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When we say the SDI results in a high-quality professional display, we mean you can't get higher resolution than this system offers in an NTSC-conforming display.

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Besides its high resolution and low price, the new SDI lets you control with optional Cromemco software packages that use simple BASIC- and FORTRAN-like commands.

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The SDI's high resolution gives a professional-quality display that strictly meets NTSC requirements. You get 756 pixels on every visible line of the NTSC standard display of 482 image lines. Vertical line spacing is 1 pixel.

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CONTACT YOUR REP NOW
The Model SDI has been used in scientific work, engineering, business, TV, color graphics, and other areas. It's a good example of how Cromemco keeps computers in the field up to date, since it turns any Cromemco computer into an up-to-date color display computer.

The SDI has still more features that you should be informed about. So contact your Cromemco representative now and see all that the SDI will do for you.
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In This Issue

Although the mysteries and menaces lurking in the shadows of this issue’s cover may exist only in the minds of an imaginative Adventure player or the cover artist, Robert Tinney, that doesn’t make them any less real to the person playing the game. This issue explores the many aspects of Adventure and Adventure-like games. It includes two complete Adventures in BASIC, an excellent introductory article (“On the Road to Adventure,” by Bob Liddell), two articles on the state of the art in Adventure games, and a handful of game reviews.

This issue also contains “Computer Testing,” an article by Steve Ciarcia, as well as the second set of several articles continued from the November graphics issue: “Micrograph,” “Graphic Color Slides,” and “A Simplified Theory of Video Graphics.”

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What’s Wrong with Technical Writing Today?

Chris Morgan
Editor-in-Chief

In going through the scores of articles that cross my desk each month, I’ve begun to notice that many of them are poorly written. I’m talking here not so much about incompetent writing (although the number of spelling and syntax errors is alarming), but rather about misguided writing, writing that is difficult to read, unclear, or wasteful of the reader’s time. The problem is certainly not BYTE’s alone. Editors of other magazines have told me much the same story. Thinking about possible solutions to the problem led me to write this editorial.

The quality of technical writing affects all of our readers in one way or another. Whether you program for a living or just for fun, you need to write clear, concise documentation to accompany your programs. And you undoubtedly have to write reports as part of your job or your studies.

There are tricks to good technical writing. I’d like to describe some of them here, and list some sources of information that have proved helpful to us in our writing work. I’ve also included a list of recommended reading at the end of the editorial.

Ask someone on the periphery of our field what the problem is with our prose, and he or she will probably say, “There’s too much jargon.” Things like: I/O, ASCII, byte, CPU, compiler, nonvolatile memory, BASIC, NAND gate, modern, macro, Pascal, floppy disk, Z80, 8080, 8086, 8090, 6502, 68000, Z80, BCD, CP/M, Unix, Xenix, bootstrap, OS, DOS, DMA, CAI, CAD, CAM, vectored interrupt, monitor, RS-232C, S-100 bus, global variable, checksum, NOP, SW, VOM, and so on, and so on.

It’s a lexical maze for the uninitiated. But is jargon really our downfall? I think not. We need jargon in the same way that doctors and psychologists do — as a convenient form of shorthand. Programmers have traditionally wrestled with the problem of fitting the most program into the least amount of memory space, so it’s only natural that their everyday speech has been condensed down to a sort of technical “alphabet soup.” Jargon isn’t intrinsically bad — it’s how you use it that counts.

Knowing Your Audience: The Seesaw Effect

Outside of grammar, syntax, and spelling (all of which I’ll deal with later), there is the major consideration of your intended audience.

Imagine your readers to be sitting at irregular intervals along a large seesaw. At one end are the most technically astute members of your audience; at the other, the interested novices. In the middle are people with varying degrees of knowledge in the subject you are writing about. Your job is to keep the seesaw as level as possible by attending to the various groups in proportion. If there are many novices involved, you must “hold up” their side by providing them with a lot of introductory material. But if you go too far in this direction, the experts will get bored, dismount, and leave you hanging with a partial audience. It’s a quandary, one that has no simple answer. Some topics are so technical that even the most intelligent novice will be left in your wake. You can’t understand the workings of a compiler, for instance, until you know a lot about computer languages in general.

Some seesaws can’t be balanced despite the best intentions of the writer. It is the job of the writer to know this. Nevertheless, within limits, a lot can be
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done to encourage those readers who are interested in your topic, but who may need some extra clarification. This leads me to the first of what I immodestly refer to as Morgan's Laws of Writing (not to be confused with DeMorgan's Law):

Morgan's Law #1: No Writer Ever Got Shot Down for Writing Too Clearly.

How do you write clearly? A good first step is to buy a copy of The Elements of Style by Strunk and White. There is more wisdom contained in this slim volume than in many a three-pound guide to English Usage.

Next, find some good technical writing and study it. I've included a bibliography of good technical books at the end of this editorial. We can learn a lesson from painters and musicians who take it for granted that good paintings and pieces of music by other artists should be carefully studied. Donald Knuth's three-part series of books, The Art of Computer Programming, contains some of the best writing you're likely to find in our field — and he's funny, to boot!

Another excellent writing tip comes from Peter Jacobi, a professor of journalism at the Medill School of Journalism:

*Read your writing out loud. How does it sound? Is it awkward, circumlocutory, pedantic? If so, rewrite it. There's something about reading a piece out loud that lays bare its weaknesses. You can be clear without turning off the majority of your audience. See the accompanying text boxes for some Do's and Don'ts of clear writing.*

Morgan's Law #2: The Beginning Is Half the Thing.

Actually, this is an old Roman saying I borrowed. The main point of it is that the first few paragraphs of an article are crucial to the rest of the text. The chances are you'll win or lose your readers at the beginning. Still, it's the one part of an article that fledgling writers gloss over in their eagerness to write the main body of the text. One very good writer I know told me he spends up to half of his article-writing time creating the first few paragraphs!

Morgan's Law #3: Avoid the Penguin Syndrome.

A famous story made the rounds a few years ago involving a publisher of children's books. A copy of one of the company's books about penguins appeared in the publisher's mailbox along with a letter from an eight-year-old girl that read, "Dear Sirs: I am returning your book, because it told me more about penguins than I wanted to know."

The moral? Tell your readers what they need to know, and no more. If you're zealous about a given topic, tell the reader how to get more information by including a comprehensive list of references. Don't waste space.

Morgan's Law #4: Writing Is Nonlinear.

Article ideas don't come in an orderly sequence. Be prepared to jot down your ideas as they come, as writer John McPhee does. McPhee is blessed with a short-term memory that permits near-total recall. Even so, he writes

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Clear Writing: Some Do's

DO: (1) Tell your audience what you're going to talk about, (2) Talk about it, and (3) Tell them what you talked about. This old saw from your creative-writing class in high school is as valid as ever. Not observing it is a common failing of much technical writing today.

DO: Include a theme sentence near the beginning of your writing that concisely sums up what you want to say in the piece.

DO: Tell your story in miniature in the captions to figures, photos, tables, listings, and other illustrations. Your readers may not have time to read all of your article: give them a quick summary and they'll thank you for it. Scientific American magazine does this sort of thing very well.

DO: Spell out acronyms and abbreviations when they first appear in text. How many times have you been stopped cold by an unfamiliar abbreviation in the middle of an interesting article?

DO: Use verbs. Avoid adjectives and adverbs. A verb in an article title can add a lot of spice. (See Electronics magazine for good examples of verbs in titles.) Adjectives and adverbs, to paraphrase Robert Benchley, are the spinach of technical prose. Everybody says they're vital, but few of us would miss them if the majority of us suddenly disappeared tomorrow. John McPhee (perhaps the best nonfiction writer in the country) has written several books on technical subjects (such as The Curve of Binding Energy) that illustrate these principles better than a hundred paragraphs from me.

DO: Break up your text into digestible chunks with subheadings.

DO: Remember the questions you had when you were first learning a subject.

Clear Writing: Some Don'ts

DON'T: Use the passive voice as your primary voice. Many of us were taught to use the passive voice when writing technical reports and the like. But the passive voice lends an air of coldness and formality to writing — the sort of thing you'd expect in technical transactions, but not in an article that's designed to be read. For example, "I ran the program" is more personal than "The program was run." Sometimes you need the passive voice for variety, but in general, own up: Say I, me, my, we, us or you.

DON'T: Make your reader search for information in an article. If you have a list of items in text, perhaps they could be set off in a table. If you have a glossary in your article, tell the reader at the beginning.

DON'T: Use big words when small words will do. A good example is utilize, a word that can almost always be replaced with use. Another popular word that should be avoided is implement. Don't implement when you can install, design, code, control, enable, connect, build, or operate; your readers will have a better idea of what you are doing.

DON'T: Use a clever title for an article if it fails to convey the article's content. Imagine that your title is all that the reader has to go on in deciding whether or not to read your work.
Why not kill two birds with one stone?

If you have an Apple* and you want to interface it with parallel and serial devices, we have a board for you that will do both. It's the AIO™

**Serial Interface.**
The RS-232 standard assures maximum compatibility with a variety of serial devices. For example, with the AIO you can connect your Apple* to a video terminal to get 80 characters per line instead of 40, a modem to use time-sharing services, or a printer for hard copy. The serial interface is software programmable, features three handshaking lines, and includes a rotary switch to select from 7 standard baud rates. On-board firmware provides a powerful driver routine so you won't need to write any software to utilize the interface.

**Parallel Interface.**
This interface can be used to connect your Apple* to a variety of parallel printers. The programmable I/O ports have enough lines to handle two printers simultaneously with handshaking control. The users manual includes a software listing for controlling parallel printers or, if you prefer, a parallel driver routine is available in firmware as an option. And printing is only one application for this general purpose parallel interface.

**Two boards in one.**
The AIO is the only board on the market that can interface the Apple to both serial and parallel devices. It can even do both at the same time. That's the kind of innovative design and solid value that's been going into SSM products since the beginning of personal computing.

The AIO comes complete with serial PROM's, serial and parallel cables, and complete documentation including software listings. See the AIO at your local computer store or contact us for more information.

2190 Paragon Drive
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---

**Maybe we can save you a call**

Many people have called with the same questions about the AIO. We'll answer those and a few more here.

Q: Does the AIO have hardware handshaking?
A: Yes. The serial port accommodates 3 types—RTS, CTS, and DCD. The parallel port handles ACK, ACK, and STB.

Q: What equipment can be used with the AIO?
A: A partial list of devices that have actually been tested is provided: IDS 440 Paper Tiger, Centronics 2779, Qume Sprint 5, NEC Spinwriter, Comprint, Heathkit H14, IDS 125, IDS 225, Hazeltine 1500, Lear Siegler ADM-3, DTC 300, AJ 841.

Q: Does the AIO work with Pascal?
A: Yes. The current AIO serial firmware works great with Pascal. If you want to run the parallel port, or both serial and parallel ports with Pascal, order our "Pascal Patcher Disk."

Q: What kind of firmware option is available for the parallel interface?
A: Two PROM’s that the user installs on the AIO card in place of the Serial Firmware PROM’s provide: Variable margins, Variable page length, Variable indentations, and Auto-line-feed on carriage return.

Q: How do I interface my new printer to my Apple using my AIO card?
A: Interconnection diagrams for many popular printers and other devices are contained in the AIO Manual. If your printer is not mentioned, please contact SSM’s Technical Support Dept. and they will help you with the proper connections.

Q: I want to use my Apple as a dumb terminal with a modem on a time-sharing service like The Source. Can I do that with the AIO?
A: Yes. A "Dumb Terminal Routine" is listed in the AIO Manual. It provides for full and half-duplex, and also checks for presence of a carrier.

Q: What length cables are provided?
A: For the serial port, a 12 inch ribbon cable with a DB-25 socket on the user end is supplied. For the parallel port, a 72 inch ribbon cable with an unterminated user end is provided. Other cables are available on special volume orders.

The AIO is just one of several boards for the Apple that SSM will be introducing over the next year. We are also receptive to developing products to meet special OEM requirements. So please contact us if you have a need and there is nothing available to meet it.
DON'T: Use it or other pronouns if the meaning is obscured. Vague pronoun references in an article slow the reader down. What does the 'it' mean?

Writing for BYTE
If you'd like to write for BYTE, we offer the following guidelines:

Knowing the reader: Over three-quarters of BYTE's readers are involved professionally with computers as programmers, systems analysts, engineers, or technicians. Most of them are dyed-in-the-wool hobbyists at heart and spend a lot of time with their systems. The majority have college degrees or higher, although we also have many student readers. They are interested in virtually every aspect of personal computing, including high-level languages, original hardware designs, reviews of software and hardware (we are especially interested in these), graphics, artificial intelligence, using computers to control the home, games, robots, etc, etc.

Although many of our articles contain highly technical information, we also encourage the submission of lower-level tutorial articles to enable readers to brush up on the basics. BYTE's readers like to have fun with their systems, too — a fact that should not be overlooked.

Form of the Submitted Article
- All submissions should be double-spaced and typewritten on 8¼ by 11 inch paper, with the narrow dimension vertical. Double-spacing is important, since proofreader's marks and other additions must be made to the manuscripts.
- Take the time to write complete, descriptive captions for all figures, tables, listings, and photos.
- Schematic diagrams should be neatly drawn, using the schematics in BYTE as a guide. Note that we prefer a certain type of connector designation, and that power connections to integrated circuits are usually listed in a separate power-wiring table rather than being included in the schematic. The direction of flow in a flowchart is assumed to be downward and to the right. No directional arrows should be used unless the flow is contrary to the aforementioned directions. Again, see the magazine for examples.
- We prefer not to typeset listings, but rather to photograph them for the magazine in order to eliminate the possibility of typographical errors. Because of this, we ask authors to submit listings printed on white paper with a dark ribbon (preferably new).
- Photographs can be either color or black and white, but should be as sharp as possible. We prefer color slides to color prints.
- All submissions should be accompanied by a stamped, self-addressed envelope with sufficient postage affixed. We acknowledge all manuscripts upon arrival, and make a final determination within 8 to 12 weeks.

Reference Books
Ralston, A., and Meek, C., eds. Encyclopedia of Computer Science. New York: Petrocelli/Charter, 1976. Although this book is oriented more toward large computers, it contains a wealth of information about high-level languages, assembly language, data processing, and hundreds of other topics, all presented in lucid fashion. Every serious computer science library should have a copy.
Todd, Alden. Finding Facts Fast. Berkeley CA: Ten...
Edison had over 1,800 patents in his name, but you can be just as inventive with an Apple.

Apple is the company with the brightest ideas in hardware and software and the best support — so you can be as creative with a personal computer system as Edison was with the incandescent bulb.

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**Apple speaks many languages.**

Since more than 100 companies create software for Apple, you'll have the most extensive library in the personal computer world. Want to write your own programs? Apple is fluent in BASIC, Pascal, FORTRAN, PILOT and 6502 assembly language.

There's even a series of utility programs called the DOS Tool Kit that not only lets you design high-resolution graphic displays, but lets you work wonders with creative animation.

**More illuminating experiences in store.**

You won't want to miss all the Apple products being introduced at your computer store all the time. Don't let history pass you by. Visit your nearest Apple dealer or call 800-538-9696. In California, 800-662-9238. Or write: Apple Computer, 10260 Bandley Drive, Cupertino, CA 95014.
Heath Faces Horizon

John Dye remarked in his letter (August 1980 BYTE, page 18) that he cannot run his Heathkit H-14 printer with a North Star Horizon at any data transfer rate over 110 bps (bits per second). A simple reconfiguration of the Horizon headers, as designed by Don Baker, will allow it to recognize the BUSY from the H-14.

I have assembled three H-14s and interfaced them with Horizon systems at 4800 bps with no problems. Heathkit supplies a modification-instruction pamphlet which allows you to obtain a BUSY signal on the printer's connector pin 4. This pin translates to pin 15, DB: XMIT CLK (DCE), on the Horizon motherboard. To accomplish the handshaking, jumper the right configuration-header at location 4D as follows:

Connect pin 2 to pin 16
Connect pin 4 to pin 14
Connect pin 5 to pin 11
Connect pin 7 to pin 8
Connect pin 9 to pin 10 and
Connect pin 12 to pin 12 of the right special-clock header at location 2C.

David M Koehler
306 Timber Trl
Lafayette IN 47905

APL Plot

I was very pleased to see BYTE's August 1980 FORTH issue, since I am working part-time with FORTH doing a computer-aided design package to be used with the fine Mauro Engineering Postplotter. Incidentally, the new product announcement for this plotter in the August 1980 BYTE (page 249) referred erroneously to the unit as a printer in the heading.

The self-replicating programs in "Programming Quickies" (see "Self-Reproducing Programs," by Burger, Brill, and Machi, August 1980 BYTE, page 72) are a challenge that APLers cannot pass up. I have a 22-character line of APL that reproduces itself when executed, which was published a few years ago in APL News, a free publication of APL Press (not to be confused with Personal APL News, my publication, which is now part of the APL Market Newsletter from Southwater Corporation). Anyone who is interested should contact Eugene McDonnell of I P Sharp in Palo Alto, California.

If we take the character string:

and then print it and execute it, we get:

The key to this line is the fact that the reshape function wraps around to the beginning of the right argument. I hope that the following makes it clear what is happening:

and then print it and execute it, we get:

A
1+23p11p ' ' ' ' ' '1+23p11p
and then print it and execute it, we get:

A
1+23p11p ' ' ' ' ' '1+23p11p

The DOUBLERTM. It packs almost twice the data on a disk track as your single-density system. Depending on the type of drive, you can store up to four times more data on one side of a minidiskette than you can store using a standard Model I mini-disk drive.

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This is much shorter and also much simpler in conception than the other self-replicating programs given. It is not, however, a definable function, but an expression. I don’t think it would be difficult to write an APL function that would produce its own visual representation, even without using the visual representation function which makes the question trivial:

```
PRINTMYSELF
```

This function returns its character form as a value, and only prints by default if that value is not assigned to a variable; the expression given earlier also yields a value and not just printing. Only LISP can improve on that, by returning a function as its value, rather than a character vector (character string to the rest of you).

Other variants of this amusement have been worked out in APL before. Try creating two expressions, each of which gives the other as its value or its printed result, or a cycle of three or more.

Mokurai Cherlin
Director, Micro Systems Development
APL Business Consultants Inc

Thief-Reproducing Program

We are rather amazed and amused by the “Self-Reproducing Programs” (see the “Programming Quickie,” by Burger, Brill, and Machi, August 1980 BYTE, page 72). We were amazed by the elegance of the “optimal” C program presented (especially given C’s notable lack of expressive power), and amused by the proposed LISP solution (which, by the way, won’t work. What was proposed will not evaluate to a function — it needs an enclosing DEFINE or DEFUN).

Consider the problem of creating an expression which evaluates to itself. A microsecond’s thought usually yields a constant, usually 1. Indeed, any friendly APL or LISP interpreter would be more than happy to return 1 when 1 is typed to it. However, many people would claim that 1 is data, and not a program. For the sake of this letter, we will pay homage to this unfounded prejudice, and go “up” a level in our analysis.

The canonical “program” in the lambda calculus which reduces to itself is:

```
\( \lambda x . x \)
```

The first \( \lambda x . x \) is the “program” and the second \( \lambda x . x \) is data to the program. When this “program” is “executed” the formal parameter \( x \) is bound to \( \lambda x . x \) parameter of the program \( x \), then \( x \) is concatenated with itself once (this is what \( xx \) means), and then this value is returned. (You may find it instructive to compare this with the “optimal” C program.)

We shall try to emulate this in LISP. The first attempt yields:

```
((lambda (x) (list x))(lambda (x) (list x)))
```

However, this fails because the data part will get evaluated. We can try:

```
((lambda (x) (list x))(lambda (list x)))
```

but this only yields:

```
((lambda (x) (list x))(lambda (list x)))
```

which is missing the quote mark. An interesting hack is to change the way lambda evaluates by executing (macro lambda form (list 'quote form)). The first attempt above will now work because when (lambda (x) (list x)) is evaluated it will return a copy of itself, which is what we want. However, there are those that would claim this is cheating because we have implicitly changed the behavior of the evaluator. We will admit this objection and continue with our analysis.

After much musing around trying to get the quote mark back in we stumble upon:

```
((lambda (lambda) (list (list 'lambda 'lambda) 'lambda)) (list quote lambda))
```

which does what we want. Note that this uses no PROG, SETQ’s or REPLACE’s. Also note that the lambda variable need not be named lambda, this is merely a hack. It is trivial to make a program out of this expression by throwing up the necessary DEFUN’s:

```
(DEFUN PRINTME/)
((lambda (lambda) (list 'DEFUN 'PRINTME/) (list 'LIST 'LAMBDA 'LAMBDA 'LAMBDA) (list 'QUOTE 'LAMBDA))

'LIST 'DEFUN 'PRINTME/) (list 'LIST 'LAMBDA 'LAMBDA)
```

```
The same engineers who helped win the “First World Microcomputer Chess Championship” under the auspices of the World Chess Federation on September 4, 5, and 6, 1980 in London, England—five straight wins with no loss or draw—and the “First Official North American Microcomputer Chess Championship” on September 5, 6, and 7, 1980 in San Jose, California—four straight wins without a loss or draw—are proud to announce Fidelity’s newest chess product...

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Circle 13 on Inquiry card.

However, neither of these two solutions would be written that way in a modern LISP (e.g., MacLISP or Lisp-MachineLISP, instead using the backquote facility) they would be written:

\[
\text{((lambda (x) '(x ',x)) '(lambda (x) ' (x ',x)))}
\]

and:

\[
\text{(DEFUN PRINTME())
((LAMBDA (X) ',X,X))
'(DEFUN PRINTME () ((LAMBDA (X) ',(X ',X)))))
\]

The real way it would be written in MacLISP is (DEFUN PRINTME () (GRINDEF PRINTME)). This whole exercise really isn't very interesting in LISP because this sort of thing is done routinely. Routines are constantly being consed up by other routines, and macros which write their own macros are becoming a standard tool. LISP doesn't discriminate against something just because it is code.

Daniel Weise
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Leedex / Sup'R' Terminal Incompatibility

Any BYTE reader who owns an Apple II system and is considering expanding to 80 columns may be interested in my experience with the Leedex monitor and the Sup'R' Terminal RF (radio-frequency) modulator board. While the Leedex monitor is an excellent value and performs well with the standard 40-column Apple II, I found it impossible to get a legible display while using it in conjunction with the Sup'R' Terminal board. Repeated efforts at adjusting both the board and the monitor failed to produce a legible display. The only solution proved to be using another monitor, namely a Hitachi.

Sunil Subbakrishna
Shakti Systems
Wilmette IL 60091

Bar-Code Reader as Light Pen?

Before reading Carl Helmers's editorial "Bar Codes, Revisited..." (April 1980 BYTE, page 6) on the Hewlett-Packard HEDS-3000 bar-code data-entry wand, I considered the possibility of buying a light pen for my Apple II. Afterwards, I couldn't see buying two pieces of equipment when one might do both jobs.

Circle 14 on Inquiry card.
Mountain Computer makes more peripherals for the Apple Computer than Anybody.

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APPLE CLOCK
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More power for your system through firmware. Six sockets accept 2716 EPROMs or ROM equivalents. Six or any combination can be used at once. Scratch-pad RAM and two TTL connectors. Special 2K ROMs available for powerful system enhancement: Keyboard Filter ROM—COPYROM—Others coming soon.

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At last! An intelligent, high-quality device for data entry from user-marked cards. Implement BASIC programming, examination scoring, inventory maintenance and other applications requiring off-line data preparation for batch entry later. Connects to any computer having RS-232 interface. Software and cards are available for jobs in business, science and education.

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That is, can the wand be altered so as to become a light pen?

John Gibbs

If you don't activate the infrared LED (light-emitting diode) in the HEDS-3000, you can certainly sense light coming into the wand from an external source, such as the video display's CRT (cathode-ray tube). There might be problems in matching the wave length of the light from the CRT to the spectral sensitivity of the infrared phototransistor in the wand...CH

Telecommunication Options

I enjoyed Carl Helmers's June editorial very much. (See "The Grass Roots Electronic Post Office, or, How Electronic (and Private) Mail Is Already Here," June 1980 BYTE, page 6. thru 10.) The prospect of using my terminal for rapid and inexpensive communication is very exciting.

The costs you mention for sending computer messages using voice telephone lines will be greatly reduced by taking advantage of the digital communication provided by Telenet or Tymnet. This is easily done by means of The Source or MicroNet information services. Electronic mail can be sent with The Source for $8.50 per hour of connection time, counting both send and receive time during "nonprime" hours, but not counting the initial charge. Similarly, MicroNet charges $10 per hour (for both send and receive) and has a lower initial charge. In addition, both systems permit users to chat on-line with other users through their respective terminals.

Robert W. Hosken
Avitar Exports
21515 Hawthorne Blvd #432
Torrence CA 90403

According to my table of telephone rates, the cost for a one-hour telephone call from New Hampshire to California during the 60% discount time period (which Carl Helmers used as an example) would be $9.65. The cost will be less, of course, for a call over a shorter distance.

Using The Source or MicroNet has the advantage that the two correspondents do not have to send and receive simultaneously and opens the possibility for multiple recipients of the same communication...RSS

Info on Micropolis Software Wanted

The Micropolis Users Group (MUG) is an association whose desire is maximizing the use of the Micropolis-supplied software. As part of this endeavor, we are compiling a directory of all software that runs on MDOS or Micropolis BASIC without requiring a second operating system (such as CP/M). I would appreciate suppliers of such software informing me of their products.

Of course we are also always interested in new members. Membership is $12 per year for twelve monthly newsletters.

Buzz Rudow
Micropolis Users Group
604 Springwood Cr
Huntsville AL 35803

6809 Time-Sharing

Don Kinzer's article in the June 1980 BYTE ("A Time-Sharing/Multi-User Subsystem for Microprocessors," page 122) describes how a sixteen-user time-sharing system can be implemented. The system, based on a 6800 microprocessor, uses a minimum of hardware and software. However, using the new 6809 processor, even less hardware and software is required.

The first savings of hardware occurs at power-up/reset. Most processors, including the 6800, accept a nonmaskable interrupt (NMI) at any time—even at reset. Obviously, if an NMI occurs before the stack is initialized correctly, the program will bomb. The problem is usually solved by adding a special circuit that disables all interrupts until the processor is properly initialized (as shown in figure 4 of Kinzer's article).

On the 6809, the NMI is blocked until the first load of the system stack pointer (SP). Thus, no special reset circuitry is needed. After initialization is complete, the stack pointer is loaded to enable the NMI. Note that most interrupt timers must still be initialized: when using the 6809, simply use the RESET signal to clear the timer to a known state.

The 6809 allows direct addressing anywhere in the memory map. By use of a direct page (DP) register, the 64-K-byte addressing range is divided into 256 pages. In a time-sharing environment, the DP register could be loaded with a different value for each user, resulting in each user accessing a different 256 bytes of temporary storage.

An alternate method of implementing a time-sharing/multi-user system is with the 6829 memory-management unit (MMU). The MMU expands the address space of the 6809 from 64 K bytes to 2 megabytes. Each MMU can handle four concurrent tasks; the address space of each task can be fully protected from other tasks. In addition, a total of eight MMUs can be used in a system.

Letters continued on page 298

A growing line of tools to expand the Apple.

7445A Processor Interface (for use with the CS-128/128C).

Time events in four operating modes—continuous, single shot, frequency comparison, and pulse width comparison. Includes three 16-bit interval timers, plus flexible patch area for external interface. Programmable interrupts, on-board ROM, and much more.

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7001B Arithmetic Processor. Interfaces with Apple's so you just plug in and run. Based on the AM 9511 device, provides full 16/32-bit arithmetic, floating point, trigonometric, logarithmic, exponential functions. Programmable I/O data transfer, much, much more.

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740A A 08B IEEE 488 Interface. A true implementation of the IEEE 488 standard—the standard protocol for instrumentation and test devices. Control and monitor test instruments such as digital voltmeters, plotters, function generators, or any other device using the IEEE 488.

7114A PROM Module. Permits the addition or replacement of Apple II firmware without removing the Apple II ROMs. Available with on-board enable/disable toggle switch.

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The Challenger 8P DF.

The general purpose microcomputer was first introduced as a computer for hobbyists and experimenters. However, as the industry has grown, microcomputers have become specialized for personal use or for small business use. There is virtually no computer for the serious experimenter with one important exception, the Ohio Scientific Challenger 8P.

The C8P is unique in that it incorporates the features of state-of-the-art personal computers, with the memory and disk storage capacity of business computers, along with the "mainframe" bus architecture and open ended expansion capability of industrial control computers.

Personal Computer Features

The C8P DF's specs beat all personal computers hands down. It executes instructions two to three times faster, and displays more alphabetic characters on its screen than other models. It has upper and lower case and graphics in 16 colors. The C8P's standard I/O capabilities are far more extensive than any other computer, with joystick and keypad interfaces, sound output, an 8-bit D/A converter, 16 parallel I/O lines, modem and printer interfaces, AC remote control and security monitor interfaces and a universal accessory port that accepts a prom blaster, 12-bit analog I/O module, solderless prototyping board and more.

Ohio Scientific offers a large library of personal applications programs, including exciting action games such as Invaders and Star Trek, sports simulations, games of logic and educational games, personal applications such as biorhythms, calorie counter, home programs such as checking and savings account balancers and a home budgeter just to name a few. A new Plot BASIC makes elaborate animations easy, and music composition program allows you to play complex multi-part music through the computers DAC.

At the systems level the machine comes standard with OS-65D, an advanced disk operating system with Microsoft BASIC and an interactive Assembler Editor. Optional software includes UCSD PASCAL and FORTRAN and an Information Management System (OS-MDMS). Dozens of independent software suppliers now also offer personal programs for the C8P.
**Business Computer Features**

The C8P DF utilizes dual 8" floppy disk drives which store up to eight times as much information as personal computer mini-floppies, and an available double-sided option expands capacity to 1.2 megabytes of on-line storage. The C8P DF is compatible with Ohio Scientific's business computer software, including OS-650 an advanced operating system, and an Information Management System (OS-DMS) with supplementary inventory, accounting, A/R-A/P, payroll, purchasing, estimation, educational grading and financial modeling packages. The system also supports word processing (WP-3) and a fully integrated small business accounting system (OS-AMCAP V1.6). The C8P DF's standard modem and printer ports accept high-speed matrix printers and word-processing printers directly.

**Home Control and Industrial Control**

The C8P DF has the most advanced home monitoring and control capabilities ever offered in a computer system. It incorporates a real time clock and a unique FOREGROUND/BACKGROUND operating system which allows the computer to function with normal BASIC programs, at the same time it is monitoring external devices. The C8P DF comes standard with an AC remote control interface, which allows it to control a wide range of AC appliances and lights remotely, without wiring, and an interface for home security systems which monitors fire, intrusion, car theft, water levels and freezer temperature, all without messy wiring. In addition, the C8P DF can accept Ohio Scientific's Votrax voice I/O board and/or Ohio Scientific's new universal telephone interface (UTI). The telephone interface connects the computer to any telephone line. The computer system is able to answer calls, initiate calls and communicate via touch-tone signals, voice output or 300 baud modem signals. It can accept and decode touch-tone signals, 300 baud modem signals and record incoming voice messages. These features collectively give the C8P DF capabilities to monitor and control home functions with almost human-like capabilities.

For process control applications, a battery back up calendar clock with automatic computer restart capabilities is available. Ohio Scientific's unique accessory ports allow the connection of a nearly unlimited number of 48 line parallel I/O cards and 12-bit high speed instrumentation quality analog I/O modules to the computer by inexpensive 16-pin ribbon cables.

**Exploring New Frontiers**

Ohio Scientific's vocalizer software processes normal BASIC print statements with conventional spellings and speaks them clearly in real-time on computers equipped with the UTI (CA-15B or CA-14A). This voice output capability, combined with the C8P's remote control, remote sensing, telephone interface capabilities and reasonable cost open up new frontiers for computer applications.

**Documentation**

The C8P DF is not a beginner's computer and doesn't come with beginner's documentation. However, Ohio Scientific does offer detailed documentation on the computer which is meaningful for experts, including a Howard Sams produced hardware service manual that includes detailed block diagrams, schematics, parts placement diagrams and parts lists. Ohio Scientific is now also offering fully documented Source Code in machine readable form for OS-650, the Challenger 8P's operating system allowing experimenters and industrial users to customize the system to their specific applications.

**What's Next?**

Ohio Scientific is working on a speech recognizer to complement the UTI system, with a several hundred word vocabulary. The company is also developing an 8 megabyte low-cost, add-on hard disk for use in conjunction with natural language parsing to further advance the state-of-the-art in small computers. The modular bus architecture of the C8P assures system owners of being able to make use of these new developments as they become available just as the owner of a 1976 vintage Challenger can directly plug in voice output, the UTI and other current state-of-the-art OSI products.

The C8P DF with dual 8" floppies, BASIC and two operating systems costs about $3000, only slightly more than you would pay for a dual mini-floppy equipped personal computer with only a fraction of the capabilities of the C8P.

For more information and the name of the dealer nearest you, call 1-800-321-6850 toll free.

**Ohio Scientific**

1333 SOUTH CHILlicothe ROAD
AURORA, OH 44202 • (216) 831-5500
Multimachine Games

Ken Wasserman and Tim Stryker
Mach 2 Software
96 Hammersmith Apts
Danbury CT 06810

Quickly reconnoitering your base perimeter, you begin to lay down mines to protect it from invasion.

square filled with one of your mines looks just like a stretch of virgin grassland.) As you do this, the steady clickety-click you hear from your opponent's keyboard tells you that he is not exactly idle either—he is probably mining the area around his base.

Or perhaps his base is well protected by mountain ranges, and he is now already actively seeking yours? Or maybe he has decided on the decoy ploy, and is building and mining an entirely false base to confuse you? You have no way of knowing!

Running out of mines, you frantically return to your base to restock, then rush out again to complete the mining operation. Suddenly you hear the sound of a mine exploding. Has your opponent run across your mine field already? Or did he, in his own haste, run afoul of one of his own mines? Thankful you had the foresight to make your mine fields orderly, you investigate: one of them is missing! Your opponent's tank is now badly damaged, but there are still four more where that one came from, and, more important, he now has some idea as to where your base is.

Out of mines again, and unwilling to return to base to restock, you are unable to patch the breach—instead, you take off after the intruder, and suddenly—there he is! His tank appears within your tank window! You fire—and miss—he maneuvers, fires—and hits you!

Your tank goes into condition yellow—you maneuver, fire—and miss—fire again—a hit! His tank, which was in condition red from having hit the mine, is completely destroyed, but you know that the second of his supply of five tanks has now been made available to him back at his base, wherever that is. Quickly slipping into a nearby forest to survey the area, you suddenly run across what can only be his second tank!

You reason as follows: in order for his second tank to have gotten back to this area as fast as it did, his base

Cassettes containing Flash Attack for the PET, at $15 each, and kits containing all the hardware needed to run Flash Attack and other games on the PET, including CB2 sound, at $15 each, are available from: Mach 2 Software, 96 Hammersmith, Danbury CT 06810.

There you are, staring into a poor dumb tube, spending hours trying to wheedle, cajole, flatter and coax your machine into coughing up a few more points, or maybe into reluctantly admitting every now and then: “YOU WIN!!!(bell)(bell))!!” How much satisfaction is there in that, really? How much challenge? So you beat the computer. So what? So the computer beat you. Who cares? Do you ever long for a scenario something like the following? ....

Tonight will be the final, deciding match of the battle series—the winner will have won the regional computer-club title and will be eligible for the national playoffs next month in San Diego. As you and your worthy opponent, both dressed in black, enter the room, a hush falls over the gathered assembly. You approach your respective consoles, and, at a prearranged signal from the presiding judge, the game begins.

The screen before you contains a wealth of information about the status and positioning of your various forces. You have two “windows” onto the field of play, one centered on your base, the other on your current tank. You see no sign of your opponent or his base in either window, for the field of play is very large: you know that he is out there somewhere, but, as the game begins, you have no idea where.

As you begin to move your tank out of your base, you find that it stays centered in its own window, thereby making previously unseen portions of the field visible to you, while, from the point of view of your base (which is immobile) your tank appears to move away from window center until shortly it disappears off the edge. Quickly reconnoitering your base perimeter, you begin to lay down mines to protect it from invasion. (These mines are visible to you but not to your opponent, to whom a

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must be nearby. Accordingly, you ignore the fact that his tank begins firing at you, opting instead to try to catch a glimpse of his base in your tank window before your tank is destroyed.

You maneuver—are hit!—your tank is now in condition red, and you find it difficult to move properly—nevertheless you forge ahead—there is his base! You move again, and hit a mine—your tank is destroyed! However, remembering the coordinates your tank was at when you saw his base, you make a lightning mental conversion from rectangular to polar coordinates, and, shouting insults across the room to distract your opponent's attention, you swiftly key the polar data into your angle and range registers and fire off an intercontinental ballistic missile from your base. A high, falling whistle is heard, followed by a colossal explosion.

A deathly quiet ensues: your condition display glows with the word "SUPREME," while on your opponent's screen you know the condition to be "DEFUNCT." You have triumphed in the first game of tonight's seven-game match—as you glance across to see the look of fierce determination on the face of your opponent, you realize that the remaining games may not be won so easily. The judge, looking at both players, slowly raises his hands, and the second game begins...

Creating a Game

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The game hinges on the players' judicious use of incomplete information.

The basic factors that go into making a game like this interesting are threefold:

1. More than one human player is involved in the game. Rather than having the user compete against the machine, the machine is utilized to permit two or more people to compete with each other in ways that would be impossible without the aid of the machine.

2. Success in the game hinges on the players' judicious use of incomplete information. Although the game may, in fact, be entirely deterministic in the sense that each legal move a player proposes gets put into effect without the intervention of any randomizing influence, the fact that each player only has a limited notion as to what his opponents are up to lends a definite element of suspense and calculated risk-taking to the game.

3. The game is played in real time: one's options are constrained not so much by the rules of the game as by one's own fleetness of hand and mind (or lack thereof).

Many conventional board games, and virtually all conventional card games, embody factors 1 and 2. Many video pinball parlor games, such as Atari's Pong and Tank, embody factors 1 and 3, while most of the rest of the available microcomputer game software embodies either none of these factors (computer chess, backgammon, etc), factor 2 alone (Star Trek, Adventure, etc), or, in exceptional cases, factors 2 and 3 together (real-time Star Trek, etc).

It is interesting to note that, of all the major league sports, the one that embodies all three of these factors most fully is football—this may be the reason why the sport is so overwhelmingly popular.

Bringing all three of these factors together in a single computer game virtually requires that more than one console be used. Since, to most of us, a requirement for multiple consoles is equivalent to a requirement for multiple machines, the issue that will be addressed here is: what is needed in the way of hardware and software to support the implementation of multimachine games?

Two-Machine Games

In the case of two-machine games, the answer turns out to be surprisingly simple and inexpensive. Most microcomputers come already supplied with a general-purpose, 8-bit, parallel I/O (input/output) port poking out the back somewhere. For those that do not, an add-on port of this type can generally be purchased at nominal expense. As in the PET, the port should ideally have the property that, even though configured for output, it will still return a correct reading of the states of the pins involved when a "read" operation is performed on it.

Also, as with the PET, the port should represent the high state upon output by means of a passive pull-up resistor. Ports not satisfying these conditions may still be
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used as long as there is provision made within them for individually programming each bit position to be either input or output (examples of the use of such ports will not be given here).

What is needed, then, is an arrangement that will allow a byte at a time to be transferred from either machine to the other. Figure 1 gives the wiring diagram for the cable needed; as you can see, each bit position on each machine is simply directly connected to the corresponding bit position on the opposite machine. This is true for all bits except for the 2³ bit, labeled ASYM, which is grounded on one machine and left floating high on the other. The whole package, including connectors, should cost less than $5.

Listing 1 contains a program designed to test the cable. It is designed for use on a pair of PETs, but, with minor modifications, it should be capable of supporting any pair of machines with ports satisfying the conditions discussed above. With the cable in place, and with both machines running this program, what should happen is that any keys hit on either machine should be displayed on the screen of the other. Type a shift-Q (not the STOP key) to exit the program and return to BASIC.

The three utility routines of interest here start at lines 10000, 10200, and 10400, respectively. The routine at line 10000 simply initializes the port: location 59471 is the PET's User Port I/O data register, while 59459 is the register used to configure the data pins for input and output. The POKE in line 10060 configures all eight pins as output.

The SEND routine at line 10200 may be called whenever it is desired to send a byte to the opposite machine. However, the opposite machine must call its own RECEIVE routine, at line 10400, in order for the transfer to take place. There is a potential pitfall here: if, when writing your own code to use these routines, you create a situation in which both machines are trying to send a byte to the other at the same time, or if both machines try to receive a byte from the other at the same time, both will "hang."

The programs running on the two machines must be set up in such a way that whenever one of them decides to send a byte, the other realizes this and sets up to receive it. Given this fact, the purpose of the ASYM bit in figure 1 becomes evident: it guarantees that start-up problems will not arise when running identical copies of a single program in both machines. Consider yourself in the position of the program in listing 1 as you begin running; eventually you would reach the point where you would like to start up a dialogue with the other machine.

Question: should you send a byte to the other machine first, or receive one? You and the other machine had better come to complementary conclusions as to which to do first. Solution: you use the setting of the ASYM bit to decide. This is exactly what happens in line 210 in the listing. If, upon reading the port contents, you find that the 2³ bit is high, you receive first; otherwise you send first. From that point on, in this example, you simply alternate sending and receiving, and everything is fine.

Let's take a closer look at what is actually involved in transferring a byte using this scheme. The nine lines shown in figure 1 can be broken down into four groups:

1. **GND.** This is a signal ground, which must be present in...
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Figure 1: The cable arrangement needed for connecting two PETs in game-playing configuration. Each machine runs the same program, and exchanges relevant information, one byte at a time, with the opponent's computer. The bit labeled $2^4$ determines the initial state of each machine and, thus, whether it first transmits or receives.

Figure 2: Timing diagram for information transfer using the cable scheme of figure 1. The transmitting computer puts information on the DATA lines, low-order nybble first, and brings the LNR line low. The receiving computer brings the DRCV line low when the information has been accepted. The process is repeated for the high-order nybble, but HNR is used to indicate the presence of new data. When DRCV is brought high, the transmitter and receiver functions reverse.

order for the two machines to have a common reference voltage.

- DATA 0 thru 3. These lines, which are controlled by the sender, carry the actual data being transferred, a nybble at a time (a nybble is half of a byte, or 4 bits).
- ASYM. This has already been discussed.
- DRCV, LNR, and HNR (data received, low-order nybble ready, and high-order nybble ready). These are the so-called "handshake" lines. LNR, which is a signal from the sender to the receiver, is brought low by the sender to indicate to the receiver that the low-order nybble of the byte being sent is now ready to be read off of the DATA lines. HNR, also a signal from the sender to the receiver, is brought low by the sender to indicate to the receiver that the high-order nybble of the byte being sent is now ready to be read off the DATA lines.

DRCV, which is a signal from the receiver to the sender, is brought low by the receiver once he has read the high-order nybble off of the DATA lines, to indicate to the sender that the high-order nybble has been received and that, as far as the receiver is concerned, the transaction is complete.

Figure 2 shows a timing diagram of the whole operation. Essentially, what happens is this:

The sender puts the low-order nybble on the DATA lines, and (by bringing LNR low) says, "Here is the low-order nybble." The receiver reads in the low-order nybble, and (by bringing DRCV low) says, "I've got it." The sender then puts the high-order nybble on the DATA lines, and (by bringing HNR high) says, "Here is the high-order nybble." The receiver reads in the high-order nybble, combines it with the low-order one to make a complete byte, and (by bringing DRCV high again) says, "All set. Goodbye." The sender must then return all lines to the high state before returning to his caller.

All lines are left in the high state except when actually in use so that if one machine tries to send or receive while the other is off doing something else, the first machine will simply wait until the other is ready before proceeding.
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The only modifications necessary for this scheme (to handle ports lacking the previously discussed properties) would be: to have code at the beginning of the RECEIVE routine which configured the DRCV line for output and the remaining lines for input; to have code at the beginning of the SEND routine that configured the DRCV line for input and the remaining lines for output; and to have code at the ends of both routines for reconfiguring all lines as input. The port initialization routine would also have to be changed to initially configure all lines for input.

Listing 2: Functionally the same as listing 1, this program is tailored for the PET computer and has several utility routines implemented in machine code.

```plaintext
100 REM*** PROGRAM TO TEST INTER-
110 REM*** MACHINE COMMUNICATIONS
120 REM*** USING MACHINE LANGUAGE
130 REM*** AND OTHER EFFICIENT
140 REM*** PROGRAMMING TECHNIQUES
150 REM***
200 GOSUB10000:SYS909
210 IFPEEK(59471)AND16THEN240
220 U=USR(S):IFS$="#"THEN999
230 R$=CHR$(USR-1):PRINTR$;[240
250 IFR$="e"THEN220
260 GOSUB10000:SYS909

REM*** U=USR C- 1 ) •• RECEIVES U
REM*** U=USRC+N ) ••... RECEIVE S U
REM***
999 END
1000 REM*** THIS ROUTINE SETS UP THE
1010 REM*** FOLLOWING FACILITIES
1020 REM*** IN MACHINE LANGUAGE:
1030 REM***
1040 REM*** SYS909 ... INITS PORT
1050 REM***
1060 REM*** U=USR(+N) ...) SENDS N
1070 REM***
1080 REM*** U=USR(-1) ...) RECEIVES U
1090 REM***
10100 FORI=826TO917:READX:POKEI,X:NEXT
10110 POKE158:POKE23
10120 IFPEEK59003=0THENRETURN
10130 POKE827,154:POKE830,97:POKE834,98
10140 POKE869,109:POKE882,98:POKE903,98
10150 RETURN
11000 DATA 32,167,208,166,179,208,32
11100 DATA 165,180,72,9,240,41,191,141
11200 DATA 79,232,104,74,74,74,74,9
11300 DATA 208,44,79,232,48,251,141,79
11400 DATA 232,4,79,232,16,251,48,44
11500 DATA 32,103,3,76,120,210,44,79
11600 DATA 232,112,251,173,79,232,41,15
11700 DATA 133,180,169,127,141,79,232
11800 DATA 169,32,44,79,232,208,251,173
11900 DATA 79,232,10,10,10,10,5,180,168
11000 DATA 234,234,169,0,162,255,142,79
11110 DATA 232,142,67,232,96
```

Putting It All Together

Just having the capability to transfer bytes back and forth between two machines does not guarantee success in writing multimachine games. We now need a general strategy for controlling the flow of information between the various machines in such a way that the moves made by each player are processed in a consistent manner by all machines involved. Among other things, the strategy used must ensure that all of the machines involved agree as to the order in which the various players' moves are to be processed. Only one such strategy, the key-oriented strategy, will be discussed here. Although many other approaches to the problem do exist, this one is particularly “clean” and therefore easily debugged; it is also reasonably efficient in both space and time.

The information transfers addressed by any general strategy of this kind fall into two groups: those that occur at initialization time and those that occur during the actual play of the game. The key-oriented strategy calls for all information pertinent to the initial state of the game, including information that may be kept secret from one or more players, to be made known to all machines at initialization time.

Then, during play, a continuous conversation is set up among the machines in which the only information changing hands consists of individual keystrokes generated by the players at their keyboards. If a player generates no keystroke to be sent on a given pass, a zero byte is sent out to the other machine(s) to indicate this fact. Every machine maintains the full status of every player but only displays the information its own player is supposed to see.

Listing 3 shows a program, Real-Time Two-Machine Hangman, designed to illustrate the use of the key-oriented strategy. To keep it short, such things as instructions, gruesome representations of gallows, and so on have been left out. The object of the game is not, as it is in normal Hangman, to guess your opponent's word within a set number of letter-guesses while he sits around telling you where your correct guesses fit in. Instead, both you and your opponent choose words that the other tries to
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guess—whoever guesses the other's word first wins.

The program as shown is, of course, only capable of running on a pair of PETs. However, with suitable alteration of the SEND/RECEIVE software, it should be possible to run it on any pair of common microcomputers possessing the cabling arrangement described above.

**Game Time**

To play the *Hangman* game, attach the cable, type the program in, and RUN it on both machines. You and your
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opponent will each be asked to enter a word—if the words entered are of different lengths, the program prints an error message and reprompts both players for new words. Once the program has accepted the two words, any key you strike is taken to be a letter-guess directed at your opponent's word.

Each time you hit a key, your machine displays the results of your guess—that is, your target word so far, with dashes in the positions corresponding to letters not yet guessed, and a tabulation of the letters you have tried so far. The program automatically detects when one player has guessed every letter in his opponent's word, and declares the winner accordingly.

The initialization phase of listing 3 encompasses lines 10 through 240 and all of the subroutines appearing from line 5000 on up. During this phase, the program POKEs the machine-language software into place, initializes the port to the other machine, and then (in line 110) prompts its own player for input and reads the reply into W$(1).

Then, using the ASYM bit as usual to determine whether to send first or receive first, it essentially exchanges word lengths with the other machine and checks to make sure that the two word lengths are equal. Once satisfied that they are, the program proceeds to exchange words with the other machine (using the subroutines at 5000 and 5100), placing the other player's word into W$(2). Both machines now know both players' words. Each machine has its own player's word in its own copy of W$(1) and the opposing player's word in its own copy of W$(2).

The Play Phase

At this point, the program is ready to enter the play phase, but first it must set the initial value of the player select variable P to either 1 or 2, depending on the setting of the ASYM bit. The reason for this is that the section of code from line 300 to line 500 is used to process proposed letters, or moves originating from both players—this is the essence of the key-oriented strategy. The variable P, which flips back and forth during play between 1 and 2 via the statement "$P=1-3-2$" in line 500, is used on each pass to determine whether to attempt to get a keystroke from one's own keyboard (which is what the GET statement in line 280 does) or to receive from the other machine the result of its attempt to get a keystroke from its own keyboard (which is what the assignment in line 270 does).

The value of P is also used in the main processing loop as the index into each of the two-element arrays W$, F$, and T$, to ensure that the proper player's status is updated as a result of the processing of the keystroke. The net implication is that P must be initialized to 1 on one machine and to 2 on the other so that the play phase will begin correctly.

During the play phase, then, the program simply circulates in the main processing loop shown, alternating the value of P back and forth between 1 and 2 on each pass. When P is 2, the machine's own keyboard is interrogated, the resulting keystroke (or a zero if the resulting keystroke was null) is sent off to the other machine, and the keystroke is processed by examining W$(2)$ for occurrences of it. F$(2)$ and T$(2)$ are updated accordingly and, in lines 410 and 420, are printed out.

When P is 1, the keystroke to be processed comes from the other machine (in order for this to happen the other machine's copy of P will at this point be equal to 2). The keystroke is processed by examining W$(1)$ for occurrences of it, and F$(1)$ and T$(1)$ are updated but not printed out, since they are of interest only to the player on the other machine.

Checking for the end-of-game is thus very simple: as soon as F$(P)$ becomes equal to W$(P)$, the game is over, and the value of P for which this was the case can be used (as it is in line 1020) to determine who won.

This is how a typical real-time two-machine game involving incomplete information is implemented. Other good candidates for implementation in this manner would be Star Trek, Kriegspiel (a version of chess in which neither player is ever entirely sure just where his opponent's pieces are located), and Stratego. You can easily design entirely new Adventure games, a submarine battle for example, using the basic approaches given here. The possibilities are certainly more exciting and creative than playing Battleship with pencil and graph paper.
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Suppose for a moment that you are a custom-electronics manufacturer. You have accepted a job to produce 1000 sequential-controller boards for a major photocopier manufacturer. (It is not unusual for large companies to farm out control subassemblies.) For all practical purposes, the controller board is a microcomputer that has various output combinations in response to designated inputs. As a subassembly manufacturer, you have the responsibility for testing the controller boards as well as building them.

The controller board in question has ten inputs and ten outputs. When a particular input signal is received (perhaps from the copy button), the controller activates one or more outputs, waits a preset time limit, and then changes the output. Depending upon the input-signal combination, the sequence may have one to five steps. The timing intervals can also vary within each sequence.

Without going into too much detail, it is easy to see that what we are discussing could prove to be a nightmare to test. It could conceivably be done manually in perhaps 2 or 3 hours with a maze of switches, indicators, and wires. With 1000 of them to build, it would take the services of two workers, and only six units could be shipped a day. (If you are lucky, you won’t have to deliver 1000 controllers in 3 months.)

If you have any business sense at all, you know that such a situation is worth avoiding. (Customers have a habit of changing schedules just when the only technician who knows the test procedure goes on vacation.) The obvious solution is automatic testing, or more explicitly, computerized testing.

Automated Testing by Computer

Automated testing is an activity where a machine simultaneously activates and monitors signals according to a prescribed test plan. While it is not a necessity, most automatic testers incorporate microcomputers because of the cost advantages and flexibility they impart to the tester. Microcomputers replace bulky relays and hardwired logic in older designs. The latest economically priced units are in fact nothing more than a basic computer with some specialized front-end interfacing.

In many applications, it is cheaper to configure your own test system and program it for a specific application rather than buy a “board tester.” In our photocopy-board example, the hardware for ten input and ten output bits is relatively inexpensive. The application program to do the testing requires some thought, however.

There are two ways to write software for automatic test and controller applications. One is to use assembly language, and the other is to use a high-level language such as BASIC, tiny-c, or FORTH.

Companies that manufacture electronic devices in 1000-quantity are quite concerned about memory size and costs. High-level languages take considerably more memory space for a given application than straight assembly code. Every extra 1 K byte costs $10. This results in $10,000 difference for each 1 K increment on 1000 photocopier controllers. In high-volume applications where cost is the most important factor, assembly language is used to save space.

As a custom-electronics manufacturer, you have similar decisions to make concerning computer hardware. You must design an automated device to efficiently test the photocopier controller. Unfortunately, you are building only one unit and will not have the large production volume over which to amortize the software-development costs. Your only choice is to risk becoming uncompetitive by raising the price of assembling each controller board. Therefore, it is in your best interests to keep these testing costs low.

High-Level Languages in Control Applications

The cost for developing a program is much higher than you probably thought. (Many business profes-
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sionals discover this only after buying computers.) The general industry practice of estimating software is to charge at the rate of one line of code per hour regardless of the language used. This results in a cost of $20 to $40 per line. You may write ten lines of code in the first hour, but with all the documentation, debugging, and testing involved, one per hour is realistic by the time the application is thoroughly finished.

For a high-level language such as BASIC, the average line-for-line coding-time comparison is about 10 to 1 over assembly language. As much can be accomplished with a single IF . . . THEN . . . ELSE statement as ten or fifteen assembly-language instructions. For limited production items, or one-of-a-kind applications, where one line of high-level code costs no more than one line of assembly code, it is more reasonable to consider the former.

The major limitation of high-level languages such as BASIC is that they are interpretive and slow (2 to 5 ms per line). They require a fixed block of code (2 K bytes for a tiny BASIC to 24 K bytes for a fully extended disk version) to interpret and execute any amount of program statements in addition to the memory containing the user program. The size of the interpreter depends upon the sophistication of the instruction repertoire.

“Slow” is a relative term. If you need to activate a signal only 10 times a second, then there is no conflict. Doing something 500 times a second is more involved. As the interpreter code is reduced in size and complexity, the processing speed is increased. In its bare-bones state, a tiny BASIC has only integer arithmetic, no alphanumeric string-handling capability, limited array-handling capability, and limited math functions. But it is fast by comparison to fully extended high-level languages. If full processor speed is required in some portions of the application, one or more special assembly-language subroutines can be called and executed from the high-level language program, which takes over again at the conclusion of the assembly-language subroutine.

An Actual Automatic Tester Application

In “I/O Expansion for the TRS-80,” Parts 1 and 2 (Garcia’s Circuit Cellar in the May and June 1980 BYTE, pages 22 and 42, respectively), I presented an article on the design of a serial/parallel I/O (input/output) interface for the TRS-80 called the COMM-80. (A block diagram of the interface is shown in figure 1.) I have received an influx of reader inquiries concerning component sources and terminal software. This leads me to believe many people are building the interface.

This assumption, as well as a need to have a good diagnostic program for any computer peripheral in production, prompted me to design the hardware and software necessary to automatically test a COMM-80. In addition to providing anyone who has constructed the interface with a useful test program, the resulting effort fully demonstrates use of a high-level language in a test/control application.

Reviewing quickly, the COMM-80 is an interface designed specifically for the TRS-80 (it can be attached to any 8-bit computer with a bidirec-
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Figure 1: Block diagram of the COMM-80 I/O interface showing the interrelationship of the signals.
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Text continued from page 46:

Tut

The Test Sequence

As I previously mentioned, most automatic testers consist of a microcomputer and some front-end interfacing hardware. In this applica-

Photo 1: TRS-80 system and test equipment for the COMM-80. The COMM-80 unit under test is on the left with the cover removed and cables attached. The programming techniques employed and described in the testing of this unit are applicable to many other computer-control applications.

Photo 2: Test cables required to run diagnostics on a COMM-80 serial/parallel I/O interface. The cable on the top (from figure 3) connects the test-unit printer port to the master-unit printer port. The 8-bit parallel output is also wired to a sixteen-pin dualinline plug header to test the programming-plug input.

The cable on the bottom (from figure 6) connects the test unit RS-232C signals to the master unit's RS-232C port. The prototyping board contains a beeper that is triggered when the computer outputs data through the test-unit printer port.

tion, I chose to use the TRS-80 as the test computer for obvious reasons, but the software is written so that it can be executed on most similar BASICS. The front-end equipment, consisting of a serial and parallel port, is coincidentally another COMM-80 that is set at an address different (hexadecimal 37F8) from the test unit. When the test unit is exercised, the computer reads the results through the second (master) unit. The entire computer configuration is shown in photo 1. The second unit is required only to provide the automatic test computer with the proper serial/parallel I/O capability.

There are four major tests involved, and special cables are required to attach the test unit to the master unit (see photo 2). When attached, they appear as in photo 3. The sequence of tests includes in order: address decoding, TTL (transistor-transistor logic)-level parallel I/O, RS-232C handshaking, and serial I/O. A flowchart for the sequence of test routines is shown in figure 2.

Address Decoding

The address-selection section of a peripheral device determines where within the computer’s addressing range the computer will find this peripheral. For the COMM-80, there are sixteen locations between hexadecimal locations 3708 and 37F8 to which it can be set. To be compatible with standard Radio Shack software, the setting should be 37E8. Generally speaking, the failure in address decoders is usually the switch and not the logic. It is not enough to set the unit for address 37E8 and presume that, if it works, the rest of the addresses will. All sixteen addresses need not be checked, but each one of the 4 selectable address bits should be cycled. My preference is to check six combinations: all on, all off, and one on at a time. The only way to determine if they work is to successfully accomplish I/O communication at each address.

Figure 3b is a diagram of a circuit that facilitates this test. It is a simple one-quarter-second beeper that is activated by the 1 µs printer output strobe pulse. Only the address-decoder circuitry and the 74121 (IC16) strobe-pulse generator on the COMM-80 board are involved. If a test unit is set for an address of 37E8,
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Circle 44 on inquiry card.

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the beeper will sound every time the computer writes data to that address. In addition to providing a method for testing the address decoder, the beeper serves as an audible indicator during other test sequences.

An integrated-circuit test clip facilitates access to +5 V (to power the beeper). It also conveniently picks up the strobe pulse and provides ground, even though they are available on the printer connector. The beeper circuit is completely independent of the other cables, but it is constructed on a board attached to the RS-232C connector, for convenience.

Figure 4 charts the test sequence, and listing 1 contains the actual code. This software, as well as that of the other tests, is designed as an independent subroutine to allow multiple passes.

Initially, all switches are set to the open position (hexadecimal address 37F8), and the computer attempts to write to the printer at port 37F8. If the address decoder works, the beeper should sound continuously. If not, there is a problem. Once continuous beeping is achieved, reset the address switches (as shown in photo 4) to hexadecimal address 3778 and press the @ key. This action tells the computer to try to write to printer port 3778. Once again the beeper should sound. The sequence is repeated five times with the last address, hexadecimal 37E8, being left as the switch setting for all future tests. The master unit is permanently set at address 37F8 for all remaining tests. The test takes whatever time it takes to flip the switches and press a key.

**Printer Port and Programming Plug**

Figure 3a outlines the hardware necessary to test parallel I/O. On the COMM-80, there is one full 8-bit parallel I/O port for the printer and one 8-bit option-select programming-plug input port. The latter has no physical connection to the serial hardware, but is used to set serial-communication options under software control. With the interface set at hexadecimal 37E8 the programming

Text continued on page 58

Listing 1: BASIC program testing the address decoding of the COMM-80.

```basic
100 PRINT ************ ADDRESS CHECK ************
105 REM THIS SUBROUTINE CHECKS EACH ADDRESS BIT OF THE ADDRESS
107 REM SELECTION SWITCH
130 PRINT "SET ALL ADDRESS SWITCHES TO THE OPEN POSITION"
140 GOSUB 510
150 POKE 14326, 0
160 GOSUB 500
170 IF A$ = "@" THEN 180 ELSE 150
180 PRINT:PRINT "CLOSE SW1 ONLY" :GOSUB 510
190 POKE 14200, 0
200 GOSUB 500
210 IF A$ = "@" THEN 220 ELSE 190
220 PRINT:PRINT "CLOSE SW2 ONLY" :GOSUB 510
230 POKE 14264, 0
240 GOSUB 500
250 IF A$ = "@" THEN 260 ELSE 230
260 PRINT:PRINT "CLOSE SW3 ONLY" :GOSUB 510
270 POKE 14296, 0
280 GOSUB 500
300 IF A$ = "@" THEN 310 ELSE 270
310 PRINT:PRINT "ADDRESS TEST CONCLUDED •••• LEAVE ADDRESS SWITCHES IN THIS SETTING";
360 PRINT "FOR REMAINDER OF TESTS AND SHIPPING"
370 GOSUB 2500
380 RETURN
2500 A$=INKEY$ :RETURN
```

Listing 2: BASIC program testing the printer parallel port and programming-plug of the COMM-80.

