JULY 1980 Vol. 5, No. 7 $2.50 in USA/$2.95 in Canada
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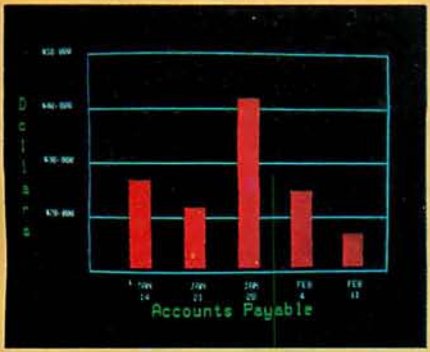
BYTE®

the small systems journal

COMPUTERS AND EDUCATION



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High-resolution display with alphanumerics

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Here's a color display that has everything: professional-level resolution, enormous color range, easy software, NTSC conformance, and low price.

Basically, this new Cromemco Model SDI* is a two-board interface that plugs into any Cromemco computer.

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The resolution surpasses that of a color TV picture.

BASIC/FORTRAN programming

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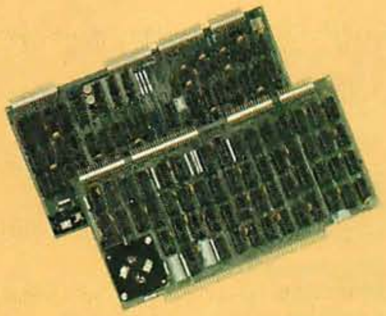
Pick any of 16 colors (from a 4096-color palette) with instructions like DEFCLR (c, R, G, B). Or obtain a circle of specified size, location, and color with XCIRC (x, y, r, c).

*U.S. Pat. No. 4121283



Model SDI High-Resolution Color Graphics Interface

HIGH RESOLUTION

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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Model SDI plugs into Z-2H 11-megabyte hard disk computer or any Cromemco computer

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Along with the SDI we also offer an optional fast and novel **two-port** memory that gives independent high-speed access to the computer memory. The two-port memory stores one full display, permitting fast computer operation even during display.

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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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cle 1 on inquiry card.

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Yes, the Cromemco Model Z-2H is in a class by itself in the computer field.

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- **Fast hard-disk transfer rate of 5.6 megabits/second**
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- **COBOL**
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- **Word Processing System**
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In The Queue

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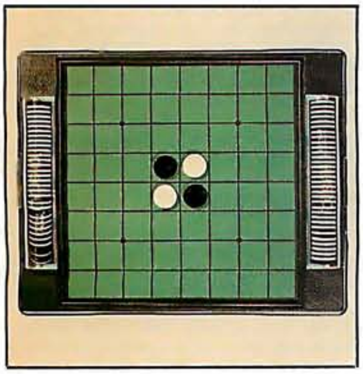

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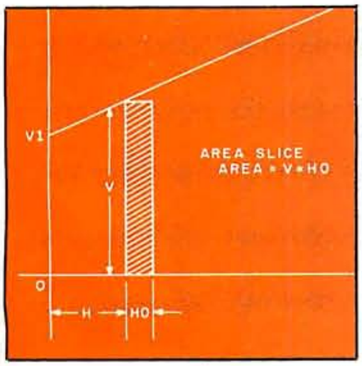

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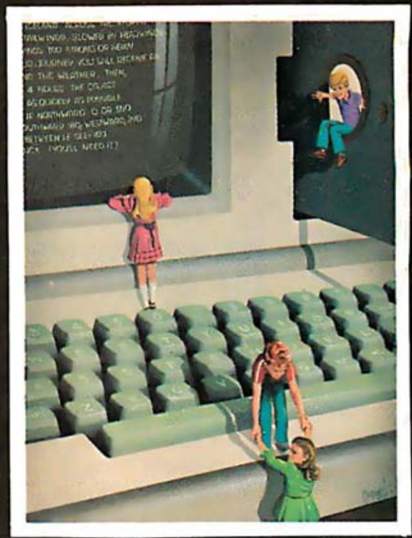
Foreground

Background

Nucleus



ON THE COVER

Our cover this month, Computers in Education, by Robert Tinney, is a fanciful version of a personal computer "playground." Computers are becoming fixtures in our schools, and this month's BYTE takes a look at some of the implications of this new wave in education. For more details about the education articles in this issue, see the guest editorial by Dr Ludwig Braun beginning on page 6.

