction is paid. Assuming the F equaled 1 when the transaction was originally written, we now want to update it to a paid status. We will further assume that the new value of F will reflect the date it was paid (although it could be a check number or any other numeric counter, E). Lines 270 through 310 read the data and update E. Line 330 asks if this is the proper invoice number. If it isn't, line 350 is executed: this tests
<table>
<thead>
<tr>
<th>Listing 6: In order to update a Skip Sequential file, each record must be searched until the proper one is located. A new value of the same length must then be written into that record.</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 REM &quot;This program updates a variable in a Skip Sequential files using North Star DOS and BASIC&quot;</td>
</tr>
<tr>
<td>110 REM Must set a variable, E, equal to the number of bytes per floating point number.</td>
</tr>
<tr>
<td>120 REM</td>
</tr>
<tr>
<td>130 REM 10-15-80</td>
</tr>
<tr>
<td>140 REM</td>
</tr>
<tr>
<td>150 REM</td>
</tr>
<tr>
<td>160 REM</td>
</tr>
<tr>
<td>170 REM</td>
</tr>
<tr>
<td>180 REM This program assumes we want to set the flag variable, F, to equal the current date, which is held in variable Y. The transaction to be updated has an invoice number that must match W1.</td>
</tr>
<tr>
<td>190 REM</td>
</tr>
<tr>
<td>200 REM</td>
</tr>
<tr>
<td>210 REM</td>
</tr>
<tr>
<td>220 REM</td>
</tr>
<tr>
<td>230 REM</td>
</tr>
<tr>
<td>240 REM DIM W(30)</td>
</tr>
<tr>
<td>250 REM P=5\REM</td>
</tr>
<tr>
<td>260 REM</td>
</tr>
<tr>
<td>270 OPEN #0,&quot;BYTE&quot;</td>
</tr>
<tr>
<td>280 READ #0,B</td>
</tr>
<tr>
<td>290 READ #0,D,N,A,N,F</td>
</tr>
<tr>
<td>300 L+LEN(W)</td>
</tr>
<tr>
<td>310 L=E+(5\4)+L+2\REM</td>
</tr>
<tr>
<td>320 REM</td>
</tr>
<tr>
<td>330 IF N=W THEN 430\REM</td>
</tr>
<tr>
<td>340 REM</td>
</tr>
<tr>
<td>350 IF E B THEN 290\REM</td>
</tr>
<tr>
<td>360 IF &quot;CANNOT FIND A MATCH FOR INVOICE NUMBER&quot;,N</td>
</tr>
<tr>
<td>370 REM</td>
</tr>
<tr>
<td>380 END</td>
</tr>
<tr>
<td>390 REM</td>
</tr>
<tr>
<td>400 REM</td>
</tr>
<tr>
<td>410 REM</td>
</tr>
<tr>
<td>420 REM</td>
</tr>
<tr>
<td>430 REM WRITE 80E(2-5),Y,NOENMARK</td>
</tr>
<tr>
<td>440 REM</td>
</tr>
<tr>
<td>450 REM</td>
</tr>
<tr>
<td>460 END</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Listing 7: Microsoft BASIC-80 version of the initialization routine for a Skip Sequential file.</th>
</tr>
</thead>
<tbody>
<tr>
<td>105 REM &quot;This program initializes the Skip Sequential files for Digital Research's CP/M operating system and Microsoft's BASIC-80.&quot;</td>
</tr>
<tr>
<td>110 REM</td>
</tr>
<tr>
<td>120 REM 10-15-80</td>
</tr>
<tr>
<td>130 REM</td>
</tr>
<tr>
<td>140 REM</td>
</tr>
<tr>
<td>150 REM Purdum, ECOLOSS</td>
</tr>
<tr>
<td>160 REM</td>
</tr>
<tr>
<td>170 REM The function of this program is to initialize the data file called BYTE for use as a Skip Sequential data file. It assumes double-precision numbers are used in the data file.</td>
</tr>
<tr>
<td>180 REM</td>
</tr>
<tr>
<td>190 REM</td>
</tr>
<tr>
<td>200 REM A random file with a fixed record length of 8 bytes.</td>
</tr>
<tr>
<td>210 REM</td>
</tr>
<tr>
<td>220 REM OPEN &quot;R&quot;,#1,&quot;BYTE&quot;,8:REM</td>
</tr>
<tr>
<td>230 REM</td>
</tr>
<tr>
<td>240 REM FIELD #1,8 AS Y</td>
</tr>
<tr>
<td>250 REM M=1\REM</td>
</tr>
<tr>
<td>260 REM LET Y=N+10(K(H)</td>
</tr>
<tr>
<td>270 REM PUT #1,1,CLOSE #1:END</td>
</tr>
</tbody>
</table>

for an end-of-file condition. If we haven't read all of the data, we go to 290 and read some more. If the proper match is in 330, control is sent to 430 to write today's date (assumed to be in Y) in place of F. Note how this is accomplished. Upon finding a match in 330, E contains the number of bytes read thus far. Since F is a 5-byte number, we need to back up 5 bytes before writing Y in place of F. For this reason, five is subtracted from the variable E in line 430. The rest of the line writes the date, Y, with no end-of-file mark, to the file. We are, of course, assuming that Y is also a number.

Skip Sequential for BASIC-80

We have also included a program similar to the above but modified for Microsoft's BASIC-80. The program listings are similar to the North Star BASIC versions, but the differences between interpreters do require some changes.

One of the major differences between North Star BASIC and BASIC-80 is that BASIC-80 requires that record length be given when the file is opened. Listing 7 shows how a Skip Sequential file is initialized using BASIC-80. Since we use dollar amounts as one of the variables in the data file (i.e., A), the programmer will...
probably want to use double-precision numbers. In BASIC-80, 8 bytes are required for each numeric variable. Lines 220 and 240 inform the interpreter that we will be using a fixed record length of 8 bytes instead of the 1-byte length in the North Star BASIC (Microsoft BASIC-80 does not allow a record length of 1). Line 260 contains
verts the value of \( M \) into a string for writing to the disk. This is essentially identical to the use of random-access files in North Star BASIC to this point.

Listing 8 illustrates how the data is written to the Skip Sequential file. The only unusual part of the program occurs between lines 390 and 460. Line 390 makes the name held in \( N_S \) an even multiple of 8 bytes. The value of \( X \) tells us how many multiples there are, and since we need to know this \( X \) value later to read \( N_S \), line 410 saves it in the file as part of the transaction. Lines 440 through 480 save \( N_S \) to the disk as 8-byte records. The remainder of the program is the BASIC-80 equivalent of writing the flag variable and the updated record counter.

Listing 9 is the program to read the Skip Sequential file. The only unusual segment is the reconstruction of \( N_S \) in lines 310 through 330. The updating need not be discussed, since it would be identical to updating any other random file in BASIC-80.

Several improvements could be made to the BASIC-80 version. For example, \( X \) could be "packed" with the date, given the double-precision numbers of BASIC-80 and the fact that \( X \) will never exceed four in the sample program. We also think that there may be a way to trick the interpreter into accepting a 1-byte record length instead of 8 bytes, but we haven't experimented sufficiently. Still, Skip Sequential can save disk space over conventional random-access files, albeit the savings aren't quite as great.

Concluding Thoughts

Skip Sequential files do offer many advantages to the programmer and, indeed, the end user. In general, Skip Sequential files may be used for the following: in almost any application where ordinary sequential files are appropriate; in any situation where data is archival in nature (e.g., data backups, transactions, or historical entries); and where only limited updating is required (e.g., setting flags). As a general rule, Skip Sequential strings cannot be updated unless the new and old string lengths are the same. For this reason, data sets that require frequent updating, such as mail or customer lists, are better suited to random-access files.

Finally, Skip Sequential files can be used in a way that simulates ISAM (indexed-sequential access method) files. For example, if a separate file holds the byte-counter values that exist for the first entry of each month, those byte-counter values can be read first and used to jump to the first entry of the month in the Skip Sequential file. This will further enhance the speed of data retrieval.

While the documentation for the Skip Sequential method has been copyrighted, and we have applied for a trademark on the name, I encourage you to make use of the files. If you plan to make commercial use of the Skip Sequential method, I'd appreciate it if you would contact us first.

Acknowledgments

I would like to thank my business associate and friend, Dr. J. B. Orris, for his comments on an earlier draft of this article.

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Finding Words That Sound Alike

The Soundex Algorithm

The name I am searching for is "Johnson." But is it spelled "Johnson," "Johansen," "Jonson," "Jonsen," or "Johanson"? The Soundex algorithm can help find words that sound alike by reducing a string to a Soundex code string consisting of a letter and up to three digits.

Alphabetic strings that sound alike generate identical Soundex code strings. The Soundex system is used in the Whatsit data-management system (from Computer Headware, POB 14694, San Francisco, CA 94114) that runs on the Apple, but the program presented here is my own. In the Whatsit program, you can ask, "WHAT SOUNDS (LIKE) JOHNSON?" Whatsit then lists every word it "knows" that sounds like the word "Johnson."

The Soundex algorithm was recently described by P.A.V. Hall and G.R. Dowling ("Approximate String Matching," ACM Computing Surveys, 12, 4, December 1980, p. 388), and it works as follows. We will call the entry-name string \( E \) and the reduced output code string \( R \). The first character of \( R \) is merely the first character of \( E \). The remaining letters of the \( E \) string are replaced by their group code numbers as shown in table 1. Then all zeros are removed, and consecutive occurrences of the same digit are reduced to a single digit. Finally, the code is truncated on the left to leave one letter and up to three digits.

The Soundex program in listing 1 is written in Applesoft BASIC. To simplify conversion to other BASICS, I will give examples of the Applesoft MID$ and LEFT$ functions. \( A = \) MID$(B, 6, 4) \) will set the string variable \( A \) to a four-character substring of \( B \) starting at the sixth character. \( A = \) LEFT$(B, 2) \) will set \( A \) to the first two (i.e., leftmost) characters of \( B \).

The Soundex subroutine beginning at line 1000 of listing 1 will accept the input string \( E \) and return the reduced-code string \( R \), and it will throw away nonalphabetic characters. Lines 10 through 40 dimension the arrays \( E \) and \( R \), which are used for demonstration purposes only. The array \( W(N) \) is initialized to the group number corresponding to the Nth letter of the alphabet.

Listing 1: Written in Applesoft BASIC, this program accepts a character string \( E \) as input, converts it to the Soundex code string \( R \), and prints out all words that have the same code string.

```basic
10 J = 0
20 DIM E$(99), R$(99)
30 DIM W(26)
40 FOR J = 1 TO 26: READ W(J): NEXT
50 PRINT: !PUT "INPUT STRING:" ; E$: PRINT
60 GOSUB 1000
70 J = J + 1
80 R$(J) = R$
90 E$(J) = E$
100 FOR M = 1 TO J
110 IF R$(M) = R$ THEN PRINT E$(M)
120 NEXT
130 GOTO 50
1000 REM SOUNDEX SUBROUTINE
1010 L = LEN (E$)
1020 S$ = ""
1030 R$ = LEFT$(E$, 1)
1040 ST = 0
1050 IF L < 2 THEN RETURN
1060 FOR I = 2 TO L
1070 C = ASC (MID$(S$, I, 1))
1080 IF C > ST THEN R$ = R$ + MID$(S$, I, 1)
1090 ST = C
1100 W = W(C)
1110 IF W < 0 THEN S$ = S$ + CHR$(W + AB)
1120 NEXT
1130 L = LEN (S$)
1140 IF L = 0 GOTO 1210
1150 FOR I = 1 TO L
1160 C = ASC (MID$(S$, I, 1))
1170 IF C > ST THEN R$ = R$ + MID$(S$, I, 1)
1180 ST = C
1190 NEXT
1200 IF LEN (R$) > 4 THEN R$ = LEFT$(R$, 4)
1210 RETURN
1220 DATA 0,1,2,3,0,1,2,0,0,2,2,4,5,5,0,1,2,6,2,3,0,1,0,2,0,2
```

March 1982 © BYTE Publications Inc 473
For example, \( W(3) \) contains the number 2 corresponding to the assignment of the letter C (i.e., the third letter of the alphabet) to the group 2. This initialization occurs in line 40, using the data statement in line 1220, and should be done once at the beginning of your main program.