```basic
10 REM COMM-80 DIAGNOSTIC PROGRAM
20 REM
30 REM MASTER UNIT SET FOR ADDRESS FB-FB
40 REM
50 DATA 0,1,2,4,8,16,32,64,128,255
55 FOR X=1 TO 10 :READ Z(X) :NEXT X
1000 PRINT:PRINT:PRINT "UHH! PRINTER PORT AND PROGRAMMING PLUG TEST *******"
1010 FOR X=0 TO 9
1020 POKE 14312,Z(X) :REM SET DATA ON TEST UNIT PRINTER OUTPUT
1030 S=PEEK(14312) :REM READ TEST UNIT PRINTER INPUT
1040 S1=INP(233) :REM READ TEST UNIT PROGRAMMING PLUG
1050 S2=PEEK(14328) :REM READ MASTER UNIT PRINTER INPUT
1060 IF S+S1+S2<>3*Z(X) THEN 1200
1070 NEXT X
1080 "PROGRAMMING PLUG AND PRINTER PORT CHECK OK"
1090 RETURN
1200 IF S2<>Z(X) THEN PRINT "BAD PRINTER OUTPUT PORT --- FAILED ON " ;Z(X) ;" DATA VALUE" :GOSUB 2500 :RETURN
1210 IF S1<>Z(X) THEN PRINT "BAD PROGRAMMING PLUG INPUT --- FAILED ON " ;Z(X) ;" DATA VALUE" :GOSUB 2500 :RETURN
1220 IF S<>Z(X) THEN PRINT "BAD PRINTER PORT --- FAILED ON " ;Z(X) ;" DATA VALUE"
1230 GOSUB 2500 :RETURN
2500 PRINT:PRINT:PRINT "PRESS ANY KEY TO CONTINUE TEST"
2510 IF INKEY$<>"" THEN RETURN ELSE 2510
```

Figure 2: Flowchart of the four-step sequence employed to test the COMM-80.
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Figure 3: Hardware for testing the parallel I/O (figure 3a) and addressing (figure 3b) capabilities of the COMM-80. Figure 3a shows an I/O test cable that connects the master and test units. Figure 3b shows a beeper circuit that tests the address selection of the COMM-80.

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OUR MESSAGE.
plug is read as input port hexadecimal E9.

The concept behind this is to have the test unit send a data byte from its own output port to both input ports. The master unit reads the same 8 bits to determine that they are set correctly. While we could have gone from input to output (sixteen wires) between master and test units, nothing better would be accomplished. Figure 5 and listing 2 outline this activity in detail. The test takes about 1 second.

RS-232C Handshaking Test

A similar technique is employed to check the RS-232C handshaking signals. The necessary interface cable is outlined in figure 6. Figure 7 and listing 3 detail the logic flow.

There are two output (DTR, Data Terminal Ready, and RTS, Request To Send) and four handshaking signals (RI, Ring Indicator; CD, Carrier Detect; DSR, Data Set Ready; and CTS, Clear to Send) on the RS-232C interface. Some are almost never used, but all must be checked and functioning. The test is accomplished by tying the input to the output on the test unit and monitoring the output lines again through the master unit. With two signal lines, there are four possible combinations, and all are checked. The test takes about 1 second.

Serial I/O Test

The serial section of the COMM-80 incorporates a COM5016 data-rate generator and a COM2017 UART (universal asynchronous receiver/transmitter). Both are programmable devices. Through them, it is possible to automatically set data rates, parity, word size, and stop-bit options completely through software. This makes testing much easier and eliminates the necessity of manually flipping switches. Figure 8 and listing 4 outline this test.

Upon initial examination, the software looks straightforward. Ten bytes of data (all on, all off, and each individual bit set) are sent from the master unit to the test unit at each of the sixteen data rates. The communication path is then reversed and 10 bytes are sent from the test unit to the master at each data rate to complete the test.

It may be surprising to note that a close examination reveals no assembly-language routine to transmit or receive the serial data. Even at 19,200 bps (bits per second), the serial communication and UART program interaction are accomplished completely in BASIC. (Remember that it takes less time to write a program in the higher-level language. So, if you don’t need assembly-language routines, why bother?)

A UART is a hardware device that appears to the computer as a parallel port. To send data, we merely address this port and load 8 bits of data into it. At the conclusion of the output instruction, the UART automatically converts this byte to serial format and transmits it at a rate that is dependent only on the transmit-clock input to the UART. If this clock

Photo 3: A production COMM-80 under test with cables attached. A second unit beneath it provides the computer with the necessary I/O capability to successfully interface to both a serial and parallel port. This capability is also available using a Radio Shack Expansion Interface with a RS-232C board installed.

Photo 4: Address selection during test. When the beeper is heard, the proper address has been selected on the dual-inline plug switch.
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Figure 4: Flowchart showing the sequence of the address-decoder test program.

Listing 3: BASIC program testing the RS-232C handshaking signals of the COMM-80.

60 DATA 0,0,0,2,128,48,1,64,192,3,129,240
65 FOR X=0 TO 3 : READ A(X),B(X),C(X) : NEXT X
2000 REM THIS SUBROUTINE CHECKS THE RS-232 HANDSHAKE LINES
2002 REM THE DTR AND RTS SIGNALS ARE TIED TO RI, CD, DSR, AND CTS
2005 PRINT:PRINT:PRINT "******* RS-232 HANDSHAKE SIGNAL TEST **
2010 POKE 14312,0 : REM SOUND BEEPER
2020 FOR X = 0 TO 3
2040 OUT 234 , A (X) : REM SET DTR AND RTS ON TEST UNIT
2050 D=INP(248) : D=D AND 192 : REM READ CTS AND DSR ON MASTER
2060 IF D<>B(X) THEN 2200
2070 E=INP(232) : E=E AND 240 : REM READ TEST UNIT LINES
2080 IF E<>C(X) THEN 2300
2090 NEXT X
2100 PRINT " RS-232 HANDSHAKE SIGNALS CHECK OK"
2110 RETURN
2200 PRINT " MALFUNCTION ON DTR OR RTS OUTPUT SIGNALS":RETURN
2300 PRINT " MALFUNCTION ON RI, CD, DSR, OR CTS INPUT SIGNALS":RETURN

Listing 4: BASIC program testing the serial input and output of the COMM-80.

50 DATA 0,1,2,4,8,16,32,64,128,255
55 FOR X=1 TO 10 : READ Z(X) : NEXT X
75 DIM N(16)
80 DATA 50,75,110,134,5,150,300,600,1200,1800,2000,2400
85 DATA 3600,4800,7200,9600,19200
90 FOR X=0 TO 15 :READ N(X) : NEXT X
2500 PRINT:PRINT:PRINT "PRESS ANY KEY TO CONTINUE TEST"
2510 IF INKEY$<>"" THEN RETURN ELSE 2510
3000 PRINT:PRINT:PRINT " SERIAL INPUT TEST "
3010 POKE 14312,0 : REM SOUND BEEPER AT START OF TEST
3020 GOSUB 3500
3030 FOR B=0 TO 15
Listing 4 continued on page 62
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Listing 4 continued:

3040 GOSUB 3600
3050 PRINT "CHECKING :N(B):" BITS PER SECOND"
3060 FOR X=1 TO 10
3070 OUT 251,2(X):REM LOAD MASTER UNIT WITH OUTPUT DATA
3075 IF B<5 THEN GOSUB 3950
3080 S=INF(234):REM READ TEST UNIT STATUS REGISTER
3090 S=INF(234) :REM MASK OR, PE, AND FE
3100 IF S1>0 THEN 3800
3110 IF S1=0 THEN 3850
3120 D=INF(235):IF D<>Z(X) THEN 3900
3130 NEXT X
3140 NEXT B
3145 RETURN
3150 PRINT "PRINT :PRINT****** SERIAL OUTPUT TEST ******"
3155 POKE 14312, 0:REM SOUND BEEPER AT START OF TEST
3160 GOSUB 3500
3170 FOR B=0 TO 15
3180 GOSUB 3600

Listing 4 continued on page 64

Figure 5: Flowchart showing the sequence of operations of the parallel I/O test program.

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The $895* Emulator™ performs exactly as you command. With the depression of just a few keys, Emulator users can select terminal control codes of any one of four popular video terminals. The Lear-Siegler ADM-3A, The Soroc 10-120, The DEC VT-52, Or the Hazeltine 1500. Incredible! It's like having four terminals for the price of one.

But, best of all, not only does the Emulator replace these terminals, it outperforms them by offering enhanced user-oriented features. Features that those other terminals just don't have - at any price.

Standard Emulator™ features include: a sharp, crisp 12" non-glare screen with a full 24 line by 80 column display. Twin RS232C serial ports - one for the host computer and one for your printer. Four separate cursor control keys. A separate 18 key numeric pad. Keyboard selectable baud rates and operating modes. And, a host of visual attributes.

No matter which dumb or smart terminal you're using today, don't buy another until you check out our new Emulator™. You'll get the performance of four terminals for the price of one. And you'll probably save hundreds of dollars over the price you paid for your last terminal. Plus, you'll get unparalleled reliability, nationwide service and quick delivery. Call or write us today for all the details. InterTec terminals are distributed worldwide and may be available in your area now.

*Quantity one - Dealer inquiries invited.
Circle 40 on inquiry card.

CHOOSE...

Choose an Apple Desk

A compact bi-level desk ideal for an Apple computer system. This 42" x 31 1/2" desk comes with a shelf to hold two Apple disk drives. The top shelf for your TV or monitor and manuals can also have an optional paper slot to accommodate a printer.

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Mini racks and mini micro racks have standard venting, cable cut outs and adjustable RETMA rails. Choose a stand alone bay or a 48", 60", or 72" desk model in a variety of colors and wood tones. A custom rack is available for the Cromemco.

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Diablo 1600's & 2300's
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T.I. 810 & 820
NEC Spinwriter
Okidata Slimline
Lear Siegler 300's
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Carson, California 90746
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---

Listing 4 continued:

3190 PRINT "CHECKING " ;N(B) ;" BITS PER SECOND"
3200 FOR X=1 TO 10
3210 OUT 235,2(X) :REM LOAD TEST UNIT WITH OUTPUT DATA BYTE
3220 IF B<5 THEN GOSUB 3950
3230 S=INP(250) :REM READ MASTER UNIT STATUS REGISTER
3240 S1=S AND 56 :REM MASK OR, PE, AND FE
3250 IF S1>0 THEN 3800
3260 IF S AND 128=0 THEN 3850
3270 D=INP(251) :IF D<>Z(X) THEN 3900
3280 NEXT X
3290 NEXT B
3300 PRINT:PRINT:PRINT "TEST COMPLETE"
3310 RETURN
3320 OUT 233,B+B*16 :OUT 249,B+B*16 :REM SET EQUAL BAUD RATES
3330 RETURN
3500 OUT 232,0 :OUT 248,0 :REM RESET MASTER AND TEST UNITS
3510 OUT 234,228 :OUT 250,228 :REM SET BOTH UNITS FOR 8 BITS,
3520 REM EVEN PARITY AND 1 STOP BIT
3530 RETURN
3540 OUT 233,B+B*16 :OUT 249,B+B*16 :REM SET EQUAL BAUD RATES
3550 RETURN
3800 PRINT "STATUS BIT ERROR" ;GOSUB 2500 :RETURN
3850 PRINT "NO DATA RECEIVED" ;GOSUB 2500 :RETURN
3900 PRINT "WRONG DATA RECEIVED" ;GOSUB 2500 :RETURN
3950 FOR A=0 TO 60 :NEXT A :RETURN

Text continued from page 58:

is 800 Hz, then the information will go out at 50 bps. If, on the other hand, the clock is 153,600 Hz, the information will go out at 9600 bps. The only difference to the programmer is that, at 9600 bps, he can transmit the next byte sooner.

To read the incoming data, the program periodically reads the UART-status register as would be done with any input port and checks to see if the DAV (data available) flag is set. When that occurs, the program reads the data from the UART and resets the DAV line. Similar I/O-port manipulations accomplish error checking and option setting.

This can be done in BASIC just as well as in assembly code—only, not quite as often. We may be able to send data at 19,200 bps, but it can be sent by BASIC only at about 10 characters per second. Similarly, we may be able to read data from the UART in BASIC at 19,200 bps, but it also better not come any faster than 10 characters per second.

Since we can control the rate at which we send data, we can easily

Text continued on page 70
YOU WILL FIND WHAT WE DID!!

Specifications KG-12C

Input Signal: 1.0±0.2V P-P composite Video sync. negative, fully compatible.
Input Impedance: 75 ohms
CRT: 12", 90° deflection
CRT Color: Green P31 phosphor
Video Amplifier Bandwidth: 18 MHz
Display Format: 25 lines of 80 characters
Scan Frequency: Horizontal—15.75 KHz Vertical—60 Hz
Power Requirement: AC 117 volts 50/60 Hz
Size: 11½" high x 12½" wide x 12" deep
Weight: 16 Lbs

BMC INTERNATIONAL (USA), INC
SUITE 600, UNION BANK BLDG.,
11222 LA CIENEGA BLVD., INGLEWOOD, CA90304
TEL (213) 641-4588 TLX 182379 BMC USA INC

BMC INTERNATIONAL
No. 27, 5-CHOME, TANIMACHI, HIGASHI-KU,
OSAKA 540, JAPAN CABLE "BMCINT" OSAKA
PHONE: OSAKA 768-7791 TELEX: 64930 NISEMIC

Circle 41 on Inquiry card.
Circle 42 on inquiry card.

Guaranteed to operate with Cromemco, North Star and most other S-100 systems. All manuals include applications programs in BASIC. DIP switch selectable port base address.

A/D MODULE
Dependable high-speed analog-to-digital conversion. 12-bit precision, 32 single-ended input channels, or 16 true differential inputs. High-speed sample and hold amplifier. 25 µsec conversion time. Precision analog multiplexer. Vectored interrupt capability. Optional instrumentation amplifier with gain from 1 to 1,000. AIM-12, standard input module with instrumentation amplifier $725
AIM-12B, input module only $635
AIM-11B, 11-bit precision module $575

D/A MODULE
Four independent channels for digital-to-analog conversion. 12-bit precision over full 0° to 70°C range. Jumper selectable outputs. Binary or 2's complement digital inputs. Flexible bit-mapping jumpers allow compatibility with any existing I/O mapped software (either 12- or 8-bit). Super simple programming.
AOM-12, output module $495

REAL TIME CLOCK
Features new OKI CMOS clock chip for day, date, hours, minutes, and seconds. 12 or 24 hour time format. On-board battery backup. Full year operation without battery replacement. Read or write time directly from I/O port. Vectored interrupt capability.
CLK-24 $250

Also available: Industrial control output current module, 4–20 mA — $395.
Nonvolatile CMOS memory, 250 nsec, 4K bytes with battery backup — $395.

California: add 6% tax.
Money back guarantee. 10-day trial.
OEM and dealer inquiries invited.

Figure 6: Schematic diagram of the RS-232C interconnection cable between the master and test units.

Figure 7: Flowchart showing the sequence of operations of the RS-232C handshaking test.
Figure 8: Flowchart of the sequence of operations of the serial input and output tests. Figure 8 continued on page 68
SERIAL OUTPUT TEST

FOR (N,B) DATA RATES:
50, 75, 110, 134.5, 150, 300,
600, 1200, 1800, 2400, 3600, 4800, 7200, 9600,
AND 19200 BITS PER SECOND

SET TEST UNIT AND MASTER UNIT TO SAME DATA RATE

SET TEST UNIT AND MASTER UNIT TO: 8-BIT WORD,
1 STOP BIT, EVEN PARITY

FOR 2(X) DATA BYTES:
0, 1, 2, 4, 8, 16, 32
64, 128, 255

NEXT B

OUTPUT DATA BYTE FROM TEST UNIT TO MASTER UNIT

READ MASTER-UNIT STATUS REGISTER

IS MASTER-UNIT DATA-INPUT BUFFER FULL AND NO ERROR FLAGS?

YES

PRINT "STATUS BIT ERROR"

READ DATA AVAILABLE

IS MASTER-UNIT DATA-INPUT BYTE = X (X)?

NO

PRINT "WRONG DATA RECEIVED"

NEXT X

HAVE 10 DATA BYTES BEEN TRANSMITTED?

YES

HAVE ALL 16 DATA RATES BEEN CHECKED?

YES

EXIT

NO

EXIT

NO
NEVER UNDERSOLD!
That's right, if you can find a lower price in this magazine for any of the items listed in this ad, we will reduce our price below our competitor's price. See each box below to determine how much EXTRA we will cut off of THEIR price if we're not lowest. Please consider the competitor's shipping charges. OUR SHIPPING IS FREE!*
You probably know about the SoftCard—our ingenious circuit card that converts an Apple II into a Z-80 machine running CP/M.

You may even know that with the SoftCard, you get Microsoft's powerful BASIC—extended to support Apple graphics and many other features.

Now, whenever you're ready to get beyond the BASICS, the SoftCard can take you into whole new realms. Starting with two advanced language packages from Microsoft.

**FORTRAN AND COBOL TO GO.**

Now you can run the world's most popular engineering/scientific language and the most popular business language on your Apple. Think what that means: you can choose from literally thousands of "off-the-shelf" applications programs, and have them working with little conversion. Or design your own programs, taking advantage of all the problem-solving power these specialized languages give you.

**FORTRAN-80**

A complete ANSI-standard FORTRAN (except COMPLEX type), with important enhancements. The extremely fast compiler performs extensive code optimization, and, since it doesn't require a "P-code" interpreter at run time, your programs will typically execute 2-3 times faster than with Apple FORTRAN.

FORTRAN is easy to learn if you know BASIC, and the package includes a huge library of floating point, math, and I/O routines you can use in all your programs.

**COBOL-80**

Virtually the only choice for serious business data processing. It's ANSI 1974 standard COBOL, with many user-oriented features added: formatted screen support for CRT terminals, simple segmenting of very large programs, powerful file handling capability, trace debugging, and much more. A separate Sort package is coming soon.

FORTRAN-80 and COBOL-80 are just two more reasons why the Apple with SoftCard is the world's most versatile personal computer. Get all the exciting details from your Microsoft dealer today. And start getting beyond the BASICS.


SoftCard is a trademark of Microsoft. Apple II is a registered trademark of Apple Computer, Inc. Z-80 is a registered trademark of Zilog, Inc. CP/M is a registered trademark of Digital Research, Inc.
Introducing 7 data-shielding improvements from Verbatim for greater disk durability, longer data life.

Improvements to protect your data from head-to-disk abrasion. Improvements to shield your data against loss due to environmental conditions. Improvements that'll deliver a longer lifetime of trouble-free data recording, storage and retrieval than ever before possible.

It's all made possible by Verbatim, with these improvements:

1. A longer-lasting lubricant. Our new lubricant is more resistant to diffusion, to protect against data-destroying head-to-disk contact.

2. An improved liner. Our new liner cleans and removes debris better. It also enables more lubricant to reach the recording head, protecting against head wear.

3. A thicker, more durable coating. Our disks have a more uniform oxide coating for more adhesive and cohesive strength. We've also made it thicker; providing 10% more protective lubricant and an optimized signal resolution for the new recording heads.

4. Advanced polishing techniques. Our burnishing makes our disks uniformly smooth, for better data transfer, less head wear.

5. Reinforcing hub rings. All Verbatim disks are available with hub rings to aid in registration, eliminate slippage, reduce errors, and give...
formance of a lifetime!

better alignment repeatability.  
6. Testing standards that  
go far beyond industry stand-
ards. Every Verbatim disk  
meets or exceeds the most  
demanding of IBM, Shugart,  
ANSI, ECMA and ISO stand-
ards--because we insist on  
Verbatim being the industry  
standard of excellence. 

We analyze raw materials  
down to their molecular con-
tent. We subject every coating  
batch to more than 70 chemi-
cal, magnetic and electrical  
tests. Two separate test groups  
employ life-cycle tests using  
more than 400 disk drives  
from every manufacturer. And  
we conduct "worst case" test-
ing of every bit of every byte  
of every track of every single  
disk. All to insure that Verba-
tim disks always pass the  
ultimate test: satisfying you.

7. A 100% Error-Free  
Certification that means  
more than just "100% error-
free!" Our certification isn't  
based on random sampling,  
or statistical averaging. Rather,  
it's based on extensively test-
ing every single disk. So we  
can state that our disks really  
are 100% error-free, and back  
it up with a one year warranty.

"Try new Verbatim for the  
performance of a lifetime."

We play it back, Verbatim!

Circle 47 on inquiry card.
Dungeon Campaign

Gregg Williams, Editor

One of my favorite games for the Apple II is *Dungeon Campaign*, from Synergistic Software (see "At a Glance" box for details). I cannot think of any game that causes such delight in playing, and I cannot think of a game that offers so much entertainment per unit of program. *Dungeon Campaign* is an example of fine game design and expert use of limited resources. Even though it does not use either game paddles or high-resolution graphics, it is far more entertaining than most games that do.

When the game begins, the computer draws four levels of mazes and erases them (this takes a minute or two). It has just created the maze that you will explore. After the full maze has been created, the program places you in the middle of a blank area that represents the top level of the maze. You use five 1-keystroke commands (U, D, R, L, and J) to move your explorer group (shown as a red square) up, down, right, or left (J for jump can precede any of these commands to jump over a square that might contain danger). As you move in the maze, adjacent walls become visible, allowing you to explore the level you are on. If you are lucky in your explorations, you will find some treasure, your group of explorers will not be totally destroyed, and you will leave the bottom level of the maze, thus winning the game.

The object, of course, is to find treasure; but in your explorations you may find stairways, pit traps, monsters, poison gas, man-eating dragons, and several other inhabitants; I will not tell you about these others to give you the surprise of discovering them. Combat with different kinds of monsters is resolved by die rolls for each side and subsequent computation (all done by the program); this gives the program an entertaining *Dungeons and Dragons*-like flavor.

The program is, at times, subtle. For example, sometimes the bottom level is drawn with the single exit blocked off (the maze is randomly created for each game). At first, I thought there was no way to leave the maze and win the game. But, in a later game, I discovered a "magic carpet" treasure that can be used only once to take your explorers over walls. This is an indication of the sophistication of this seemingly simple (but always enjoyable) game.

---

At a Glance

<table>
<thead>
<tr>
<th>Name</th>
<th><em>Dungeon Campaign</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Low-resolution color graphics game</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Synergistic Software</td>
</tr>
<tr>
<td></td>
<td>5221 120th Ave SE</td>
</tr>
<tr>
<td></td>
<td>Bellevue WA 98006</td>
</tr>
<tr>
<td></td>
<td>(206) 641-1917</td>
</tr>
<tr>
<td>Price</td>
<td>$15 cassette, $17.50 disk</td>
</tr>
<tr>
<td>Format</td>
<td>Cassette tape or 5-inch disk</td>
</tr>
<tr>
<td>Language</td>
<td>Applesoft and Integer BASIC versions (both)</td>
</tr>
</tbody>
</table>

Computer: Apple II or Apple II Plus, with 32 K bytes of memory (16 K bytes for cassette Integer BASIC version)

Documentation: Instruction sheet plus instructions in program

Features: Sound effects through Apple II speaker

Audience: Game enthusiasts of all ages (simple enough for children)
The best news since CP/M...
Customizable full screen editing

Changes You Make On the Screen Become The Changes to the File.

Full screen editing is the fastest and easiest method of editing all types of text files. Straight forward enough for novices, yet also the choice of professionals. VEDIT is a proven full screen editor with unequalled features. You will appreciate that you can easily edit 10 times faster than with a command editor. Since VEDIT is customizable, it adapts to your applications and preferences, instead of requiring you to adapt to it.

VIDIT is ideally suited to program development and its special features make it the most valuable development tool a programmer can have. VEDIT appeals to word processing users too. Many simple text editing tasks, such as mailing lists, are faster and easier to do with VEDIT than with more complex word processors.

Features of VEDIT:

Full screen editor with status line and cursor. The screen continuously displays the region of the file being edited. Changes are made by first moving the cursor to the text you wish to change. You can then overwrite, insert any amount of new text or hit a function key. These changes are immediately reflected on the screen and become the changes to the file.

Full array of cursor movements with single key movement to begin and end of lines and to tab positions.

Function keys for character delete, line delete and allowing line splitting and concatenating.

Text movement is very easy using a text register.

Flexible command mode allows global search and substitute, repetitive editing operations.

File handling allows files to be merged on input, split on output, drive selection and more. Blocks of text are readily copied from one file to another.

Disk buffering can automatically perform Read/Write for files larger than available main memory.

Tabs settable to any positions. Tab key inserts tab character or spaces to next tab position.

Extensive 60 page, clearly written manual with sections for both the beginning and experienced user.

You Customize the Fastest Editor for Word Processing, C-Basic, Fortran and Assembler:

Keyboard layout for all cursor and function keys.
Your screen size. (Up to 70 lines, 200 columns).
Default Tab positions and various parameters.
Scrolling methods.
Cursor type, blinking, reverse video.
Its ideal for diverse hardware, keyboards and applications. For OEMs too.

Ordering: Specify your CRT terminal type, video board or microcomputer, the 8080/Z80 or Z80 code version, and disk format required.

Standard Package: Disk and manual...........$110
Manual: Price refunded with software purchase $ 15
PICEON V-100: 24 X 80 Video display board . . $445

VISA and MASTER CHARGE Welcome.
Attractive Dealer Terms.
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Since KRAM™ was introduced in 1979 it has fast become known as the users. Now, after hundreds of requests we have added MULTI-KEY, IBM/370 users have VSAM (Virtual Storage Access Method) to provide fast, flexible keyed-access to their data. Now SUPER KRAM (Keyed Random Access Method), from United Software of America, gives Apple and Pet users the same flexibility, substantially increasing the processing power of the Apple and Pet.

Until SUPER KRAM the only "random access" capability in the Apple and Pet consisted of a crude form of "relative record" processing. While this is usable for very simple applications, it falls far short of the needs of today's business and analytical applications. Using SUPER KRAM records may be processed by any one of multiple "Key" values, which may consist of any kind of data: numbers, letters, special characters, etc. Even Apple's long-awaited DOS 3.3 doesn't have anything like this!!

KRAM™2.0 Regular Features

- Written in 6502 machine code
- Basic compatible
- Create/Open a dataset
- Put record by key
- Add & delete records by key
- Get any record by Full/Partial key
- Access by any key in as little as .2 sec. (.1 sec. with Corvus disk)
- Supports multiple disks
- Read next or previous record
- Dynamic space allocation
- Dynamic space reclamtion
- Dynamic index compression
- Files never need reorganization
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(212) 682-0347 Telex 640055

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APPLE WORLD turns your Apple into a sophisticated graphics system capable of creating animated three-dimensional color images, projecting them in true perspective on the screen, rotate them, move them closer, further away, and many other exciting and imaginative things.

Draws objects with 65,000 points per side.

A powerful screen-oriented text editor is included to facilitate image formation. This program was recently featured on Tom Snyder's Prime Time Saturday TV Show and is now available for sale.

APPLE WORLD's powerful editor is so easy to use that children will love it. You can now "sketch" your dream house, boat, car, or fantasy empire. Then view it as it would be seen from 10,000 feet, or you can ZOOM in until the screen is filled with a doorknob. You could then go inside and move from room to room examining furniture placement as your screen rotates within the room. Images or specific parts of images can easily be saved to disk or printer.

Does all this sound like science fiction? You won't think so after you have visited Apple World.

Introductory Price $59.95

For 48K Apple II or Plus with Disk
You've Asked For It, Now You Got It!

quickest and most powerful access method for serious Apple and Pet
MULTI-INDEX, functions, as well as increasing processing speed.

SUPER KRAM’S™ Added Features

- **MULTIKEY SUPPORT** — Allowing simultaneous access to a KRAM file by more than one key field.
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**LOGICAL RECORDS (KEYS MAY BE NON-UNIQUE)** — Records added to the KRAM files are immediately accessible by any of the defined keys for the file (Automatic Upgrade).

**KRAM 2.0 files are totally compatible with SUPER KRAM**

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Apple & Pet requirements - KRAM 2.0 and SUPER KRAM are designed to work with both Apple II's, Disk II, and Corvus Systems 10 Megabyte Winchester Disk, and Commodore's 2040, 3040, and 8050 Disk units. KRAM 2.0 and SUPER KRAM require 32K/48K Apple and a least one disk drive.

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For 48K Apple II or Plus with Disk II $39.95 for disk
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SUPER KRAM™ Only $175
A Stellar Trek

Harold Nelson, Editor

You, captain of the starship Enterprise, begin your task of freeing the galaxy from the threat of the Klingon Empire and its Romulan allies by selecting the members of your crew. Next you must make some general strategy decisions.

There are two types of encounters (games) to choose from. Regular games are always different, while tournament games have identical outcomes if played in the same way. This is an interesting feature, because most games of this type are either stochastic (output from a given input is somewhat random) or deterministic (output from a given input is fixed). This feature of choice between these two kinds of games opens many possibilities for developing and practicing strategies, competing against other players, and still not "running out of game" as soon as a game has been successfully completed.

At a Glance

<table>
<thead>
<tr>
<th>Name</th>
<th>A Stellar Trek</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>High-resolution color graphics game</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Rainbow Computing Inc</td>
</tr>
<tr>
<td>Location</td>
<td>9719 Reseda Blvd</td>
</tr>
<tr>
<td>Price</td>
<td>$24.95</td>
</tr>
<tr>
<td>Format</td>
<td>5-inch floppy disk</td>
</tr>
<tr>
<td>Language</td>
<td>BASIC</td>
</tr>
</tbody>
</table>

THE FIRST TRS-80® COMPATIBLE COMPUTER
WITH HIGH DENSITY COLOR GRAPHICS!

LNW RESEARCH introduces the LNW80, a high performance color computer, compatible with the TRS-80™ Model I. The fully integrated LNW80 is a sophisticated and versatile microcomputer with the following powerful features:

COMPATIBILITY
Backboard and software compatible to the Radio Shack TRS-80™ Model I computer, provides the widest software base of any microcomputer.

DISPLAY
Quality upper and lower case display.

Two modes of color graphics, high resolution graphics, 384 x 192 in eight colors - higher density than the Apple II. Low density color graphics of 128 x 192 are also available in eight colors.

High resolution - black and white graphics - of 384 x 192 mixed with text and TRS-80™ standard graphics.

Reverse video - composite video, RF output.

PERFORMANCE
The LNW80 utilizes the fast Z-80A microprocessor which executes at a speed of 4 MHz - over twice the speed of the TRS-80™ Model I.

NEW
EXTERNAL DATA SEPARATOR
ASSEMBLED AND FULLY TESTED
$14.95
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SYSTEM EXPANSION
AT $69.95 [PC BOARD & USER MANUAL] +
- SERIAL RS232/70 A 110
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- 32K BYTES MEMORY
- PARALLEL PRINTER PORT
- DUAL CASSETTE PORT
- REAL-TIME CLOCK
- SCREEN PRINTER PLUS
- ONBOARD POWER SUPPLY
- SOFTWARE COMPATIBLE
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Sound engineering and common sense were the basic ingredients in our design parameters for the IMM-816. Your needs were our guidelines. The end result is a reliable memory with remarkable features at competitive prices.

* FULL IEEE COMPLIANCE
* LOW POWER 8279 STATIC MEMORIES
* 8 BIT EXTENDED ADDRESS OPTION
* ADDRESSABLE IN 2 SEPARATE BLOCKS OF 8K BOUNDARY

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* WAIT STATE ENABLE OPTIONS (0-2)
* MWRT/PWR OPTION
* 16 ENABLE

MODEL IMM-816

All lines are buffered to one low power Schottky TTL load. Our memory can coast at 2MHz or zip along at a fast 4 MHz clip. All functions are DIP switch selectable without wire jumpers. We used high quality parts such as the Angat face-grip, low profile sockets to assure maximum component retention.

If your system employs Bank Select operation, our Memory Manager Card (Model IMM-900) may be used to emulate virtually any bank select format currently in existence; i.e. Cromemco, Alpha Micro, Horizon, etc. The memory management card consists of a simple I/O port, switch selectable to any 8 bit address. Data is written to 8 IEEE extended address lines (A16-A23) to set the desired active bank.

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| IMM 816K-85 | 4MHz KIT | $315 |
| IMM 816A-45 | 2MHz Assembled & Tested | $285 |
| IMM 816A-85 | 4MHz Assembled & Tested | $350 |
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| IMM 900A | Assembled & Tested | $88 |

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Canoga Park, California 91306 • (213) 887-5737
Photo 1: The Klingon ship in sector 9 (row), 9 (column) fires on the Enterprise in sector 5,2. In addition to the Enterprise and three Klingon ships, there are six stars in this quadrant. To the right of the quadrant display is important status information. Below that is a grid giving information on the quadrants surrounding the one currently occupied by the Enterprise, with the displayed quadrant in the center. In the space below the display you are given some messages and enter your commands.

Photo 2: A photon torpedo from the Enterprise is on its way to the Klingon ship in sector 3,1.

Your next decision is to determine the length of your trek (in stardates, not real time). The longer the game, of course, the more opponents you will have to overcome.

Finally, you will select the level of difficulty for your encounters. The choices range from Novice (quite easy), through Expert (extremely difficult), to Emeritus (perhaps not humanly possible).

Having made your choices, you are ready to begin your mission. From this point on, the format for playing A Stellar Trek is basically that of the standard Star Trek games. You can move about the galaxy of sixty-four "quadrants" seeking Klingons or visiting starbases for energy and repairs. The Move commands (manual or automatic) require some thought and care in execution, but the documentation explaining their use is quite clear.

When you encounter Klingons or Romulans, you can do battle using either phasers or photon torpedoes. Again, use of these commands requires some care but here, too, the documentation is very good (see box).
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A Stellar Trek also has several interesting commands not present in standard versions of Star Trek games. For example, you can scan a nearby planet for dilithium crystals. If they are present, you can beam down to the planet, mine the crystals, and return them to the Enterprise. The dilithium crystals can then be used as an emergency source of energy, though they tend to be unstable. You can, if you are desperate enough, employ an experimental death ray. Even if the Enterprise is abandoned or destroyed, all is not necessarily lost.

An important feature, since games can take a very long time, is the Freeze command. This enables the player to save the game being played for later completion.

A Stellar Trek makes very fine use of the Apple II high-resolution graphics. (See photos 1 and 2.)

As indicated above, this game is not played in real time. The only annoying aspect of the game, in fact, is the amount of time it takes for displays to change, to enter new commands, and to be able to react to new situations. It also takes an awfully long time for a photon torpedo to find (or miss) its target.

Apart from the fact that this is not a fast-paced game, it is, in all other respects, an excellent version of an old standard. It requires thought, planning, and some luck. It provides engaging enjoyment (or frustration for the unwary). A Stellar Trek is a very fine game and makes good use of the capabilities of the computer.

Note: The documentation contained in the original package received did not explain all of the options available with the use of the phasers. However, a call to the people at Rainbow Computing Inc resulted in an updated version of the documentation. This new version nicely clarifies all possible uses of the phasers and a few other matters in addition. This immediate action based on our suggestions is very impressive. It seems that this company has a sincere interest in user satisfaction from its software.
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- Basic St

APPENDIX C

Almost every single program included in these volumes will run in every Computer system that operates in Basic. A few changes may be required for some Basics but most of these changes are covered in one of the Tables and Appendices included in Volumes III, VI, VIII, and X.

Volume VI - Disk programs are compatible with TRS-80 disk basic

The disk programs in Volumes VI, VII and X are written in (C/F/M) Basic and Disk Extended Microsoft Basic. Other programs written in 8K Basic.

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<thead>
<tr>
<th>Feature</th>
<th>MICRO B⁺⁺</th>
<th>The Other One</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Random Access by Key</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>- Wild Card Search</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>- Key-Sequential Access</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>- Multiple Keys</td>
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<td>YES</td>
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<tr>
<td>- Automatic Space</td>
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<td>YES</td>
</tr>
<tr>
<td>- Reclamation</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>- Eliminate Overflow Files</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>- Maximum Number of Entries</td>
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<td>10,000</td>
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<tr>
<td>- Eliminate Index File</td>
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<td>NO</td>
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<tr>
<td>- Reorganization</td>
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<td>NO</td>
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<tr>
<td>- Guaranteed Optimal Index File</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>- Maximum Disk Accesses To Reach Any of 10,000 Entries</td>
<td>3</td>
<td>?</td>
</tr>
<tr>
<td>- Duplicate Key Values</td>
<td>YES²</td>
<td>NO</td>
</tr>
</tbody>
</table>

¹32,767 for the source code versions.
²Source code versions only.

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Product Review

Morloc’s Tower

Gregg Williams, Editor

The Automated Simulations’ Dunjonquest games are as close to a computer-automated Dungeons-and-Dragons-type dungeon as I have seen. Naturally such games do not have the inventiveness or the vindictiveness of a human dungeonmaster. They do have the advantage of allowing you solitary play. And, in contrast to conventional Adventures which are essentially puzzles that, once solved, hold no interest, the Dunjonquest games are randomly configured at startup to give you a worthwhile game even if you have won the game before.

Morloc’s Tower is a Dunjonquest of average complexity, simpler than The Temple of Apshai, yet more complicated than the beginner’s Datestones of Ryn. Your character is Brian Hammerhand, and his self-imposed task is to kill Morloc the Mad before sunrise to prevent the destruction of Hagedorn, a village under Morloc’s rule. The format of the game is simple: the screen shows an overhead outline of the room you (i.e. Brian) currently are in (see photo 1). Your character, a small graphics figure in the center of the room, can be caused to move, fight, search, and perform other tasks by an appropriate 1- or 2-keystroke command. There are thirty rooms in the Tower, six levels of five rooms each, and they are drawn for you as you enter them through doors (secret and visible) and stairwells.

At a Glance

<table>
<thead>
<tr>
<th>Name</th>
<th>Morloc’s Tower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language</td>
<td>BASIC</td>
</tr>
<tr>
<td>Type</td>
<td>Graphic role-playing Adventure game</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Automated Simulations Inc</td>
</tr>
<tr>
<td>Computer</td>
<td>Radio Shack TRS-80</td>
</tr>
<tr>
<td>Documentation</td>
<td>Sixteen-page booklet, 5½ by 8½ inches (14 by 21.5 cm)</td>
</tr>
<tr>
<td>Audience</td>
<td>Game enthusiasts (10 years or older)</td>
</tr>
<tr>
<td>Price</td>
<td>$14.95</td>
</tr>
<tr>
<td>Format</td>
<td>Cassette (also available on floppy disk)</td>
</tr>
</tbody>
</table>
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The game is similar to conventional Adventures in that there are several treasures in the Tower, some of which are necessary to kill Morloc, others of which will hinder or harm you in the attempt. And, of course, there are monsters that will try to kill you. As an example of commands in Morloc’s Tower, fighting commands are A (attack), T (thrust), P (parry), F (fire a normal arrow), and M (fire a magic arrow). Each command has different effects on you and your attacker, usually trading off effectiveness of attack or defense with the degree of fatigue or wounds suffered by you. The game takes place in real time, which means you have to act quickly in fights. This makes the game a lot more interesting than most Adventures.

This game, like other role-playing games, takes a lot of time to play, and Morloc’s Tower must be played at one sitting; there are no commands to save the state of the game. The version that I used, a cassette version for the TRS-80 Model I, is contained on both sides of the cassette. Side one is the program itself, while side two contains three sets of data statements, one of which is read to create a game in one of three levels of complexity. (I found that you have to leave the remote jack in the TRS-80 cassette recorder during loading; the program doesn’t have enough time to “digest” the data if the tape runs uninterrupted.)

My only complaint against the game is one of speed; character movement is just a bit slow, and the delay of over a minute to redraw a fully explored level (when returning to it from another level) is quite annoying. Both these problems could be solved with a machine-language version of the game. This is the route that all the major Adventure writers (Scott Adams and Greg Hassett, in particular) have taken to improve the quality of their games.

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One Friday afternoon recently, I decided to try my hand at a new game that sounded most intriguing. The evening before I had read over the game documentation pamphlet (I would urge any Odyssey adventurer to do the same before undertaking a game). On this particular Friday, I played one game which ended in less than success. A friend then joined me and we played a game together—one person at the keyboard and the other going through the documentation pamphlet. We must have begun this game around 4:30 PM. After thoroughly touring the island on which the game begins (see photo 1) and amassing a large army, a good deal of wealth, and considerable equipment, we decided to embark on a ship we had just purchased (very reasonably priced) for another island. Thinking it was about 6:30 PM, we decided to have something to eat before going to sea. We were astonished to discover that it was actually about 8:00 PM. We had been playing for nearly four hours, though it seemed like only half that time.
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Obviously, we decided, this is a game worthy of high praise. There is only one warning for the prospective player. The warning is simple: make sure you have sufficient time. It is obviously an engrossing game. It might be advisable to keep a clock handy or even set an alarm to remind you of your desired quitting time. Since a game in progress can be saved on any initialized disk and completed later, it is probably better to break off a game than risk the loss of family or job.

Upon returning to our game on that Friday evening, we set sail and were just getting the knack of handling our ship when we were lost in a fog bank and ran aground. We spent quite awhile trying, unsuccessfully, to get free. When we first went aground there was a brief message to the effect that local fishermen would help us for a price. This message appeared quite briefly and did not reappear.

In a case such as this, if the correct command is not found, it may seem as though there is a bug in the program causing it to go into an infinite loop. A call to Synergistic Software convinced us that this is not the case and that there is one command that can result in freeing a ship caught in this situation. (Hint: Use quadroons.)

Some friends have said that they would like to see a little more detail in the documentation about the outcome of battles with bandits and various monsters is determined. But, on the other hand, the element of uncertainty and chance that the user experiences may add to the excitement and enjoyment of the game. Also, the documentation does include the relative worth of the different offensive and defensive devices available. And, with some luck, one can increase his ability to avoid battle when its outcome appears doubtful.

The finest feature of this game is its use of high-resolution color graphics. It is the best use of color graphics in a game for the Apple that I have seen.

While this program does not operate in real time, certain features of the game give the user the illusion that it is doing just that. This is especially true of traveling on horseback, flying on a magic rug (should you encounter a wizard inclined to give you one), and sailing.

Another strong feature of the game is the great number of possible encounters both on land and at sea and the variety of outcomes that can result from these encounters. These are too numerous to list or begin to describe in a brief review, and learning to deal with them is a major part of the enjoyment of this game.

It is also interesting that, as opposed to some Adventure games, it is virtually impossible to reproduce an Odyssey game. Each game starts at a randomly chosen point and the locations of castles, tombs, and other objects and creatures are also changed with each game. Hence, each game is unique.

Conclusions

- This is a very fine game for the Apple II computer. It makes excellent use of color graphics. Fans of Adventure and Dungeon games should find this to be an interesting and challenging addition, with some new twists, to their collections. For those just developing an interest in this type of game, Odyssey is such a good one that starting with it may greatly diminish the interest you have in other Adventure games.
- The documentation seems, at the very least, adequate. Some users may desire more detail on how various aspects of the program work. At any rate, there is enough information, presented in a clear and interesting manner, to allow virtually anyone to start playing the game.
- My only criticism of the program is that some of the messages offering hints on what to do next (such as that mentioned above about the local fishermen) appear so briefly that if their meaning is not clear at first or if you are momentarily distracted, they might as well not have been there at all.
- It is important to keep in mind that a well-played game of Odyssey is going to take a lot of time, but games can be saved and played in installments. The only short game is an unsuccessful game with an obvious outcome.
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The Twelve Computerized Days of Christmas

Teri Li and Elizabeth Cooper, POB 481, Peterborough NH 03458

On the first day of Christmas, my computer gave to me
A glitch on the video screen.

On the second day of Christmas, my computer gave to me
Two keyboard bounces,
And a glitch on the video screen.

On the third day of Christmas, my computer gave to me
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the fourth day of Christmas, my computer gave to me
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the fifth day of Christmas, my computer gave to me
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the sixth day of Christmas, my computer gave to me
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the seventh day of Christmas, my computer gave to me
Seven system resets,
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the eighth day of Christmas, my computer gave to me
Eight worthless printouts,
Seven system resets,
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the ninth day of Christmas, my computer gave to me
Nine burnt-out fuses,
Eight worthless printouts,
Seven system resets,
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the tenth day of Christmas, my computer gave to me
Ten disk-drive lockouts,
Nine burnt-out fuses,
Eight worthless printouts,
Seven system resets,
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the eleventh day of Christmas, my computer gave to me
Eleven damaged diskettes,
Ten disk-drive lockouts,
Nine burnt-out fuses,
Eight worthless printouts,
Seven system resets,
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
Three loose plugs,
Two keyboard bounces,
And a glitch on the video screen.

On the twelfth day of Christmas, my computer gave to me
Twelve blown-out circuits,
Enter damaged diskettes,
Ten disk-drive lockouts,
Nine burnt-out fuses,
Eight worthless printouts,
Seven system resets,
Six I/O spasms,
Five blank cassettes,
Four garbled SAVEs,
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Graphic Color Slides

Part 2

In “Graphic Color Slides, Part 1” (November 1980 BYTE, page 126), I demonstrated a series of subroutines for the Compucolor II that together can be used to plot a set of points, an equation, or horizontal or vertical bar graphs. The listings in this article, when added to the subroutines given in listing 1 of the cited article, will enable us to plot several new types of graphs. These listings also demonstrate the use of these subroutines in building special-purpose programs that generate a desired kind of graph. The programs listed here are designed to run on a Compucolor II with extended disk BASIC and at least 16 K bytes of programmable memory.

The first three graph programs have been written as part of a single program (see listing 1); the equation plotting, histogram, and regression routines all use the subroutines unaltered. Both the histogram and regression routines use a statistics subroutine at line 11400 that calculates the arithmetic average (program variable MEAN) and the standard deviation (variable DEVIAT). The monthly analysis chart routine, given in listing 2, illustrates how the graphics subroutines can be modified for a new application; the subroutine lines in listing 2 are the only lines being changed, not the entire subroutine. As before, the variable names used in these listings have been chosen to describe their function.

Equation Plotting

The equation plotting routine is contained in lines 1000 thru 1086 of listing 1. This routine is similar to the one in last month’s article in that it allows the user to change screen colors and to save a finished graph; but this routine allows you to graph a new equation, select a different type of plot (line or vertical bars), and choose different X- and Y-ranges. Photos 1a thru 1d illustrate the same equation, \( Y = X^4 - 4X^3 \), plotted in several different ways.

Histogram

The histogram plotting routine, lines 2000 thru 2390 in listing 1, allows the distribution of a given set of data to be displayed as a histogram. In addition, the theoretical Gaussian (bell-shaped) curve with the same mean and standard deviation is superimposed on the histogram; also, the areas under the curve and the histogram are the same.

Within the listing, the one-dimensional data to be plotted as part of the histogram is stored in \( \text{ARRAY}(N,0) \)—that is, in \( \text{ARRAY}(1,0) \), \( \text{ARRAY}(2,0) \), \( \text{ARRAY}(3,0) \), etc. The data is analyzed to determine the largest and smallest numbers to be graphed on the horizontal axis and the step size (variables HIGH (0), LOW (0), and JUMP (0), respectively). The user selects the number of bars in the histogram, and the value is stored in the variable COLUMNS. The data is classified as belonging to one of COLUMNS groups, and the tally of the number of data items belonging to group \( N \) (where \( N \) is between 1 and COLUMNS, inclusive) is stored in \( \text{ARRAY} N, 1 \). The height of the equivalent Gaussian curve is calculated in the statistical subroutine at line 11400, leading to the display of
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the histogram and Gaussian curve with labeled X- and Y-axes.

The same data, once entered, can be displayed with different colors and a different number of histogram bars. Photos 2a thru 2c show the same set of data displayed in different ways.

Regression
The regression routine, lines 4000 thru 4760 of listing 1, allows two sets of data to be plotted with a regression line for comparison. The two sets of data are graphed as X, Y pairs (with the X data being the independent variable and the Y data the dependent variable). Then the computer finds the best line that describes a certain presumed relationship (linear, logarithmic, exponential, or reciprocal, as chosen by the user) for those points. If the chosen relationship is linear (if the user is performing a linear regression), the actual Y value is plotted with its given X value. If the relationship is logarithmic, exponential, or reciprocal, the dependent (Y) variable is replaced by the appropriate transformed value—that is, the X data point is plotted opposite In Y, e^Y, or 1/Y, respectively.

After the data pairs and the regression type have been entered, the original Y data (stored in ARRAY [N,2]) is transformed according to the regression type, with the transformed Y values stored in ARRAY (N,1). At this point, the program makes the necessary calculations and displays the resulting graph, plotting the data points and the regression line that best fits them. (Actually, the regression line given by any regression except linear regression is not a straight line but rather a logarithmic, exponential, or reciprocal curve that best fits the data. These curves appear as straight lines because we are graphing X not against Y, but against a transform function of Y—in Y, e^Y, or 1/Y, respectively.)

Once the data has been entered, it can be displayed in different colors with different kinds of regression. Photos 3a thru 3d show the same data graphed varying the colors and regression type. The data was taken from the following example: we have four test tubes (2, 3, 4, and 6) from a larger series of test tubes, and each one has a chemical solution in it; the independent (X) variable is the tube number, and the dependent (Y) variable is the measured strength of the solution in that tube. A linear regression on these data points (photo 3a) provides a poor fit, as does exponential regression (photo 3b). Logarithmic regression provides a better fit (photo 3c), but reciprocal regression provides the best fit of all (photo 3d).

Monthly Analysis Graph
The monthly analysis graph, shown in photos 4a and 4b, is a specific case of a graph that will plot the values of one or more variables over a given range of the independent variable. Here, income for 4 years is plotted for each month of the year. The

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Monthly Analysis Graph
The monthly analysis graph, shown in photos 4a and 4b, is a specific case of a graph that will plot the values of one or more variables over a given range of the independent variable. Here, income for 4 years is plotted for each month of the year. The
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Listing 1: Menu-driven program to produce equation plots, histograms, or regression graphs. In order to run correctly, this program needs the subroutines from Listing 1 of Part 1 of this article added to it.

5 REM KY 5 REM GRAPHES. (C) A.W. GROGONO. AUGUST 1979
6 REM HISTOGRAM, REGRESSION, EQUATION, VI
40 RESTORE .CLEAR 200:DIM I$(12)
50 DATA 1,2,6,4:FOR I= 1 TO 4:READ COLOUR(I):NEXT I
90 PRINT "S P E C I A L G R A P H S":PRINT
110 PRINT :PRINT ,"1. CREATE HISTOGRAM"
120 PRINT :PRINT ,"2. LINEAR REGRESSION"
130 PRINT :PRINT ,"3. PLOT EQUATION"
140 PRINT :PRINT ,"4. ERASE/REVIEW IMAGES"
150 PRINT :PRINT ,"5. MAIN MENU"
190 PRINT :PRINT :INPUT "X-BARS OF: " ; CHOICE
200 ON CHOICE GOSUB 2000,4000,1000,1000,2200: GOTO 5
220 LOAD "MENU":RUN
490 REM WRITE EQUATION AT 500, EG: 500 Y= X^2 - 3* X
510 RETURN
991 REM
992 REM SUBROUTINE TO PLOT EQUATION
993 REM
2000 GOSUB 10000: REM HISTOGRAM
2010 AX1S= 0:GOSUB 10200:GOSUB 10310
2015 IF HIGH(O) THEN 2020
2017 BIG(O)= BIG(O)+ JUMP(0)/ 2: GOSUB 10310
2020 PLOT 6,6,12,3,5:PRINT "THE HISTOGRAM WILL EXTEND FROM ";
2030 PRINT LOW(O):" TO ";HIGH(O):PRINT :PRINT
2040 PRINT ,"SELECT NUMBER OF COLUMNS IN HISTOGRAM: ";PRINT
2050 DATA 4„6„8„12„16„24
2060 RESTORE 2050,PRINT :FOR I= 1 TO 6:READ COLUMNS$:
2070 PRINT ,";CHR$(64+ I):" ;COLUMNS$;" COLUMNS"
2080 PRINT :NEXT I
2110 PRINT ,"INPUT "SELECT A - F: ";J$:J$:ASC(J$)- 64:REM
2120 IF J$< 10 OR J$> 6 THEN PLOT 28,11:GOTO 2110
2130 RESTORE 2050:FOR I= 1 TO J$:READ COLUMNS$:NEXT I
2140 COLUMNS= VAL (COLUMNS$)
Listing 1 continued on page 102
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The number of color maps and the colors in each map is completely under software control. With a 6-plane memory (640 x 480 x 6), up to 64 colors can be displayed on the screen simultaneously. With a 3-plane memory (320 x 240 x 3), up to 8 simultaneous colors can be displayed from any one of eight color maps. The output of the color map produces eight levels each for red, blue and green. The result is the selection of 512 possible levels of intensity, saturation and hue. Switching from map to map is under software control.

Zoning
The 8600 monitor screen can be divided into a maximum of four variable size zones. In a typical application, the upper three zones can display graphics while the lower zone displays text. The text can be scrolled or slow scrolled while the graphics are changing to coincide with the text changes.

While some of the features of Terak's new 8600 can be found in other computer graphic systems, no other system in the $5K-$20K price class (and even those costing thousands more) provides a comparable combination of features and benefits. Features such as

Low Entry Cost
The basic 8600 color system is priced at about $15,000. It can be upgraded to higher resolution and a greater number of colors, but even fully expanded it still comes in at less than $19,000.

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Dual Processors For Speed and Flexibility

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DEC Based Hardware and Software

The DEC based hardware and software includes the LSI-11 main processor, RT-11 operating system and Q bus compatibility. As a result, the 8600 will support a variety of software and easily integrates peripheral devices.

USCD Pascal, Too

The 8600 also supports the easy to use USCD Pascal operating system for program development, text editing, word processing and interactive applications.

Siggraph Core Standards, 2D1 Level

Graphic support is provided for USCD Pascal and RT-11 for Fortran, Basic and Pascal.

The Other Reasons?

Add such things as graphics display list processing, a high resolution quadrant, four modes of display blanking, emulation, remote on-line diagnostics, etc. The list goes on and on. But to fully appreciate the system you should see one in action. We'll be happy to set up an appointment. Just contact us.

Flexible

Character Generation

Unlike the rigid cell sizes of many graphic display systems, the 8600 character generation is under software control. Characters can be programmed to any size or shape including the creation and display of foreign languages such as Arabic, Hebrew, Russian, etc., mathematical symbols, primitives, specially configured letters, characters or symbols and a host of others.

Fill Algorithms

Terak's fill algorithms are fast and allows you to fill the inside of simple or complex geometric figures without calculating points. This not only helps define charts, graphs, etc., but greatly enhances the appearance of presentation material.

Smooth or Line Scrolling

The speed of the vertical, bi-directional scrolling is under operator control. It can be slowed down for text editing or speeded up for search. And, unlike most terminals that jump a line at a time, the 8600 moves in increments of one scan line. The result is a smooth moving text that is easy to read.

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The 8600 can be synchronized to receive externally generated RGB signals or transmit 8600 signals to external video monitors. This lets you combine and/or overlay internally and externally generated characters and graphics onto a single screen if mixing hardware is incorporated in the system.
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Listing 2: Programs for monthly analysis graph. Because this program modifies some of the previously written subroutines, this program should be added to the subroutines given in listing 1 of Part 1 of this article. (If the subroutines are added to this listing, the program will not run correctly.)

5 REM KY 5 REM  GRAPH  (C) R.W. GROGONO. AUG. 1979
6 REM MONTHLY ANALYSIS FOR UP TO 7 YEARS
40 RESTORE :CLEAR 200:DIM I$(12)
50 DATA 1.2.1.2.4.6.3.5.7:FOR I= 1 TO 9:READ COLOUR(I):NEXT I
90 PLOT 29,27,24,15,14,2,255,6,1,12,3,16,3:REM CLEAR PAGE
96 REM
99 REM
252 PRINT "MONTHLY COMPARISON":PRINT
254 PRINT :PRINT ","THIS PROGRAM ALLOWS YOU TO" 
255 PRINT :PRINT",ENTER PROFITS OR INCOME ETC"
256 PRINT :PRINT",MONTHLY FOR UP TO 7 YEARS."
257 PLOT 10,10,10,9,9:PRINT "YOU CAN START AND FINISH"
258 PRINT :PRINT",PART WAY THROUGH THE FIRST"
259 PRINT :PRINT",AND LAST YEARS RESPECTIVELY"
260 PRINT :PRINT",BY ENTERING THE NUMBERS OF"
261 PRINT :PRINT",OF THESE MONTHS."
264 PRINT :PRINT:"1. CREATE GRAPH":REM
266 PRINT :PRINT ",2. ERASE/REVIEW OLD GRAPHS"
267 PRINT :PRINT ",3. RETURN TO MAIN MENU":PRINT :PRINT , ,
268 INPUT "ENTER 1 - 3 "::I:IF I= 2 THEN GOSUB 7000:GOTO 5
270 IF I= 3 THEN "SET MENU":RUN
272 PLOT 12,3,16,5:INPUT "ENTER # OF YEARS: ":N
274 FOR Y= 1 TO N: PLOT 6,Y,10,9,9:PRINT "ENTER YEAR NUMBER ":Y;
275 INPUT ":;Y$(Y):NEXT Y:PLOT 10,9,6,1:PRINT "FOR YEAR ";
276 PRINT Y$(1):INPUT ":, ENTER # OF FIRST MONTH: 1-12: ":FIST
277 PLOT 10,9,6,6:PRINT "FOR "":Y$(N);
278 INPUT ":, ENTER # OF LAST MONTH: 1-12: ":LAST
279 GOSUB 10000: FOR Y= 1 TO N: GOSUB 10030: NEXT Y
280 LITTLE(0)= 0:BIG(0)= 12
281 LITTLE(1)= ARRAY(1,2):BIG(1)= ARRAY(1,2)
282 FOR Y= 1 TO N: FOR ITEM= 1 TO 12
283 IF Y# ITEM= 10:REM COPY NEXT YEAR
284 NEXT ITEM:AXIS= 1:GOSUB 10215:NEXT Y:REM FIND BIG, LITTLE
285 GOSUB 600:REM SELECT ZERO END FOR Y-AXIS
286 GOSUB 10500:REM FRAME
287 FOR Y= 1 TO N: F= 1:IF Y= 1 THEN F= FIRST
288 L= 12:IF Y= NTTHEN L= LAST
290 FOR ITEM= 1 TO N: GOSUB 10300: FOR ITEM= 10 TO 12
292 NEXT ITEM
320 GOSUB 11000:REM LINE
322 PLOT 3,59,20+N- Y$: 3:PRINT Y$(Y):REM YEAR IN GRAPH-COLOR
324 NEXT Y:GOSUB 11500:REM SAVE
325 GOSUB 11000: IF K= "C" THEN GOTO 256: REM COLORS
330 PLOT 3,15,31:INPUT "ENTER A TO ALTER Y-AXIS ZERO: ":J$ 
340 IF J$= "A" THEN 200: REM NEW ZERO
350 GOTO 5
690 PLOT 6,6,14,12,3,16,5:PRINT LABEL$(1):PLOT 15,6,1,10,10
680 PRINT ",SELECT LENGTH OF SCALE":PRINT
610 PRINT :PRINT ",1. WITH ORIGIN STARTING AT ZERO"
620 PRINT :PRINT ",2. MAXIMUM ENLARGEMENT"
630 PRINT :PRINT ",;INPUT "SELECT 1 OR 2: ":I
640 IF I= 1 THEN LITTLE(1)= 0 
650 GOSUB 10300:RETURN : REM SCALE VALUES
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Text continued from page 98:

independent (X) variable is the month of the year, while the dependent (Y) variable is the income in dollars for 1 month; four variables (the income in each of 4 years) are plotted on this graph.

When you run the monthly analysis graph program (by adding listing 2 to the subroutine lines of listing 1 in last month's article), you are asked for the numbers of the years to be graphed, followed by the beginning month for the first year and the ending month of the last year to be graphed. (This program is written to account for the possibility that you may not have all the data for the
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beginning and ending years.) After the title, Y-axis label, and monthly data values have been entered, the program calculates and displays the data on the color video display screen. The Y-axis can start at zero (as in photo 4a), or it can start at some nonzero value to allow maximum use of the Y-axis (as in photo 4b). As before, the colors used in the graph may also be changed.

Summary
The programs were written with readability as the main objective. You may wish to decrease the memory needed to store these subroutines by omitting REMark statements and putting multiple statements on a line. Care should be exercised, however, when compressing statement lines because some subroutines are written to be entered at more than one point.

The Compucolor PLOT statement was more fully explained in last month's article.

The four kinds of graphs described in this article demonstrate how the graphics subroutines can be combined (with or without modification) to form complex programs that produce specialized graphs. These subroutines can be used to substantially reduce the time required to create a given graph. In addition, the use of photographed color images (as opposed to color slides of conventionally produced graphs) can significantly decrease both the time and cost necessary to add color graphs to a slide presentation.

Photo 3: Examples of regression charts. The program in listing 1 allows the entered data to be graphed using different colors and different types of regression—linear (photo 3a), exponential (photo 3b), logarithmic (photo 3c), or reciprocal (photo 3d).

Photo 4: Examples of monthly analysis graphs. These graphs superimpose a variable plotted over a 12-month span for up to seven 12-month graphs. The Y-axis can start either at zero (photo 4a) or at some predefined value (photo 4b).
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Product Review

Sargon II
An Improved Chess-Playing Program for the Apple II

John Martellaro
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The advertising literature for Sargon II quotes a magazine article: "Buy this program when it becomes available..." My reaction: the program is available; buy it. Sargon II is everything Sargon I should have been. It is a mature effort. The program is clean, strong, and debugged. Nearly every deficiency of Sargon has been corrected:

- Sargon II has book openings.
- Sargon II recognizes stalemates.
- The levels of play are geared to clock time instead of ply search. As the pieces disappear, the ply search goes deeper, keeping the time relatively constant.
- Setting up a board position is easier.
- The program shows the move it is thinking of making.
- It will suggest a move for you.
- The graphics are new and very handsome.
- There is the much-asked-for asterisk prompt to indicate that the program is thinking.
- Every check is logged on the screen.
- Move entry is easier, but still not as easy as in Microchess 2.0.
- The playing strength is vastly improved.

Sargon II plays well. I play at an unofficial 1700+ United States Chess Federation (USCF) rating and have never lost a serious chess game to any microcomputer program (Boris 1978, Microchess 2.0, Sargon I), but I lost the first two trial games against Sargon II — mostly from being taken by surprise at its unwillingness to be bullied. Carelessness? Impatience?

After this appalling result, I promptly invited two friends over. They have official USCF ratings of 1650 and 1714, and the former player is extremely familiar with the openings.

We set Sargon II at level 3, the highest level that makes moves in tournament time. By our combined efforts, we cleaned Sargon II off the board — mostly by our
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familiarity with the standard opening moves.

The 1650-rated player, whose lifetime high rating is 1850, has played every available computer chess game, including large mainframe computers. None has ever survived his "fried-liver attack." [The fried-liver attack involves placing the White King's Bishop on c4 and a White Knight on g5, attacking the weak King's Bishop pawn; or the equivalent setup for Black....RSS] Sargon II fared no better and succumbed in 13 moves.

Convinced now that Sargon II could be beaten, I rolled up my sleeves, got very mean, and again set the program for level 3. After 90 minutes of trekking through a bloody, grim Ruy Lopez opening, fending off a Queen-side attack, and using my mobility on the Kingside, I broke through. On move 40, Sargon made a mistake (failure to look far enough ahead), and I blew its position wide open. But for that one mistake, the game would have been a draw.

During the dozen or so games I have played against Sargon II, I have lost only one more game and have made the following observations. Sargon II has much needed and clearly visible improvements over Sargon I. It castles at the most propitious time and actually seeks an opponent's weaknesses and tries to gain tactical advantages.

The pawn play is much improved. Sargon II senses the worth of passed pawns and actively tries to promote them. Sargon I had little use for pawns.

After our three-game "tournament" mentioned above, we set up an endgame position out of curiosity. We took White with King at c1 and pawns at c2, b2, and h2. We gave Sargon II a King at g8 and pawns at g7, h7, a7, and b7. This should be a won game for Black with careful

<table>
<thead>
<tr>
<th>White (Sargon II)</th>
<th>Black (Three humans, rated 1700+, 1714, and 1650)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. e2-e4 e7-e5</td>
<td>a7-e5</td>
</tr>
<tr>
<td>2. Ng1-f3 Nf8-b4</td>
<td>Nf6-b5</td>
</tr>
<tr>
<td>3. Bf1-b5 Ng8-c6</td>
<td>Nf6-b5</td>
</tr>
<tr>
<td>4. Nb1-c3 Nc6-d4</td>
<td></td>
</tr>
<tr>
<td>5. d2-d3</td>
<td></td>
</tr>
</tbody>
</table>

This looks like a good developing move, but Sargon II needed to play a little more sharply here. 5.Nf3xe5 leads to a much better game for White.

5. ... c7-c6
6. Bd5-a4 d7-d6
7. O-O

It looks safe enough for Sargon II. He has castled and mobilized his pieces by move 7. Sargon I never managed that.

7. ... Bc8-d7
8. Bc1-e3 Nd4xf3
9. g2xf3 Bg4-h3
10. Rf1-e1

An unfortunate move to have to make. If White could have seen what was in store, he might have abandoned the Rook and moved the King to h1.

10. ... Nf6-h5

This clears the way for the Queen. An important move in the attack.

11. Qd1-d2

A clever and amusing trap by White. If we had played 11. ... Od8-h4 to pour it on, then 12.Be3-g5, and we lose our Queen. We very nearly fell for it. So far, Sargon II has played like an intelligent, but inexperienced, player. This is the first "trap" I have seen set by a microcomputer chess program.

11. ... Qd8-f6

But at the last second, we don't fall for the trap and attack the weak pawn at f3 instead.

12. Nc3-d5?

A desperation move; White ignores the weak pawn at f3, but probably saw 12.Qd2-e2, Qf6-g6 check, and is ready to try anything.

12. ... Qf6x3

It's all over now for White.

13. Nd5-c7 check Ke8-d7
14. Be4xc6 check Kd8xc6

The horizon effect, trying to avoid fate: any human would have done the same.

15. Nc7xa8 Qf9-g2 checkmate

Table 1: Score of a game played between Sargon II (with the White pieces) and three humans (with the Black pieces), one of whom is an openings expert. While Sargon lost the game, it went down fighting. This contest shows the style and limitations of the program, which played at level 3. The notation is algebraic.
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play. At times, Sargon II pushed its look-ahead procedure to level 8. (This cannot be set from the keyboard.) Sargon pushed its pawns carefully, but blundered by trying to fight on both fronts for too long. The program finally made a critical mistake and allowed us a draw. We wound up with just the two Kings on the board. Curiously, at that point, instead of calling a draw Sargon’s King started advancing toward our King, perhaps thinking that with a hidden dagger up its sleeve, it could finish us off. Such violence would be a patent violation of chess law.

Sargon II is the first chess program I have seen which has doubled its Rooks on a file with malice obviously intended. It is also the first program I’ve played that has actually set a trap. Perhaps this is a glimpse of artificial intelligence!

The program will suggest a move for you if you type control-K. You would be wise to ignore this advice if you are an experienced player. Why? These programs play well tactically but with poor strategy. Any suggested move will be devoid of the strategic thought which you, as a human, ought to be applying.

Sargon II may be the strongest chess program you can buy, dedicated chess-playing devices included. I am impressed beyond all expectation. If I were to estimate its Elo rating, I would say it is possibly 1500 at level 3.

However, as with any software product, there are some minor complaints. If you bought Sargon I for $20, you may flinch at buying Sargon II for $30 ($35 on floppy disk). Such a price seems hard to justify, and you would expect that for a $30 program, the packaging would be a little better. For example, the shell of the cassette I received was the glued-together type, instead of the higher-quality shell with screws.

Also, the instruction book is not what you would expect of a $30 program. The book was not carefully produced and assumes too much prior knowledge on the part of the user. There is an error on page 4 where it says to type a control-R followed by a Return. If you hit the Return, you’ll find yourself helplessly transferred into the monitor, and since the program is locked and protected, you’ll have to reload it.

Another possibility for grief lies in the use of a printer to record the game. If Sargon II changes its decision about a move, it will overwrite the previous move. This works fine for a video display, but on a printer there would be a blob after two or more move changes.

About the only other request you might make of Sargon II is to have the listing of the entire game in memory instead of letting lines scroll off the top of the screen. Often a user gets too busy playing to record the game by hand. Not everyone can afford a printer; but this is a minor affair.

In summary, Sargon II is about all we computer chess players could wish for in 1980. No doubt, stronger programs will be written (Sargon III is still in an experimental stage), but this one will keep your attention unless you are a wizard in the openings. Dan and Kathe Spracklen are to be commended for a superb implementation on the 6502 microprocessor: in fact, I give them an A+ rating for the implementation. The Spracklens and the Hayden Book Company also get an A+ for correcting the problems in Sargon I, but unfortunately, Hayden gets a C on the packaging.

[Next month the author reviews Sargon 2.5...ed]
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</thead>
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<td>SPEED (Seconds to load &quot;Blackjack&quot;)</td>
<td>56</td>
<td>6</td>
<td>6¼</td>
</tr>
<tr>
<td>CAPACITY (thousands of bytes)</td>
<td>36 (5&quot;)</td>
<td>36 (75&quot;)</td>
<td>59 (TRS005)</td>
</tr>
<tr>
<td>RELIABILITY (Designed for digital data?)</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>SYSTEM COST (First unit plus interface)</td>
<td>$60</td>
<td>$250</td>
<td>$800</td>
</tr>
<tr>
<td>MEDIA COST (in quantities of ten)</td>
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Micrograph
Part 2: Video-Display Processor

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Colorado Springs CO 80907

Part 1 of this article (BYTE, November 1980, page 64) presented some background on interactive computer-graphics systems, with an emphasis on the characteristics of display processors (the portion of the graphic system that produces the actual image). The instruction set for a color raster-scan graphics-display processor was also presented. Part 2 will feature the hardware for a low-cost display processor, called Micrograph, which implements this instruction set. You can find the essential characteristics of Micrograph listed in Table 1. The processor's hardware, including a circuit description, construction hints, and enhancement ideas, will be the topic of the latter portion of this part of the series.

Block Diagram
As Figure 1 indicates, Micrograph is relatively simple in terms of hardware: there is nothing tricky about its design. Micrograph is built around a Zilog Z80 microprocessor, which shares a bus with a video-display generator. The bus control arbitrates between the microprocessor and the display generator so that only one device is allowed to access the bus at a time.

Also connected to the system bus are several I/O (input/output) ports, which are used to communicate with a host computer. The I/O interface includes ports for transmission of data and instructions from the host computer and ports for the transmission of data and status to the host computer. Micrograph thus appears to the host computer as an intelligent peripheral. With this architecture, the display processor does not tie up the

Table 1: Summary of the characteristics of the Micrograph color-display system.

Features:
- 64 by 64, 128 by 128, and 256 by 192 pixel resolutions available.
- Up to eight different colors displayed at one time.
- Single-board processor, based on Zilog Z80 and Motorola MC6847 Video-Display Generator.
- Costs approximately $275 to construct.
- Supported by high-level graphics primitives to produce images efficiently.
- Supports graphics and alphanumeric.
- Interfaces to a host microcomputer via three 8-bit I/O ports (status, input, and output) and by radio frequency or video entry to a standard, unmodified color television.

Figure 1: Block diagram of Micrograph hardware. The Z80 microprocessor provides an active element for implementing the instruction set described in Part 1 of this article. By using a video-display generator device developed by Motorola, the hardware is simplified. The processor and display generator share a common bus that is separate from the host system's bus, so that Micrograph is a truly intelligent peripheral.
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allow its use with almost any microprocessor. I chose the Z80 because it was convenient in terms of the software development tools I had available.

The 6847 has several modes of operation, including alphanumeric, semi-alphanumeric, and full graphics modes. The device offers different graphics-display resolutions, including sixteen lines of thirty-two alphanumeric characters and 64 by 64 pixel, 128 by 64 pixel, 128 by 64 pixel, 128 by 96 pixel, 128 by 96 pixel, and 256 by 128 pixel graphics. The circuit also produces up to eight different colors that can be displayed at one time. Of course, with memory size held constant as the resolution increases, the number of colors that can be displayed at one time decreases. For example, the 128 by 192 pixel resolution has four colors, and the 256 by 192 pixel resolution has two colors. (Table 2 summarizes the modes available to the Micrograph user.)

Ready for use with the 6847 is a companion device, the MC1372 color television video modulator. This circuit interfaces directly to the MC6847 to provide either an RF (radio-frequency) or composite-video television signal. This allows Micrograph to be connected directly to an unmodified color television. Both of these devices are obtainable from most Motorola distributors; and in single quantities, the MC6847 costs around $35 and the MC1372 costs around $5.

For those readers who would rather avoid the expense of building a complete version of Micrograph, the MC6847 will still offer a very inexpensive way to produce a colorgraphics display. In the event that you wish to connect the video-display generator to an existing microcomputer, the following discussions are still applicable. However, the advantage of dedicating a microprocessor to control the video display is that the host computer doesn't have to wait while the video generator accesses display-refresh memory. Furthermore, the Micrograph instruction set allows the host processor to deal with manipulating images, rather than worrying about the overhead of scanline conversion and otherwise maintaining the display.

**Circuit Description**

Figure 2 provides the complete schematics for Micrograph. As we noted in the block diagram, the Z80

Table 2: Summary of the modes available to the Micrograph user. The Motorola MC6847 Video-Display Generator integrated circuit supports other resolutions, which are not available in the systems presented here. The 6847 control signals include: two lines to select between alphanumericics, semigraphics, and graphics; three lines to select the graphics-mode resolution; a color-set select line; and an inverse-video select line.

<table>
<thead>
<tr>
<th>Mode Number</th>
<th>A/G</th>
<th>A/S</th>
<th>GM1</th>
<th>GM2</th>
<th>GM3</th>
<th>CSS</th>
<th>INV</th>
<th>Colors</th>
<th>Border</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>0</td>
<td>0</td>
<td>green on black</td>
<td>black</td>
<td>32 characters by 16 lines</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>1</td>
<td>x</td>
<td>orange on black</td>
<td>black</td>
<td>64 by 32, eight colors</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>x</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>x</td>
<td>x</td>
<td>black, green, yellow, blue, red, buff, cyan, magenta, orange (depends on color code)</td>
<td>green</td>
<td>64 by 64, four colors</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>x</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>x</td>
<td>1</td>
<td>black, green</td>
<td>green</td>
<td>128 by 64, two colors</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>x</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>x</td>
<td>1</td>
<td>buff, cyan, magenta, orange</td>
<td>green</td>
<td>128 by 96, four colors</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>x</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>x</td>
<td>1</td>
<td>black, green</td>
<td>green</td>
<td>128 by 96, four colors</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>x</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>x</td>
<td>1</td>
<td>same as 3</td>
<td>green</td>
<td>128 by 192, two colors</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>x</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>x</td>
<td>1</td>
<td>same as 3</td>
<td>green</td>
<td>128 by 192, four colors</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>x</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>x</td>
<td>1</td>
<td>same as 3</td>
<td>green</td>
<td>256 by 192, two colors</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>x</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>x</td>
<td>1</td>
<td>same as 4</td>
<td>buff</td>
<td>4 colors</td>
</tr>
</tbody>
</table>

Table continued on page 126
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Charge Card ___________________________ Exp Date __________

Master Card Interbank Number__________________________

Signature_____________________________________

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Address __________________________________________

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Phone ____________________________

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Signature_____________________________________

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Figure 2: Schematic diagram of Micrograph, which continues on page 126. See figure 5 for additional connections that must be made to the system but are not shown in figure 2.
and the MC6847 share the same bus. Since both of these devices have three-state address and data lines, they can simply be wired to the same physical bus. The only problem that must be dealt with is the selection of a single device to use the bus at a given time. This problem is simplified by the bus-control lines of the Z80 (the BUSRQ and BUSAK control lines) and the MC6847 (with the FS and MS control lines). On the Z80, whenever the BUSRQ line is pulled low, the BUSAK line will go low later, indicating that a request to use the bus has been acknowledged. At that time, the processor's address and data lines enter a high-impedance mode, the processor essentially "disappears," and another system can control the bus.

On the MC6847, there are similar lines to control bus access. The FS line goes low during the vertical retrace period. The MS line on the MC6847 can then be brought low to allow the Z80 access to the bus while the video-display generator's address and data lines are in a high-impedance condition.

In this design, the video-display generator has priority for memory accesses. This approach limits the amount of time the microprocessor has to execute, but since we have a
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dedicated processor, this is not really a problem. This approach also provides a stable display that will not "tear" since the video-display generator has the bus the entire time it needs it. As we see in figure 3, the bus control can be handled by two inverters, which are part of the 74LS14 Schmitt-trigger inverters in figure 2.

The Microprocessor

The discrete components shown near the Z80 in figure 2 are required for clock-line pull-up, as specified by the processor for executing display "primitive" instructions, but it does help to maintain a stable display without the "tearing" effect that occurs when the display generator cannot read from memory when it needs to.

The Modulator and Display Generator

Note that the connections to the MC6847 are simple: the address lines (A0 thru A12) and data lines (D0 thru D7) go to the shared bus. At the bottom of the schematic, there are seven control lines that determine the display mode. These lines are controlled by one of the four I/O ports.

The MC6847 and MC1372 connect directly together. In this configuration, the MC1372 is wired to provide an RF output, so that Micrograph may be tied to the antenna leads of a television through a matching transformer. (See figure 4 for the wiring option to provide direct video output.)

Also tied to the modulator is the clock circuitry, which provides the 3.579545 MHz signal, which is the standard color-burst frequency. This clock is routed to both the video-display generator and the modulator.

The variable capacitor in the timing circuit is used to fine-tune the displayed colors. On the right side of figure 2 is the RF tank circuit, which can be tuned to station 3 or 4.

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<table>
<thead>
<tr>
<th>Address</th>
<th>BusQ</th>
<th>MC6847</th>
<th>SYSTEM BUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z80</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of bus control](image)

For clock-line pull-up, as specified by the processor for executing display "primitive" instructions, bus control is given priority. This approach limits the amount of time available to the processor for executing display "primitive" instructions, but it does help to maintain a stable display without the "tearing" effect that occurs when the display generator cannot read from memory when it needs to.

**The Microprocessor**

The discrete components shown near the Z80 in figure 2 are required for clock-line pull-up, as specified by Zilog. The nonmaskable interrupt (NMI) and wait (WAT) lines are pulled high, since Micrograph operation requires neither wait states nor nonmaskable interrupts.

**The Shared Bus**

The Z80 and MC6847 address and data lines are simply tied together. The leftmost 74LS367 bus driver circuit is used to provide additional address (A13) and control (WR, RD, IOREQ, and MREQ) lines, which are active only when the MC6847 has control of the bus. These lines are needed since the MC6847 does not supply these signals. In this case, the address line (A13) is tied high to force addressing of the refresh memory in the 8 K to 16 K range of the Z80 microprocessor's address space.

The next integrated circuit, a 74LS14, is used to provide a manual and power-up reset circuit and also to drive the clock line to the microprocessor. The 74LS73 JK flip-flop is used to derive the Z80 clock signal from the video-display-generator clock output.
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Figure 6: Memory map for the Micrograph board.

Bus Control
The address and control lines are routed to 74LS367 bus drivers, where they are then passed to the memory and I/O circuitry. The top four address lines are also routed to a 74LS154 four-to-sixteen-line decoder to provide memory chip-select decoding. Finally, the two 8216 bus drivers buffer the data lines. Their direction is controlled by the DBIN signal from the shared bus.

I/O Circuitry
Only two PIO (peripheral-input/output) circuits are needed. PIO 0 provides a status indication to the host through one port. (See figure 5 for the format of the status byte.) The other PIO 0 port is routed to the video-display generator to select the proper display format. (Figure 5 also provides the format of this control byte.) The second PIO circuit is used to communicate with the host computer.

One of the ports is used to receive data and instructions from the host (the input port), and the other port is used to transmit data back to the host (the output port). In either case, the strobe lines for both of these ports are controlled by the host to indicate that Micrograph is being sent an instruction or that the host has just received a data byte. The protocol for communicating with the host computer will be further discussed in Part 3 of this article. Refer to tables 3 and 4 on page 132 for the port assignments in the microprocessor address space.

Firmware and Frame Buffer
Three 2708 EPROMs (erasable programmable read-only memories) are used to hold the 2.6 K bytes of the object code required to control Micrograph. Four type-2114 1024 by 4-bit static-memory devices provide the 2 K bytes needed by the firmware for variables and data for the programmable character generator. Refer to figure 6 for a memory map and to tables 3 and 4 for memory and port assignments.

In the frame buffer, 6 K bytes of memory are required, and 2114s are used to keep the device count low. Figure 6 provides the map for the frame-buffer memory also.

That is all the hardware needed to produce a color-graphics display. Thanks to the MC6847, Micrograph can be built with only thirty-four
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DIPs (dual-in-line packages) and a handful of discrete components. Micrograph can be constructed on a single board and requires only a +5 V, +12 V, and -5 V power supply.

Construction
Photos 1a and 1b show my prototype Micrograph. I used a universal wire-wrap board, and as the photo indicates, a spacious layout was possible as a result of the low device count. In the leftmost section of photo 1a are the Z80 and the two PIO devices. In the next section are part of the bus drivers and the EPROMs. In the middle section are the rest of the bus drivers and some of the 2114 memory circuits. In the next and final sections are the rest of the memory integrated circuits and the video-display circuitry. Note the few discrete components required: most are decou-

<table>
<thead>
<tr>
<th>Type of memory</th>
<th>Address (decimal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPROM</td>
<td>0 to 3071</td>
</tr>
<tr>
<td>private memory</td>
<td>4096 to 6143</td>
</tr>
<tr>
<td>color memory 0</td>
<td>7168 to 7183</td>
</tr>
<tr>
<td>color memory 1</td>
<td>7184 to 7199</td>
</tr>
<tr>
<td>color memory 2</td>
<td>7200 to 7216</td>
</tr>
<tr>
<td>refresh memory</td>
<td>8192 to 14335</td>
</tr>
<tr>
<td></td>
<td>(for System I)</td>
</tr>
<tr>
<td></td>
<td>8192 to 16383</td>
</tr>
<tr>
<td></td>
<td>(for System II)</td>
</tr>
</tbody>
</table>

Table 3: Type and location of memory used in the Micrograph board.

<table>
<thead>
<tr>
<th>Port Number</th>
<th>Device Name</th>
<th>Use</th>
<th>Type of Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>port 0</td>
<td>PIO 0, port A</td>
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Table 4: Port numbers and their usage by Micrograph.

"The MDBS data base system is fantastic!"

That's the essence of this letter from Leonard L. Overton, Jr., president of LS Business Systems, Inc. Here's what he says...

"The MDBS data base system has made a fantastic improvement in the productivity of our custom programming operation. The implementation of this system in our business has allowed us to change to a completely different concept of producing custom microcomputer based software. The old system of a myriad of files, pointers, updates, and file structures has been changed to a simple graphical representation of the data network and its logical relationships (the schema).

"Representing an application with a schema that can readily be transferred to the computer through the data definition language has increased our software productivity in the following ways:

1. The system designer gets a much clearer picture of how clean, efficient, and effective his design is. Improvements are made easily and rapidly.
2. The programmer can spend his time producing the calculational and interactive parts of the system rather than getting bogged down in the intricacies of the data structure. This not only reduces the amount of code generation but also reduces programmer fatigue due to tedious repetition.
3. Communication with the end-user is much more effective when he can see an easily understood, graphical depiction of how his data will be handled. A good understanding by the end-user in the early stages of the design can eliminate costly program changes or data restructuring later.
4. Debugging time is greatly reduced and so are calls from customers who find the hidden bugs that always show up in a complex data structure written on a file basis.

"In short, the MDBS data base system is not only a very effective software development tool but has become the foundation on which we are building our future applications software. This change has enabled us to produce quicker, cleaner, and more flexible applications software at a lower cost to our end-users."

To find out what a fantastic job the MDBS system can do for you, see the facing page and then contact us without delay!

Micro Data Base Systems, Inc.
Box 248, Lafayette, Indiana 47902
Micro-computer data base management at its best!

Get the most out of your micro-computer. Use our advanced and productive data management system.

**HDBS** is an extended hierarchical data base system offering:
- fixed length records
- file level read/write protection
- one-to-many set relationships

**MDBS** is a full network data base system offered as an upgrade from HDBS... or it may be ideal as your initial system. Unique and versatile, it adds these features:
- full network CODASYL-oriented data structures
- variable length records
- multiple levels of read/write protection
- one-to-one, many-to-one, and many-to-many sets
- non-redundancy of data, easy updating
- occurrences of a record type may own other occurrences of the same type
- a single set may have multiple owner and member record types

**MDBS-DRS.** As an add-on to MDBS, the DRS system offers extraordinary flexibility in data base restructuring to meet new needs.
- Item, record, and set types can be added, deleted, or renamed in an existing data base as well as other data base characteristics. You can redesign the data base after it is already on-line!
- Detailed reports can be quickly generated
- One-to-many set relationships
- File-level read/write protection
- Wild card and "match-one" string specifications included
- Item, record, and set types can be added, deleted, updated, or renamed
- Complex retrieval conditions may be specified
- Detailed reports can be quickly generated
- Wildcard and "match-one" string specifications included

**MDBS-QRS.** An interactive Report-Writer/Query-System for HDBS/MDBS data bases. Features...
- may be customized for non-technical users
- complex retrieval conditions may be specified
- detailed reports can be quickly generated
- wildcard and "match-one" string specifications included

**HDBS and MDBS Packages Include:**
- DDL data definition language analyzer/editor
- 260-page users manual
- DMS data management routines callable from host language
- Sample application program and DDL files
- Relocator to re-org all routines
- System specific manual for bringing up our software

Both HDBS and MDBS Systems...
- Run under... CP/M with CBASIC, Microsoft BASICs, FORTRAN or COBOL; InterSystem PASCAL/Z; Sorcim PASCAL/M; Micro Focus CIS COBOL; Digital Research PL/I
- OASIS
- TRSDOS and NEWDOS (Models I and II) with Disk BASIC
- North Star DOS with North Star BASIC
- Apple DOS and AppleSoft BASIC
- Machine Language Interface available on all above systems.
- Up to 256 record-types definable in the data base; each record-type may contain up to 255 item-types; each item-type may be up to 9,999 bytes in length.
- Names of data items, records, sets, and files are wholly user definable.
- Commands to add, delete, update, search, and traverse the data base.
- Straightforward use of ISAM-like structures.
- Records can be maintained in several sorted orders.
- Written in machine language for maximum execution efficiency and minimal memory usage.
- Independent of types and sizes of disk drives. Support data base spread over several disk drives (max.8); disks may be mini- or full-sized floppy or hard disks.
- Available versions: Z80 (requires approx. 18K), 6502 (approx. 30K), 8080 (approx. 22K)
- Total memory requirement must allow for buffer areas. For Apple users, a language card is recommended.
- 8086 version available. (Call or write for details and prices.)

Ordering Information (applicable to Z80, 8080 and 6502 versions):

<table>
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<td>System Specific Manuals (each)</td>
<td>$5.00</td>
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When ordering, specify intended use with:
1. North Star DOS and BASIC
2. CP/M - CBASIC
3. CP/M - Microsoft BASIC 4.2X
4. CP/M - Microsoft BASIC 5.X
5. CP/M - Microsoft BASIC or FORTRAN Compiler
6. CP/M - Microsoft COBOL
7. CP/M - InterSystem PASCAL/Z
8. CP/M - Sorcim PASCAL/M
9. CP/M - Digital Research PL/I
10. CP/M - Micro Focus CIS COBOL
11. TRSDOS and NEWDOS and TRS-Disk BASIC (Models I and II)
12. Apple DOS and AppleSoft BASIC
13. OASIS
14. Machine Language Programs (Specify operating system)

Within a given operating system, add $125.00 for each additional language selected.
For prices outside the U.S. and Canada, please ask for price lists.
Add $2.50 handling fee for non-cash order ($5.00 outside U.S.).

Indians residents add 4%.
We accept Visa and Master Charge.

54-page "primer" on data base systems for micro-computers — only $10.00 per copy.

Dealer Demo-Package ($60.00) includes Primer, HDBS/MDBS Manuals, Demo-Disk, etc.

Setting standards of excellence for data base software... worldwide.

Micro Data Base Systems, Inc.
Dept. B, Box 248, Lafayette, IN 47902
317-448-1816

Circle 86 on inquiry card.
pling capacitors. This physical layout follows the schematic layout almost exactly.

In photo 1b (page 136) is a view of the wirewrap side. It took me two weekends to wrap the board, using a Slit N' Wrap tool marketed by Vector and also an electric wirewrap tool. I used Slit N' Wrap techniques for the bus and, as best as I could, tried to color-code the whole device.

Any construction technology can be used to build this board, but there are a few hints I might pass along. To begin, ensure that the video-modulator circuitry is well isolated from the rest of the system: keep the wiring as short as possible in this section. Furthermore, because of the relatively high frequencies used, be sure to minimize stray capacitance: a shielded board will help reduce interference.

Micrograph is best built in stages. I suggest you start with the video-display generator and modulator circuit. Wire this area first, then temporarily wire some memory on the 6847's bus. You can go ahead and board will help reduce in-

... the wire wrap side. You can go ahead and

... bus and, as best as I could, tried to color-code the whole device.

... are cycling through the entire 6 K bytes of memory.

... times using all the refresh memory. Note that the 256 by 192 or 128 by 192 resolution modes will utilize all the memory. You might even connect an oscilloscope to the address lines to check that the lines are cycling through the entire 6 K bytes of memory.

... when power up the system, if your supplies are independent, be certain the -5 V supply powers up first and powers down last, if it can't be done simultaneously with the rest of the power. (I didn't do it that way and, consequently, destroyed six EPROMs; then I read an obscure warning in an Intel data book.)

Enhancements: System II

There are a number of enhancements to the system that will improve the system performance, although I have not implemented them. The first obvious improvement is to use a Z80A (capable of using a 4 MHz clock) and run the system on the color-burst clock. This will immediately double the speed of the display processor. Of course, be sure that your memory is fast enough to handle the extra speed.

You might also try to use dynamic memory. I used static memory to reduce the development risk and make the design and testing of the board easier, but if the timing works out, the use of dynamic memory would significantly reduce the cost of the system.

These are some basic improvements that can be made, and I'll offer some more radical changes, which I call System II. When I first designed Micrograph, I created a system consisting of over 100 DIPs for the video section alone. This design supported two formats: 128 by 128 with sixteen colors and 256 by 256 with two colors. The system also supported a color-look-up table, to allow a set of $2^{12}$ (or 4096) possible
MicroAge Computer Stores sell solutions to your professional, business and household-management problems, not just hardware. That's what makes the MicroAge difference! From systems integration to easy-to-understand application software, research and development to warranty service and repair, systems consulting to training and installation. In all these, we offer the latest, most innovative approaches. That's why we are the forerunners...the pioneers in the microcomputer industry.

But don't just take our word for it. Visit the MicroAge Computer Store nearest you and see the difference solutions make. We have differences you'll experience with every time and money-saving idea. The difference that will keep you satisfied now and for years to come!

FOR FRANCHISE OPPORTUNITY INFORMATION CALL (602) 967-1421
Photo 1: Two views of the completed Micrograph prototype. The use of a universal wirewrap circuit board (photo 1a) allows a spacious layout that almost exactly follows the schematic diagram of figure 2. Photo 1b shows the wiring that required approximately two weekends of the author's time. A daisy-chaining wirewrap tool was used for the majority of the bus wiring, while control signals were made in the standard wirewrap fashion; power is provided to the integrated circuits via buses printed and etched on the board.

Conclusion

This article concludes the presentation of the hardware required to support Micrograph. I have examined the circuit design, discussed construction details, and looked at various system enhancements. Photos 2a and 2b provide some examples of displays possible with Micrograph.
UniFLEX is the first full capability multi-user operating system available for microprocessors. Designed for the 6809 and 68000, it offers its users a very friendly computing environment. After a user 'logs-in' with his user name and password, any of the system programs may be run at will. One user may run the text editor while another runs BASIC and still another runs the C compiler. Each user operates in his own system environment, unaware of other user activity. The total number of users is only restricted by the resources and efficiency of the hardware in use.

Multi-User

The design of UniFLEX, with its hierarchical file system and device independent I/O, allows the creation of a variety of complex support programs. There is currently a wide variety of software available and under development. Included in this list is a Text Processing System for word processing functions, BASIC interpreter and precompiler for general programming and educational use, native C and Pascal compilers for more advanced programming, sort/merge for business applications, and a variety of debug packages. The standard system includes a text editor, assembler, and about forty utility programs. UniFLEX for 6809 is sold with a single CPU license and one years maintenance for $450.00. Additional yearly maintenance is available for $100.00. OEM licenses are also available.

Support

UniFLEX is a true multi-tasking operating system. Not only may several users run different programs, but one user may run several programs at a time. For example, a compilation of one file could be initiated while simultaneously making changes to another file using the text editor. New tasks are generated in the system by the 'fork' operation. Tasks may be run in the background or 'locked' in main memory to assist critical response times. Inter-task communication is also supported through the 'pipe' mechanism.

Multi-Tasking

UniFLEX is offered for the advanced microprocessor systems. FLEX, the industry standard for 6800 and 6809 systems, is offered for smaller, single user systems. A full line of FLEX support software and OEM licenses are also available.

FLEX

technical systems consultants, inc.
Box 2570, West Lafayette, IN 47906
(317) 463-2502 Telex 276143

UniFLEX and FLEX are trademarks of Technical Systems Consultants, Inc.
### DECEMBER MEMORY SPECIALS

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### LS SERIES

**LOOK AT THIS LS PACING!**

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### MA1012A CLOCK MODULE

Complete alarm clock module with special transformer and spec sheets included. Just add switches. 8.99 3/44

**TERMS:** Include $2.00 for shipping. $10.00 minimum order. Send SASE for complete catalog.

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1101 South Winchester Blvd.
San Jose, California 95128
408-247-4852

---

Photo 2: Examples of Micrograph displays.

Listing 1 contains the second third of the Micrograph software (begun in Part 1 and to be completed in Part 3). In the final part of this article, I will discuss the software needed by Micrograph to implement the instruction set presented in Part 1, cover the major algorithms implemented in the system (such as the scan-line conversion algorithm), and examine how to operate Micrograph.

Listing 1 begins on page 327
DYNACOMP

Quality software for:

ATARI
PET
APPLE II

STAR-80 (Level II) NORTH STAR CP/M 8" Disk

GAMES

BRIDGE II.0 (Available for all computers) Prices: $17.95 Cassette $21.95 Diskette

An all-inclusive version of the most popular card games. This program book 7006 and 94-LSY either contract or duplicate bridge. Depending on your contract, this program is written in a combination of easy and difficult to learn skills. The computer will deal the cards and the computer will double your contract. BRIDGE II is proven to improve your bridge skills.

HEARTS I.5 (Available for all computers) Prices: $14.95 Cassette $18.95 Diskette

An exciting and entertaining computer version of this popular card game. Hearts is a trick-oriented game in which the purpose is not to win but to lose the queen or the queen of spades. Play against two computer opponents who are armed with hard-to-beat playing strategies.

CRIBBAGE II.0 (Available for all computers) Prices: $14.95 Cassette $18.95 Diskette

This is a well-designed and easily mastered two-handed version of the classic card game, cribbage. It is an excellent program for anyone who wants to play cribbage. As the beginner learns the game, in particular the scoring and keeping score of the cribbage board is continuously shown on the top of the display (showing the [LS/RT] graphics capabilities), with the cards drawn underneath. The computer automatically keeps score and also pronounce the points using the traditional mnemonic phrases.

CHESS MASTER (North Star and TRS-80 only) Prices: $19.95 Cassette $23.95 Diskette

This complex and very powerful program provides five levels of play. It includes diagnostics, in print moves and print moves at the termination of the game. Additionally, the board may be pretty before the start of the play, providing a visual reference to the moves. To maximize execution speed, the program is written in assembly language for SOFTWARE SPECIALISTS of California. Full games are employed in the TRS-80 version, and two modes of output display are provided to accommodate North Star users.

STARTALK 3.1 (Available for all computers) Prices: $5.95 Cassette $9.95 Diskette

This is the classic StarTalk simulation, but with several new features. For example, the Klingons now show at the Enterprise without warning and rip apart starships in other quadrants. The Enterprise also now has a cloaking device and a new warp drive. The Seattle is located in the space where the Enterprise is built by three heavy corvettes and a warship. Dorn, an alien race, it must turn the Enterprise over to them to save the universe.

SPACE TILT (Apple only) Prices: $14.95 Cassette $19.95 Diskette

The game begins with the player on the starship starting with the computer. The player must determine if the player can turn the ship into the correct position. If successful, the player can advance to the next level. If unsuccessful, the player must try again.

GAMES PACK I and GAMES PACK II Prices: $5.95 each, Cassette $13.95 Diskette

GAMES PACK I contains BLACKJACK, LUNAR LANDING, CRAPS, HORSEBACK, SWITCH and more. GAMES PACK II includes EIGHT HUNS, JOTTO, ACEY-DECY, LITE, WUMPUS and other. Available for all computers.

STUD POKER (Atari only) Prices: $11.95 Cassette $15.95 Diskette

This is the classic gambler's card game. The computer deals the cards one at a time and you place your bets on each hand. The computer does not count and usually hits the buttons. However, it sometimes misses! It includes a 5-card draw and 5-card draw betting pattern practice. This package will run on a 16K Atari.

STATISTICS and ENGINEERING

DATA SMOOTHER (Available for all computers) Prices: $14.95 Cassette $18.95 Diskette

This special data smoothing program may be used to rapidly derive useful information from noisy electronic and biological engineering data which are usually complex. The software features choice in degree and range of fit, as well as smoothed first and second derivative calculation. Also included is automated plotting of the input data and smoothed results.

FOURIER ANALYZER (Available for all computers) Prices: $14.95 Cassette $18.95 Diskette

Use this program to examine the frequency spectra of limited duration signals. The program features automatic scaling and plotting of data in both linear and semilog graphs. The program also includes the analysis of complex patterns in such fields as electronics, communications and business.

TFA (Transfer Function Analyzer) Prices: $19.95 Cassette $22.95 Diskette

This is a special software package which may be used to evaluate the transfer functions of systems such as filters and filters. It includes the ability to provide complex excitation to the program. TFA is a major modification of FOURIER ANALYZER and contains both engineering-oriented display and use of the data. In addition, TFA has included a number of new and improved features.

REGRESSION I (Available for all computers) Prices: $15.95 Cassette $23.95 Diskette

REGRESSION I is a unique and exceptionally versatile one-dimensional linear square "polynomial" curve fitting program. Features include very high accuracy, automatic degree determination option, an interactive iterative fitting hardness, automatic scaling and curve plotting, a uncertainty analysis on standard deviation, correlation coefficient, etc. The program is written in assembler language, with a few new features in the program. REGRESSION I is a powerful program for any computer.

REGRESSION II (PARAFIT) (Available for all computers) Prices: $19.95 Cassette $23.95 Diskette

PARAFIT is designed to handle the cases in which the parameters are unknown (possibly random) as well as cases in which the parameters are fixed and known. It includes the ability to evaluate the fit of the data points of the regression data. Data and results may be manipulated and plotted and as well as the data. REGRESSION II is a powerful version of the REGRESSION I program. REGRESSION II also includes the addition of a new feature, the ability to perform linear and PARAFIT (for those complex functions).

RECOMMEND I and II may be purchased together for $75.95 (cassette) and $89.95 (diskette).

MAIL LIST II (North Star only) Price: $15.95

This handy program allows you to maintain a special data base of all files and programs in the stack of disks which are available on a particular disk. MAIL LIST II is easy to use and very capable of handling many large jobs. Available for all computers.

TEXT EDITOR I (Letter Writer) Prices: $16.95 Cassette

An easy to use, non-oriented editor which provides variable line widths and provides non-linear paragraph indentation. This editor is suitable for computer students and is quite capable of handling much larger jobs. Available for all computers.

IBM BUILTIN II (Available for all computers) Price: $19.95

This is a line-by-line program which maintains information about keywords on a disk file (or more). The program scans the file for the keyword, and if found, it adds the keyword to the file. Keywords are added by a simple keyword or by cross-referencing two or three keywords.

DFILE (North Star only) Price: $19.95

This handy program allows North Star users to maintain a special data base of all files and programs in the stack of disks which is available on a particular disk. DFILE is easy to use and very capable of handling many large jobs. Available for all computers.

COMPARE (North Star only) Price: $19.95

COMPARE is a single disk utility software package which compares two BASIC programs and displays differences in the programs in the display screen. The differences are in terms of the number of statements, and the line numbers at which variable differences occur. COMPARE compares the user's disk files with the disk files of all of its neighbors and determines which files are different.

COMPRESS (North Star only) Price: $12.95

COMPRESS is a single disk utility program which allows you to maintain the lastest in your BASIC programs. COMPRESS also contains non-linear and REM data. The result is a compressed BASIC program which uses much less disk space and can be easily expanded. File compression rates of 20:1 are commonly achieved.

GRAFXI (TRS-80 only) Price: $12.95 Cassette

GRAFXI is a unique program which allows you to easily create graphics directly from the keyboard. Use "Draw" your figure using the program's interactive cursor control. The figure will be automatically saved to your BASIC program as a string variable. Draw a "Happy Face," call it VI and then print it from your program using PRINT "HI" This is a very easy way to create and save graphics.

TIDY (TRS-80 only) Price: $19.95 Cassette

TIDY is an assembly language program which allows you to maintain the lastest in your BASIC programs. TIDY also contains non-linear and REM data. The result is a compressed BASIC program which uses much less disk space and can be easily expanded. File compression rates of 20:1 are commonly achieved.

SIMULATIONS and EDUCATION

BLACK HOLE (Apple only) Price: $19.95 Cassette

This is an exciting graphical simulation of the problems involved in observing a black hole with a space probe. The subject is extremely complex, and is not recommended for a first time project, unless it is close to a black hole. This is to be achieved without the cost of the simulation. The ideal station is in the area of the solar system. The probe is a space station which can land on the black hole. You can create the probe in real time and observe it from the solar system. The program employs Hi-Res graphics and is educational as well as challenging.

VERDEZ (Available for all computers) Price: $14.95 Cassette

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A Simplified Theory of Video Graphics

Part 2

Color Television
To produce color television displays we need a picture tube with a phosphor screen that can be made to glow in different colors. This is done by a method similar to the half-tone method of color printing; a full-color picture is made by superimposing three single-color images made up of very small dots. At the normal viewing distance the dots are too small for the human eye to resolve, so that the colors appear to merge into a single image. The inside of a color television screen is covered with an array of small dots of three different phosphors that glow in red, green, or blue when struck by electrons. By carefully controlling the brightness of each colored dot we can produce any color we desire. (See text box, "The Primary Colors").

The major problem is independent color control. We need three separate electron beams (ie: one for each color) arranged so one beam strikes only the red phosphor dots, one beam strikes the green dots, and one beam strikes the blue dots. It is not practical to aim the beams this precisely; instead, a shadow mask is used. The shadow mask is a perforated metal plate placed just behind the phosphor screen in the picture tube. The three electron beams can strike the phosphor dots only after passing through holes in the mask. The electron guns that produce the beams are positioned so each beam strikes only dots of the correct color; thus each gun casts an electron "shadow" on phosphors of the other colors. Brightness of each of the primary colors is controlled by the intensity of the corresponding electron beam.

Color by Direct Drive
A straightforward approach to color computer displays uses three identical video-refresh circuits, each with its own refresh memory, in order to generate separate signals for the three electron guns. This approach is relatively expensive; it takes three times as much refresh memory as an equivalent black-and-white display. If this method were used with the 200 by 300 dot display example discussed in Part 1 of this article, \(3 \times 7500 = 22,500\) bytes of refresh memory would be required.

We can have a more economical system using direct drive of the three colors, but using only one refresh memory. (Some switching circuitry is necessary to display two colors instead of black and white.) With a special-character graphics system, we can use a few of our extra character codes to select the colors. The color displayed in place of white is called the foreground color and the one displayed instead of black is called the background. By inserting color-select characters wherever they are needed, it is possible to make different parts of the display show different colors. If each of the electron guns is either on or off, the colors available with this system will be the eight possible combinations of the three primary colors:

1. no color, or black
2. red
3. green
4. blue
5. red + green = yellow
6. green + blue = cyan
7. blue + red = magenta
8. all three = white

The main drawback to the use of direct drive (often referred to as R-G-B) is the cost of the color monitor. Professional monitors with separate red, green, and blue video inputs are not mass-produced, so they are quite expensive. Compucolor, the only personal computer manufacturer using direct-drive color, builds a low-cost

Note that the numbers used for figures, photos, and tables in this article have been continued from Part 1, which appeared in the November 1980 BYTE, page 180.
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The Primary Colors

In grammar school, most of us were taught that there are three primary colors (red, yellow, and blue) and that any other color can be produced by mixing these three. You may be wondering how color television manages to use red, green, and blue as its primary colors. First of all, the primary colors we learned in school are appropriate only for pigments such as paints and crayons; light sources such as the glow of phosphor dots in a color picture tube don’t work the same way.

The creation of a color by mixing pigments relies on the subtraction (or partial absorption) of colors from the light falling on the pigment. If you mix pigments without adding white, the image gets darker. However, creating a color by mixing light works by addition, so if you combine several colors of light, the result is lighter.

Complementary colors are essentially opposites: if you mix complementary-colored pigments the resulting color is black, but if you mix complementary-colored beams of light, the resulting color is white. This 'symmetry' means that primary colors for light will be the complements of primary colors for pigments.

This still sounds paradoxical: how can red, green, and blue be the complements of red, yellow, and blue? This apparent problem is caused by the vagueness of our color names. The colors in the two sets of primaries are actually all different, but one color in each set is reddish and one is bluish. You can see examples of the pigment primaries by examining a printed reproduction of a color graph in which the printing plates are out of register. Here you can perceive the colors of the inks and that the "red" ink is actually red-violet, or magenta, and that the "blue" ink is blue-green, or cyan.

To see the primary colors used in television, try viewing a color test pattern by tuning to a television station before it is broadcasting programs. If you adjust your television set's color controls so the primaries are as pure as possible, you will find the green slightly yellowish, the red a bit orangy, and the blue almost indigo. If we arbitrarily use our vague color names for specific colors and call the television primaries red, green, and blue, we must call the pigment primaries magenta, yellow, and cyan to avoid confusion. The two sets of primary colors make up complementary pairs, like this:

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Bit mapping is not the only way to produce NTSC (National Television System Committee) color signals. Our computer can have circuits that work like character generators, to decode different values of refresh data into appropriate dot patterns, for even more colors. The circuits can produce dots a quarter-cycle long, separated by spaces two-thirds of a cycle long and vice versa, which are still at the frequency of 3.58 MHz. The quarter-cycle dots can be at any of four phases, as can the three-quarter cycle dots, giving us eight more colors for a total of twelve, plus black and white. The quarter-dot colors will have a low average voltage level and, hence, lower brightness when compared to the longer three-quarter cycle dots. In other words, four of the twelve colors produced by this technique will be dark, four will be medium bright, and the re-

Text continued on page 150
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Outline of the NTSC Color Standards

In 1953 the NTSC (National Television System Committee) announced a method of color television broadcasting that was adopted as the US standard. The NTSC system superimposes color picture information onto the older black-and-white signal in such a way that the resulting composite signal is compatible with the old standards. This means that color broadcasts may be viewed on black-and-white sets (and vice versa), and this made it possible to continue using black-and-white equipment.

A color television camera is essentially a combination of three monochrome (ie: black-and-white) cameras, each viewing the same scene through a different colored filter. The most straightforward way to transmit color television into the home would be to send these three signals over the air, but that would require the equivalent of three television channels and would not be economically feasible.

Studies of human vision have shown that fine details in color are not resolved as well as they are in black-and-white. This is fortunate since it allows transmission of color picture information with a much narrower bandwidth than three separate channels would require. In order to take advantage of this effect, the NTSC technique converts the three signals from a color camera into one full-resolution black-and-white signal called the luminance signal, and two color-difference signals called chrominance signals (which are filtered to limit their bandwidth, thereby decreasing their resolution).

The total bandwidth required for the luminance signal plus the two chrominance signals is about 40% greater than the bandwidth of a black-and-white signal, still too broad to keep within the 4.5 MHz bandwidth that was originally allocated for the video signal. The NTSC system puts the chrominance signals into the band that is already occupied by the luminance signal. This trick is accomplished by putting the chrominance signals onto a subcarrier, which is then added to the luminance signal. The subcarrier is so called because, while it modulates the radio-frequency carrier along with the normal video signal, it is also a carrier.

The subcarrier frequency must be higher than that of the information it is to carry, although there is a maximum frequency that will still fit within the 4.5 MHz bandwidth. Another reason for putting the subcarrier at a relatively high frequency is that the luminance signal has less energy at higher frequencies, so there is less interference between the luminance and the subcarrier. There are still more complex aspects of the NTSC technique required to minimize this interference and to preserve certain other characteristics of the original black-and-white television signal, but their importance in computer applications is not great enough to warrant a full description here. The net result is that the horizontal line frequency is changed slightly in the NTSC system, to 15,734.26 Hz, and the color subcarrier is put at 3.579545 MHz. This is usually referred to as the 3.58 MHz color subcarrier.

The two chrominance signals modulate the 3.58 MHz subcarrier together in such a way that the resulting signal has an intensity or amplitude proportional to the amount of color at each point in the picture and a phase that determines the particular color. There must be a standard phase for the receiving set to refer to in decoding the color information, so a short burst of unmodulated 3.58 MHz subcarrier is transmitted during part of each horizontal retrace interval. This so-called color burst is used by the receiver to generate a reference subcarrier phase.