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Address all editorial correspondence to the editor at the above address. Unacceptable manuscripts will be returned if accompanied by sufficient first class postage. Not responsible for lost manuscripts or photos. Opinions expressed by the authors are not necessarily those of BYTE.

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Subscription WATS Line: (800) 258-5485
Office hours: Mon-Thur 8:30 AM - 4:30 PM, Friday 8:30 AM - Noon, Eastern Time

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Editorial

Computers in Learning Environments

An Imperative for the 1980s

Guest Editorial by Dr Ludwig Braun

Editor's Note: *Our guest editorial this month is by Dr Ludwig Braun, professor and Director of the Laboratory for Personal Computers in Education at the State University of New York at Stony Brook. Dr Braun is well known in computer-education circles for his extensive work in making computers in the classroom a reality. His remarks serve as an excellent introduction to the series of education articles featured in this issue of BYTE.*

BYTE firmly believes that the time to establish a dialog about the role of personal computers in the classroom is now. To this end we have established a feature called "Education Forum," which will appear in BYTE semi-regularly. (See the Education Forums in this issue by Tom Dwyer, Arthur Luehrmann, and Louis Frenzel.) Future Education Forums will include commentaries by MIT's Seymour Papert (the August 1980 BYTE) and James Garson of the University of Notre Dame (in the September 1980 BYTE).

Two articles in this issue discuss the controversial topic of CAI (computer-aided instruction), "PILOT/P: Implementing a High-Level Language in a Hurry," by David Mundie, and "The Personal Computer: Last Chance for CAI?", by Louis Frenzel. (Computer-aided instruction is a drill-and-practice approach to computerized education begun in the 1960s, which alienated many people both inside and outside of the educational community.) Some readers might take us to task for covering what they think is a moribund approach to computer learning. Nonetheless, we feel that Louis Frenzel's article puts CAI in a realistic perspective. David Mundie's article describes the PILOT language, which is designed to implement CAI programs. Some educators feel there is a place for drill-and-practice in the schools; that the "sin" of CAI is really one of omission rather than commission—it simply does not go far enough in making full use of the potential of the personal computer. Tom Dwyer, however, makes the case that the philosophy behind CAI is inherently wrong.

*Whether you are for or against CAI, we invite you to contribute to and to join in this important debate through BYTE's Education Forum....*CM

The computer has had a role in education in the United States for two decades. Until recently its role has been minimal for a number of reasons. Among these reasons are:

- The lack of adequate amounts of high-quality courseware.
- A lack of training among teachers and administrators in the uses of computers in education.
- The cost of providing computing, which frequently has been far beyond the budget even of the very interested school.

Because of the advent of the large-scale integrated (LSI) circuit technology in this country, the last inhibitory factor above has been decreased dramatically. It now is possible for schools to buy quite powerful microcomputers at

prices in the order of $500 to $1000, with the possibility that these costs will decrease by a factor of two within the next five years. Now that the cost of computing is within the reach of most schools, there is an urgency for the elimination of the other two principal inhibitors cited above.

There are several compelling arguments in favor of immediate and dramatic intervention in our educational system in order to take advantage of the many benefits which the computer can contribute. Among these compelling arguments are:

A. *Our educational system is widely perceived as being unsatisfactory.*

Among the indicators which lead to this feeling of dissatisfaction are:

1. The significant increases in the number of dropouts (eg: in New York City more than 40% of students drop out before graduating from high school).
2. An increase in the number of students who are performing below their grade level. Frequently such students fall further and further behind the longer they stay in school. This may be a contributing cause of increased dropouts.
3. Declining Scholastic Aptitude Test (SAT) scores and increasing numbers of failures in statewide tests such as the Regents examinations in New York state.
4. Decrease in average daily classroom attendance among students currently enrolled.
5. Unacceptably high levels of youth unemployment, especially among minority youths.
6. Continuing decline in the education of our students in the sciences as measured by the recent National Assessment of Educational Progress (NAEP) studies as well as those of the National Research Council and the National Science Foundation.

> Our educational system is widely perceived as being unsatisfactory.