Lines 50 through 130 form a simple demonstration program that stores each word as it is typed in together with its code word. The original word and the code word are stored in arrays \( E$( ) \) and \( R$( ) \), respectively. Each time you add a word, the program prints out all words that have the same code word, finding them by doing a linear search through the code words.

### The Soundex Subroutine

The Soundex subroutine appears in lines 1000 through 1220. Lines 30 and 40 are also needed to initialize array \( W \). The first letter of \( E$ \) is put into \( R$ \). If the length of \( E$ \) is 0 (null string) or 1, then the subroutine terminates (line 1050). Otherwise each character of \( E$ \), starting at the second character, is scanned and its group code is put into the intermediate string \( S$ \) unless the character is not a letter or the letter falls in group 0. For example, if we type SOMMERSET, when the program gets to line 1130, \( S$ \) will contain S5S623. Next, consecutive occurrences of the same group number will be reduced to a single occurrence of that number. Thus the 55 in S5S623 will become a single 5. When the program gets to line 1200, the string \( R$ \) will be S5S623. Line 1200 truncates the string \( R$ \) to four characters, becoming S562, which is the code word for SOMMERSET. Let's take another look at the steps, shown before the execution of each line:

<table>
<thead>
<tr>
<th>line</th>
<th>( S$ )</th>
<th>( R$ )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1030</td>
<td>null</td>
<td>S</td>
</tr>
<tr>
<td>1130</td>
<td>55S623</td>
<td>S</td>
</tr>
<tr>
<td>1200</td>
<td>55S623</td>
<td>S5S623</td>
</tr>
<tr>
<td>1210</td>
<td>55S623</td>
<td>S562</td>
</tr>
</tbody>
</table>

Table 1

This algorithm has some serious limitations. Although our “Johnson” examples work fine, with the resulting code for the different spellings being J525, “phone” and “fone” do not give the same code because they start with different letters; “Rogers” and “Rodgers” do not work because the d is not in the same code group as g. And words like “tough” and “tuff” do not translate to the same code because g and f are in different code groups. But the Soundex algorithm works well for most words and proper names.

To try the Soundex algorithm, enter the program in listing 1 and run it. Type in some names. Every time you type a new name, the program will list on the screen all the words entered that have the same Soundex code. If you add the line

65 PRINT \( R$ \)

the Soundex code will also be printed.

### Applications

The Soundex subroutine has many applications. If you have a card-file program that searches for items by matching a “key” string, rather than returning the message

MATCH NOT FOUND

or some such, your program could jump into the “Soundex mode,” look for matches that sound similar to the key, and then list them. You could then look through the list of near matches to see if the word sought is in the list. This short Soundex subroutine can add a lot of “flash” to what might otherwise be a mundane program.

---

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**Multifunction Desktop Computers**

The AWS family of multifunction workstations offer 0.5 megabyte of storage. These desktop workstations are based on the 16-bit Intel 8088 microprocessor and carry a combination of floppy- and Winchester hard-disk drives in the same enclosure as the processor and the display screen. Each AWS work station supports up to 512K bytes of RAM (random-access memory) based on 64K-byte RAM integrated circuits, an 80-character by 28-line video-display unit, and an optional mass-storage unit. The units can function as stand-alone terminals or as members of a local network by means of a high-speed data link, sharing peripherals and databases.

In single-units, the AWS work station ranges in price from $53990 to approximately $11,500, depending on optional equipment. For additional details, contact Pauline Alker, Convergent Technologies, 2500 Augustine Dr., Santa Clara, CA 95051, (800) 538-7560; in California (408) 727-8830. Circle 550 on inquiry card.

---

**Single-Board Computer Can Support 56K Bytes of Memory**

The Flexi Plus is a 6809-based single-board microcomputer that can accommodate up to 56K bytes of on-board RAM (random-access read/write memory), ROM (read-only memory), and EPROM (erasable programmable ROM) in any combination. Flexi Plus features extensive serial and parallel I/O (input/output) capabilities, a 20-milliamper current-loop TTY (teletypewriter) port, and a universal cassette interface. When used without its 6809 option, the Flexi Plus can serve as an expansion board for most 6502-, 6800-, or 6809-based systems.

 Optionally, the Flexi Plus can be expanded to include an IBM-format-compatible floppy-disk controller that can support up to four 8-inch drives or three 5½-inch drives. Additional options include an IEEE-488 bus controller and a fully buffered RS-232C communications port with programmable data formats and transfer rates from 50 to 19,500 bps (bits per second).

The Flexi Plus costs $5320. The 6809 and the RS-232C options are available for $75 each. Both the floppy-disk and the IEEE-488 bus controllers cost $125. Literature is available on request. Contact Robert M. Tripp, The Computerist Inc., 34 Chelmsford St., Chelmsford, MA 01824, (617) 256-3649.

Circle 551 on inquiry card.

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**STD Bus Controller Card**

The ZT7805 controller card for the STD bus features an 8085A microprocessor, 1K bytes of programmable memory, up to 8K bytes of ROM (read-only memory), IEEE-488 I/O (input/output) and two serial RS-232C ports, and a control monitor with I/O subroutines. The board costs $650. Contact Ziatech Corp., 2410 Broad St., San Luis Obispo, CA 93401, (805) 541-0488. Circle 552 on inquiry card.

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**Modular Microcomputer**

The Sintel-85 is a modular microcomputer training system based on the Intel 8085 microprocessor. It has 2K bytes of ROM (read-only memory) with expandable monitor, 256K bytes of RAM (random-access read/write memory), three programmable I/O (input/output) ports, a 6-digit display with both address and data fields, and a 24-key keyboard with eight command keys and 16 hexadecimal keys.

Sintel-85 can be expanded to include up to 64K bytes of memory and 256 I/O ports. A wide range of expansion and interface boards are available, including A/D (analog-to-digital) and D/A (digital-to-analog) converters, cassette interface, an immediate expansion board, and audio-visual I/O ports interface. The immediate expansion board augments the basic system with additional RAM, 4K bytes of EPROM (erasable programmable ROM), two counters/timers, and 44 programmed I/O lines. It includes two 8156 units, two 2114 static RAMs, and sockets for two 2716 ROMs. Also available is an I/O expansion board that lets you exercise and simulate I/O instructions, external systems operation, and program debugging. An oscillator lets you oper-
ate a small speaker. For more details, contact Beth Belkin, Government of Israel Trade Center, 350 Fifth Ave., New York, NY 10118. (212) 560-0661. In Israel, contact Sintel Systems Ltd., 13 Ovadia St., POB 9209, Haifa, Israel 34564, (04) 334944; Telex: 46400 BXHA IL, ext. B134. Circle 553 on inquiry card.

Business System Has Three Z80s

The ARCmicro is a small-business microcomputer system with three separate Z80 microprocessors: the system processor, the disk processor, and the terminal processor. The system supports two 5 1/4-inch Winchester disks for a total of 20 megabytes of formatted storage and four 5 1/4-inch double-sided, double-density floppy-disks totaling 3.2 megabytes of storage. System memory is expandable from 64K bytes to 256K bytes. The terminal processor controls all video-display units, printers, and communications links with the system processor, which frees the system processor from interrupts and increases communications throughput.

Other features of the ARCmicro include a shadow ROM (read-only memory) that contains self-diagnostics and bootstrap programs that execute during system initialization. The self-diagnostic programs perform memory and peripheral device tests to assure integrity each time the system is initialized. The ROM then "disappears" from the address space and is available for use by the program memory.

The ARCmicro is currently available as a complete microcomputer system called the ARCmicro/PAC, which includes a DEC [Digital Equipment Corporation] VT-101 video display, a DEC LA-34 printer, and either the CP/M 2.2 or the MP/M II disk operating system. Contact ARC Automation Group Inc., POB 1009, Bryan, TX 77805, (713) 693-6122. Circle 554 on inquiry card.

SOFTWARE

Step FORTH to RPL

RPL is a FORTH-like language that runs on PET and CBM (Commodore Business Machines) computers. RPL (Reverse Polish Language) uses the Commodore BASIC screen editor for program entry and editing, but does not inhibit the use of BASIC throughout a software development session. The RPL Compiler and the screen-oriented, object-level Symbolic Debugger reside in the top 8K bytes of memory and can be called directly from BASIC commands. Source code is saved to disk or cassette and is compiled memory-to-memory.

RPL has special keywords and symbols that let you nest multiline IF... THEN... ELSE constructs and FOR... NEXT loops. Other special keywords and symbols offer named subroutines and functions of arbitrary length, 16-bit integer arithmetic and logical manipulations, built-in character-string handling, stack-management directives that include n-index and n-rotate, access to machine language, predefined arrays with numeric and string contents, local and global symbols, and forward and backward symbolic references, including GOTO. Also provided are GET, INPUT, and PRINT operators.

The RPL Compiler, including a 60-page user's manual, is available on disk for $49.95 or on cassette for $44.95. The complete Compiler and Symbolic Debugger costs $80.91 on disk or $71.91 on cassette; manuals are available for $10 and $4, respectively. For details, contact Samurai Software, POB 2902, Pompano Beach, FL 33062, (800) 327-8965, ext. 2; in Florida (305) 782-9985. Circle 555 on inquiry card.

Take Your Projects to Task

Task is a management tool to help you schedule a project. It combines the procedures of PERT (Performance, Evaluation, and Review Techniques) and the Critical Path Method, which divides a complex project into assignments and determines which are critical to the overall completion of the project. Task determines the scheduled start and completion dates for each assignment in a project, which tasks cannot be delayed if the project is to be completed on time, and the amount of time each noncritical task can be delayed without affecting the completion date of a project. Among the options included with Task are the ability to create a calendar to work with a particular work schedule, an expanded Gantt diagram, and a management report that can detail each task, including its start and finish times.

Task is a compiled program running under CP/M. It costs $329 and is available from AM3, Suite 200, 1935 Cliff Valley Way NE, Atlanta, GA 30329, (404) 634-9535. Circle 556 on inquiry card.
Overlay Compiler
An overlay structure is now possible with North Star BASIC under an extension to the Comstar compiler. Overlay structures differ from program chaining in that a root program segment and selected program variables remain intact when a new program segment is introduced. Overlay structures permit large programs to be executed.

The Overlay extension is suitable for menu-driven programs and includes a Comstar-CP/M capability. The Overlay extension is available to registered owners of the Comstar compiler for $75 from Allen Ashley, 395 Sierra Madre Villa, Pasadena, CA 91107, (213) 793-5748.

Smartkey for CP/M and Software Applications
The Smartkey is a keyboard utility for the CP/M operating system that solves the problem of incompatibility between the console keyboard hardware and applications software. The program acts as an interface between the keyboard and CP/M by allowing the user to "redefine" the keyboard. Codes generated by individual keys can be changed at will or made to generate a sequence of characters at each keystroke. The keyboard's layout can be improved or customized for particular applications software, and sets of key definitions can be saved to disk for later use. Definitions can be altered at any time.

Smartkey does not require hardware or software knowledge to install. It's available for $39 from FBN Software, 1111 Sawmill Gulch Rd., Pebble Beach, CA 93953, (408) 373-5303.

Mail-List Manager
The One-Disk Mail-List Manager is a mailing-list management and a label-printing utility for Radio Shack's TRS-80 Models I and III. The program disk can hold 430 records that include name, company, address, and zip code. Records can be sorted alphabetically or by zip code using machine language at a speed of 100 records every 3.5 seconds. Entries are made on a first-name-first basis, and multiple entries are handled by single-keystroke repetition of the address. Labels can be printed from sorted or unsorted lists and by any combination of selection fields. Other features include a label-selecting Print Key that can print labels for any geographic area (e.g., city, state, or zip code).