It turns out that most television sets do not do a very good job of separating the chrominance and luminance signals that are combined so cleverly in the NTSC system. Compromises made in the interests of lotter cost cause most sets to lose the fine detail in the picture and pick it up as chrominance instead. This means that fine vertical black-and-white stripes will sometimes produce spurious colors on the screen. You can see this effect by watching for colored streaks across those striped shirts worn by news announcers.
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COMPUTERS

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Figure 2: The cause of video-display dropouts. Several popular microprocessor systems use a display scheme that switches the refresh memory out of the video-refresh circuitry whenever some refresh memory location is changed. This is interpreted by the display as a blank line on the screen for a short interval.

Two or more dots together produce white on the display.

Another problem arises when trying to superimpose text and color. Since the characters are made of lines only one dot wide, some parts of the characters will match the dot patterns of the colors and they will disappear if displayed on a colored background. One way to avoid this is to make characters of elements at least two dots wide. This prevents their merging into colored backgrounds, but at a price: you cannot fit as many of these wider characters into the display.

Undocumented Features and Quirks

Several of the personal computers listed in Part 1 of this article have subtle quirks that are not apparent at first glance and are never mentioned in the manufacturers' specifications or sales literature. While they could easily escape your notice during a demonstration at the computer store, they could become very irritating once you become aware of them. If you are planning to use one of these computers for graphics, you should be aware of these quirks before you decide which computer to buy.

Although you may discover other problems, these are the major design flaws in the personal computers listed:

- asymmetrical plotting
- video-refresh dropouts
- limited color resolution
- adjacent color interactions

Asymmetrical Plotting

Asymmetrical plotting makes a plot with the same number of dots horizontally and vertically come out not as a square but as a rectangle. Some personal computers are quite bad in this respect while others produce almost perfectly symmetrical plots. You can figure whether or not a display is symmetrical by finding the ratio of its horizontal resolution to its vertical resolution, and comparing the result with the aspect ratio of the display portion of the screen. The aspect ratio is the display width compared with the display height: a standard television screen is a third wider than it is high, so its aspect ratio is 4:3. If a computer's display is symmetrical, the number of dots it takes to fill the screen in each direction will be proportional to the size of the screen in that direction. You will probably

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be able to program the computer to compensate for an asymmetric display, but the results may look so ragged that you prefer to live with the asymmetry.

**Video-Refresh Dropouts**

Video-refresh dropouts look something like the interference produced by static from electric motors and automobile ignitions (i.e., short, horizontal black lines that appear very briefly and in random locations on the screen.) They are not external interference in this case, but are self-inflicted. Whenever a Radio Shack TRS-80 or an Exidy Sorcerer accesses the video-refresh memory (either to read it or to change it), the computer interrupts the video refresh. (See figure 2.) The severity of the resulting display-data dropouts depends partly on the nature of the data being displayed. If only text is being displayed, with a black background, most of the dropouts will occur in areas of the screen that are already black and pass unnoticed. (The small-keyboard Commodore PET has dropouts too, but they are white and only appear when the display is PEEKed or POKEd.)

Dropouts happen only while the data in the computer’s video-refresh memory is being read or changed; if the display is being changed often, as during animation, the occurrence of dropouts will increase. So if you are planning to use your computer for animated graphics, look for models that do not have this problem.

In order to avoid having video dropouts, some personal computers have refresh memory that runs twice as fast as necessary for refreshing the display. This makes it fast enough to respond to a memory-access request by the computer between two successive transfers to the display. The computer and the display share the refresh memory by taking alternate memory cycles. Neither interferes with the other in any way.

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Limited Color Resolution

If you choose a computer that generates NTSC video in order to use an ordinary color television set for your display, you may be disappointed by the poor horizontal resolution. Even though the computer produces a signal with up to 280 dots per horizontal line, the television set will only show black-and-white resolution of about 160 dots per line and color resolution that is even lower - 40 or 50 dots per line.

We must define three different kinds of horizontal resolution when discussing graphics displays on a color or television receiver. To start with, you can distinguish the 280 dot positions even on a color set. (We might call this figure the accuracy of the display, since it determines the smallest difference that the computer can display.) The resolution problem arises due to the way most color television sets separate the color information from the rest of the video: they send all of the high-frequency information to the color circuits. This limits the picture bandwidth to only 2 to 3 MHz and the horizontal resolution to 160 to 200 dots per line.

This resolution, poor as it is, applies only to brightness changes in the picture (ie: black-and-white information). If you display different colors next to each other, the colors will smear across the width of four or five dots. This is due to the narrow bandwidth of the color circuits. A bandwidth of about half a megahertz allows only about fifty color changes across the width of the screen. In spite of this, you can produce quite good displays on a color television set by using a lot of black and white along with colors. Most of the picture consists of brightness differences and has horizontal resolution of about 160 dots per line. Displaying black between different colored areas keeps the color smears from being visible.

Color Interactions

Suppose you want to draw several lines on your color-graphics display. If you try to make the lines different colors, you will discover that the compromises made in the designs of some personal computers limit the number of colors that can be adjacent. If you try to put more than two colors close together, the computer will sometimes change one of the colors plotted earlier, depending on which color is used last. This can be rather disconcerting the first time it happens to you and worse when you find that it is a characteristic of your computer. You may be able to minimize the effect it has on your displays by understanding the mechanism behind it in order to "program around it."

This problem arises in the Compucolor II and in the Texas Instruments TI-99/4 because of their background-foreground schemes for specifying colors. Programs on these machines can use any one of the available colors for the dots being displayed (ie: the foreground) and any other color for the background. Each character cell can have its own
foreground and background colors, so the colors can be different in different parts of the display. However, inside a region that is the size of a character, there can be only two colors. If you try to draw a colored line through a cell that already has two other colors in it, the foreground points in that cell will be displayed as the new color.

The Apple II has a similar problem due to the tricky way it selects colors in high-resolution mode. High-resolution graphics on the early Apple II have only two colors, plus black and white. It uses bit mapping of 7 bits out of each displayed byte. Later models have been modified to use the eighth bit in each byte to select two more colors by shifting the phase of the dots made by the other 7 bits. This means that the color-select bit in each byte determines which two colors are available for seven adjacent points. If a line happens to fall in the same seven-dot-wide region as one already plotted, with the color-select bit the other way, the color-select bit will get changed to match the new line. (See table 2.)

**Which Method Is Best?**

By now it shouldn't be surprising that I don't single out one personal computer as the best. It should also be obvious that my criticism of particular features of certain manufacturers' computers does not automatically disqualify them or imply that their competitors' machines are superior. Careful examination of newer computers is likely to reveal other peculiar features.

My explanations of these undocumented quirks are intended to show how published specifications fail to provide complete descriptions of these machines. The different approaches to graphics displays may result in similar specifications, but the displays may perform quite differently in a particular application. You should try to understand these differences so you can evaluate them in terms of your own needs and make your own judgments.

The most important graphics feature of a personal computer is simply having graphics. Of course, you can produce video displays that are adequate for some applications on a system that does not have any graphics features. For example, photo 3 shows a plot of a histogram produced by means of standard characters. Most of the ubiquitous Star Trek games also use this approach, which might be called **pseudographics**. Still, such displays are limited both in information content and in visual appeal.

The personal computers I have mentioned all have at least some kind of block-graphics display. Photo 3 and photo 4 show the same histogram...
displayed using pseudographics and low-resolution block graphics.

The next important feature of a graphics display is color. If you doubt the validity of that statement, ask yourself why, when television made the transition from black and white to color, all the commercials were done in color long before all the programs were. Statistically speaking, you could say that a color display can convey three times as much information as a black-and-white display with comparable resolution. This generalization fails to describe the impact that color provides. If your objective in having graphics on your computer is to enhance the effectiveness of your displays, then you are almost certain to find that color capability is worth the cost.

Next we come to the question of resolution, and here things get a little complicated. An inexpensive way to get high resolution is by means of special characters, but this method is not well suited for producing graphs of curves or other mathematical functions. You can directly compare the specifications of the other types of graphics systems, subcell and mapping, because these enable you to plot a curve as a series of points in ordinary rectangular coordinates. The higher the resolution, the smoother and more accurate these plots will be.

However, special-character graphics systems do not allow you to plot arbitrary curves in high resolution. Only predetermined shapes can be displayed, except on the Texas Instruments and Exidy machines with their programmable graphics characters. While it should be possible to write a program to dissect a curve into 8 by 8 graphics cells on these computers, it would be extremely tedious. This means that the resolution of a special-character system is not directly comparable with that of the other types. How important that is to you depends on your need to plot curves with your computer. It also demonstrates another way that specifications can be misleading if you look only at the numbers.

I hope that the information I have provided has not given you the idea that the graphics displays on all the current personal computers are unusable. I think it is very exciting that we can get so much graphics capability on such inexpensive machines. My objective in presenting this description has been to help you see the reasons behind their differences. If you can understand them, you will be able to figure out which type is most appropriate for making the kind of graphics displays you are interested in.

References
RCA's new VP-3301 is a professional quality, ASCII encoded, interactive data terminal, suitable for a wide variety of industrial, educational, business and individual applications requiring interactive communication between computer and user. Connects directly to your computer or to a standard modem for over the phone access to time sharing networks and databases. And it's compatible with networks such as those provided by CompuServe Information Services and Source Telecomputing Corp. Microprocessor intelligence and LSI video control integrated circuits bring performance, features and flexibility at a low price. Power supply included.

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On the Road to Adventure

Bob Liddil
The Programmer's Guild
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Adventure! The very word brings forth visions of high intrigue and danger. The armchair adventures of the personal computer user can be every bit as exciting as the real thing, without the personal risk.

Adventure players are just as dedicated to their activity as are any of the many different types of gaming enthusiasts. They expect a high standard of excellence.

This article by no means claims to cover all there is to know about Adventure. [The capitalized word Adventure will be used to refer to this class of games as a whole . . . GW] What I will do is introduce the reader to the styles and procedures that have popularized Adventure to almost cult status and present the currently popular authors along with their works. Additionally, there will be tips on how to play Adventure without tearing your hair out and going totally crazy.

What Is Adventure?

Adventure is a semi-intelligent, word-recognizing computer program that employs a narrative style to present an unsolved puzzle. (For an example of an Adventure dialog, see listing 1.) The format of the game can be almost any organized grouping of locations that are bound together by a single theme. The clues to the puzzle are tied to the theme so that the game flows logically and smoothly. Solving the puzzle in whole or part leads to the treasure or to valuable clues to the ultimate winning of the game. Some Adventures are goal oriented, while others rely on the accumulation of valuable objects.

The commands in Adventure affect four factors: where you are, what you see, where you can go, and what you can do.

Magic words are popular with some Adventure authors.

Your puppet, the narrator inside the program who resides in the world of your Adventure, can freely use the data provided by the computer to deliver your options to you. When you respond, the puppet executes your command and lives (or dies) through the consequences.

By paying careful attention to the information given you through the faculties of your puppet, you can move him freely through his environment. One mistake can cost you the game (and the puppet his life).

How to Play Adventure

Your puppet will do whatever you command if it is within his power. He is totally dependent on you for his sequence of action. He understands quite a vocabulary of two-word English sentences, but you must be careful because he takes your commands literally. Thus, a command to a puppet standing at the edge of a cliff to JUMP will cause the puppet to hurl himself into space, resulting in (depending on the author) consequences ranging from death to soft landing. A command of SHOOT HORSE in a western Adventure could leave you afoot.

GO, GET, LIFT, CARRY, PUSH, KICK, SHOOT, ATTACK, KILL, FEED, LEAD, and DRINK are only a few of the many (usually more than one hundred) direct-action commands available to the player of Adventure. One Adventure by Scott Adams has a fully functional bathroom with a presumably anatomically correct puppet responding to the direct-action command USE 1.

EXAMINE always gets results, even when the response is a seemingly nonhelpful. I SEE NOTHING SPECIAL. This is still a clue in that it eliminates the object just examined from further consideration. Sometimes EXAMINE reveals something that you have overlooked. In a recent outer-space scenario, I carried a phaser pistol for almost an hour before remembering to examine it. When I did, I discovered that it had two settings, stun and destroy. I had been stumped, but now I destroyed a certain object and things fell logically into place. I was able to proceed with the game, following it to an entertaining and pleasant conclusion.

Movement commands are usually simplistic. In some Adventures, possible directions to take are displayed at the top of the screen with the title "OBVIOUS EXITS ARE:" These may not be your only options, however. Lost in a desert, with a road in sight (and the message YOU SEE: A ROAD, CACTUS, SAND displayed), you may have the additional movement-command options of GO ROAD, GO CACTUS, or GO SAND. These may produce such diverse results as YOU ARE ON A ROAD, YOU SEE: DESERT, MOUNTAINS, TOWN or OUCH! I'M STUCK FULL OF PRICKLY PEAR NEEDLES or I'VE BEEN BIT TEN BY A RATTLESNAKE, I'M DEAD.

About the Author

Bob Liddil is a freelance writer and is both game designer and president of The Programmer's Guild. He is interested in photography and noncomputer fantasy war-gaming, and his equipment includes a Radio Shack TRS-80 Model I computer with 48 K bytes of memory, two MPI disk drives, and a Centronics 730 printer.
The MODEL 800 MST is certainly pleasing to look at, but its true beauty lies beneath the surface. A glimpse at its features reveals why it is rapidly becoming the most sought after printer in the world...

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- Elongated characters in all six densities
- 1920 character buffer
- Uses either perforated or roll paper
- Fully adjustable tractors to 9½"
- Auto self-test

... but maybe its most attractive feature is the price... $699.00.
Listing 1: Sample dialog from an Adventure. These three screens are from Lost Dutchman’s Gold, an Adventure from The Programmer’s Guild. The questions and long replies are by the Adventure program. The two-word replies at the end of each indented line are the player’s command. Although the format will vary from Adventure to Adventure, each one will tell you something about your immediate surroundings. In this Adventure, the information above the heavy lines is rewritten after each command. In other words, the legend DEAD BURDENBEAST at the top of the last screen is displayed only after the command SHOOT BURDENBEAST (at the bottom of the screen) is given.

YOU ARE IN A SMALL CAMP, YOU SEE:
CARRYSACKS, UNITED BURDENBEAST, LEATHER PIECE, CAMPFIRE.

OBVIOUS EXITS ARE : WEST NORTH SOUTH EAST

WHAT DO YOU WANT TO DO NOW? EXAMINE CARRYSACKS

IT IS A WELL WORN DOUBLE CARRYSACK

WHAT DO YOU WANT TO EXAMINE NOW?

OK

YOU ARE IN A SMALL CAMP, YOU SEE:
CARRYSACKS, UNITED BURDENBEAST, LEATHER PIECE, CAMPFIRE.

OBVIOUS EXITS ARE : WEST NORTH SOUTH EAST

WHAT DO YOU WANT TO DO NOW? EXAMINE CARRYSACKS

IT IS A WELL WORN DOUBLE CARRYSACK

WHAT DO YOU WANT TO DO NOW? EXAMINE BURDENBEAST

OK

YOU ARE IN A SMALL CAMP, YOU SEE:
DEAD BURDENBEAST, LEATHER PIECE, CAMPFIRE.

OBVIOUS EXITS ARE : WEST NORTH SOUTH EAST

WHAT DO YOU WANT TO DO NOW?

OK

YOU ARE IN A SMALL CAMP, YOU SEE:
CARRYSACKS, UNITED BURDENBEAST, LEATHER PIECE, CAMPFIRE.

OBVIOUS EXITS ARE : WEST NORTH SOUTH EAST

WHAT DO YOU WANT TO DO NOW?

OK

YOU ARE IN A SMALL CAMP, YOU SEE:
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OBVIOUS EXITS ARE : WEST NORTH SOUTH EAST

WHAT DO YOU WANT TO DO NOW?

OK

YOU ARE IN A SMALL CAMP, YOU SEE:
CARRYSACKS, UNITED BURDENBEAST, LEATHER PIECE, CAMPFIRE.

OBVIOUS EXITS ARE : WEST NORTH SOUTH EAST

WHAT DO YOU WANT TO DO NOW?

OK

Not that you shouldn’t try all available options—there could just as easily be a treasure or a clue behind that cactus or in that underbrush. Things can often be examined from a distance. If not, a curt YOU CAN’T DO THAT YET will appear on the screen, followed by a nasty electronic snicker from deep within your computer. Generally, when the word YET appears in a message, you know you are on the right track.

Magic words or teleportation phrases are popular with some Adventure authors. SAY the magic word and the whole world spins around, taking you elsewhere or elsewhen.

This is a convenient way to travel, but it can be a two-edged sword that might land your puppet in never-never land for an indefinite stay. There are at least two Adventures in which teleportation phrases are employed (with pitfalls in both). A third accepts an incantation from another Adventure; however, the response is instant death.

CLIMB is a word you can use to get somewhere when saying a magic word does not teleport you. If you are carrying an object, you may have to drop it to proceed with climbing. Generally, what can be climbed into can be climbed out of. Don’t be afraid

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words GO, DRINK, and EXAMINE)
can result in your puppet being
poisoned. In real life you would never
imbibe without looking at a label; why
kill off your puppet needlessly?
The same reasoning applies to any
phase of your Adventure. Apply
common sense and you will win
every time.
On the other hand, the author of
your Adventure, while bound by the
laws of order and fair play, is not
above puns, a little chicanery, or out-
and-out silliness. Watch for double
meanings in the author's choice of
words; he will fool you, if he can,
with painfully obvious clues.
The HELP, SCORE, and INVEN-
TORY commands are always ex-
pained in the openings of the pro-
grams. They accomplish what their
names imply.
Adventures are tremendous fun,
but you must stay alert and ask the
right questions: What do I see? Where
can I go? What is the easiest way to
get there? What can I do where I am?
These questions can help you solve
the puzzle and win the game.
There are six main vendors of
microcomputer-based Adventures:
Scott Adams, Greg Hassett, Radio
Shack, The Programmer's Guild,
Microsoft, and Mad Hatter Software.
The following sections give a syn-
opsis (revealing none of the secrets,
however) of their product lines at the
time of this writing.

Scott Adams Adventures
Twenty-eight-year-old Scott
Adams is generally credited with
being the father of microcomputer
Adventures. The game began as a
"head toy" for the PDP-10 and other
large computers. Through Scott
Adams and his company, Adventure
International, it soon found its way
into the 16 K-byte TRS-80 heartland
of America. Here is a list of his
Adventures:
- Adventureland is a lighthearted
little trip into the countryside. This
first effort was written in BASIC,
then changed to machine language. It
is a good beginning point for the
novice since it is not too complicated.
There are a bog and a lake and
numerous other natural features to
keep things lively. This is an Adven-
ture that uses a magic word.
- Pirate's Cove is rated as a classic.
Its smooth storytelling style quickly
sets the standard for all Adventures
to follow. There are four basic loca-
tions: a flat in London, an island, a
Treasure Island, and never-never-
land. The wild and wacky characters
that populate this game only enhance
it. A pirate, a mongoose, a parrot,
and assorted other beasties give this
Adventure a delightfully humorous
effect.
- Mystery Fun House is an excu-
sion into the madcap world of a car-
nival funhouse. It includes passing a
gatekeeper and exploring multiple
corridors. You must find a variety of
objects within the funhouse and get
out within the time limit. This one is a
real brain teaser.
- Mission: Impossible pits you
against unknown enemies in a race to
stop a nuclear reactor from being
destroyed. To complicate matters,
there is a bomb planted in your head.
This one is pretty tough to solve and
is an absolute must for those whose
Adventure skills have become well
honed.
- Strange Odyssey is one of the
best of this series. You are alone on a
strange planetoid with only a broken
spaceship and your wits. There is a
rock with alien runes on it. If you
solve the mystery of gaining en-
trance, a stargate to brave new
worlds with treasures awaits you.
Manipulation of objects with alien
environments plays an important role
in the solution of this puzzle.
- The Count is an Adventure that
will leave your blood cold as you at-
tempt to rid the world of Count
Dracula once and for all. You must
race against time to beat the sunset,
find the Count in his humanoid form,
and overcome his powers to drive the
stake home. As for your motivation,
there is an angry crowd preventing
you from shirking your duty. A sub-
puzzle of this Adventure, deciphering
the hallways, will keep you occupied
for hours.
- Voodoo Castle is a weird Adven-
ture. It seems that Count Christo
has been cursed, and you are the only
one who can save him. Starting off in a
chapel, you must explore the stony
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Speed is the essential difference between machine-language and BASIC Adventures.

hallways and darkened dungeons of Voodoo Castle. There is a juju man, a kachina doll (a likeness of the Count), a book for removing curses, and much more. For entertainment value, this one rates very high.

- Pyramid of Doom takes you to an unexplored pyramid somewhere in Egypt. You have the key and can begin the search for a treasure under the watchful eyes of an ever-present nomad. This one is so good that after two weeks, I still haven't solved even a portion of it... yet.

- Ghost Town is an Adventure with a Western theme that has all the mystique of a John Wayne epic. The puzzle is one of the most rewarding and entertaining of Scott's nine Adventures. The maze is an authentic ghost town complete with saloon, hotel, jail, boot hill and an outrageous piano-playing ghost. This one is great fun.

Greg Hassett's Adventures

Of note to Adventure shoppers are the differences between the machine-language versions of Adventure and BASIC-language versions. The latter are appearing on the market in ever-increasing numbers. Speed is the essential difference. To most players of Adventures, the difference in execution time is of little importance. To the Adventure cultist, however, speed is everything. With this in mind, the authors who write Adventures in BASIC, ever in the shadow of Scott Adams and his beginnings in BASIC, are one by one graduating to machine language, blinking cursors, and (blinding) speed. One such author is Greg Hassett.

Greg is a 13-year-old schoolboy from Chelmsford, Massachusetts. His eye for detail and wry writing style have placed his Adventures in direct comparison with those of Scott Adams. This is unfortunate for two reasons. Greg's work is often judged unseemly and dismissed due to his age or the fact that most of his programming has been in BASIC. When criticized on their own merit, however, the Hassett Adventures stand up well in both entertainment and value per dollar.

- Journey to the Center of the Earth is a perky little trip into the interior of our planet. The earthdigger in which you are riding gets a busted Gonkulator, and you have to find a new one (or something to replace it with) somewhere in the maze of tunnels in which you find yourself. Giant bugs and treasure make this beginner's game interesting.

- House of the Seven Gables pits you against a wicked witch in a haunted house. More complicated than its predecessor, this program will be deadly to those who take its puzzle lightly. Unique objects of value and scenes of personal combat give a player his money's worth with this one.

- Atlantis: If undersea is where you want to be, this one is for you. Personal combat is taken one step further with the guardians of treasures being fierce sea creatures. The entire Adventure is done under water, and it's a lot of fun. Whirlpools and octopi and denizens of the deep await you here.

- Sorcerer's Castle allows you to challenge the evil sorcerer on his own turf. Well, if you can find your way out of the woods, you'll be just in time to fight and may even confront the evil sorcerer personally. Treasure abounds here, with ample puzzlement to please even the most demanding Adventure enthusiast.

- In Enchanted Island, magic and mystery join hands to present an Adventure of worth. The highly different flavor of this program would be spoiled by the presentation of any details in this review. It is the author's most challenging Adventure written in BASIC.

- Enchanted Island Plus: Like Scott Adams, Greg Hassett also quests for the increased speed offered by a machine-language Adventure. This program has it all—speed, blinking cursor, and an increased number of locations. This Adventure is a must buy.

- Mystery Mansion summons you in a dream to come solve the mystery of a haunted mansion. Good pace and colorful descriptions are the selling points for this Adventure. It is a fast, well-written machine-language Adventure, and it should especially appeal to younger Adventure fans.

- World's Edge gives you a future where the Earth's pollution count has finally reached a critical level. You can save the planet from extinction
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with 2.2 kg of APC-80 located on a small distant planetoid. However, the element is considered holy by the inhabitants of the planetoid, so a fight is imminent... This is by far the most imaginative plot from Greg, who seems to love to add combat to his Adventures. It is also another of his machine-language Adventures.

Radio Shack Adventures
- **Pyramid 2000**, the first Adventure from Radio Shack, is a machine-language scenario set in Egypt. You explore the pyramid for gold and glory without the scrolling or blinking cursor that hallmark other microcomputer Adventures. Still, the authors have managed to work a much-used theme to its maximum, drawing a fairly complex and entertaining puzzle.

- **Haunted House**, like its cousin Death Dreadnought, deals not with gold or glory, but survival. Once inside the house, you are pitted against unseen enemies with awesome telekinetic powers. Levitating knives and eerie occurrences await the Adventurer here. Produced for Tandy Corporation by Device Oriented Games of Dallas, this is an excellent offering.

The Microsoft Adventure
Microsoft Consumer Products, a sibling company to the Microsoft that has written so many versions of BASIC, has a very heavy version of Adventure available on disk only (most Adventures are supplied on cassette tape). It is reputed to be a copy of the original Adventure written by Crowther and Woods for the Digital Equipment Corporation PDP-10. The original Colossal Cave is there, and there is ample room on the floppy disk for the over 400 eloquent descriptions.

The Programmer's Guild Adventures
One of the newest of the Adventure publishers is a little company called The Programmer's Guild. It distributes three Adventures written by independent authors. *Lost Dutchman's Gold* and *Spider Mountain* are by Teri Li, and *Death Dreadnought* was coauthored by Biff and Spudd Mut [pseudonyms, I hope... .GW] of Device Oriented Games.

- **Lost Dutchman's Gold** is a Western Adventure. In the Superstition Mountains of Arizona, you accompany the ghost of Backpack Sam, a grizzled old prospector, who knows the secret of the Lost Dutchman's mine. There are Indians, a stubborn mule, a ghost town, and the Superstitions, dark and mysterious, to keep you spellbound throughout the simulation.
- **Spider Mountain Adventure** is a classic *Dungeons and Dragons* type Adventure that employs Shelob, a giant spider, as guardian of the many treasures of Spider Mountain. Armed with only a crossbow, you face orcs and spiders in the maze of tunnels under the mountain.
- **Death Dreadnought**, rated R by its own publisher due to extreme descriptions of violence, pits man against an unseen horror that has devastated an entire alien battlecruiser. As the last living human on board, the Adventurer is required merely to escape. This, however, is no small task with a killer on your trail and an unsolved maze before you. This one is not for the squeamish or faint of heart.

Mad Hatter Adventures
Mad Hatter Software, which began as a distributor for the Hassett Adventures, recently launched two titles of its own.
- **Sleuth** is a detective story, a whodunnit Adventure with graphics and sound. The graphics consist of video maps of where you are, and the sounds are the primitive tink-boop sounds that characterize early sound effects for the TRS-80.
- **Quest** uses the same graphics and sound techniques as *Sleuth* but is more of a fantasy Adventure. Neither held my attention the way the other Adventures reviewed did. Plotlines are thin and seem to be built around gimmickry rather than solid plots and programming.

How to Write an Adventure
Adventures are, first and foremost, puzzles. You (the Adventure author) must be prepared to satisfy the Adventurer's lust for the unsolvable, while at the same time making it easy enough for the novice.

Choose a recognizable theme. In *Spider Mountain*, for example, it is evident that the Mountain is the goal.
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So, as the game begins, we leave the campsite, hiking as fast as we can for the mountains we see in the distance. An hour or so of looking for a way to find the treasure on the mountains soon convinces us that the goal must be inside or possibly under the mountains. In fact, the author has sidetracked us away from the real entrance to Spider Mountain, but this is OK as long as it is enjoyable and related to the rest of the Adventure.

Clues and equipment may be scattered throughout the theme area. Their locations should not be obvious to avoid easiness, but they should also not be impossible to find. Avoid highly complicated situations; they interrupt the flow of your game.

Several minor or subtheme areas will spice up the game. It is not necessary to provide a lot of memory-consuming action in the lesser areas; however, nobody likes an empty room (desert, etc), so at least put something there for your player's trouble.

Scott Adams' use of subtheme areas in Strange Odyssey is one of the best examples of this concept. By breaking his Adventure up into different worlds, each with its own complications and dangers, Scott effectively entertains his audience without frustrating them. Some of the differences among the stargate worlds of this Adventure are deadly, but not to the point of aggravation.

Make sure that your overall theme does not duplicate an Adventure already in existence. Both Adams and Hassett have extensive lines of Adventure scenarios. Mad Hatter Software and The Programmer's Guild, which have only a few Adventures each, are both planning more.

Research your settings. Make sure that your locations ring of authenticity and that your descriptions are accurate; otherwise, your reader will spend more time criticizing than playing.

Be certain that your Adventure has a large enough vocabulary to function well. If you add radical words to your vocabulary, be sure that provisions are made for giving clues about them to your player.

Be innovative. Don't wait around for someone else to do it. Introduce new features into your game. Make your Adventure unique in the marketplace.

Above all, be entertaining. Your audience will come back for more and more if you give them their money's worth each and every time they play.

Adventure is the product of imagination appealing to imagination. It is not just the puzzle, or the theme, or the nonplayer characters and their personalities. It is a verbal tapestry of interwoven phrases that whisk you away to magical kingdoms of the mind. The computer becomes a tool of reaching that conveys you where it will. You go along eagerly, breathlessly, awaiting what comes next.

Such are the worlds created by Adams, Hassett, Li, and all the Adventure writers who have not yet been published. What they have in store for us next is anyone's guess. But I bet it's well worth waiting for.
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I have been involved for several years with Zork, one of the larger and (I would like to think) better worked out CFS games. The authors (Marc Blank, Tim Anderson, Bruce Daniels, and I) have spent a lot of time trying to make the universe of Zork as consistent and complete as possible within the bounds of the space available. The first version of Zork was written for the Digital Equipment Corporation PDP-10; it eventually grew to strain even the megabyte address space of that machine. The game was completely rewritten for microcomputers and is now limited primarily by the size of a 5-inch floppy disk. Zork games swap data (programs and text) into memory from the disk as needed and therefore aren't limited by the size of the system's user memory.

Standard 5-inch floppy disks store about 100 K bytes (some store more, some less). This works out to about 10,000 words of English prose and a similar amount (about 40 K bytes) of code. This is large for a microcomputer-based program, but as literature it's still only at the short story length.

Zork is shrunk to fit into the micro-world by running on a Zork-language virtual machine. This means that the code that is running while you are playing Zork is much more compact than the same program would be if written in machine language (on a Radio Shack TRS-80, for example). This is because the instruction set of the virtual machine is tailored to CFS games. For example, the Zork-language instruction to move an object from one room to another takes just 3 bytes of storage. The other advantage is that the Zork code is machine independent; all it takes to move Zork to another machine is to write the Zork-language interpreter for that machine. Such interpreters currently exist for the Apple II, PDP-11, PDP-10 and the TRS-80. For more details about the Zork-language see "How to Fit a Large Program into a Small Machine," by Marc S Blank and S W Galley, July 1980, Creative Computing.

Even using a disk to store parts of the game, the PDP-10 Zork was still too large for the micro-world. As a result, we split it into two smaller, independent games: The Great Underground Empire, Part I, and The Great Underground Empire, Part II, each of which is a self-contained program. There was room left over, so we added some new problems to round things out.

Still, a lot of universe can fit into a microcomputer and disk. Zork "understands" a useful subset of English (mostly imperative sentences), including sentences as complex as "Put all of the books but the green one under the rug." The Zork vocabulary is over 600 words and includes 100 verbs. A parser this powerful is a good-news/bad-news proposition. On the one hand, such a parser makes possible the implementation of subtle and realistic problems. When the most complicated sentence you can understand is "Drop uranium," you are limited to producing certain types of situations. If you can say "Tell the Robot 'Put the uranium in the lead box'," then the game can become more interesting.

Zork has a fairly complicated parser for imperative sentences. It endeavors to reduce its input to a construction of:

\[ <\text{verb}> <\text{direct object}> <\text{indirect object}> \]

where the objects are optional. Prepositions are folded in-
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One method of dealing with players who are "killed" in Zork is to resurrect them in a forest.

to the verb, which allows Zork to differentiate

>PUT BOMB UNDER TROPHY CASE

from

>PUT BOMB IN TROPHY CASE

(Lines beginning with > are the player's input.)

Similarly, adjectives are used to distinguish among several books, doors, or any collection of like objects. In conjunction with all and but, adjectives provide powerful constructs:

>TAKE ALL THE TREASURES

>BURN ALL THE BOOKS BUT THE BLACK ONE

The parser also allows the player to be laconic, if he so desires. If only one object in the vicinity fits the verb he uses, it will be selected and the player will be informed:

A menacing troll brandishing a bloody axe blocks all passages out of the room.

>KILL TROLL

(with sword)


On the negative side, having a clever parser means that the player may expect almost any concept to be understood. Unfortunately, only a small number of concepts can be implemented given the available space.

Some concepts that Zork does implement are:

- **Properties**: Objects can have properties or attributes, some of them changeable. Lamps can be on or off, treasures valuable or worthless, villains fighting-mad or peaceful. Some of these properties never change; a container is always a container, for example. But other properties can change; for example, some containers may be opened and closed at will.

- **Containment**: Objects may have contents. Bottles can contain water and be open or closed. Some objects are transparent. Some objects must be unlocked before they can be opened. The capacity of an object is limited. (For example, a paper bag won't hold as much as a bucket.)

- **Weight**: Objects have weight. A solid gold coffing weighs a lot more than a newspaper. The amount a player can carry depends on the total number of objects carried and on the total weight of the objects and their contents.

- **Position**: An object may be in, on, or under another object.

- **Vehicles**: The player may be in a vehicle which is traveling through the locations in the game. In addition to the player, the vehicle may have other contents distinct from the player's belongings and the "contents" of the location.

- **Time**: Game events may be scheduled to happen at arbitrary future times. Time-bombs may go off, matches burn out, lanterns grow dimmer, and so on.

- **Actors**: Actors are other characters who have roles in the game. They may fight or choose not to. They may speak to the player or be spoken to. They may move around or stay in a particular place.

- **Fighting**: The player may engage in combat with other inhabitants of the game. He may be wounded (affecting his ability to carry heavy loads), or he may kill his opponent and retrieve the opponent's weapon.

Every object in Zork has a pointer to its location (which may be "nowhere"), which is its parent; a pointer to the next object in the same location, which is its sibling; and a pointer to its first contents, which is its first child. Thus, a container points to its contents, and the contents point back to it.

One result of this implementation is that an object can
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be in only one place at one time. Things like water, which can potentially be infinitely finely divided, are difficult to implement in Zork for this reason. Consequently Zork has two "water" objects; one for water in general (flowing in streams, filling reservoirs, leaking from pipes) and one for water in the player's possession (in a bottle, for example). In handling water, the general sort always eventually ends up as the specific sort, and exceptions aren't tolerated:

> FILL BOTTLE WITH WATER
The bottle is now full of water.
> FILL BOTTLE WITH WATER
The water spills to the ground and evaporates.

Another aspect of containment involves problems of weight and capacity. The weight of an object must always be the sum of its own weight and the weight of its contents. Naturally, each of the contained objects has its weight calculated the same way. On the other hand, the volume of an object is filled only by the size of the objects directly in it.

LOOK
You are in the magic boat.
The magic boat contains:
A shovel.
A lamp.
A solid-gold coffin.
The solid-gold coffin contains:
A brown sack.
The brown sack contains:
A lunch.
A clove of garlic.

Of course, containers have other properties. They can be open or closed, opaque or transparent, locked or unlocked.

> INVENTORY
You are carrying:
A glass bottle.
The glass bottle contains:
A quantity of water.
> DRINK WATER
I can't reach the quantity of water.
> OPEN BOTTLE
Opened.
> DRINK WATER
Thank you very much. I was rather thirsty.

The concept of a surface is implemented as a special kind of containment. Objects which have surfaces on which other objects may sit are actually containers with an additional property of "surfaceness."

Vehicles are an even more specialized case of containers. A vehicle has a property called the action property that is allowed a chance to give special handling to any input of the player. For example, a spaceship vehicle might want to restrict the player's movement during the acceleration phase of a flight or prevent him from taking objects that are outside the ship.

Possibly the most useful concept in Zork is that of time. An arbitrary event may be scheduled to occur at an
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arbitrary time in the future: for example, the discharging of the batteries in a lantern is controlled in this way.

Introducing time also introduces some problems. If an event is scheduled, the circumstances under which it is valid must be coded into it. Otherwise, the behavior of the game can appear nonsensical. Suppose the player lights the fuse on some dynamite. If he sticks around, he will be blown to smithereens. He runs away, only to find that the dynamite has apparently followed him. He still gets blown up because, when the explosion happens, the program doesn't check to see if he is still there.

One method of dealing with players who are "killed" in Zork is to resurrect them in a forest. In an early version of Zork, it was possible to be killed by the collapse of an unstable room. Due to carelessness with scheduling such a collapse, 50,000 pounds of rock might fall on your head during a stroll down a forest path. Meteors, no doubt.

In an effort to introduce a little more randomness into what was at one time a deterministic game, we added fighting. The player was allowed to attack any of the monsters or other characters he encountered during his travels. The scheme we implemented is conceptually simple. There is a range of possible outcomes for any attack, either by the player on a villain or vice versa. You can be killed outright, knocked unconscious, wounded, wounded seriously, staggered, or you can have your weapon knocked from your hand.

The villain, each time it is his turn to riposte, has the option of parrying or turning and running (if he is not limited to one room, as the troll is). Some weapons are better against certain opponents than others. The relative strengths of player and opponent figure into the outcome as well (the player's strength is a function of health and progress in the game). The results are a selection of appropriate messages describing the fight as it progresses.

> KILL THIEF WITH SWORD
Clang! Crash! The thief parries.
> AGAIN
The thief receives a deep gash on his side.
> KILL
The thief slowly approaches, strikes like a snake, and leaves you wounded.
> ATTACK
The thief is disarmed by a subtle feint past his guard. The robber, somewhat surprised at this turn of events, nimbly retrieves his stiletto.
> KILL THIEF
A good stroke! Blood wells down the thief's leg. You evidently frightened the robber. He flees, but the contents of his bag fall to the floor.

Well, he may live to fight another day, but you recovered some of his booty. Fighting in Zork is pretty primitive when compared to real life or even to a "melee" in the popular game Dungeons and Dragons. You could make combat more elaborate, and in fact there are CFS games that have gone in that direction, producing quite realistic "hack and slash" games.

Possibly, the most enjoyable aspect of writing Zork was designing the other characters the player may encounter. Zork contains various other actors, including a troll, a thief, a wizard, various monsters and friendly gnomes, and a beautiful princess. Some of these are pretty simple. The troll is basically an obstacle. He doesn't move but merely bars the way and must be defeated by force of arms.

The thief, on the other hand, is embodied by a complex program. After a while, he begins to take on a personality of his own: the slightly down-at-the-heels younger son of a noble family, perhaps. He is cultivated but has a rather nasty sense of humor. For example, his idea of fun is to foul up the standard Adventure maze-mapping technique of identifying rooms by dropping objects in them. When he finds a player doing that, he will wander around switching objects, no doubt chuckling all the while:

You are in a maze of twisty little passages, all alike.
> DROP KNIFE
Dropped.
In the distance, you hear a voice saying, "My, I wonder what this fine rope is doing here?"

Some actions of the thief are motivated by the characterization; he is unlikely to kill you during a fight if he knocks your weapon out of your hand—too well bred. On the other hand, maybe his thiefly reflexes will get the better of him.... Many of the thief's actions are motivated by simple probability. There is a certain chance he will stop in any room while roaming around, a certain probability that he will steal any particular object (high for treasures, of course), and a probability that he will decide to attack the player. His behavior, nonetheless, can seem very realistic: Sometimes he seems to dog...
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the player, who no sooner finds a treasure than the thief filches it.

There is a rich range of possibilities in producing games in which characters in the story (other than the player) act more like real people and less like monsters or one-dimensional villains. But the simulation of human behavior is still an unsolved problem in the field of artificial intelligence. The best approximations to date have been the classic simulations of a nondirective psychotherapist (Weizenbaum's Eliza) and of a psychotic paranoid (Colby's Parry). But even they would not make very interesting characters in a story. (These two curious beings actually met once, as recorded in "Parry Encounters the Doctor" by Vinton Cerf, in Datamation, July 1973.)

There are other, more mundane areas in which Zork could be extended. For example, take a simple concept like clothing. If the player can reference his clothing (or even a magic ring he might be wearing) some interesting questions arise. Is there a distinction between wearing something and carrying something? Probably, because when the player says "drop all," he probably doesn't mean to include his clothes. Also, the existence of clothes probably means the definition of many parts of the body. You could take this to extremes:

> INVENTORY
You are empty-handed.
You are wearing a diamond ring on your right index finger.
You are wearing bells on your toes.
You are wearing a coonskin cap on your head.

Of course, if you implement clothes, there might as well be pockets, and backpacks, and other "different" sorts of containers. It would have to be defined whether the player can reference things inside them (what if the flap of the backpack is closed, for example?). What happens if he falls into a lake? Do the clothes drag him down? What about wearing a suit of armor? Clothes probably need a weight or need to produce a fatigue effect on the player.

The mention of falling into a lake brings up another possible extension to Zork. Currently players aren't allowed to swim. One reason was to avoid the problems associated with the player's belongings dragging him under. Another is the question of what happens to his belongings. Do they get wet? If so, do they ever dry out again? What about wet matches (to give one example)? Is wet paper still burnable? How long can the player swim? Can he hold his breath and swim underwater? There are any number of questions that have to be considered if such a feature is to be implemented.

Even the addition of a run-of-the-mill object can produce complications. In early versions of Zork, the troll's axe disappeared when he was killed. We finally decided to let the player recover it, as advances in Zork weapons technology removed the reason for destroying it. Unfortunately, we didn't think it through. One of our best play testers, on hearing that "you can finally get the axe," immediately said, "Great, I'm going to go up to the forest and chop down some trees." Oops. We never thought of that, not to mention using the axe to chop through doors, split timbers, and any number of other commonplace uses for something we were thinking of strictly as a weapon.

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The authors of Zork have thought about several possible extensions to the Zork parser. One that has come up many times is to add adverbs. A player should be able to do the following:

>`GO NORTH QUIETLY`
You sneak past a sleeping lion who sniffs but doesn’t wake up.

The problem is to think of reasons why you would not do everything “quietly,” “carefully,” or whatever. Perhaps there should be time and fatigue penalties for doing things in a nonstandard way:

>`SEARCH WALL CAREFULLY`
This would take a long time (and all the while the lamp is burning down), possibly tiring the player out. To be fair to the player, he should not need to search every wall carefully, or walk quietly everywhere. There should be reasonable clues or hints as to why and where he should do such things.

This long discussion of the problems of extending Zork is not intended to scare anyone (including the authors of the game). The idea is to show that apparently simple extensions to the game have their nonobvious ramifications. Of course, it would be simple to ignore them, but we think that the authors of a game should play fair with the players. Just as it’s disappointing to see the wires holding up Flash Gordon’s spaceship, it’s disappointing to see:

>`PUT RING ON FINGER`
I don’t know the word ‘finger’.

We authors would hardly claim that Zork is perfect in this respect, but we have made an effort in that direction. When we add something new, we try to think of how the player might try to use it and what verbs he might try to apply to it. Within the space available, we’ve tried to put most of those things in.

All the CFS games that I have encountered are similar in one major respect: they are about problem solving and the acquisition of treasure. This is probably because a structure containing problems and rewards is obvious and easy to implement.

It is possible to imagine games in which the goals are different. Some programmers in southern California have designed a game in which the moral choices the player makes have a significant impact on the game. For example, does the player give an old man some water? Similarly, the problem-solving idea could be shifted into something closer to scientific research. The player could be introduced into an environment where he performs experiments, ponders the results, and ultimately gains understanding and control of that environment.

Innovations in form as well as content are possible. There are already CFS games that try to give the player a graphic view of his surroundings. As microcomputer technology advances, this will become more common, and the renditions will achieve higher quality: it will be technically feasible to have a CFS game “illustrated” by Frank Frazetta or Jeff Jones. On the other hand, the player’s imagination probably has a more detailed picture of the Great Underground Empire than could ever be drawn. I can even recall discussions among the game’s implementors over who should play the thief in the movie version.

Another area where experimentation is going on is that of multiplayer CFS games. Each player (possibly not even aware how many others are playing) would see only his own view of the territory. He would be notified when other players enter or leave the room, and could talk to them. There was briefly a multiplayer version of the PDP-10 Zork several years ago, and today there is a “Multiple User Dungeon” at Essex University in England.

There are major problems, however. One is producing problems that are compatible with different numbers of players (from one to, say, a dozen). If it takes five players to solve a problem (one to hold the light bulb and four to turn the ladder?), what happens if only two people are playing? The other problem, as far as the microcomputer owner is concerned, is that few can afford an unlimited number of machines or even video monitors to accommodate so many players.

CFS games as an art form can continue to grow as long as their medium continues to grow. Zork is already constrained by the size of today’s microprocessors (it was large even on the PDP-10), but the new generations of 16- and 32-bit machines offer the opportunity of enormous further growth. The possibilities of new concepts, new milieux, and new purposes are enormous. We would like to think that it will not be long before authors view such scenarios as just another medium of expression. I find the prospect exciting because I enjoy playing CFS games as much as writing them.
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Character Variation in Role-Playing Games

Jon Freeman
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There is no role-playing in games of the Adventure/Zork family.

no point to playing except playing, and no ultimate aim except the continuing development of your “character”—the alter ego who stalks the imagined landscape in your stead.

Even microcomputers in a fraction of a second can make complicated calculations that would take a Dungeons and Dragons referee minutes of page-turning and piles of charts. However, no computer games can handle all the aspects alluded to above as well as the best-run noncomputer games. Computer-based games can therefore be grouped according to which aspects they emphasize and which they ignore.

There is no real role-playing, for instance, in the Adventure/Zork family: the protagonist is just you in a strange setting. Games of that sort concentrate on the perceived open-endedness of action: not only is there a multitude of command options available (typically far more than Dunjonquest’s eighteen or so), but also they are not made known to you except by trial and error. It can be quite challenging to find the right answer; the outcome of events is probabilistic, not predetermined.

Character Variation in Dunjonquest

The Dunjonquest series employs a different approach. For one thing, situations are primarily defined graphically, not textually: you see the situation rather than just being told about it. More to our present purpose, while some Dunjonquest games, like Morloc’s Tower, have a specific object (finding and slaying the mad and elusive wizard Morloc), there is an open-endedness of result in all of them on the micro level (if you’ll excuse a small pun). Generally speaking, there are no “right” answers; the outcome of events is probabilistic, not predetermined.

Brian Hammerhand, the assigned alter ego/protagonist of Morloc’s Tower and The Datestones of Ryn, can, for example, slay a dire wolf nine times out of ten, but on any particular occasion he may survive the encounter unscratched, or limp away badly mauled and out of breath—and there is also that tenth time. Moreover, the exact outcome of any encounter depends both on the tactics you choose and on the specific traits of your surrogate character. The experience is different every time you play and quite different with each new character you take on your adventure. You are role-playing: getting outside yourself and into the skin of another (albeit imaginary) being.

In The Temple of Apshai, Hellfire Warrior, The Cliffs of Tyyr, and others in the Dunjonquest series, six traits or attributes are used to distinguish Samson the Strong from Cugel the Clever, and Dorgan the
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Dolt from either. Three traits (ego, intelligence, and intuition) cover the mental aspects of a character, and three traits (dexterity, strength, and constitution) cover the physical attributes. Each of these is assigned a number (randomly, if the program is creating the character) from a low of 3 to a high of 18—the equivalent of rolling three six-sided dice, which is how such characters are normally created in games like Dungeons and Dragons. (This commonality allows you to bring characters from “outside” into the Dunjonquest world.)

The numerical valuation permits the use of charts and tables, or computer calculations, to affect or resolve outcomes during the course of the adventure. It also permits $16^4 = 16,777,216$ different characters, which is enough to allow all the variation you could ask for if the system is set up to handle it.

**Dexterity and Constitution**

In the Dunjonquest systems, character variation affects the game in many ways. For instance, in any round of combat between an adventurer (you and your character) and a monster (dragon, troll, goblin, common thug, etc), there is a chance the character will strike the monster with his sword, and a separate chance that the monster will strike the adventurer with his teeth/claws/club/bad breath. Dexterity, representing a combination of reflexes, coordination, speed, etc, interacts with the adventurer’s choice of weapons in a complex way to modify those combat probabilities.

Simply put, with a dexterity of 4, Cleavon the Clumsy has trouble keeping his shield out of his own way; he spends much of his time futilely slicing the air and is an easy target for attacking monsters. In contrast, Flash Farrad (dexterity 17) will hit his opponent far more often and will block more blows with his shield. Reasonably enough, since Farrad is better at hitting where he aims, his advantage over Cleavon extends to the amount of damage he is likely to do (but other factors — size of the weapon and strength of the sword arm — enter in; see the following).

Constitution, a measure of health and endurance, is perhaps the single most important trait, since it represents specifically the number of points of damage a character can sustain before dying. A monster must do exactly three times as much damage to Steel Strongheart (constitution 18) to kill him as it would take to do in poor Ferdinand the Frail (constitution 6). (In fact, Ferdinand is too sickly to pass muster in the Dunjonquest character-generation sequence, which rejects hopelessly inferior characters.) Furthermore, Ferdinand will tire (from moving or fighting) three times as fast as Steel. Since fatigued characters must rest or risk falling easy prey to monsters through sheer exhaustion, even running away can be hazardous to unhealthy adventurers.

**Strength and Ego**

Strength measures how strong the character is and affects damage done in combat both directly and indirectly. Heavier weapons do potentially more damage, but not all characters can wield even a broadsword, and only the strongest can manage a hand-and-a-half sword one-handed. More directly, the nominal damage (obtained by a random “die roll” itself affected by dexterity and other factors) done by the adventurer to the monster he is fighting is multiplied by one-tenth the strength value to determine the gross damage done. On a “roll” that yields a nominal damage of five points, nerdley the Not-so-Strong (strength 8) actually does only $5 \times 0.8 = 4$ points of damage, while Manfred the Mighty (strength 16) would receive $5 \times 1.6 = 8$ points of damage out of the same swing of a sword. Strength is also part of the complex algorithm used to calculate fatigue, which is, in part, related to the ratio between the amount of weight an adventurer is carrying at any moment and the square of his strength. Stronger characters can manage heavier armor and more treasures without strain.

Ego is a measure of mental toughness and willpower. In part, it expresses the differing reactions of people to stress: in a bad situation, Casper Milquetoast (ego 3) gives up, while Darvon the Determined (ego 16) redoubles his efforts. This translates into an increase (for Darvon) or decrease (for Casper) in the probability that either will strike the monster he is fighting; the value of the increase/decrease is dependent on the extent of their injuries.

In Dunjonquest games in which the
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protagonist is a magician, ego affects the power of a spell much the same way strength modifies a physical attack. In all games, ego is added to intelligence to determine the success of a character's attempt to parley with a monster. Finally, it interacts with intelligence in a more complex way to affect a character's ability to bargain in the Inn, Apothecary, and Magic Shoppe.

Intelligence and Intuition

Intelligence in Dunjonquest is limited to the "left-brain" powers of logical reasoning and verbal expression. Since it most closely represents that quality brought to bear on the game by you, the player, the character's intelligence affects play less than any other attribute. It helps or harms the ordinary adventurer chiefly in his negotiations with monsters or the Innkeeper and company, and it controls the complexity of spells used.

The final attribute, intuition, is the complement of intelligence; it covers real and imagined "right-brain" functions like spatial perception, ESP, and luck. The probability of finding secret doors, traps, and monsters lurking in the next room is directly dependent on the attribute of intuition. Poul the Perceptive (intuition 15) finds secret doors with ease; Igor the Insensitive (intuition 5) finds traps only by falling into them.

All six attributes can be subtly and, to the player, often invisibly affected by potions and magical devices, enhanced by experience, or decreased by "undead" monsters like spectres, shades, and such. In fact, by means of the subtle but significant effects of incremental alterations in each attribute, the speed and power of a computer allow for more meaningful variation in [and more objective evaluation of . . . ] individual characters than would any noncomputer role-playing game yet published. Since monsters are even more complicated and individualized than adventurers, the variety of possible events and outcomes is truly mind-boggling. Once the hard-core fantasy enthusiasts realize this, even the referees may trade in their charts and tables for microcomputers.

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A Short History

Time flies. The copyright date on my game, Pirate's Adventure, reads 1978. It seems like yesterday, but it has been two and a half years since I started on my Adventures . . .

At the time I was working as a systems programmer for Stromberg Carlson when I was first introduced to the classic Adventure game written by Crowther and Woods to run on a DEC (Digital Equipment Corporation) PDP-10. After playing for only a few minutes I was hooked. It took almost ten days of early-morning and late-evening sessions before I achieved the coveted score of 350 and the title of Grand Master. I had done it—I was a bona fide adventurer! Yet it seemed unfair that such a fascinating game was restricted to such an expensive machine.

Back then, I had just gotten my Radio Shack TRS-80 Level II computer, and (having recently finished my backgammon program) I was looking for another good game to write. The concept of character strings intrigued me, and I wanted a game that used them. (Up to that point, I had programmed primarily in FORTRAN and assembly language, neither of which can handle strings easily.)

Adventure seemed to fit my needs exactly. But I didn't want to copy someone else's program, and I was afraid I wouldn't get much of an Adventure in a 16 K-byte BASIC computer—especially when the FORTRAN version I played took about 300 K bytes!

I mentioned the idea of getting some sort of Adventure into my small machine to friends; fortunately, I was not daunted by their laughter. After all, I could remember when it was supposedly impossible to get a BASIC interpreter to run on an 8080 microprocessor!

 Interpreter? Did I say interpreter? Suddenly the idea fell into place! I had written many compilers and operating systems. Why not write an Adventure interpreter? This would allow me to write many Adventures and would also provide the compression I needed to fit them into a small machine. (Inside, I'm really a frustrated science-fiction writer; I have over 3000 science-fiction books in my collection but have never tried to write one myself.)

So, weeks later, my initial, skeletal Adventure evolved into a working interpreter with a skeleton Adventure to plug in. It took some six months of play-testing before my first Adventure, Adventureland, was finally released through The Software Exchange of Milford, New Hampshire, and Creative Computing Software. Thus the Scott Adams Adventure Series was born.

And, at that same moment, it almost died. For six months I had been so engrossed in programming Adventure that my wife Alexis (who at the time was pregnant with Maegen, our daughter) started hiding my floppy disks around the house to get my attention. Once she hid them in the oven—boy, did she get some attention that time! I then decided that one Adventure was enough.

Some time after that, Alexis unexpectedly announced that she wanted to write an Adventure, and it was this effort that led to the Scott Adams Adventure given in listings 1 and 2, Pirate's Adventure. With her basic ideas, we created an Adventure that was different from any that had ever been written before. Instead of simply searching for treasures in this Adventure, you now had an added ingredient—a "mission." (In this case, you had to figure out how to build a pirate's ship!) This set the stage for many of my later mission-oriented Adventures that replace a cumulative score with a do-or-die situation. These include my Mission Impossible, The Count, Voodoo Castle, and Mystery Fun House Adventures.

All my current Adventures, for the Apple II, the Radio Shack TRS-80, and the Exidy Sorcerer, are written in machine language and run much faster and cleaner than the original BASIC versions (of which there were only two and a half). I probably would never have written these programs in machine language if it had not been for the gentle nudges I received from a friend I've never met but greatly respect, Lance Micklus.

Program Notes

Pirate's Adventure was first sold commercially to run in Level II BASIC on a 16 K-byte TRS-80. Both the Adventure-interpreter program (in BASIC) and a data file created by the Adventure-editor program were on the cassette tape. After you loaded the interpreter program, you used it to read the data file, an operation that took 20 minutes but allowed me to compress a lot of Adventure into very little memory space.

In planning this article, I had to devise a means of creating the tape data file without using the Adventure editor. The BASIC program in listings 1 provides the means. This program, which runs on a TRS-80 with 16 K.
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<td>335</td>
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<tr>
<td>SYMTAC SUPER SOUND GENERATOR</td>
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<tr>
<td>SVA 8 INCH DISK CONTROLLER CARD</td>
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<tr>
<td>VERSA WRITER</td>
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<tr>
<td>DIGITIZER SYSTEM</td>
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<tr>
<td>VIDEX VIDEOTERM 80 COLUMN CARD</td>
<td>315</td>
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<tr>
<td>VIDEX VIDEOTERM w/images ROM</td>
<td>335</td>
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<tr>
<td>LOBO DISK DRIVE ONLY</td>
<td>385</td>
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<tr>
<td>w/cont. &amp; DOS 3.3</td>
<td>499</td>
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<td>GPIB IEEE-488 (1978) Int. card</td>
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<td>ARITHMETIC PROCESSOR CARD</td>
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<td>SPEECHLINK 2000 (64 Word Vocab.)</td>
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<td>M6R SUP R M OD TV MODULATOR</td>
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<tr>
<td>CORVUS 10 MEGABYTE HARD DISK DRIVE SYSTEM w/pwr supply</td>
<td>4395</td>
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<td>CORVUS CONSTITUTION</td>
<td>595</td>
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<td>16K MEMORY UPGRADE KIT (TRS-80, APPLE II)</td>
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<td>ABT NUMERIC INPUT KEYPAD (specify old or new kbd)</td>
<td>115</td>
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<tr>
<td>ALF MUSIC SYNTHSIZER</td>
<td>235</td>
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<td>BRIGHTEN LIGHTPEN</td>
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<td>M&amp;R SUPER-TERMINAL 80 COLUMN CARD</td>
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<td>SMARTER 80 COL</td>
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APPLE II SOFTWARE

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<td>VISICALC</td>
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<td>CCA DATA MANAGEMENT</td>
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<td>THE CONTROLLER General Business System</td>
<td>519</td>
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<tr>
<td>THE CASHIER Retail Management &amp; Inventory System</td>
<td>199</td>
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<tr>
<td>APPLEWRITER Word Processor</td>
<td>65</td>
</tr>
<tr>
<td>APPLEPOST Mailing List system</td>
<td>45</td>
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<tr>
<td>DOW JONES PORTFOLIO EVALUATOR</td>
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<td>APPLE CONTRIBUTED</td>
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<tr>
<td>APPLESOFT ASSEMBLER/ DISASSEMBLER</td>
<td>75</td>
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<tr>
<td>APPLEBUG ASSEMBLER/ DISASSEMBLER</td>
<td>85</td>
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<tr>
<td>ENUMOXIV/X10 BSR REMOTE CONTROL SYSTEM</td>
<td>165</td>
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<tr>
<td>INTROLUXI0 controller card only</td>
<td>165</td>
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<tr>
<td>ROMWRITER SYSTEM</td>
<td>155</td>
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<tr>
<td>MUSIC SYSTEM</td>
<td>465</td>
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<tr>
<td>(16 voices/stereo)</td>
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<td>A/D/IA 16 CHANNELS</td>
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<td>EXPANSION CHASSIS (8 slots)</td>
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<td>FORTRAN</td>
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<td>DOS 3.3</td>
<td>49</td>
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<td>APPLE PLOT</td>
<td>60</td>
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<td>TAX PLANNER</td>
<td>65</td>
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<tr>
<td>SARGON II Chess on Diskette</td>
<td>32</td>
</tr>
<tr>
<td>TRIOLOGY OF GAMES</td>
<td>27</td>
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<tr>
<td>SPACE GAME ALBUM</td>
<td>38</td>
</tr>
<tr>
<td>SPACE INVADER (Cass.I)</td>
<td>18</td>
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<tr>
<td>SPACE INVADER (Disk.)</td>
<td>23</td>
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<td>SYBEX APPLE-80</td>
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<tr>
<td>9800 Simulator</td>
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<td>FORTH II by PROGRAMMA SOFTWARE</td>
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<td>SINGLE DISK COPY ROUTINES</td>
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<td>APPLEBUG DEBUGGER</td>
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<td>APPLESOFT UTIL PROGRMS BY HAYDEN</td>
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<td>THE CORRESPONDENT</td>
<td>35</td>
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<td>ASTREROIDS IN SPACE</td>
<td>19</td>
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<tr>
<td>HEAD-ON</td>
<td>25</td>
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<td>3D ANIMATION PACK</td>
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<tr>
<td>BATTLESHIP COMMANDER</td>
<td>23</td>
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<tr>
<td>FASTGAMMON</td>
<td>26</td>
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<tr>
<td>STAR CRUISER</td>
<td>24</td>
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<td>TRANQUILITY BASE</td>
<td>24</td>
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<tr>
<td>More software available</td>
<td></td>
</tr>
<tr>
<td>Please write us for a list</td>
<td></td>
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CHRISTMAS SUPER SALE

APPLE II PLUS

<table>
<thead>
<tr>
<th>Option</th>
<th>Price</th>
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<tbody>
<tr>
<td>16K FOR ONLY $925</td>
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<tr>
<td>48K FOR ONLY $1049</td>
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DISK II DRIVE w/controller & DOS 3.3

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<th>Additional Options</th>
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APPLE II HARDWARE

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<tr>
<td>DISK II DRIVE</td>
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<td>SILENTYPE PRINTER</td>
<td>515</td>
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<tr>
<td>APPLE II ACCESSORIES</td>
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<tr>
<td>APPLE II SOFTWARE</td>
<td></td>
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</tbody>
</table>

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PROJECT DEVELOPMENT PACK ..... 89

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For Best Price

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WORD PROCESSING PACK ..... 17.8
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SANYO 9" B&W ..... 165
SANYO 12" B&W ..... 255
PANACOLOR 10" COLOR ..... 329
NEC 12" HI-RES COLOR ..... 875
NEC 12" LO-RES COLOR ..... 399
NEC 12" GREEN PHOSPHOR... 239
TELEVIDEO 912BC ..... 698
TELEVIDEO 9208 & C ..... 745

WATANABE MIPLAT

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LEDEUX VIDEO 100 ..... 139
SANYO 9" B&W ..... 165
SANYO 12" B&W ..... 255
PANACOLOR 10" COLOR ..... 329
NEC 12" HI-RES COLOR ..... 875
NEC 12" LO-RES COLOR ..... 399
NEC 12" GREEN PHOSPHOR... 239
TELEVIDEO 912BC ..... 698
TELEVIDEO 9208 & C ..... 745

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PRINTERS

ANALEX DP-8000 ..... 775
ANALEX DP-8000 ..... 1350
BASE 2 ..... 649
CENTRONICS 777 ..... 825
PAPER TIGER IDS-460 w/graphica ..... 1195
PAPER TIGER IDS-460 w/graphica ..... 895
NEC SPINTER ..... 2550
TRENDCOM 200 ..... 519
BLENTYPE W/PR ..... 519
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EPSON MX 80 1024 col. ..... 620
QUME SPRINT 5 ..... 2550

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Circle 130 on inquiry card.
Listing 1 co 11ti1111erl:

6250DATA©,59 08,521 ,1 143, 1000,0,0,4553 ,0, 5265 , 0 ,0 ,0,0,0, 1800,0,5300,224,0,0,0,0,
17517. 17850, 1200.0,0.0.0.0, 17100,0,5300, 124,0,0.0,0.15350,0,4350,208, 1040, 1050,0
.0. 10919.0.5300, 184.242,0.0.0.3500.0,7800.921, 150. 140,0,0.7410.9000.5300,0,0.0
E260 DATA0,0,450,0 , AUT,ANY,GO,NORTH,*CLI,SOU TH, *WAL,EAST,*RUN,WEST,*ENT,UP,*PAC,
DOWN, *FOL,STA,SAY,PAS, S AI,HAL,GET ,BOO,*TAK,BO T,*CAT,*RUM,*PlC,WIN,*REM,GAM,*WEA,
MON, * PUL,PIR,FLY.ARO,DRO,BAG,*REL,*DU F , * THR,TOR,*LEA,OFF,*GIV,MAT,DRI .YOH.*EAT
5270 DATA3 0, INV, LUM,SAI,RLJG,LOO.KEY,*SHO, INV,WRI,DUB,REA,SRI, .• FIS,YOH,ANC,SCO ,S
HA,SAV,PLA.KIL,CAV,*ATT,PAT,LIG,DOO ..• CHE,OPE.PAR.*SMA.HAM,UNL,NAI,HEL,BOA,AWA, *
SHI,*BUN,SHE,,CRA,QUI,WAT,BUI,*SAL,*MAK,LAG,WAK,*TID,SET,PI T,CAS,SHO.DIG,*BEA
5 2 80 DATABUR,MAP,FIN,PAC,JLJM,BON,EMP,HOL,WEI,SAN •. BQX,,SNE,0,0,0,0,0,0,,0,0,0,0,
0,0,APARTMENT IN LONDON,0,0,0,0,0,1,ALCOVE,0,0,4, 2 ,0,0,SECRET PASSAGEWAY,0,0,0, 3
,0,0.MUSTY ATTIC,0,0,0,0.0,~
6290 DATA* I 'M OUTSIDE AN OPEN WINDOW ON A LEDGE ON THE SIDE OF A
VER Y TALL BUILD I NG.0,0,8,0,0,0,SANDY BEACH ON A TROP ICA L ISLE,0,12,13, 14,0, 11,MA
ZE OF CAVES,0,0 , 14 , E,0.0,MEADOW,0,0,0,8,0.0,GRASS SHACK, 10,24,10,10,0,0,*I'M IN
THE OCEAN,0,0
5300DATR0,0,7,0,PIT.7,0,14, 13 ,0,0,MAZ E OF CAVES,7, 14, 12, 19, 0,0,MAZE OF CAVES,0,
0,0,8,0,0, *I 'M AT THE FOOT OF A CAVE RIDDEN HILL.
A PATH LEADS TO THE TOP,17 ,0,0,0,0,0, TOOL SHED.0,0, 17,0,0,0,LONG HALLWAY,0,0,0 , 1
5,0,0,LARGE CAVERN,0,0,0,0,0
5310 DATA14, * I'M ON TOP OF A HILL. BELOW IS PIRATES ISL AND. ACROSS THE SEA
OFF I N THE DISTANC E I SEE * TREASU RE* ISLAND,0, 14, 14, 13,0,0,MAZE OF CAVES,0,0,0,0
,0 ,0, *I'M ABOARD PIRAT E SHIP ANCHORED OFF SHORE,0,22,0,0,0,0
5320 DATA*I'M ON THE BEACH AT TREASURE ISLA ND ,21, 0. 23,0,0,0,SPOOKY OLD GRAVEYARD
F I LLED WITH PI LES
OF EMP TY AND BROKEN RUM BDTTLES,0,0,0, 22 ,0,0,LRRGE BARREN FIELD, 10,5,5,5, 0,0,SHA
LLDW LAGOON .
TO THE NORTH IS THE OCEAN,0,0,0,23,0 , 0
5330 DATRSACKED AND DESERTED MONASTARY,0,0,0,0,0,0,,0,0,0,0,0,0,,0,0,0,0,0,0,,0,
0,0,0.0,0, ,0,0,0,0.0,0,,0,0,0 ,0,0,0.,0.0,0 ,0,0,0 , .• 0 .0.0, 0.0,0,*WELCOME TO NEVER
NEVER LANO.,THERE'S A STRANGE SOUND
5 3 40 DATATHE NAME OF THE BOOK IS -TREAS URE I SLAND ­
THERE' SR WORD ENGR AVED IN THE FLYLEAF -YDHO­
AND A MESSAGE - LONG JOHN S ILVER LEFT 2 TREASURES ON TREAS URE
ISLAND!-,NOTHING HAP PENS, THERE'S SOMETHING THERE ALRIGHT. MAYBE I SHOULD
5350 DATATHAT'S NOT VERY SAFE,YOU MAY NEED MAGI C HERE,EVERYTHING SPINS AROUND AN
D SUDDENLY YOU ARE ELSEWHERE ... ,TORCH I S LIT. I WAS WRONG. I GUESS ITS NOT A MONG
DOSE CAUSE THE SNAKES BIT IT., I'M SNAKE BIT
53 6~ DATA PARRO T ATT ACKS SNAKES AND DRIVES THEM OFF.PIRATE WON' T LET ME, ITS LOC KE
D, ITS OPEN, TH ERE ARE A SET OF PLANS IN I T, NOT WHILE I 'M CARRYING IT,CROCS STOP M
E. SORRY I CAN'T, WRONG GAME YOU SILLY GOOSE ! , I DON' T HAVE IT
5370 DATAP I RAT E GRABS RUM AND SCUTTLES OFF CHORTLI NG •••. I TH INK ITS ME. HEE HEE.
,ITS NAILED TD THE FL DOR !,-MAGIC WORD - HO AND A. ..
CWORK ON IT . YOU'LL GET
IT) ,NO. SOMETHING I S MISSING', IT WAS A TIGHT SQUEEZE!,SDMETHING WON'T FIT
6380 DATASINCE NOTH I NG IS HAPPENING, I SLIPPED AND FELL ..•• SOMETHING FALLS OU T, TH
EY 'RE PLANS TD BUILD JOLLY ROGER CA PIRAT E SHIP !)
YOU'LL NEE D HAMMER NA ILS LUMBER ANCHOR SAILS AND KEEL.,I'VE NO CONTAINER, IT SOAK
S INTO THE GROUND
53g0 DATATOO DRY. FISH VANI SH., PIRATE RWAl\ENS . SAYS - AYE MATEY WE BE CASTING OFF
SOON­
HE THEN VANISHES
,WHAT A WASTE ... , I'VE NO CREW, PIRATE SAYS -AYE MATEY WE BE NEEDING A MAP FIRST­
64~ ~ DATAAFTER A MON TH AT SEA WE SET ANCHOR OFF OF A SANDY BEACH.
ALL ASHORE WHO'S GOING ASHORE ...• TR Y - WEIGH ANCHOR-, THERE'S A MAP IN IT, ITS A M
AP TO TREASURE ISLAND. AT THE BOTTOM I T SAYS
-30 PACES AND THEN DIG!­
541~ DATA* WELCOM E TO - PIRATES ADVENTURE- BY SCOTT & ALEXIS ADAMS *
, I TS EMPTY, I'VE NO PLANS ! ,OPEN IT ? ,GO THERE?, I FOU ND SOMETHING', I DIDN'T FIND AN
YTHI NG, I DON'T SEE IT HERE, Of\ I WAU\ ED OFF 30 PACES.
542~ DATACONGRATULATI ONS ! ! !
BUT YOUR ADVENTURE IS NOT OVER YET ...
. READING EXP ANDS THE MIND, THE PARROT CRYS. - CHECK THE BAG MATEY- , - CHECK THE CHEST
MATEY- ,FROM THE OTHER S I DE 1 ,0PEN THE BOOK !,THERE'S MULTIPLE EXITS HERE !
6430 DATACROCS EAT FISH ~ND LEAVE.I'M UNDERWATER. I CAN'T SWIM. BLUB BLUB...• -PI
Lis ti11g I rn1llimuu { a n page 200
198

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Why Not the Best?
From The Dynamic RAM Company.

2MHz 4MHz
16K—$249  $259
32K—$375  $395
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We have now been shipping our 2MHz dynamic RAM boards for over two years. Hundreds of 4MHz boards have been going out every month since early 1979. Our reliability is proven in the thousands of systems which contain our board. Many quality-minded systems houses across the country and overseas are using our boards for their equipment.

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Despite rising 16K memory chip prices (at least from reputable suppliers), Central Data continues to give you the best buy in memory today. Nobody offers a board with a capacity of 64K, assembled, tested, and guaranteed for a full year at the price we do.

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Standard S-100 Interface. Our board is designed to interface with any standard S-100 CPU. All of the timing of the board is independent of the processor chip, and the board is set up for different processors by changing two plugs on the board.

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Central Data
Listing 1 continued:

ECES OF EIGHT—ITS STUCK IN THE SAND. USE 1 WORD, PIRATE SAYS —AYE MATEY WE BE WAI TING FOR THE TIDE TO COME IN—. THE TIDE IS OUT. THE TIDE IS COMING IN.

6440 DATA ABOUT 20 POUNDS. TRY—SET SAIL—, TIDES A CHANGING MATEY—. NOTE HERE —I BE LIKING PARROTS. THEY BE SMART MATEY—. PIRATE FOLLOWS YOU ASHORE AS IF HE IS WA ITING FOR SOMETHING. FLIGHT OF STAIRS, OPEN WINDOW, 2 BOOKS IN A BOOKCASE. 

6450 DATA LARGE LEATHER BOUND BOOK/BOOK/, 0. BOOKCASE WITH A SECRET PASSAGE BEHIND IT. PIRATE’S DUFFEL BAG/BAG/, 4. SIGN ON WALL —RETURN TREASURES HERE. SAY SCORE—SIGN BY STAIRS—ANTONYM OF LIGHT IS UNLIGHT—. EMPTY BOTTLE/BOT/, 0.


6450 DATA LARGE LEATHER BOUND BOOK/BOOK/, 0. BOOKCASE WITH A SECRET PASSAGE BEHIND IT. PIRATE’S DUFFEL BAG/BAG/, 4. SIGN ON WALL —RETURN TREASURES HERE. SAY SCORE—SIGN BY STAIRS—ANTONYM OF LIGHT IS UNLIGHT—. EMPTY BOTTLE/BOT/, 0.


6470 DATA OPEN DOOR WITH HALL BEYOND, 0. PILE OF SAILS/SAIL/, 17. FISH/FISH/, 10. DUBLERO N/DR/, 25. TOOLS SHE D/. LOCKED DOOR, 17. OPEN DOOR WITH PIT BEYOND, PIRATE SHIP, ROCK WALL WITH NARROW CRACK IN IT. NARROW CRACK IN THE ROCK, 17. SALT WATER, 10. SLEEPING PIRATE, 0.

6490 DATA BOTTLE OF SALT WATER/BOT/, 0. PIECES OF BROKEN RUM BOTTLES, 4. NON-SKID SNE AKES/SNE/, 1. SHOVEL/SHOE/, 15. MOLDY OLD BONES/BON/, 0. SAND/SAN/, 6.

6500 DATA THE TIDE IS COMING IN. WATER WINGS/WIN/, 15. FLOTSAM AND JETSAM, 0. MONAST ARY, 23.

6510 REM

6520 REM PROGRAM STARTS HERE...

6530 REM

6540 CLEAR800:DEFINTA-Z:POKE15553,255:RESTORE

6550 CLS:INPUT"PREPARE DATA TAPE (HIT ENTER)";TP$;D=-1

6560 CLS:PRINT64*4, "ADVENTURE DATA TAPE BUILDER — WORKING"

6570 READ IL,CL,NL,RL,MX,R,TT,LT,ML,TR;PRINT#D,IL,CL,NL,RL,MX,R,TT,LT,ML,TR

LISTING 1 CONTINUED ON PAGE 202

FEATURES INCLUDE:

- Uses Standard Typewriter Ribbon
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- Manual Paper Advance
- Manual Selftest and Reset
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- Interfaces with Apple, Atari, OSI, T.I., TRS-80 and the List Goes On

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Listing 1 continued:

6590 FORX=0TOCN STEP2:FORXX=0TO1:FORYY=0TO7:READ CACXX,Y):NEXTY,XX:X=0
5600 FORX=0TO1:READ RMX,X);RMX(1),RMX(2),RMX(3),RMX(4),RMX(5),RMX(6),RMX(7),V
5610 FORX=0TOCN:PRINT#D,CA(X,0),CA(X,1),CA(X,2),CA(X,3),CA(X,4),CA(X,5),CA(X,6),CA(X,7)
5620 FORX=0TOCN:READ IA(X),IA(X,1),IA(X,2),IA(X,3),IA(X,4),IA(X,5),IA(X,6),IA(X,7):NEXTI
5630 FORX=0TO6:READ NV$(X),NV$(X,1),NV$(X,2),NV$(X,3),NV$(X,4),NV$(X,5),NV$(X,6),NV$(X,7
5640 FORX=0TO6:READ RMCX,X),RMCX(1),RMCX(2),RMCX(3),RMCX(4),RMCX(5),RS$(X):NEXT
5650 FORX=0TO6:READ MS$(X):NEXT
5660 FORX=0TO6:READ IA$(X),IA$(X,1),IA$(X,2),IA$(X,3),IA$(X,4),IA$(X,5),IA$(X,6),IA$(X,7):NEXT
5670 IFB$<>TO THENPRINT "BAD TAPE":END

Listing 2: Main program of Scott Adams' Pirate's Adventure for the TRS-80. This program uses the data tape generated by listing 1.

10 'COPYRIGHT SCOTT ADAMS, 1978
20 CLEAR4000:DEFINTA-Z:DE=-1
30 IFD0-1THENCLOSE:OPEN"I",O,SV$ELSEREAD"READY SAVED TAPE";L$:PRINT"MINUTES":READL:
40 PRINT"YOU WILL AT TIMES NEED SPECIAL ITEMS TO DO THINGS, BUT I'M SURE YOU'LL BE A GOOD ADVENTURER AND FIGURE THESE THINGS OUT.";
50 PRINT"HAPPY ADVENTURING... HIT ENTER TO START":K$:CLS:RETURN
60 RAR=AR:LX=L:DF=0:SF=0:INPUT"USE OLD 'SAVED' GAME";K$:IFLEFT$(K$,1)="Y"THEN130
70 INPUT"YOU ARE CARRYING";X$="...";PRINT"TO FIND OUT WHAT YOU'RE CARRYING YOU MIGHT SAY: TAKE INVENTORY TO GO INTO A HOLE YOU MIGHT SAY: GO HOLE TO SAVE CURRENT GAME: SAVE GAME"
80 PRINT"YOU WILL AT TIMES NEED SPECIAL ITEMS TO DO THINGS, BUT I'M SURE YOU'LL BE A GOOD ADVENTURER AND FIGURE THESE THINGS OUT.";
90 PRINT"HAPPY ADVENTURING... HIT ENTER TO START":K$:CLS:RETURN
100 RAR=AR:LX=L:DF=0:SF=0:INPUT"USE OLD 'SAVED' GAME";K$:IFLEFT$(K$,1)="Y"THEN130
110 IFD0-1THENCLOSE:OPEN"I",O,SV$ELSEINPUT"READY SAVED TAPE";K$:PRINTINT(IL$=6/3
120 INPUT#D,SF,LX,DF：R:FORX=0TOIN:INPUT#D,IA(X):NEXT:IFD()-1CLOSE
130 GOSUB5600:GOSUB2400:GOTO160
140 INPUT"TELL ME WHAT TO DO":TP$:PRINT"GOSUB170:IFFPRINT"YOU USE WORD(S) I DON'T KNOW":GOTO140
150 GOSUB3600:IFIA(9)=1 THENLX=L:IFLX(THENPRINT"LIGHT HAS RUN OUT":IA(9)=0ELS
160 IFLX(25PRINT"LIGHT RUNS OUT IN":LX=I3:PRINT"";
170 K=0:NT$(0)="":NT$(1)=""

Listing 2 continued on page 204
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Listing 2 continued:

180 FORX=1:TOLEN(TPS)$:K$=MID$(TPS$,X,1):IFK$=""THENK$=1ELSENT$(K$)=LEFT$(NT$(K$))+K$,
LN)
190 NEXTX:FORX=0:TO1:NV$(X)=0:IFNT$(X)=""THEN230ELSEFORX=0:TOLEN(K$:Y,X):IFLEFT$(
K$+1)=""THENK$=MID$(K$,2)
200 IFX=1:IFY<7THENK$=LEFT$(X, LN)
210 IFNT$(X)=K$THENNNV$(X)=YELENNEXTX:GOT0230
220 IFLEFT$(NV$(X),X),1)=""THENNNV$(X)=NV$(X)-1:GOT0220
230 NEXTX:X=NV$(0):10ORLEN(NT$(0)):1@ANDNNV$(1):1:RETURN
240 IFDFIFH(A9)=-1ANDH(A9)"RPRINT""I CAN'T SEE, ITS TOO DARK.";RETURN
250 K=-1:IFLEFT$(RS$(R),1)=""THENPRINTMID$(RS$(R),2);ELSEPRINT"I'M IN A";RS$(R); 
260 FORZ=0:TO1:IFK$=ZPRINT"RPRINT". VISIBLE ITEMS HERE:
";K=0
270 GOT0300
280 TPS$=IA$(Z);IFRIGHT$(TPS$,1)=""THENFORW=LEN(TPS$}-1TO1STEP-1;IFMID$(TPS$,W,1)=""THEN
ENTP$=LEFT$(TPS$,W-1)ELSENEXTW
290 RETURN
300 IFIA$(Z);RTHEN320ELSEGOSUB280;IFPD$(0)+LEN(TPS$)+3;63THENPRINT
310 PRINTTP$":. ";
320 NEXTX:PRINT
330 K=-1:FORZ=0:TO5:IFIFRMR(R,Z)@0PRINT"
340 OBVIOUS EXITS: "";K=0
350 IFRM(R,Z);@0PRINTNV$(Z+1,1);" ";
350 NEXTX:PRINT:RETURN
360 F2=-1;F=1;F3=0;IFNV$(0)=1ANDNNV$(1);7THENG10ELSEFOR=0:TOC$;V=CA(X, O)/150;IFNV$(
0)=0IFV$@RETURN
370 IFNV$(0);0THENX:GOT0390ELSECA(X,O)-V+150
380 IFNV$(0)=0THENF=0;IFRN$=100;HENX:GOT0390
390 IFN$(0);1ANDN$(0)THENX:GOT0390
400 F2=-1;F=0;F3=-1;FORY=1:TO5;W=CA(X, Y);IL=W/20;K=W-LL*20;F1=-1;ONK+1GOT0550,430

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Listing 2 continued:

450, 470, 490, 500, 510, 520, 530, 540, 410, 420, 440, 460, 480
410 F1=-1:FORZ=0TOIL:IFIA(Z)=1THENV550ELSENEXT:F1=0:GOTO550
420 F1=0:FORZ=0TOIL:IFIA(Z)=-1THEN5550ELSENEXT:F1=-1:GOTO555
430 F1=IA(LL)=-1:GOTO550
440 F1=IA(LL)<>-1ANDIA(LL)=0:GOTO550
450 F1=IA(LL)=-1:GOTO550
460 F1=IA(LL)<>-1ANDIA(LL)=0:GOTO550
470 F1=IA(LL)=R:GOTO550
480 F1=IA(LL)=R:GOTO550
490 F1=R=LL:GOTO550
500 F1=R=LL:GOTO550
510 F1=R=LL<>-1:GOTO550
520 F1=SFANDCINT(2+LL+.5):F1=F1<>1:GOTO550
530 F1=SFANDCINT(2+LL+.5):F1=F1<>1:GOTO550
540 F1=SFANDCINT(2+LL+.5):F1=F1<>1:GOTO550
550 F1=SFANDCINT(2+LL+.5):F1=F1<>1:GOTO550
560 F1=SFANDCINT(2+LL+.5):F1=F1<>1:GOTO550
570 AC=CA(X,K)/150:GOTO550
580 AC=CA(X,K)-CINT(AC(X,K)/150)*150
590 IFAC=101THENELSEIFAC=0THEN950ELSEIFAC=52THENPRINTMS*(AC):GOTO950:ELSEENDAC
590 GOSUB500:AC(6960)=AC(5960):AC(5960)=AC(5960)
600 PRINTMS*(AC)=50:GOTO550
610 L=DF:IFTHEN=DFANDIA(9)<>RANDIA(9)-1:IFLPRINT"DANGEROUS TO MOVE IN THE DARK!"
620 IFNV(1):PRINT"GIVE ME A DIRECTION TOO.":GOTO1040
630 K=RM(R,NV(1)-1):IFK<1PRINT"I FELL DOWN AND BROKE MY NECK.";K=RL:DF=0:
ELSEPRINT"I CAN'T GO IN THAT DIRECTION":GOTO1040
640 IFNOTCLS
650 R=K:GOSUB240:GOTO1040
660 L=0:FORZ=1TOIL:IFIA(Z)=-1LET=L+1
670 NEXTZ
680 IFL=MXPRINTZ=50970
690 GOSUB1050:IA(P)=1:GOTO560
700 GOSUB1050:IA(P)=1:GOTO560
710 PRINT"SAVING GAME";IFD=1THENPRINT"READY OUTPUT TAPE";K$=PRINT(1/L5/60)+1
720 PRINTD;SF:LX,DF;R:FORZ=0TOIL:PRINTD;IA(W)=NEXT;IFD()-1CLOSE
730 GOTO560
740 GOSUB1050:R=P:GOTO560
750 GOSUB1050:L=P:GOSUB1050:Z=IA(P):IA(P)=IA(L):IA(L)=Z:GOTO560
760 GOSUB1050:IA(P)=0:GOTO560
770 DF=1:GOTO560
780 DF=0:GOTO560
790 GOSUB1050
800 SF=SF ORCINT(.5+2+P):GOTO560
810 GOSUB1050
820 SF=SFANDNOTCINT(.5+2+P):GOTO560
830 PRINT"I'M DEAD...";R=RL:DF=0:GOTO560
840 GOSUB1050:L=P:GOSUB1050:IA(L)=P:GOTO560
850 INPUT"THE GAME IS NOW OVER
ANOTHER GAME";K$=IFLEFT$(K$)="N"THENENDELSFORX=0TOIL:IA(X)=I(X):NEXT=GOTO100
860 GOSUB240:GOTO560
870 L=0:FORZ=0TOIL:IFIA(Z)=TRIFLEFT$(IA(Z),1)="^"LET=L+1
880 NEXTZ:PRINT"I'VE STORED";L;"TREASURES.
ON A SCALE OF 0 TO 100 THAT RATES A";CINT(L/TT*100):IFL=TTTHENPRINT"WELL DONE."
GOTO560ELSE560
890 PRINT"I'M CARRYING:";K$="NOTHING";FORZ=0TOIL:IFIA(Z)=-1THEN910ELSEGOSUB220:
IFLEN(TP$)+POS(0))>63PRINT
900 PRINTTP$".";";K$=""
910 NEXT:PRINTK$=GOTO560
920 P=0:GOTO560
930 P=0:GOTO562
940 LX=L:IA(9)=-1:GOTO560

Listing 2 continued on page 210
Now NRI takes you inside the world’s most popular microcomputer to train you at home as the new breed of computer specialist!

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(TRS-80 is a trademark of the Radio Shack division of Tandy Corp.)
Listing 2 continued:

950 CLS:GOTO9560
960 NEXTX
970 IFNVC(0)()@THEN990
980 NEXTX
990'
1000 IFNVC(0)@THEN1040
1010 Gosub1060
1020 IFPRINT"I DON'T UNDERSTAND YOUR COMMAND";GOTO1040
1030 IFNOTF2PRINT"I CAN'T DO THAT YET";GOTO1040
1040 RETURN
1050 IP=IP+1:W=CA(X,IP):P=W/20:M=W-P+20:IFM()@THEN1050@ELSERETURN
1060 IFNVC(0)()@10ANDNV(0)()180DF;THEN1230
1070 IFNVC(1)@PRINT"WHAT?";GOTO1180
1080 IFNVC(0)()@10THEN1110
1090 L=0:FORZ=0TOIL:IFIA(Z)=-1THENNL=L+1
1100 NEXTI:IFL=MXPRINTT;GOTO1180
1110 K=0:FORX=0TOIL:IFRIGHT*(IA*(X),1)()"THEN1190ELSELL=LEN(IA*(X))-1:TP=MS*(IA*(X),1,LL):FORY=LLTOSTEP-1:IFMID*(TP,Y,1)()""THENEXTY=GOTO1190
1120 TP=LEFT*(MS*(TP,Y+1),LN)
1130 IFTP()()NV*(NV(1),1)THEN1130
1140 IFNVC(0)=10THEN1160
1150 IFIA*(X)()-1THEN=1=GOTO1190ELSEIASA(X)=R:K=3:GOTO1170
1160 IFIA*(X)()RTHEN=2=GOTO1190ELSEAS=(X)=1:K=3
1170 PRINT"OK, ";
1180 F=0:RETURN
1190 NEXTX
1200 IFK=1THENPRINT"I'M NOT CARRYING IT"ELSEIFK=2PRINT"I DON'T SEE IT HERE"
1210 IFK=0IFNOTF3PRINT"ITS BEYOND MY POWER TO DO THAT";F=0
1220 IFK()@THENF=0
1230 RETURN
1240 IFD()@THEN1330ELSEINPUT"READY DATA TAPE. HIT ENTER"
1250 INPUT#D,IL,CL,NL,RL,MX,AR,TT,LT,ML,TR
1260 W=(IL+CL/2+NL/10+RL+ML)/12:PRINTW+1;"MINUTES TO LOAD."
1270 DIMNV<:1,NI,CA(CI,7),NV*(NL,1),IA*(IL),IA(IL),RS*(RL),RM(1L,5),MS*(ML),NT*(1),
12(IL)
1280 FORX=0TOCL STEP2;Y=X+1:INPUT#D,CA(X,0),CA(X,1),CA(X,2),CA(X,3),CA(X,4),CA(X,5),CA(X,6),CA(X,7),CA(Y,0),CA(Y,1),CA(Y,2),CA(Y,3),CA(Y,4),CA(Y,5),CA(Y,6),CA(Y,7):NEXT
1290 FORX=0TOCL STEP10:FORY=0TO1:INPUT#D,NV*(X,Y),NV*(X+1,Y),NV*(X+2,Y),NV*(X+3,Y),NV*(X+4,Y),NV*(X+5,Y),NV*(X+6,Y),NV*(X+7,Y),NV*(X+8,Y),NV*(X+9,Y):NEXT,X
1310 FORX=0TOCL STEP1:INPUT#D,MS*(X):NEXT
1320 FORX=0TOIL:INPUT#D,IA*(X),IA*(X):IFX=IA*(X):NEXT:IFD=-1RETURN
1330 REM

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bytes of memory, has the sole purpose of generating the Adventure-data file that will be read by the Adventure-interpreter program. The program of listing 1 writes the data on a C-60 cassette and verifies that the tape has been correctly written. Allow about 45 minutes for this program to run.

The Adventure-interpreter program appears in listing 2. It will read the tape data file in about 20 minutes and then start play of the game.

If you plan to run Pirate's Adventure, on a 32 K-byte TRS-80 or larger machine, you can merge the two programs as follows: delete lines 6510 thru 6790 of listing 1. Append the data statements of listing 1 to listing 2, replacing all occurrences of INPUT#D in listing 2 with the word READ.

It is possible to run this program on machines other than the TRS-80. If your machine runs a version of Microsoft BASIC (eg: Apple II running Applesoft, Commodore PET, Exidy Sorcerer, or any Ohio Scientific computer), you will have fewer changes to make. Here are some of the obscure changes that may have to be made (depending on your machine and version of BASIC):

- A logical operation returns the value \(-1\) (or hexadecimal FF) when true, and 0 otherwise. For example, executing:

  \[
  \text{PRINT} \ (1=2), \ (1=1)
  \]

causes the numbers 0 (denoting false) and \(-1\) (denoting true) to be printed.
- The flag SF is a 16-bit integer that is set and tested with boolean algebra commands. This can be replaced by the following:

  1. Dimension SF as SF(15)
  2. Replace \(F1=SF \text{ AND CINT}(21L+ .5)\) with \(F1=SF(L)\)
  3. Replace \(SF=SF \text{ OR CINT}(21P+.5)\) with \(SF(P)=-1\)
  4. Replace \(SF=SF \text{ AND NOT CINT}(5+21P)\) with \(SF(P)=0\)

  *IF... THEN... ELSE statements in TRS-80 Level II BASIC assert that, if the condition being tested is true, the statements between the words THEN and ELSE are performed. If the condition is false, the statements following the ELSE are performed. If your BASIC does not have the ELSE clause, you will have to split the statement into multiple lines.
- \(\text{LEFT}(A$,B)\) returns the substring of \(A\$\) from the first character to the \(Bth\) character. Similarly, \(\text{MID}(A$,B,C\) returns the substring from the \(Bth\) character on, for a total of \(C\) characters, and \(\text{RIGHT}(A$\) returns the last (ie: rightmost) \(B\) characters in the string.
- If you cannot create a two-dimensional array of strings (eg: \(\text{DIM A$(20,3})\) as a twenty-row by three-column array of strings), you will find conversion nearly impossible because this feature is used heavily in the program.

Happy adventuring, and watch out for the tides on Pirate's Island—they can be tricky.

Please note that the Pirate's Adventure is copyrighted. Its publication in BYTE entitles the reader to personal use only. The program may not be distributed in any way without the written permission of the author.
Continuous, no-clutter, textual display, and short easy-to-remember commands make Mince one of the finest editors available for small computers. Mince is based upon Emacs, a text manipulation system previously available only on a few large computers. The many features Mince now brings to the microcomputing world include, for example, the ability to switch back and forth between several documents, or even to display two different documents at once so that you can make changes in one based on the other.

Scribble is a text formatter that, when combined with Mince or another editor, forms a comprehensive document preparation system. Scribble is based on Scribe, which was developed at Carnegie-Mellon University to provide a simple yet powerful formatting environment for the non-technical user. Scribble commands allow you to specify the logical structure of the document rather than worry about formatting details.

Gemstones are professionally crafted programs that represent the state of the art in their respective domains. The documentation for each Gemstone includes not just a user's manual but also a design overview and related theoretical material. Each Gemstone also represents an ongoing commitment to user support, in the form of a newsletter, program updates, and a telephone hotline.

Amethyst, first of the Gemstones, combines Mince, Scribble, the BDS C compiler, and the source code for the Mince command set. This package makes possible simple reconfiguration of the editor to meet your needs. Not only can you customize the editor to your taste, you can even write your own programs and make use of the C compiler. This way well make Amethyst the ultimate 8080/2-Z-80 program development system.

But what makes this Gemstone sparkle in our eyes is support! For Amethyst owners, service is our most important product. Purchasing Amethyst entitles you to free future updates and additions, as well as a newsletter containing other users' comments on how to get the most from the system. We will provide any single command or simple document type that you find missing from Mince or Scribble for free, as well as providing more complex changes at additional cost. Further, our programming staff is available by phone or mail for consultation in bringing Amethyst up on your computer or helping you modify it to meet your needs.

We see your customization requests as feedback on the quality of our product. If there's something you think we've forgotten, we're just as anxious to have it in the software as you are. Big or small, you're important enough to have an editor that works a little more the way you want and a little less the way anyone else thinks it ought to.

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NEWS AND SPECULATION ABOUT PERSONAL COMPUTING

Conducted by Sol Libes

$299 Color Computer From Commodore: Commodore International Ltd has announced several new products, including the $299 VIC-20 color computer, which has been the subject of much speculation over the past year. The VIC (Video Interface Computer) connects to any television set or monitor and features color (22-character by 23-line display); sound; 5 K bytes of programmable memory (expandable to 32 K bytes); user-programmable function keys; full-size typewriter keyboard; high-resolution graphics; standard PET BASIC; a graphics character set; provisions for joysticks, paddles, and light pen; and external slots for extra memory and ROM (read-only memory) packs. Peripherals to be available include a tape-cassette unit, single floppy-disk drive, and printer. Commodore's new low-priced CBM 2031 single disk-drive unit (also part of the new products announcement) will be available in a serialbus version for use with the VIC-20. The CBM 2031 will be able to store up to 170 K bytes on a single 5-inch floppy disk. It will retail for under $600.

Another significant announcement from Commodore was made with much less fanfare: a new, high-capacity business computer called the CBM 8096 that will feature an 80-column display, 96 K bytes of programmable memory, FORTRAN, COBOL, Ozz (Commodore's new user-adaptable data-management and retrieval program), and probably VisiCalc. It could have a dramatically low price. The CBM 8096 in conjunction with a high-capacity disk drive (like Commodore's new CBM 8062, with 3.2 megabytes capacity), could undersell the already low-priced Radio Shack Model II.

Availability: Do not expect to see the VIC-20 before the second quarter of 1981. The CBM 8096 will not be out before the fourth quarter of 1981.

Winchester 8-Inch Drives Off To Slow Start: Manufacturers of 8-inch miniaturized Winchester hard-disk drives are reporting that sales, so far, have been disappointing. Apparently there is a wait-and-see attitude on the part of customers. This appears to be due to standardization and interface problems, as well as the emergence of 5-inch miniature Winchester drives. Sales for 1980 were predicted to be in excess of 60,000 units; however, it appears that fewer than 37,000 will be shipped, with IBM taking a very sizable portion of this number.

Sales of 8-inch miniaturized Winchester drives are expected to increase at a healthy rate. Some industry analysts are predicting 500,000 units by 1985. It is further predicted that these drives will take over the 20- to 200-megabyte market previously held by 14-inch Winchester drives. It is expected that the 5-inch Winchester drives will dominate the under 20-megabyte market.

Model 33 Teletypewriter To Be Discontinued: The Teletype Corporation's Model 33 teletypewriter, affectionately known as "TTY" by long-time users, will be phased out of production by the end of 1981 after twenty-five years of production. Teletype will also stop production on the models 26, 32, 33, DRPE, BRPE, and 4210. The Model 33 was the primary terminal for interactive computer use in the 1960s and early 1970s. Although it was designed for message transmission via telephone lines, early computer designers adopted it and its ASCII (American Standard Code for Information Interchange) character code as a standard. Parts and documentation support will be continued for five years.

DEC Shuts Two Computer Stores: DEC (Digital Equipment Corporation), the first computer company to open a chain of computer stores, has halted the planned expansion of its store network. Further, it has closed two of its twenty-seven stores. Reportedly, DEC spent between three and five million dollars to open the stores plus an equal amount for operating expenses, yet only a few of the stores have become profitable. The stores closed are in Detroit and the Wall Street district of New York City. More stores are expected to be shut down.

Xerox, CDC (Control Data Corporation), and Commodore all have followed DEC's lead by opening computer stores. Xerox expects to open fifteen stores in 1981, while CDC and Commodore stated that they expect to open "hundreds" of computer stores.

Reader's Digest Buys The Source: In a surprise move, the Reader's Digest has purchased a 51% interest in the Source Telecomputing Corporation. According to the Washington Post, Reader's Digest paid $3,000,000—a substantial amount of money for a company with no assets and only a marketing concept. The Source is entirely a resale operation: communications from Telenet, computing from a time-sharing service called Dialcomm, and data bases from all over. The Washington Post article also disclosed a messy court battle between Bill Von Meisler, who developed the idea for The Source (and some years ago, developed the idea for the Mailgram), and Jack Taub, who cussed Von Meisler in a financial power struggle last year.

A recent article in Business Week described The Source's woes. When Jack Taub took over the company last October, he immediately fired forty-five of the seventy employees, cut expenses, and procured additional financing. However, many suppliers...
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The sort/merge/selection utility for CBASE32 written in assembly language. Can be loaded by CBASE during run-time; also can be used as a stand-alone utility. Formats: 80 characters, Northstar 2D & Micropolis Mod II.

**BASE2M**

Industry standard intermediate code compiler with run-time interpreter. Features include character, integer & external precision arithmetic, CP/M, CP/M+ & related TRS-80 versions available. As well as 80 column single density, Northstar 2D & Micropolis Mod II.

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**BYTHE December 1980 215**
still report that they have not been paid and Taub had been asking them to wait until 1982.

The Source promised in its advertisements that airline schedules, restaurant guides in major cities, and mailgram-like services would be available. The mailgram went into effect last April and the airline schedules in June. The restaurant guide still covers only two cities. Also, at present a maximum of 100 users can use the system simultaneously; higher demand on The Source has led to some long-delayed responses.

Most users seem to accept The Source's problems as those of a pioneer with development difficulties and that slowly, but surely, the services are improving. Most agree that even with its problems, The Source is very worthwhile.

The Reader's Digest could be just what The Source needs to become successful. The purchase indicates that the Reader's Digest is clearly moving into the electronic journalism/communications/information field.

The Japanese Are Coming: Until now the US has dominated the micro-mini, and large-computer markets across the globe. However, things are changing and 1981 will no doubt see the Japanese as a major factor in the computer market. The Japanese are already pushing foreign computer suppliers out of the Japanese marketplace and are presently setting up marketing organizations in the US and Europe. They are moving slowly and very carefully, which is quite different from the American way of operating. Therefore, do not look for the Japanese computers to suddenly dominate the market. Rather, look for slow, but steady, growth as the Japanese learn how to adapt and market products in foreign marketplaces.

There is no doubt that the hardware is first-rate—a congressional task force recently concluded that Japan has caught up to the US in semiconductor technology and in certain areas, may be ahead of us. In fact, most American computer makers are already using Japanese components in their computers, and the trend is increasing.

This picture is essentially the same as that of the introduction of Japanese cars into this country. Japanese cars were first introduced in the US about 20 years ago. Today they account for 40% of the market. Their cars cost more than US cars but are designed and made better. The same thing will probably happen in the computer market. Who knows, in another ten years we may see government-supported loans for Apple, Commodore, or Radio Shack.

XENIX, UNIX-Like.

UNIX-Equivalent—What Next? There are now at least three UNIX-like operating systems available for microcomputers, only one of which is licensed by Western Electric. By now, Microsoft should have its XENIX operating system, developed in the C-language under Western Electric license. It will be available for 2800-based systems. Electrolabs already has its "UNIX-Like" systems available for 280-based systems, and Morrow Designs has announced a "UNIX- Equivalent" system for use with its 280 system. Microsoft claims that XENIX is to be a superset of UNIX and that it will conform to Release 7 of UNIX. Further, Microsoft hopes to establish a clear consensus for UNIX and XENIX software developed by users. XENIX will be sold primarily to OMs (original equipment manufacturers), and Microsoft will receive $500 for each single-user copy sold. Electrolabs claims that its OS-1 Operating System "appears exactly like UNIX to the user" and that it "provides for up to 1024 users plus "lots more"—all in 12 K bytes of code. A 4-K-byte CP/M adapter is also included (with source code) in the $249 price.

The Morrow operating system will be advertised as a "UNIX-Equivalent." It will be designed to run specifically with the new Morrow 280 processor card, which includes a hardware mathematics processor and a programmable system-supervisor circuit for memory management.

Three-Dimensional System To Be Introduced: Genisco Computers, Costa Mesa, California, is expected soon to announce the first three-dimensional computer-graphics display. It will use a vibrating parabolic mirror and strobe display to create the illusion of a three-dimensional object hovering in space before the operator. The system will probably sell for about $100,000, and it is expected to find applications in air-traffic control, molecular research, and oil exploration.

Data Errors To Increase With Sunspots: NOAA (the National Oceanic and Atmospheric Administration) is predicting that increases in sunspot activity will cause disruption of data communications worldwide. This increase occurs every eleven years, with 1981 thru 1983 being a period of intense activity. The last such period occurred between 1969 and 1972. The effect is felt to be more severe at higher altitudes.

Double-Sided Floppy Woes Persist: Makers of double-sided floppy-disk drives finally appear to be delivering reliable units. Users report that the 5-inch dual-sided drives exhibit excellent reliability. However, 8-inch drives still appear to have problems, and full production of high-reliability units is not expected for several more months. Experts are predicting that not until 1982 will we see a crossover point where more double-sided floppies are made than single-sided units.

Fired Programmer Sued For Erasing Programs: A suit filed by Leeds & Northrup (L & N) against a former employee accuses him of erasing several valuable programs shortly after being fired from his project manager/projector position and before his password had been removed from the system. L & N is asking for $10,000 in damages and a court order restraining the former employee from future tampering with the computer. Fortunately, L & N was able to restore the obliterated programs from backup magnetic tapes.
ARCHIVES BUSINESS COMPUTER
CP/M-BASED ... 1.5 MB CAPACITY ... S-100 BUS

A full 1.5 megabytes of storage on double-sided 5¼" diskettes; single-sided drives also available. CP/M operating system and standard S-100 bus allow for wide application possibilities and easy expansion.

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The Archives Business Computer represents the new generation of all-in-one computers, ideally targeted at professional and business customers. The compact desk-top unit includes two 5¼" drives that can be sold CP/M-based applications software; a 12" green phosphor monitor; detachable keyboard with numeric cluster, function keycluster and 23 relegendable function keys; 64K RAM, and Z-80 microprocessor... options include a direct-connect Bell 103 compatible modem and hardware floating point chip.

The new Archives Business Computer is now available from PGI Wholesale, the nation's leading microcomputer distributor. Call us toll-free for the most competitive pricing and widest selection of name-brand products in the industry! A complete Research and Development Evaluation Report on the Archives Business Computer is available to dealers free of charge. The Archives is immediately available at substantial dealer discounts.

Manufacturer's suggested retail prices from $6,500 for dual drive single-density to $7,500 for double-density 1.5 megabyte system.

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competing with lower-level systems such as the Atari 400 and TI-99/4 personal computers.

Although Tandy denies it, the Model III appears to be a replacement for the Model I. Considering that the Model III contains the monitor, keyboard and disk drives in a single enclosure, and is software compatible with the Model I, and offers additional enhancements, most industry people feel that the Model I will be phased out when the Model III systems finally arrive at the stores.

The Pocket Computer is really a marketing experiment. Neither Tandy nor any of the other pocket-computer makers really know if there is a meaningful market for this machine. Quasar and Panasonic talk about selling one million of their new hand-held computers next year (at $400 each). Tandy, however, is selling its at $250 and may garner the major portion of the market.

But what is the market for these pocket machines? The makers are projecting that they will be bought by salesmen and executives who, via a modem, will contact their home computers to book orders, check order status, receive and send messages, etc. Will hobbyists be attracted to these machines? The successful systems today all have a strong hobbyist base. It will, therefore, be interesting to see if these pocket devices catch on as planned.

**Random Rumor Bits:**

Zilog is still having problems delivering bug-free 28000 chips. AMD (Advanced Micro Devices) is rumored to be working on the Z8003, a 32-bit version of the Z8000, scheduled for release in 1981. NEC is rumored to be about ready to announce a new video-display-controller integrated circuit capable of handling a bit-mapped graphics display of 1024 by 1024 pixels, devoting 16 bits to each pixel. It will be capable of being configured for gray scale or color (3 bits each for red, green, and blue intensities) and still have 7 bits left over for things like blinking pixels, intensity protection, etc. Intel, Western Digital, National Semiconductor, and Texas Instruments are all rumored to be working on controllers for Winchester floppy-disk drives. When these integrated circuits are available, it should reduce the cost of these controllers from the present $1000 to $900.

Apple Computer will soon begin production of the new Apple III in a new plant located in Ireland.
A superior operating system and top application software bring out the best in a microcomputer. That’s why Marot offers the OASIS Operating System and compatible software for owners of Z80 based micros. They make a terrific trio.

1 Z80 MICROs — great machines. Tandy’s TRS-80 MOD II’ with DMA, bank select possibilities and nationwide service. Altos. Cromemco. Horizon. And many others. Great machines—but it takes a great operating system to tap their full potential.

2 ENTER OASIS — available from Marot. OASIS is fast emerging as the operating system for Z80 commercial applications and serious programmers. Why?...rapid formatting and back-up of diskettes; efficient disk utilization; excellent line editor and document processor for file management and textwriting; user accounting with logon, password, privilege level and use accounting; machine independence of programs, data and text files; sequential, direct and keyed index (ISAM) files; interpreted and compiled BASIC; COBOL-ANSI ’74; single and multi-user versions; and more. No wonder pros say ‘OASIS makes micros run like minis’!

3 APPLICATION SOFTWARE — available from Marot. OASIS is your active, invisible partner supporting these excellent, ready-to-run products:

**Magic Wand**. The word processor combining the ease of screen editing with micro power.

**HDBS**. For data management needs restricted to hierarchical tree structure and fixed length records.

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Marot and its Dealers offer OASIS and many professional software products to individuals, OEMs and dealers. Licensing arrangements are also available. Just call or write and start your own terrific trio.

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It's a typical Sunday afternoon here at Chaos Manor. In one room a dozen kids are playing games on the Radio Shack TRS-80, while here in the office I've been playing about with the C programming language after adding a check-writer to my accounting programs. My wife, the only practical member of the family, gently reminds me of my deadlines: galley proofs of a new novel, *King David's Spaceship* (Simon and Schuster); two chapters of the latest Niven/Pournelle collaboration, *Oath of Fealty* (Simon and Schuster, Real Soon Now); plus three columns; a speech to a librarians' convention; and inputs for a NASA study on America's fifty-year space plan. Some business people worry about cash flow; for authors it's work flow—work comes in bunches, like bananas, and sometimes it seems everything has to be done at once.

So, since it's what we've been doing here lately, I'll talk about computer games and programming languages; a disparate set of topics, but not quite as unconnected as they might seem at first glance.

Languages

One of the biggest unsolved problems in the microcomputer field is languages: which ones are going to be standard? Everyone learns BASIC, of course, because it comes with the machine, and it's a very easy language to learn. Pretty soon, though, you come to the limits of the BASIC supplied with the computer; and then what?

A few years ago there wasn't a lot of choice. You could buy FORTRAN, and perhaps COBOL; you could learn assembler; but then you were stuck. Moreover, there didn't seem to be any obvious advantages to FORTRAN and COBOL, both of which were not only hard to learn, but also difficult to connect up with the computer. Most of the books on those languages were written with big mainframe machines in mind, and the documentation for the small-system versions was, to put it kindly, rather skimpy. Moreover, the user manuals were filled with mysterious references to "logical devices" and other such nonsense, while giving almost no clear examples of how to get programs running on a home computer.

The result was a great expansion of BASICS. What was once a simple teaching language, designed largely to let new users become familiar with the way computers think, became studded with features. Every time you turned around there was a new BASIC interpreter, each one larger than the last, and almost none of them compatible with each other. Whatever portability BASIC had enjoyed vanished in a myriad of disk operations, functions, WHILE statements, new input formats, etc, etc, and, at the same time, the "free" memory left over after loading BASIC got so small that you couldn't handle much data.

The logical end of that process is Microsoft's newest BASIC-80. Understand, it's an excellent BASIC. It has features that, not long ago, the most advanced languages didn't have. It's well documented—at least the commands and functions, which are listed alphabetically, are clearly described. The general information section could be expanded with profit—at present it's written for users who are already more or less familiar with how BASIC operates. There are elaborate procedures for error trapping, and they all work. The editor has been improved. There are procedures (not very well documented) for linking in assembly-language subroutines. You can use long variable names, such as "Personal.data.1" and "Personal.data.2", and be certain the program will know they are different variables.

In other words, there's a lot going for it; but it takes up 24 K bytes of memory, and it's still BASIC. If you want to understand your program six weeks after you write it, you'll have to put in a lot of REMark statements, every one of which takes up memory space. As with all BASICS, you have to sweat blood to write well-structured code (and if you don't bother, that will come back to haunt you when you want to modify the program). And, like all BASICS, it is slow. Fairly simple sorts, even with efficient algorithms, take minutes; disk operations are tedious.

I suspect that Microsoft BASIC-80 is the end of the line; they have carried BASIC about as far as it can go. They've done it very well, but they've also reached the inherent limits of the language; and those limits may not be acceptable.

Of course most programmers have always known that
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even the best BASIC interpreter wasn't good enough; that if you add enough features to make the language useful, you'll end up with a very slow monster that takes up far too much memory, and that even if you could tolerate those limits, the language itself forces sloppy thinking and inelegant code. However, knowing the problem didn't make the solution obvious; indeed, it's not obvious yet. We can recognize the limits to BASIC and still not agree on what to do about it.

There seem to be two fundamental paths. One is to start over; to relegate BASIC to its original function as a teaching language, and switch to some other language for serious programming. Many took this path, and came out with microcomputer versions of such languages as C, APL, ALGOL, LISP, FORTH, STOIC, and Pascal.

The other way is to compile BASIC. One of the first compiled BASICS, BASIC E, is in the public domain; I obtained a fairly decent version with (barely) adequate documentation from the CP/M User's Group several years ago. Then Software Systems brought out an improved BASIC E called CBASIC. It is easy to use and features really excellent documentation, some of the best I've ever seen. It has decent file structures; you are not limited to either sequential or random-access disk files, but may use sequential operations on random-access files.

There are irritants in CBASIC, particularly with regard to line-printer operations. CBASIC has only the PRINT and PRINT USING commands; there is no LPRINT. To get hard copy, you must execute a LINEPRINTER statement, then one or more PRINT statements, then do a CONSOLE statement to have the copy sent to the terminal. Every time you do the CONSOLE statement, the print buffer empties, and you can get unwanted stuff printed on your hard copy; worse, you can also get unwanted line feeds, making it tough to format hard copy (although CBASIC does allow you to output characters through a port so that, if you are clever enough, you can control the line printer directly; you could even make a CBASIC program drive a Diablo for reverse printing if you wanted to spend the time writing that program). Another needless limitation is that CBASIC allows a maximum carriage width of 133 characters, although a 12-character-per-inch printer can print lines 158 characters long.

Irritants or no, CBASIC is both well designed and well documented. It has WHILE; IF-THEN-ELSE (with chaining); long variable names; and logical operations (IF, AND, OR, NOT). It has excellent documentation, some of the best I've ever seen. It has decent file structures; you are not limited to either sequential or random-access disk files, but may use sequential operations on random-access files.

And it saves memory by compiling. To use CBASIC, one creates a program with any editor that makes ASCII (American Standard Code for Information Interchange) files (Electric-Pencil-created programs have to be put through a converter), then turns the CBASIC compiler loose on it. What comes out isn't true compilation; the compiler strips out remarks and useless line numbers, and compacts the remainder into an INT (intermediate) file; when you want to run the program, you must load in a 10 K-byte run-time package. The INT file is still interpreted; it is not a machine-language program. You can, though, include scads of remarks, put each statement on a separate line, leave lots of blank space, put in rows of asterisks, indent whole sections of the program, and thus vastly increase program readability without using up memory space. A CBASIC program can be written for legibility.

But it's still BASIC. Because a program can be reasonably well structured and self-documenting doesn't mean that it will be; BASIC makes it easy to write incomprehensible code and difficult not to. And CBASIC is very slow, no faster than Microsoft BASIC-80 and often slower.

There's another limit. It's very hard to write long programs in CBASIC. This problem is inherent in any compiled language—whether true compilation to machine code, or pseudocompiling to an INT file. For example, assume that I want to add a small feature to my accounting package (which I did in fact write in CBASIC two years ago). I load the source program into the text editor. I add the feature and hook it into the program; since I do sweat blood to write structured code, that's fairly easy. Now I must save the altered source and put it through the compiler. Since it's a long program, the compilation takes many minutes—and toward the end, I get a SYNTAX ERROR message. I've put a comma where it wants a semicolon.

Now I have to load the editor, read in the source, make the change, save, and recompile. Presuming that this time it goes without error, I may have used half an hour just to change", " to ;"—and I still have no test of the program's logic. If I now test for logic and it's not right, well, I have to start all over again, hoping that this time I don't manage a new syntax error....

Thus, you can use up a whole afternoon adding something quite simple to a big program. There must be a better way. Why can't someone come up with a language that runs interpretively like normal BASIC, letting you correct both syntax and logic errors while in an interactive mode; and then allow you to compile the result? While we're at it, let's wish for the compiled program to be in true machine language, code that could be put into read-only memory, and, moreover, code that would be fast.

That's the route that Microsoft took. Their BASCOM compiler works just that way with their BASIC-80. It will also compile Microsoft BASIC 4.5, and, with considerable modifications to syntax, programs written in both CBASIC and BASIC E. Moreover, it's a very powerful compiler. It implements almost all the features of BASIC-80, including WHILE, IF-THEN-ELSE, CASE, logics, and string operations, etc. It sounds like the answer to a prayer.

Of course there are problems. Random-access disk operations are unbelievably messy, and worse, a random-access file cannot be accessed sequentially. There's considerable overhead burden. For example, this program:

```
10 PRINT "Hello"
20 END
```

required 9 K bytes when compiled into a CP/M COM file; there's obviously a big run-time package built into BASCOM. Worse, present Microsoft user contracts require that anyone marketing a program compiled by
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But let's assume much of this is fixed. Microsoft has a good reputation for responding to customer suggestions. As an example, at the West Coast Computer Faire I spoke to the Microsoft representatives about the lack of a FILES statement (a means of finding out the file names present on disk) in BASCOM; BASIC-80 supported FILES, but not the compiler. Two weeks later I received an updated version of BASCOM—and lo!—the FILES statement had been implemented, along with several features other users had suggested.

At the National Computer Conference, Microsoft representatives said they were "rethinking" their contract policy and would probably change it; that change may have been implemented by the time you read this. I have also mentioned to them the desirability of allowing sequential access to random files, and they've promised to look into that. It's not unreasonable to assume they'll tighten up the overhead-code problem. Thus, as I said, let's assume that the major problems of BASCOM are fixed. What will we have?

First, the combination of BASIC-80 and BASCOM is superb for quick and dirty jobs and for those little special-purpose programs that aren't going to be run very often (possibly only once). For example, I recently wanted to reformat some financial data files. The program had to go open the file, read the data, make a couple of changes, and write the information out in a new format. The only problem was that I also wanted to sort the data before putting it back out, and this had to be done for a lot of files. Doing it with interpretive BASIC would take hours and hours; while writing even that simple a program in Z80 assembler would, at best, use up an afternoon, and might take a lot longer.

The solution was to write it in BASIC-80, test syntax and logic while in interpretive mode, and compile with BASCOM. That took an hour. In another hour, I had reformatted about one hundred files. BASCOM is fast, blindingly fast; sorts that take 3.5 minutes in CBASIC are done by BASCOM (using the same algorithm) in under 20 seconds.

In other words, the combination of BASIC-80 and BASCOM has a lot going for it. If I'd written this review a year ago, I'd have concluded that BASIC-80/BASCOM was what the world has been waiting for, and spent the rest of the review suggesting incremental improvements to make it even better.

Now I'm not so sure.

The problem is that when all the improvements are done; when all the bugs (if any; I've found none in the latest versions of BASCOM) are eliminated; when all the new features are added; when the code is tightened; when the disk operations are simplified—when all that's done, it's still BASIC.

And there are many who believe BASIC is a dead end; that the inherent limits to the language are just too severe for it ever to be acceptable; that incremental improvements actually harm rather than help the field, because they encourage new-comers to stick with BASIC instead of learning something better. My mad friend is convinced of that. So are a number of my associates.

"But," I protested to my mad friend, "I'm interested in using computers. I don't care about elegance. What I want is something that lets me get the jobs done quickly, and BASIC-80/BASCOM does that...."

"But at a stiff price. How many times have you had to start over with a program because it just wasn't worth the effort to improve one of those BASIC routines? BASIC doesn't let you build software tools. It's like Pidgin English—you can manage to buy dinner and sell copra with Pidgin, but you'll never write Hamlet, or the Declaration of Independence, or even good laws...."

And the argument starts over and goes on until we get hungry, and, at the bottom line, it's all a matter of opinion; and since my space is limited, I'll drop it for the moment. Just now the bottom line is that BASIC-80 and BASCOM work, and, if you're willing to accept the inherent limits of BASIC, they're quite splendid; but those limits are severe.

Looking Elsewhere

What, then, are the microcomputer user's best alternatives to BASIC? Once again, let me be honest: these are opinions. They're opinions based on considerable user experience, but they're opinions still; and I have found that every known language has passionate supporters, so I am bound to make someone unhappy.

The earliest alternatives to BASIC were FORTRAN and COBOL. These, in my judgment, are languages whose time has long passed. They have little to recommend them, because they have nearly all the limits of compiled BASIC without the advantage of letting you program in the interpretive mode before compiling. I've had both for years, and after an initial flurry of enthusiasm for FORTRAN (I never cared at all for COBOL, which may be all right for very large systems, but is plain crippled on microcomputers) they went on the shelf and haven't come off it. Neither FORTRAN nor COBOL lets you write structured code. True, FORTRAN with RFFOR (excellently described in Kernigan and Plauger's book Software Tools, Addison-Wesley, 1976) overcomes some of the limits; but to use RFFOR requires another compilation stage, so that it can take over an hour to find and correct a trivial error in a fairly simple program. The Software Tools approach to programming is excellent, and I strongly recommend the book; but in my judgment the deficiencies of FORTRAN with RFFOR are simply overwhelming, and I cannot recommend using them.

Then there's Pascal, which very well may be the wave of the future. Pascal began unfortunately: the first widespread implementation of Pascal for microcomputers was from the University of California, San Diego, and it just didn't work for most users. The hooks into the disk operating system were clumsy, and it was very slow.

Then came some other versions of Pascal, and they too had horrible problems; you had to be really sophisticated to use them. Bugs appeared, and, unless you knew an awful lot, you couldn't tell whether you'd made a program error or the compiler was at fault. Implementing early Pascals required a constant and fairly complex dialogue between user and publisher.

As a result, a lot of us lost interest in Pascal. The language looked great in theory, but if you couldn't run it, that hardly mattered.

There are now a lot of Pascals: Pascal for the Apple, Pascal for the TRS-80, Pascal for CP/M; Pascal that
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**System Monitor (Terminal Version):** 2k bytes of deluxe system monitor ROM located at F000, leaving 2k free for user RAM/RROM. Features include tape load with labeling... examine/change contents of memory; insert data... warm start... examine and change all registers... single step with register display at each break point... go to execution address... programs... move blocks of memory from one location to another... fill blocks of memory with a constant... display blocks of memory... read/write stuck address... load rate selection... 9000 baud... variable display line length... display window... display cursor... display character... channel information... high-speed printer... serial console in and out control channel so that monitor can communicate with I/O.

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Explorer/85's computer board provides the advanced Intel 8085 cpu, an 8532 ROM with 2k deluxe monitor/operating system, and an advanced 815 RAM I/O... all for less than the price of RAM/EPROM and S-100 expansion, plus generous programming aids.

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pseudocompiles to an INT file the way CBASIC does (Pascal users call the INT file "p-code"); Pascal that truly compiles into machine language for 8080, Z80, 8086, etc. All these look good, and people I respect tell me they run; but since I haven't implemented any of them yet, I can't report on them. I can say that Pascal has many enthusiasts, and might well be the standard language of the future. Then there's Ada, a Pascal-like language heavily supported by the DOD (Department of Defense), which will certainly be around for many years. If I were preparing for a secure career in programming, I'd learn Pascal instantly and keep very close tabs on the progress of Ada.

In the next couple of months, we're adding a Pascal expert to the staff here, and I'll devote a whole column to Pascal/Ada; for now, I must simply pass them over.

Pascal has enthusiasts. So does C, a programming language developed at Bell Telephone Laboratories. The best (and indeed nearly the only) manual on C is Kernighan and Ritchie's *The C Programming Language* (Prentice-Hall, 1978). This is an excellently written book which anyone at all interested in the C language simply must read. It succeeds in communicating a lot of enthusiasm for C. There are lots of examples of real programs that work. Kernighan, incidentally, is the same Brian Kernighan who coauthored *Software Tools*.

C is nothing like BASIC. There are far fewer commands, for one thing. On the other hand, there are a number of conventions. For example, the BASIC statements:

\[
\text{FOR } I = 0 \text{ TO } N - 1 \\
\text{NEXT } I
\]

would appear in C as:

\[
\text{for ( } i = 0 ; i < N ; i ++ )
\]

which looks complex, but is, with a bit of experience, quite readable. The i++ means that i is first to be tested against N; then incremented; the expression could have been written with ++i, which would require that i be incremented before the test against N.

Despite (perhaps because of) the numerous time-saving conventions such as + +i, C can be learned by a BASIC user in a couple of weeks. Real facility requires practice; more practice than BASIC, precisely because there are many fewer limits in C. Programming with elegance and style takes work—but in C such programs are possible, while BASIC simply won't let you write elegant code.

I have two C compilers for microcomputers. I'm told there's also an interactive tiny-c, which I have not seen running, but which is said to be a good teaching aid, although severely limited in capability. [Editor's note: See "A User's Look at Tiny-c," by Christopher O Kern, December 1979 *BYTE*, page 196...RSS] Of my two C compilers, only one is suitable for those not already familiar with the C language. This is BDS C, available from Lifeboat Associates for $125. BDS C comes with a copy of Kernighan and Ritchie's book and quite extensive documentation on the BDS (BD Software) implementation.

The BDS compiler uses two passes. One might at first think that a disadvantage because of the time required, but in fact it is not: the first pass is done very fast, and checks for trivial errors, such as missing semicolons, comments improperly delimited, unmatched parentheses and brackets (C loves brackets, braces, and parentheses), and the like. The second pass goes a bit slower but is still much faster than the CBASIC compiler.

Like BASCOM, compiled C code must be put through a linker, and like Microsoft's, the BDS documentation tells you precisely how to do this. When it's all finished, you have a CP/M command file; and the resulting code is very fast. I've not yet been able to benchmark BDS C against a similar BASCOM program, because when you translate from BASIC to C you actually restructure the program; but I have two Othello games, one in C and the other compiled by BASCOM, and they seem to run at about the same speed. The C program, however, is about 8 K bytes compiled; the BASIC program, performing the same searches and playing at the same level, compiled to over 20 K bytes. Other programs doing similar jobs also run in comparable times, and with about the same differences in program size.

Disk operations in BDS C are fairly simple if you understand CP/M, not so simple if you don't—and CP/M's documentation is so notoriously unclear that you'll have to work for a couple of days understanding CP/M before you can write decent disk I/O (input/output) operations for BDS C. It is worth sharpening up your understanding of CP/M, though, because BDS C lets you do everything CP/M will; get the names and sizes of files currently on disk, make backups, rename and delete, etc, and it's no more difficult to understand than the FIELD statements in Microsoft BASIC or the dreaded FORMAT statement in FORTRAN.

String operations in C are more difficult than in BASIC. Actually, they aren't; ie: it's possible to write, in C, all the string functions of BASIC (such as LEFT$, etc), then call them as needed; and once you have written them, you can use them in any program that needs them—and leave them out if not wanted. And, in fact, that illustrates one of the fundamental differences between BASIC and C: the BASIC language provides a number of functions which you must have present whether you need them or not, and which must be used exactly the way BASIC wants them used. C, on the other hand, allows you to leave out functions you don't want, and rewrite those you keep to suit your precise requirements.

There is, however, one very severe limit to BDS C: it does not support floating-point data types. One can use floating-point variables, because BDS supplies a number of functions that can be called to do floating-point arithmetic; but the result is clumsy. If you want to learn the C language, and write games, calendar programs, and almost anything that doesn't involve crunching a lot of numbers, BDS C is highly recommended; however, it isn't suitable for writing an accounting or financial package.

The other C compiler for microcomputers is the Whitesmiths C Compiler, which is available from Lifeboat Associates for $630. This is a full implementation of the standard C described by Kernighan and Ritchie, and is highly regarded by many professionals who work with large machines like DEC's (Digital Equipment Corporation) PDP-11. In fact, Whitesmiths C was written for large machines, and it is only an accident that it could be scaled down for microcomputers. The president of Whitesmiths Ltd is P J Plauger, a fellow science fiction writer, and more important, coauthor of *Software Tools*.12
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Although the Whitesmiths Compiler is an excellent professional tool, I cannot recommend it to anyone who doesn't intend to program in C in a big way—and even then I'd recommend buying the BDS C compiler as well. Whitesmiths C compiles, eventually, to true machine code; but it does so by going through an intermediate assembly language called A-Natural. It's slow, and since there's no first pass to find trivial errors, the Whitesmiths compiler can grind away for half an hour before reporting a misplaced semicolon. It is certainly not what I'd choose to learn the language with—but I would get it if I were going to market programs written in C.

Ubiquitous Microsoft doesn't market a C compiler, but it does have a LISP interpreter. The Microsoft muLISP-79 is well done, if you like the LISP language. You may not care for the language, but those who like it like it a lot. LISP stands for list processing, and it makes creating highly complex linked lists very easy.

LISP is, however, a peculiar language. It was written in the 1950s by Dr John McCarthy, now Director of the Stanford Artificial Intelligence Laboratories (SAIL), and it's extensively used at Stanford and MIT (where McCarthy wrote it).

LISP does bit-by-bit arithmetic, meaning that there is no theoretical limit to the precision you can obtain; if you want an exact numerical expansion of, say, 2 to the 55th power, or 87 factorial, you can get it from LISP, and with only about three lines of code for a program—and you'll get the answer faster than you think. LISP is one of the fastest languages I know of, often approaching assembly-language programs in speed of operation.

LISP programs are very tight; it's almost impossible to write unstructured code in LISP. It's also very nearly impossible to understand a LISP program, even if you wrote it; at least that's been my experience. You can strain like a gearbox and produce code that runs, and which you understand just at that moment; but hours later it's gibberish. The only thing less comprehensible than a LISP program is one in APL—APL doesn't even use normal letters, but instead requires a special keyboard that can generate strangely bent arrows and other weird symbols. Both LISP and APL programmers delight in writing a whole page of instructions into one line (and you can do it, too, because both languages allow functions to call themselves). They also like to baffle fellow professionals by showing a line of code and challenging anyone to say what it does.

It's very hard to comment a LISP program—but that's all right, because it isn't traditional for LISP programmers to comment their programs anyway.

In other words, I am not a wild enthusiast for LISP as a "standard" microcomputer language. It's true that one or another LISP variant is used by just about everyone in the artificial intelligence field; for certain purposes there's nothing better. But for general-purpose programming, LISP and APL are, in my judgment, simply too obscure.

The Microsoft muLISP-79 was written by The Soft Warehouse in Hawaii; I got mine directly from the authors and haven't seen the Microsoft versions (for CP/M and the TRS-80), although they were supposed to be sent weeks ago. I am told that Microsoft has rewritten some of the documentation, which could only improve it. The problem with documenting LISP is that the language is fairly obscure; you need not only a user's manual, but an introduction to LISP itself, which is far more than the muLISP-79 manual claims to be.

The best way to learn LISP is to attend Stanford or MIT and get tutorial instruction from someone already proficient. The next best way is to get access to the MIT Macsyma Consortium computer and run the TEACHLISP programs. There are also a couple of MIT documents which are pretty good introductions. I wish I knew of a good commercial textbook, but I don't. If you want to learn LISP, you've no choice but to play about with it; since muLISP-79 is interactive, that's not so hard to do, and there are some decent examples in the documents supplied. If you like playing with powerful languages, muLISP-79 is recommended—but don't blame me if you don't use it very often after the first wave of enthusiasm.

Which concludes my overview of languages. I haven't mentioned STOIC and FORTH, because they're really a kind of assembler language using the programmer as a parser; they make programming a bit easier, but you've got to be into assembler work before you can use them, and this is, after all, the User's Column.

Drawing Conclusions

So what's the best language to learn? I don't know. I like C. I also like what I've seen of Pascal, assuming the current crop will really run on microcomputers. And despite my misgivings, I still find myself using BASIC-80/BASCOM, particularly for quick and dirty jobs.

It seems certain—to me at least—that Pascal is going to be around a long time, especially what with all that DOD support for the Ada variant. Now that there seem to be some decent Pascal compilers available for microcomputers, we're going to see a lot of software written in Pascal, and those who want to modify their software will have to be familiar with the language.

But there may not be a real conflict between Pascal and C. Both are vastly different from BASIC; different in conception, in terminology, but more important, in the "philosophy" or style of programming employing them. Learning either will help break the BASIC habit of sloppy program structure; and having done that, you'll have little trouble learning the other, or indeed any other well-structured language.

And that can't hurt users or programmers.

Adventure and Other Games

Now, what about computer games? Well, when microcomputers first came out, games were the rage. It wasn't so much fun to play the games, which tended to be rather dull (you wouldn't play much tic-tac-toe with a human opponent); the fun was in writing the programs and seeing just how smart you could make the machine. With the possible exception of Star Trek, nobody spent much time with the games once they were written and perfected.

That's no longer true. Nowadays you can buy computer games that are fun to play. For example, at both the West Coast Computer Faire and the National Computer Conference, the most popular exhibit was Atari's. Not that so many were wild about the Atari computers, or the educational games, or that sort of thing, but boy did they stand in line to play Star Raiders, a real-time game in which you are a pilot of an X-wing fighter, or perhaps it's a Colonial Viper, and you go zipping about through space destroying villains and saving civilizations....

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The game of *Adventure* was first written in FORTRAN by Larry Crowther and Don Woods. It bore some slight resemblance to *Hunt the Wumpus*, in that the game consisted of wandering through unknown territories and encountering various hazards. Unlike Wumpus, though, the *Adventure* map is fixed. The game always begins at a well house, and you may continue to explore until you are killed. Actually, it doesn't end even then: the computer will resurrect you if you like.

You move about in *Adventure* by telling the computer where you want to go. The object of the game is to find treasures and bring them to the well house. On the way you encounter various obstacles and monsters, such as a large green snake, a dragon, and a ferocious bear chained to the wall. (The problem is that the bear's silver chain is a treasure.) You also find various objects: a rod, a bird-cage, and other such things, some of which may be useful in solving puzzles that lead to treasure.

The game quickly became a cult object among programmers. Computer-installation supervisors estimated that when *Adventure* arrived, two weeks' work would be lost due to the staff bootlegging time to run the game. Various fixes were tried, including restricting the times at which *Adventure* could be accessed, but nothing really worked except letting the disease run its course; when all the programmers had solved the game, then only then did they get back to work. Until then, they were driven to it as if hypnotized. To make it worse, it was customary not to tell anyone how to solve the game, although strange and misleading hints were allowed.

*Adventure* now exists for various microcomputers. The game itself is public domain (although programs to implement it are not), so there are many versions offered. I have one for 8-inch floppy-disk CP/M systems sold by Workman and Associates (POB 482, Pasadena CA 91102, $23.95 postpaid) and another for the Radio Shack TRS-80® Level II (Model I) by Microsoft, $24.95, and available from most dealers. Both run quite fast — faster, in fact, than the FORTRAN versions did on a DEC PDP-10. Both require 32 K bytes of memory and a single disk drive, and both are full implementations of the original Crowther and Woods *Adventure*, including the "Save" feature that allows you to store an incomplete game so that you don't have to start over every time.

The Workman version recognizes a number of commands that were not in the original *Adventure*, but the puzzles and their solutions remain unchanged.

In addition, both the Workman and the Microsoft versions store most of the game information on disk, and every time you give a command they have to go to the disk to get the response. There's no help for that, of course; the *Adventure* data base requires over 50 K bytes of ASCII (American Standard Code for Information Interchange) characters. Thus the disk gets a good workout. This presents no problem with the Workman and Associates CP/M version, because any good CP/M copy routine will allow you to make a backup; but the Microsoft TRS-80 version has been carefully rigged to make backup copies nearly impossible. I say nearly; within
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- Provision for expansion to 256 channels

**TM-AD200 OPTIONS**

- Programmable gain up to 500
- 14 bit accuracy
- 16 bit accuracy
- Screw terminal and signal conditioning panel with optional thermocouple cold junction compensation
- 100 KHz throughput with 12 bit accuracy
- Low level, wide range (10mV to 10V FSR) permitting low level sensors such as thermocouples, pressure sensors and strain gauges to be directly connected to the module input

**TM-AD100 FEATURES**

- Complies with IEEE S-100 specifications
- 4 independent
- 12 bit accuracy
- 25 KHz throughput
- I/O or memory mapped
- Input ranges: ±10V, ±5V, 0 to +10V, 0 to +5V
- Minimal software required.

**S-100 BOARDS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Features</th>
<th>Price</th>
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<tr>
<td>8086 CPU</td>
<td>W/vectored interrupts</td>
<td>$450</td>
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<tr>
<td>8Kx16/16Kx8</td>
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<td>$395</td>
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<td>8086 PROM</td>
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<td>Serial I/O</td>
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<tr>
<td>Parallel I/O</td>
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<tr>
<td>&amp; Timer</td>
<td></td>
<td>$350</td>
</tr>
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</table>

For digital to analog conversion, Tecmar’s D/A Board provides four independent 12 bit high speed D/A channels.

**TM-DA100 FEATURES**

- Complies with IEEE S-100 specifications
- 4 independent digital to analog converters
- 12 bit accuracy
- 3 μsec settling time
- I/O or memory mapped
- Output ranges: ±2.5V, ±5V, ±10V, 0 to +5V, 0 to +10V

**APPLE PET**

<table>
<thead>
<tr>
<th>Model</th>
<th>Features</th>
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</thead>
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<tr>
<td>TRS-80</td>
<td>12 Bit High Speed 8 Ch. Differential</td>
<td>$395</td>
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<tr>
<td>PET 4 Channel</td>
<td>Each D/A Module</td>
<td>$495</td>
</tr>
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**KIM**

<table>
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<th>Model</th>
<th>Features</th>
<th>Price</th>
</tr>
</thead>
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<tr>
<td>TRS-80 or PET expansion board, power supply, and enclosure</td>
<td>$200</td>
<td></td>
</tr>
</tbody>
</table>

**S-100 Real Time Video Digitizer**

- Digitizes and Displays in 1/60 sec, flicker-free
- 16 Gray Levels
- Switch Selectable to display Black and White Graphics (8 pixels/byte)
- Maximum Resolution: 512 pixels/line x 240 lines
- Minimal software requirements

**Data Acquisition Systems and Video Microcomputer Systems Available**
either TRSDOS or Apparat's NEWDOS it is impossible, but since I have the Omikron CP/M Mapper installed on my TRS-80, I can make backups of anything, using a CP/M sector-by-sector copy routine.

(As an aside: I've been informed that both Parasitic Engineering and Field Engineering Consultants Ltd also make memory mappers that will allow you to run CP/M on the TRS-80 Model I. I've had no chance to test either of them. My Omikron Mapper continues to work flawlessly, by the way.)

I often wonder about companies that deliberately try to keep you from copying software—especially when it's supposed to run on something as inherently flaky as a TRS-80 5-inch disk. Experienced users never run their primary source disks; making a backup is just common sense, even if you have excellent hardware like Percom or Matchless disk drives. (I've tested both on my TRS-80, and I'm quite happy with them.) Moreover, making it hard to copy a disk is often like waving a red flag at a bull—there are plenty of sophisticated users who will consider it a challenge, and, having with great effort found a way to make copies, will feel ethically justified in distributing them to all their friends.

In any event, the Workman and Microsoft Adventure implementations have provided many hours of trouble-free enjoyment, and I recommend them highly.

Just after the Adventure craze hit, there were rumors of another game, Zork, which is to Adventure as Adventure is to Wumpus. Zork was developed at the Massachusetts Institute of Technology by "the Four Implementors": Tim Anderson, Marc Blank, Bruce Daniels, and David Lebling. The game was written in MIDL (or "Muddle"), a LISP-like language, and featured an enormous underground dungeon, dozens of clever puzzles, and a highly intelligent command parser that understands much that Adventure finds incomprehensible. Although Zork never quite caught on the way Adventure did, it became widespread—and where it did appear, it cost more time than ever Adventure had, because it was both more difficult and more interesting.

Implementers Lebling and Blank have devised a microcomputer implementation of Zork in parts. Zork: The Great Underground Empire, Part I is being sold for the Apple II and the TRS-80 on 5-inch floppy disk by Personal Software, 1330 Bordeaux Dr, Sunnyvale CA 94086, at a price of $39.95. [Editor's note: Part II is still under development, but Part I alone constitutes a complete game that can be played through to a satisfactory ending...R55] Like the Microsoft Adventure, Zork requires constant access to the disk but cannot be copied by normal means. I've been just a little afraid of running the primary disk, so I haven't checked out everything; besides, the kids are still mapping Adventure. I've played with this Zork enough to know that I like it (and I wasted incredible amounts of time playing the original Zork on a PDP-10).

Adventure and Zork became popular during the D & D (Dungeons and Dragons) craze—a madness which shows little sign of peaking out even yet. It was inevitable that other D & D games would come forth, and sure enough, Automated Simulations Inc (ASI), POB 4232, Mountain View CA 94040, has come out with a whole series, from the introductory Datestones to the full four-level dungeon in Temple of Aphsai. These games are sold in
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If your machine
would like to read
these programs,
object code versions
are available in these
disk formats: Per­
com, ICOM, SSB,
SWTPC, TANO and
others.

WRITE FOR PRICES
I'd like the single-player version somewhat better if it were faster; in my favorite scenario, *Damocles*, it can take several minutes for the computer to plan out its move, and worse, you can't just go away, because the battle results are presented dynamically and can't be recalled once shown.

The Orion games are quite realistic. Classical principles of fleet warfare work, and strategy and tactics are more important than luck. Since players can modify the ships at will, it's possible to tailor the games to a balance of power so that an experienced player (or the computer in the single-player version) doesn't routinely stomp a newcomer, and the game can be changed again as the players gain experience.

All of the Automated Simulations games are implemented in BASIC. They can be copied, listed, and even modified. In theory, one ought to be able to compile *Invasion Orion* with Microsoft's TRS-80 version of BASCOM and thus speed it up. Obviously, you will have to modify the games a bit; in particular, you will have to lengthen the loops that govern how long displays stay visible. I'm anxious to try this, but so far the TRS-80 BASCOM hasn't arrived, so I can't say for certain that it will work.

Needless to say, I enjoy all the Automated Simulations games, and recommend them highly. And, needless to say, I enjoy the C language and BASIC-80, etc, etc. So what does it all mean? Well, it means that I have to get the kids away from the TRS-80 and have some computer fun of my own, here at Chaos Manor.
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- Starfleet Orion TRS-80, PET, Apple $19.95
- Invasion Orion TRS-80, PET, Apple $19.95

Personal Software  
1330 Bordeaux Dr  
Sunnyvale CA 94086

- Zork: The Great Underground Empire, Part 1 TRS-80 or Apple disk $39.95

Books  
Kernighan, Brian W and Dennis M Ritchie.  
The C Programming Language.  

Kernighan, Brian W and P J Plauger.  
Software Tools.  
Reading MA: Addison-Wesley Publishing Company, 1976, $11.95

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These, plus a host of convenience features, make this calculator the most versatile machine ever.

Display and Keyboard

Perhaps at some time you have marveled at the ingenuity of the person who discovered that, if you hold your calculator upside down after entering 710.77345, it will read “SHELL OIL”. Well, you don’t need to resort to tricks like that on the HP-41C, because the usual red seven-segment light-emitting diodes (LEDs) are gone. They are replaced by a large, high-resolution black-on-white liquid-crystal display (LCD) capable of displaying all twenty-six uppercase alphabetic characters, ten numerals, and twenty-three other characters (see photo 1). In addition, the display contains eleven “status annunciators,” which inform you of various calculator modes currently active. For example, if you select radian measure instead of degrees for trigonometric functions, “RAD” appears at the bottom of the display. There is even a SHIFT annunciator that indicates when the shift key has been depressed.

The keyboard is HP’s usual very high-quality, thirty-five-key, tactile-feedback keyboard, augmented by four push-on-push-off mode-selection switches. With fifty-nine displayable characters and 130 built-in functions, it should be apparent that the thirty-nine keys have several duties. In fact, each key is etched with three labels: its standard (unshifted) function, its shifted function (above the key), and its alpha-mode function (on the bottom sloping side of the key). Alpha-mode characters are enabled as long as the alpha-mode switch is set. The more unusual alpha-mode characters (such as “¥,” “€,” “£,” “$, etc) are selected by using the shift key in alpha mode. To keep the keyboard reasonably uncluttered, this set of special characters is not etched on the keys but appears in a pictorial layout on the back of the calculator.

Even with each key potentially performing quadruple duty, there are simply not enough keys for all the functions. To employ one of the more esoteric functions, you depress the execute (XEQ) button and spell the name of the desired function. For example, to compute 12! (12 fac-
If you happen to be heavily involved in statistics, you may find this a nuisance because FACT (the factorial function) will be frequently needed. This is where the "programmable keyboard" feature of the HP-41C comes in handy. You can assign or reassign any function to any key you like by using the ASN function. For example:

\[
\text{ASN}\ \text{ALPHA}\ \text{FACT}\ \text{ALPHA TAN}
\]

assigns the FACT function to the button normally used to activate the tangent function. A push-on-push-off USER mode switch determines whether user-defined or standard meanings are currently associated with the keys. If you forget what function you have assigned to a key, you can find out by simply holding down the key. For our example, holding down the TAN button will show "FACT" on the display while in user mode and "TAN" while in normal mode.

User-programmed functions can also be assigned to keys, allowing the calculator to be customized to your application. Two keyboard overlays with stick-on labels are provided for identification of user-defined keys.

Photo 1: The Hewlett-Packard HP-41C calculator. Each key on the HP-41C has up to three labels associated with it: the label etched into the top face of the key, the label visible directly above the key, and a letter of the alphabet (enabled by toggling the ALPHA button) etched into the bottom face of the key. Additional functions are called by hitting the XEQ button and spelling out the function name. (Photo courtesy of Hewlett-Packard.)

The electric pencil II
for the TRS-80 Model II* Computer

The Electric Pencil is a Character Oriented Word Processing System designed to be a natural extension to the use of the TRS-80 Model II. Written in BASIC, the Electric Pencil is a full-featured word processor. It is completely menu-driven and features a full-screen editor, word processor, spelling checker, and a comprehensive set of editing commands.

The Electric Pencil allows you to:

- Create and edit documents
- Spell check documents
- Format documents
- Print documents
- Save documents

The Electric Pencil is easy to use and is completely integrated with the TRS-80 Model II. It is compatible with all popular word processors and word processing systems, making it easy to transfer documents between systems.

The Electric Pencil is available for the TRS-80 Model II and includes a full set of documentation and support. If you are looking for a powerful and easy-to-use word processor, the Electric Pencil is the perfect choice.

*Requires a compatible word processor or Compatibility Shell.
To facilitate the entry of multiple-key sequences, the display provides prompting messages, and invalid keys are disabled. In addition to the normal clear-display key, there is a backspace key to facilitate corrections. If you forget the name of a function (programmed or standard), depressing the CAT (catalog) key will list all functions currently known to the calculator.

Memory
The HP-41C has continuous memory, which means that the contents of memory are preserved even when the calculator is turned off. You can even replace the batteries without destroying the contents of memory. The HP-41C's size-N throw-away batteries typically last 1 or 2 months, instead of the 9 to 12 months claimed in the documentation. A BAT annunciator warns you when you have only about 2 weeks' worth of life left in the batteries. The HP-41C can also be run using an AC adapter.

Not only are user programs saved in continuous memory, but so is virtually everything relating to the calculator: data, flags, user-key assignments, registers, and display formats. You can even set a flag so that, when you turn on the calculator, it immediately continues executing a program from where it left off when shut down!

The standard calculator contains sixty-three registers of memory. Each register is 7 bytes long and can be used to store one number, up to six characters, or several programs. The total memory space can be partitioned into any combination of program and data storage, or it can be left at the default partition of seventeen data registers and forty-six program registers. The instruction set contains eighty-six 1-byte instructions, thirty-one 2-byte instructions, three 3-byte instructions, and one 4-byte instruction. Instructions with alphanumeric operands such as LABEL, GOTO, etc., use 1 extra byte per character. In a typical mix of instructions, the HP-41C can store about 200 lines of program code in the default forty-six registers of program space. An HP-41C containing four optional expansion-memory modules contains over 2.1 K bytes of continuous memory, capable of storing an average of over 1300 program steps.

Programming
Programming is easier on the HP-41C than on any other calculator. You need not be concerned with addresses or instruction lengths; instead, programs are entered on automatically numbered lines, as is done on many microcomputer text editors. Lines may be freely inserted or deleted anywhere, with automatic renumbering of subsequent lines. Alphabetic labels of up to seven characters can be used for tagging the destination of branches or for program, subroutine, and function names. Also, any number of programs may be resident in memory, each uniquely indentified by an alphabetic name. Programs can be selectively edited, deleted, or entered without affecting other programs.

Best of all, the key codes displayed by other calculators are gone, and are replaced by mnemonic instruction displays. For example, if you examine an instruction for storing a number into register 15 on the Texas Instruments TI-59, it is displayed on three separate lines as "42", "01", "05", where "42" is the TI-59's key code for the STO key. On the HP-41C, however, the same operation is displayed on a single line as "STO 15". This improvement is analogous to stepping up to assembly-language programming from machine-language, an advantage that really speeds up program development and checkout.

Two powerful loop-control instructions have been added to the function repertoire of the HP-41C: increment and skip if greater (ISG), and decrement and skip if equal (DSE). These instructions allow a single register to serve as a loop counter, increment value, and final value simultaneously, by coding the number in the register in the form:

\[ \text{iiii}, \text{fff}, \text{cc} \]

where ii is the current counter value, fff is the final value, and cc is the increment. For example, the BASIC loop:

\[ \text{FOR I = 1 TO 50 STEP 2} \]

\[ \text{NEXT I} \]

is programmed on the HP-41C as:

\[ 1.05002, \text{iiii = 1}, \text{fff = 050}, \text{cc = 2} \]
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Figure 1: Musical notes on the HP-41C. The TONE function on the HP-41C produces one of ten musical notes that roughly correspond to the notes presented in this figure.

STO 01 Store the loop-control number in register 01
LBL "TOPLOOP" Top of loop label
ISG 01 Increment register 01 by 2, skip next line if greater than 50
GTO 'TOPLOOP' Otherwise, repeat this loop

The integer part (\texttt{iii}) of register 01 is incremented by 2 in each pass until 51 is reached; the GTO is then skipped and the loop is exited at the bottom.

A full complement of indirect operations (including indirect subroutine calls) and register arithmetic are supported. Subroutines may be nested up to 6 levels deep. Ten different compare operations are available, including a test for character string equality. Fifty-five flags are provided, some of which are predefined for controlling calculator functions such as display format, mode of operation, etc.

There are eleven user-defined flags, five of which have built-in status annunciators on the display. I found the flags with annunciators useful for monitoring program execution during debugging. Since running programs have complete control over the display format, it is easy to display several labeled numeric values on the display at the same time. User-defined prompts for data entry are also easily programmed. In fact, an executing program can even turn the calculator off.

Error Detection

When a running program encounters an error condition, the calculator displays an English error message. Dividing by 0, for instance, produces the diagnostic "OUT OF RANGE". If you depress the PROG key, the display will show the exact line number and instruction that caused the error. If desired, a flag can be set to ignore errors, or errors can be detected under program control for user-specified recovery.

Besides flags for various error conditions, there are flags that detect whether the data entered is numeric or alphabetic in nature. Since these flags are set only if data is entered, they can be used in conjunction with the PAUSE function to poll the keyboard during program execution to see if a key has been depressed. The PAUSE instruction activates the keyboard for about 1 second, after which normal execution resumes. The data entry flags can be tested to see if any keys were depressed during a pause; if so, the corresponding key indentifications, which are stored in the display register, are available to the program. This feature facilitates the programming of games with real-time user responses.

Let the Music Play

The calculator can produce ten different audible tones under keyboard or program control. I found the volume level of the tones a little too low for my taste; it is barely audible in a noisy office. After successfully programming "Mary Had a Little Lamb," I decided to tabulate which musical notes are actually provided; the results are presented in figure 1. Those with perfect pitch may find the error in the frequencies of the notes a little annoying, but the tones are close enough to produce recognizable music.

Documentation

One of life's little pleasures is reading Hewlett-Packard documentation, which is among the best in the industry. It took me three evenings to finish the entire 268-page HP-41C Owner's Handbook, working each example program as I read. For me, the manual struck just the right balance between simplicity and comprehensiveness. My only complaint is that the text does not always make clear which functions are available on the keyboard and which must be spelled out. For instance, I spent several minutes fruitlessly searching for the multiple-line-delete (DEL) function shown in the example on page 138 as a key, only to conclude that it must be accessed by depressing:

\texttt{XEQ ALPHA DEL ALPHA}

A second manual, HP-41C Standard Applications Handbook, gives ten sample programs ranging from hexadecimal conversions to a blackjack game. These programs detail a wealth of programming techniques including random-number generation, character-string concatenation and substring extraction, display formatting, table lookup, etc. In addition, a year's free membership to Keynotes, the HP calculator newsletter, is included with your purchase.

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<th>HORIZON-2-32K-D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture</td>
<td>Single Board</td>
<td>S100 bus</td>
</tr>
<tr>
<td>CPU</td>
<td>Z80A, 4MHz.</td>
<td>Same</td>
</tr>
<tr>
<td>Dynamic RAM (std)</td>
<td>64 Kb.</td>
<td>32 Kb.</td>
</tr>
<tr>
<td>Disk drive type</td>
<td>Double density</td>
<td>Same</td>
</tr>
<tr>
<td>No. of drives (std/max)</td>
<td>2/4</td>
<td>Same</td>
</tr>
<tr>
<td>Capacity per drive (on-line)</td>
<td>200 Kb.</td>
<td>180 Kb.</td>
</tr>
<tr>
<td>Direct Memory Access (DMA)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>CP/M® disk operating system</td>
<td>Standard</td>
<td>Optional</td>
</tr>
<tr>
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<td>$2,995.</td>
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</tbody>
</table>

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Expansion

One of the most exciting aspects of the HP-41C is the array of available peripheral devices, including:

- a twenty-four-column thermal printer
- an attachable magnetic card reader/writer
- application packs in read-only memory
- continuous-memory expansion modules
- bar-code program reader

Several of these accessories are shown in photo 2. The 82143A battery-powered thermal printer produces 127 characters, including all uppercase and lowercase letters, in either single width (twenty-four characters per line) or double width (twelve characters per line). (See photo 3 for an example of printer output.) In addition, user-defined characters may be defined within a 7 by 7 dot matrix. Simple printer-plots are supported. The printer can also be used to trace program execution during debugging.

The 82104A magnetic card reader is similar to the built-in unit on the HP-67 and HP-97 and is compatible with cards produced on these machines. Up to sixteen registers can be stored on each side of a card; the calculator prompts you to enter as many cards as needed. Programs, data flags, and even key reassignments can also be saved on the cards. For the security-minded, programs can be designated as execute-only, in which case an attempt to display or alter the program will result in the display of the message, "PRIVATE."

Plug-in application packs (useful routines stored in read-only memory modules) are available in disciplines such as aviation, medicine, surveying, finance, stress analysis, etc. Programs in these applications modules can be copied into continuous memory, if desired, for customizing by the user.

For large programs, from one to four 82106A continuous memory modules may be plugged in to extend the built-in memory from the standard 63 to a maximum of 319 registers, in 64-register increments. The extended memory can be partitioned between program and data storage and is continuous, just like the memory supplied with the standard HP-41C.

An accessory just recently made available is a wand that is used to read bar-codes similar to the kind found on most grocery products. This will enable users to load programs directly from HP-41C Solution Books to be published by Hewlett-Packard, which will use bar-code listings of programs to supplement the usual step-by-step keystroke listings. An HP-41C user with a bar-code wand will be able to enter these programs by running the wand across the bar-code listing, eliminating the tedium and error associated with manually entering a program.

The Great Calculator Race

A strong contender for the programmable calculator market is the Texas Instruments TI-59, which sells for less money than the Hewlett-Packard machine and includes a
SOFTWARE COMPATIBLE

- Reads all Level II BASIC tapes
- Reads all SYSTEM tapes
- Full range of peripherals
- Video output for monitor and TV
- Optional FASTLOAD at 8000 baud
- Optional Upper/Lower case

The PMC-80 is a "work-alike" computer to the popular TRS-80* Model I, Level II by Tandy, Radio Shack. The PMC-80 has 16K bytes of RAM and the complete Level II 12K BASIC ROM by Microsoft that makes it 100% software compatible with programs from Radio Shack and from the hundreds of other independent suppliers. The built-in cassette player reads standard Radio Shack programs for the TRS-80.*

The PMC-80 will operate with any of the many peripherals Radio Shack and other independent vendors have invented to plug into the TRS-80.* Most importantly, the Interface Adapter permits Expansion Interfaces with memory expansion to 48K to be added. An Expansion Interface will also permit the addition of Radio Shack compatible 5 1/4" disks and disk operating systems, RS 232, printers, etc.

*TRS-80 is a registered trademark of Tandy, Radio Shack.

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standard magnetic card reader and larger standard memory (960 bytes, as opposed to 441 bytes on a standard HP-41C). (Price information for the Hewlett-Packard machine is given at the end of this article.) Of course, it doesn’t have an alphanumeric display or continuous memory; still, it is an attractive alternative to the HP-41C.

I decided to run a small benchmark test to compare speed and memory usage on both machines. Conducting proper benchmark tests is an involved and time-consuming process. Instead, I settled for one representative test that should be adequate for at least rough comparison. I programmed both the HP-41C and the TI-59 to compute the present value of a bond with “periodic coupons,” as given by the formula:

\[ P = \sum_{j=1}^{N} \frac{(1 + Y)^{N-j} + M}{(1 + Y)^{N-j}} \]

where:

- \( P \) = present value
- \( I \) = coupon value
- \( N \) = number of periods
- \( M \) = maturity value
- \( Y \) = yield rate, in percent

I picked this example because it requires a mix of arithmetic, looping, and register operations; I intuitively felt that this mixture is representative of the operations performed in many of the problems suitable for pocket calculators. I programmed both calculators in the same manner, deliberately trying to avoid “trick” programming but taking advantage of each machine’s strengths where possible (such as short-form addressing on the TI-59 and stack manipulation on the HP-41C).

The programs for the HP-41C and the TI-59 are in listings 1 and 2, respectively. Although I expected the HP-41C to run slower since it uses ultra-low-power technology, both calculators took about the same amount of time to execute the benchmark. The HP-41C program uses less memory space, but of course it has only about half as much memory available in its standard configuration.

Listing 1: HP-41C benchmark program to calculate the present value of a bond with “periodic coupons.” This problem, described in the text, was used as a benchmark program against the Texas Instruments TI-59 because it uses both arithmetic calculations and program looping. The TI-59 benchmark program is given in listing 2, and the results of the comparison are given in table 1.

<table>
<thead>
<tr>
<th>LINE</th>
<th>PROGRAM STEP</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>LBL &quot;BOND&quot;</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>FIX 2</td>
<td>Set dollars and cents format</td>
</tr>
<tr>
<td>03</td>
<td>STO 01</td>
<td>SAVE M in 01</td>
</tr>
<tr>
<td>04</td>
<td>STOP</td>
<td>Input N</td>
</tr>
<tr>
<td>05</td>
<td>STO 02</td>
<td>Save N in reg 02</td>
</tr>
<tr>
<td>06</td>
<td>STOP</td>
<td>Input I</td>
</tr>
<tr>
<td>07</td>
<td>STO 03</td>
<td>Save I in reg 03</td>
</tr>
<tr>
<td>08</td>
<td>STOP</td>
<td>Input Y</td>
</tr>
<tr>
<td>09</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>/</td>
<td>Convert to decimal fraction</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>STO 04</td>
<td>Save ((1 + Y)) in reg 04</td>
</tr>
<tr>
<td>14</td>
<td>RCL 02</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>CHS</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Y \times X</td>
<td>((1 + Y)^{N-j})w</td>
</tr>
<tr>
<td>17</td>
<td>RCL 01</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>*</td>
<td>(M(1 + Y)^{N-j})w</td>
</tr>
<tr>
<td>19</td>
<td>0</td>
<td>Initialize sum to 0</td>
</tr>
<tr>
<td>20</td>
<td>&quot;LBL 01&quot;</td>
<td>Top of summation loop</td>
</tr>
<tr>
<td>21</td>
<td>RCL 04</td>
<td>((1 + Y))</td>
</tr>
<tr>
<td>22</td>
<td>RCL 02</td>
<td>I</td>
</tr>
<tr>
<td>23</td>
<td>CHS</td>
<td>J</td>
</tr>
<tr>
<td>24</td>
<td>Y \times X</td>
<td>((1 + Y)^{N-j})</td>
</tr>
<tr>
<td>25</td>
<td>+</td>
<td>New summation</td>
</tr>
<tr>
<td>26</td>
<td>DSE 02</td>
<td>J = J - 1...</td>
</tr>
<tr>
<td>27</td>
<td>GTO 01</td>
<td>...Until J = 0</td>
</tr>
<tr>
<td>28</td>
<td>RCL 03</td>
<td>Then recall I</td>
</tr>
<tr>
<td>29</td>
<td>*</td>
<td>Times summation</td>
</tr>
<tr>
<td>30</td>
<td>+</td>
<td>Plus second term = result, P</td>
</tr>
<tr>
<td>31</td>
<td>END</td>
<td></td>
</tr>
</tbody>
</table>

**REFERENCES**

- RS201 TRS-80 Monitor and Drive ..................................... 109
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**LINE PROGRAM STEPS**

<table>
<thead>
<tr>
<th>REGISTERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1, M, maturity value</td>
</tr>
<tr>
<td>R2, N, number of periods</td>
</tr>
<tr>
<td>R3, I, coupon value</td>
</tr>
<tr>
<td>R4, (1 + Y), where Y is yield rate as decimal fraction</td>
</tr>
</tbody>
</table>

**COMMENTS**

- Set dollars and cents format
- Save M in 01
- Input N
- Save N in reg 02
- Input I
- Save I in reg 03
- Convert to decimal fraction
- Initialize sum to 0
- Top of summation loop
- \((1 + Y)\)
- \(I\)
- \(J\)
- \((1 + Y)^{N-j}\)
- \(M(1 + Y)^{N-j}\)
- J = J - 1...
- ...Until J = 0
- Then recall I
- Times summation
- Plus second term = result, P
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Listing 2: Texas Instruments TI-59 benchmark program to calculate the present value of a bond with "periodic coupons.

The results of the comparison with the HP-41C are given in table 1.

REGISTERS

- \( R_1 \): Maturity value
- \( R_2 \): N, number of periods, and J, loop index
- \( R_3 \): I, coupon value
- \( R_4 \): \( 1 + Y \), where \( Y \) is yield rate as decimal fraction
- \( R_5 \): Scratch register for summation

A subjective conclusion I drew after programming both calculators is that the HP-41C is much easier to program and debug because of its line-oriented, mnemonic display. The results of this comparison are given in table 1.

Sample Program: Codebreaker

Because I am a games enthusiast, I decided to write a game program as an example of an HP-41C program. I programmed a variation of the popular "codebreaker" type games, where the calculator generates a random code and the player attempts to guess the code. The flowchart for this program is given in figure 2.

To begin, the player first decides on the number of digits for the code, from three to five digits. Assume that a three-digit game is chosen. The calculator will then secretly pick a three-digit number with no two digits the same. The user then enters a three-digit guess.

After evaluating the guess, the calculator displays the number of digits that are exactly right and the number of digits that exist in the true code but are not in the proper position. For example, if the secret code is 108 and 802 is the guess, the display will show:

802 RT:1 MP:1

indicating one entirely right (RT) digit (the 0) and one misplaced (MP) digit (the 8).

The user continues guessing until the correct answer is found. Text continued on page 258

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>KEY ENTRY</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>000 76</td>
<td>LBL A</td>
<td>Set dollars and cents format</td>
</tr>
<tr>
<td>001 11</td>
<td>FIX</td>
<td></td>
</tr>
<tr>
<td>002 58</td>
<td>STO R2</td>
<td>Save M in reg 01</td>
</tr>
<tr>
<td>006 91</td>
<td>R/S</td>
<td>Input N</td>
</tr>
<tr>
<td>007 42</td>
<td>STO R2</td>
<td>Save N in reg 02</td>
</tr>
<tr>
<td>009 91</td>
<td>R/S</td>
<td>Input I</td>
</tr>
<tr>
<td>010 42</td>
<td>STO R1</td>
<td>Save 1 in reg 03</td>
</tr>
<tr>
<td>012 91</td>
<td>R/S</td>
<td>Convert to decimal fraction</td>
</tr>
<tr>
<td>016 00</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>017 85</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>018 01</td>
<td>=</td>
<td></td>
</tr>
<tr>
<td>019 95</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>020 42</td>
<td>STO R1</td>
<td>Save ((1 + \frac{Y}{100})^t) in reg 04</td>
</tr>
<tr>
<td>021 04</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>022 45</td>
<td>RCL</td>
<td></td>
</tr>
<tr>
<td>023 43</td>
<td>+/-</td>
<td></td>
</tr>
<tr>
<td>025 94</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>026 65</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>027 43</td>
<td>RCL</td>
<td></td>
</tr>
<tr>
<td>028 01</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>029 95</td>
<td>=</td>
<td></td>
</tr>
<tr>
<td>030 42</td>
<td>STO R2</td>
<td>Save (M^*(1 + \frac{Y}{100})^t)</td>
</tr>
<tr>
<td>031 05</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>032 25</td>
<td>CLR</td>
<td></td>
</tr>
<tr>
<td>033 42</td>
<td>STO R1</td>
<td></td>
</tr>
<tr>
<td>034 06</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>035 76</td>
<td>LBL</td>
<td></td>
</tr>
<tr>
<td>036 44</td>
<td>SUM</td>
<td>Top of summation loop</td>
</tr>
<tr>
<td>037 43</td>
<td>RCL</td>
<td></td>
</tr>
<tr>
<td>038 04</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>039 45</td>
<td>Y^t</td>
<td>New summation</td>
</tr>
<tr>
<td>040 43</td>
<td>RCL</td>
<td></td>
</tr>
<tr>
<td>041 02</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>042 94</td>
<td>+/-</td>
<td></td>
</tr>
<tr>
<td>043 95</td>
<td>=</td>
<td></td>
</tr>
<tr>
<td>044 44</td>
<td>SUM</td>
<td>Times summation</td>
</tr>
<tr>
<td>045 06</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>046 97</td>
<td>DSZ</td>
<td></td>
</tr>
<tr>
<td>047 02</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>048 44</td>
<td>SUM</td>
<td>Until (J = 1)</td>
</tr>
<tr>
<td>049 43</td>
<td>RCL</td>
<td></td>
</tr>
<tr>
<td>050 03</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>051 49</td>
<td>PRD</td>
<td></td>
</tr>
<tr>
<td>052 06</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>053 43</td>
<td>RCL</td>
<td>2nd term</td>
</tr>
<tr>
<td>054 05</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>055 85</td>
<td>+</td>
<td></td>
</tr>
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<table>
<thead>
<tr>
<th>TI-59</th>
<th>HP-41C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of data registers used</td>
<td>5</td>
</tr>
<tr>
<td>Program size (as displayed)</td>
<td>59 lines</td>
</tr>
<tr>
<td>Program size (internal representation)</td>
<td>59 steps</td>
</tr>
<tr>
<td>Total memory used/total memory</td>
<td>99/960</td>
</tr>
<tr>
<td>Percentage of total memory used</td>
<td>10.3</td>
</tr>
<tr>
<td>Execution time, seconds</td>
<td>43</td>
</tr>
</tbody>
</table>

Benchmark equation programmed:

\[ P = \sum_{j=1}^{N} \left(1 + \frac{Y}{100}\right)^j + M(1 + \frac{Y}{100})^t \]

Data used:

- \( M = 20,000 \), \( N = 50 \), \( I = 1400 \), \( Y = 8\% \)
- Answer: \( P = 17,533.30 \)

Table 1: Results of the HP-41C/TI-59 benchmark. The programs of listings 1 and 2 are the basis of the data given above. The difference between the two program-size figures for the HP-41C is due to the fact that it combines several program steps into an assembly-language-like instruction when displaying it. The figures in parentheses refer to the HP-41C filled with its maximum amount of memory; the figures just before them refer to the HP-41C as purchased.
Figure 2: Flowchart for the HP-41C Codebreaker game. Listing 3 gives the HP-41C keystrokes for the equivalent program.
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<thead>
<tr>
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<th>OUR PRICE</th>
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</thead>
<tbody>
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<td>289 MICROCOMPUTER SYSTEM</td>
<td>$2,995</td>
</tr>
<tr>
<td>48KB Memory</td>
<td></td>
</tr>
<tr>
<td>219 Video Terminal (24 x 80)</td>
<td></td>
</tr>
<tr>
<td>2 Serial EIA ports</td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>$950</td>
<td>$795</td>
</tr>
</tbody>
</table>

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Photo 3: Sample thermal printer output. The 82143A peripheral printer is capable of printing both uppercase and lowercase letters, as well as numbers, symbols, and user-defined special characters, all in two print densities. The printer can also be used for program tracing or equation plotting. (Print sample courtesy of Hewlett-Packard.)

Text continued from page 254:

obtained; the number of guesses made is then displayed and the game is over. Since the game displays results from only the most recent guess, pencil and paper are good accessories for keeping track of previous guesses and results.

Examining the Program

Several interesting capabilities of the HP-41C are explored in this program (see listing 3). Line 02 places a text string into the alphanumeric display register, which holds from zero to twenty-four characters. Line 03 causes the register's prompting message to be displayed and halts for user input. Lines 04 thru 11 validate the user input and save the desired number of digits, P, in register 00.

Lines 12 and 13 initialize the display format as integer only with no decimal point displayed. Lines 14 thru 16 tell the player how many random digits will be picked. Line 17 is a call to subroutine RDIG, which returns a random digit, 0 to 9; I used the random-number generator described in the HP-41C Standard Applications Handbook.

Text continued on page 262
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Listing 3: HP-41C Codebreaker game program. This program chooses a random 3- to 5-digit number with nonrepeating digits and gives the player clues about the code, based on the player's guesses. This listing uses the same conventions as listing 1.

REGISTERS
- \( R_0 \): Number of digits (positions) to play, \( P, 3 \leq P \leq 5 \)
- \( R_1 \): First digit of actual code number
- \( R_2 \): Second digit of actual code number
- \( R_3 \): Third digit of actual code number
- \( R_4 \): Optional fourth digit of actual code number
- \( R_5 \): Optional fifth digit of actual code number
- \( R_6 \): Current user guess, normalized to 0..dddd format
- \( R_7 \): Scratch for indirect register access, loop control
- \( R_8 \): Number of exactly right (RT) digits in current user guess
- \( R_9 \): Number of misplaced (MP) digits in current user guess
- \( R_{10} \): Seed for random number generator
- \( R_{11} \): Count of number of guesses made by user
- \( R_{12} \): Scratch for loop control

LINE PROGRAM STEPS

<table>
<thead>
<tr>
<th>LINE</th>
<th>PROGRAM</th>
<th>STEP</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>LBL &quot;MM&quot;</td>
<td></td>
<td>Program name</td>
</tr>
<tr>
<td>02</td>
<td>&quot;NO. DIGITS?&quot;</td>
<td></td>
<td>Prompt user to enter no. of digits, 3 to 5</td>
</tr>
<tr>
<td>03</td>
<td>PROMPT</td>
<td></td>
<td>Get digit from user's guess</td>
</tr>
<tr>
<td>04</td>
<td>STO 00</td>
<td></td>
<td>Save P places requested</td>
</tr>
<tr>
<td>05</td>
<td>3</td>
<td></td>
<td>Init count of guesses made</td>
</tr>
<tr>
<td>06</td>
<td>X&gt;Y?</td>
<td></td>
<td>If number right = ( P )...</td>
</tr>
<tr>
<td>07</td>
<td>STO &quot;MM&quot;</td>
<td></td>
<td>If less than 3 places, re-prompt</td>
</tr>
<tr>
<td>08</td>
<td>RDN</td>
<td></td>
<td>Show no fractional part in display</td>
</tr>
<tr>
<td>09</td>
<td>5</td>
<td></td>
<td>Show correct guess</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td></td>
<td>Discard fraction</td>
</tr>
<tr>
<td>11</td>
<td>GTO &quot;MM&quot;</td>
<td></td>
<td>If P greater than 5, re-prompt</td>
</tr>
<tr>
<td>12</td>
<td>FIX 0</td>
<td></td>
<td>Show no fractional part in display</td>
</tr>
<tr>
<td>13</td>
<td>CF 29</td>
<td></td>
<td>Shift out next digit</td>
</tr>
<tr>
<td>14</td>
<td>&quot;T M PICKING &quot;</td>
<td></td>
<td>Repeat for all P digits</td>
</tr>
<tr>
<td>15</td>
<td>LBL 00</td>
<td></td>
<td>Loop control</td>
</tr>
<tr>
<td>16</td>
<td>AVIEW</td>
<td></td>
<td>Tell user how many random digits</td>
</tr>
<tr>
<td>17</td>
<td>XEQ &quot;RDIG&quot;</td>
<td></td>
<td>Get candidate random digit, 0 to 9</td>
</tr>
<tr>
<td>18</td>
<td>RCL 00</td>
<td></td>
<td>Recall no. of places, ( P, 3 \to 5 )</td>
</tr>
<tr>
<td>19</td>
<td>1000</td>
<td></td>
<td>Enter/</td>
</tr>
<tr>
<td>20</td>
<td>/</td>
<td></td>
<td>Save on stack</td>
</tr>
<tr>
<td>21</td>
<td>1</td>
<td></td>
<td>If same, increment &quot;misplaced&quot; count</td>
</tr>
<tr>
<td>22</td>
<td>+</td>
<td></td>
<td>Correct &quot;misplaced&quot; count is (MP - RT)</td>
</tr>
<tr>
<td>23</td>
<td>STO 07</td>
<td></td>
<td>Store new digit in array</td>
</tr>
<tr>
<td>24</td>
<td>LBL 01</td>
<td></td>
<td>Show guess in display</td>
</tr>
<tr>
<td>25</td>
<td>RDN</td>
<td></td>
<td>Show no. of digits exactly right, ( RT )</td>
</tr>
<tr>
<td>26</td>
<td>STO IND 07</td>
<td></td>
<td>Also show number &quot;misplaced,&quot; MP</td>
</tr>
<tr>
<td>27</td>
<td>LBL 02</td>
<td></td>
<td>Go get new guess</td>
</tr>
<tr>
<td>28</td>
<td>XEQ &quot;RDIG&quot;</td>
<td></td>
<td>Come here on end-of-game only</td>
</tr>
<tr>
<td>29</td>
<td>RCL 07</td>
<td></td>
<td>Show correct guess</td>
</tr>
<tr>
<td>30</td>
<td>INT</td>
<td></td>
<td>Show count of guesses used</td>
</tr>
<tr>
<td>31</td>
<td>STO 08</td>
<td></td>
<td>Ring the bell to celebrate</td>
</tr>
<tr>
<td>32</td>
<td>LBL 03</td>
<td></td>
<td>End program.</td>
</tr>
<tr>
<td>33</td>
<td>RDN</td>
<td></td>
<td>Subroutine to display guess</td>
</tr>
<tr>
<td>34</td>
<td>STO IND 08</td>
<td></td>
<td>Recall P</td>
</tr>
<tr>
<td>35</td>
<td>X=Y?</td>
<td></td>
<td>Number of digits to display</td>
</tr>
<tr>
<td>36</td>
<td>GTO 02</td>
<td></td>
<td>Recall normalized guess, 0..dddd</td>
</tr>
<tr>
<td>37</td>
<td>SHEEP</td>
<td></td>
<td>Shift out next digit</td>
</tr>
<tr>
<td>38</td>
<td>DSE 08</td>
<td></td>
<td>Save on stack</td>
</tr>
<tr>
<td>39</td>
<td>GTO 03</td>
<td></td>
<td>Discard fraction</td>
</tr>
<tr>
<td>40</td>
<td>GTO 01</td>
<td></td>
<td>Get units place only, 0 to 9</td>
</tr>
<tr>
<td>41</td>
<td>RND</td>
<td></td>
<td>Display digit</td>
</tr>
<tr>
<td>42</td>
<td>GTO 12</td>
<td></td>
<td>Listing 3 continued on page 262</td>
</tr>
<tr>
<td>43</td>
<td>&quot;GUESS?&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>LBL 04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>PROMPT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>RCL 00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>Y&lt;Y?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>STO 04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>&quot;GUESS?&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>/</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Save guess in format 0..dddd |
Initialize count of "right" digits |
Initialize count of "misplaced" digits |
Increment guess counter |
P |
Actual code digit |
Get digit from user's guess |
Compare corresponding actual digit |
If match, increment right count |
Repeat for all P digits |
If number right = \( P \)...
...exit, game over |
Else set up for "misplaced" counting |
P |
Set up inner loop count |
Get digit from user guess |
If same, increment "misplaced" count |
Repeat for P positions, inner loop |
Repeat for P positions, outer loop |
Correct "misplaced" count is (MP - RT) |
Show guess in display |
Show no. of digits exactly right, \( RT \) |
Also show number "misplaced," MP |
Go get new guess |
Come here on end-of-game only |
Show correct guess |
Show count of guesses used |
Ring the bell to celebrate |
End program. |
Subroutine to display guess |
Recall P |
Number of digits to display |
Recall normalized guess, 0..dddd |
Shift out next digit |
Save on stack |
Discard fraction |
Get units place only, 0 to 9 |
Display digit |
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Listing 3 continued:

121 BDN Recall shifted guess
122 DSE 06 Repeat till all P digits displayed
123 GTO 12
124 RTN Return from subroutine
125 LBL “GDIG” Subroutine to return I digit of guess
126 RCL 06
127 I 0 Register 07 = desired position in guess
128 RCL 07
129 Y/X Return from subroutine, digit on top of stack
130 *
131 INT
132 10
133 MOD
134 RTN Return from subroutine
135 LBL “RDIG” Come here to get random digit, 0 to 9
136 RCL 11 Seed
137 9821
138 *
139 .211327
140 + New random seed, 0 to 1
141 FRC New random number
142 STO 11
143 10
144 *
145 INT
146 RTN Return from subroutine, digit on top of stack
147 END

Text continued from page 258:

The most interesting part of the program is contained in lines 18 thru 40, which consist of two nested loops for selecting P random digits with no two digits the same. Lines 18 thru 23 initialize the outer loop control parameters in register 07. For example, if three digits are desired, register 07 will be initialized to 1.003. The end of

the loop is on lines 39 and 40, with line 39 incrementing register 07 until it reaches 3.

Register 07 is used inside the loop as the subscript for an array of size P in registers 01 thru P, each to contain one digit of the code number. An inner loop, controlled by register 08, compares all previously selected digits to the new candidate digit, and rejects any duplications. The logic of this code selection segment of the program can be illustrated by its BASIC equivalent:

```
10 DEF FNR = INT(RND*10)
20 D = FNR
30 FOR I = 1 TO P
40 N(I) = D
50 D = FNR
60 NEXT J
70 NEXT I
```

After the code is selected, the user's guess is entered. Each user guess is stored in register 06 in a normalized format obtained by dividing the guess by 10. For example, a guess of 012 would be stored as .012 in a three-digit game; a guess of 30987 would be stored as .30987 in a five-digit game. This format is used so that function GDIG (line 125) can extract the Ith digit, D, from the guess, G, by calculating D = MOD (INT (G * 10^I)).

The balance of the program is fairly straightforward. Lines 94 thru 98 illustrate how to simultaneously display five individual numbers and two alphanumeric character strings. Note that subroutine SHOG (line 108) displays each digit of user's guess individually; otherwise, a guess with a leading zero would not show the zero because of the automatic leading-zero suppression of the calculator.

**Conclusion**

I found the HP-41C far more pleasurable to program and use than its predecessors, primarily because of the alphanumeric display capabilities. The list prices of the HP-41C and its accessories are as follows:

- HP-41C programmable calculator (with 63-register memory) $295
- 82106A 64-register Memory Module $45
- Application Pacs, each $45 to 70
- 82143A Peripheral Printer $350
- 82104A Plug-in Card Reader $195
- 82153A Wand $125
- HP-41C Solution Books $12.50
- 82045A Thermal Paper (box of six rolls) $6
- 82120A Rechargeable Battery Pack $40

I am able to find discounts of about 15% off the list price in my area. Larger discounts can be expected with the passage of time. The HP-41C is manufactured by Hewlett-Packard Co, Corvallis Division, 1000 NE Circle Blvd, Corvallis OR 97330.

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BYTE December 1980 263
Microsoft Adventure
Bob Liddil, POB 66, Peterborough NH 03458

For there are treasures to be found
As mysteries unfold
In the depths of the great unknown
In the search for yellow gold.
But beware the shadows,
For who knows what they hold
In the great Colossal Cave?
From "Adventure's Song"
—Frerover the Bard

Of all the computer simulations available for the microcomputer user, none stirs the imagination quite like Adventure. And of all the Adventure games Microsoft's is one of the most intriguing.

The premise of this Adventure, exploration of the Colossal Cave, is not a new one. It is, in fact, the basis for the original Adventure that has been appearing around university campuses and mainframe computers for years. According to Microsoft, the Digital Equipment Corporation PDP-10 version is reproduced faithfully for the TRS-80 with 32 K bytes of programmable memory and a single disk drive.

[Editor's note: I had the good fortune to log onto a Digital Equipment Corporation PDP-11/70 that was running the original Adventure. This version credited Willie Crowther with the original version of the program and Don Woods with "most of the features of the current version." Although the Softwin Company is credited with writing the Microsoft Adventure, the names of Willie Crowther and Don Woods should be added to the list. Short sessions with both the Microsoft and the PDP-11 versions of the Adventure showed them to be virtually identical in content, program logic, and wording. Mr. Letwin has added some features (explained below) and has made slight format changes that make the version more playable...GW]

The Microsoft Adventure sets itself against the de facto norm later established by Scott Adams. The split screen, the blinking cursor, all the slick niceties of the Adams and similar Adventures are missing. That does not detract from the game, though, because they are replaced by technical innovations that make game play easy and painless.

The Adventure's acceptance of shorthand commands is a joy. Instead of tediously typing GO HOUSE or GET KNIFE, one need only type HOUSE or KNIFE. The computer understands and complies. The directional shorthand commands, N, S, E, W, U, and D (for the four compass points and the directions UP and DOWN), are convenient. Adventurers will be very comfortable with the ease with which this program functions.

Adventurers in the Colossal Cave will come across situations they may recognize from other Adventures. This is acceptable. It gives a player a sense of comfort and familiarity in an otherwise hostile environment.

Most of the descriptions used for locations and objects are stored on the floppy disk and called only when needed. This arrangement prevents the descriptions from being terse as a result of limited program space. These plush and vivid descriptions add much to the enjoyment of the game. The puzzle of this Adventure, while difficult to

---

At a Glance

<table>
<thead>
<tr>
<th>Name</th>
<th>Language</th>
<th>Computer</th>
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<tr>
<td>Microsoft Adventure</td>
<td>Machine language</td>
<td>Radio Shack TRS-80</td>
</tr>
<tr>
<td>Type</td>
<td></td>
<td>Model I with single disk</td>
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<td></td>
<td></td>
<td>drive and 32 K bytes of</td>
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<td></td>
<td></td>
<td>memory (also available for</td>
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<td>Apple II with one disk drive</td>
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<td>and 32 K bytes of memory;</td>
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<td>same price)</td>
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<td>$29.95</td>
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<td>Format</td>
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<td>5-inch floppy disk</td>
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Audience General audience
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decipher fully in one or even a half dozen sittings, is not impossible. It is well laid out, challenging, and presented logically. It is solvable, given time.

There are monsters lurking in the shadows. There is, in the first level of the cave, a knife-wielding dwarf who attacks repeatedly at nearly every turn. I suspected for a while that there was a dwarf-creating machine somewhere far below me in the depths of the cave, turning out rubber-stamp dwarves that stood in line to try to kill me. As fast as I dispatched one, another popped up to take his place.

Just out of plain view, a mystery figure beckons to me in the dim light. In trying to reach this spectre, to find out why he/she/it is there, I got lost in a maze of crisscross tunnels, not once but five times.

The nonplayer characters are not the only barrier to your progress as an adventurer. The cave is the adventurer's worst enemy. Its passages twist and turn, creating the kind of terminal (sic) frustration that has made this *Adventure* a favorite of thousands of personal-computer users.

The game is divided into three skill levels consisting of the beginning, intermediate, and advanced caves. The intensity of play increases by level so that, by the time the *Adventure* program offers a Grandmaster game to a player, the player has survived virtually every fantasy situation conceivable. The Grandmaster level is attainable only after every other puzzle is solved and all treasures have been obtained. Few Grandmasters exist. It is a goal worth working toward.

The Microsoft *Adventure* is a gold mine for the enthusiast and a nightmare for the software pirate. (After all, you would expect Microsoft to actively protect its product.) I was unable to copy the Microsoft *Adventure* disk, even with the help of several disk inspection/modification programs.

The Microsoft *Adventure* is attractively packaged and well documented. The buyer should have no trouble finding it on the pegboard of his local computer store. It is worth the price being charged. The *Adventure* lover is in for many hours of pure enjoyment with this one.

**Conclusions**

• This is an interesting *Adventure* in many ways. First, it is the original *Adventure* that was first running on a PDP-10. It is also one of the most sophisticated *Adventure* games I have seen. Since it is written in machine language, it is faster than the *Adventures* that are written in BASIC. It draws its descriptions from the floppy disk; therefore it is a fuller *Adventure* than most other *Adventures*, which offer limited description as a result of storing the text with the program and are limited by the amount of memory in the computer.

• This *Adventure* has a different format from that of other microcomputer *Adventures*. This should not be construed as a shortcoming; I mention it only for the benefit of *Adventure* enthusiasts accustomed to the other, more recent format.

• Microsoft *Adventure* is actually a series of *Adventures* that reveal themselves as the player becomes more skillful. It can be enjoyed by both the novice and the experienced player. The ability to save the game on disk allows a player to take advantage of deeper levels of play without being confined to one sitting.
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783 NORTH WATER STREET  MILWAUKEE WISCONSIN 53202  414 289 9988
Lost Dutchman's Gold

Bob Liddil
The Programmer's Guild
POB 66
Peterborough NH 03458

Teri Li
POB 481
Peterborough NH 03458

Lost Dutchman's Gold is an Adventure game that takes place in the Old West at the turn of the century. The object of the game is to find the gold (and other treasures) hidden in the Lost Dutchman's Mine and successfully find your way out. The Adventure starts in an abandoned miner's shack where you'll find a rifle and a shovel. If you can find it, there is also a map of the mine hidden somewhere to help you on your Adventure.

This program (see listing 1) is written in Applesoft BASIC and requires 24 K bytes of memory and one disk drive. It will also run on nondisk Apples if the commands related to saving a game to disk are deleted. With some modifications, this Adventure game should run on other microcomputers that use Microsoft BASIC.

Unfortunately, the disk commands in this program contain invisible control-D characters at the beginning of some lines. (It is the control-D character that signals the beginning of a disk command within a PRINT statement.) All PRINT statements that begin with the words OPEN, CLOSE, READ, WRITE, VERIFY, and NOMON should have as their first character the invisible control-D character. To the best of my knowledge, the lines that need this character are lines 36, 85, 95, 2353, 2550, 4000, and 4100. We regret this inconvenience to our readers....GWJ

Listing 1: Lost Dutchman's Gold. Written in Applesoft BASIC, it requires 16 K bytes of programmable memory.

10 POKE 34,0: POKE 35,24: TEXT : HOME
20 VTAB 5: PRINT " WELCOME TO THE SEARCH FOR THE LOST DUTCHMAN'S GOLD. I'M THE GHOST OF BACK-PACK SAM, YOUR GUIDE ON THIS ADVENTURE.
YA CAN USE 2 WORD COMMANDS TO FIND CLUES 'N MOVE 'BOUT. GET, GO, PUT, DROP,
30 PRINT "SCORE, INVENTORY 'N 'B OUT 100 MORE WORDSMAKE SENSE TA ME. ASK FOR HELP IF YA GET STUMPED."
40 PRINT "I HOPE YA DON'T END UP A GHOST, LIKE ME!"
50 PRINT "GOOD LUCK!!"
35 REM WORLD COPYRIGHT (C) 1980 BY TERI LI. ALL RIGHTS RESERVED.
36 DIM NS(26,7),OS$(32,3),RS(46):
   B = 0:IN = B:LN = 50:LM = LN
   X1 = B:X2 = B:TS$ = "":M1$ = T$:M2$ = T$:QM$ = T$:U = B:U
   L = B:IM = 2:BD = 21:L = 1:C
   S = CHR$(11): PRINT "NOMON I,0,C
   40 FOR L = B TO 26: FOR I = B TO 7: READ NS$(L,I): NEXT I,L
   50 FOR I = B TO 32: READ OS$(I,0),OS$(I,1),OS$(I,2):OS$(I,3) = "": NEXT
   60 FOR I = B TO 46: READ RS$(I): NEXT
   70 PRINT "HIT SPACE' TO START."
   : GET QM$:L = 1: INPUT "REST OLD GAME?";QM$: IF LEFT$(QM$ + "",1) < > "Y" THEN 100
   80 INPUT "NAME?";QM$:QM$ = "LDG/"
   : QM$: ONERR GOTO 4000
   85 PRINT "VERIFY";QM$: PRINT "OPEN EN";QM$: PRINT "READ QMS"
   90 INPUT L,CL,IN,LM,UL,IM
   91 FOR X = 0 TO 32: INPUT OS$(X,1),OS$(X,2),OS$(X,3): NEXT
   95 PRINT "CLOSE";QM$: POKE 216,0
   100 IF ((OS$(12,2) = STR$(L) OR
      O$(12,3) = "1") AND CL > 0) OR
      L < 15 THEN 150
   102 POKE 34,0: POKE 35,23: HOME
   : PRINT "IT'S TOO DARK TA SEE E!!"; IF L = 15 AND OS$(6,3)
The entire EasyWriter family of office communication products is available through your local computer store or directly from our office in Berkeley, Ca.

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Circle 183 on inquiry card.
Listing 1 continued:

```
< "1" AND OS(4,3) < > " \\
 1" THEN PRINT "YA HEAR A ST \\
 RANGE NOISE ! \\
110 POKE 35,24: GOTO 350 \\
120 T$ = "OK": RETURN \\
140 B = 1: PRINT : PRINT "YA SEE \\
: "; RETURN \\
150 IF CL = 1 THEN LN = LN - 1: IF \\
LN < 1 THEN CL = 0 \\
160 I = PRE(0): L1 = L \\
170 B = 0: POKE 35,BD: POKE 34,0: \\
VTAB 1: HOME: POKE 35,24: PRINT \\
"YER "$S(L,0)"": FOR J = 0 TO \\
32: IF VAL($S(J,2)) < > L \\
THEN 240 \\
175 IF B = 0 THEN GOSUB 140 \\
180 IF OS(J,3) = "-7" OR OS(J,3) \\
= "-2" THEN PRINT "BURN " \\
; \\
190 IF J < > 1 OR VAL ($S(1,2)) \\
< > L THEN 200 \\
193 IF OS(1,3) = "" THEN PRINT \\
"UNITED ": GOTO 200 \\
196 IF OS(1,3) = "-9" THEN PRINT \\
"DEAD "; \\
200 IF OS(J,3) = "-3" THEN PRINT \\
"SMASHED "; \\
210 IF L < > 26 OR J < > 32 THEN \\
220 \\
213 IF UL = 1 AND L1 = 12 THEN PRINT \\
" ; \\
216 PRINT "LOCKED "; \\
220 IF CL = 1 AND J = 12 THEN PRINT \\
"LIT "; \\
230 PRINT $S(J,0)"." \\
240 NEXT J \\
250 IF U1 = 1 AND L = 1 THEN PRINT \\
"OPEN TRAP DOOR. "; \\
260 IF $S(L,1) = "" THEN PRINT \\
: GOTO 330 \\
265 IF B = 0 THEN GOSUB 140 \\
270 IF L < > 16 THEN 280 \\
273 IF U < > 0 THEN PRINT "UN" \\
; \\
276 PRINT "LOCKED ";: GOTO 290 \\
280 IF L < > 17 THEN 290 \\
283 IF U = 1 THEN PRINT "UNLOCK \\
ED ":: GOTO 290 \\
286 PRINT "BLOCKED "; \\
290 PRINT $S(L,1)". \\
310 IF L = 17 AND U = 0 THEN $S( \\
L,2) = " " + RIGHT($S(L,2) \\
),2) \\
320 IF L = 16 AND U = 1 THEN $S( \\
L,2) = "E" + RIGHT($S(L,2) \\
),2) \\
330 CALL - 868: PRINT : IF $S(L,2) \\
= "" THEN PRINT "NORTH "; \\
336 IF $S = "S" THEN PRINT "SOUTH "; \\
337 IF $S = "E" THEN PRINT "EAST "; \\
338 IF $S = "W" THEN PRINT "WEST "; \\
340 NEXT : CALL - 868: PRINT \\
350 B = 0: PRINT "---------------------------------

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370 IF L = 9 AND OS(22,2) = "" THEN \\
OS(22,2) = "11" \\
390 INPUT "--NOW WHAT?"; QMS \\
410 IF LN < 10 AND CL = 1 THEN PRINT \\
"YER RUNNIN' L长城 ON KEROSENE \\
415 IF QMS = "SAVE" OR QMS = "SAVE GAME" THEN 2520 \\
420 IF QMS < "SCORE" THEN 450 \\
423 IF L < > 6 THEN T$ = "YA GET \\
T NOTHIN' FOR BEIN' HERE!": GOTO \\
1900 \\
426 Z = 0: FOR I = 14 TO 17: IF O \\
$S(I,2) = "6" THEN Z = Z + 1 \\
430 NEXT \\
440 PRINT "YA GOT "Z" TREASURES, \\
TOTAL "(Z / 4) * 100\%%": IF \\
Z = 4 THEN PRINT "YA MADE IT!!!": GOTO 2220 \\
445 T$ = "YA MISSED SUM TREASURE! \\
": GOTO 1900 \\
450 IF CL = 0 AND L = 15 AND $S( \\
6,3) < > "1" THEN PRINT "Y E GAD!": PRINT "YA BEEN BIT \\
BY A RATTLE": PRINT "YER D \\
EAD ": GOTO 2220 \\
460 IF L = 17 AND U = 1 AND RND \\
(1) * 9 + 1 < 2 THEN PRINT 

270 December 1980 © BYTE Publications Inc Circle 184 on inquiry card.
"$[+].#&@ CAVE IN ! ! / : +!
% ] #&@ CAVE I
! ! / : +
*@ " : 

PRINT "THE IRO DOOR'S BLOC
KEO,": PRINT "YER TRAPPED!!"