In a September 17, 1979 excerpt from *Education Daily*, it is noted that the whole question of scientific literacy is a problem for the country. The National Assessment of Educational Progress report shows a decline in science knowledge in school children of all ages. The report points out that in the nine-year-old group, on a national basis, some 65,000 fewer of this group could answer the typical science questions in 1973 compared to 1970, while 70,000 fewer of the seventeen-year-old group could answer science questions correctly in 1973 than could in 1970.

7. Increased concern about spiralling costs incurred by the requirement to "mainstream" handicapped students (ie: put them into classrooms with other students), as well as by the introduction of programs for gifted children and children with learning disabilities. All of these problems are exacerbated by the general lack of training among teachers in dealing with these special students.
8. Unacceptable levels of failure in state-mandated competency tests for high school graduation.

In each of the indicators of need cited above, there is evidence that the computer can provide assistance to the teacher in addressing these needs. Such assistance typically is not available otherwise.

It was not possible, within the constraints of time and finances, to do a complete literature search to support the contention above that the computer can help in improving our educational system; however, some major items of evidence will be mentioned below.

With respect to increasing attendance as a result of the use of the computer, two studies may be cited: one dealing with secondary schools in the District of Columbia, and the other dealing with community colleges in Ontario, Canada. (See references 1 and 2, respectively.) A finding from the secondary schools in the District of Columbia was that, at a tax cost to the public of $8.43 per student day, there was an increase in student attendance across the three pilot schools totaling $30,790 (from daily attendance revenues). This was based upon only 700 students in the pilot

program. Extrapolating this to the proportion for the total number of students in all public secondary schools in the District of Columbia (approximately 24,000 students), conceivably such a productivity gain would be on the order of $1 million per year. In the case of the community college system in Ontario, the use of the computer lowered the attrition rate or, conversely, increased the attendance rate of students in remedial or basic mathematics courses from a dropout rate of 60% with traditional instruction, to a rate of only 20% attrition with the CAI (computer-aided instruction) mathematics. In terms of a dollar's gain or cost-productivity gain index, the amount of money per year on a province-wide basis is $9,600,000. The value of these two studies is that they demonstrate that the use of the computer to aid instruction *can* result in a substantial gain in the use of the tax dollar for education.

Other indicators come from a series of reviews on the value of CAI for achievement and time to learn in elementary and secondary education —in particular the basic skills of mathematics and language arts. For example, Vinsonhaler and Bass (see reference 3) reviewed a series of elementary education drill-and-practice programs which compared the use of CAI to traditional instruction. Their finding was essentially that augmenting classroom instruction with CAI provides superior performance on SAT or Master of Arts in Teaching (MAT) standardized tests. Other reviews of the literature include that by Jamison, Suppes, and Wells (see reference 4), and another by Edwards, Norton, Taylor, Weiss, and Van Dusseldorp (reference 5), both of which support the notion that supplementary instruction with CAI led to higher achievement than occurred with traditionally taught students. In addition, the Human Resources Research Organization (HumRRO) project (reference 1) found that in consumer mathematics, the use of the computer to augment an already individualized course of instruction provided a significantly higher achievement record for the slower students over the so-called faster students. In this case, prior grade achievement scores and intelligence were unrelated to the achievement within the consumer mathematics course. Rather, the use of the computer provided the basis for their improved scores.

> Because we are moving into an information age, and because computers are becoming ubiquitous in our society, it is essential that we develop a computer-literate society.

The most recent review of the effectiveness of the use of the computer (see reference 6) yields similar results, ie: when the computer is used to aid instruction in the elementary- and secondary-school level, the achievement and/or the time reduction to learn materials is significantly im-

Text continued on page 108

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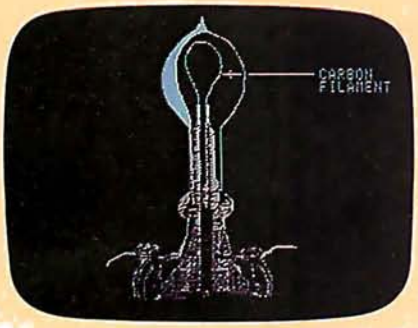

With Apple, Edison could've written a program to determine why some filaments burned longer than others.