The One-Disk Mail-List Manager requires 32K bytes of memory; conversion to Model III DOS is necessary. It costs $34.95 and is available from Manhattan Software, POB 1063, Woodland Hills, CA 91365. MasterCard or Visa holders can order by calling (213) 704-8495.

Continuous Wave Interface for TRS-80
MFJ Enterprises' CW Transceiver Program and Hardware Interface lets you send CW on your keyboard and receive CW on your video-display screen. It features a tri-split screen for received messages, transmit buffer, and programmable message index. Its text buffer can hold 3295 characters when used with a 16K-byte machine, and it can be preloaded while receiving messages. The package has ten 199-character programmable message memory with on-screen message index. Messages can be repeated or combined, and speed is adjustable from 12 to 55 words per minute (wpm). For group-code practice, up to 2200 characters can be stored. The package automatically receives up to 100 wpm and allows you to store up to five screens of received CW. When the transmit buffer is empty, the mode is automatically changed to receive.

MFJ's hardware interface plugs between the transceiver and the computer without modifications. The cassette-based, disk-compatible program and the hardware-interface package run on a 16K-byte TRS-80 Model I or III. The Transceiver and Hardware Interface costs $99.95, plus a $4 shipping charge. Contact MFJ Enterprises Inc., POB 494, Mississippi State, MS 39762, (601) 322-5869. MasterCard or Visa holders can order by calling (800) 647-1800.

Let Your Modem Do the Talking
The automated sales force at Telephone Software Connection delivers its products at any time of the day or night over telephone lines. The Connection's Apple-compatible software comes with complete documentation embedded in the programs. The Connection presently offers telecommunications software, games, and educational programs, as well as utilities for the Apple II. Several free programs are offered by means of the telecommunications hook-up.

For more information, contact Telephone Software Connection Inc., POB 6548, Torrance, CA 90504, (213) 516-9430. The telephone number for the modem connection is (213) 516-9432. Payment is by credit card.

Circle 557 on inquiry card.

Circle 558 on inquiry card.

Circle 559 on inquiry card.

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Circle 561 on inquiry card.
Educational Game Show

The Game Show is a multiplayer educational game program featuring animated color graphics. It comes with games in vocabulary, history, algebra, sailing, and computer terms. An authoring system that lets you add your own topics is provided.

The Game Show runs on the Apple computer. It costs $45, which includes documentation, a one-year warranty, and a backup disk. Available at computer dealers or directly from Computer-Advanced Ideas Inc., Suite 341, 1442A Walnut St., Berkeley, CA 94709. [415] 526-9100. Circle 562 on inquiry card.

Profile III+

Profile III+ is a database management package for Radio Shack's TRS-80 Model III computer. It can communicate with Personal Software's Visicalc financial-modeling program and with Radio Shack's Superscrip$t word-processing program. This combination gives the Model III owner a complete management-information tool.

Profile III+ is menu-driven with user options appearing at the bottom of the screen. Customized or special limited menus can be created. The system's screen editor lets database designers visually organize an input screen, and fields and user prompts can be moved by means of function keys. Screens can be password-protected. Up to 99 fields per record can be defined, and as many as 64,000 records are allowed. Maximum record size is 1020 characters. Up to 36 fields can be searched or sorted, and wild cards containing partial-field values are permitted.


Integrate Real-Time Software Tasks

The Multi-Tasking Kernel is a tool for integrating multiple real-time software tasks in 8085-, Z80-, 6502-, and 6809-based microcomputer products. The package includes source code for a basic multitasking organization in which tasks self-schedule in a round-robin fashion. The package provides the user with guides through a series of enhancements for carrying out sophisticated, interrupt-initiated, preemptive priority dynamic-task scheduling. Also included are descriptions of dedicated and shared resource scheduling, time-slice scheduling, and intertask communication schemes.


BASIC Editor for TRS-80s

EDIT is a full-screen BASIC editor for Radio Shack's TRS-80 Models I and III. It features a floating-point cursor with automatic repeat functions and a Scriptlet-like control structure for easy handling. More than 30 commands permit professional-quality editing of BASIC text at the character, word, line, or block level.

EDIT was developed in England by Southern Software. It costs $40 and is being distributed in the U.S. by Allen Gelder Software, POB 11721, Main Post Office, San Francisco, CA 94101. Circle 565 on inquiry card.

Insurance Rating Programs

Orion Business Systems' Orionrater programs could make the insurance agent's rating book a piece of the past. This series of property and casualty rating programs can quickly compare and print out quotes. They are simple to operate and do not require insurance or technical backgrounds. Among the programs available are Auto insurance, Homeowners/Condo Owners and Renters insurance, Commercial Truck insurance, and Commercial Liability insurance.


C/80 Compiler

C/80 is a compiler for the C programming language that provides random-access file I/O (input/output) and Macro-80 compatibility. It generates 8080 assembly-language code for the assembler or for Microsoft's Macro-80 relocatable assembler and linking loader. All C language control statements and arithmetic and logical operators are supported as well as character and 16-bit integer data, pointers, arrays, strings, data initialization, inline assembly language, conditional compilation, and most preprocessor functions. C/80's run-time library provides standard C I/O functions and features dynamic storage allocation, I/O redirection, and a run-time execution-profile facility for easy program optimization.

C/80 lacks structures, pointers to pointers, and long and floating data types. Available on 8-inch CP/M disks and on 5¼-inch Heath/Zenith CP/M or HDOS disks, C/80 costs $39.95. Contact The Software Toolworks.
What's New?

Atari Graphics Composer

The Graphics Composer is a joystick/paddle graphics software package for Atari 400/800 microcomputers. With it, you can draw the outline of a picture in high-resolution screen mode 8 or 7 using a joystick or paddle; then you can use color fill-in, color brushes, and text to complete your graphics scheme. The graphics can then be saved to disk or cassette.


Circle 570 on inquiry card.

New C Compiler

Phase One Systems has unveiled a C compiler for its Oasis operating system. Oasis C supports most Unix Version Seven C features. It produces Z80 assembler code and is provided with an optimizer that reduces compiled code between 30 and 50%. Among the attributes of Oasis C are pointers, structures, assignment operators, a full I/O (input/output) library, and compile options. A version of Oasis C for the 16-bit-compatible Oasis-16 will be available.

Oasis C costs $250. For complete details, contact Phase One Systems Inc., Suite 830, 7700 Edgewater Dr., Oakland, CA 94621, (415) 562-8085.

Circle 571 on inquiry card.

PERIPHERALS

Model III Cash-Register Expansion System

The CR-180 is a cash register/point-of-sale expansion system for the TRS-80 Model III microcomputer. It stores transactions for up to 100 employees, saves eight methods of payments, and provides inventory control and complete reporting. The CR-180 can produce daily sales and cash reports by employee and by type of transaction, inventory usage reports, and gross profit computation. Also, price and shelf labels can be printed.

The CR-180 expansion system is supplied with an electronic cash drawer and a receipt printer which plug directly into the TRS-80 Model III. Audio has been added for keystroke confirmation. Prices range from $900 to $1900. Contact Integrated Cash Register/Futuresoft, Southern Region, Suite 203, 2301 Park Ave., POB 1446, Orange Park, FL 32073, (904) 269-1918.

Circle 572 on inquiry card.

Draft- and Letter-Quality Printer

Printer Systems' Model 1800 printer can produce both correspondence- and draft-quality printouts. It is plug-compatible with IBM Series I or System 34/38 computers as well as Univac, Burroughs, Honeywell, DEC (Digital Equipment Corp.), and Data General computers. In the draft mode, the Model 1800 prints at 200 cps (characters per second) with a 7 by 9 dot-matrix format. In the correspondence mode, it prints at 50 cps in a 40 by 18 format. The Model 1800 features a forms-length selector switch and quiet operation.

The Model 1800 printer is available for $2695 from Printer Systems Corp., Suite 104, 1 West Deer Park Rd., Gaithersburg, MD 20760, (301) 840-1070.

Circle 573 on inquiry card.

I/O Control Card

The G519/I/O card is an interface between the Multibus and Gordo's industry-standard PB-16/PB-24 I/O (input/output) module boards. The card can control up to 72 AC or DC input or output modules in any combination or position on the I/O module board. It can also serve as a general-purpose TTL (transistor-transistor logic) interface card for control of up to 72 bidirectional I/O lines.

Gordo's International also has interface cards for the RM-65, the Exorcisor II, and STD bus. The G519 I/O card is priced at $500. For details, contact Gordo's Corp., 250 Glenwood Ave., POB 100, Bloomfield, NJ 07003, (201) 743-6800.

Circle 574 on inquiry card.

Analog Peripheral

The Analog Peripheral is a self-contained 8-bit A/D (analog-to-digital) converter that can connect to any computer. It has a switch-selectable RS-232C output line with data transmission rates from 110 to 9600 bps (bits per second). Other features include a 26-pin parallel output, four input channels, conversion speeds of 100 microseconds, power supply, and plug-in sensors for temperature, light, and other analog signals. For complete details on the Analog Peripheral, contact Cambridge Development Laboratory, 36 Pleasant St., Watertown, MA 02172, (617) 926-0869.

Circle 575 on inquiry card.
What's New?

Genius Display System
The Genius is an Apple-compatible, full-page video-display terminal. The 15-inch Genius displays 57 lines of text by 80 characters, or optionally 66 lines by 80 characters. The Genius is compatible with the Wordstar word-processing system and many CP/M-based programs. Large sections of code can be displayed at one time, which is a plus for software developers, and the high-resolution display has an 87 MHz bandwidth and 6K bytes of high-speed buffer memory.


Single-Pen Drum Plotter
The Complot CPS-20 is a single-pen, 11-inch drum plotter that can interface with most computers. The only alteration needed to use the CPS-20 with different computers is the switching of a single interface card. The high-efficiency CPS-20 operates at 3 inches per second at a resolution of 0.005 inch. It costs $3995. Contact Houston Instrument, One Houston Square, Austin, TX 78753, (512) 837-2820. Circle 577 on inquiry card.

Line Controller Adds Voice Synthesis
The SLC-II is a serial line controller that combines microprocessor intelligence with a versatile voice-synthesis capability. The controller can automatically dial telephone lines and talk by means of its electronically synthesized voice. It can listen and respond to incoming messages that originate at a remote terminal or are generated by a telephone key-pad. The SLC-II's vocabulary includes more than 300 words as well as the complete alphabet and numerals, and it will spell any word it cannot say.

The SLC-II provides ASCII input/output, Touch-Tone input, printer output, external amplifier output, and synthesized voice output. A built-in power backup is provided by rechargeable batteries. In addition, the SLC-II features an automatic dial/auto-answer modem; 16K, 32K, or 80K bytes of programmable memory; and automatic time and date entry with day, month, and year. Applications include data collection and transmission, telephone access to large databases, alarm signaling, and security or facility monitoring. Connections to existing computer systems are made by standard RS-232C or 20 mA serial-loop interface.

In single-unit quantity, the SLC-II costs $1795. Contact Digital Pathways Inc., 1260 L’Avenida, Mountain View, CA 94043, (415) 969-7600. Circle 578 on inquiry card.

Dot-Matrix Printer
NEC Home Electronics' PC-8023A dot-matrix printer can bidirectionally print the upper- and lowercase ASCII (American Standard Code for Information Interchange) character set featured on the PC-8001A microcomputer. In addition, the printer provides many Greek, mathematical, and graphics symbols. The high-speed PC-8023A is equipped with a standard parallel interface and features the ability to print dot-graphics screens on paper. Up to three copies of fanfold, roll, or cut-sheet paper and originals are possible using either pin- or friction-feed delivery. Paper widths range from 11.5 to 25 cm (4½ to 10 inches).