 := 0
IF QMS = "HELP" THEN X = VAL
(N$(L,3)): ON X GO SUB 2300,2
310,2320,2330,2350,2370,2380
,2390: GOTO 100
480 IF QMS = "HELP" THEN X = VAL
(N$(L,3)): ON X GO SUB 2300,2
310,2320,2330,2350,2370,2380
,2390: GOTO 100
490 XI = LEN (QMS): IF XI < 3 THEN
T$ = "WHAT?": GOTO 1900
493 X3 = 0: FOR X2 = 3 TO XI : M1$ =
MID$ (QMS,X2,1): IF M1$ = ""
THEn X3 = X2:X2 = XI
495 NEXT X2:X2 = X3: IF X3 = 0 THEN
X2 = XI
500 P$ = LEFT$ (QMS,3): IF X2 <
> X1 AND X2 + 3 > X1 THEN 6
10
501 II = -1: FOR I = 0 TO 42: IF
P$ = RS(I) THEN II = I
502 NEXT : IF II > -1 THEN I =
II: GOTO 520
510 IF XI = X2 THEN T$ = "WHAT?"
: GOTO 1900
511 T$ = "SORRY, BUT YA CAN'T":" +
LEFT$ (QMS,X2): IF X2 < XI THEN
T$ = T$ + RIGHT$ (QMS,X1 -
X2)
512 T$ = T$ + ".": GOTO 1900
520 IF I < 8 AND X1 = X2 THEN ON
I + 1 GO SUB 2010,2010,2010,2
1900
540 JJ = -1:M1$ = MID$ (QMS,X2
+1,3): FOR J = 0 TO 32: IF

M1$ = LEFT$ (O$(J,0),3) THEN
JJ = J
542 NEXT :J = JJ: IF JJ > -1 THEN
630
543 IF M1$ = "IRO" THEN 580
545 IF I = 36 THEN 940
550 IF N$(L,1) = "" THEN 560
552 X = 1:A = 2:XI = LEN (N$(L,1)
): FOR X2 = 5 TO XI: IF M1$ =
(N$(L,1),X2,1) < > CHR$ (4
6) THEN X2 < > XI THEN NEXT
: GOTO 560
553 M2$ = MID$ (N$(L,1),2,3): IF
M2$ = M1$ THEN 556
554 X2 = X2 + 2:A = A + 1: NEXT : GOTO
560
556 X2 = XI: NEXT :B = A: IF I =
10 THEN PRINT "YA SEE NOTHI
N' SPECIAL." : GOTO 160
557 GOTO 630
560 FOR X = 43 TO 46: IF M1$ = R
$X) THEN X = 46: NEXT : GOTO
650
565 NEXT
570 IF O$(4,3) = "1" OR O$(6,3) =
"1" THEN IF I = 23 AND M1$ =
"SEL" THEN PRINT "OK": PRINT
"YER DEAD." : GOTO 2220
580 IF I = 32 THEN GO SUB 780: GOTO
1900
590 IF I = 33 THEN GO SUB 860: GOTO
1900
600 T$ = "I CAN'T TELL WACHA WANT
.": GOTO 1900
Listing 1 continued on page 272

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Listing 1 continued:

610 $S = "I MUST BE DUMB, YA DON' T MAKE SENSE.": GOTO 1900
630 IF I < 9 THEN 650
633 IF J < 33 AND J > = -1 THEN
B = VAL (0$(J,2))\nIF B < > L AND B > 0 THEN 1890
636 IF J > 32 THEN J = 29
640 ON I - 8 GOSUB 1250,1390,139
0,1390,1250,1700,1700,1700,1700
700,1820,1820,1250,700,700,1
080,1060,1060,920,1150,1190,
1200,730,730,850,860,1250,90
0,940,1700,1690,1320,1340,18
20,2500
650 IF I < 9 THEN ON I + 1 GOSUB
970,970,970,2220,680,970,192
0,2000,1320
660 GOTO 1900
680 IF 0$(J,3) < > "1" THEN 1890
681 $S = "DON'T HAVTA!: RETURN
700 IF J < > 23 THEN 1060
701 IF L = 14 THEN 0$(23,2) = "1"
702 IF L = 15 THEN 0$(23,2) = "1"
703 IF L = 16 AND U = 1 THEN 0$(23,2) = "17": GOTO 120
704 IF L = 17 THEN 0$(23,2) = "1"
705 IF L = 19 THEN 0$(23,2) = "2"
706 0$(J,3) = "-3": GOTO 120
710 GOTO 120
730 IF J > 6 OR J = 6 OR
J = 8 OR J = 9 OR J = 11
J = 12 OR J = 13 OR J = 19 OR
J = 27 OR J = 28 THEN 740
735 GOTO 1050
740 IF 0$(J,3) = "1": RETURN
750 0$(J,3) = "-3": 0$(J,2) = STR$(L): GOTO 120
770 $S = "DON'T HAVTA!: RETURN
780 IF L < > 16 THEN 800
783 IF U < > 0 THEN 770
786 IF 0$(10,3) = "1": RETURN
788 GOTO 1900
800 IF L < > 26 THEN 820
803 IF U < > 0 THEN 770
806 IF 0$(10,3) = "1": RETURN
808 GOTO 1900
820 IF 0$(1,3) < > "1": RETURN
825 IF 0$(0,3) = "2": RETURN
830 GOTO 1050
840 IF CL = 1 AND 0$(12,3) = "1"
THEN CL = 0: GOTO 120
860 IF (L = 16 OR L = 17) AND U =
1 THEN U = 0: GOTO 120
870 IF L = 26 AND U = 1 THEN U =
0: GOTO 120
880 IF L > 26 THEN 820
Listing 1 continued on page 274


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Specialty Video Systems celebrates the tenth anniversary of the game of Life with the introduction of a complete Life processor on a single S-100 card.

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Van Nuys, CA 91404
(213) 782-5137

---

Listing 1 continued:

```
1156 IF OS(J,3) = "1" THEN IN = IN - 1
1157 OS(J,3) = "-7":OS(J,2) = STR$(L)
1158 IF J > 0 THEN 1060
1160 IF OS(0,3) < < "-7" THEN 1060
1163 OS(0,2) = STR$(L): FOR J = 5 TO 21: IF OS(J,2) = "-1" THEN OS(J,3) = "-7"
1170 NEXT: GOTO 1060
1190 IF J < < 12 THEN 1150
1193 IF OS(J,3) < < "1" OR OS(1,3) < < "1" THEN 1150
1195 CL = 1: GOTO 120
1210 IF J = 13 THEN PRINT "YES CH!!!": PRINT "IT'S KROSEN'S!": PRINT "YA JUST POISONED YOURSELF": GOTO 2220
1220 IF J < < 9 THEN 1050
1230 PRINT "WHEEE!!!": PRINT "YA GOT PLASTERED AND LOST A DA Y.": IF CL = 1 THEN LN = LN - 10
1235 RETURN
1250 IF J > 32 OR J < 0 THEN 1260
1253 B = VAL(OS(J,2)): IF OS(J,3) = "2" OR B = L OR B = -1 THEN 1260
1255 IF J < < 22 THEN 1890
1257 TS = "IT AIN'T HERE.": RETURN
1260 IF J > 21 OR J = 1 OR J = -1 THEN TS = "WHO THE Heck YA THINK YA IS??": C$ = "PAUL RUHJON??: YA AIN'T STRONG 'NUF.": RETURN
1270 IF OS(J,3) = "-7" THEN TS = "IT'S BURN'T UP 'N RUINED.": RETURN
1280 IF IN > 4 THEN TS = "YA CAN'T YER HANDS 'R FULL.": RETURN
1283 IF OS(J,3) = "1" THEN PRINT "YA ALREADY GOT IT!": RETURN
1286 IF VAL(OS(J,1)) = 0 AND I < < 16 THEN 1290
1287 IN = IN + 1: IF OS(J,2) = "-1" THEN IM = IM - 1:OS(J,2) = ":7S(J,3) = "1": GOTO 1290
1288 OS(J,3) = "1":OS(J,2) = ""
1290 IF J < < 9 AND J < < 11 AND J = < > 2 THEN 120
1293 IF J = 9 THEN TS = "-6": THEN OS(8,2) = "6"
1295 IF J = 11 THEN TS = OS(12,2) = ":-8": THEN OS(12,2) = ":8" TS = "-8": THEN OS(18,2) = ":-14": THEN OS(18,2) = ":14"
1300 RETURN
1320 IF OS(J,3) < < "1" THEN PRINT "YA DON'T HAVE IT!": RETURN
1325 TS = "OK": IN = IN - 1:OS(J,2) = STR$(L):OS(J,3) = ":": RETURN
1340 IF OS(5,3) < < "1" THEN 18 90
1350 IF L = 7 THEN L = 8: GOTO 1 20
1360 IF L = 12 THEN L = 13
1370 GOTO 120
1390 GOSUB 120: ON J + 1 GOTO 14
```
1565 GOTO 1460
1570 IF I = 1 THEN TS = "IT SEZ :": + CS + "BRING TREASURES TO SALOON, SAY 'SCORE.'": RETURN

1575 GOTO 1550
1580 IF I = 1 THEN TS = "IT SEZ :": + CS + "WATCH FOR OTHER R IDER FANTASY CREATIONS ADEVENTURES!": RETURN
1585 GOTO 1550
1590 TS = "THEY' S A SAVAGE LOOKIN'",

Listing 1 continued on page 276
SPECTACULAR Offers

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Circle 195 on inq uiry card.

Listing 1 continued:
'BAND, " + C $ + "' N THEY SEE N YA!" : RETURN
1600 $S = "JUS' AN OLE ORC CART F O U L O' ROCKS. " : RETURN
1610 IF OS(5,2) = "-25" THEN OS(5,2) = "1 SPR " THAR'S SUMT HIN' HERE! !" : RETURN
1615 GOTO 1460
1620 IF I = 11 THEN $S = "IT SEZ :" + C $ + " WELCOME TO FRONTI ER TOWN. " : RETURN
1625 GOTO 1550
1630 IF OS(10,2) = "-6" THEN OS(10,2) = "6" : $S = "THAR'S A S ET OF KEYS THAR! !" : RETURN
1635 GOTO 1460
1640 B = INT ( RND (1) * 3 + 1) : ON B GOTO 1650,1660,1670
1650 $S = "IT'S A BARREL CACTUS." : RETURN
1660 $S = "IT'S A CHOLLA CACTUS." : RETURN
1670 $S = "IT'S A SAGUARO CACTUS." : RETURN
1690 IF J = 4 AND I = 38 THEN 17 80
1700 IF J < > 1 OR VAL (OS(1,3)) < 0 THEN $S = "SORRY, B', THAT AIN'T POSSIBLE. " : RETURN
1710 IF I < > 38 THEN 1720
1715 IF OS(1,3) = "" THEN $S = " TENDERFOOT! YA HA'NT LEAD IN FIRST." : RETURN
1717 GOTO 1780
1720 IF OS(1,3) = "1" THEN 1320
1723 IF OS(7,3) = "1" THEN IF I < > 16 THEN $S = "TRY 'LEAF D.' " : RETURN
1730 ON I - 13 GOTO 1740,1750,1760,1770
1740 $S = "HE GOT AWAY FROM YA. " : RETURN
1750 $S = "YER TOO SLOW, HE GOT A WAY." : RETURN
1760 IF OS(7,3) > "1" THEN $S = "BAD LUCK, YA TRIPPED AND HE RUN OFF." : OS(1,3) = "1" : OS(1,2) = STRS (L) : RETURN
1763 IF OS(1,3) = "" THEN 1280
1766 GOTO 1320
1770 $S = "HE BUCKED YA OFF." : RETURN
1780 INPUT "WITH WHAT?" ; QMS : IF J = 4 THEN 1800
1782 IF LEFT$ (QMS + " ",3) < > "SAD" THEN $S = "IT PELL OFF " + C $ + " HE GOT AWAY." : OS(1,3) = "1" : IN = IN - 1 : OS(1,2) = STRS (L) : RETURN
1790 IF OS(0,3) = "1" THEN OS(0,3) = "2" : IN = IN - 1 : GOTO 1
1795 GOTO 1320
1800 IF LEFT$ (QMS + " ",3) < > "BUL" THEN 1050
1805 IF OS(8,3) < > "1" OR OS(4,3) < > "1" THEN 1320
1810 GOTO 120
1820 IF OS(7,3) < > "1" THEN 13
1822 INPUT "ON OR IN WHAT? (IE '
ON TABLE1) ?";QMS:PS = LEFTS
(QMS + "",2); IF PS < > "I"
N" AND PS < > "ON" THEN T$ = "HUU?": RETURN
1930 M$ = MID$ (QMS,4,3)
1940 IF PS < > "ON" THEN 1850
1941 IF M$ = "MUL" THEN 1790
1943 IF J < > 13 THEN 1320
1945 IF LN = 0 THEN T$ = "IT'S E
MPTY.": RETURN
1947 LM = 0: GOTO 1320
1950 IF M$ < > "SAD" THEN 1860
1952 IF M$ < "SAD" THEN 1860
1955 IF LM = 1 AND I = 12 THEN PRINT
1957 OS(J,2) = "-1":OS(J,3) = "":
1958 IN = IN - 1:IM = IM + 1:T$ = "OK": RETURN
1960 IF M$ = "MUL" THEN T$ = "Y
A GOT KICKED!": RETURN
1970 IF M$ < "LAN" THEN 1050
1972 IF OS(13,3) < > "1" OR OS(12,3) < > "1" THEN 1890
1975 IF IM = 50 THEN LN = LN + 5
1976 : IM = 0; GOTO 120
1980 T$ = "JAR'S EMPTY.": RETURN
1989 T$ = "YA CAN'T DO THAT... YE
T!"
1990 PRINT T$;T$ = "": GOTO 100
1992 PRINT "YA GOT WTH YA: ": IF
IN = 0 AND OS(I,3) < > "I" THEN
T$ = "NOTHIN'": RETURN
1993 B = VAL (OS(0,3));X1 = B: IF
B < > 1 THEN 1940
1993 PRINT : PRINT OS(0,0)
1993 CON
1933 ATANING: ":": FOR I TO 22
1933 IF OS(I,2) = "-1" THEN PRINT
1933 OS(I,0)
1936 NEXT: IF X1 < > 2 THEN PRINT
1936 "NOTHIN'!
1940 IF OS(I,3) = "1" THEN PRINT
1940 PRINT "THE MULE, WHICH YER
LEADIN. ": IF B = 2 THEN PRINT
1940 "(CARRYIN' SADDLEBAGS)"
1950 PRINT :X1 = 0: FOR I = 2 TO 22: IF VAL (OS(I,3)) < 1 THEN 1970
1955 IF CL = 1 AND I = 12 THEN PRINT
1955 "LIT",
1960 PRINT OS(I,0)
1960 
1970 NEXT
1980 T$ = "": RETURN
2000 IF L = 19 THEN HOME : PRINT "A
YA FELL 100 FEET 'N LANDED
ON ROCKS."
2005 IF L = 23 OR J = 32 OR M$ = "P" THEN T$ = "OK": RETURN
2006 GOTO 1050
2010 T$ = "WHERE?": RETURN
2020 IF L = 25 THEN L = 26: GOTO
2030 IF L = 26 THEN L = 25
2040 GOTO 120
2100 DATA 
Listing 2 continued on page 278
IEEE-488 BUS SYSTEM BUILDING BLOCKS
For Commodore PET/CBM and other computers...

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86-DOS, Seattle Computer Products 8086 operating system, is now available for the LDP88 with a BIOS for the LDP88. 86-DOS combination.

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Listing 1 continued on page 280

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2110 DATA ON A DIRT ROAD, MOUNTAIN NS. PATH. ROAD. MOUNT.
DESSERT. WINTERS, 2,4,2,2,2, ON A DIRT PATH, MINER'S SHACK. ROAD.
MOUNTAINS. W "5,1,4,2,2

2120 DATA AT THE SUPERSTITION MOUNTAINS. ROAD. DESSERT, S N, 4, 4,2,2,2, AT WEAVER'S NEEDLE.
NS, , 9, 9,7,

2130 DATA IN A NARROW Defile, BUS HES. CAVES. NS", 1, 1, 10, 12
3,8, IN A SMALL CAVE., E , 9,
, BEHIND A BUSH, BUSCH., W
, 1,9,., IN A BOX CANYON, BUSH
ES. TREES. BOULDERS. " S", 4

2140 DATA IN FRONT OF A HIDDEN MINE, MINE SHAFT, ESNW, 6, 14, 12,
12, 12, IN THE MOUTH OF A DIME, MINE SHAFT, EW
, 1, 15, 13

2150 DATA AT THE END OF A TUNNEL ION DOOR. W ", 1, 17, 15,
, IN A LARGE CHAMBER, IRON DOOR
, WNES, 1, 16, 19, 18, 20, IN A MAZE OF TUNNELS, NSEW, 6, 18, 18, 1
8, 18, IN FRONT OF A PIT, DARK
HOLE, S ", 1, 23, 17,

2160 DATA AT AN INTERSECTION, SNW", 6, 22, 21, IN A DEAD END TUNNEL, E
, 8, 20, , IN A BLOCKED TUNNEL, N
, 8, 20,
, AT THE BOTTOM OF A SHAFT, W
ALL S
, 8, 24,

2170 DATA IN A TUNNEL, NS
, 6, 23
, 25, AT THE END OF A TUNNEL
LADDER. N ", 6, 26, 24, AT THE TOP OF A LADDER
, 6, 1, 25

2180 DATA SADDLEBAGS, 2, 1, MULE, 3
, BURLAP SACK, 4, 14, SHOVEL, 4, 1
, RIFLE, 4, 1, MAP, 1, 25, GUN, 1, 1
, CARROTS, 1, 1, BOX OF RIFLE BULLETS, 1, 6, WHISKEY BOTTLES
, 2, 6, KEYS, 1, 6, PILE OF BONES
(MINE), 2, 8

2190 DATA LANTERN, 2, 8, JAR OF LIQUID, 3, 1, 11, SPANISH COINS, 1
, 10, TURQUOISE, 1, 23, SILVER
, 1, 21, GOLD, 1, 22, MATC
ES, 1, 14, CRATES, 3, 17, NOTE, 1
, 12, PAPER, 1, 6, INDIANS, 11

2200 DATA ORE CART, 14, BED, 1, 1
, GN, 5, BROKEN GLASS, 6, TABLES
, 6, CHAIRS, 6, ROCKS, 10, WOOD
EN RAILS, 15, CACTUS, 2, TRAP
DOOR, 26

2210 DATA GO, GUE, RUN, QUIT, DIG, CL
, I, INV, JUM, DRO, GRT, FKA, REA, LO
, O, MOV, CAT, CHA, LFA, RID, PUT, PL
A, PIC, PUS, PUL, SHO, GPE, CLO, GT
, V, BUR, LIG, DRT, BRE, HIT, UNL, LO
C, TAK, LIS, SAY, FEE, LOA, INT, FO
L, FOU, EAT, NOR, SOU, EAS, WES

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Circle 201 on inquiry card.
LISTING 1 CONTINUED:

2220 VTAB 24: INPUT "DO YA WANT TA TRY AGIN'?"; QMS: IF LEFTS
(TQMS + " ",1) = "Y" THEN RUN

2230 POKE 34,0: POKE 35,24: HOME :
NEW

2300 PRINT "TRY EXAM'IN THIN'S."
RETURN

2310 PRINT "ROADS GO PLACES."
RETURN

2320 PRINT "MAYBE THE TRAIL GOES SUMMAR."
RETURN

2330 IF $S(5,3) < 1 THEN PRINT
"YA GOT A MAP?" : RETURN

2340 PRINT "TRY 'FOLLOW.'" : RETURN

2350 IF VAL ($S(1,2)) = L THEN PRINT
"THE MULE LOOKS THIN."
RETURN

2360 GOTO 2300

2370 PRINT "KEEP GOIN'" : RETURN

2380 PRINT "IT'S SLIRPY, BUTCHA
MIGHT MAKE IT DOWN." : RETURN

2390 PRINT "THIS HERE'S A MINER,
YA KNOW." : RETURN

2500 IF J = 7 THEN $S = "THEY TA
STE PUNT GOOD." : RETURN

2510 $S = "CAN'T DO THAT... WEIRD
O!" : RETURN

2520 INPUT "SURE?"; QMS: IF LEFTS
($MS + " ",1) < "Y" THEN
390

2530 INPUT "NAME?"; QMS: QMS = "$D/
+ QMS": ONERR GOTO 4100

2535 PRINT OPEN "QMS": PRINT "WR
ITE "QMS

2540 PRINT L", "CL", "LN", "IN", "LM
", "U", "UL", "IM

2541 FOR X = 0 TO 32: PRINT $S(X
,1), "$S(X,2)", $S(X,3) : NEXT

2550 PRINT "CLOSE "QMS": POKE 216
,0: PRINT "SAVED!!" : GOTO 390

4000 POKE 216,0: PRINT "CLOSE "Q
MS: $S = PEEK (222): IF EE = 2
OR EE = 3 OR EE = 11 THEN
PRINT "BAD NAME. TRY ANOTHER
R."
GOTO 80

4010 IF EE = 6 THEN PRINT "NO F
ILE NAMED "QMS": GOTO 70

4020 PRINT ">>> DISK PROBLEM. ER
ROR #E: GOTO 70

4100 POKE 216,0: PRINT "CLOSE "Q
MS: $S = PEEK (222)

4110 IF EE = 2 OR EE = 3 OR EE = 11 THEN PRINT "BAD NAME. TR
Y ANOTHER" : GOTO 2520

4120 IF EE = 4 THEN PRINT "DISK
WHITE PROTECTED!" : GOTO 2520

4130 IF EE = 9 THEN PRINT "DISK
FULL!": PRINT "DELETE"QMS: GOTO
2520

4140 IF EE = 10 THEN PRINT "FILE
LOCKED! (AND I DIDN'T DO I
T)!" : GOTO 390

4150 PRINT ">>> DISK PROBLEM. ER
ROR #E: GOTO 390

9999 END
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the next few years will see a massive influx of computers into serious war-gaming.
— The General

Ever since the advent of the war game as a hobby in the early 1950s, the marriage of the war game and the computer has been a recurring topic of discussion in periodicals and at gaming conventions. Certain aspects of designing and playing war games appeared to be natural applications for the computer—recording and manipulating large quantities of data, simulating incomplete intelligence in a two-player game, and recording and storing games in progress. The design and publication of war games is, however, a commercial field like any other, and until recently, the high cost of the hardware and software involved sent the average war gamer back to his manual unit-strength roster sheets with a sigh of "what if."

Although Star Trek and other computer "war games" have been in existence for some time, attempts to apply computers to a serious historical-simulation game are relatively recent. (The quotation above, taken from an article entitled "Panzer Dreamer," was published as recently as September 1979.) Simulations Publications Inc (SPI), a major war game publisher, announced in April 1979 that it would soon market a line of Radio Shack TRS-80 "game assistance" programs that could be used to speed up manual play of specific SPI games. SPI has also designed and published some general-purpose software including a range algorithm for use with the company's standard hex-grid maps.

In January 1980, however, the small California firm of Strategic Simulations Inc published a game called Computer Bismarck—and the war game hobby entered the computer age. This game represents a milestone in the development of commercial war games.

The Game

Computer Bismarck simulates the breakout of the German battleship Bismarck into the North Atlantic in 1941, and the massive British naval and air effort to locate and sink the Bismarck. (The version for an Apple II with one disk drive and 48 K bytes of memory is the one being reviewed here.) The game can be played in two modes; as a two-player game with one player commanding the Bismarck and the other the British forces, or as solitaire, with the player commanding the British forces against the wily efforts of "Otto von Computer." In either case, the objectives are the same: the British must sink or damage the Bismarck while protecting their merchant convoy routes to and from North America, and the Germans must avoid being sunk while disrupting convoys and possibly sinking British warships.

The game begins with all forces located as they were at 1200 hours on May 22, 1941. Play proceeds in turns, with each turn representing four hours of time. During a turn, each player enters movement and search commands by keyboard for each of his ships and aircraft. A color map, displayed on the computer video screen, shows the locations of friendly forces and of enemy forces that were spotted in the previous turn.

After all orders have been entered, the computer carries out all movement simultaneously and determines whether opposing forces have sighted each other. Combat can result when opposing forces find themselves in the same map square. Combat resolution (including
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aerial bomb/torpedo attacks, surface gunfire/torpedo attacks, and submarine attacks) is done by the computer, and damage points are assigned to the forces involved as appropriate. Damage cumulatively reduces the speed, firepower, and/or the structural integrity of a ship. The number of hits required to sink a ship varies with the characteristics of the particular ship and the amount of damage it has sustained in previous combat.

Once combat resolution is completed, another turn begins and the cycle is repeated. Factors such as weather (which affects searching), ammunition expenditure, and reinforcements are monitored by the computer and introduced into play as appropriate. The game ends when the Bismarck is sunk, when one player has accumulated a lead of 30 victory points, or after the 0800, May 27, 1941, turn.

Physical Description
Along with the program floppy disk, the Computer Bismarck package includes two plastic-coated mapboard charts for move plotting, a sixteen-page rulebook (containing strategy suggestions and historical background, as well as the game rules), a set of data charts, a setup sheet, and two grease pencils for use with the mapboard charts. The printing and graphics are of professional quality throughout. The components are packaged in an unnecessarily large, but attractively illustrated, box. All in all, the game is an excellent physical product. A minor irritation with the graphics is the use of three-digit lead of 30 victory points, or after the 0800, May 27, 1941, turn.

Game Evaluation
The promotional literature for Computer Bismarck claims that “without the drudgery of the organizational overhead of paper-and-pencil games, your mind is free to develop and test sophisticated search, combat, and logistics strategies...” (Campaign, number 79). Regrettably, this claim is largely untrue. Although Computer Bismarck does relieve the player of many of the paperwork aspects of conventional war games, it introduces new problems that can actually increase the time required to complete a single turn.

The mechanics of Computer Bismarck are based almost entirely upon those of the conventional war game Bismarck, published in 1979 by the Avalon Hill Company. While the designers of Computer Bismarck wisely chose not to adapt the detailed combat mechanics of the Avalon Hill game, the movement and search procedures, orders of battle, and capability factors assigned to the ships and aircraft are derived almost directly from the Avalon Hill version. There is certainly nothing wrong about this; indeed, it was probably wiser to adapt an existing design rather than use a new and untried system (although it would seem proper as a matter of courtesy to acknowledge that the game was based on an Avalon Hill design).

The fact remains, however, that the original game was designed for manual play, and its search procedure—moving ship counters on a playing board—was reasonably efficient for that medium. In Computer Bismarck, ships are moved by entering the square-by-square track that each ship is to follow, consulting the mapsheet each time to verify the square coordinates and checking the rules for convoy destinations and other details. This can be rather time-consuming, as the British frequently have thirty-plus ships in play, not to mention aircraft. It also causes a player to become mired in the details of individual ship movement to the exclusion of strategic considerations. Computer Bismarck also perpetuates the irritating system of ship movement rates which, in the Avalon Hill original, was apparently scaled so that the map-board would fit exactly into the box.

The failings of Computer Bismarck can be summarized by saying that it does not take advantage of the possibilities offered by the computer. For example, it would have been relatively easy to design a movement system based on the target square principle; ie: a ship would be ordered to proceed to square X and patrol there until further orders are given. The convoys could also be “programmed” to steam toward their destinations unless ordered otherwise (eg: to avoid the Bismarck). These changes would also have made the game much more realistic. Also, the task force system used in the Avalon Hill game could easily have been adapted to the computer version, increasing both playability and realism.

Instead of thinking along these lines, the designers of Computer Bismarck chose to retain the conventional pencil-and-paper system of the Avalon Hill game; by doing this, the designers precluded many of the advantages that computerization might have provided. It is difficult to believe that they couldn't have done better.

In all fairness, it should be pointed out that the computer version does offer one unique advantage: the possibility of solitaire play. Preliminary play testing indicates that “Otto von Computer” is indeed a skillful op-
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asteroids in space

by Bruce Wallace

An exciting space action game! Your space ship is traveling in the middle of a shower of asteroids. Blast the asteroids with lasers, but beware — big asteroids may fragment into small asteroids! The asteroid game allows you to rotate your space ship, fire your laser gun, and give it thrust to propel it through endless space. From time to time you will encounter an alien space ship whose mission is to destroy you, so you'd better destroy it first. High resolution graphics and sound effects add to the arcade-like excitement that this program generates. Runs on any Apple II with at least 32K of RAM and one disk drive.

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Battleship Commander

by Erik Kilik and Matthew Jew.

A game of strategy. You and the computer each start out by positioning five ships of different sizes on a ten by ten grid. Then the shooting starts. Place your volleys skillfully — a combination of logic and luck are required to beat the computer. Cartoons show the ships sinking and announce the winner. Sound effects and flashing lights add to the enjoyment of the game. Both AppleSoft and integer BASIC versions are included. Requires at least 32K of RAM.

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Babble

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Have fun with this unique software. You write a story, entering it as a BABBLE program. As you write the story you specify certain words to be selected by the computer or entered from the keyboard at execution time. Run the program and watch BABBLE convert your story into an elegant prose collection of incoherence. The ways in which BABBLE can entertain are limited only to your imagination. You can compose an impressive poetic speech or write a novel. You can plan a dinner menu. You can even form images on the screen or compose musical tunes with the help of BABBLE. The cassette version requires at least 16K of RAM and the diskette version requires at least 32K of RAM. BABBLE is written in machine language and runs on any Apple II computer.

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FASTGAMMON

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Astronapple

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Your Apple computer becomes your astrolayer, generating horoscopes and forecasts based on the computed positions of the heavenly bodies. This program offers a delightful and stimulating way to entertain friends. ASTRONAPPLE produces natal horoscopes (birth charts) for each person based on his or her birth data. Any two people may be compared for physical, emotional, and intellectual compatibility. The program is written in AppleSoft BASIC with machine language subroutines. It requires either RAM or RAM AppleSoft and at least 32K of memory.

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Fracas

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Summary

- The field of computer war games has vast potential, and it is perhaps unfair to expect the first published example to be a fully developed product. Others, much improved, are certain to follow; as of this writing, Avalon Hill has announced the availability of four “war games for home computers.” (One of them, entitled North Atlantic Convoy Raider, is described as “a computer simulation of the Bismarck convoy raid of 1941.”) It is likely that Computer Bismarck will be remembered as the Tactics II of computer gaming—somewhat crude, but a fine effort and definitely a first.

Conclusions

- Computer Bismarck allows solitaire play against the computer. This a great advantage for the war gamer who cannot find suitable opponents.
- The game is very attractively produced, including plastic-coated mapboard charts and a well-designed rulebook organized in much the same way as rulebooks from other war game publishers. This adds considerably to the pleasure in playing the game.
- Movement of pieces in this game, which must be done one piece at a time, is time-consuming and tedious.

War-Gaming—The Hobby

Shortly before the First World War, the noted science-fiction writer HG Wells published a book entitled Little Wars. It contained a set of rules for simulating historical battles and campaigns using model soldiers on tabletop battlegrounds. From that point on, miniature war games acquired a troop of devoted followers.

A new type of commercial war game was introduced in 1953, when Charles S Roberts published Tactics. Tactics was a board game in which the opposing forces, represented by cardboard unit counters, were maneuvered over a gridded map. Each unit was rated according to its combat and movement ability, and battles were resolved by comparing the strengths of opposing forces and applying a luck factor via dice roll.

Tactics was quite successful (a revised version, Tactics II, is still on the market today), and other games soon followed. The majority of the early titles dealt with historical actions such as Gettysburg, Waterloo, and the Battle of the Bulge. The Avalon Hill Company, founded by Roberts in 1958, was for many years the only professional publisher of commercial war games. In 1970, Simulations Publications Inc began producing games and introduced a number of innovative design concepts. Avalon Hill and SPI continue to be the giants of the war-game industry, although a number of smaller firms have since appeared.

There are currently several hundred war game titles in print, and sales are climbing toward a million games per year. Game topics range from the campaigns of Alexander and Caesar to World War II, Vietnam, and even to the intergalactic struggles of the distant future.

Information about the war-gaming hobby can be obtained from the many publications on the subject. A few of the most useful sources are listed below:

Book:
The Comprehensive Guide to Board Wargaming, by Nicholas Palmer, published in paperback by McGraw-Hill, 1979, is an excellent introduction to the subject, although some of the game reviews are already dated.

Magazines:
The General (POB 896, Fallbrook CA 92028) is a respected source for game reviews, strategy articles, and other features.
The General (published by the Avalon Hill Company, 4517 Harford Rd, Baltimore MD 21214) is limited to coverage of Avalon Hill games only, but it is very good on the subjects it covers.

Strategy and Tactics (published by Simulations Publications Inc, 257 Park Ave S, New York NY 10010) offers a complete, ready-to-play war game in each issue, as well as historical articles and general gaming information. SPI also publishes Moves, which is devoted mainly to game design and strategy, and Ares, which covers the relatively new field of science-fiction/fantasy war games.
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Encode/Decode is available in two versions:

Encode/Decode I provides a level of security suitable for normal use. Encode/Decode II provides enhanced security for the most demanding needs.

Both versions come supplied on discette with a complete user manual

Encode/Decode I: $50.00 Encode/Decode II: $100.00 Manual alone: $15.00

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- conversational mode
- send files
- receive files

Requirements: 32K CP/M

Supplied with user manual and 8080 source code: $150.00 Manual alone: $50.00

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In the game, you are placed at a randomly chosen location in a forest with a certain combat strength that is randomly determined. Also, you encounter monsters guarding various tempting treasures and are given a choice of fighting them, running from them, or bribing them; greed and wit are certainly tested here.

To fight the monster, enter a 1. When the program asks you for the number of combat points you wish to use, enter any number smaller than your combat strength (ie:

```
1 REM MONSTER COMBAT
2 REM WRITTEN BY LEE CHAPEL 6/15/80
3 DIMA(10,10):PRINTTAB(20)"MONSTER COMBAT"

10 FORI=1TO9:FORJ=1TO9:A(I,J)=INT(RND(I)*12)+1:IFRND(I)<.75 THEN25
20 NEXT

40 ONKGET0300,350,635
50 PRINT"YOUR COMBAT STRENGTH IS";C:GOSUB400:
60 PRINT"FIGHT","RUN","OR "BRIBE":K

70 FORI=1TO9:FORJ=1TO9:A(I,J)=INT(RND(I)*12)+1:IFRND(I)<.75 THEN25
80 NEXT

90 FORI=1TO9:FORJ=1TO9:A(I,J)=INT(RND(I)*12)+1:IFRND(I)<.75 THEN25
100 NEXT

110 X=INT(RND(I)*6+2):Y=INT(RND(I)*6+2)
200 FORH=100TO25STEP-50:IFH•M<5ANDH>=1THEN490
300 IFK>CTHENGOSUB600:PRINT"COMBAT POINTS ":GOTO490
310 IFK>CTHENGOSUB600:PRINT"COMBAT POINTS ":GOTO490
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990 IFK>CTHENGOSUB600:PRINT"COMBAT POINTS ":GOTO490
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Listing 1 continued on page 290
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True multitasking, multiuser OS for timesharing or real-time control applications.
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- Versatile, easy-to-use input/output supports multiple devices.
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- Provides log-on password protection and user file security.
- Can run on small, inexpensive systems with floppy disks and as little as 32K memory.

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OS-9™ LEVEL ONE OPERATING SYSTEM

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- Additional control statements for structured programming: IF ... THEN ... ELSE, FOR ... NEXT, REPEAT ... UNTIL, WHILE ... DO, LOOP ...

MICROSOFT 6809 BASIC

Standard Microsoft BASIC optimized for the 6809 and OS-9™.
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- Automatic line numbering and renumbering.
- Supports random and sequential file I/O. Full PRINT USING for formatted output.

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- Available on ROM, disk or cassette tape.

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Most software is available on ROM, diskette and tape in versions for many popular 6809 computers. Source listings and yearly maintenance/update service are sold separately for most programs.

*Specify manufacturer and type of CPU and I/O controllers. Contact Microwave* for specific availability.
the amount you think it will take to defeat the monster). Each monster has its own combat strength. If you enter a number of combat points equal to the monster's strength, you have a fifty-fifty chance of defeating it. Entering a higher number increases your chances of winning, while entering a smaller number lowers your chance of winning. No matter how much strength you use, there is always at least a one-in-a-thousand chance that the monster will kill you—not bad odds, unless you have cold feet. Also, the more treasure you have, the more strength you need to use to achieve the same odds against the monster in combat.

If you choose to run (option 2), your chances of getting away from a monster successfully decrease as each new monster's strength possibly increases. Thus you are more likely to get away from a minotaur than from a basilisk. If you succeed in running away, you are placed in a new randomly selected square; not getting away usually results in a battle. Occasionally, while you are running, the monster will catch and kill you—one of the risks you must accept.

Of course trying to bribe (option 3) your foe is an age-old alternative to running or fighting. For this, you must use your hard-earned treasure. Whether or not you win depends on the value of the treasure he is guarding. The greater the treasure, the more you have to pay to successfully bribe the monster. If he doesn't care for your bribe, you usually have to fight him.

There are other things in the forest besides monsters, but these are best left for the player to discover. One thing that I will mention is the mirror you may find. This kills basilisks, the most fearsome of all the creatures you will meet. A basilisk can kill people by looking them in the face, but when it looks into a mirror it frightens itself to death.

Movement through the forest is easy: just enter the direction you want to go—N for north, E for east, NE for northeast, and so on. North is the top of the map and east is the right. The Xs mark out the forest in the display, the Is are walls through which you cannot pass, and the 0 is you. To leave the forest, just move onto any blank area around the edge of forest.
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<table>
<thead>
<tr>
<th>Volts</th>
<th>1 mV to 1 KV @ 0.2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amperes</td>
<td>1 uA to 10 A @ 1%</td>
</tr>
<tr>
<td>Ohms</td>
<td>10 uOhm to 19.99 MOhm @ 0.2%</td>
</tr>
<tr>
<td>Temperature</td>
<td>-40 °C to +150°C +/-3 °C</td>
</tr>
<tr>
<td>Capacitance</td>
<td>1 pF to 199.9 uF @ 1%</td>
</tr>
<tr>
<td>Conductance</td>
<td>0.1 nS to 199.9 nS @ 0.2%</td>
</tr>
<tr>
<td>Diode Test</td>
<td>1 mV to 1999 mV @ 0.2%</td>
</tr>
<tr>
<td>Size</td>
<td>2.9&quot; x 6.4&quot; x 7.0&quot;</td>
</tr>
<tr>
<td>Weight</td>
<td>3 lbs 8 oz (including batteries)</td>
</tr>
</tbody>
</table>

**EVEN IDIOTS**

While no instrument is totally idiot-proof, the Touch Test 20 certainly comes close when any function is selected, this instrument automatically selects the least sensitive range of the function, to avoid embarrassing but all too common smoke test situations. We're told (though we do not advise such mistreatment), that you can plug the test leads into a 120 volt wall socket and select any function without causing terminal damage to the instrument.

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**COMPUTER-METER**

Microprocessor technology and the inventors of the digital meter have teamed up to bring you the world's most versatile test instrument.
Scores for this game generally range from 500 to 700. If you get over 1000, you are doing very well. A sample listing of the game at its end is given in listing 2.

Experience has shown me that this game becomes more exciting as the map gets larger. If you have more than 4 K bytes of memory in your system, you can increase the map size by changing the proper lines in the program (mainly lines 10, 15, 705, and 900). You can also add more monsters and treasure or add other options to the game.

Table 1 lists the monsters and their combat strengths; table 2 lists the treasures and their values. So load up, enter the forest, and hunt!

### Table 1: A list of monsters that can be found in the forest and their combat strengths.

<table>
<thead>
<tr>
<th>Monster</th>
<th>Combat Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>minotaur</td>
<td>10</td>
</tr>
<tr>
<td>cyclops</td>
<td>20</td>
</tr>
<tr>
<td>zombie</td>
<td>30</td>
</tr>
<tr>
<td>giant</td>
<td>40</td>
</tr>
<tr>
<td>harpy</td>
<td>50</td>
</tr>
<tr>
<td>griffin</td>
<td>60</td>
</tr>
<tr>
<td>chimera</td>
<td>70</td>
</tr>
<tr>
<td>dragon</td>
<td>80</td>
</tr>
<tr>
<td>wyvern</td>
<td>90</td>
</tr>
<tr>
<td>basilisk</td>
<td>100</td>
</tr>
</tbody>
</table>

### Table 2: A list of treasures and their values.

<table>
<thead>
<tr>
<th>Treasure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ten silver spoons</td>
<td>10</td>
</tr>
<tr>
<td>a jeweled sword</td>
<td>30</td>
</tr>
<tr>
<td>a jar of rubies</td>
<td>50</td>
</tr>
<tr>
<td>fifty silver coins</td>
<td>50</td>
</tr>
<tr>
<td>a box of jewels</td>
<td>75</td>
</tr>
<tr>
<td>100 gold pieces</td>
<td>100</td>
</tr>
<tr>
<td>a treasure chest</td>
<td>200</td>
</tr>
</tbody>
</table>

Listing 2: Part of a sample run of Monster Combat program. Each X represents part of the forest, each I represents part of a wall that must be circumnavigated, and the single 0 represents the player.

YOUR COMBAT STRENGTH IS 1270
A CHIMERA IS GUARDING 50 SILVER COINS
DO YOU (1) FIGHT, (2) RUN, OR (3) BRIBE? 2
YOU MUST FIGHT
HOW MANY COMBAT POINTS DO YOU WISH TO USE? 132
YOU BEAT THE MONSTER
YOU NOW HAVE 80 TREASURE POINTS
WHAT DIRECTION (HIT 1 FOR THE MAP)? SW

YOUR COMBAT STRENGTH IS 1138
A DRAGON IS GUARDING 10 SILVER SPOONS
DO YOU (1) FIGHT, (2) RUN, OR (3) BRIBE? 3
HOW MUCH DO YOU WISH TO PAY? 10
YOUR BRIBE WAS ACCEPTED. YOU NOW HAVE 70 TREASURE POINTS
WHAT DIRECTION (HIT 1 FOR THE MAP)? W

YOU SURVIVED THE FOREST
YOU WON A TREASURE TOTAL OF 70
CONGRATULATIONS

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<tr>
<th>Qty</th>
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<th>Amount</th>
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<td>#1-7 Bridges of Kongsberg</td>
<td>$20</td>
</tr>
<tr>
<td></td>
<td>#2-Fun and Games</td>
<td>$20</td>
</tr>
<tr>
<td></td>
<td>#3-Homebrew</td>
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</tr>
<tr>
<td></td>
<td>#4-Software Mirage</td>
<td>$20</td>
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<tr>
<td></td>
<td>#5-Computer Engineering</td>
<td>$20</td>
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<tr>
<td></td>
<td>#6-Total Eclipse</td>
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<td>#7-Computer Hardware</td>
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<td>#8-Perspectives</td>
<td>$20</td>
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<td></td>
<td>No. 5-8</td>
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<td>$</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>$</strong></td>
</tr>
</tbody>
</table>

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Editorial continued from page 12

Speed Press, 1979. As Alvin Toffler says, "The shortest distance between two facts may well be Alden Todd." Even practiced denizens of the library will find information of interest in this book about reference sources.


Some Examples of Good Technical Writing


Hofstadter, Douglas R. Gödel, Escher, Bach: An Eternal Golden Braid. New York: Basic Books, 1979. This Pulitzer prize-winning work discusses computer science, art, music, philosophy, and physics in a way that is nothing short of wondrous. It is positive proof that a technical book can be artistic, rigorous, and fascinating.

Swann and Johnson, Prof. E. McSquared's Original, Fantastic, and Highly Edifying Calculus Primer, Joint Edition. Los Altos CA: William Kaufmann, Inc, 1975. This colorful offbeat book is actually a cleverly disguised introduction to differential calculus in comic book form. It manages to be witty and rigorous at the same time. Would that there were more books like this one.


Two other writers should be mentioned for their contributions to good technical writing: Jeremy Bernstein and Philip Morrison. Their book reviews about scientific and mathematical books appear regularly in the New Yorker and the Scientific American, respectively, and they are among the best in their field.

Articles Policy

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A Strategic Bug

The program in the article by John Rheinstein “Fifteen: A Game of Strategy (or Tic-Tac-Toe Revisited)” (June 1980 BYTE, page 230) contains an error in line 720. Instead of:

"720 IF T2 > 0 THEN 270"

the line should read:

"720 IF T2 > 0 THEN 750"

If the program is input as given, you get nothing but a sequence of prompts that say “YOUR MOVE.”

An alternate fix is to delete line 460 and lines 650 thru 810. The program then runs satisfactorily, but does not recognize a tie game after only 8 moves (which is possible as the user always

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Circle 212 on inquiry card.
move first), and does not recognize a tie game at all if the program is modified to let the machine move first.

Mr. Rheinstein has provided an interesting twist on the old game of tic-tac-toe. I've played several dozen games and haven't won yet, but I'm still trying!

Clinton R. Foulk
5101 Delancy St
Columbus OH 43220

Error in Airborne Navigation


In the program listing on page 246, six consistent substitutions of "8" for "g" were made; for instance, in line 09, "8es 0" should have been "ges 0". The errors were in lines 9, 14, 25, 30, 33, and 44. The use of "g" refers to an operation involving the blue function-key.

We at BYTE hope that no one has navigated incorrectly due to this error.

Benchmarking Errors

We cannot seem to get benchmark programs right. There is an error in listing 1 of the Technical Forum article "Some More Notes on Performance Evaluation," by Carl Helmers, in the July 1980 BYTE (pages 216 thru 219). The article itself contains a correction for a previous BYTE article on benchmarking.

110 IF A(I)=0
THEEN 100 ELSE 85

should read:

110 IF A(X)=0
THEEN 100 ELSE 90

Our thanks go to Tom Kelly Jr of Salem, Ohio, and other readers for pointing this out to us.

In addition, our staff found that the program has no way to print out the results by executing lines 120 thru 170. To correct this, change line 110 to:

110 IF A(X)=0
THEEN 100 ELSE 85
and add line 85:

85 IF 2X>1 THEN 120

We apologize for these errors.

Sorry, Wrong Number

The October 1980 issue of BYTE contains an error on page 347, in the "What's New?" column. The telephone number listed for Moore Business Forms Inc, is incorrect. The numbers are (800) 942-8330 in Indiana, and (800) 323-8326 for the rest of the US.

National Computer Conference 1981 Needs Panelists

Interest has been steadily mounting for a panel discussion on personal robotics and artificial intelligence ideas, applications, and accomplishments. And now, the Personal Computing Festival of the National Computer Conference 1981 will offer this opportunity. If you wish to participate in this discussion, send a description of your interest area and the contents of a 5-minute presentation to A. Gelles, 185 W. Houston St, New York NY 10014. Participants should be professionals in robotics and artificial intelligence disciplines.

The conference will be held in Chicago, Illinois, on May 5 thru 7, 1981. Additional information may be obtained by writing to the above address.
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<td>Phone</td>
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Circle 218 on inquiry card.
Beware Automatic Color TVs

BYTE readers should be made aware that RF (radio-frequency) modulators such as the popular Sup'R' Mod II manufactured by M & R Enterprises may not be compatible with certain television sets. Unhappily, I discovered this fact when I purchased a new RCA color television equipped with all-electronic tuning for use with an Apple II equipped with a Sup'R' Mod II. It seems that the electronic tuners are so stable and accurate that they are not required to have a fine-tuning control. Unfortunately, the UHF (ultra-high frequency) oscillator in a typical radio-frequency modulator is anything but stable and accurate. To "find" the signal put out by the radio-frequency modulator, either a fine-tuning control on the television or a frequency-adjustment control on the radio-frequency modulator is an absolute necessity. Having neither in my case (the Sup'R' Mod II has no frequency adjustment), I am out of luck.

It may be that radio-frequency modulators operating on VHF (very-high frequency) channels 3 or 4 may be more accurate. But in any event, BYTE readers should be aware of this potential problem if they are in the market for a color television for use as a monitor, or for a radio-frequency modulator to use with the new breed of television sets lacking fine-tuning controls.

Jacob Z Schanker, PE
105 Colony Ln
Rochester NY 14623

In a related situation, I cannot play back prerecorded videotapes on my 1978 color television. Commercial tapes add an antipiracy signal that causes the picture to roll. This can be remedied by adjusting the vertical hold on your television—unless you have an automatic color television (like mine) that doesn't have such a control anywhere . . . GW

Fidelity versus Digicast (or Datacast)

Although I missed the article on the Digicast Project in the January 1979 BYTE (our BYTE magazine goes through a lot of hands), I would like to comment on Noel Moss's letter in the April issue. (See "The Digicast System: Receiving Data and Information Over Your FM Radio," by A I Halsema, January 1979 BYTE, page 100; also see "Digicast Data," April 1979 BYTE, page 8.)

As a former FM broadcast engineer, I disagree with Mr Moss's contention that "high-fidelity music transmission is not restricted by the current modulation limits." In the lab, yes, but in these Tennessee hills multipath will create distortion problems even when the absolute signal strength is just fine. Stereo in particular is subject to damage in reception quality due to multipath.

What those music syndicators have been trying to tell us is: you can't cheat Mother Nature. Sure, you can put subcarriers all over the place and broadcast stereo. (Dorren quadraphonic, while you are at it?) But you can't do that and see around corners at the same time. In hilly terrain or metropolitan areas, it is best to limit your bandwidth as much as possible, or suffer the high cost of listener dissatisfaction with your mobile reception.

SCA (subsidiary communications authorization) for digital data is a special problem. For some time we at station WSMC attempted to use our subcarrier to route telemetry from the transmitter to the studio's remote control. Please bear in mind that the data rate of this is about 2 bps (bits per second). The result was a very noticeable flutter sound in receivers that did not have a line of sight to our antenna, which was modulated by mountain peaks in mobile reception.
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The Digicast Project has been renamed the "Datacast Project" by its principal proponent, Jim Warren. No regular Datacast service is now in operation, but in a recent telephone conversation, Mr Warren told me, "The only thing that's holding up Datacast is Jim Warren." He added that several tests have been performed both in Sacramento, California, and in the San Francisco Bay area, and that he intends to pursue Datacast when some other projects are completed.

I also talked with Harry R. Anderson, the broadcast engineer who helped perform the tests. He agrees with many of the points made by Mr. Moss (noting that few people can detect a 1 dB difference in volume), but he says that the theoretical causes of multipath distortion should not be affected by SCA subcarriers.


The End of the CBT

The article by Ron Parsons about a 6860-based modem was excellent. (See "An Answer/Originate Modem," June 1980 BYTE, page 24; also see the "BYTE's Bits" item, "Tracking Down the Modem Filters," September 1980 BYTE, page 312.)

Unfortunately, on January 1, 1980, the Bell Telephone system made the CBT data-access arrangement (DAA) obsolete. No telephone-line interface

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Unfortunately, on January 1, 1980, the Bell Telephone system made the CBT data-access arrangement (DAA) obsolete. No telephone-line interface

Circle 224 on inquiry card.
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devices can be obtained through the telephone company. With this act, the telephone company made obsolete an entire generation of equipment, including modern and telephone-answering devices.

At present, I can find no one who is providing CBT couplers or devices equivalent in function for sale, although the telephone company insists that these are available through "electronics supply houses."

The current regulations specify that any device to be directly connected to the telephone lines must be certified as compatible by the FCC (Federal Communications Commission). This is beyond the means of most individuals. About the only legal means left is to purchase one of the commercially available direct-connect modems or settle for an acoustically coupled unit.

James R Boattight
3112 W 11th
Topeka KS 66604

Comments on the August issue

Editor’s Note: BYTE readers were even more vocal than usual this month about our August 1980 FORTH language issue. Apparently, the combination of Steve Ciarcia’s article ("A Build-It-Yourself Modem for Under $50"), the many FORTH articles, and the article by Theron Wierenga on "Construction of a Fourth-Generation Video Terminal" (no pun intended) combined to hit a collective nerve. Here are some of the short, usually anonymous reader comments we received on the monthly BOMB cards (for an explanation of the BOMB card, see the back of this issue).

Incidentally, wildly enthusiastic comments about FORTH outnumbered negative comments by a factor of 10 to 1:

• More FORTH!! Pascal’s just another language to eliminate programmers, but FORTH is a language for programmers (and engineers and scientists and businessmen and kids and everybody)
• I would like to see more articles on FORTH—best single issue since Volume 1, Number 1
• Excellent coverage. I believe FORTH is a language worth learning and using. My TRS-80 will be running MMSFORTH as soon as possible!
• Economically, FORTH has got to be a major breakthrough. Memory doesn’t come cheap and you don’t need much of it!
• FORTH is fantastic. It’s like heroin... you gotta have more once you try it. How about some more in the near future?
• I was quite impressed by FORTH and
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because of #4 [John James's "What is FORTH? A Tutorial Introduction"] I am getting TFORTH for the TRS-80.

- The simplicity of FORTH is an ideal showcase for modularity and extensibility. #3 [Charles Moore's "The Evolution of FORTH, An Unusual Language"] was entertaining and human. The diagrams from #4-6 [three other FORTH articles] were wonderfully simple, direct, and to the point.
- Best overall issue in a long time. I have already ordered a FORTH compiler for my 16 K Apple II.
- Let's have all you can get on how to implement and how to use threaded languages.

The few negative comments we got were also strongly stated:

- Easily the worst issue ever.
- Yeech! This issue soured on the way!
- Too much emphasis on FORTH. I like to see a variety each month (maybe spread it out). (Had the emphasis been nearer my interests, would have loved it. You can't please all the people . . .)

Other languages were also mentioned as topics for future articles (future BYTE authors, take note):

- Loved it!! More FORTH, APL, LISP, and other wild and crazy languages.
- I hope that at some time in the near future, an issue will be devoted to C.
- SNOBOL NOW!
- How about some programs in the Apple Pascal system assembler?

For next year's language issue, please consider one that directly supports concurrency—Concurrent Pascal, Ada, etc.

Other comments included general enthusiasm for the issue and a good deal of respect for the article on Khachiyan's algorithm ["Khachiyan's Algorithm, Part 1: A New Solution to Linear Programming Problems"]: [...]

More Steve Ciarcia!

- Superb issue! Hope there is another volume of Ciarcia's Circuit Cellar and a BYTE Book of FORTH to be made available for the Christmas season!
- Still have not figured out the math in #7 ["Khachiyan's Algorithm, Part I"] but a little bit (lot?) of work won't hurt me. Give us more on FORTH. Best issue to date.
- More hardcore math like the Khachiyan algorithm.
- The editorial ["Threads of a FORTH Tapestry"] gets an 8!
- The Khachiyan algorithm piece appeals to a very narrow readership and is quite advanced—as noted. However, we all need something to tease us into advancement once in a while!
Circle 235 on inquiry card.

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<td><strong>PLUG COMPATIBLE WITH THE AIM-65/SYM EXPANSION CONNECTION BY USING A RIGHT ANGLE CONNECTOR (SUPPLIED) MOUNTED ON THE BACK OF THE MEMORY BOARD.</strong></td>
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<tr>
<td><strong>MEMORY BOARD EDGE CONNECTOR PLUGS INTO THE G6800 BUS.</strong></td>
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<tr>
<td><strong>CONNECTS TO PET OR KIM USING AN ADAPTOR CABLE.</strong></td>
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<tr>
<td><strong>RELIABLE—DYNAMIC RAM WITH ON BOARD INVISIBLE REFRESH—LOOKS LIKE STATIC MEMORY BUT AT LOWER COST AND A FRACTION OF THE POWER REQUIRED FOR STATIC BOARDS.</strong></td>
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<tr>
<td><strong>USES -5V ONLY, SUPPLIED FROM HOST COMPUTER.</strong></td>
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<tr>
<td><strong>FULL DOCUMENTATION ASSEMBLED AND TESTED BOARDS ARE GUARANTEED FOR ONE YEAR AND PURCHASE PRICE IS FULLY REFUNDABLE IF BOARD IS RETURNED UNMOUNTED WITHIN 14 DAYS.</strong></td>
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Heathkit Group in San Diego

The San Diego Heathkit Computer Users Group has been formed to help users on the local level. The club meets on the first Wednesday of each month at the La Mesa Heathkit Store at 7 PM. Membership is $10 per year. The club wishes to exchange newsletters and ideas with other clubs. Contact R A Cobb, 12202 Kingsford Ct, El Cajon CA 92021, (714) 443-4772.

Microcomputer Users International

Microcomputers Users International is a group serving the Sault Ste Marie area. The group publishes a monthly newsletter entitled Northern Bytes. The newsletter is available to other groups on an exchange basis. Meetings are held on the third Tuesday of each month. Contact Jack Decker, 1804 W 18th St, Lot #155, Sault Ste Marie MI 49783, (906) 632-3248. In Sault, Ontario, phone (705) 942-1363, and ask for Phil Barton or Frank Gardner.

National Computer Association (NCA)

The organizational structure of the NCA, an independent nonprofit computer user group, has been expanded. The NCA is now offering full membership to vendors, consultants, OEMs (original equipment manufacturers), manufacturers, end users, and affiliated membership to computer clubs. Also, subgroups for members with similar interests are now being offered. The subgroups are being formed along product-interest lines. Monthly newsletters will be published containing technical information. A new subgroup must have a potential of 200 members. Membership within NCA is $35, which includes membership within a subgroup. Computer club affiliation entitles the club to receive all NCA publications. Clubs may join for an annual fee of $50. Club members can join as individual members, if so desired. Contact NCA, 1485 E Fremont Ct S, Littleton CO 80122, (303) 797-3559.

PIE for PET Users

PIE (PET Information Exchange) is made up of PET/CBM users. Meetings are informal and are held approximately twice every month at various locations in Rhode Island. A newsletter is published. The dues are $6 per year. The group is involved in a project to install two BASF floppy-disk drives behind the name-plate on a new 32 K-byte PET. Other future projects include a computer bulletin board service for the group members. Contact PIE, 27 Leicester Way, Pawtucket RI 02860.
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Small Computer News is a biweekly newsletter covering the microcomputer field. Written for the computer hobbyist, manufacturer, and retailer, each issue contains information on the microcomputer business, new product previews, convention news, and free-lance and career employment opportunities. Subscriptions, including first class postage, are available for $24.50 per year from Edwards Publications, 78-56 86th St, Flushing NY 11365, (212) 441-4082.

Electronic Magazine for DEC Users

Digital Digest is a digital magazine that operates 24 hours a day. To utilize this information exchange, users need a 300 bps modem and terminal set up for seven data bits, even parity, and one stop bit. The initial data line number is (404) 447-5254. The magazine is directed at the DEC (Digital Equipment Corporation) PDP-11 user and will be expanded to handle Data General users. Featured in the magazine will be a free PDP-11 software exchange, DEC users buying group co-op, electronic mail box, software and hardware product index, and more. The electronic version of Digital Digest is free and the printed version is $15 per year. The Digital Exchange software exchange system is free for contributing members and $95 for noncontributors. Contact Digital Publications Inc, 1101 Noble Forest Dr, Norcross GA 30092.

OSI-MUG

OSI-MUG (Ohio Scientific Michigan Users Group) has recently been formed. The club has over 130 members, primarily from the southeastern Michigan area. The members are interested in exchanging information with similar groups. Contact OSI-MUG, 3247 Lakewood Ave, Ann Arbor MI (313) 761-5358.

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INAUG

INAUG (International Apple Users Group) is dedicated to increasing the flow of information between Apple users worldwide. The INAUG requests that all Apple users and groups unite and join its group. Please send a self-addressed, stamped envelope for more information. The address is INAUG, POB 96, Twain CA 95984, (916) 283-3497.

Another Apple Group

The OKC Apple Users Group meets at various computer stores in the Oklahoma City area on the first and third Tuesday of each month. Its newsletter is entitled OKC Apple Times. Membership dues are $10 per year, which includes a subscription to the newsletter. OKC is a member of the International Apple Corps. Contact The Secretary, OKC Apple, c/o Greenbriar Digital Resources, POB 1857, Edmond OK 73034.

UK TRS-80 Users Group

This United Kingdom-based group currently has over 230 members, and along with publication of their monthly newsletter, they organize single-day and weekend workshops in different parts of the country. A software library is available for members' use. Membership is by subscription to the newsletter, which is £5.75. Contact Brian Pain, 40a High St, Stony Stratford, Milton Keynes, England.

The Portland Computer Society

This group has over 180 members and a busy schedule of meetings. The main meeting is held on the third Saturday of each month at the Far West Federal Savings, Fred Meyer Raleigh Hills Shopping Center, 4770 SW 76th (Beaverton Hillsdale Hwy). They have many other special interest groups that meet regularly. A news-
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Prince William Computer Club

The Prince William Computer Club holds its regular meetings at the Prince William Branch Library, Woodbridge, Virginia, on the first Tuesday of each month at 7:30 PM. For information, call Don Bennett, (703) 670-4773.

The Red Sea Apple Club

The Red Sea Apple Club is located in Saudi Arabia. Most members have Apple II computers with two disks and the Pascal system. They are interested in corresponding with any and all clubs and individuals so that they can keep up with the current trends in the American microcomputer world. The group is also interested in swapping disks. The club’s address is Red Sea Apple Club, c/o Saudi Arabian Parsons Ltd, POB 3694, Jeddah, Saudi Arabia.

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04 = ENTER A/C RECEIVABLES
05 = ENTER A/C PAYABLES
06 = ENTER/UPDATE ORDER
07 = ENTER/UPDATE INVENTORY
08 = ENTER/UPDATE BANKS
09 = EXAMINE/MONITOR SALES LEDGER
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11 = EXAMINE/MONITOR (INCOMPLETE RECORDS)
12 = EXAMINE PRODUCT SALES
13 = EXAMINE/MONITOR (INCOMPLETE RECORDS)
14 = PRINT PROFIT/LOSS ACCOUNT
15 = UPDATE END MONTH FILES MAINTENANCE
16 = PRINT WEEK/MONTH PURCHASES
17 = PRINT WEEK/MONTH SALES
18 = ENTER/UPDATE PAYROLL (NOT YET AVAILABLE)
19 = PRINT YEAR AUDIT
20 = PRINT CASH FLOW FORECAST
21 = PRINT PROFIT LOSS ACCOUNT
22 = ENTER/UPDATE PAYOUT (NOT YET AVAILABLE)
23 = RETURN TO BASIC
24 = EXIT

WHICH ONE? (ENTER 1-24)
01 SUB. MENU EXAMPLE: 01 = EXAMINE: 02 = INSERT: 03 = AMEND: 04 = DELETE
05 = PRINT (1,2,3); 06 = NUMERIC COMBINATIONS: 07 = SORT

SELECT FUNCTION BY NUMBER:
13 = PRINT CUSTOMER STATEMENTS
14 = PRINT SUPPLIER STATEMENTS
15 = PRINT AGENT STATEMENTS
16 = PRINT TAX STATEMENTS
17 = PRINT WEEK/MONTH SALES
18 = PRINT WEEK/MONTH PURCHASES
19 = PRINT YEAR AUDIT
20 = PRINT PROFIT/LOSS ACCOUNT
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December 1980

December 9-12 and 15-17
Training Courses for Engineers, Fairchild's Microcomputer Education Center, San Jose CA. This series of technical training courses are offered for design engineers who must learn to design the microprocessor into a working system. The curriculum includes courses on data communications and the 6856 device, 3870 microcomputer designs, the 6800 microprocessor, and bit-slice techniques. Contact the Center at MS42-2120, 101 Bernal Rd, San Jose CA 95119, (408) 224-7095.

January 1981

January 7-9
The Fourteenth Annual Winter CES, Las Vegas Hilton, Convention Center, and the Jockey Club Hotel, Las Vegas NV. Over 700 manufacturers will be exhibiting goods from the audio, video, personal electronics and microcomputer industries. Contact The Consumer Electronics Shows, 2 Illinois Center, Suite 1607, 233 N Michigan Blvd, Chicago IL 60601, (312) 861-1040.

January 12-15
Communications Networks 1981, Albert Thomas Con-
Omikron’s Accounting Software

We made our reputation with our Mapper systems. One year ago we told TRS-80 Mod I owners that they could have standard CP/M, 8" drives, compatibility with the Mod II, the ability to transfer files from TRSdos to CP/M or run Newdos80, the TRSdos compatible operating system, with 8" and 5" drives all on line at once. Most of the readers said "too good to be true" and it was only the slowly spreading word (plus some excellent reporting—see August Byte column by Jerry Pournelle) that convinced you it worked.

Here we go again! A field-proven, fully integrated accounting package with self-instructive documentation for $350.00. Too good to be true? A General Ledger which has been running in the real world long enough to shake out the bugs and has sold for many times our price of $100.00. Too good to be true? Ok, if we have to, we can wait for the word to spread. But just to get the ball rolling—let me give you the particulars:

REQUIREMENTS:
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Storage - 2 disk units 250 kbytes each
Language - Microsoft Basic
O/S - CP/M

BENEFITS: This is not another re-write of the Osborne packages but a professionally produced and marketed set of accounting software originally produced for the Mitsu/Altair machine. It has been tested and debugged in actual use. It comes with sample data and a manual designed for self-instruction. They are thoughtfully designed, interactive programs with clear prompts for ease of operation. Source code and documentation to aid in customization are also included.

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January 16-17
Microcomputer Conference, Arizona State University, Tempe AZ. The goal of this microcomputer conference is to introduce educators to the applications of computers in the classroom. The emphasis of the conference is to provide an awareness of microcomputers and their impact on society. For further information, contact Dr. Gary G. Bitter, Arizona State University, Payne 203, Tempe AZ 85281.

January 27-29
Advanced Semiconductor Equipment Exposition, San Jose Convention Center, San Jose CA. Over 100 exhibitors will feature equipment at this trade show. The show's emphasis is on new products and emerging technology in the semiconductor processing and production fields. Contact Carlgard & Associates, 491 Macara Ave, Suite 1014, Sunnyvale CA 94086, (408) 245-6870.

January 28-31
The Third IMM/Data Comm International Japan Exposition, Harumi Exposition Center, South Hall, Tokyo, Japan. Over 15,000 scientists, design engineers, technical managers, applications engineers, and other specialists are expected to attend this show. Internecon Japan/Semiconductor International is held concurrently. The conference program will include talks on microcomputer-controlled data communications systems, peripheral interfacing, software management, and more. Contact Industrial and Scientific Conference Management Inc., 222 W Adams St, Chicago IL 60606, (312) 263-4866.

February 1981

February 2-5
The Second Middle East Electronic Communications Show and Conference, Bahrain Exhibition Centre, Bahrain. This conference will cover communications research, technology, and administration in satellite communications, digital communications, networks and industrial systems, and business communications. An exhibition will also be held. Contact TMAC, 680 Beach St, Suite 428, San Francisco CA 94109, (800) 227-3477.

February 4-5
Computer and Office Automation Show and Conference, Hyatt Regency Hotel, Vancouver, Canada. This conference will feature data-processing equipment, small-business computers, computer peripheral products, medium and high-speed copiers, word-processing systems, and conventional office products and services. Seminars on the role of computers in information management, electronic mail, data base applications, and other related topics, will be given. Contact Whiteside Publishing Ltd, Suite 1201, 55 Bloor St W, Toronto, Ontario, Canada M4W 3K2.

February 9-13
Reliability Engineering, Testing and Maintainability Engineering, University of California at Los Angeles. This course is designed for reliability, product assurance, logistics, quality assurance, and design engineers. The course is intended for those required to design and to predict the reliability of components, equipment, and systems. The fee is $790. Contact Continuing Education in Engineering and Mathematics, UCLA Extension, POB 24001, Los Angeles CA 90024, (213) 825-1047.
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BYTE December 1980 317
Blowing in the Wind

Dear Steve,

I wish to interface a digital anemometer to my Cromemco System III, but I have only a vague idea of the steps involved. I live on a windy hilltop and want to log wind-velocity data (to help me select the best type of windmill for electrical power generation).

The anemometer that I have is a Trade-Wind Model DIG78, manufactured by Trade-Wind Instruments, 1076 Loraine St, Enumclaw, WA 98022. The indoor display unit shows wind speeds from 00 to 99 mph (miles per hour) either instantaneously or by maximum gust encountered. This display uses CD4511 latch/decoder drives. (See figure 1.)

My general idea is to employ some three-state buffer circuits to transfer BCD (binary-coded decimal) data from the anemometer to the computer, then load the data into the accumulator with the IN instruction. What portion of the anemometer electronics should I tie into? What S-100 bus line should I use as a device-select signal?

Paul Palaske

Interfacing an anemometer to a computer sounds like something I'd do. Connecting it to an S-100 computer isn't terribly difficult. The accompanying circuit diagram should work, provided Trade-Wind Instruments used the devices you listed in the classical tradition. It is not enough to simply send the BCD signals to the S-100 bus; they must also be latched and gated at the proper time.

First, so that the computer knows what port it is reading, IC1 and IC2 are wired to decode hexadecimal port FF. (If you prefer another address, refer to my "Circuit Cellar" article on parallel ports in the June 1980 BYTE, page 37 "I/O Expansion for the TRS-80, Part 2: Serial Ports"). This signal is used to gate the output of a dual 4-bit latch (IC4) onto the bus. This latch is necessary because there is no way to tell how long the BCD-data signals in the anemometer are valid. It may be only a microsecond or two. When the output digits are updated, they are automatically latched into the IC4 as well. In this way, computer-program execution speed is independent of the electronics in the anemometer. This circuit should provide what you need... Steve

---

**Figure 1**

---

**Existing Anemometer**

---

**Computer Interface**

---

**Input Port FF Hexadecimal**

---

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- EBCDIC ↔ ASCII or BAUDOT

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Circle 261 on inquiry card.
Interfacing a Joystick

Dear Steve,

I would like to interface an Atari joystick (made up of simple switches, not potentiometers) to the input port of my Exidy Sorcerer microcomputer. I don’t believe the software will be difficult, but do I hook up the “common” wire from these switches to +5 V, and each lead to an input bit on the port? Are “tie-up” resistors required?

Richard Legault

Although I am not familiar with the Sorcerer, I assume that the input port is TTL (transistor-transistor logic) or LSTTL (low-power Schottky TTL); if so, I suggest that you attach a pull-up resistor and switch to each bit as shown in the diagram (see figure 2). When the switch is open, a logic 1 is presented to the input port; when the switch is closed, a logic 0 is presented....Steve

Figure 2

![Diagram of joystick interface](image)

I can think of a few ways for you to build an under $50 computer, but not in less than a month. To keep costs down, it would have to be built from scratch. If it used a printed-circuit board, it would be much more expensive. There have been circuits for microcomputers in BYTE and other magazines many times within the past three years. I suggest you check the back issues or request an index from the magazines.

Once you have a circuit, you will still need the parts. You may be unaware that some companies, notably Intel, practically give away whole computers in the name of education. Write to Intel Corporation, calling attention to the product manager to the particular microprocessor you are interested in, and ask about the price and delivery of “University Kits.” These are functional, cosmetically rejected devices that are practically given away for a nominal handling charge. In 1976, people were getting 8080A kits including programmable memory, EPROMS (erasable programmable read-only memories), and I/O (input/output) devices, worth about $800 from the distributors, for $20. I’m sure other companies have the same interest in supporting the schools....Steve

Periodical Guide

Dear Steve,

I am currently building a Central Data 2650 computer system, which uses S-100 circuit boards for memory and I/O (input/output). Could you please send me a list of construction articles that have appeared in BYTE and other magazines that might help me?

Kenneth Johnston

It sounds to me as though you need a good periodical guide. I suggest that you order a complete set of the Periodical Guide for Computerists, E. Berg Publications, 14751 112th Ave NE, Kirkland WA 98033. The guides start in 1975, and cost between $5 and $6 per year thru 1979. They include both subject and author indexes for over 9800 articles from BYTE, Electronics, Computer Design, Radio Electronics, and twenty other magazines.

The guides include listings under such varied topics as construction, languages, and robotics. These guides should help you find what you want....Steve

Quick and Cheap

Dear Steve,

For my high school science fair project, I am interested in building a microcomputer to show the advantages and uses of a microprocessor. I have not been able to find suitable plans, and I think that you can help me.

The unit I would like to construct should be of reasonable cost ($50 or so), show the basic workings of a microprocessor, and still be of some use to me in my home or on my farm. The unit could also incorporate photovoltaic or heat-sensor devices. I have failed so far to find anything that fulfills my requirements. Do you know of any plans or kits that are close to what I am describing?

I would very much appreciate it if you could spare some time and do some searching for me. My science fair is about a month away, so I need your advice as soon as possible.

Kevin Meyenburg

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Pathways Through the ROM, Guide to Level II BASIC and DOS. Robert M Richardson, Roger Fuller.

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Circle 266 on inquiry card.

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Listing 1: The second third of the firmware for Micrograph control, written for the Z80 microprocessor used in the prototype. The first fifteen pages of this listings were given in Part 1 of this article. The remaining portion of the firmware will be included in January 1981 BYTE's final installment of this series, along with a description of the software and an explanation of its use.

Micrograph continued:

```
931: ; E (TEMPORARY)
932: ; H (POINTER)
933: ; L (POINTER)
934: ;
935: ; 1/O PORT O (DISPLAY CONTROL)
936: ;
937: ; STRUCTURES GDR (GRAPHIC DISPLAY REGISTERS)
938: ;
939: LREG: AND 00001111B ; CLEAR OF CODE
0340: EREP CP 00001111B ; TEST FOR RESET
0341: EREP CF 00001111B ; TEST FOR RESET IF GDR15
0342: LP 8F ; LOAD LOAD BYTE
0343: LP 16F ; CLEAR POINTER
0344: LDR 118010 ; SET UP BASE ADDRESS
0345: ADD HL,DE ; ADD BASE ADDRESS
0346: CALL FETCH ; GET DATA
0347: LD (HL),A ; SAVE THE DATA
0348: OUT (D),A ; SENT DISPLAY CONTROL
0349: RET ; RETURN
0350: ;
0351: ;
0352: ; LSUB *******************************************************************************
0353: ;
0354: ; LSUB LOADS A SUBROUTINE INTO RAM AT THE SPECIFIED ADDRESS AND WITH THE SPECIFIED LENGTH. LSUB FIRST GETS THE SUBROUTINE NUMBER, THEN SETS THE LENGTH IN SLONG. THE SUBROUTINE ADDRESS IS SAVED IN SLINK. GETBLK IS THEN CALLED TO READ IN THE DATA.
0355: ;
0356: ; CALLS FETCH
0357: ; GETBLK
0358: ;
0359: ; CALLED BY PRIMAT (INDIRECTLY)
0360: ;
0361: ; REGISTERS A (PRIMITIVE OF CODE, TEMPORARY)
0362: ; B (LENGTH)
0363: ; C (POINTER)
0364: ; D (POINTER)
0365: ; E (POINTER)
0366: ; F (POINTER)
0367: ; G (POINTER)
0368: ; H (POINTER)
0369: ; IY (INDEX)
0370: ;
0371: ; I/O NONE
0372: ;
0373: ; STRUCTURES SLINK (SUBROUTINE LINK)
0374: ; SLONG (SUBROUTINE LENGTH)
0375: ;
0376: LSUB: AND 00001111B ; CLEAR OF CODE
0377: ;
```

Listing 1 continued on page 328
Listing 1 continued:

942  CALL FETCH   ;GET ADDRESS HIGH BYTE
943  LD  H.A     ;SAVE HIGH BYTE
944  LD  (Y+1),A ;SAVE HIGH BYTE
945  CALL GETBLK ;GET DATA
946  RET         ;RETURN
947  ;LSYM ********************************************
948  1000  LSYM LOADS SYMBOL DEFINITIONS INTO THE INTERNAL
949  1001  SYMBOL GENERATOR, SYMTAB. LSYM FIRST CHECKS TO SEE
950  1002  IF ALL OR JUST ONE SYMBOL IS TO BE LOADED. IF ALL
951  1003  ALL ARE TO BE LOADED, LSYM LOAD 1024 SYMBOL ELEMENTS
952  1004  (FOR 128 SYMBOLS). OTHERWISE, LSYM LOADS & SYMBOL
953  1005  ELEMENTS FOR ONE SYMBOL.
954  1006  
955  1007  CALLS FETCH
956  1008  GETBLK
957  1009  
958  1010  CALLED BY PRIMAT (INDIRECTLY)
959  1011  
960  1012  REGISTERS A    (PRIMITIVE OP CODE)
961  1013  B    (COUNTER)
962  1014  C    (COUNTER)
963  1015  H    (POINTER)
964  1016  L    (POINTER)
965  1017  
966  1018  I/O   VONE
967  1019  
968  1020  STRUCTURES SYMTAB (SYMBOL TABLE)
969  1021  
970  0300  LBA7
971  0301  2806
972  1022  LSYM: BIT 0,A   ;TEST FOR LOAD TYPE
973  1023  JR  Z,LSYM1   ;JUMP IF SINGLE LOAD
974  1024  LD  HL,SYM TAB ;LOAD POINTER
975  1025  LD  C,4     ;LOAD COUNT
976  1026  LSYM: LD  B,0   ;SLT COUNT OF 256
977  1027  CALL GETBLK ;GET DATA
978  1028  DEC  C     ;DECREMENT COUNT
979  1029  JR  NZ,LSYM  ;JUMP IF NOT DONE
980  1030  RET         ;RETURN
981  1031  LSYM1: CALL FETCH ;GET SYMBOL NUMBER
982  1032  AND 0111111B ;MASK HIGH BIT
983  1033  LD  L,A     ;SAVE OFFSET
984  1034  LD  H,0     ;CLEAR POINTER
985  1035  SLA  L     ;SHIFT OVER
986  1036  RL  H      ;THREE BITS
987  1037  SLA  L     ;TO PROPERLY
988  1038  RL  H      ;COMPUT
989  1039  SLA  L     ;THE
990  1040  RL  H      ;OFFSET
991  1041  LD  BC,SYM TAB ;POINT TO SYMTAB
992  1042  ADD  HL,BC ;ADD BASE ADDRESS
993  1043  LD  B,0     ;GET COUNT
994  1044  CALL GETBLK ;GET DATA
995  1045  RET         ;RETURN
996  1046  ;MOV ***********************************************************
997  1047  ;MOV MOVES THE CURRENT XY POSITION. THE XY POSITION
998  1048  ;MAY BE UPDATED BY ABSOLUTE OR RELATIVE OFFSETS.
999  1049  ;AND BY LONG OR SHORT OFFSETS. THE POINT MAY OR MAY
1000  ;NOT BE ILLUMINATED IN EITHER THE PRIMARY OR SECONDARY
1001  ;COLOR. MOV FIRST DETERMINES THE NEW XY LOCATION
1002  ;BY ADDING OFFSETS IF THEY ARE RELATIVE, AND BY
Listing 1 continued:

03FB 4F 1055: ; LOADING NEW POSITIONS. MOV NEXT CHECKS TO SEE IF
03FC DD7E05 1056: ; THE POINT WILL BE ILLUMINATED. IF NO, THE PROPER
03FD DD7743 1057: ; COLOR IS INSERTED AT THAT PIXEL.
0402 C0A107 1058:
0405 DD5600 1059: ; CALLED BY CASE
0408 D05E01 1060: ; FETCH
040B CD8D01 1061:
0410 CB89 1062: ; PUT
0413 CB85 1063: ; CALL CASE
0416 CB3F 1064: ; REGISTER
0419 CB3F 1065: ; A (PRIMITIVE OF CODE, TEMPORARY)
041C CB3F 1066: ; B (CASE)
041F CB3F 1067: ; C (TEMPORARY)
0423 CB8F 1068: ; D (TEMPORARY X)
0426 ED44 1069: ; E (TEMPORARY Y)
0427 82 1070: ; IX (INDEX)
0428 57 1071:
0429 F1 1072: ; I/O
042A ED60F 1073:
042C ED5F 1074: ; STRUCTURES
042E 3804 1075: ; GDRO (X)
0430 ED8F 1076: ; GDR1 (Y)
0433 83 1077: ; GDN2 (PRIMARY COLOR)
0436 ED44 1078: ; GDR3 (SECONDARY COLOR)
0437 83 1079: ; GDR5 (VECTOR MODE)
0438 9F 1080:
0439 1113 1081: ; MOV: LD C,A ; SAVE A COPY OF A
043B 1114 1082: ; LD A,(IX+GDR5) ; GET VECTOR MODE
043D 1115 1083: ; LD (IX+REF),A ; SAVE REFERENCE
043F 1116 1084: ; CALL CASE ; DETERMINE CASE
0441 1117 1085: ; LD D,(IX+GDR1) ; GET X
0443 1118 1086: ; LD E,(IX+GDR1) ; GET Y
0445 1119 1087: ; CALL FETCH ; GET DATA
0447 111A 1088: ; BIT 3,C ; TEST IF LONG
0449 111B 1089: ; JR NZ,MOV3 ; JUMP IF LONG
044B 111C 1090: ; JR NZ MOV3 ; JUMP IF ABSOLUTE
044D 111D 1091: ; JR NZ,MOV3 ; SAVE A COPY OF A
044F 111E 1092: ; JR NZ MOV3 ; SHIFT OVER
0451 111F 1093: ; JR N2,MOV3 ; TO MASK ALL BUT
0453 1120 1094: ; JR N2,MOV3 ; X OFFSET
0455 1121 1095: ; JR N2,MOV3 ; CLEAR SIGN
0457 1122 1096: ; JR N2,MOV3 ; NEGATE THE VALUE
0459 1123 1097: ; JR N2,MOV3 ; ADD THE OFFSET TO X
045B 1124 1098: ; JR N2,MOV3 ; SAVE THE NEW VALUE
045D 1125 1099: ; JR N2,MOV3 ; RESTORE A
045F 1126 1100: ; MOV: ADD A,D ; MASK ALL BUT Y OFFSET
0461 1127 1101: ; ADD A,D ; TEST SIGN OF OFFSET
0463 1128 1102: ; ADD A,D ; JUMP IF POSITIVE
0465 1129 1103: ; ADD A,D ; CLEAR SIGN
0467 112A 1104: ; ADD A,D ; NEGATE THE VALUE
0469 112B 1105: ; ADD A,D ; ADD THE OFFSET TO Y
046B 112C 1106: ; ADD A,D ; SAVE THE NEW VALUE
046D 112D 1107: ; ADD A,D ; JUMP TO PROCESS POINT
046F 112E 1108: ; MOV1: LD E,A ; SAVE A COPY OF A
0471 112F 1109: ; LD E,A ; SHIFT OVER
0473 1130 1110: ; JR MOVY ; TO MASK ALL BUT
0475 1131 1111: ; JR MOVY ; X OFFSET
0477 1132 1112: ; MOV2: PUSH AF ; SAVE THE NEW VALUE
0479 1133 1113: ; SRL A ; RESTORE A
047B 1134 1114: ; SRL A
047D 1135 1115: ; SRL A
047F 1136 1116: ; SRL A
0481 97 1117: ; LD D,A
0483 F1 1118: ; POP AF

Listing 1 continued on page 330
Listing I continued:

| 0443 | E60F | 1117 | AND 0000111B  |
| 0444 | 51   | 1120 | LD E,A       |
| 0446 | 1922 | 1121 | JR MOV1      |
| 0448 | CB31 | 1122 | MOV3: BIT 2,C |
| 044A | 2019 | 1123 | JR NZ,MOV6   |
| 0450 | CB7F | 1124 | BIT 7,A      |
| 0452 | 2B04 | 1125 | JR Z,MOV4    |
| 0454 | CB8F | 1126 | RES 7,A      |
| 0456 | ED44 | 1127 | NEG          |
| 0458 | 02   | 1128 | MOV4: ADD A,D |
| 045A | 57   | 1129 | LD D,A       |
| 045C | 0101 | 1130 | CALL FETCH   |
| 045E | CB71 | 1131 | BIT 7,A      |
| 0460 | 2B04 | 1132 | JR Z,MOV5    |
| 0462 | CB6F | 1133 | RES 7,A      |
| 0464 | ED44 | 1134 | NEG          |
| 0466 | 53   | 1135 | MOV5: ADD A,E |
| 0468 | 1859 | 1136 | JR MOV7      |
| 046A | 57   | 1137 | MOV6: LD D,A |
| 046C | CDE01| 1138 | CALL FETCH   |
| 046E | CB44 | 1140 | LD E,A       |
| 0470 | CD200 | 1141 | MOV7: LD (X+GDRO),D |
| 0472 | CD301 | 1142 | LD (X+GDRI),L |
| 0474 | 01   | 1143 | BIT 0,C      |
| 0476 | CD4F | 1144 | JR NZ,MOV8   |
| 0478 | 1171 | 1145 | RLI          |
| 047A | CD7E02 | 1146 | MOV8: LD A,(X+GDR2) |
| 047C | CB49 | 1147 | BIT 1,C      |
| 047E | CD7E03 | 1148 | JR Z,MOV9    |
| 0480 | E001 | 1149 | LD A,(X+GDR3) |
| 0482 | CD7E0A | 1150 | MOV9: LD C,1 |
| 0484 | CD7E0A | 1151 | CALL PUT     |
| 0486 | CB47 | 1152 | POP PUT      |

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Listing 1 continued:

047F 2820 1184 JR Z,RCRAM2  ; JUMP IF SINGLE
0480 FE7D 1185 CP 01111101B  ; TEST REFERENCE
0485 2007 1186 JR NZ,RCRAM2  ; JUMP IF NOT ALL
048A 0630 1187 LD B,4B  ; SET COUNT OF 4B
048F 0001C 1188 LD HL,CRO  ; SET BASE ADDRESS
0492 CD880A 1189 CALL SENDBK  ; SEND THE DATA
0495 C9 1190 RET  ; RETURN
0496 0610 1191 RCRAM1: LD B,16  ; SET COUNT OF 16
0497 E60C 1192 RCRAM1: AND 00001100B  ; MASK OP CODE
0498 CB27 1193 SLA A  ; SHIFT OFFSET
049C CB27 1194 SLA A  ; SHIFT OFFSET
049E 6F 1195 LD L,A  ; SAVE OFFSET
049F 2600 1196 LD H,O  ; CLEAR POINTER
04A0 11001C 1197 LD DE,CRO  ; SET BASE ADDRESS
04A4 19 1198 ADD HL,DE  ; ADD BASE TO OFFSET
04A5 CD880A 1199 CALL SENDBK  ; SEND THE DATA
04A8 C9 1200 RET  ; RETURN
04A9 HL7C 1201 RCRAM2: LD B,0111100B  ; TEST REFERENCE
04AB 2027 1202 JR NZ,RCRAM3  ; JUMP IF NOT ALL
04AE CD910A 1203 CALL FETCH  ; GET OFFSET
04B0 E60F 1204 AND 00001111B  ; MASK THE OFFSET
04B2 6F 1205 LD L,A  ; SAVE OFFSET
04B3 2600 1206 LD H,O  ; CLEAR POINTER
04B5 11001C 1207 LD DE,CRO  ; SET BASE ADDRESS
04B8 19 1208 ADD HL,DE  ; ADD BASE TO OFFSET
04BF 50 1209 LD E,L  ; SAVE THE POINTER
04C0 54 1210 LD D,H  ; CLEAR THE POINTER
04C3 FD210000 1211 ADD IY,DE  ; SAVE INDEX
04C6 FD7E00 1212 JR (IY+0)  ; GET DATA
04C9 CD910A 1213 CALL SENDBY  ; SEND THE DATA
04CE FD7E10 1214 LD A,(IY+16)  ; SET DATA
04D0 CD910A 1215 CALL SENDBY  ; SEND THE DATA
04D4 FD7E20 1216 LD A,(IY+32)  ; SET DATA
04D8 CD910A 1217 CALL SENDBY  ; SEND THE DATA
04DC CA C9 1218 RET  ; RETURN
04DD 0601 1220 RCRAM3: LD B,1  ; SET THE COUNT
04DE E60C 1221 AND 00001100B  ; MASK OP CODE
04F2 CB27 1222 SLA A  ; SHIFT OFFSET
04F6 CB27 1223 SLA A  ; SHIFT OFFSET
04F8 6F 1224 LD L,A  ; SAVE OFFSET
04FB 2600 1225 LD H,O  ; CLEAR POINTER
04FD CD910A 1226 CALL FETCH  ; GET OFFSET
04F7 E60F 1227 AND 00001111B  ; MASK THE OFFSET
0502 85 1228 ADD A,L  ; ADD OFFSET
0504 6F 1229 LD L,A  ; SAVE OFFSET
0507 11001C 1230 LD DE,CRO  ; SET BASE ADDRESS
050B 19 1231 ADD HL,DE  ; ADD BASE TO OFFSET
050F CD880A 1232 CALL SENDBK  ; SEND THE DATA
0513 C9 1233 RET  ; RETURN

1234 ; RETN  ;
1235 ;
1236 ;
1237 ; RETN RETURNS FROM A GRAPHICS SUBROUTINE, RETN FIRST
1238 ; CHECKS SPRTR TO SEE IF A SUBROUTINE IS IN PROGRESS.
1239 ; IF NOT, RETN SIMPLY RETURNS. IF SO, RETN POPS
1240 ; SOFF AND SPRTR FROM GSTACK AND RETURNS.
1241 ;
1242 ; CALLS NONE
1243 ;
1244 ; CALLED BY PRIMAT (INDIRECTLY)
1245 ;
1246 ; REGISTERS A (PRIMITIVE OP CODE)
1247 ; D (TEMPORARY)

Listing 1 continued on page 332
Listing 1 continued:

1248: E (TEMPORARY)
1249: H (POINTER)
1250: L (POINTER)
1251: IX (INDEX)
1252: 
1253: I/O NONE
1254: 
1255: STRUCTURES GPC (GRAPHICS STACK POINTER)
1256: GSTACK (GRAPHICS STACK)
1257: SOFF (SUBROUTINE OFFSET)
1258: SPTR (SUBROUTINE POINTER)
1259: 
04EL: DD8405E 1260: RETN: BIT 3,(IX+SPTR) :TEST SPTR
04F2: C8 1261: RET Z :RETURN IF ZERO
04F3: D3542 1262: DEC (IX+GPC) :UPDATE THE STACK
04F4: DDSBE2 1263: LD E,(IX+GPC) :LOAD GPC
04F5: 1600 1264: LD D,O :CLEAR POINTER
04F6: 217F10 1265: LD HL,GSTACK :SET INDEX TO GSTACK
04F7: B7 1266: OR A :CLEAR THE CARRY
04F8: ED52 1267: SBC HL,DE :SUBTRACT INDEX TO GSTACK
0501: 7E 1268: LD A,(HL) :POP SOFF
0502: D771 1269: LD (IX+SOF),A :RETURN OFFSET
0505: 23 1270: INC HL :UPDATE THE POINTER
0506: 7E 1271: LD A,(HL) :POP SPTR
0507: D7740 1272: LD (IX+SPTR),A :RETURN SPTR
050A: DD542 1273: DEC (IX+GPC) :DECREMENT OFFSET
050C: CS 1274: RET :RETURN
1275: 
1276: RPIX **************************************************
1277: 
1278: RPIX READS FIXLL DATA ACCORDING TO THE GIVEN
1279: REFERENCE. RPIX CAN DUMP EITHER FULL FRAME, ONE
1280: PIXEL AT XY, OR AN ENTIRE VIEWPORT. RPIX FIRST CHECKS
1281: TO SEE IF ONLY A SINGLE POINT IS TO BE DUMPED. IF SO,
1282: RPIX DUMPS THE POINT AT XY. OTHERWISE, RPIX SETS A
1283: FLAG IF FULL FRAME IS SET. X AND Y ARE CLEARED, AND
1284: RPIX PROCEEDS FROM THE ORIGIN TO THE MAXIMUM X AND Y
1285: VALUES, LEFT TO RIGHT, BOTTOM TO TOP. IF FULL FRAME
1286: IS SET, ALL PIXELS ARE DUMPED. OTHERWISE, THE
1287: CASE AND CLIPPING SUCCESS ARE CHECKED. IF THE PIXEL
1288: IS VISIBLE, THE FIXLL IS DUMPED. RPIX COMPLETES
1289: WHEN X AND Y HAVE RECYCLED TO THE ORIGIN.
1290: 
1291: CALLS SENDBY
1292: CASE
1293: CLIP
1294: FEEK
1295: 
1296: CALLED BY PRIMATE (INDIRECTLY)
1297: 
1298: REGISTERS A (PRIMARY OF CODE)
1299: B (CASE)
1300: C (CLIP SUCCESS)
1301: D (FULL FRAME FLAG)
1302: IX (INDEX)
1303: 
1304: I/O NONE
1305: 
1306: STRUCTURES GDRO (X)
1307: GDR1 (Y)
1308: REF (REFERENCE)
1309: 
050E: 1600 1310: RPIX: LD D,0 :CLEAR FULL FRAME FLAG
0510: E50F 1311: AND 0000111B :MASK OP CODE
0512: DD7743 1312: LD (IX+REF),A :SAVE REFERENCE
Listing 1 continued:

0515  DDCB433E  1313  SRL (IX+REF)  
0519  DDCB433E  1314  SRL (IX+REF)  :SHIFT REFERENCE 
051D  CB5F  1315  BIT 3,A  :SHIFT REFERENCE 
0521  CB57  1316  JR Z,RPIX1  :TEST REFERENCE 
0523  2807  1317  JR Z,RPIX0  :JUMP IF VP REFERENCE 
0525  CD4408  1318  CALL PEEK  :TEST REFERENCE 
0526  CD910A  1319  CALL SENDBY  :JUMP IF FULL FRAME 
0528  C7  1320  RET  :GET DATA 
052C  1601  1321  CALL SENDBY  :SEND THE DATA 
0530  CD4007  1322  RPIX0: LD D,1  :RETURN 
0533  DB360000  1323  JR RPIX2  :SET FULL FRAME FLAG 
0537  DB361000  1324  RPIX1: CALL CASE  :JUMP 
053B  CB42  1325  RPIX2: LD (IX+GDR0),0  :DETERMINE CASE 
053D  2007  1326  RPIX3: BIT 0,D  :CLEAR X 
053F  CDEF07  1327  JR NZ,RPIX4  :CLEAR Y 
0542  D41  1328  CALL CLIP  :TEST D 
0544  2806  1329  CALL CLIP  :JUMP IF CLIPPED 
0549  CB910A  1330  JR Z,RPIX5  :READ THE DATA 
054C  DB3400  1331  CALL PEEK  :TEST FOR CLIP 
054F  20EA  1332  CALL SENDBY  :TEST SUCCESS 
0551  DB3401  1333  JR Z,RPIX5  :JUMP IF CLIPPED 
0554  20ES  1334  INC (IX+GDR0)  :READ THE DATA 
0556  C6  1335  JR NZ,RPIX3  :TEST FOR CLIP 
1337  RET  :TEST SUCCESS 
1338  
1340  :RREG************************************************************************** 
1341  ; RREG RETURNS THE VALUE OF THE DESIGNATED GRAPHICS 
1342  ; DISPLAY REGISTER. RREG FIRST DETERMINES THE REGISTER 
1343  ; NUMBER, THEN RETURNS THE VALUE VIA SENDBY. 
1344  ; 
1345  ; CALLS SENDBY 
1346  ; 
1348  ; CALLED BY PRIMAT (INDIRECTLY) 
1349  ; 
1350  ; REGISTERS A (PRIMITIVE OP CODE) 
1351  ; D (TEMPORARY) 
1352  ; E (TEMPORARY) 
1353  ; H (POINTER) 
1354  ; L (POINTER) 
1355  ; 
1356  ; I/O NONE 
1357  ; 
1358  ; STRUCTURES GDR (GRAPHICS DISPLAY REGISTERS) 
1359  ; 
1360  ; RREG: AND 0000111B  :MASK OFF OP CODE 
1361  ; LD L,A  :LOAD OFFSET 
1362  ; LD H,0  :CLEAR POINTER 
1363  ; LD DE,STRUCT+HDR  :SET BASE ADDRESS 
1364  ; ADD HL,DE  :ADD OFFSET 
1365  ; LD A,(HL)  :GET THE REGISTER 
1366  ; CALL SENDBY  :SEND THE DATA 
1367  ; RET  :RETURN 
1368  ; 
1369  ; RSUB************************************************************************** 
1370  ; 
1371  ; RSUB DUMPS A SUBROUTINE TO THE HOST. RSUB FIRST 
1372  ; IDENTIFIES THE SUBROUTINE NUMBER AND DETERMINES THE 
1373  ; START ADDRESS VIA SLINK. SLONG ENTRIES DETERMINE THE 
1374  ; SUBROUTINE LENGTH. RSUB CALLS SENDBK TO DUMP THE 
1375  ; DATA. 
1376  ; 
1377  ; CALLS SENDBK 

Listing 1 continued on page 334
Listing 1 continued:

13/9 ; 1379 ; CALLED BY PRIMAT (INDIRECTLY)
13/9 ; 1380 ; 13/9 ; 1381 ; REGISTERS A (PRIMITIVE OPER CODE)
13/9 ; 1382 ; B (COUNT)
13/9 ; 1383 ; D (POINTER)
13/9 ; 1384 ; E (POINTER)
13/9 ; 1385 ; H (POINTER)
13/9 ; 1386 ; L (POINTER)
13/9 ; 1387 ; IX (INDEX)
13/9 ; 1388 ; IY (INDEX)
13/9 ; 1389 ; 13/9 ; 1390 ; I/O NONE
13/9 ; 1391 ; 13/9 ; 1392 ; STRUCTURES SLINK (SUBROUTINE LINKAGE)
13/9 ; 1393 ; SLONG (SUBROUTINE LENGTH)
0565 ; 1394 ; E60F 0567 ; 1395 ; 5F
0565 ; 1396 ; 1600 0567 ; 1397 ; 0
056A ; 1398 ; CB23 056C ; 1399 ; FD219010
0570 ; 1399 ; FD19 0572 ; 1400 ; 1401
0575 ; 1402 ; FD6601 0578 ; 1403 ; FD216010
057C ; 1404 ; CB38 057E ; 1405 ; 1406
13/9 ; 1407 ; DB 13/9 ; 1408 ; CALL SEndBK
13/9 ; 1409 ; RS ~Y: AND 00001111B ;CLEAR OP CODE
1410 ; 13/9 ; 1411 ; 5F ;SAVE OFFSET
1412 ; 13/9 ; 1413 ; 0 ;CLEAR POINTER
1414 ; 13/9 ; 1415 ; 1 ;SHIFT THE OFFSET
1416 ; 13/9 ; 1417 ; 1 ;GET LINKAGE
1418 ; 13/9 ; 1419 ; ADD IY,DE ;ADD OFFSET
1420 ; 13/9 ; 1421 ; 1 ;GET LOW BYTE OF START
1422 ; 13/9 ; 1423 ; 1 ;GET HIGH BYTE OF START
1424 ; 13/9 ; 1425 ; 1 ;GET LENGTH
1426 ; 13/9 ; 1427 ; 1 ;SHIFT THE OFFSET
1428 ; 13/9 ; 1429 ; 1 ;GET LENGTH
1430 ; 13/9 ; 1431 ; CALL SENDBK ;SEND THE DATA
1432 ; 13/9 ; 1433 ; RS ~Y: ;RETURN
1434 ; 13/9 ; 1435 ; JR NZ,RSYM ;JUMP IF ALL
1436 ; 13/9 ; 1437 ; CALL FETCH ;GET ADDRESS
1438 ; 13/9 ; 1439 ; AND 01111111B ;MASK THE MSB
1440 ; 13/9 ; 1441 ; LD L,A ;SAVE OFFSET
1442 ; 13/9 ; 1443 ; LD H,O ;CLEAR POINTER
1444 ; 13/9 ; 1445 ; LD BC,SYTAB ;POINT TO START
1446 ; 13/9 ; 1447 ; SLA L ;SHIFT OFFSET
13/9 ; 1448 ; 13/9 ; 1449 ; RL H ;THREE
13/9 ; 1450 ; SLA L ;BITS TO
### Listing 1 continued:

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>059C C814</td>
<td>1443</td>
<td>RL H</td>
</tr>
<tr>
<td>059E C825</td>
<td>1444</td>
<td>SLA L</td>
</tr>
<tr>
<td>05A0 C814</td>
<td>1445</td>
<td>RL H</td>
</tr>
<tr>
<td>05A2 D9</td>
<td>1446</td>
<td>ADD HL,BC</td>
</tr>
<tr>
<td>05A3 0608</td>
<td>1447</td>
<td>LD B,8</td>
</tr>
<tr>
<td>05A5 CD800A</td>
<td>1448</td>
<td>CALL SENDBK</td>
</tr>
<tr>
<td>05A8 C9</td>
<td>1449</td>
<td>RET</td>
</tr>
<tr>
<td>05A9 210014</td>
<td>1450</td>
<td>RSYM: LD HL,SYMTAB; RETURN</td>
</tr>
<tr>
<td>05AC 0600</td>
<td>1451</td>
<td>LD B,0</td>
</tr>
<tr>
<td>05B1 CD800A</td>
<td>1452</td>
<td>CALL SENDBK</td>
</tr>
<tr>
<td>05B4 CD800A</td>
<td>1453</td>
<td>CALL SENDBK</td>
</tr>
<tr>
<td>05B7 CD800A</td>
<td>1454</td>
<td>CALL SENDBK</td>
</tr>
<tr>
<td>05BA C9</td>
<td>1455</td>
<td>CALL SENDBK</td>
</tr>
<tr>
<td></td>
<td>1456</td>
<td>RET</td>
</tr>
<tr>
<td></td>
<td>1457</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1458</td>
<td>;SYM</td>
</tr>
<tr>
<td></td>
<td>1459</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1460</td>
<td>;SYM DISPLAYS A STRING OF SYMBOLS STARTING AT THE</td>
</tr>
<tr>
<td></td>
<td>1461</td>
<td>CURRENT XY POSITION, SYM FIRST DETERMINES THE</td>
</tr>
<tr>
<td></td>
<td>1462</td>
<td>NUMBER OF SYMBOLS, THEN READS IN THE SYMBOL CODE</td>
</tr>
<tr>
<td></td>
<td>1463</td>
<td>POINTING TO THE APPROPRIATE SYMTAB ENTRY. XY</td>
</tr>
<tr>
<td></td>
<td>1464</td>
<td>POINTS TO THE LOWER LEFT CORNER OF THE SYMBOL. SYMTAB</td>
</tr>
<tr>
<td></td>
<td>1465</td>
<td>ENTRIES ARE FETCHED FOR DISPLAY OF THE 8 X 8 MATRIX</td>
</tr>
<tr>
<td></td>
<td>1466</td>
<td>WHICH DEFINES THE SYMBOL.</td>
</tr>
<tr>
<td></td>
<td>1467</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1468</td>
<td>;CALLED BY PRIMAT (INDIRECTLY)</td>
</tr>
<tr>
<td></td>
<td>1469</td>
<td></td>
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<tr>
<td></td>
<td>1470</td>
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<tr>
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<tr>
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<td>;REGISTERS A (PRIMITIVE OF CODE, TEMPORARY)</td>
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<tr>
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<td>1474</td>
<td>;B (CASE)</td>
</tr>
<tr>
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<tr>
<td></td>
<td>1476</td>
<td>;C (SUCCESS)</td>
</tr>
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<td>;D (ROW COUNT)</td>
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<tr>
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<td>1480</td>
<td>;E (COLUMN COUNT)</td>
</tr>
<tr>
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<td>1481</td>
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</tr>
<tr>
<td></td>
<td>1482</td>
<td>;H (CHARACTER COUNT)</td>
</tr>
<tr>
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<td>1484</td>
<td>;L (TEMPORARY)</td>
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<tr>
<td></td>
<td>1486</td>
<td>;IX (INDEX)</td>
</tr>
<tr>
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<td>1488</td>
<td>;IY (INDEX)</td>
</tr>
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<td>1489</td>
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</tr>
<tr>
<td></td>
<td>1490</td>
<td>;STRUCTURES GDRO (X)</td>
</tr>
<tr>
<td></td>
<td>1491</td>
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</tr>
<tr>
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<td>1492</td>
<td>;GDRO1 (Y)</td>
</tr>
<tr>
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<td>1493</td>
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</tr>
<tr>
<td></td>
<td>1494</td>
<td>;GDRO2 (PRIMARY COLOR)</td>
</tr>
<tr>
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<tr>
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<td>1496</td>
<td>;GDRO3 (SECONDARY COLOR)</td>
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<tr>
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<td>1498</td>
<td>;GDRO4 (VECTOR MODE)</td>
</tr>
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<td>1501</td>
<td></td>
</tr>
<tr>
<td>05B0 6405</td>
<td>1493</td>
<td>SYM: AND U0001111B; ;MASK THE OF CODE</td>
</tr>
<tr>
<td>05B0 6789</td>
<td>1494</td>
<td>LD H,A</td>
</tr>
<tr>
<td>05B0 6807</td>
<td>1495</td>
<td>LD A,(IX+GDRO5)</td>
</tr>
<tr>
<td>05B1 0072</td>
<td>1496</td>
<td>LD (IX+REF),A</td>
</tr>
<tr>
<td>05B2 0800</td>
<td>1497</td>
<td>CALL CASE</td>
</tr>
<tr>
<td>05B3 0001</td>
<td>1498</td>
<td>LD C,1</td>
</tr>
<tr>
<td>05B4 0501</td>
<td>1499</td>
<td>DEC (IX+GDRO1)</td>
</tr>
<tr>
<td>05B5 0600</td>
<td>1500</td>
<td>LD A,(IX+GDRO)</td>
</tr>
<tr>
<td>05B6 0608</td>
<td>1501</td>
<td>SUB E</td>
</tr>
<tr>
<td>05B7 0700</td>
<td>1502</td>
<td>LD (IX+GDRO),A</td>
</tr>
<tr>
<td>05B8 0840</td>
<td>1503</td>
<td>SYM: INC (IX+GDRO1)</td>
</tr>
<tr>
<td>05B9 0800</td>
<td>1504</td>
<td>LD A,(IX+GDRO)</td>
</tr>
<tr>
<td>05BA 0805</td>
<td>1505</td>
<td>ADD A,B</td>
</tr>
<tr>
<td>05BB 0806</td>
<td>1506</td>
<td>LD (IX+GDRO),A</td>
</tr>
</tbody>
</table>

Listing 1 continued on page 336
Listing 1 continued:

050D 7C 050E FEO0 0512 6B 0513 25 0514 DD7E01 0515 6E74 0517 5F 0518 1600 0519 CB23 051A CB12 051B CB23 051C CB12 051D CB23 051E CB12 0520 FD210014 0522 F019 0523 1608 0524 D3400 0526 7A 0527 FE00 0528 28C4 0529 DD3500 052A 15 052B DF7E00 052C F023 052D F0E8 052E 6F 0530 7B 0531 FE00 0532 2600 0533 0D7E00 0534 D068 0535 DD7700 0536 DD3501 0537 180A 0538 7B 0539 0D7E00 053A 3800 053B 6F 053C DD7E03 053D 1804 053E 6F 053F DD7E02 0540 C7E0 0541 DD3400 0542 1806

0543 1502 LD A, H :GET CHARACTER COUNT
0544 1508 CP 0 :COMPARE WITH ZERO
0546 1509 RLY Z :RETURN IF ZERO
0547 1510 DEC H :DECREMENT COUNT
0548 1511 LD A, (IX+6DR1) :GET Y
0549 1512 ADD A, 7 :ADD 7
054A 1513 LD (IX+6DR1), A :RESTORE Y
054B 1514 CALL FETCH :GET CHARACTER CODE
054C 1515 AND 0111111B :MASK THE HIGH BIT
054D 1516 ADD A, E :SAVE CODE
054E 1517 SLA E :CLEAR POINTER
054F 1518 SHIF BY
0550 1519 THR
0551 151A Bits TO
0552 151B PROPERLY
0553 151C COMPUTE AN
0554 151D OFFSET
0555 151E LOAD THE BASE ADDRESS
0556 151F ADD THE OFFSET
0557 1520 LOAD THE ROW COUNT
0558 1521 UPDATE X
0559 1522 GET THE COUNT
055A 1523 COMPARE WITH ZERO
055B 1524 JUMP IF ZERO
055C 1525 RESTORE THE POSITION
055D 1526 OTHERWISE DECREMENT
055E 1527 GET CHARACTER MASK
055F 1528 A, (IX+Q) :POINT TO NEXT MASK
0560 1529 LD L, A :SET COLUMN COUNT
0561 152A LD L, A :SAVE THE MASK
0562 152B LD L, A :GET THE COLUMN COUNT
0563 152C A, E :COMPARE WITH ZERO
0564 152D JUMP IF NON ZERO
0565 152E GET X
0566 152F DEC X :DECREMENT BY 8
0567 1530 JUMP IF X :RESTORE X
0568 1531 DEC Y :DECREMENT Y
0569 1532 JUMP TO SYM1
056A 1533 RESTORE MASK
056B 1534 SYM3 :DECREMENT COLUMN COUNT
056C 1535 SHIFT TO CARRY
056D 1536 LD L, A :JUMP IF CARRY
056E 1537 LD L, A :SAVE MASK
056F 1538 LD L, A :LOAD SECONDARY COLOR
0570 1539 LD L, A :LOAD PRIMARY COLOR
0571 153A SYM5 :CALL PUT
0572 153B SYM5 :PUT THE POINT
0573 153C INC (IX+6DR0) :INCREMENT X
0574 153D JR SYM2 :JUMP BACK

153E
153F ; 
1540 ; TO A SPECIFIED ENDPOINT. VEC FIRST DETERMINES THE
1541 ; REFERENCE OF THE VECTOR, THEN DETERMINES THE NEW
1542 ; ENDPOINTS. THE ENDPOINTS MAY BE COMPUTED ABSOLUTE,
1543 ; RELATIVE, SHORT, OR LONG. AFTER THE ENDPOINTS ARE
1544 ; SET, THE VECTOR COLOR IS DETERMINED. PLOTTING THEN
1545 ; BEGINS, USING A SCAN LINE CONVERSION ALGORITHM.
1546 ; PLOTTING STOPS WHEN THE ENDPOINTS ARE REACHED.
1547 ;
1548 ; CALLS FETCH
1549 ;
1550 ;
1551 ;
1552 ;
1553 ;
1554 ;
1555 ;
1556 ;
1557 ;
1558 ;
1559 ;
1560 ;
1561 ;
1562 ;
1563 ;
1564 ;
1565 ;
1566 ;
1567 ;
1568 ;
1569 ;
1570 ;

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Listing 1 continued:

1571 ; PLOT
1572 ;
1573 ; CALLED BY PRIMAL (INDIRECTLY)
1574 ;
1575 ; REGISTERS
1576 ; A (PRIMITIVE OP CODE, TEMPORARY)
1577 ; B (CASE)
1578 ; C (COUNTER)
1579 ; D (ABSOLUTE DELTA X)
1580 ; E (ABSOLUTE DELTA Y)
1581 ; H (X INCREMENT)
1582 ; L (Y INCREMENT)
1583 ; TX (INDEX)
1584 ;
1585 ; I/O NONE
1586 ;
1587 ; STRUCTURES
1588 ; GORO (X)
1589 ; GOR1 (Y)
1590 ; GOR2 (PRIMARY COLOR)
1591 ; GOR3 (SECONDARY COLOR)
1592 ; GOR5 (VECTOR MODE)
1593 ; M (VECTOR VARIABLE)
1594 ; MN (VECTOR VARIABLE)
1595 ; SX (VECTOR VARIABLE)
1596 ; SY (VECTOR VARIABLE)

0647 41596 VEC; LD C,A ;SAVE THE FLAGS
0648 41597 LD A, (IX+GOR5) ;GET THE VECTOR MODE
0649 41598 LD (IX+REF), A ;SAVE THE REFERENCE
0650 41599 LD 0, (IX+GOR0) ;GET CURRENT X
0651 41600 LD F, (IX+GOR1) ;GET CURRENT Y
0652 41601 CALL FJITH ;GET DATA
0653 41602 BIT 3,F ;TEST FOR LONG
0654 41603 JR NZ, 1593 ;JUMP IF LONG
0655 41604 BIT 2, C ;TEST FOR ABSOLUTE
0656 41605 JR NZ, VEC2 ;JUMP IF ABSOLUTE
0657 41606 PUSH AF ;SAVE DATA
0658 41607 SRA A ;SHIFT OVER
0659 41608 SRA A ;FOUR PLACES
0660 41609 SRA A ;TO MASK ALL BUT
0661 41610 SRA A ;X OFFSET
0662 41611 BIT 3,A ;TEST SIGN
0663 41612 JR Z, VEC0 ;JUMP IF POSITIVE
0664 41613 RES 3, A ;CLEAR SIGN
0665 41614 NEG E ;NEGATE
0666 41615 VEC0; ADD A, D ;ADD THE OFFSET
0667 41616 LD D, A ;SAVE NEW X
0668 41617 POP AF ;RESTORE A
0669 41618 AND 00001111B ;MASK ALL BUT Y OFFSET
0670 41619 BIT 3, A ;TEST SIGN
0671 41620 JR Z, VEC1 ;JUMP IF POSITIVE
0672 41621 RES 3, A ;CLEAR SIGN BIT
0673 41622 NEG E ;NEGATE
0674 41623 VEC1; ADD A, E ;ADD OFFSET
0675 41624 LD E, A ;SAVE NEW VALUE
0676 41625 JR VEC7 ;JUMP
0677 41626 VEC2; PUSH AF ;SAVE A
0678 41627 SRL A ;SHIFT OVER
0679 41628 SRL A ;FOUR PLACES
0680 41629 SRL A ;TO MASK ALL BUT
0681 41630 SRL A ;X VALUE
0682 41631 LD D,A ;SET NEW VALUE
0683 41632 POP M ;RESTORE A
0684 41633 AND 00001111B ;MASK ALL BUT Y VALUE
0685 41634 LD E, A ;SET NEW VALUE
0686 41635 JR VEC7 ;JUMP

Listing 1 continued on page 338
Listing 1 continued:

0690 C651 1636 VEC3: BIT 2, C
0692 2019 1637 JR NZ, VEC6
0694 C67F 1638 BIT 7, A
0696 2B04 1639 JR Z, VEC4
0698 C6BF 1640 RES 7, A
069A ED44 1641 NEG
069C 82 1642 VEC4: ADD A, D
069D 57 1643 LD D, A
069F CD01 1644 CALL FETCH
06A1 C7F 1645 BIT 7, A
06A3 2604 1646 JR Z, VEC5
06A5 C8BF 1647 RFS 7, A
06A7 ED44 1648 NEG
06A9 83 1649 ADD A, E
06AA 5F 1650 LD E, A
06AB 1805 1651 JR VEC7
06AD 57 1652 CALL FETCH
06AE CD01 1653 LD E, A
06B1 5F 1654 JR VEC7
06B2 C499 1655 VEC7: BIT 1, C
06B4 2005 1656 JR NZ, VEC8
06B6 D702 1657 LD A, (IX+DR2)
06B9 1803 1658 JR VEC9
06BB 2D03 1659 VEC8: LD A, (IX+GDR3)
06BL 7D79 1660 VEC9: LD (IX+COLOR), A
06C1 0E00 1661 LD C, D
06C3 E5 1662 PUSH HL
06C4 C5 1663 PUSH BC
06C5 66 1664 LD L, D
06C6 2600 1665 LD H, D
06C8 B400 1666 LD C, (IX+GDR0)
06CB 0600 1667 LD B, O
06CD 4A 1668 XOR A
06CE ED42 1669 SBC HL, BC
06D0 FA90 1670 JP M, VEC10
06D3 DD67 1671 LD (IX+SX), -1
06D6 1807 1672 JR VEC11
06D9 DD67FF 1673 VEC10: LD (IX+SX), -1
06DA 7D 1674 LD A, L
06DB 6F 1675 NEG
06DC 55 1676 LD L, A
06DE 6F 1677 LD H, E
06E0 B400 1678 LD C, (IX+GDR1)
06E2 0600 1679 LD B, O
06E4 4A 1680 XOR A
06E6 ED42 1681 SBC HL, BC
06E8 FA66 1682 JP M, VEC12
06F0 DD67 1683 LD (IX+SX), 1
06F3 1808 1684 JR VEC13
06F6 DD67FF 1685 VEC12: LD (IX+SX), 1
06F8 7D 1686 LD A, L
06FA ED44 1687 NEG
06FB 6F 1688 LD L, A
06FD 5D 1689 LD H, E
06FE 6B 1690 LD C, D
0700 2600 1691 LD B, O
0702 4A 1692 XOR A
0704 0600 1693 SBC HL, BC
0706 ED42 1694 JP M, VEC14
0708 F630 1695 LD (IX+MM), E
070A DD74 1696 LD (IX+MM), D

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Listing 1 continued:

0711  1806  1/01  JR  VEC15  ; JUMP AROUND
0713  D07245  1702  VEC14:  LD  (IX+MM),D  ; LOAD X
0715  D07246  1703  LD  (IX+MN),E  ; LOAD Y
0717  D07247  1704  VEC15:  LD  A,(IX+MM)  ; GET MM
0719  83  1705  SRL  A  ; DIVIDE BY 2
071A  D07248  1706  LD  (IX+M),A  ; SAVE IT
071C  D07249  1707  POP  BC  ; RESTORE B AND C
071E  D0724A  1708  POP  HL  ; RESTORE H AND L
0720  98  1709  CALL  CASE  ; GET THE CURRENT CASE
0722  0A007  1710  VEC16:  LD  A,(IX+COLOR)  ; GET THE COLOR
0724  D0724B  1711  PUSH  BC  ; SAVE BC
0726  D0724C  1712  PUSH  DE  ; SAVE DE
0728  D0724D  1713  PUSH  HL  ; SAVE HL
072A  D0724E  1714  CALL  PLOT  ; PLOT THE POINT
072C  D0724F  1715  POP  HL  ; RESTORE HL
072E  D07250  1716  POP  DE  ; RESTORE DE
0730  D07251  1717  POP  BC  ; RESTORE BC
0732  83  1718  LD  A,(IX+MM)  ; GET MM
0734  0A  1719  JR  NZ,VEC17  ; COMPARE MM
0736  2001  1720  RET  ; JUMP IF NOT SAME
0738  C9  1721  JR  NZ,VEC17  ; RETURN
073A  E5  1722  VEC17:  PUSH  HL  ; SAVE H AND L
073C  D07254  1723  LD  L,(IX+M)  ; GET M
073E  2600  1/25  LD  H,0  ; CLEAR H
0740  D07256  1726  LD  C,(IX+MN)  ; GET MM
0742  D07257  1727  LD  B,0  ; CLEAR B
0744  09  1728  ADD  HL,BC  ; ADD MM
0746  D07258  1729  LD  C,(IX+MM)  ; GET MM
0748  0A  1730  LD  B,0  ; CLEAR B
074A  D0725A  1731  XOR  A  ; CLEAR CARRY
074C  AF  1732  SBC  HL,BC  ; SUBTRACT
074E  0A007  1733  JP  M,VEC18  ; JUMP IF MINUS
0750  D0725C  1734  LD  (IX+M),L  ; SAVE M
0752  D0725D  1735  POP  BC  ; RESTORE B AND C
0754  D0725E  1736  POP  HL  ; RESTORE H AND L
0756  D0725F  1737  LD  L,(IX+SY)  ; GET INC Y
0758  D07260  1738  LD  H,(IX+sx)  ; GET INC X
075A  1813  1739  JR  VEC20  ; JUMP
075C  0A  1740  VEC18:  ADD  HL,BC  ; RESTORE M
075E  D07262  1741  LD  (IX+M),L  ; SAVE M
0760  D07263  1742  POP  BC  ; RESTORE B AND C
0762  D07264  1743  POP  HL  ; RESTORE H AND L
0764  E0  1744  LD  L,0  ; CLEAR L
0766  2600  1745  LD  H,0  ; CLEAR POINTER
0768  D07267  1746  LD  A,(IX+MM)  ; GET MM
076A  BA  1747  JR  NZ,VEC19  ; COMPARE WITH DELTA X
076C  2003  1748  LD  H,(IX+sx)  ; JUMP IF NOT EQUAL
076E  D07269  1749  JR  NZ,VEC20  ; SAVE VALUE
0770  2600  1750  VEC19:  LD  L,(IX+SY)  ; COMPARE WITH DELTA Y
0772  2003  1751  JR  NZ,VEC20  ; JUMP IF NOT EQUAL
0774  D0726C  1752  LD  L,(IX+SY)  ; LOAD SY
0776  D0726D  1753  VEC20:  LD  A,(IX+GDRO)  ; GET SY
0778  84  1754  ADD  A,H  ; ADD INCREMENT
077A  D0726F  1755  LD  (IX+GDRO),A  ; RESTORE X
077C  D07270  1756  LD  A,(IX+GDRI1)  ; GET Y
077E  84  1757  ADD  A,L  ; ADD INCREMENT
0780  D07271  1758  LD  (IX+GDRI1),A  ; RESTORE Y
0782  BC  1759  INC  C  ; INCREMENT COUNT
0784  18YS  1760  JR  VEC16  ; JUMP AROUND

1761 ; WAIT
1762 ; WAIT
1763 ; WAIT
1764 ; WAIT
1765 ; WAIT

Listing 1 continued on page 340

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Listing 1 continued:

1766 : GLTS THE COUNT FROM EITHER THE PRIMITIVE ITSELF OR,
1767 : IF THE EXTEND BIT IS ON, FROM THE NEXT BYTE. GDR4
1768 : (FRAME COUNT) IS SET TO -COUNT AND WAIT THEN LOOPS
1769 : UNTIL THE FRAME COUNT GOES TO ZERO.
1770 :
1771 : CALLS FETCH
1772 :
1773 : CALLED BY PRIMAT (INDIRECTLY)
1774 :
1775 : REGISTERS A (PRIMITIVE OR CODE, TEMPORARY)
1776 : IX (INDEX)
1777 :
1778 : I/O NONE
1779 :
1780 : STRUCTURES GDR4 (FRAME COUNT)
1781 :

0788 CB5F
0789 2805
078C CUBD01
0791 1802
0793 E007
1795 BU7D4
0799 D7AE
079B FE00
079D 2119
079F C9

0782 WAIT: BIT 3,A ;TEST EXTEND BIT
0783 JR Z,WAIT0 ;JUMP IF NOT SET
0784 CALL FETCH ;GET COUNT
0785 JR WAIT1 ;JUMP AROUND
0786 WAIT0: AND 0000011B ;MASK ALL BUT COUNT
0787 WAIT1: NEG ;NEGATE COUNT
0788 LD (IX+GDR4),A ;SET FRAME COUNT
0789 WAIT2: LD A,(IX+GDR4) ;GET COUNT
0790 CP 0 ;TEST FOR ZERO
0791 JR NZ,WAIT2 ;JUMP IF NON ZERO
0792 RLT ;RETURN
0793:
0794 ;XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0795 ;UTILITY SERVICE ROUTINESXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0796 ;XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0797 :
0798 ;CASE XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0799 :
1800 ;CASEL DETERMINES THE CASE OF A REFERENCED VIEWPORT,
1801 ;IF A VIEWPORT IS NOT REFERENCED, CASE EXITs. OTHER-
1802 ;WISE, CASE1 IS SET IN REGISTER B.
1803 :
1804 : CALLS NONE
1805 :
1806 : CALLED BY
1807 : LPIX
1808 : NOV
1809 : SYM
1810 : VEC
1811 : RPIX
1812 :
1813 : REGISTERS A (TEMPORARY)
1814 : B (CASE)
1815 : D (TEMPORARY)
1816 : E (TEMPORARY)
1817 : H (TEMPORARY)
1818 : L (TEMPORARY)
1819 : TY (INDEX)
1820 :
1821 : I/O NONE
1822 :
1823 : STRUCTURES GDR6 13 (VIEWPORTS)
1824 : REF (REFERENCE)
1825 :

07A0 F5 1826 CASE: PUSH AF ;SAVE AF
07A1 FDE5 1827 PUSH IY ;SAVE IY
07A3 E5 1828 PUSH HL ;SAVE H AND L
07A4 DB 1829 PUSH DE ;SAVE D AND E
07A5 0600 1830 LD B,0 ;ASSUME CASE 0

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Listing 1 continued:

| 0767 | XDEB434E | 1831 |
| 0768 | 2806     | 1832 |
| 0769 | D1       | 1833 |
| 0770 | L1       | 1834 |
| 0771 | F0E1     | 1835 |
| 0781 | F1       | 1836 |
| 0782 | C9       | 1837 |
| 0783 | FD2818610| 1838 |
| 0784 | FD284346 | 1839 |
| 0785 | 2600     | 1840 |
| 0786 | FD285A01 | 1841 |
| 0787 | C6402    | 1842 |
| 0788 | FDSE00   | 1843 |
| 0789 | FD0600   | 1844 |
| 0790 | FD0601   | 1845 |
| 0791 | FD0602   | 1846 |
| 0792 | FD0603   | 1847 |
| 0793 | FD0604   | 1848 |
| 0794 | FD0605   | 1849 |
| 0795 | FD0606   | 1850 |
| 0796 | FD0607   | 1851 |
| 0797 | FD0608   | 1852 |
| 0798 | FD0609   | 1853 |
| 0799 | FD0610   | 1854 |
| 0800 | FD0611   | 1855 |
| 0801 | FD0612   | 1856 |
| 0802 | FD0613   | 1857 |
| 0803 | FD0614   | 1858 |
| 0804 | FD0615   | 1859 |
| 0805 | FD0616   | 1860 |

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<tr>
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<td>DE</td>
</tr>
<tr>
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<tr>
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<td>IY</td>
</tr>
<tr>
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</tr>
<tr>
<td>LD</td>
<td>1Y, STRUCT + GDR6</td>
</tr>
<tr>
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<td>L, (Y+2)</td>
</tr>
<tr>
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<td>R, D</td>
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<tr>
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<tr>
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Listing 1 to be continued next month in Part 3

If you're serious about the stock market, you need **Tickertec™**

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Tickertec™ is a computer program that displays the NYSE or AMEX tickertape on your TRS-80® Model I or both exchanges as an option on the Model II. You see every trade as it is reported by the exchange and track the last ten trades, tickertape reported volume, and high and low limits on the stocks you are watching. Tickertec prices start at $1,000.00 with many optional features available including hard copy and portfolio management systems. Programs may be purchased for cash (i.e., hard dollars) or payment can be arranged in the form of discounted brokerage commissions (i.e., Soft Dollar Software™). Exchange fees are extra. Call for FREE brochure TOLL-FREE at (800) 223-6642; in New York call (212) 687-0705, or mail the coupon today.

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**Max Ule & Company Inc.**

**BY2**

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DISKETTE STORAGE SYSTEM
$24.95
for 5½" disks
for 8" disks . . . $29.95
MTC brings you the ULTIMATE diskette storage system, at an affordable price. Storing 50 to 60 diskettes, this durable, smoke-colored acrylic unit provides easy access through the use of index dividers and adjustable tabs. Unique lid design provides dust-free protection and doubles as a carrying handle.
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An economical form of storage for 10 to 15 diskettes, and is suitable for your bookshelf! Case opens into a vertical holder for easy access.
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REDEFINES
“Customer Satisfaction”
IN 1981
meta-morphosis (meta’ mor’ fa sis), n. pl. -ses (-séz’). 1. a transformation. 2. a change or successive changes in character or appearance.
3. MTC’s transition in 1981 to a bigger and better way of doing business, featuring new and improved products and services.
MTC’s transition in 1981 to a bigger and better way of doing business, featuring new and improved products and services.
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Meta Technologies strikes again... at the competition! These are factory fresh, absolutely first quality (no seconds!) mini-floppies. They are complete with envelopes, labels and write-protect tabs in a shrink-wrapped box.
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In 1980 alone, MTC has sold nearly a third of a million dollars worth of brand-name diskettes. If anyone knows quality, we do. And these are quality diskettes. The catch? They are in a plain white box. You’re not paying for fancy printing, fancy labels or fancy names on the packaging. We don’t even put our own label on the package (labels cost money). At this introductory price (our regular price will be $21.95 per box of 10) we cannot offer quantity or dealer discounts.
PLAIN JANE™ Diskettes .......... $19.80*
VERBATIM brand Diskettes (box of 10) 5½-inch (for TRS-80™) MD525-01 .................. $23.95
10 boxes of 10 . . . . (each box) ....... $22.95
8-inch FLOPPIES
Single-Density, FD34-1000 .......... $29.95
Double-Density, FD34-8000 ........ $39.95
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26111 Brush Avenue, Euclid, Ohio 44132
Circle 356 on Inquiry card.
**What's New?**

**SOFTWARE**

**Commercial Mailer Has 30,000 Name Capacity**

Commercial Mailer, from Stonehenge Computer Company, 89 Summit Ave, Summit NJ 07901, (201) 277-1020, has a capacity of up to 30,000 six-line records, with an unlimited number of lists. This program offers features including creating, adding, changing, deleting, sorting, utility/field code, and more. Required hardware includes the Apple II with 68 K bytes of memory, the Corvus 11AP Hard Disk, and an 80- or 132-column printer. Optional hardware are the Corvus Constellation and Corvus Mirror. The format is a menu type, and the system can be adapted to the user's format. The price is $250, plus $3 for shipping.

Circle 404 on inquiry card.

**Traffic Program for Radio Stations**

The Electric Log is designed for the TRS-80 Model II personal computer. The program stores up to 500 time-spot schedules and automatically generates daily program logs with date checking, product code separation, account separation, and, optionally, random tray location for automation. The Electric Bill ties into the Electric Log to provide a standard accounts receivable and statement printer. For additional information, contact The Management, POB 113, Aledo TX, (817) 441-8045.

Circle 405 on inquiry card.

**Lowercase Driver Plus**

Lowercase Driver Plus is an advanced driver routine to work with the lowercase modification kit sold by E B G (Emmanuel B Garcia Jr) & Associates. With this routine and the lowercase modification in the TRS-80, users will be able to display lowercase at all times. The keyboard then will work as a regular typewriter (ie: shifted characters will be uppercase, and unshifted characters will be lowercase). Provision has also been made for a CAPS LOCK function. An automatic repeat action that can be obtained by holding any key down for a few seconds is included. Lowercase Driver Plus will also work with most other lowercase modifications. The price is $9.95, from E B G & Associates, 203 N Wabash, Chicago IL 60601, (312) 782-9370.

Circle 406 on inquiry card.

**Chemistry Programs for High School and College**

Chemistry Lab Simulation 1 and 2 are Techno­logy Inc, Software Department, IIAP Hard Disk, and an 80- or 132-column printer. Optional hardware are the Corvus Constellation and Corvus Mirror. The format is a menu type, and the system can be adapted to the user's format. The price is $250, plus $3 for shipping.

Circle 407 on inquiry card.

**Computer War Games**

The Avalon Hill Game Company, 4517 Harford Rd, Baltimore MD 21214, (301) 254-5300, presents B-1 Nuclear Bomber, Midway Campaign, North Atlantic Convoy Raider, Nukewar, and Planet Miners. These games run on TRS-80 Model II, Apple II, and PET microcomputers. They cost $15 each.

Circle 407 on inquiry card.

**MED-PAC II**

The MED-PAC II (Medical Patient Accounting System) is a medical accounting system that features billing, recording of charges, adjustments and payments, automatic printing of insurance forms, instantaneous recall of patient records and account status, increased collections and reduced aging, analysis of services performed by each provider in the practice, and the ability to run with the accounts payable, payroll, and general ledger programs from V R Data Corporation. The company also has a Med Pac System that includes a high-resolution monitor and ASCII (American Standard Code for Information Interchange) keyboard, a 64 K-byte memory board with a Z80 microprocessor, 1 megabyte of disk storage, a letter-quality printer, manuals, on-site training lessons, and medical software. The cost of the system is $14,249. Contact Small Systems Group, 777 Henderson Blvd N-6, Folcroft Industrial Park, Folcroft PA 19032, (800) 345-8102.

Circle 408 on inquiry card.

**L216—Business Software Package**

L216 is a business package for the TRS-80 Model II with 16 K bytes of memory and Level II BASIC. A cassette data-base manager, word processor, inventory-control system, stock-management program, check-balancing program, label printer, deposit calculator, statistics program, sort utility, and a key-access utility are included. The package is priced at $99. For information, contact Micro Architect Inc, 96 Dothan St, Arlington MA 02174, (617) 643-4713.

Circle 410 on inquiry card.

**Where Do New Products Items Come From?**

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in-first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.
Word Processing for the Apple II

A word-processing program called the Datacope Scribe is available for the Apple II. On-screen editing is by character, word, sentence, and paragraph, plus block insert, block move, and block delete. General formats control the locations and justification of margins, tab locations, and the number of lines per page and their spacing. Special formats may be used to center, indent, and underline text. The program can print single or multiple copies without user intervention. Single-letter commands are included. Memory can hold approximately eleven pages of text. A BASIC program allows users to customize the machine-language program to match the user's printer, printer interface, and personal preferences. Minimum equipment requirements are an Apple II with 48 K bytes of memory, Applesoft in ROM (read-only memory), an Apple II Plus with 48 K bytes of memory, or an Apple Language System; Dan Paymar's Lower Case Adapter; a Disk II drive; and a printer and printer interface. The suggested retail price for the Datacope Scribe is $79.95. Contact Datacope, PO Drawer AA, Hillcrest Sta, Little Rock AR 72205.

Circle 400 on Inquiry card.

CP/NET Operating System from Digital Research

Digital Research Inc, originator of the CP/M and MP/M operating systems, has introduced CP/NET, a new operating system for microcomputer networks. The CP/NET software system supports network technology by allowing independent microcomputers access to common facilities, such as peripherals, programs, and data bases, via a network. CP/NET operates with CP/M and MP/M. Applications range from multiterminal word-processing and/or data-base systems that share disks and printers to industrial process-control systems that use single-board computers, without disk or console facilities, as slaves. CP/NET consists of one or more masters running MP/M and one or more slaves running CP/M or MP/M. CP/NET is network independent. Through simple modifications, a network may be constructed with any combination of shared memory, serial links or parallel I/O (input/output) with any protocol. For more information, contact Digital Research Inc, POB 579, Pacific Grove CA 93950, (408) 649-3896.

Circle 401 on Inquiry card.

Flight Simulators for TRS-80 and Apple Systems

The A2-FS1 for the Apple II, and the T80-FS1 for the TRS-80, are visual flight simulators that offer a real-time three-

dimensional out-the-window view of flight. The view updates at an average of three times per second. The animation and flight characteristics allow the non-pilot to learn basic flight control. The FS1 instrument panel contains all the instruments required under part 91 of the Federal Aviation Regulations for visual flight. The FS1 includes a stall warning, turn indicator, radar screen, ammunition indicator, and control position indicators. Controls include throttle, brakes, bomb drop, machine guns, high/low world, and declare war. The TSO features a downward map selector. The A2 includes a keyboard/paddle selector. The FS1 requires 16 K bytes of memory. The programs cost $25. The A2 is available on disk for $33.50. Contact SubLOGIC, POB V, Savoy IL 61874, (217) 359-8482.

Circle 402 on Inquiry card.

Graphics for the Apple

United Software of America has a three-dimensional high-resolution graphics package for the Apple II called Apple World, which is a text-editor-based color graphics package. The program comes with a manual and requires any Apple II or Apple II Plus with 48 K bytes of programmable memory and a floppy-disk drive. It is written in machine code. The price is $59.95 from United Software of America, 750 Third Ave, New York NY 10017, (212) 662-0347.

Circle 403 on Inquiry card.
X, Y Positioning Device Operates by Fingertip Glide

TASA (Touch Activated Switch Arrays Inc) has introduced this alternative for trackballs and other two-dimensional controllers that provide coarse and fine position adjustment by changing fingertip speed. The X, Y controller produces X, Y positioning signals when a finger is moved across its surface. It can be interfaced with plotters, video displays and other devices. The unit uses 70% less space than trackballs, has no moving parts, and is environmentally sealed. The 10.2 by 10.2 cm (4 by 4 inch) surface can be traversed at up to 60 inches per second without loss of resolution. Rapid finger movement can give coarse control; slow movement offers fine control. The Model 4460 X, Y Positioner is priced under $500 in OEM (original equipment manufacturer) quantities. For information, contact TASA Inc, 2346 Walsh Ave, Santa Clara CA 95051, (408) 727-8272.

Circle 412 on inquiry card.

MC68000 Development Boards Extend EXORmacs Systems

Motorola has introduced four MC68000 modules for use with the EXORmacs system. The User System Emulator (USE) provides the connection between the user's nondebugged hardware/software system and the diagnostic power within the EXORmacs itself. The extension provides the debug functions of MACSbug and the symbolic debugger SYMbug, along with the file-management and memory-storage capability of EXORmacs. USE consists of the USE Control Module, Buffer Box, and interface cable. The price is $1500. The VERSAbus dynamic-memory modules include a special addressing for placement of memory in both the system and the user's map throughout the 16-megabyte range of the MC68000 microprocessor. A parity feature is provided. Prices for 32 K- to 128 K-byte memory modules range from $1400 to $3500. The VERSAbus Adapter Module board plugs into EXORmacs bus slots and provides an interface between the 8-bit EXORbus modules and the 16-bit VERSAbus. The modules also provide user-selectable interrupt levels and controls required by the VERSAbus interrupt scheme. The price is $295. For more information on these and other EXORmacs products, contact Motorola Semiconductor Products Inc, POB 20912, Phoenix AZ 85036, (602) 962-2209.

Circle 413 on inquiry card.

ASCII Encoded Keyboard Kit

The JE610 ASCII (American Standard Code for Information Interchange) Encoded Keyboard kit comes with a sixty-two-key keyboard switch assembly, integrated circuits, sockets, connector, electronic components, and a double-sided printed-circuit board. Wiring instructions and circuit diagrams are included. The full 128-character ASCII set can be generated. Two user-defined keys are provided, as is a caps lock for uppercase. The keyboard assembly requires +5 VDC at 150 mA and -12 VDC at 10 mA for operation. Interfacing is accomplished by an integrated circuit or an eight-pin edge card connector. The suggested retail price is $79.95. The DTE-AK enclosure is available for $49.95. Contact Jameco Electronics, 1355 Shoreway Rd, Belmont CA 94002, (415) 592-8097.

Circle 414 on inquiry card.
Three New Computers from Radio Shack

The TRS-80 Model III is available in several configurations, and it ranges in price from $699 for the 4 K-byte version (expandable to 32 K bytes) to $2495 for units with 313 K bytes of disk storage. It is compatible with Model I TRS-80s and features Model III BASIC. Features included are: uppercase and lowercase on the video display, a printer interface, the capability to add two double-density floppy-disk drives, and more. The TRS-80 Pocket Computer weighs 6 ounces and is less than 7 inches long. It is able to do most of the smaller jobs the TRS-80 Model I computer can do. The Pocket Computer features power-off retention of programs and data. The resident BASIC includes multiple statements, mathematics functions, editing, strings, arrays, and more. The price is $249. The TRS-80 Color Computer provides color graphics and features Program Pak software that enables the user to set up the computer for a variety of educational and recreational purposes. It features a television modulator, provides high-resolution modes, and can be expanded to 16 K bytes of memory. The price is $399. For more information, contact Radio Shack, 1800 One Tandy Center, Ft Worth TX 76102, (817) 390-3272, or visit your local participating Radio Shack dealer.

Circle 415 on inquiry card.

6500 Development System

The heart of the FLAIM/65 development system is the AIM-65 single-board microcomputer manufactured by Rockwell International. The AIM-65 provides a 20-character alphanumeric display, thermal printer, and a keyboard. An expansion motherboard provides five card slots compatible with the Motorola EXORcisor bus. Dual 5-inch floppy-disk drives provide 160 K bytes of programmable-memory storage. The disk operating system is contained in EPROM (erasable programmable read-only memory). A power supply and a Centronics 730 printer are provided. Software includes an assembler and compiler. FL/65, built in to ROM (read-only memory), is a systems language designed specifically for the 6500 family. A complete FLAIM/65 system is priced at $3705 from Compass Microsystems, 224 SE 16th St, Ames IA 50010, (515) 232-8187.

Circle 416 on inquiry card.

The Decision 1 Microcomputer

Morrow Designs, 5221 Central Ave, Richmond CA 94804, (415) 524-2101, has announced the Decision 1, a multitasking, IEEE (Institute of Electrical and Electronics Engineers) standard S-100 bus microcomputer that costs under $5000 in a four-user configuration. The machine is designed for the word-processing and the business data-processing industries. The computer features a Z80 microprocessor, a UNIX-compatible operating system that runs CP/M as a subsystem, and business-applications and word-processing packages. The memory-management hardware includes a memory map that supports up to sixteen tasks without swapping. The system can support dual 800 K-byte 5-inch floppy-disk drives, dual 1.2-megabyte 8-inch drives, and a 26-megabyte Winchester hard disk.

Circle 417 on inquiry card.
Multi-User Microcomputer System

The CompuStar Multi-User system consists of a network of video-display terminals which employ individual microprocessors and dynamic program-mable memory. The terminals are tied together in a network fashion to share the resources of a single Winchester or other hard-disk device. The system shares disk drives while allowing individual users the capability to maintain restricted data bases. The system architecture is based around one of three disk storage systems. A 10-megabyte Shugart-type Winchester 8-inch drive is offered for $3995. Also offered as disk storage options are a 32- or 96-megabyte cartridge module drive. The 32-megabyte model is $11,995; the 96-megabyte model is $14,995. The multi-user systems can accept up to 255 video terminals in a single network. Each terminal, manufactured by Intertec, has twin RS-232 serial ports for printers and other peripherals. Video terminals range in price from $2495 for a 12-inch, 64 K-byte unit, to a dual double-sided, double-density floppy-disk drive, 12-inch unit that can store 1.5 megabytes of data. This terminal costs $4995. One of the basic units, allowing printer interfacing, costs $1995. For more information on the CompuStar System, contact Intertec Data Systems, 2300 Broad River Rd, Columbia SC 29210, (803) 798-9100.

Circle 418 on inquiry card.

Mercator Microcomputer

The MBS 4000 uses a 16-bit microprocessor, and the system bus is compatible with the Intel Multibus. The basic configuration includes an 8-inch Winchester disk drive and tape cartridge backup. The minimum memory configuration provides 128 K bytes of program-mable memory (expandable to 256 K), with error checking and correcting logic, and 4 K bytes of PROM (programmable read-only memory). The system includes a 400 W switching power supply. Eight serial RS-232 ports and a parallel printer port are included. A disk-expansion port and a Multibus expansion port are optional. Contact Mercator Business Systems, 2378A Walsh Ave, Santa Clara CA 95051, (408) 496-0424.

Circle 419 on inquiry card.

Business Systems from CMC

CMC Marketing Corporation, 10611 Harwin, Suite 406, Houston TX 77036, (713) 995-4960, has introduced a line of computer systems for small and large businesses and for word-processing applications. These systems are built around the Z80A microprocessor and feature the S-100 bus. Systems can be configured with floppy-disk storage of up to 4 megabytes and hard-disk storage of up to 28 megabytes. All systems can utilize the CP/M operating system. The word-processing systems, as well as the other systems, use the Magic Wand word-processing program, with an NEC Spinwriter printer. The System 100 series for small businesses offers RS-232 and parallel ports for use with a variety of printers and peripherals. Microsoft BASIC is built in. The System 200 series can support up to eight work stations. It uses the Shugart SA4000 Winchester hard disk with 14 to 28 megabytes of storage. For additional details, contact the company.

Circle 420 on inquiry card.
Computer Hot Line

This publication is devoted to computer users who want to buy systems, peripherals and other related components. Advertisements from major manufacturers are included, along with a help wanted section. Subscription rates are $45.00 for one year of first class delivery and $28.60 for regular mail delivery. Contact Hot Line Inc, POB 1373, Fort Dodge IA 50501, (800) 247-2244, ext 27, from Iowa or Canada call (515) 573-8133.
Circle 421 on inquiry card.

Matrix Printer Brochure

A brochure describing microprocessor-controlled dot-matrix printers for general and special applications is available from Dataroyal Inc, 238 Main Dunstable Rd, Nashua NH 03061, (603) 883-4157. The brochure details the Dataroyal IPS 5000 series of matrix printers for use with small-business systems and the 7000 series capable of printing bar code and variable size labels.
Circle 422 on inquiry card.

IEE Conference Volume

Communications Equipment and Systems contains information on public telecommunications: switching and networks; transmission and data; data and business-communications systems: intelligent terminals and emergency communications: systems; and equipment. The price is $41.50 from The Marketing Department, The Institution of Electrical Engineers (IEE), Station House, Nightingale Rd, Hitchin, Hertford, SG5 1R England.
Circle 423 on inquiry card.

Apple II Accessories and Software

Circle 424 on inquiry card.

Catalog of Data Communication Products

International Data Sciences Inc, 7 Wellington Rd, Lincoln RI 02865, (401) 333-2600, the manufacturer of Range Rider Modem/TDM Test Sets, Hawk 4000 Datatraps, Mini/Tech EIA (Electronic Industries Association) patch, monitor, switching modules, and Mini-Test interface monitor and breakout panels, is offering free copies of its 1980 Catalog of Data Communication Products. The catalog features the company's data test sets for synchronous and asynchronous modems, EIA and telephone line patch, monitor, and switching modules for technical control centers; data cables; error detection devices; and more. Also featured is the Model 65/60, the company's battery-operated modem test set and breakout panel combined.
Circle 425 on inquiry card.

OSI Releases Challenger III Service Manual

OSI (Ohio Scientific), 1333 Chillicothe Rd, Aurora OH 44202, (216) 562-3101, in conjunction with Howard W Sams Inc, has released the Challenger III Service Manual. This manual includes schematic diagrams, pictorial diagrams, block diagrams, parts lists, and component pinouts for the thirteen circuit boards used in the Challenger systems. Memory maps and board placement diagrams are also included. One important feature of the manual is the fold-outs which spread up to eight pages in width. This and other OSI manuals are available from Ohio Scientific dealers. For the name of your local dealer, call (800) 321-6850.
Circle 426 on inquiry card.

Book on Ada

Programming with Ada: An Introduction by Means of Graduated Examples, by Peter Wegner, is available from the Computer Bookstore, POB 556, Shalimar FL 32579, (904) 242-6439. Developed for the Defense Advanced Research Projects Agency, Ada is a multipurpose high-level language designed to meet the needs of numerical, system programming, and real-time applications, and which supports modularity and top-down program design. This book contains a history of Ada and explains its features. The price is $13.95.
Circle 427 on inquiry card.

Brochure Describes TABOL III a Business Language

TABOL III, a publication describing a new business language for building business analysis and reporting systems, is available from the General Electric News Bureau, 8150 Leesburg Pike, Suite 510, Vienna VA 22180, (202) 637-4557. This brochure discusses TABOL III and its applications involving the development, manipulation, and presentation of data in a tabular format. Applications concerning finance, manufacturing and sales, and marketing are also covered.
Circle 428 on inquiry card.

Books from Hayden

Hayden Book Company Inc, 50 Essex St, Rochelle Park NJ 07662, has introduced two books and two software programs. Programmable Pocket Calculators covers many of the Hewlett-Packard calculators and costs $8.95. Microprocessor Software Design is a compilation of articles from Electronic Design and is priced at $11.95. The first program is an Apple assembly-language development system with an assembler, editor, and formatter for the Apple II disk system with 24 K bytes of memory. It costs $39.95. The second program is Blackjack Master: A Simulator/Tutor/Game for the TRS-80 computer. The 16 K version is $19.95 and the 32 K disk version is $24.95.
Circle 429 on inquiry card.
Look at this!

Ohio Scientific Superboard II $299

- It's the first complete computer system on a board.
- Superboard II uses the ultra powerful 6502 Microprocessor
- 8K Microsoft BASIC-in-ROM
- 4K static RAM on board, expandable to 8K
- Full 53-key keyboard, with upper and lower case. Plus user expandability.
- Video interface and audio cassette interface.

The Ohio Scientific Superboard II at $299 — in today’s economy — has got to be the best buy by far. It will entertain you with spectacular graphics made possible by its ultra high resolution graphics and super fast BASIC. It will help you in school or industry, as an ultra powerful scientific calculator. Advanced scientific functions and a built-in “immediate” mode allow you to solve complex problems without programming.

The Superboard II can be expanded economically, for business uses, or to remotely control your home appliances and security. Even communicate with other computers.

Read what’s been written about Superboard II:

"We heartily recommend Superboard II for the beginner who wants to get into microcomputers with a minimum cost. A real computer with full expandability."
—POPULAR ELECTRONICS, MARCH 1979

"The Superboard II is an excellent choice for the personal computer enthusiast on a budget."
—BYTE, MAY 1979

Look at these easy hardware prices:

- **610 Board**: For use with Superboard II and Challenger 1P. 8K static RAM. Expandable to 24K or 32K system total. Accepts up to two mini-floppy disk drives. Requires +5V @ 4.5 amps. $ 298
- **Mini-Floppy Disk Drive**: Includes Ohio Scientific’s PICD DOS software and connector cable. Compatible with 610 expander board. Requires +12V @ 1.5 amps and +5V @ 0.7 amps. [Power supply & cabinet not included.] 299
- **630 Board**: Contact us for important details. 229
- **AC-3P 12” combination black and white TV/video monitor.** 159
- **4KP 4K RAM chip set.** 79
- **PS-005 5V 4.5 amp power supply for Superboard II.** 35
- **PS-003 12V power supply for mini-floppies.** 29
- **CS-600 Metal case for Superboard II, 610 and 630 board and two power supplies. (While stock lasts.)** 49
- **CS-900B Metal case for single floppy disk drive and power supply. (While stock lasts.)** 49
- **AC-12P Wireless remote control system. Includes control console, two lamp modules and two appliance modules, for use with 630 board.** 175
- **AC-17P Home security system. Includes console, fire detector, window protection devices and door unit for use with 630 board.** 249
- **C1P Sams C1P Service manual** 8
- **C4P Sams C4P Service manual** 16
- **C3 Sams Challenger III manual** 40

Ohio Scientific and independent suppliers offer hundreds of programs for the Superboard II, in cassette and mini-floppy form.

Freight Policies

- All orders of $100 or more are shipped freight collect. Orders of less than $100 please add $4.00 to cover shipping costs. Ohio residents add 5.5% Sales Tax. Hours: Call Monday thru Friday, 8:00 AM to 6:00 PM EST. TOLL FREE: 1-800-321-5805

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- Cleveland Consumer Computers & Components guarantees shipment of computer systems within 48 hours upon receipt of your order. Our failure to ship within 48 hours entitles you to $25 of software, FREE.

To Order: Or to get our free catalog CALL 1-800-321-5805 TOLL FREE. Charge your order to your VISA or MASTER CHARGE account. Ohio residents call [216] 464-8047. Or write, including your check or money order, to the address listed below.

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P.O. Box 46627
Cleveland, Ohio 44146

Order Form:

- [ ] Superboard II $299.
- [ ] 610 Board $298.
- [ ] AC-3P 12” B/W Monitor $159.
- [ ] Mini-Floppy Disk Drive $299.
- [ ] C1P Sams Service Manual $8.

(Attach separate sheet for other items.)

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(Ohio Residents add 5.5% Sales Tax)

Orders of less than $100, please add $4.00 to cover shipping costs.

All orders shipped insured UPS unless otherwise requested. FOB Cleveland, Ohio.
Queue Catalog

Queue's Catalog #3 is a directory of educational software available for the Apple II, TRS-80, PET, and Atari computers. Programs from over forty educational software publishers are described and grouped together by computer, subject matter, and grade level. All the programs can be ordered through Queue. The catalog is $8.95 from Queue, 5 Chapel Hill Dr, Fairfield CT 06432.

Circle 430 on inquiry card.

Math Guidebook

Calculator Calculus, by Professor George McCarthy, details a system for learning and teaching mathematics through computation. Algorithms produce numerical examples for limit processes, differentiation, integration, and sums of series. Programs are suitable for hand-held calculators and larger systems. Numerical techniques such as Newton's method, Padé approximation, and Fourier series are included. The price is $14.95, from EducALC Publications, Department BY, POB 974, Laguna Beach CA 92652, (714) 497-3600.

Circle 433 on inquiry card.

Systems and Instruments Catalog

Heath/Zenith Educational Systems & Instruments

A brochure introducing Alpha Micro's business-computer systems is available. The systems are multitasking, multiuser, and time-sharing. Software includes languages such as AlphaBASIC and AlphaPascal, word-processing and text-formatting applications, and over 150 separate utility programs and subroutines, including utilities for sorting, spooling, and file handling. Contact Alpha Micro, 17881 Sky Park N, Irvine CA 92713, (714) 641-0386, for a copy of the brochure.

Circle 436 on inquiry card.

Tool Kits, Cases, and Test Equipment

A catalog from Specialized Products Company, 2324 Shorecrest Dr, Dallas TX 75235, (214) 358-4663, features tools, test equipment, and cases from Fluke, Beckman, and other manufacturers. Contact the company for a copy.

Circle 431 on inquiry card.

The Fifth Edition of the TRS-80 Software Directory

The fifth edition of the TRS-80 Software Directory is available from ComputerMat, POB 1644A, Lake Havasu AZ 86403, (602) 855-3357. This edition has over 7000 listings of Model I and II software, and includes the names and addresses of over 600 software suppliers. One section is devoted to Model II software for businesses, another to mathematics and utility programs. The catalog gives information on program titles, short descriptions, BASIC needed, memory required, class, cost, and the program medium. The price is $7 per issue in the US, which includes postage. Canadian and foreign orders are $9. Distributors and suppliers of TRS-80 software can be listed in the directory at no charge by sending ComputerMat their latest catalog.

Circle 435 on inquiry card.

Universal Semiconductor Cross-Reference Guide

This cross-reference guide includes Zenith semiconductor devices that replace more than 158,000 currently used devices. The guide allows service technicians to use Zenith semiconductors in color and black and white televisions, stereo systems, radios, and personal and business computers. Contact Zenith Radio Corporation, 3000 Milwaukee Ave, Glenview IL 60025, (312) 391-0181.

Circle 437 on inquiry card.

CompuMart Catalog

CompuMart Corporation, POB 568, Department 333, Cambridge MA 02139, (617) 491-2700, has published a thirty-six-page catalog of microcomputers and peripherals. The catalog features Digital Equipment Corporation's LSI-11 hardware, Apple, Atari, Commodore, Heath, Exidy, and Texas Instruments systems and peripherals. Books on different aspects of microcomputers are also included in this catalog. The catalog can be obtained free of charge from the CompuMart Corporation.

Circle 438 on inquiry card.

BASIC Self-Teaching Guide from Radio Shack

TRS-80 Level II BASIC is a beginner's guide designed for users who have not had previous experience with computers. Short games, application programs, and the elements of developing simulation routines are presented. The book is available from participating Radio Shack stores, dealers, and Radio Shack Computer Centers for $9.95.

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- Siemens FDD100-8 8 Track Single Sided Drive $448.00
- Shugart 801R Single Sided Drive $448.00

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A Graphic Tablet

This graphic tablet, designed for small computers, is compatible with standard 7 by 9 inch display screens. For hard copy, a standard 8⅛ by 11-inch pad of paper fits onto the tablet surface. The output of the tablet matches the capabilities of the computer, thereby minimizing interface and software requirements. The resolution is 100 to 200 points per inch. Conversion rate is 100 coordinate pairs per second; standard output is biserial with an optional full parallel output. The tablet is available from Kurta Corporation, 206 S River Dr, Tempe AZ 85281; (602) 968-8709.

Circle 440 on Inquiry card.

IEEE-488-to-Parallel Interface for the PET

The P.I.E.-C is an IEEE-488-to-parallel interface for the Commodore PET computer. The device has parallel output with two handshaking lines and is compatible with Centronics printers, NEC Spinwriter, Anderson-Jacobson AJ841, Integral Data System's Paper Tiger, Anadex 8000 and 9000 printers, and any other parallel-input ASCII (American Standard Code for Information Interchange) printer. The conversion of nonstandard PET codes to ASCII codes is switch-selectable. The P.I.E.-C with case, code converter, and printer cable is $119.95. Contact LemData Products, POB 1080, Columbia MD 21044, (301) 730-3257.

Circle 441 on Inquiry card.

Streaming Cartridge Tape Drives

The Sidewinder family of streaming 1/4-inch cartridge tape drives feature a recording density of 8000 bits per inch and operating speeds of 30 and 90 ips (inches per second). The drives are designed for Winchester disk drive backup. They are offered in a Basic or Intelligent configuration with 10- or 20-megabyte capacities. Sidewinder's erase-write-read recording head operates in a two- or four-track format; the tracks are recorded serially. A microprocessor-based controller is supplied with the Intelligent Sidewinder. In OEM (original equipment manufacturer) quantities, the Basic Sidewinder is $469 for 10 megabytes and $600 for 20 megabytes. The Intelligent models are priced at $823 for 10 megabytes and $954 for 20 megabytes. Contact Archive Corporation, 3540 Cadillac Ave, Costa Mesa CA 92626, 714) 641-0279.

Circle 444 on Inquiry card.

Graphics Board for VT-100 and VT-103 Terminals

The Graphics-100 board fits in DEC (Digital Equipment Corporation) VT-100 and VT-103 video terminals to give them X,Y graphics display capability. The board provides a 1220 by 240 dot resolution on the screen. The text capability includes four character sets, three text rotations for labeling, and three type fonts. Graphics-100 memory and VT-100 memory may be displayed simultaneously. The unit includes a vector generator. Hard copy is available from the DECwriter II printer. Options include a light pen capability and software support under Selanar's PL II FORTRAN Plotting Subroutines. The Graphics-100 board is $1195; from Selanar, 2403 De La Cruz Blvd, Santa Clara CA 95050, (408) 727-2811.

Circle 442 on Inquiry card.

Pascal-100 from Digicomp Research

Pascal-100 consists of two mated boards with a Z80 microprocessor subsystem and the Pascal Microengine integrated-circuit set. Pascal-100 upgrades S-100 systems to a bilingual bus and runs the complete UCSD Pascal in native code, plus all Z80, 8080, and CP/M software. Both microprocessor subsystems can address 128 K bytes of memory or, optionally, up to 1 megabyte of memory. The system requires 48 K bytes of storage. The system is a 16-bit, plug-in module for all S-100 systems. The price is $1485. UCSD Pascal for the unit is $250, and a 1-megabyte memory addressability option is $95. Contact Digicomp Research, Terrace Hill, Ithaca NY 14850, (607) 273-5900.

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<thead>
<tr>
<th>Model No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3101</td>
<td>Mini floppy, 3101II Mini floppy w/interface card</td>
</tr>
<tr>
<td>8101CA</td>
<td>One SA800 in cabinet wipower, DDC Controller, cable and manual</td>
</tr>
<tr>
<td>8202CA</td>
<td>Two SA830 in cabinet wipower, DDC Controller, cable and manual</td>
</tr>
<tr>
<td>5101CA</td>
<td>One SA850 in cabinet wipower, DDC Controller, cable and manual</td>
</tr>
<tr>
<td>5202CA</td>
<td>Two SA856 in cabinet wipower, DDC Controller, cable and manual</td>
</tr>
</tbody>
</table>

S-100 BASED COMPUTERS

<table>
<thead>
<tr>
<th>Model No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4101C</td>
<td>SA400 in cabinet wipower</td>
</tr>
<tr>
<td>8212C</td>
<td>Two SA801 in cabinet wipower</td>
</tr>
</tbody>
</table>

GENERAL

<table>
<thead>
<tr>
<th>Model No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8212</td>
<td>Two SA801 in cabinet wipower</td>
</tr>
<tr>
<td>5212</td>
<td>Two SA851 in cabinet wipower</td>
</tr>
</tbody>
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<th>CALL FOR PRICE</th>
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<tbody>
<tr>
<td>Z-80A</td>
<td>$10.00 ea.</td>
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<tr>
<th>CALL FOR PRICE</th>
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</thead>
<tbody>
<tr>
<td>SHUGART SA801R</td>
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<tr>
<td>Bare Drives</td>
</tr>
<tr>
<td>Single Sided</td>
</tr>
<tr>
<td>Sgl./Dbl Density</td>
</tr>
<tr>
<td>CALL FOR PRICE AND DELIVERY</td>
</tr>
</tbody>
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- Self test mode automatically completes test pattern.
- Printer mode outputs graphics data in 16 sizes with 4 orientations.
- Connection to any microcomputer using parallel 7-bit ASCII code.
- Can use simple cable to parallel port, or special interface to IEEE or other.
- Modular control circuit and mechanical construction.
- Uses any hard fiber-tip pen.
- Uses 11 x 17 paper.
Includes power supply, 1/O connector, 2 pens, 50 sheets of paper, and complete manual.

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Verbatim 5" 10/02.40 50/02.35 100/02.30
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BYTE December 1980 359
Circle 282 on inquiry card.

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**EDGE CARD CONNECTORS: GOLD PLATED:**
Abbreviations: S/E Solder Eye / S/T Sold Tail / W/W Wire Wrap.

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>PART DESCRIPTION</strong></td>
<td><strong>New Sp.</strong></td>
<td><strong>1-Qt.</strong></td>
<td><strong>1024-Qts.</strong></td>
<td><strong>1024-Qts. Up.</strong></td>
</tr>
<tr>
<td><strong>PART DESCRIPTION</strong></td>
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<td><strong>1024-Qts.</strong></td>
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<td><strong>1024-Qts.</strong></td>
<td><strong>1024-Qts. Up.</strong></td>
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**B** & **T** SUMMARY CONNECTORS:

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE 6P Male</td>
<td>61.600</td>
<td>61.340</td>
</tr>
<tr>
<td>DS Female</td>
<td>61.600</td>
<td>61.340</td>
</tr>
<tr>
<td>DE 1196E</td>
<td>2 pc. Gray Hood</td>
<td>61.600</td>
</tr>
<tr>
<td>DA 16P Male</td>
<td>2.250</td>
<td>2.160</td>
</tr>
<tr>
<td>DS Female</td>
<td>61.600</td>
<td>61.340</td>
</tr>
<tr>
<td>DA 1192E</td>
<td>2 pc. Black Hood</td>
<td>61.600</td>
</tr>
<tr>
<td>DE 5P Male</td>
<td>2.250</td>
<td>2.160</td>
</tr>
<tr>
<td>DS Female</td>
<td>61.600</td>
<td>61.340</td>
</tr>
<tr>
<td>DC 27P Male</td>
<td>2.500</td>
<td>2.420</td>
</tr>
<tr>
<td>DC 1199E</td>
<td>2 pc. Gray Hood</td>
<td>61.600</td>
</tr>
</tbody>
</table>

**Circle 285 on inquiry card.**
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18 bit.102 2 MHz clock. 2K RAM. ROM/Readback board. Excellent for control. Bare Board $25.50. Full Kit $39.00. Monitor $29.00. Power Supply Kit $39.00. Tiny Basic $35.00
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Circle 287 on inquiry card.

Byte December 1980 363
Circle 288 on inquiry card.

BUILD YOUR OWN LOW COST MICRO-COMPUTER POWER SUPPLIES FOR S-100 BUS, FLOPPY DISCS, ETC.

POWER TRANSFORMERS (WITH MOUNTING BRACKETS)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>USED IN</th>
<th>PRT WINDING</th>
<th>SEC WINDING</th>
<th>SIZE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO.</td>
<td>KIT NO.</td>
<td>TAPS</td>
<td>OUTPUTS</td>
<td>W x D x H</td>
<td>PRICE</td>
</tr>
<tr>
<td>T1</td>
<td>1</td>
<td>0V, 110V, 120V</td>
<td>2x7.5A, 2x2.5A</td>
<td>3 3/4 x 3 3/4 x 3 1/2</td>
<td>21.95</td>
</tr>
<tr>
<td>T2</td>
<td>2</td>
<td>0V, 110V, 120V</td>
<td>2x12.5A, 2x3.5A</td>
<td>3 3/4 x 4 3/4 x 3 1/2</td>
<td>27.95</td>
</tr>
<tr>
<td>T3</td>
<td>3</td>
<td>0V, 110V, 120V</td>
<td>2x9A, 2x2.5A, 2x2.5A</td>
<td>3 3/4 x 4 x 3 1/2</td>
<td>29.95</td>
</tr>
<tr>
<td>T4</td>
<td>4</td>
<td>0V, 110V, 120V</td>
<td>2x4A (28V, CT), 48V, CT, @ 3A</td>
<td>3 3/4 x 3 3/4 x 3 1/2</td>
<td>22.95</td>
</tr>
</tbody>
</table>

POWER SUPPLY KITS (OPEN FRAME WITH BASE PLATE, 3 HRS. ASSY. TIME)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>USED FOR</th>
<th>SIZE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>KIT 1</td>
<td>@+8 Vdc</td>
<td>12 x 6 x 4 1/4</td>
<td>51.95</td>
</tr>
<tr>
<td>KIT 2</td>
<td>@-8 Vdc</td>
<td>12 x 6 x 4 1/4</td>
<td>58.95</td>
</tr>
<tr>
<td>KIT 3</td>
<td>@+16 Vdc, @-16 Vdc, @+28 Vdc</td>
<td>14 x 6 x 4 1/2</td>
<td>66.95</td>
</tr>
</tbody>
</table>

Each kit includes: Transformer, capacitors, resistors, bridge rectifiers, fuse & holder, terminal block, base plate, mounting parts and instructions.

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- Includes terminal software
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364 BYTE December 1980
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### DISK DRIVES

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 track, 102K Bytes. Includes power supply and TRS-80* compatible enclosure. Ready to plug-in and run the moment you receive it. Can be interfaced with each other and Radio Shack drive on same cable. 90 day warranty. One year on power supply. Available for 220 Vac (50 Hz) operation. External card edge included.</td>
<td><strong>$314</strong></td>
</tr>
</tbody>
</table>

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This 2x2½" power supply uses a wall transformer for safety and is protected against short circuit and thermal breakdown. It is rated at ±12V 120mA and can be used as a single 24V power supply at 120mA. It is ideally suited to operational amplifier experiments.

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This 2½x2½" 5V 500mA power supply is protected against short circuit and thermal breakdown and uses a wall transformer for safety. It operates JBE A-D and D-A converter, 8065 computer, 8080 computer & 6502 microcomputer. Documentation is included.

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KIT $79.95
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6502 MICRO-MICROCOMPUTER

This JBE 3½x5½" Micro-Microcomputer has the following:
- 1024 Bytes of RAM (two 2114A)
- 2048 Bytes of EPROM (2716)
- Uses one 6522 via documentation disk
- 2-bit bidirectional I/O ports
- 2-bit programmable timers
- Serial Data Port
- Latched output and input with handshaking logic
- TTL and CMOS compatible

The 6502 Microprocessor is particularly suited for control functions such as temperature control, burglar alarm, electrical wheelchair, lights, etc. This Micro-Micro interfaces with the JBE Solid State Switch and A-D and D-A Converter and uses the JBE 5V power supply (see below). 2716 EPROM is available separately.

80-153 ASSM. $110.95
KIT $89.95
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APPLE II DISPLAY BOARD

This handy little (3x7") board is ideal for teaching and troubleshooting. It has a run — stop, single step switch which makes identification of shorted lines between address or data-bits easy and shows single steps for teaching computer logic. The display board has 16 Address LEDs, 8 Data LEDs and 1 RDY LED. All lines are buffered.

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BARE BOARD $26.95

BARE BOARDS

APPLE II EXTENDER BOARD

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- Instruction set 100% compatible with the 8086

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8086 5-CHIP SYSTEM

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<td>$21.85</td>
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<tr>
<td>MDD5 5 channel dispense</td>
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Threaded languages (such as FORTH) are an exciting new class of languages. They are compact and fast, giving the speed of assembly language with the programming ease of BASIC, and combine features found in no other programming languages. An increasing number of people are using them, but few know much about how they work. Is a threaded language interpreted or compiled? How much memory overhead does it require? Just what is an "inner interpreter?"

Threaded Interpretive Languages, by R. G. Loeliger, concentrates on the development of an interactive, extensible language with specific routines for the ZILOG Z80 microprocessor. With the core interpreter, assembler, and data type defining words covered in the text, it is possible to design and implement programs for almost any application imaginable. Since the language itself is highly segmented into very short routines, it is easy to design equivalent routines for different processors and produce an equivalent threaded interpretive language for other development systems. If you are interested in learning how to write better FORTH programs or you want to design your own powerful, but low-cost, threaded language specific to your needs, this book is for you.
### MODEM SALE

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>X-MAS SALE THE STAR MODEM FROM LIVEMORE</td>
<td>$139.00</td>
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</tbody>
</table>

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<thead>
<tr>
<th>Description</th>
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<tr>
<td>SA801R</td>
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**MORE**
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  - Double Density
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### CABLES

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<tr>
<td>CND-82322F</td>
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<tr>
<td>VS-82322F</td>
<td>$10.85</td>
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<table>
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<td>FLU-0800</td>
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<td>FLU-0801</td>
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<td>FLU-0802</td>
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<tr>
<td>FLU-0803</td>
<td>$259.00</td>
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### S-100 Boards

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<th>Model</th>
<th>Description</th>
<th>Price</th>
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<tr>
<td>THE BIG Z* - Jade</td>
<td>3 or 4 MHz switchable 256K w/serial I/O</td>
<td>$145.00</td>
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<tr>
<td>CPU-30201K</td>
<td>Kit</td>
<td>$199.95</td>
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<tr>
<td>CPU-30200B</td>
<td>Bare board</td>
<td>$35.00</td>
</tr>
<tr>
<td>SBC-100 - SD Systems</td>
<td>2.5 MHz 250K CPU with serial &amp; parallel I/O ports</td>
<td>$259.95</td>
</tr>
<tr>
<td>CPC-30100K</td>
<td>Kit</td>
<td>$329.95</td>
</tr>
<tr>
<td>CPC-3010A</td>
<td>Jade A &amp; T</td>
<td>$339.95</td>
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<tr>
<td>SBC-200 - SD Systems</td>
<td>4 MHz 580K CPU with serial &amp; parallel I/O ports</td>
<td>$299.95</td>
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<tr>
<td>CPC-30200K</td>
<td>Kit</td>
<td>$375.00</td>
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<tr>
<td>CPC-3020A</td>
<td>Jade A &amp; T</td>
<td>$395.00</td>
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<tr>
<td>CB2 - S.S.M.</td>
<td>2 or 4 MHz switchable 250K CPU with RAM, ROM, &amp; I/O</td>
<td>$299.95</td>
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<tr>
<td>CPU-30300K</td>
<td>Kit</td>
<td>$339.95</td>
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<tr>
<td>CPU-3030A</td>
<td>Jade A &amp; T</td>
<td>$379.95</td>
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<tr>
<td>2810 Z-60 Memory - Cal Comp Sys</td>
<td>2/4 MHz 250K CPU w/serial I/O port</td>
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<td>CPU-30400A</td>
<td>A &amp; T</td>
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<td>1K RAM BOARD</td>
<td>$359.95</td>
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<tr>
<td>ExpandoRAM II - SD Systems</td>
<td>4 MHz RAM board expandable from 16K to 256K</td>
<td>$229.95</td>
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<td>MEM-16630A</td>
<td>16K kit</td>
<td>$299.95</td>
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<td>MEM-16631A</td>
<td>32K kit</td>
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<tr>
<td>MEM-16632A</td>
<td>64K kit</td>
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<tr>
<td>2.5 MHz RAM board expandable from 16K to 84K</td>
<td>$245.00</td>
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<tr>
<td>MEM-16130A</td>
<td>16K kit</td>
<td>$295.00</td>
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<td>MEM-16131A</td>
<td>32K kit</td>
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<td>MEM-16132A</td>
<td>64K kit</td>
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<td>32K STATIC RAM BOARD</td>
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<td>16K STATIC RAM BOARD</td>
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<td>2.5 MHz RAM board expandable from 16K to 84K</td>
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<td>MEM-16151A</td>
<td>4 MHz kit</td>
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<td>MEM-16152A</td>
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<td>MEM-16162A</td>
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<td>MEM-16163A</td>
<td>12 MHz kit</td>
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<tr>
<td>MEM-16164B</td>
<td>Bare board</td>
<td>$219.95</td>
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<tr>
<td>PROM-100 - SD Systems</td>
<td>2 MHz 512K static RAM - a real memory bargain</td>
<td>$119.95</td>
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<tr>
<td>MEM-99510K</td>
<td>Kit</td>
<td>$119.95</td>
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<tr>
<td>MEM-99510A</td>
<td>A &amp; T</td>
<td>$239.95</td>
</tr>
<tr>
<td>PB-1 - S.S.M.</td>
<td>2708, 2716 EPROM board with built-in programmer</td>
<td>$175.00</td>
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<tr>
<td>MEM-99520K</td>
<td>Kit</td>
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<tr>
<td>MEM-99520A</td>
<td>Jade A &amp; T</td>
<td>$225.00</td>
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### S.P.I.C. - Jade

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<td>IO-1045K</td>
<td>2 CTCs, 1 SIO, 1 PIO</td>
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<tr>
<td>IO-1046K</td>
<td>4 CTCs, 1 SIO, 1 PIO</td>
<td>$299.99</td>
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<tr>
<td>IO-1046A</td>
<td>A &amp; T</td>
<td>$319.00</td>
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<tr>
<td>IO-1045B</td>
<td>Bare board w/ manual</td>
<td>$95.00</td>
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<tr>
<td>IO-1045D</td>
<td>Manual only</td>
<td>$20.00</td>
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### Single Board Computers

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<tr>
<td>Z-80 STARTER KIT - SD Systems</td>
<td>Z-80 computer with RAM, ROM, I/O, &amp; keyboard</td>
<td>$319.95</td>
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<tr>
<td>CPS-30010K</td>
<td>Kit</td>
<td>$399.95</td>
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<tr>
<td>CPS-30010A</td>
<td>Jade A &amp; T</td>
<td>$399.95</td>
</tr>
<tr>
<td>AIM-65 - Rockwell</td>
<td>6502 computer with printer, display, keyboard</td>
<td>$374.95</td>
</tr>
<tr>
<td>CPK-5015E</td>
<td>1K AIM</td>
<td>$449.95</td>
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<tr>
<td>CPK-5045E</td>
<td>4K AIM</td>
<td>$699.95</td>
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<tr>
<td>SFK-74000008</td>
<td>8K BASIC ROM</td>
<td>$899.95</td>
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<tr>
<td>SFK-64000004</td>
<td>4K &amp; assembler ROM</td>
<td>$949.95</td>
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<tr>
<td>PSX-030A</td>
<td>Power supply</td>
<td>$949.95</td>
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<tr>
<td>ENX-00002C</td>
<td>Enclosure</td>
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### Motherboards

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<th>Model</th>
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<tbody>
<tr>
<td>ISO-BUS - Jade</td>
<td>Silent, simple, and on sale - a better motherboard</td>
<td>$109.95</td>
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<tr>
<td>MBS-061A Bare board</td>
<td>$199.95</td>
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<tr>
<td>MBS-061A Kit</td>
<td>$299.95</td>
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<tr>
<td>MBS-061A A &amp; T</td>
<td>$399.95</td>
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<tr>
<td>MBS-121B Bare board</td>
<td>$199.95</td>
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<tr>
<td>MBS-121B Kit</td>
<td>$299.95</td>
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<td>MBS-121A A &amp; T</td>
<td>$399.95</td>
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<td>MBS-161B Bare board</td>
<td>$199.95</td>
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<tr>
<td>MBS-161A A &amp; T</td>
<td>$399.95</td>
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### Mainframes

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>MAINFRAME - Cal Comp Sys</td>
<td>Dual drive controller plus monitor, disk controller for both 8&quot; &amp; 12&quot; disks</td>
<td>$599.95</td>
</tr>
<tr>
<td>ENC-112105 Kit</td>
<td>$399.95</td>
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<tr>
<td>ENC-112106 A &amp; T</td>
<td>$349.95</td>
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</tr>
<tr>
<td>DISK MAINFRAME - NNC</td>
<td>Dual drive controller with monitor</td>
<td>$699.95</td>
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### Video Monitors

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<th>Model</th>
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<tbody>
<tr>
<td>9&quot; B &amp; W MONITOR - A.P.F.</td>
<td>High quality, high resolution video monitor</td>
<td>$149.95</td>
</tr>
<tr>
<td>VDM-700900 9&quot; monitor</td>
<td>$199.95</td>
<td></td>
</tr>
<tr>
<td>15&quot; COLOR MONITOR - Zenith</td>
<td>The hi res color you've been waiting for</td>
<td>$599.95</td>
</tr>
<tr>
<td>VDC-201301</td>
<td>$449.00</td>
<td></td>
</tr>
<tr>
<td>12&quot; GREEN SCREEN - NEC</td>
<td>20 MHz, E3 phosphor video monitor with audio</td>
<td>$699.95</td>
</tr>
<tr>
<td>VDM-061200 12&quot; monitor</td>
<td>$699.95</td>
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### Software

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<thead>
<tr>
<th>Model</th>
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<tr>
<td>CP/M 2.2 - Digital Research</td>
<td>Latest &amp; most powerful release of CP/M</td>
<td>$249.95</td>
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<tr>
<td>SFC-52260000D</td>
<td>Manual set</td>
<td>$249.95</td>
</tr>
<tr>
<td>SFC-52260000M</td>
<td>5/4 disk &amp; manual</td>
<td>$149.95</td>
</tr>
<tr>
<td>SFC-52260000F</td>
<td>8&quot; disk &amp; manual</td>
<td>$149.95</td>
</tr>
<tr>
<td>DOS - SD Systems</td>
<td>DOS, CRASIC2, 2400 assembler/compiler</td>
<td>$249.95</td>
</tr>
<tr>
<td>SFX-56001002M</td>
<td>5/4 disk &amp; manual</td>
<td>$199.95</td>
</tr>
<tr>
<td>SFX-56001000F</td>
<td>8&quot; disk &amp; manual</td>
<td>$199.95</td>
</tr>
</tbody>
</table>
December 31 of January 1, 1981

Accessories for Apple

16K MEMORY UPGRADE
Add 16K of RAM to your TRS-80, Apple, or Exidy

MEX-16100K TRS-80 kit ... $39.95
MEX-18101K Apple Kit ... $39.95
MEX-18102K Exidy kit ... $39.95

PRINTER INTERFACE - Call Comp
Contains type-1 card w/ firmware

101-2014A A & T ... $99.95

8" DRIVES for APPLE
Controller, DOS, two 8" drive, cabinet & cable
Special package price ... $1475.00

AIO - S.S.M.
Parallel & serial interface for your Apple

101-2050K Kit ... $189.00
101-2050A A & T ... $199.00

APPLE CLOCK - Call Comp Sys
Real time clock w/ battery backup

10K-2100A A & T ... $125.00

SUPERTALKER - Mtn Hardware
Speech recognition synthesizer to speaker - mike

105-2015A A & T ... $275.00

Z-800 CARD for APPLE
28 pin CPU card with CP/M for your Apple

CPX-3000A A & T ... $289.00

MICROMODEM - D.C. Hayes
Auto answer dual modem card for your Apple or IBM

IOM-2010A Apple modem ... $349.95
IOM-1100A S-100 modem ... $379.95

Printers

BASE - Impact Printer
132 cpi, bidirectional, tractor feed, & graphics

PRM-13100 ... $675.00

DP-8501 - Anaxsys
5 x 11 dot matrix, 20 column, 200 cpi, & graphics

PRM-10501 Standard DP-8501 ... $495.00
PRM-10511 with graphics & 2K ... $1595.00

SPINWRITER - NEC
65 cpi, bidirectional, faster quality w/ storage

PRD-5450A with 16K buffer ... $2695.00

CENTRONICS 737-1
9 x 9 dot matrix, letter quality, proportional spacing

PRM-15737 Parallel ... $795.00
With interface for Apple ... $895.00

NOVATION CAT
300 baud, auto answer/originale acoustic modem

IOM-5200A Special sale price ... $129.00

D-CAT 300 baud, direct connect modem

IOM-5201A Special sale price ... $189.00

EPROM ERASERS
L.S. Engineering UV eraser for up to 48 EPROMs

XME-5200 A & T ... $39.95
XME-5201 Without timer ... $99.95
XME-3101 With timer ... $94.95

TV-1 - Best Buy
The inexpensive alternative to video monitors

IOR-8040A Kit ... $68.95
Call for your free 1980 catalog

8" DISK DRIVES
Highly reliable double density floppy disk drives

Shugart 8010A single sided, double density... $425.00
Special Sale Priced ... 2 for $800.00
Siemens FDD100-0D2 single sided, double density... $395.00
MSF-201120 5 mg warranty ... $395.00
Special sale price ... 2 for $750.00

JADE DISK DRIVE PROGRAMS

JADE DISK PACKAGE
Double-D controller kit, two 8" double density drives
CP/M 2.2, cabinet, power supply, & cables
Special sale price ... $1395.00

DISKETTES - Jade
Bargain prices on magnetoferic media

5 1/4" single sided, single density, box of 10

MMD-511003 Soft sector ... $27.95
MMD-511103 10 sector ... $27.95
MMD-511160 10 sector ... $27.95
5 1/4" double sided, double density, box of 10

MMD-5220103 Soft sector ... $39.95
MMD-5110103 Soft sector ... $33.95
8" single sided, single density, box of 10

MMD-8120103 Soft sector ... $33.95
8" double sided, double density, box of 10

MMD-8220103 Soft sector ... $35.95

Floppy Savers - Tri-Star
Protect your valuable disks from spine damage

MMA-205 5VDC kit ... $13.95
MMA-208 8" kit ... $15.95

Mainframes

MAINFRAME - Cal Comp Sys
12 slot S-100 mainframe with 20 amp power supply

KNC-112106 A & T ... $1395.95

Disk Mainframe - NNC
Dedicated disk controller w/ 8 slot motherboard

EMS-112320 with 30 amp p.s. ... $699.95

TRS-80 APPLE
16K MEMORY UPGRADE KIT
$39.95

Circle 354 on inquiry card.
THE GREAT Q.T. BOARD SET SALE

Q.T. BD SET #1 (KIT)
Z80 CPU (Rev I)
Expandable + with 32K
Monitor For Serial Terminal

Q.T. BD SET #2 (KIT)
Z+CPU (Rev I)
Expandable + with 64K
FDC II Dbl Den Controller A&T
Monitor For Serial Terminal

Q.T. MEMORY EXPANSION KITS
for
TRS-80 • APPLE • EXIDY

SPECIAL SINGLE BOARD COMPUTER
4 MHz Z80A CPU, dbl Den Controller (5¼” or 8” simultaneously), CMIP compatible, on-board EPROM/RAM/ROM, two serial & two parallel ports, real time clock, std 2K monitor & disk routine on ROM, one year warranty.

DOUBLE DENSITY CONTROLLER
Controls up to 4 min or 4 max drives simultaneously, IBM diskette format, works with sgl or dbl sided drives, 1K RAM data buffer, works with any CPU regardless of clock speed, CMIP 2.2 furnished for 5¼” or 8”, disk compatible.

Q.T. MINI-SYSTEMS
• (4 MHz) Z80A CPU, dbl Den Controller
• Two serial & two parallel ports • Real time clock • 2K Monitor on ROM • 48K Memory board • Mainframe with 6 slot mother board • DOS on 5½” disk w/manuals

Q.T. MINI-SYSTEM II (½ Megabyte)$2195
Two B-5I sgl sided/sgl den drives
Q.T. MINI-SYSTEM II (1 Megabyte)$2495
Includes two B-5I dble sided/dbl den drives

CONNECTORS
RS232 Set .......................... $7.50
1 Male DB-25, 1 Female DB-25, 1 Cover
DB25P .............................. $3.25
DB25S .............................. $4.25
Cover .................................. $1.50
S-100 (IMSAI STYLE) ......... $2.50 ea.
Gold Solder Tin ........................ 10 for $2.25

TELEVIDEO
912C ................................ $999.00
920C ................................ $799.00
• Typewriter keyboard • Microprocessor controls • Upper/lower case • Adjustable baud rates (75-9600 baud) • Special function keys

Second page memory options...$25.00
DISKETTES
FREE PLASTIC LIBRARY CASE INCLUDED WITH THE PURCHASE OF EVERY BOX OF DISKETTES

$24.95

Memory

TRS-80
APPLE II

16k memory (8) 4116's

$39

Installation is simple. Anyone who has ever changed a spark plug should be able to upgrade his microcomputer.

How can California Digital offer these memory upgrades as low as $25 below our competition? Simple, we buy in volume which we wholesale to dealers and sell the balance directly to owners of personal microcomputers. These 16k static memory circuits are factory prime and unconditionally guaranteed for one full year. 30-day, before you change your mind, pick up the telephone and order your upgrade memory from California Digital. Add $3 for TRS-80 jumpers.

$2716 EPROM SALE $13

We have slashed prices in an effort to reduce our overstocked inventory. These are single five volt EPROMs manufactured by one of the three largest producers of semiconductor. All are first quality prime devices. Ceresia $130.

FREE

Ultra-Violet Products UVS 11E
UV EPROM ERASER

With purchase of
FORTY
2716 EPROM's

$79 value

CONNECTORS

$395

801/2R Disk Drive

15 lbs.

with 4012 unit and 32K PROMS programmed and calibrated. 

$27K$ 1195

BMC VIDEO MONITOR

$259

PORTABLE DATA ENTRY SYSTEM

Keyboards were specifically designed for retail store order entry. The operator merely enters the necessary control numbers, which are then converted by the computer into data codes to be transmitted to a central station. The keyboard is placed in the same enclosure as all the necessary electronic components and is battery-powered. The operator sits on a bench with keyboard, a small control panel and a small television screen. The complete $1850 system does not require any additional power. 30-day return privilege. Optional 500 character per second terminal also available. 30-day return privilege.

PRINTRONIX

$4500

Leer Seiler Inc.
In Plant
POCKET INTERCOM

$14.95

PORTABLE DATA ENTRY SYSTEM

Litho printers are supplied in a 16 character keyboard enclosed in a plastic case. A four-line display, which can be expanded to eight lines, is used to display the data. The keyboard is arranged on the same console as all the necessary electronic components and is battery-powered. The operator sits on a bench with keyboard. The complete $1050 system does not require any additional power. 30-day return privilege. Optional 500 character per second terminal also available. 30-day return privilege.

Digital Tools

$9.95

We have added a new 10-base seven-digit projection module. The module is an essential for the over-the-counter display of the 801/2R Disk Drive. The module is an essential for the over-the-counter display of the 801/2R Disk Drive. The numbers are arranged on the same console as all the necessary electronic components and is battery-powered. The operator sits on a bench with keyboard. The complete $1050 system does not require any additional power. 30-day return privilege. Optional 500 character per second terminal also available. 30-day return privilege.

WESTERN UNION

$24.95

All merchandise sold by California Digital is premium grade. Shipping: First five pounds $2.00, each additional add 1.40. Foreign orders 10% shipping. Sales tax will be reimbursed. California residents add 6.5% sales tax. COD's discouraged. Open accounts extended to state supported educational institutions and companies with a mining or transportation. Warehouse: 15608 Inglewood Blvd. Visitors by appointment.
Introducing the
ANACOM 150
DOT MATRIX PRINTER
Mfg. suggested list $1350
California Digital Introductory Price
$995

New
from INTEGRAL DATA
460 Paper Tiger with GRAPHICS
INTEGRAL DATA INC.
$1150

TEC V-300
Word Processing
Daisy Wheel Printer
$1595

HazenTime
VDT-H
$1400-$695
$1410-$725
$1420-$895
$1500-$950
$1510-$1025

Hewlett Packard
$2650

Apple II
$988

TI-810
$1495

Centronics
730 $595
737 $795

Centronics 730 and the 737 are guides to suggested attachment of equipment by Centronics or compatible form. Prices are subject to change without notice.

Calif. sales tax 7%

Assembled - Tested - Burned-in

Quiet Buss

8003-B
IB slot
IMSAI

IBM direct price $1295
CALIFORNIA DIGITAL

$1195

MOSCONI & TULLUS TOYS

8000 $795

Apple II

APPLE

740 $800

Apple II

APPLE

800 $747

400 $495

CALIFORNIA DIGITAL

8003-8
IB slot
IMSAI

$169

620 $650

APPLE II

APPLE

800 $747

400 $495

CALIFORNIA DIGITAL

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IB slot
IMSAI

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APPLE II

APPLE

800 $747

400 $495

CALIFORNIA DIGITAL

8003-8
IB slot
IMSAI

$169

620 $650

APPLE II
THE FERGUSON PROJECT: Three years in the works, and maybe too good to be true. A tribute to hard-headed, no compromise, high performance, American engineering! The Big Board gives you all the most needed computing features on one board at a very reasonable cost. The Big Board was designed from scratch to run the latest version of CP/M*. Just imagine all the off-the-shelf software that can be run on the Big Board without any modifications needed! Take a Big Board, add a couple of 8 inch disc drives, power supply, an enclosure, C.R.T., and you have a total Business System for about 1/3 the cost you might expect to pay.

FULLY SOCKETED FEATURES: (Remember, all this on one board!)

**64K RAM**
Uses industry standard 4116 RAM's. All 64K is available to the user, our VIDEO and EPROM sections do not make holes in system RAM. Also, very special care was taken in the RAM array to eliminate potential noise and glitches.

**Z-80 CPU**
Running at 2.5 MHZ. Handles all 4116 RAM refresh and supports Mode 2 Interrupts. Fully buffered and runs 8080 software.

**SERIAL I/O (OPTIONAL)**
Full 2 channels using the Z80 SIO and the SMC 5116 Baud Rate Generator. Full RS232. For synchronous or asynchronous communication, in synchronous mode, the clocks can be transmitted or received by a modem. Both channels can be set up for either data-communication or data-terminals. Supports Mode 2 Int. Price for all parts and connectors: $85.

**24 x 80 CHARACTER VIDEO**
With a crisp, flicker-free display that looks extremely sharp even on small monitors. Hardware scroll and full cursor control. Composite video or split video and sync. Character set is supplied on a 2716 style ROM, making customized fonts easy. Sync pulses can be any desired length or polarity. Video may be inverted or true. 5 x 7 Matrix - Upper & Lower Case

**FLOPPY DISC CONTROLLER**
Uses WD1771 controller chip with a TTL Date Separator for enhanced reliability. IBM 3740 compatible. Supports up to four 8 inch disc drives. Directly compatible with standard Shugart drives such as the 9370 or SAM1. Drives can be configured for remote AC off-on. Runs CP/M* 2.2.

**TWO PORT PARALLEL I/O (OPTIONAL)**
Uses Z-80 PIO. Full 16 bits, fully buffered, bi-directional. User selectable hand shake polarity. Set of all parts and connectors for parallel I/O: $29.95

**REAL TIME CLOCK (OPTIONAL)**
Uses Z-80 CTC. Can be configured as a Counter on Real Time Clock. Set of all parts: $14.50

**SYSTEM COMPARISON**

<table>
<thead>
<tr>
<th>Option</th>
<th>Basic Kit</th>
<th>Deluxe Kit</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP/M 2.2</td>
<td>$195.00</td>
<td>Price varies</td>
</tr>
</tbody>
</table>

**CFM 3.0 2K SYSTEM MONITOR**
The real power of the Big Board lies in its PFM 3.0 on board monitor. PFM commands include: Dump Memory, Boot CP/M*, Copy, Examine, Fill Memory, Test Memory, Go To, Read and Write I/O Ports, Disc Read (Drive, Track, Sector), and Search. PFM occupies one of the four 2716 EPROM locations provided.

**PFM 3.0 RUNS CP/M 2.2**
The popular CP/M* D.O.S. modified by MICRONIX SYSTEMS to run on Big Board is available for $150.00.

**PC BOARD**
Blank PC Board with Rom Set and Full Documentation: $195.00

**DIGITAL RESEARCH COMPUTERS**

<table>
<thead>
<tr>
<th>Option</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>64K RAM KIT</td>
<td>$330.00</td>
</tr>
<tr>
<td>80 x 24 Video Kit</td>
<td>$345.00</td>
</tr>
<tr>
<td>Floppy Disk Controller Kit</td>
<td>$235.00</td>
</tr>
<tr>
<td>80-60 CPU KIT</td>
<td>$295.00</td>
</tr>
<tr>
<td>SER &amp; PAR I/O</td>
<td>$129.95</td>
</tr>
<tr>
<td>S-100 Mother Board</td>
<td>$225.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$1330.90</td>
</tr>
</tbody>
</table>

**FULLY SOCKETED FEATURES:**

- Features:记住，所有这些都在一个板子上！
- 64K RAM: 行业标准的4116 RAM。所有64K都可用于用户，我们的VIDEO和EPROM部分不会破坏系统RAM。此外，还采取了非常特殊的措施来避免RAM阵列中的潜在噪声和闪烁。
- Z-80 CPU: 以2.5 MHz运行。处理所有4116 RAM刷新并支持模式2中断。全缓冲，兼容8080软件。
- SERIAL I/O (可选): 全2通道，使用Z80 SIO和SMC 5116波特率生成器。全RS232。支持同步或异步通信。在同步模式下，时钟可以由调制解调器传输或接收。两个通道可以设置为数据通信或数据终端。支持模式2中断。所有部件和连接器的价格为$85。
- 24 x 80 CHARACTER VIDEO: 具有清晰、无闪烁的显示，看起来非常锐利，即使在小型监视器上也是如此。具有硬件滚动和全光标控制。复合视频或分离视频和同步。字符集随2716风格的ROM提供，非常容易自定义。同步脉冲可以是任何所需的长度或极性。视频可以反转为真。5 x 7矩阵 - 上下文。
- FLOPPY DISC CONTROLLER: 使用WD1771控制器芯片与TTL日期分隔器增强可靠性。IBM 3740兼容。支持最多四个8英寸磁盘驱动器。与标准Shugart驱动器兼容，如9370或SAM1。驱动器可以配置为远程AC关机。运行CP/M* 2.2。
- TWO PORT PARALLEL I/O (可选): 使用Z-80 PIO。全16位，全缓冲，双方向。用户可选择手动摇控。所有部件和连接器的并行I/O设置价格为$29.95。
- REAL TIME CLOCK (可选): 使用Z-80 CTC。可以配置为计时器或实时时钟。所有部件的价格为$14.50。
- SYSTEM COMPARISON:

<table>
<thead>
<tr>
<th>选项</th>
<th>基本套件</th>
<th>高级套件</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP/M 2.2</td>
<td>$195.00</td>
<td>根据型号而定</td>
</tr>
</tbody>
</table>

**PFM 3.0 2K SYSTEM MONITOR**

- PFM 3.0运行CP/M 2.2

**DIGITAL RESEARCH COMPUTERS**

**TERMS:** 初始出货将会在3到5周后进行，根据订单情况。VISA, MC, cash accepted. We will accept COD's (for the Big Board only) with a $75 deposit. Balance UPS COD. The $75 deposit assures your place in line for the initial production run of Big Board.

**DIGITAL RESEARCH COMPUTERS**

<table>
<thead>
<tr>
<th>地址</th>
<th>电话</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.O. Box 401565 • Garland, Texas 75040 • (214) 271-3538</td>
<td>392 BYTE December 1980</td>
</tr>
</tbody>
</table>

**TRADEMARK OF DIGITAL RESEARCH. NOT ASSOCIATED WITH DIGITAL RESEARCH OF CALIFORNIA, THE ORIGINATORS OF CP/M SOFTWARE**

**1 TO 4 PIECE DOMESTIC USA PRICE.**

Circle 357 on inquiry card.
DIGITAL RESEARCH COMPUTERS
(214) 271-3538

32K S-100 EPROM CARD
NEW!

USE 2716's
Blank PC Board - $34
ASSEMBLED & TESTED
ADD $30

SPECIAL: 2716 EPROM'S (450 NS) Are $14.95 EA. With Above Kit.

KIT FEATURES:
1. Uses +5V only 2716 (2KB) EPROM's
2. Allows up to 32K of software on line!
3. IEEE S-100 Compliant.
4. Addressable as two independent 16K.
5. Crommenko extended or high-speed bank select.
6. On board wait state circuitry if needed.
7. Any or all EPROM locations can be disabled.
8. Double sided PC board; solder-masked and silk-screened.
10. Unselected EPROM's automatically powerdowned for low power.
11. Fully buffered and bypassed.
12. Easy and quick to assemble.

16K STATIC RAM KIT - 100 BUSS

PRICE CUT!

$199.95 KIT

FOR 4MHZ ADD $10

KIT FEATURES:
1. Addressable as four separate 4K Biquad.
2. On board bank select circuitry (Crommenko Standard).
3. Allows up to 16K on board.
4. Uses 2114 (40NS) 4K Static RAMs.
5. On board selectable wait states.
6. Double sided PC board; solder-mask and silk screened layout.
7. Gold plated contact fingers.
8. All address and data lines fully buffered.
9. Kit includes all parts and sockets.
10. Phantom is jumpered to Pin 87.
11. Low power under 1.5 amps typical from 8-16 Volt Bus.
10. Blank PC Board can be populated as any multiple of 4K.

16K DYNAMIC RAM PARTIALS
INTEL 2108 8K X 1 RAMS
8 FOR $9.95 32 FOR $35
FACTORY PRIME!

Huge special purchase of INTEL Dynamic RAM's. These are 2108-4, 300NS, 8K, Ceramic DIP. The 2108 is the INTEL 2116 (16K) tested for either upper or lower 8K Only. These are factory prime. Full Spec. See INTEL 1978 Cat. for details or Memory Design Handbook for application data. Both IMSAI and EXTENSITY did mfg. S-100 RAM boards using these devices. — P.S. These devices will not work in the SD EPANDORAM®. Please specify upper or lower 8K. (S1626 or S1627). A super easy RAM to interface to a 280, 16 PIN DIP.

16K STATIC RAM SS-50 BUSS

PRICE CUT!

$210 KIT

FULLY STATIC!

FOR 2MHZ

6800 BUSS!

BLANK PC BOARD - $30 COMPLETE SOCKET SET - $12 SUPPORT IC'S AND CAPS - $19.95

OUR #1 SELLING RAM BOARD!

STEREO! 1-100 SOUNO COMPUTER BOARD

$84.95 COMPLETE KIT

(With Data Manual)

BLANK PC BOARD W/ DATA

COMPUTER PARTS SPECIALS

74LS175 - .99 8035 Intel Single Chip CPU - 5.95
74LS240 - 1.79 Signetics 2901 4 Bit Slice - 6.95
74LS241 - 1.79 AMD 2903 4 Bit Super Slice - 12.50
74LS244 - 1.79 AMD 29705 Dual Port RAM - 8.95
74LS373 - 1.99

NEW! G.1 COMPUTER SOUND CHIP
AV3-8910. As featured in July, 1979 BYTE® A fantastically powerful Sound & Music Generator. Perfect for use with any 8 Bit Microprocessor. Contains 3 Tone Channels, Noise Generator, 3 Channels of Amplitude Control. 16 bit Envelope Period Control, 2-8 Bit Parallel I/O. 3 D to A Converters, plus much more! All In one 40 Pin DIP. Super easy interface to the 8-100 or other buss. $19.95 PRICE CUT!

SPECIAL OFFER: $14.95 each, Add $3 for 60 page Data Manual.

TERMS: Add $1.50 postage. We pay balance. Orders under $15 add 7% handling. No C.O.D. We accept Visa and Master Charge. Tex. Res. add 5% Tax. Foreign orders (except Canada) add 20% P & H. Orders over $50, add 5% for insurance.

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(OF TEXAS)
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CompuMart has been selling computers by mail since 1971. Our thousands of satisfied customers rely on CompuMart for services not generally available from the others. Namely:

- Product Selection/Each product advertised by CompuMart has been evaluated by our in-house staff for best price, performance, and supplier reliability.
- Return Privilege/After receipt of our products, you are protected by CompuMart's exclusive, 10-day return privilege good for all products except software.
- Support/Our Customer Service Dept. and expert technicians are always there to assist you by phone or at CompuMart's outlets. Our knowledgeable phone sales force can provide you with detailed information and complete product specifications.
- Phone Ordering/For added convenience, CompuMart maintains a toll-free ordering number 1-800-343-5504.

NEW FROM Integral Data
The IDS 445 Printer

So now all we can tell you is that it's fantastic. Priced lower than the 440 and equipped with a better print head. Advanced technology strikes! IDS 445 w/Graphics Capabilities $994
IDS 445 w/o Graphics Capabilities $795

FREE Cable with your Paper Tiger.

The IDS 460

Since its introduction 5 months ago this printer has already proved itself. Features include: Correspondence quality printing, High-resolution graphics capability, programmable print justification—a great printer.

$1,285

The Omni 810 Printer from Texas Instruments

Ti Omni 820 Receive-Only (RO) Package. Includes machine-mounted paper tray and cable. A compressed print option and device forms control are standard features.

$2,155

CENTRONIC PRINTERS

New! The incredible Model 737- Correspondence and Draft Quality Printing for Under $1,000. This is the first printer in its class to offer print quality suitable for text processing, plus the performance and application flexibility required for data processing.

737-1 (Parallel Interface) $899
737-2 (Serial Interface) $1,045

Tractor Feed Printer-Centronics' Most Popular Model. Perfect for the needs of a small business system. Recommended by Apple and Radio Shack.

$1,079

FREE Cable with purchase of any Centronics printer.

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These notices are free of charge and will be printed one time only on a space available basis. Notices can be accepted from individuals or bona fide computer users clubs only. We can engage in no correspondence on these and your confirmation of placement is appearance in an issue of BYTE.

Please note that it may take three or four months for an ad to appear in the magazine.

WANTED: F8 and 8800 software for private use. Have F8 evaluation kit and SwTPC 6800. Would like almost any type of program. Also, interested in low-cost hardware. Luke Shipheir, d519 J Lawndale Dr, Greensboro NC 27405.

WANTED: Apple II Plus, Apple II, and/or any Apple computer accessory including tapes. Bruce Helzel, Box 1141, Muskegon MI 48802, (800) 387-2576 nights.

FOR SALE: A 32 K. large-keyboard Commodore PET computer. Will sell to best offer. I also want to buy an Apple II computer with or without one disk drive. Scott, (401) 728-4878.

FOR SALE: Two Shugart SA-500 disk drives mounted in Indigirad cabinet with power supply and cable; $1200. Xitex terminal board; $130. SwTPC AC-30 cassette interface; $75. Mike Moore, 53 Whippletree Rd, Fairport NY 14450, (716) 377-0207.

FOR SALE: Two Truesight SA-500 disk drives mounted in Indigirad cabinet with power supply and cable; $1200. Xitex terminal board; $130. SwTPC AC-30 cassette interface; $75. Mike Moore, 53 Whippletree Rd, Fairport NY 14450, (716) 377-0207.

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FOR SALE: Must quit hobby, so I am selling all my new surplus parts including P8080 and SC1964 microprocessors and AY-1013A UARTs. Please send SASE for complete list and prices. T E Papain, 711 Black Rock Turnpike, Fairfield CT 06430.

AIM-65 BASIC: Looking for a simple way to write and read data cassettes with AIM-65 BASIC? I have a method that uses only a few BASIC statements. It may suit your needs. For a listing, send SASE and $1 for handling. Jerry K Radke, 15 N Ct, Morris MN 56267.

FOR SALE: Digital Group ZBO microcomputer with 42 K programmable memory, keyboard, monitor, two digitai-teape decks, and much software. Complete $1300. Steven Fonsella, 7538 Evergreen, Goleta CA 93017, (805) 968-5893.


FOR SALE: Two Shugart SA-500 disk drives mounted in Indigirad cabinet with power supply and cable; $1200. Xitex terminal board; $130. SwTPC AC-30 cassette interface; $75. Mike Moore, 53 Whippletree Rd, Fairport NY 14450, (716) 377-0207.

FOR SALE: HP-41C alphanumeric programmable calculator. Includes 2 K memory (double density—takes only two ports), printer, card reader with blank cards, rechargeable nickel battery pack, financial decisions application module, all HP manuals, and accessories. Operates perfectly. Total retail price over $1200. Will ship prepaid and insured to first cashier's check or money order for $995. R D Rutter, 1600 Broadway, Suite 1200, Denver CO 80202.

WANTED: APLS cartridge and instruction booklet for video Brain computer. A Giovanniuzzi, 4325 Olive St NE, Cedar Rapids IA 52402.

WANTED: BYTE magazine issue #1 (September 1975) thru issue #15 (November 1976) except issue #4, December 1975. All original publications in excellent condition. (No marks, etc.) Best offer. Walter C Dowd, POB 136, Van Brun Sta, Brooklyn NY 11215.


FOR SALE: New P4 CRT; $30. Purchased from Electrofax, never used. Will ship UPS COD. Frank Sneade, Rt 1 Box 60A, Rawlings VA 23876, (804) 948-7835.

FOR SALE: Anderson Jacobson 841 1/2 serial terminal (15 cps ASCII Selectric), Perfect condition. $1230 list. Asking $800 or best offer. D C Crane, POB 79286, Houston TX 77074, (713) 461-4518.

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BYTE BOOKS is pleased to offer DIGITAL HARMONY, a major new work by John Whitney, a pioneer of the special effects technology used in STAR WARS and 2001: A SPACE ODYSSEY. His book explores the special union of music and computer graphics, and expands the frontier between sight and sound, synthesizing the two to create a new art form. Whitney tells how it's done, provides a thorough theoretical background, and includes listings and programs for those interested in joining in the discovery of this new art form. DIGITAL HARMONY lays the foundation for audio-visual art made possible by microcomputers. It is must reading for all art, music and home computer enthusiasts. Illustrated in Color.
FOR SALE: Texas Instruments 1604L university-module computer complete with power supply, expanded user memory, wired for RS-232, and all manuals, $250. (See page 680 under MIS by T. S. Byrne) A Schwartz, 3454 Camino Teatro, La Jolla CA 92037.


WANTED: AIM-65 users to participate in program exchange. Send cassette tape with your programs and receive a matching number in return. Format requirements: BASIC programs should be clearly documented with machine language programs that include well-documented source files along with object. Special hardware requirements should be documented. Minimum tape gaps: $20 for BASIC, $50 for source, $20 for object. Directly available include SASE. Jim Darnell, 1522 Springdale Dr, Owensboro KY 42301.

FOR SALE: Cromemco 2PU with CP/M 1.4, SSG General Ledger (menu), and Selectvote III-C; $1000. Two 16K static-memory boards and one SIO board; $200. Manuals included with original disk. John Mayer, 4153 Gardenia Ave, Lake Worth FL 33461, (305) 968-6420 after 7 PM ET.

WANTED: Anyone interested in donating, for tax deduction purposes, new or used computer equipment and software such as TRS-80, PET, etc. Robert Hudgens, Math Dept., Brinkley High School, Brinkley AR 72021, (501) 734-2571 or (501) 734-1318 after 4 PM.

FOR SALE: Heath H-9 video terminal, serial and parallel I/O with RS-232C cable included; $275. Heath H-8 serial I/O and cassette interface. Can be used for additional serial port at minimum cost; $50. Both assembled by professional engineer, G Hammond, POB 54, Weirs Beach MS 39566, (601) 396-4612.

FOR SALE: Seclectic terminal (AJ841), Excellent condition. Best offer. I Feb, 3636 S 38th St, Omaha NE 68137, (402) 965-2106.

FOR SALE: Nematron ELF II with cabinet, RF modulator, light pen, Giant board, two 4 K programmable-memory boards, power supply, ASCII keyboard with cabinet, and Tiny BASIC; $670 worth for $335. Royal Dossari, 2795 Phainest Rd, Excello MS 35531, (812) 471-9252.

FOR SALE: MEX800002 Evaluation Kit II, Assembled and tested. Includes standard power supply (5 V, 3 A) and ten pounds of documentation. Get started on 8800 machine language with this turn-key system. $150. Roy Gilbert, 1335 Birchell, San Dimas CA 91773, (909) 963-6201.

WANTED: TRS-80 Level II programs to swap. Games, home, or business programs. Send tape or listing with your address, January Smith, Treehouse Ap $90-A, San Marcos TX 78666.


WANTED: High-resolution color monitor such as RGB or equivalent. Ron Hyomes, 727 Merrihula Ave, Van Noy's 94105, (714) 786-9914.

FOR SALE: Two used Callcomp 8-Inch floppy disk drives. Stufkert interface; $250 each. 15-Inch Ball Brothers CRT monitor; new, $200. Bob Athan, 1643 N Helm, Suite 110, Fresno CA 93727, (209) 252-6146.


FOR SALE: Complete Zenith (H89) H-89 system including H-89 computer, 48 K programmable memory, H-88S serial I/O, cassette interface, HDS and Microsoft BASIC, H-14 printer, all manuals, and lots more (software and over thirty disks). All in brand-new condition. $3999 for all, $2199 without printer, David Hortowitz, 1909 Sielan, White Rock K5 6720, (301) 681-0456 between 6 and 9 PM CT.


FOR SALE: Rockwell AIM-65, 4 K programmable memory, read-only monitor memory, Enclosures Group large new; $540 package, all manuals, and $430. E Veale, 19 Midleton Ln, Williamboro NJ 08046.

FOR SALE: Assembly and tested Vector Graphic program readable-only memory/programmable memory board with Vector Graphic Extended Monitor (version 2.0). $570 plus shipping. All documentation included. Will sell for $125 or best offer. Dick Balch, 632 Chestnut St, Irwin PA 15642, (412) 864-2283.


FOR SALE: Mits: two 16 MCD programmable memories at $200; four 4 MCD programmable memories at $50; ACR, $75. Clare-Pender ASCII keyboard; $25. A5E53 telfax typewriter, stand, long-roll paper, RS-232; $300 plus shipping. DEC LA30, tray, table, RS-232; $750 plus shipping. Modupart; 30 cpa paper-tape punch, interface plans included; $100. All working when last used. Documentation offered, but first check for starter price accepted. John Neville, Box 400, Orona MN 56569, (612) 532-3103.

FOR SALE: Two PDP-8 systems. One is discrete-element PDP-8, one is PDP-8I. Both negative buses. Each has 4 K core memory, DF32 hard disk, DM10 multiplexer, PA6501 high-speed paper-tape punchreader controller. PDP-8 has four T55 tape drives, PDP-8I has two T550 dual-tape drives. Also, several high-speed tape drives and several high-speed paper-tape punches. Documentation will come with orders. Much software will consider offers for entire system or for individual units. Laurence A Marshall, Department of Physics, Gettysburg College, Gettysburg PA 17325, (717) 334-3131.

FOR SALE: Sorcerer 8 K computer with BASIC ROM-PACK, Micro Vetter, various tapes, all connecting cords, manuals, and club newsletters. Like new. $500 or best offer. Mike Nowak, 4825 Gallagher, Rochester MI 48063, (313) 652-6115 after 4 PM.

FOR SALE: Heath H-19 video terminal, expertly assembled and tested; $250. New $450. Similar to Apple. Mike Nowak, 4825 Gallagher, Rochester MI 48063, (313) 652-6115 after 4 PM.

FOR SALE: Exidy Sorcerer Model I with 32 K, Standard BASIC, Development, word-processing read-only memory, and Paces, Sony TVMonitor, Sony TCM-767 cassette recorder, all manuals, and cabling, $385. John H Palevich, 472 Memorial Dr, Cambridge MA 02138, (617) 434-0085 weekdays between 6 and 10 PM.

FOR SALE: Altair 8800A, North Star floppy disk, 24 K expandable memory, 8 K eproms, RS-232 interface, video-display module, CRT, keyboard, and all A supply. Software: North Star BASIC, word processor, etc. Please write for base, assembler, financial and household programs plus many games. Complete manuals and documentation. All working. First $2750 or best offer. Glen Brickley, 12683 68th St N, Largo FL 33773, (813) 585-7078 evenings.

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B. Our custom forms have a guarantee that speaks for itself. Our time on forms range from two to five weeks for custom work and before we start a job we now give a guaranteed shipping date and price, depending on art work, from two to five weeks and for every day we're late we give you a 10% discount.

To get a quote just mail the detached portion of this ad with sample of form or layout and we will call you the day we get the information with a price and guaranteed day of shipment.

C. The swingline table top decollator is a portable unit which separates both carbon and carbonless continuous computer forms into stacks. The separated carbon is easily and neatly removed from carbon pick-up spool. Form size is up to 15" wide. Wt. is 10 to 110 lb. bond paper, and the speed is variable from 75 to 200 feet per minute and takes only 120 volts AC 60 hertz to operate.
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D. The Dataltech Intimus 306 shredder works for Scotland Yard, for government authorities, for important corporations, banks and embassies. The cutting capacity is 12 to 14 sheets at one pass. Cross cut is 1/35 x 3/8. It has a 2 H.P. motor and runs off of 220/360 V 3 phase.
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E. The Intimus 306 is designed for trouble free operation and has a switch for forward and reverse rotation. It has 2 motors with terminal overload. Housing consists of coated steel, mounted on rubber cushions for noiseless shredding. The 306 can sit on a table or a stand. Cutting width is ¼" or ⅛" and has two 300 watt 110 V 60 cycle, 1 phase motors.
Wt. 66 Lbs. Price $1199.00

F. The Intimus Simplex is designed for security without problems in the office. One push of the button renders confidential information into five illegible paper strips ⅛" thin. The simplex has a wide opening in the middle for throw away of cans, etc. Even a paper clip is simply cut into pieces. The cutting capacity is 8 to 10 sheets at one time. It has a 1½ H.P. motor and runs off of 110 volts.
Wt. 27 Lbs. Price $599.00

G. Our catalog consists of more information on equipment in this ad. Other models are available plus a complete line of calculators and typewriters by Adler, Lathem time recorders, several varieties of sales and our disintegrator that destroys paper, aluminum, film and carbon to a complete loss of identity.

Price $2.00

H. Free Brochures and more information:
1. Business Forms
2. Calculators
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4. Time Recorders
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Terms: Check or money order U.S. funds only. Prepaid orders add 3% S/H, COD's add 5% S/H (U.S.only). California residents add 6% sales tax.
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Through its years of microcomputer experience, Ohio Scientific has effectively channeled this tremendous computer power into a "friendly" computer with hundreds of personal uses, via a huge software library of programs for a broad range of personal, home, educational and business use.

This available software allows you to use and enjoy your computer without becoming an expert. The Challenger, however, is a powerful, general purpose computer which can be programmed in several languages by those who choose to.

Here are just a few of the popular uses of an Ohio Scientific Challenger Computer:

Education
The personal computer is the ultimate educational aid because it can entertain while it educates. Software available ranges from enhancing your children's basic math, reading and spelling ability, through tutoring high school and college subjects, to teaching the fundamentals of computers and computer programming.

Entertainment
Many of the Challenger's games educate while they entertain, from cartoons for preschoolers to games which sharpen mathematical and logical abilities. But, entertainment doesn't stop here. The Challenger's graphics capabilities and fast operation allow it to display action games with much more detail than the best video games, providing spectacular action in games such as Invaders, Space Wars, Tiger Tank and more! All popular sports such as golf, baseball and bowling are available as simulated computer games as well as many conventional games such as chess where the computer plays the role of a formidable opponent.

Accounting
Your Challenger computer can keep track of your checkbook, savings account, loans, expenses, monitor your calorie intake and your biorythms.

And more:
This may seem like a lot of uses, but it's only the tip of the iceberg for a general purpose computer. For example, your Challenger can be expanded to control lights and appliances, manage your energy usage and monitor for fire and break-ins. Furthermore, it can communicate with you, with other computers and the new personal computer information services over the telephone.

In fact, the uses of general purpose, personalized computers are expanding daily as more and more people discover the tremendous capabilities of these new technological wonders.

Ohio Scientific offers you four personalized computer systems starting at just $479.