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Statement from the Heath Company

In the February 1980 BYTE on page 16, Sol Libes stated in reply to a letter that the Heath Company has discontinued production of the H-8 computer. I wish to state flatly and categorically that this is simply *not* the case. Not only does Heath have plans to continue selling the unit, but we have scheduled additional production, and are modifying the unit — including expensive changes to our tooling — to meet the proposed Federal Communications Commission RFI (radio-frequency interference) guidelines, as will be required for the continued *production* of the H-8 *after July 1st, 1980.*

Additionally, Heath has begun offering new products (as printed-circuit boards) for the H-8, including two items in the April catalog, and additional items planned for *possible* introduction in later catalogs. This activity is justified based on the H-8's sales, which have increased significantly in the last six months as an unexpected result of our introduction of the H-89.

The continued popularity of the H-8 was reported in both *BUSS* and *Intelligent Machines Journal* (IMJ) in November, 1979. IMJ had previously and erroneously reported that the H-8 was to be discontinued, which may have been the source of Mr Libes's incorrect information. A report to this effect had also appeared in the *Amateur Computer Group of New Jersey News,* which was also in error.

Further, in discussing the S-100 bus, Mr Libes states that there are "several times more languages, operating systems, and applications packages for S-100 systems than for any other system." This statement exhibits a "syntax error"; the S-100 bus has nothing at all to do with software, and it is obvious that Mr Libes is referring to "CP/M" systems, and not to "S-100" systems.

Barry Watzman
Computer Product Line Manager
Heath Company
Benton Harbor MI 49022

Sol Libes Replies

Since items in the Letters column of BYTE are printed on a space-available basis, several months elapsed between the writing of my reply and its printing in the February BYTE. The report that Heath was stopping production of the H-8, due to poor sales, was told to me by a vice-president of Heath, who, you must agree, is an unimpeachable news source. Some time later, I was informed that Heath had decided to resume production of the H-8. Regretfully, it was too late to change the item in question. Hence, I still consider my news reporting to be true and reliable, as I always try to make it.

Further, at the time that I wrote the reply, S-100-based systems were the only systems capable of running CP/M and hence my statement that "several times more languages, operating systems, and applications packages are available for S-100 systems than for any other system" was also true. In fact, I feel that this statement is still true today; for, although CP/M has now been adapted

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to run on the H-8, there are still many other operating systems, languages, etc that still run only on S-100-based systems.

Thus, I feel, despite your request, that no correction is required.

A Computer Tutor

I read with great interest the article entitled "SETS — Tutoring in BASIC" by Linda M Schreiber (March 1980 BYTE, pages 244, 245). Not only does the idea of tutoring preschoolers with a microcomputer hold true, but it also holds true for students in any age group, kindergarten thru college.

As interest in education declines, and as the basic areas of reading, writing, and mathematics begin to suffer, we as a country must make an effort to correct this situation. The microcomputer is a new tool that is beginning to catch on. Schools and universities are buying large numbers of these devices for many uses, including teaching. However, the expertise in using the computer to teach or tutor is not there in the schools, at this time. Why not make use of the pool of talent that abounds in the local computer enthusiasts?

Programs such as SETS could be written based on the needs of local educational institutions by local computer hobbyists. With a patient and interesting device (the computer) and the expertise of teachers and hobbyists, we can begin to change the trend in education and make education meaningful again.

As a final technical note, please note that in other versions of BASIC lines 120 and 130 should be changed to:

```
120 C=INT(RND(0)*4) +35
130 N=INT(RND(0)*9) +1
```

For a complete listing of the SETS routine that has been written in a business-oriented dialect of BASIC and includes 45 symbols, written messages under the faces, and other items, please contact me.

David A Schneider
1929 Browning Rd
Madison WI 53704

A Much Appreciated Comment

For once, I would like to write you, not as a longtime contributor to BYTE, but as an ordinary reader of BYTE.

The subject: the comments by Carl Helmers against biorhythms in the November 1979 editorial ("Is Pseudo-Science Done by Computer Pseudo-Computer-Science?", page 6).

And the message: RIGHT ON!

I am profoundly heartened by the social responsibility that BYTE has taken upon itself with articles such as these. Please keep up the good work.