The PC-8023A's matrix options include 7 by 9 English or 8 by 8 graphic and dot graphic, ranging from 40 columns by 4 characters per inch to 136 columns by 17 characters per inch. Print speed is 100 cps (characters per second), and all fonts fea-
Apple II ROM Board

The Andromeda ROM (read-only memory) Board lets you plug utility programs into your Apple II and access them without loading from disk. The Board has space for 2K- or 4K-byte PROMs (programmable read-only memories) and it can accommodate 2K-byte programmable memory devices. (This gives you read/write capabilities for developing custom PROM programs.) Two 2732 PROMs allow a total of 8K bytes of memory on the ROM Board.

The ROM Board is supplied with a utility ROM that gives you five options with your Applesoft programs: you can perform automatic line numbering, alphabetize a disk catalog, control a program list with a page mode, restore crashed Applesoft programs in memory, and create a disk without using the disk operating system. The ROM Board with utility ROM costs $125 and is distributed by Computer Data Services, POB 696, Amherst, NH 03031, (603) 673-7375.

Circle 580 on inquiry card.

Heavy-Duty Printer

The Model MP150 matrix printer has a heavy-duty print head, rated for continuous duty, with an expected life in excess of 100 million characters. Characters are formed bidirectionally in a logic-seeking mode to optimize system throughput. Nine print wires provide clear characters with true descenders and underscores. The MP150 can print 136 characters per line at 10 characters per inch, or up to 226 columns can be printed by selecting the 12- or 16.7-character-per-inch density. Double-width characters are software-selectable. A 7 by 9 matrix font is used for high-speed data printing and an 11 by 9 serif-style matrix font can be used for high-quality printouts. The MP150 features the standard 96-character ASCII (American Standard Code for Information Interchange) set with four strap-selectable foreign fonts.

The MP150 is capable of high-resolution dot-addressable graphics for plotting, printing of screen graphics, and drawing of illustrations. Forms handling is carried out by a stepper-motor-drive tractor paper feed that can be adjusted to accept forms from 7.5 to 38 centimeters (3 to 15 inches) in width. Eight user-selectable forms lengths, skip-over-perforation, and six user-selectable character densities are featured.

The MP150's 1K-byte buffer is expandable to 8K bytes, and its Centronics-type interface can accept parallel TTL (transistor-transistor logic) level data at over 1000 characters per second. Optionally, an RS-232C serial interface can be added to the MP150. The RS-232C interface can accept data at any one of seven rates up to 9600 bps (bits per second) and it supports X-ON/X-OFF and ETX/STX protocols. Another option is an IEEE-to-Centronics interface adapter card for connecting devices with an IEEE-488-bus output port.

The Model MP150 printer costs $1095. Contact MPI, 4426 South Century Dr., Salt Lake City, UT 84107, (801) 263-3081.

Circle 581 on inquiry card.

Universal Systems Interface

The Shugart Associates Systems Interface (SASI) is a universal interface that allows streaming-tape cartridge and floppy- and Winchester-disk drives to use a standard system interface. SASI eliminates having to develop new controllers, host adapters, and software drivers each time a new memory device is integrated into a system. Other SASI operating features include the ability to attach up to eight host processors and controllers per SASI bus, a search capability to assist file-management systems in locating key parameters, multiple command types, and self-arbitration for control of the SASI bus on a memory-device-priority basis.

SASI is already available on Shugart's SA1400 Series of disk-drive controllers.

In OEM (original equipment manufacturer) quantities, the price for Shugart's SA1400 series of disk-drive controllers with an SASI interface begins at $565. For complete details, contact Shugart Associates, 475 Oakmead Parkway, Sunnyvale, CA 94086, (408) 733-0100.

Circle 582 on inquiry card.

Scorpio Family

The Scorpio family of 8-inch Winchester disk drives from Ampex have an average access time of 30 milliseconds with a data-transfer rate of 1.2 megabytes and an average latency of 8.3 milliseconds. This is achieved by means
of a linear voice-coil actuator in a closed-loop servo system. All critical components are enclosed in a sealed module to assure long-term reliability and data integrity. Additional features ensuring data integrity include head-landing zones, module shock mounting, and self-actuating head-carnage and disk spindle locks. Mean time between failures is 10,000 hours.

The Scorpio family is available in two versions: Model 80 with 82.9 megabytes of storage and the Model 80 with 82.9 megabytes of unformatted storage capacity and 20,160 bytes per track over 823 cylinders. The Model 80 is interface-compatible and software-transparent to any host system using industry-standard 80-megabyte disk drives, such as the Ampex DM-980.

For further details on the Scorpio family, contact Ampex Corporation, Memory Products Division, 200 North Nash St., El Segundo, CA 90245, (213) 640-0150.

Circle 583 on inquiry card.

Wireless Building Automation

The Telebrain RS-232C is a wireless computer interface that can communicate programmed, automated-switching decisions throughout an entire facility using the existing AC wiring. It can transmit switching decisions emanating from a host computer, per software developed by the facility, to any one of 1600 independent control points, or Tele switches. The Teleswitch receives and identifies the command and performs the necessary switching.

Telebrain incorporates National Energy's Solution 100 and Solution 1600 programs and the Telegain amplifier. The Solution 100 software includes independent programmable control of up to 83 unique points allowing for 7-day programming, daily start-up, shut-down, and duty cycling. Telebrain can interface with any computer that has an RS-232C serial output port.

Applications include facility management and automation including lighting control, activation of security systems, materials handling, and energy management encompassing load scheduling, demand limiting, duty cycling, optimum start-up, and so on, based on analog input. For complete details, contact National Energy Corp., 1795 Williston Rd., South Burlington, VT (800) 451-3410; in Vermont (802) 658-6445.

Circle 584 on inquiry card.

Color Word-Processing System

NEC Home Electronics' color word-processing system features a self-teaching program and a 12,000-word dictionary. The system is menu-driven, which reduces the possibility for errors, and features all-green text, instructions in yellow or blue, and violet-highlighted potential deletions. The system provides automatic page numbering, draft printing without leaving the document, stock-paragraph and form-letter appending to any document, automatic disk-overflow routine, user-oriented document name listing, unlimited headers and footers, disk-supply indicator, single-key commands, and block move, copy, delete, write, print, and justification capabilities.

When combined with NEC's PC-8001A microcomputer, color monitor, printer, I/O (input/output) unit, and a disk drive, the color word-processing system adds the final touch to a complete computer system that costs less than $6000. Contact NEC Home Electronics USA, Personal Computer Div., 1401 Estes Ave., Elk Grove Village, IL 60007, (312) 228-5900, for complete details.

Circle 585 on inquiry card.

Portable Terminal Has Modem and Printer

Business people will find the Lex-21 portable printing and communications terminal useful in providing access to remote computing services, in field service, for inventory checks, accounting systems, electronic mail, and up-to-the-minute price quotations. Lex-21 features a 59-key ASCII (American Standard Code for Information Interchange) keyboard and a 40-column thermal printer with upper- and lowercase descenders and a 5 by 7 dot-matrix character format. It has a built-in full-duplex 300 bps (bits per second) modem with originate or answer modes, Bell 103A compatibility, and an FCC-approved handset connection. Its industry-compatible asynchronous communications protocol allows transmission at 10 or 30 characters. Its battery-backed memory includes a 1K-byte receive buffer and 2K bytes of compose and edit memory.

The Lex-21 costs $1195. For details, contact Lexicon Corporation, 1541 Northwest 65th Ave., Fort Lauderdale, FL 33313, (305) 792-4400.

Circle 586 on inquiry card.
**What's New?**

**Video Selector**

The Archer Video Selector is a compact, push-button video-switching and control center designed to eliminate the need to repeatedly change cable connections. It simplifies signal routing even for complex home video systems. Two banks of push buttons provide the necessary switching and signal routing between four 75-ohm coaxial inputs and one phono jack to three 75-ohm coaxial outputs. The inputs permit the connection of any combination of five video sources, such as cable television, an antenna, a videocassette or videodisc player, a camera, and a small computer. The three outputs allow simultaneous viewing and recording of a selected input.

The Archer Video Selector offers a signal-path bandwidth from 50 to 900 MHz. No power is required. The Archer Video Selector costs $79.95 and is available at Radio Shack stores and participating dealers. Contact Radio Shack, 1800 One Tandy Center, Fort Worth, TX 76102, (817) 390-3300.

Circle 587 on inquiry card.

**ROM Simulator**

Lamar Instruments' ROM (read-only memory) simulator is designed to reside in an Apple II-based development system for use in developing software for another, "target" computer. The device can take the place of a ROM, PROM (programmable ROM), or EPROM (erasable programmable ROM) normally located in the target computer and is useful for developing software eventually destined to be placed in ROM. The ROM simulator connects to the target computer by means of a 24-pin dual-inline package (DIP) and a ribbon cable.

The double-sided ROM simulator has plated-through holes, silk-screened legends, gold-plated contact fingers, and is solder-masked. It has 2K bytes of high-speed, low-power, CMOS (complementary metal-oxide semiconductor) static programmable memory that resides in hexadecimal C800 to CFFF in the Apple II memory map. It contains the necessary logic to automatically switch control of the address and data bus from the Apple II to Lamar Instruments' Superkorn (i.e., target) ROM sockets. The price is $295. Contact Lamar Instruments, 2107 Artesia Blvd., Redondo Beach, CA 90278. (213) 374-1673.

Circle 588 on inquiry card.

**Options Package for DS180 Printer**

DataSouth Computer's special package of options for its DS180 matrix printer includes graphics, compressed print, display mode, an expanded buffer, and a dot-addressable raster-scan feature that lets you print computer-generated charts and graphics. Under program control, six print wires can be addressed to print high-density output at a resolution of 75 by 72 dots per inch.

In the compressed print mode, the package permits manual or program selection of print sizes including 10, 12, and 16.5 characters per inch as well as expanded modes of 5, 6, and 8.25 characters per inch. This permits the DS180 to print from 132 columns on an 8½-inch form to 217 columns on a 14½-inch form.

The display mode lets you print out or "display" the nonprinting ASCII (American Standard Code for Information Interchange) control codes.

The package of options costs $150. The DS180 printer, which operates at 180 characters per second, costs $595. Contact DataSouth Computer Corp., 4740-A Dwight Evans Rd., Charlotte, NC 28210, (704) 523-8500.

Circle 589 on inquiry card.

**Wire-Wrap Tool**

The Model OK-729 pneumatic wire-wrapping tool features precision steel drive components enclosed in a Lexan-reinforced case. A positive indexing mechanism with adjustable stop location and a 6-foot (2-meter) flexible air hose are provided. The OK-729 is available in two versions: a 5000 RPM (revolutions per minute) version and a model with a higher torque and a speed of 3000 RPMs for cut/strip/wrap applications. Both versions are designed to operate at 80 to 100 pounds per square inch and are fully rated for heavy-duty applications on wire as large as 18 AWG (American Wire Gauge) or for more delicate work on wire as small as 30-32 AWG.

The OK-729 wire-wrap tool is available for $188.57. Contact OK Machine and Tool Corp., 3455 Conner St., Bronx, NY 10475, (212) 994-6600.

Circle 590 on inquiry card.

**New EEPROM**

The ER5716 EEPROM (electrically erasable programmable read-only memory) is the newest member of General Instrument Microelectronics' line.
of electrically alterable nonvolatile memories. It's based on N- (negative-) channel silicon-gate MNOS [metal-nitride-oxide semiconductor] technology and is designed for applications that require a large (16K-bit) memory, such as microprocessor-program storage, where nonvolatility is essential but occasional data changes must be made. The ER5716 features improved access time and infinite read capabilities. It is bulk-erasable and can be electrically reprogrammed.

The ER5716 EEPROM is available in single units at General Instrument dealers. In OEM [original equipment manufacturer] quantities, it costs $35.70. Contact General Instrument Corp., Microelectronics Div., 600 West John St., Hicksville, NY 11802, (516) 733-3107, for additional information. Circle 591 on inquiry card.

Cope with Scopes

The XYZs of Using a Scope will not only show you how an oscilloscope works, but how to make one work for you. Divided into two sections, the primer first covers the nuts and bolts and oscilloscope control functions, then expands to demonstrate waveforms, waveshapes, and measurement techniques.

The XYZs of Using a Scope is available free from Tektronix Inc., POB 4828, Portland, OR 97208, (800) 547-6711; in Oregon (800) 452-6773. Circle 592 on inquiry card.

Robotics Arm for Education and Hobby

Colne Robotics of England recently introduced the Armdroid I, an educational and hobbyist manipulating arm. The arm has five axes of rotation (base, shoulder, elbow, wrist up and down, and wrist rotate), a three-finger gripper, and is completely stepper-motor-driven. The Armdroid I will operate with any microcomputer, requiring only a latched 8-bit parallel port to interface. The arm has a 17-inch reach, can lift 10 ounces, has a gripping force of 5 pounds and a resolution of 0.15 inch.

Colne Robotics intends to produce a newsletter for owners of the arm, as well as introduce new products to enhance the arm, such as tactile sensors for closed-loop operations. The Armdroid I can be easily modified to accept experimental devices such as alternate gripper devices, tactile sensors, micro switches, and potentiometers.

The Armdroid I is available in kit form for $595 and includes 280 machine-language driver software for the TRS-80 Model I and the power/interface board kit. An assembled version is also available for $695. For further information, contact Colne Robotics Inc., 207 Northeast 33rd St., Ft. Lauderdale, FL 33334 or Colne Robotics Co. Ltd., 1 Station Rd., Twickenham, Middlesex TW14 4LL, England, 1-892-7044; Telex: 8814066 GCIC.

Circle 593 on inquiry card.

High-Density Memory Requires Less Space

Electronic Designs' EDH-4816 is a 128K-byte high-density memory that requires only one fifth the area of an equivalent DIP [dual inline package]. The EDH-4816 consists of eight industry-standard 16K by 1-bit random-access read/write memories in carriers mounted on a 32-pin SIP (single inline package). The EDH-4816 has all standard operating modes. Access time is 200 ns (nanoseconds); cycle time is 375 ns.

In single-unit quantities, the EDH-4816 costs $68. In 100-unit quantities, the price is $59. Contact Electronic Designs Inc., 230 Elliot St., Ashland, MA 01721, (617) 881-5244.

Circle 594 on inquiry card.

TRS-80 Network

Radio Shack will use ARCNET to provide a low-cost, high-speed local network for the TRS-80 Model II microcomputer. ARCNET is the local network component of Datapoint's ARC (Attached Resource Computer) system. ARCNET provides an inexpensive, efficient means to link a large number of computers together. Each computer in the ARCNET can access common databases, such as accounting, word-processing information or electronic filing systems, and share peripherals (printers, for example) throughout the network. In addition to Datapoint's new LSI integrated-circuit network interface, Radio Shack will use ARCNET protocols and software for cost-effective, high-speed computer resource networking. The ARCNET will permit as many as 255 Model IIs and their peripherals to be interconnected.

Datapoint processors and peripherals, such as its
Why use their flexible discs:

Athena, BASF, Control Data, Dystar, IBM, Maxell, Nashua, Scotch, Shugart, Syncom, 3M, Verbatim or Wabash

when you could be using

MEMOREX

for as low as $1.94 each?

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Memorex Flexible Discs are packed 10 each to a carton and 10 cartons to a case. For purchase orders in quantities of 100 units for quantity 100 pricing. We are also willing to accommodate your smaller order requirements. Discounts available in increments of 10 units at a 10% surcharge. Quantity discounts are also available. Order 50 or more discs at the same time and deduct 1% for every 1,000 or more saves you 2%, 3% or more saves you 4%, 5% or more saves you 6%, 10% or more saves you 10% on an unit basis. Discounts are available on a per unit basis only. Please call for details.

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Memorex Flexible Discs will be replaced by Memorex if they are found to be defective in materials or workmanship within one year of the date of purchase. Other than replacement, Memorex will not be responsible for any damages or losses (including consequential damages) caused by the use of Memorex Flexible Discs.

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Computer Products Division

884 Phoenix Drive 1002 Ann Arbor, Michigan 48108 U.S.A.

Call TOLL-FREE (800) 521-4414 or outside U.S.A. (313) 964-4444
A Planning Guide to Successful Computer Instruction is an aid for planning and evaluating the use of computers in the classroom. Written for teachers and administrators, the guide suggests criteria for assessing available computer and microcomputer hardware and software for instructional purposes. Among the topics covered are computer instruction site development and management and sources of hardware and software for education use.


Trade-A-Computer
Trade-A-Computer is a monthly classified magazine dedicated to selling, buying, and trading new and used computer products. Trade-A-Computer has an online data-entry service called Ad-Line, a 300-bit-per-second software system that asks a series of questions concerning your ad, then composes the ad after completing its inquiry. There are no additional charges for this service.


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 home-brewers 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.
SPECIALS on INTEGRATED CIRCUITS

- 5602 7.45 10/6.95 50/6.55 100/6.15
- 5602A/5612A 8.40 10/7.95 50/7.35 100/6.90
- 5620 PIA 5.15 10/4.90 50/4.45 100/4.15
- 5622 VIA 6.45 10/6.10 50/5.75 100/5.45
- 5632 7.90 10/7.40 50/7.00 100/6.70
- 2114-L200 3.75 25/3.50 300/3.25
- 2114-L300 3.15 25/2.90 200/2.65
- 2716 EPROM 7.00 5/6.45 100/5.95
- 2532 EPROM 14.50
- 6110 Hitch ZX x 8 CHIPS RAM 14.80
- 4116 1 for 17
- Zero Insertion Force 24 pin Socket 2.00
- 6550 RAM (PET) 12.70
- S-100 Wire Wrap Socket 2.40

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MODEM SPECIAL $99
SIGNALMAN MK1 from Anchor Automation
DIRECT CONNECT Modem with RS-232 Cable and Connector includes: Fully compatible with all Bell 103 modems 0 to 300 bps, full duplex, frequency shift keying modulation automatic ANSI-DSNG selection DIRECT CONNECT autodial tone carrier detect indicator self-contained battery powered
PET/CBM Version (MK1P) $169
For Commodore Computers, the Signalman MK1P includes connector cable, and machine language software (parallel)

STAR MODEM Protocol/Vermore Data Systems
RS232 MODEM SALE $128
IEEE 488 MODEM SALE $199
RS232 CITT $170
IEEE 488 CICT $270

We carry Apple II+ from Bell & Howell

CASH MANAGEMENT SYSTEM $45
Easy to use. Keeps track of cash disbursements, cash receipts, cash transfers, expenses for up to 50 categories.

SPECIALS on INTEGRATED CIRCUITS

- 5602 7.45 10/6.95 50/6.55 100/6.15
- 5602A/5612A 8.40 10/7.95 50/7.35 100/6.90
- 5620 PIA 5.15 10/4.90 50/4.45 100/4.15
- 5622 VIA 6.45 10/6.10 50/5.75 100/5.45
- 5632 7.90 10/7.40 50/7.00 100/6.70
- 2114-L200 3.75 25/3.50 300/3.25
- 2114-L300 3.15 25/2.90 200/2.65
- 2716 EPROM 7.00 5/6.45 100/5.95
- 2532 EPROM 14.50
- 6110 Hitch ZX x 8 CHIPS RAM 14.80
- 4116 1 for 17
- Zero Insertion Force 24 pin Socket 2.00
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We carry Apple II+ from Bell & Howell

CASH MANAGEMENT SYSTEM $45
Easy to use. Keeps track of cash disbursements, cash receipts, cash transfers, expenses for up to 50 categories.

**CBM-PET SPECIALS**

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
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<td>8023 Printer</td>
<td>130 col. 130 col. b/directional</td>
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<td>8030 Printer</td>
<td>10 col. B/D, 10 col. B/D</td>
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<td>6300 Data Base System for CBM 8032</td>
<td>$350</td>
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<td>VISICALC for PET, ATARI or APPLE</td>
<td>$155</td>
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<td>SM-KIT - Super PET ROM Utilities</td>
<td>$49</td>
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<td>Programmers Toolkit - PET ROM Utilities</td>
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<td>PET Spremac I II ROM Switch</td>
<td>$36</td>
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<td>2 Meter PET to IEEE or EEE to EEE Cable</td>
<td>$40</td>
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<td>Dust Cover for PET</td>
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<td>IEEE-Parallel Printer Interface for PET</td>
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<td>IEEE-82537 Printer Interface for PET</td>
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<tr>
<td>The PET Revealed</td>
<td>$17</td>
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<tr>
<td>Library of PET Subroutines</td>
<td>$17</td>
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**EDUCATIONAL DISCOUNTS**

Buy 2 PET/CBM Computers, receive 1 FREE

WorldPro 3 Plus - 32K CBM, disk, printer | $215
WorldPro 8 Plus - 80K CBM, disk, printer | $325
DZ Data Base System for CBM 8032 | $350
VISICALC for PET, ATARI or APPLE | $155
SM-KIT - Super PET ROM Utilities | $49
Programmers Toolkit - PET ROM Utilities | $25
PET Spremac I II ROM Switch | $36
2 Meter PET to IEEE or EEE to IEEE Cable | $40
Dust Cover for PET | $7
IEEE-Parallel Printer Interface for PET | $110
IEEE-82537 Printer Interface for PET | $150
The PET Revealed | $17
Library of PET Subroutines | $17

**RAM-ROM for PET/CBM**

- 4K or 8K bytes of soft ROM with optional battery back-up.
- Adds extra RAM which can be write protected like ROM.
- 4K Version - $55
- 8K Version - $110
- Battery Backup - $30

**EPROM** Programmer for CBM/PET | $79

Branding iron with software/hardware for 2716 and 2532

**WE WILL MATCH ANY ADVERTISED PRICE**

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- SCOTCH (3M) 8" $10.20 50/2.70 100/2.65
- Verbatim 8" Double Density $10.15 50/3.35 100/3.20
- Verbatim 5" Double Density $10.25 50/4.20 100/4.25
- BASF 5" $10.25 20/3.35 100/3.00
- Wabash 5" in Plastic Box $10.27 50/2.50 100/2.50
- Wabash 8" in Plastic Box $10.25 75/2.65 100/2.55

**WE STOCK MAXELL DISKS**

- Diskette Storage Pages 10 for $3.95
- Disk Drive Cases 2 8" - 2.85 5" - 2.15
- Disk Hub Rings 8" - 50 for $7.50 5" - 50 for $6.00

**Cassettes - ABFA PE-811 Premium**

High output, low noise. 5 screw housings.
C-10 10/55 50/50 100/48
C-30 10/73 50/58 100/66

**ALL BOOKS AND SOFTWARE PRICES DISCOUNTED**

OSBORNE/McGraw-Hill, HAYDEN, SYBEX etc.

**Syntek Systems**

SYM-1 Microcomputer **SALE 189**
SYM BAS-1 BASIC or RAE 1/2 Assembler
KTM-2900 Syntek Video and Keyboard
KTM-3600 Syntek Tubeless Terminal

**Zenith**

**Data Systems**

**RAM/ROM for PET/CBM**

- 4K or 8K bytes of soft ROM with optional battery back-up.
- Adds extra RAM which can be write protected like ROM.
- 4K Version - $55
- 8K Version - $110
- Battery Backup - $30

**EPROM** Programmer for CBM/PET | $79

Branding iron with software/hardware for 2716 and 2532

**Watanabe Intelligent Plotter**

**WRITE FOR CATALOG**

Add $1.25 per order for shipping. We pay balance of UPS surface charges on all prepaid orders. Prices listed are on cash discount basis. Regular prices slightly higher. Prices subject to change.
SUNNY INTERNATIONAL
(Transformers Manufacturer)
(213) 328-2425 MON-SAT 9-6

CPU

<table>
<thead>
<tr>
<th>Item</th>
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<td>CCS 2810</td>
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<td>Godbout Z-80A</td>
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<td>Godbout 8085A</td>
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MEMORY

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<td>CCS 2065 64K dynamic</td>
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<td>CCS 2116 32K static</td>
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I/O

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<td>Godbout Interface 1</td>
<td>$225</td>
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<tr>
<td>Godbout Interface 2</td>
<td>$225</td>
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</table>

NEW !!!!