W D Maurer
George Washington University
SEAS
Washington DC 20052

Don't Let Interrupts Disturb Conversion

I would like to compliment Michael McQuade for his article "A Fast, Multibyte Binary to Binary-Coded-Decimal Conversion Routine" in the February 1980 BYTE (page 106). Both his description of the method and the algorithm itself are straightforward and clear. In fact, his listing was well enough documented that I was prompted to read it very carefully.

Twice in the program occurs the following sequence:

```
POP   H   ;RESTORE HL ...
DCX   SP
DCX   SP  ;LEAVE HL ON STACK.
```

While this code seems to do the job indicated by the comments, a problem arises if an interrupt comes along between the POP and the second DCX. In this case, the value to be left on the stack will be overwritten by the program counter as the interrupt is acknowledged. The following sequence is not only shorter, but always performs the desired function:

```
POP  H    ;RESTORE HL ...
PUSH H    ;LEAVE HL ON STACK.
```

Keep up the good work at BYTE. After becoming a computer professional, I was very pleased to find out that the magazine which I read as a hobbyist contains articles which are much better written and provide more useful information than those in the trade journals.

Donald Reaves
64 S Madison Ave
Spring Valley NY 10977

A Simplification...And a Bug Report

It wasn't until a friend's comment directed my attention to the Update adjoining Carl Helmers' Editorial in the February 1980 BYTE (page 8) that I became aware of problems regarding ASCII idle (DLE) characters in an implementation of the UCSD Pascal routine GOTOXY.

First of all I regret the contortions that Carl felt necessary to find a solution, particularly since there is an alternative solution provided by the system, *even if undocumented and less devious.* It involves the fifth, or CONTROL, parameter that the user passes to UNITWRITE. If bit number 2 of this parameter is set (on), special-character processing of ALPHALOCK, EOF, and that troublesome DLE is disabled. Thus

UNITWRITE(1,ABYTE,1,,5);
(bits 0 and 2 are set, all others cleared)

would pass the character at address ABYTE to the CONSOLE asynchronously regardless of whether it was a control-P.

Second, as attested to on page 109 of the *APPLE Pascal Reference Manual,* decimal constants may be achieved on the 6502 Version of the UCSD Assembler by ending the constant in a decimal point ".", for example

13 hexadecimal
equals 19. decimal

The assembler was designed to be able to deal with binary, octal, decimal, and hexadecimal constants. It is up to machine-specific compile-time constants to determine which base is the default and which if any other bases are usable, and the postfix character that discriminates them.

Again I am sorry for the lack of documentation. Also thanks for the friendly words about the UCSD Assembler.

Bill Franks
Assembler Author
Institute for Information Systems
University of California, San Diego (UCSD)
La Jolla CA 92093

*Thanks for clearing up a misconception that crept into a previous editorial....*CH

Electronic Anticipatory Democracy?

Please consider asking readers of BYTE how many personal computer owners would be interested in responding to government issues via personal computer equipment or through personal computer information networks.

I recently read that a major computer time-share or systems-support company had made arrangements with one of the wire services to make available the latest news items directly on personal terminals.

It occurred to me that this is about half of what is needed to implement the concept of "anticipatory democracy characterized by electronic transmission and sharing of information," proposed by some members of the World Future Society as the hope for America's future. The other half would be the installation of small computer systems accessible to government representatives in the various levels of government.

Too often government is considered to be a separate entity, essentially alienated from the people it represents. As evidence of this, consider that most individuals have an opinion on at least one issue, but few have communicated that opinion to a representative in any level of government.

In addition, government issues are often complex, and submission of an opinion may result in a reply not exactly encouraging to the constituent. The awesome workload of representatives makes it difficult for them to provide long, detailed explanations of pending legislation or the dependence of one issue on seemingly unrelated issues. Thus, the constituent faces a relative lack of complete information or the prospect of having to go through *n* iterations to obtain and assimilate it.

An electronic democracy can alleviate this problem be providing high-speed access to vast quantities of information and "canned" responses to submitted opinions in most cases. Presently, about a month elapses before I receive a reply from my Representative or Senators in the federal government. The speed-up factor alone could provide an order of magnitude or better improvement in efficiency in administering the representative end of government.

Finally, electronics enthusiasts are a special breed, and while performing a vital service simply by participating in government, they also concurrently form a subtle lobbying element for their special interests.

David L Knoper
4652 E 19th St
Tucson AZ 85711

It is not clear that a "canned" response done electronically is any better than a similar reaction carried out via quill and ink.

*Might the problem lie elsewhere? Is not a government that tries to do too much guaranteed to be "complex" and unresponsive? Look instead upon the communications technologies as ways of illustrating that much of what government pretends to do is unnecessary now that we have a cheaper and more efficient product....*CH

A Synthetic Instrument

Hal Chamberlin's article in the April 1980 BYTE ("Advanced Real-Time Music Synthesis Techniques," page 70) was very good. It provides an extreme wealth of detail that could only be otherwise had from reading many volumes on the subject. I question, however, the possibility of such an instrument as shown in figure 9a on page 186. The drawing represents a physical impossibility similar to the tuning-fork optical illusion. How many ends does this device have? How can a square prong have a cylindrical end? Where do the left-side piece and right-top piece end? Viva the poetic license!

Oh well, the article was good, anyway.

Andrew Shecktor
4022 Pilgrim Rd
Plymouth Meeting PA 19562

*Please observe that the Glockenflute was described as "a hypothetical instrument."...*RSS

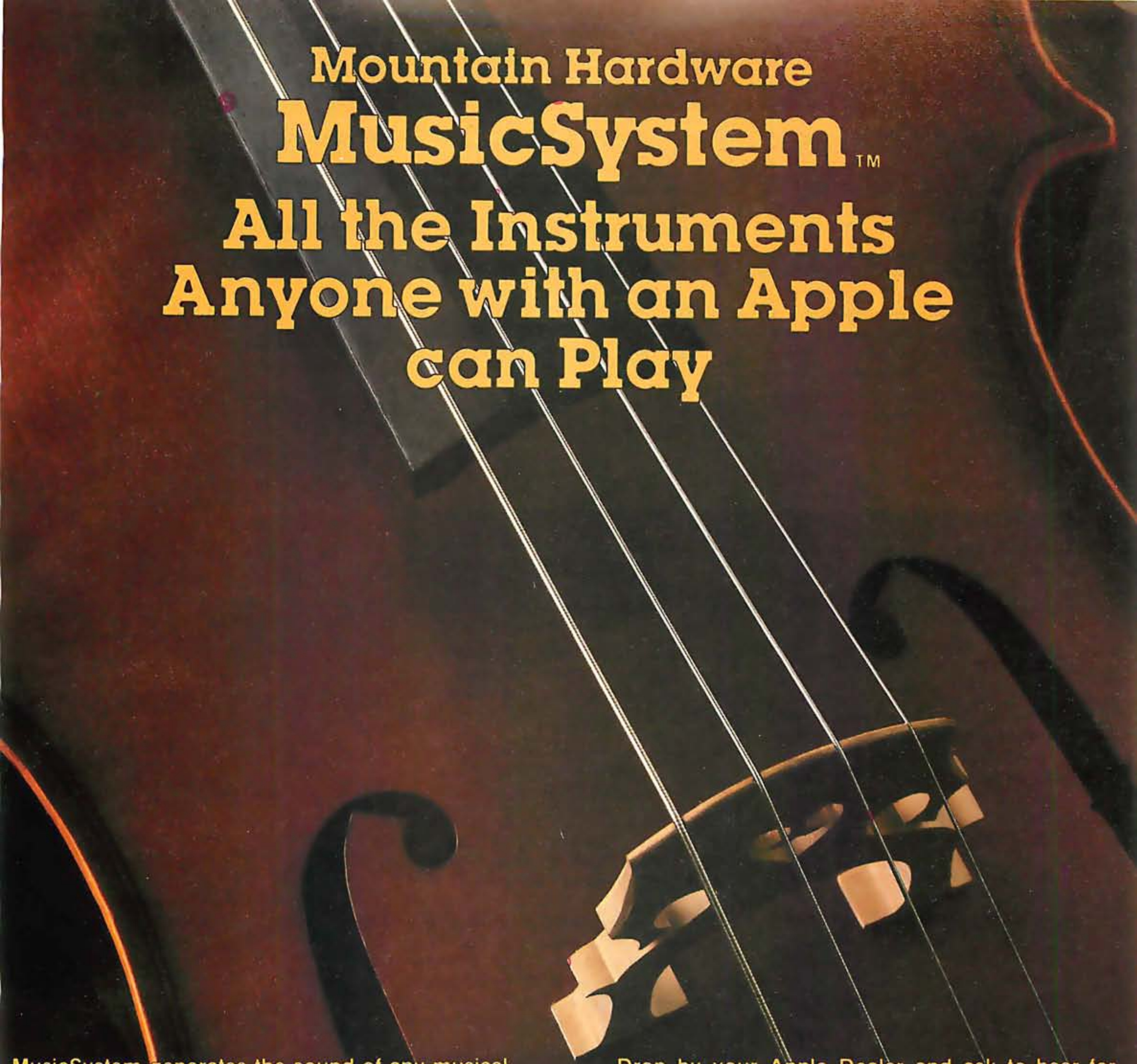
Comments on Text Compression

I enjoyed (as always) the December 1979 issue of BYTE, in particular the article "Text Compression" by J L Peterson (page 106). My interest in the topic is a long-standing one, and I believe Mr Peterson has several good points to offer (and does well in doing so).

I offer the following comments on the article:

- Figure 3 on page 108 notes that: "This scheme is useful only when the repeat count is greater than 2." I would suggest that if an escape flag, a count, and a character are needed, then the method is useful only when the count is greater than *3*. For example, in figure 3, top-left, the string of "***" has been replaced with "$3*" — no savings at all.

  One approach which will allow lengths of 3 or more to be compressed is if an escape character and count can be combined into one byte. If, for instance, all values below X'40' were not used, then X'00' thru X'3F' could be an escape/count character (which allows repeats up to 128).
- The comments on the problem of escape character presence in the data are also good. While the implication was there, Mr Peterson could have been more explicit about the data *expansion* that takes place in this event; ie: $ replaced by 0 or 1.