Qume Sprint 9
DAISY WHEEL PRINTER .. $2395

- 45 CPS, RO. Available in KSR version.
- Call for further particulars.
- Ribbons: $125/case
- Bidirectional tractor feed $225

NEW !!!!

ABM 85 Video Terminal .. $ 895

- Detachable keyboard
- Televideo 920, ADM 3A compatible
- High resolution green phosphor (23 MHZ)
- Extra multi-bus or S-100 slot for stand-alone capability

Terms of sale: cash or checks, MC/ VISA. Min. order $25. CA residents add 6% tax. Prices subject to change without notice. All goods subject to prior sale.

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LOW COST POWER SUPPLIES
FOR S-100, FLOPPY DISKS.

S-100 POWER SUPPLY KITS (OPEN FRAME WITH BASE PLATE, 3 HRS. ASSY. TIME)

<table>
<thead>
<tr>
<th>Item</th>
<th>USED FOR</th>
<th>@ + 8 Vdc</th>
<th>@ - 9 Vdc</th>
<th>@ + 16 Vdc</th>
<th>@ - 16 Vdc</th>
<th>@ + 28 Vdc</th>
<th>SIZE W X D X H</th>
<th>PRICE</th>
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<tr>
<td>KIT 1</td>
<td>15 CANIDS SOURCE</td>
<td>15A</td>
<td>2 5A</td>
<td>2 5A</td>
<td>12&quot; x 5&quot; x 4&quot;</td>
<td>54.95</td>
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<tr>
<td>KIT 2</td>
<td>SYSTEM SOURCE</td>
<td>25A</td>
<td>3A</td>
<td>3A</td>
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<td>KIT 3</td>
<td>DISK SYSTEM</td>
<td>15A</td>
<td>1A</td>
<td>2A</td>
<td>1A</td>
<td>2A</td>
<td>2A</td>
<td>1A</td>
</tr>
</tbody>
</table>

DISK DRIVE POWER SUPPLY "R3" REGULATED OPEN FRAME, ASSY & TESTED .. $ 69.85

SPEC'S: 5V @ 3A OR 2.5V @ 6A SHORTS PROTECT 2 SIZES AVAILABLE 1) 9" (W) x 6" (D) x 4" (H) 2) 8" (W) x 4" (D) x 5" (H)
OPTION 1) REPLACE 24V BY +12V 2) FOR SIZE 1 ONLY ADD -12V @ 1A AT AN ADDITIONAL $12.00
IDEAL FOR THE THREE 5 or 5.25 FLOPPY DISK DRIVES SUCH AS STUAGT 801/851 SIEMENS FDD 100-8200-8 OR 100-5 ETC

DISK SYSTEM PWR SUPPLY "S3" OPEN FRAME, ASSY & TESTED. COMPACT SIZE 10" (W) x 6" (D) x 5" (H) .. $ 97.85

REGULATED OUTPUTS FOR DISK DRIVES 5V @ 4A 5V @ 1A 24V @ 4A SHORTS PROTECT UNREGULATED OUTPUTS FOR S-100 5V @ 1A 12V @ 3A (OPTION ADD OVP FOR +5V ADD $5.00)
A COMPLETE UNIT FOR DISK SYSTEM WITH THE MAINFRAME CONTAINING 12 SLOTS & TWO 8 OR 5.25 DISK DRIVES

POWER TRANSFORMERS (WITH MOUNTING BRACKETS)

<table>
<thead>
<tr>
<th>Item PRIMARY</th>
<th>SECONDARY #1</th>
<th>SECONDARY #2</th>
<th>SIZE W X D X H</th>
<th>PRICE</th>
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<tr>
<td>T1 110/200 2 x 8 Vac. 15A</td>
<td>28 Vac. CT. 25A</td>
<td>3/4&quot; x 3/4&quot; x 3/4&quot;</td>
<td>22.95</td>
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<tr>
<td>T2 110/200 2 x 8 Vac. 25A</td>
<td>28 Vac. CT. 35A</td>
<td>3/4&quot; x 3/4&quot; x 3/4&quot;</td>
<td>28.95</td>
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<tr>
<td>T3 110/200 2 x 8 Vac. 15A</td>
<td>28 Vac. CT. 25A</td>
<td>3/4&quot; x 3/4&quot; x 3/4&quot;</td>
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<tr>
<td>T4 110/200 2 x 8 Vac. 6A</td>
<td>28 Vac. CT. 15A</td>
<td>3/4&quot; x 3/4&quot; x 3/4&quot;</td>
<td>23.95</td>
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<tr>
<td>T5 110/200 2 x 8 Vac. 6A</td>
<td>28 Vac. CT. 2A</td>
<td>3&quot; x 3&quot; x 2 3/4&quot;</td>
<td>15.95</td>
<td></td>
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</tbody>
</table>

SHIPPING: For each power supply $5.50 in Calif., $8.00 in other states, $10.00 in Canada. For each Transformer $3.00 in all States, $12.00 in Canada. Calif. Residents add 6% Sales Tax.
**CRT CONTROLLER**

This intelligent CRT Controller uses an 8068 CPU & an 8279 Integrated CRT Controller. It features:
- 25 lines (80 char./line)
- 5 x 7 dot matrix
- Upper & lower case
- Two 2716's (controller & char. register)
- Serial Interface RS232 & TTL
- Baud rates of 110, 150, 300, 600, 1200, 2400, 4800, and 9600
- Keyboard scanning system
- Unencoded keyboard required for encoding
- +5 V & +12V Power Supplies
- Does not have graphic capabilities

Documentation includes program listing and composite video circuit.

**6522 APPLE II INTERFACE**

The JBE 6522 Parallel Interface for the Apple II Computer, plugs directly into any slot 1 through 7 in the Apple. This card has 2 6522 Vias that provide:
- Four 8 bit bi-directional I/O
- Four 8 bit programmable
- Four 8 bit parallel I/O
- Four 8 bit parallel I/O
- Serial Shift registers
- Handshaking

A 74LS250 is for timing. Four 16 pin sockets provide easy connections to other peripheral devices. (Dip jumpers with ribbon cables are also available from JBE. The 6522 Parallel I/O card interfaces to the JBE EPROM programmer. Understating of machine language required to use this board. Inputs and outputs are TTL compatible.

**Z-80 MICROCOMPUTER**

Single board large scale Integration Microcomputer. This 4.5 x 6.5 board uses the Z80 Microprocessor, two 6522 Vias, four 2114 RAM's, 2516, 2716 or 2532 EPROM. The fully buffered 2244 pin bus is similar to the KIM®, SYM®, and AIM® expansion connector. The four 8 bit I/O ports connect through 16 pin dip sockets. This board was designed for control and is ideal for Personal and D.E.M. use.

**8052 MPU**
- Two 6522 Vias
- Four 2114 RAM's (2K bytes)
- One EPROM 2516 or 2532
- Crystal Clock 1 Mhz
- Requires 5V 1AMP Power
- 4.5 x 6.5 card
- Power on reset
- Fully buffered-expandable
- Solder mask-both sides

Use your Apple II Computer, JBE 6522 Parallel Interface card and EPROM Programmer for a development system for SLIM.

**Prices**
- 61-260A $199.95 Assembled
- 61-260K $149.95 Kit
- 61-260B $99.95 Bare Board

**8052 MICROCOMPUTER**

6502 MPU, 6522 VIA, 2716 EPROM, 2114 RAM single board computer, Single 5 volt power supply at 450 Ma. Two independent 8 bit I/O ports with handshaking. RC controlled 1 Mhz clock. Complete documentation. I/O lines use 90 pin edge connector. Data and address lines are not accessible. Mod for 2532 is included. EPROM is not included.

1. 6502 MPU $199.95
2. 6522 VIA (2 Parallel I/O ports) $149.95
3. 2114 RAM (1K) $129.95
4. 2716 EPROM (with Monitor) $199.95

Both versions include power on reset and cassette interface.

**Z-80 MICROCOMPUTER**

240 MPU, Z-80 PID, 2716 EPROM, 2114 RAM single board computer. Single 5 volt power supply at 300 Ma. Two independent 8 bit I/O ports with handshaking. RC controlled 2 Mhz clock.

All address and data lines are brought off the board to the 50 pin edge connector. (similar to the Apple II bus)

This board also features power on reset and cassette interface.

81-030 C Fully Populated $349.95
81-030M Partially Populated $249.95
81-030K Bare Board $89.95
2716 EPROM (with Monitor) $19.95
2715 EPROM (with Tiny Basic) $19.95
### IBM ACCESSORIES

<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
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<td>512K Dynamic Ram Card</td>
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<tr>
<td>Hi-Speed Parallel I/O Card</td>
<td>299</td>
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<tr>
<td>Hi-Speed Serial I/O Card</td>
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<tr>
<td>Real-Time System Clock</td>
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### Commodore VIC-20

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<td>Commodore VIC-20</td>
<td>259</td>
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### S-100

**California Computer Systems**

- **Floppy Disk Controller** | 339
- **64K Dynamic Ram Board** | 149
- **200 ns** | 469
- **Z-80 CPU board** | 269
- **S-100 12 Slot Mainframe** | 399
- **2-Port Serial/2-Port Parallel Interface** | 249

### NEC Microcomputer

**16K RAMBOARD** by ConComp for Apple II Computers

**FOR ONLY** $129

### ATARI 800 16K

**CALL FOR BEST PRICE**

- **Atari 400 w/16K** | 349
- **410 Program Recorder** | 549
- **510 Disk Drive** | 499
- **225-40 Col. 7x7 Dot matrix printer** | 499
- **823-40 Col. Quiet Thermal Printer** | 349
- **500 Interface Module** | 159
- **Atari 400 RAM Module** | 129
- **Atari 520C Model** | 189

### Video Monitors

- **Amdek Leader Video 100 12” B&W** | 129
- **Amdek Leader Video 100 12” Green Phosphor** | 149
- **Amdek (Hilco 13” Color / Audio output)** | 399
- **NEC 12” Green Phosphor Display JP-1201M** | CALL
- **NEC 12” Lo-Res Module Display** | CALL
- **NEC 12” Hi-Res Module Display** | CALL
- **Sansa 9” B&W Display** | 185
- **Sansa 9” Green Display** | CALL
- **Sansa 12” B&W Display** | 299
- **Sansa 12” Green Phosphor Display** | 299
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<th>Telephone</th>
<th>PT030 Wall Jack</th>
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<td>NEW!</td>
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MICROLINE - OKIDATA
WITH FRICTION AND TRACTOR FEED

VFD-2000 - VISUAL TECHNOLOGY
THE MOST RELIABLE TERMINAL WE'VE EVER USED!
Detachable keyboard, RS232C or DB9, Male, 110 to 120VAC, 12" non glare 80 x 24 display, RS232 AUX port and composite video output.