- From figure 4, page 110, I would also suggest that SQR() would be as appropriate as any other keyword, and would provide a compression of 3 bytes.



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Phone ____________________

- Figure 4, page 110, the last line states "... and $5 would mean "READ"." This should have been "and $5 would mean " READ "."

For interested readers, I offer the following additional references:

1. Ruth, S R, "Data Compression for Large Business Files"; *Datamation;* volume 18, September 1972.
2. Wells, M, "File Compression Using Variable Length Encoding"; *Computer Journal*; volume 15, 1972.
3. Hagamen, W D, "Encoding Verbal Information As Unique Numbers"; *IBM Systems Journal;* volume 12, number 4.
4. Floyd, R E, "Data Compression Using A Noun-Vector Lookup Table"; *IBM Technical Disclosure Bulletin*; volume 13, number 12.
5. Heaps, H S, "Data Compression of Large Document Data Bases"; *Journal of Chemical Information and Computer Science;* volume 15, number 1.
6. Floyd, R E, "Improved Data Base Compression Through Combined Software Techniques"; *IBM Technical Disclosure Bulletin;* volume 21, number 2.

R E Floyd
1501 S W 7th St
Boca Raton FL 33432■

BYTE's Bits

8088 System from Ciarcia's Circuit Cellar

A printed circuit board for the small (5 integrated circuits) Intel 8088 system described in a recent Ciarcia's Circuit Cellar series is now available for purchase. (See "Ease Into 16-Bit Computing," by Steve Ciarcia, March 1980 BYTE, page 17, and April 1980 BYTE, page 40.)

The bare, unpopulated printed circuit board may be obtained for $29.95 from John Bell Engineering, POB 338, Redwood City CA 94064, (415) 367-1137.

TRS-80 Model II Available on Lease

Radio Shack is now leasing complete TRS-80 Model II microcomputer systems. A & A Financial Corporation, is offering a thirty-six-month true lease, preceded by a ninety-day warranty period. The ninety-day warranty permits the customer to evaluate the system and determine that it will handle the necessary applications. The lease can be cancelled during the warranty period. At the end of the lease term, the customer has the option to buy, to continue leasing, or to move to a larger system. Rental payments may be fully tax deductible as a business expense. Another aspect of the lease program is that the customer will be able to work directly with Radio Shack to inquire about warranty claims and learn about the operation of the system.