TERMINALS

600000 Mailing label.Edwards Shipping 10 lbs, $89.95.
600015 Video Printer, $495.00
600016 Single 5 " cabinet with P.B. $495.00
600017 Dual 8 " cabinet with power supply $495.00
600018 Single 6 " cabinet with P.B. $395.00
600019 Dual 6 " cabinet with power supply $395.00
600020 Single 8 " cabinet with P.B. $395.00
600021 Dual 8 " cabinet with power supply $395.00
600022 Single 5 " cabinet with P.B. $495.00
600023 Dual 6 " cabinet with power supply $495.00
600024 Single 8 " cabinet with P.B. $495.00
600025 Dual 8 " cabinet with power supply $495.00

VFD-2000 - VISUAL TECHNOLOGY
THE MOST RELIABLE TERMINAL WE'VE EVER USED!
Detachable keyboard, RS232C or DB9, Male, 110 to 120VAC, 12" non glare 80 x 24 display, RS232 AUX port and composite video output.

www.priorityoneelectronics.com
SAVE $1,000.00 ON

2.4 MEGA-BYTE S-100 DUAL 8" DISK COMPUTER SYSTEM

HERE'S WHAT YOU GET:
2210 MICROCOMPUTER SYSTEM

- 2 or 4 MHz operation
- Z-80 CPU
- 65,536 bytes of dynamic RAM
- RS-232-C serial port
- Accepts 8" and 5¼" floppy disk drives
- 12-slot, cream colored mainframe
- Internal cabling installed
- CP/M 2.2 (on diskette) Operating System

The Model 2210 Computer System is a Z-80 based system containing 65,536 bytes of dynamic RAM memory and floppy disk controller mounted in a 12 slot mainframe. The system is ideally suited for applications where user defined peripheral devices are to be used and a high degree of system flexibility and expandability is desirable.

The system components are the Models 2810 CPU, 2065 8-K Byte Memory Module, 2422 Floppy Disk Controller and 2200 Mainframe. Also included in the system are internal cables interconnecting the CPU serial channel, disk controller 8" disk channel and disk controller 5¼" disk channel to the mainframe back panel. This permits connecting user peripherals directly to the system without the need of opening the mainframe.

Of the 12 slots available in the mainframe, only three are used for the basic system components. 8 slots are available for user options or other CCS products such as memory (expandable up to 512K bytes or serial and parallel I/O boards).

System software is provided using the CCS version of the CP/M Operating System, Version 2.2. The system is totally linked to permit auto-boot start-up with the CP/M on diskette.

The system is completely integrated and tested prior to shipment from CCS to assure proper configuration and system integrity.

BCCCS221001

$2350.00

We add two REMEX 4000 Double Density, Double Sided 3ms 8" drives and a QTCDDC88 Dual 8" disk enclosure with power supply, data cable and documentation

SALE PRICE $2930.00

This is a complete system, just add a terminal

IF THAT'S NOT A GOOD ENOUGH DEAL FOR YOU, WE WILL SELL YOU THE BCDIDAT82AT FOR $475.00 OR THE BCDIDAT83AT FOR $700.00 WHEN YOU BUY THIS SYSTEM AT THE SAME TIME!

DIRECT CONNECT MODEM PRICE BREAKTHROUGH!

THE SIGNALMAN MK 1

Meet the direct connect SIGNALMAN MK 1, the smallest, lightest, most compact modem available today. As long as you will self-contained battery and exclusive oxide Corner Detect Signal allows you to install the SIGNALMAN anywhere out of the way, and out of sight. Now, there is no need for messy cables, and no need to look at an LED to verify carrier.

Anchor's SIGNALMAN has been designed for transmitting both voice and data on a single channel over all common telephone lines. And when you're in the data position, your SIGNALMAN automatically changes from ORIGINATE to ANSWER and back again on the need arises — ending all that conclusion.

Your SIGNALMAN is fully compatible with all BASIC systems — putting your computer in instant communication with thousands of other computers.

Anchor Automation, Inc. invented, the size of a IBM 105 modem — putting your computer in instant communication with thousands of other computers.

Anchor Automation, Inc. invented, the size of a IBM 105 modem — putting your computer in instant communication with thousands of other computers.

Direct Connect Modem
Built-in RS232C Cable and Connectors
Self-contained 9V Battery
Walt plug-in transformer available
Audiophile earphones
Automatic tone selection
Talk/Listen switch
Complete with RJ22 Pin and Modular Handset Cables, minimum list price.

PRODUCT FEATURES
Direct Connect Model
Built-in RS232C Cable and Connectors
Self-contained 9V Battery
Walt plug-in transformer available
Audiophile earphones
Automatic tone selection
Talk/Listen switch
Complete with RJ22 Pin and Modular Handset Cables, minimum list price.

ORDER PART NO BCPCDCCSSA INCLUDE $30.00 FOR SHIPPING

SALE PRICE $2930.00

This is a complete system, just add a terminal

ANCHOR AUTOMATION

$129.00

Circle 318 on Inquiry card.

BS232C SPECIFICATIONS

Data Rates: Serial Binary, asynchronous
Operate Mode: Direct Connect
Automatic ANSWER/ISDN selection
9600 baud
300, 1200, 2400, 4800, 9600 bps
Modulation: Frequency shift keyed (FSK)
8:1 synchronous transfer rates: 2400, 4800, 9600 baud
Receive Frequency
MARK 1.2251 Hz
SPACE 1.2250 Hz
9600 baud
Receive Frequency
MARK 1.2251 Hz
SPACE 1.2250 Hz
9600 baud
Carrier Detect Thresholds:
- 18 dbm (MARK) / 29 dbm (SPACE)
- 19 dbm (MARK) / 20 dbm (SPACE)
- 9 dbm (MARK) / 11 dbm (SPACE)

BCANCMX1

$129.00

ORDERING INFORMATION
5MB LIGHTNING FAST DMA S-100 HARD DISK

SAVE $500.00

5MB LIGHTNING FAST DMA S-100 HARD DISK

DISCUS M5 by MORROW DESIGNS

INTRODUCTORY PRICE: $1,995.00

LIST PRICE: $2,495.00

PRIORITY 1 ELECTRONICS

PRIORITY 1 ELECTRONICS is pleased to announce Morrow Designs' DISCUS M5, the lowest cost 5 megabyte Winchester sub-system and the fastest. Now you can afford a hard disk for the price of floppies. Morrow Designs is the largest supplier of hard disk sub-systems to the S-100 market. With the new DMA Hard Disk Controller and the ST506 mini-Winchester drive, Morrow has attained speeds over 600,000 bytes per second.

As with all Morrow Designs' systems, Morrow delivers it complete. Drive, controller, cabinet, power supply, fan, transformer, cables, CP/M 2.2 operating system, Microsoft Basic 60 and a ninety day warranty.

The DISCUS M5 regularly sells for $2,495.00. Priority 1 Electronics is proud to offer the DISCUS M5 for a limited time at only $1,995.00. Winchester speed, 5Mb capacity and reliability for only $1,995.00. Three additional drives may be daisy-chained to the controller for future expansion. Perfect to back up each other at the end of each day.

A few facts about the ST506 drive which is being used in the DISCUS M5

- Storage Capacity of 6.38 megabytes formatted as shipped.
- Winchester design reliability, 9.5 gram head load force, 19 micron flying height.
- Same physical size and mounting as the minifloppy.
- Same DC voltages as the minifloppy.
- Band actuator and stepper motor head positioning.
- 5.0 megabit/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.

This is the hard disk controller that the S-100 bus has been waiting for. Please allow us to introduce you!

A few interesting facts:
- The only single S-100 DMA Hard disk controller board on the market today.
- Fully compatible with high speed 6MHz and 8 MHz CPUs of today and tomorrow.
- DMA bus arbitration as outlined by the IEEE 896 standard.
- Controls 1 to 4 soft sectored Winchester drives.
- Supports both 5 1/4" and 8" drives.
- ST505 or SA 1000 interface compatible.
- 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.
- Contains its own on-board microprocessor.
- 24-bit address burst DMA transfers.
- Channel driven.
- All disk drive routines resident on the controller.
- Variable format.
- No buffering required.
- Maximum transfer rate 5,000,000 bits per second.

Pure Speed

The speed of this Winchester controller is enhanced by Morrow's channel driven concept. This DMA hard disk controller (DMAHDC) picks up its commands from the host processor via memory on the system bus. The host processor writes commands into memory and then picks them up during DMA cycles from this memory. Channel commands and transfers may be located anywhere in the 24-bit address range. At the completion of the command, the controller returns appropriate status and can generate an interrupt. Commands may be chained together by the CPU to allow the controller to execute many commands in succession, generating an interrupt at the end of each command and/or at the end of the completed command chain.

Communications

An imbedded microprocessor enables the user to easily communicate with this intelligent device. All low level disk drive routines are resident on the controller itself. These include:

- Formal seek.
- Read a header or read a sector.
- Write a sector.
- Return status.
- Set DMA address.
- Set channel address.

Circle 316 on inquiry card.

ORDERING INFORMATION

ORDER TOLL FREE (800) 423-5922

Include $10.00 for UPS Ground Shipping.

See prices are for prepaid orders only. Orders on open account will be accepted at $2,295.00 each.

$1,995.00
ORDER PART NO. BCM05SDM5S

PRIORITY 1 ELECTRONICS

DISCUS M5 is an entry-level Winchester sub-system designed to allow the user to introduce his system as technology advances to additional platters and tracks.

The controller has no peer today in the S-100 bus market.

Systems Interfaced:
- Xerox 1108
- North Star
- Tandy 1000
- Cromemco
- Sol 20
- Exidy
- Vector Graphics
- Commodore 8052
- Dynabyte
- Godbolt
- Micronram
- MCA Inter万台

Look to Morrow for answers!

Look to PRIORITY 1 for the best price!

Priority 1 Electronics, as the world's largest stocking distributor of Morrow Designs' products committed to buy an entire production run of DISCUS M5 sub-systems so we can offer them at a special introductory low price. The DISCUS M5 is a good buy at the list price of $2,495.00. The DISCUS M5 is an excellent value at our introductory low price of:

$1,995.00
No one can match the features or performance at our MARKET-SHATTERING PRICES!

Buy with confidence from the nation's largest Hitachi distributor.

BCHITV1050 100 MHz, List $2375.00
Sale $1595.00
BCHITV550B 50 MHz, List $1745.00
Sale $1250.00

BCHITV352 35 MHz, List $1150.00
Sale $795.00
BCHITV202 20 MHz, List $850.00
Sale $595.00

HITACHI Oscilloscopes are innovative oscilloscopes designed and manufactured by Hitachi Denshi Ltd. The wide experience gained by HITACHI electronic specialists in producing oscilloscopes has resulted in this line of modern oscilloscopes featuring wider band width, more compact design and light weight. Through adopting circuitry with linear IC's and logic IC's plus modern manufacturing techniques, including automatic component-insertion machines. These oscilloscopes offer increased stability, improved reliability, excellent performance and enhanced operating ease.

The panel layout is designed to create maximum operating ease by considering measuring processes and operation frequency. The layout is divided into three blocks according to respective functions identified by different colors. This convenience-oriented design for users improves daily controllability and drastically reduces operating errors.

HITACHI — THE MEASURE OF QUALITY

Circle 319 on Inquiry Card
**SAIDE**

**Sunnyvale • Woodland Hills • Hawthorne • San Diego**

**Printers**

**Accessories for Apple**

**Single Board Computer**

**Modems**

**SMARTMODEM** - Hayes

**CAT MODEM** - Novation

**Apple-CAT - Novation**

**Z-80 STARTER KIT - SD Systems**

**Video Monitors**

**Video Terminals**

**PERSONAL COMPUTERS**

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**BETTER THAN EPSN - Okidata**

**EXEPLNG PRINTERS - Epson**

**INEXPENSIVE PRINTERS - Epson**

**DISK DRIVES - Micro Sci**

**VISION 80 - Vista Computer**

**ALIQ ASP. PIO - S.S.M.**

**CPS MULTICARD - Mtn. Computer**

**TELEVIDEO 910**

**AMBER SCREEN - Volker Craig**

**VIEWPOINT - ADDS**

**DIALOGUE 80 - Ampex**
### S-100 CPU Boards

<table>
<thead>
<tr>
<th>Board Name</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>THE BIG 2* - Jade</td>
<td>2 or 4 MHz switchable 2.5* CPU with serial I/O, accommodates 2704, 2716, or 3723 EPROM, board rises from 75 to 9600</td>
<td>$328.95</td>
</tr>
<tr>
<td><strong>CPUs</strong></td>
<td><strong>Price</strong></td>
<td></td>
</tr>
<tr>
<td>CPU-30201K Kit</td>
<td>$138.95</td>
<td></td>
</tr>
<tr>
<td>CPU-30201A &amp; T</td>
<td>$186.95</td>
<td></td>
</tr>
<tr>
<td>CPU-30200B Bare board</td>
<td>$35.00</td>
<td></td>
</tr>
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</table>

**S-100 PROM Boards**

<table>
<thead>
<tr>
<th>Board Name</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROM-100 - SD Systems</td>
<td>2704, 2716, 3723 EPROM programmer</td>
<td>$196.95</td>
</tr>
<tr>
<td><strong>MEM-99320K</strong> Kit</td>
<td>$196.95</td>
<td></td>
</tr>
<tr>
<td><strong>MEM-99320A &amp; T</strong></td>
<td>$249.95</td>
<td></td>
</tr>
</tbody>
</table>

**PB-1 - S.S.M.**

<table>
<thead>
<tr>
<th>Board Name</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2704, 3710 EPROM board with built-in programmer</td>
<td></td>
<td>$194.95</td>
</tr>
<tr>
<td><strong>MEM-99510K Kit</strong></td>
<td>$194.95</td>
<td></td>
</tr>
<tr>
<td><strong>MEM-99510A &amp; T</strong></td>
<td>$219.95</td>
<td></td>
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</tbody>
</table>

**S-100 Video Boards**

<table>
<thead>
<tr>
<th>Board Name</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VB-3 - S.S.M.</strong></td>
<td>16 characters x 8 times expandable to 64 x 48 for a full page of text, upper &amp; lower case, 256 user defined symbols, 160 x 192 graphics matrix, memory mapped, has key board input</td>
<td></td>
</tr>
<tr>
<td><strong>109-695K 4 MHz kit</strong></td>
<td>$349.95</td>
<td></td>
</tr>
<tr>
<td><strong>109-695A 4 MHz A &amp; T</strong></td>
<td>$439.95</td>
<td></td>
</tr>
<tr>
<td><strong>109-698K 80 x 48 upgrade</strong></td>
<td>$39.95</td>
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</tr>
</tbody>
</table>

**S-100 Disk Drives**

<table>
<thead>
<tr>
<th>Drives Name</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 1/4 Disk Drives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shugart SA400L single-sided bld-density 40 track</td>
<td>$234.95 ea</td>
<td>$2 for 224.95 ea</td>
</tr>
<tr>
<td>Shugart SA450L single-sided bld-density 70 track</td>
<td>$349.95 ea</td>
<td>$2 for 339.95 ea</td>
</tr>
<tr>
<td>Qume DT-50 bld-sided bld-density 80 track</td>
<td>$359.95 ea</td>
<td>$2 for 349.95 ea</td>
</tr>
<tr>
<td>MPI B-51 single-sided bld-density 40 track</td>
<td>$234.95 ea</td>
<td>$2 for 224.95 ea</td>
</tr>
<tr>
<td>MPI B-82 bld-sided bld-density 40 track</td>
<td>$234.95 ea</td>
<td>$2 for 224.95 ea</td>
</tr>
<tr>
<td>MPI B-91 single-sided bld-density 77 track</td>
<td>$349.95 ea</td>
<td>$2 for 339.95 ea</td>
</tr>
<tr>
<td>MPI B-92 bld-sided bld-density 77 track</td>
<td>$349.95 ea</td>
<td>$2 for 339.95 ea</td>
</tr>
</tbody>
</table>

| 8" Disk Drives | | |
| Shugart SA810R single-sided double-density | | |
| Shugart SA851R single-sided double-density | | |
| Qume DT-8 double-sided double-density | | |
| Siemens FDD 100-8 single-sided bld-density | | |

**S-100 Mainframes**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MAINFRAME - Cal Comp Sys</strong></td>
<td>12 slot S-100 mainframe with 32 amp power supply</td>
<td></td>
</tr>
<tr>
<td>ENC-112105 Kit</td>
<td>$129.95</td>
<td></td>
</tr>
<tr>
<td>ENC-112106 A &amp; T</td>
<td>$179.95</td>
<td></td>
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</tbody>
</table>

**S-100 RAM Boards**

<table>
<thead>
<tr>
<th>Board Name</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEMORY BANK - Jade</td>
<td>4 MHz, S-100 bank selectable, expandable from 16K to 64K</td>
<td></td>
</tr>
<tr>
<td><strong>MEM-97300B Bare Board</strong></td>
<td>$49.95</td>
<td></td>
</tr>
<tr>
<td><strong>MEM-97301K Kit no RAM</strong></td>
<td>$196.95</td>
<td></td>
</tr>
<tr>
<td><strong>MEM-32731K 32K Kit</strong></td>
<td>$239.95</td>
<td></td>
</tr>
<tr>
<td><strong>MEM-84733K 64K Kit</strong></td>
<td>$279.95</td>
<td></td>
</tr>
<tr>
<td><strong>Assembled &amp; Tested</strong></td>
<td></td>
<td>$50.00</td>
</tr>
</tbody>
</table>

**S-100 Disk Controllers**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DOUBLE-D - Jade</strong></td>
<td>Double density controller with the inside track, on-board 2.5* RAM, power port, IEEE S-100, non function on an interrupt driven bus</td>
<td></td>
</tr>
<tr>
<td>IO-1200K Kit</td>
<td>$299.95</td>
<td></td>
</tr>
<tr>
<td>IO-12000 Bare board</td>
<td>$219.95</td>
<td></td>
</tr>
</tbody>
</table>

**S-100 I/O Boards**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S.P.L.C. - Jade</strong></td>
<td>Our new I/O card with 3 SIO's, 4 CTC's, and 1 P10</td>
<td></td>
</tr>
<tr>
<td>101-1045K 2 CTC's, 1 SIO, 1 P10</td>
<td>$179.95</td>
<td></td>
</tr>
<tr>
<td>101-1045A A &amp; T</td>
<td>$239.95</td>
<td></td>
</tr>
<tr>
<td>101-1046K 4 CTC's, 2 SO's, 1 P10</td>
<td>$219.95</td>
<td></td>
</tr>
<tr>
<td>101-1046A A &amp; T</td>
<td>$299.95</td>
<td></td>
</tr>
<tr>
<td>101-1045B Bare board</td>
<td>$179.95</td>
<td></td>
</tr>
</tbody>
</table>

**S-100 Motherboards**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ISO-BUS - Jade</strong></td>
<td>Silent, simple, and on sale a better motherboard</td>
<td></td>
</tr>
<tr>
<td>6 Slot (94&quot; x 94&quot;)</td>
<td>$19.95</td>
<td></td>
</tr>
</tbody>
</table>

**S-100 Mainframes**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EPROM ERASER - Spectronics</strong></td>
<td>Ultraviolet EPROM eraser</td>
<td></td>
</tr>
<tr>
<td>XME-3100A With out timer</td>
<td>$69.95</td>
<td></td>
</tr>
<tr>
<td>XME-3101 With timer</td>
<td>$94.95</td>
<td></td>
</tr>
<tr>
<td>XME-3200 Economy Model</td>
<td>$39.95</td>
<td></td>
</tr>
</tbody>
</table>

**Circle 200 on inquiry card.**
Single User System

SBC-200, 64K Expandoram II, Versafloppy II, CP M 2.2

$1095.00

4 MHz Z-80A CPU, 64K RAM, serial I/O port, parallel I/O port, double-density disk controller, CP M 2.2 disk and manuals, system monitor, control and diagnostic software.

Add $100.00 for upgrade to Expandoram III 64K (expandable to 256K).

- All boards are assembled and tested

SBC-200

2 or 4 MHz single board computer

- S-100 bus compatible
- Powerful 4 MHz Z-80A CPU
- Synchronous/asynchronous serial I/O port with RS-232 interface and software programmable baud rates up to 9600 baud
- Parallel input and parallel output port
- Four channel counter/timer
- Four maskable, vectored interrupt inputs and a non-maskable interrupt
- 1K of on-board RAM
- Up to 32K of on-board ROM
- System monitor PROM included

The SBC-200 is an excellent CPU board to base a microcomputer system around. With on-board RAM, ROM, and I/O, the SBC-200 allows you to build a powerful three-board system that has the same features found in most five-board microcomputers. The SBC-200 is compatible with both single-user and multi-user systems.

CPU-30200A A & T with monitor $289.95

Versafloppy II

5" & 8" double density controller

- S-100 bus compatible
- IBM 3745 compatible soft sectored format
- Controls single and double-sided drives, single or double density, 5" and 8" drives in any combination of four simultaneously
- Drive select and side select circuitry
- Analog phase-locked loop data separator
- Vectored interrupt operation optional
- Standard CP M 2.2 disk operating
- Control/diagnostic software PROM included

The Versafloppy II is faster, more stable and more tolerant of bit shift and "jitter" than most controllers. All control and diagnostic software included.

IOD-1160A A & T $359.95

For CP M 2.2 and manual set add $99.95

Expandaram III

64K to 256K expandable RAM board

SD Systems has duplicated the famous reliability of their Expandaram I and II boards in the new Expandaram III, a board capable of containing 256K of high speed RAM. Utilizing the new 64K x 1 dynamic RAM chips, you can configure a memory of 64K, 128K, 256K, or 512K, all on one S-100 board. Memory address decoding is done by a programmed bipolar ROM so that the memory map may be dip-switch configured to work with either COSMOS/MFPM type systems or with OASIS-type systems.

Extensive application notes concerning how to operate the Expandaram III with Cromemco, InterSystems, and other popular 4 MHz systems are contained in the manual.

MEM-65064A 64K A & T $495.00
MEM-65128A 128K A & T $639.95
MEM-65192A 192K A & T $789.95
MEM-65256A 256K A & T $879.95

Expandaram III Multi-User System

SBC-200, 256K Expandoram III, Versafloppy II, MPC-4 COSMOS Multi-User Operating System, C BASIC II

$1995.00

Two Z-80A CPUs (4 MHz), 256K RAM, 5 serial/1 I/O ports with independently programmable baud rates and vectored interrupts, parallel input port, parallel output port, 8 counter timer channels, real time clock, single and double sided single or double density disk controller for 5 1/4" and 8" drives, up to 38K of on-board ROM, CP M 2.2 compatible COSMOS interrupt driven multi-user disk operating system, allows up to 8 users to run independent jobs concurrently. C BASIC II, control and diagnostic software in PROM included.

- All boards are assembled and tested

MPC-4

Intelligent communications interface

- Four buffered serial I/O ports
- On-board Z-80A processor
- Four CTC channels
- Independently programmable baud rates
- Vectored interrupt capability
- Up to 4K on-board PROM
- Up to 2K of on-board RAM
- On-board diagnostic software

This is not just another four port serial I/O board! The on-board processor and firmware provide sufficient intelligence to allow the MPC-4 to handle time consuming tasks, whilst leaving your CPU free to do your real work. To increase overall efficiency, each serial channel has an 80 character input buffer and a 128 character output buffer. The on-board firmware can be modified to make the board SLIX or so compatible. In combination with SBC's COSMOS operating system (which is included with the MPC-4), this board makes a perfect building block for a multi-user system.

101-1504A A & T with COSMOS $495.00

Place Orders Toll Free
Continental U.S.
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Clarcia Wins BOMB by Remote Control

Steve Ciarcia's project on using your computer for remote control earned him first place in the December BOMB contest. Now if we could only send him the $1000 cash prize by remote control. Senior editor Greg Williams took second place with his photo essay, "The Coinless Arcade." Though Greg is a gamer, he's not a gambler and when playing video games he can't afford to lose because as a staff member he is ineligible for the second-place $500 prize. Third place went to William Barden Jr.'s "Color Computer from A to D, Make Your Color Computer 'See' and 'Feel' Better," the first installment in a series devoted to Radio Shack's TRS-80 Model I, Model III, and Color Computer.
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