Further information on leasing a Radio Shack TRS-80 Model II is available at Radio Shack stores, dealers, and Radio Shack Computer Centers, or from A & A Financial Corporation, 800 Two Tandy Center, Fort Worth TX 76102.

A Brainstorm of a Contract

Synchro-Sound Enterprises, 193-25 Jamaica Ave, Hollis NY 11423, (212) 468-7067, has signed a contract with Intertec Data Systems of Columbia, South Carolina, for 1000 SuperBrain Computer Terminals. This stock of terminals will be available for distribution to dealers throughout the country. Synchro-Sound distributes a variety of computers and computer peripherals.

BYTE's Bugs

Just a Little Bit More...

The February 1980 issue of BYTE contains an incorrect price in the What's New? section. The Alpha Micro 90-megabyte disk subsystem on page 212 is pictured with a microprocessor unit. This configuration should read as $30,000. The disk subsystem alone costs about $15,000 and is sold only as an upgrade for existing Alpha Micro integrated systems. We apologize for the disappointment and trouble this has caused.

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Handheld Remote Control for Your Computerized Home

Steve Ciarcia
POB 582
Glastonbury CT 06033

Remote control is on the minds of many people these days. The Busy Box AC remote-control interface for household appliances I presented in January has been received with great interest. (See "Computerize a Home" January 1980 BYTE, page 28.) It probably just whetted the appetites of most experimenters.

The Busy Box interface, which connects the BSR X-10 Home Control System (as sold by Sears) to a personal computer, is intended to facilitate inexpensive AC remote control. When attached to a computer such as a Radio Shack TRS-80, it can easily turn on the television set precisely at 7 o'clock as you flop in your easy chair after a hard day at the office. (Delivering slippers is still the dog's job.) By using a sufficient quantity of the remote output modules and coordinating software, the appearance of a completely computer-controlled home can be obtained.

This control is limited, however. Without physically typing on the computer keyboard, there is no direct method for the operator to command the computer to turn on remote-control channel 2 of the X-10, or for the computer to verify that this activation has in fact occurred. It is left to the operator to either indicate the status of each output or clear everything at the start. While this might at first seem to be unimportant in most domestic control applications, it is a major annoyance. In critical control applications, it is a definite liability.

Control systems incorporating no feedback of status are called *open-loop* systems. When feedback on the effect of control outputs is provided, the control loop is completed, and the system is then referred to as a *closed-loop* control system.

While various methods may be employed to directly drive the BSR system with control information, any change in output status is not relayed back to the computer. The control computer does not know that you have overridden the system and manually turned on the TV. Nor does it know that you have just changed your mind about staying up to watch the late, late show. It is easy for you to get out of synchronization with preprogrammed timing, and you may find yourself suddenly sitting in the dark with the TV off.

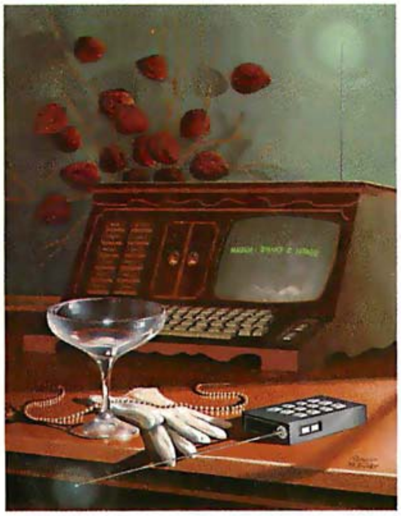

Illustration 1: *The January 1980 BYTE featured several articles on the theme of home control, including the Circuit Cellar article "Computerize a Home." This month's Circuit Cellar includes designs for the wireless remote-control unit depicted by artist Robert Tinney on the January cover.*

For example: I thought I'd like to automatically shut off the TV set after the late show in case I fell asleep. I set the real-time software to shut off the X-10's remote-control channel 4 at 2:30 AM. It turned out, however, that the only one who could keep time was my computer. Even allowing an extra hour to make up for changes in schedules and interruptions, invariably everything would go black just as Charlie Chan gathered everyone together in the living room to disclose the identity of the murderer.

True, I could have kept changing the shut-off time in software, but that would have cured only one symptom and would not have attacked the real problem. I needed a way to tell the computer, "Tonight, I will retain control of the TV set," and to tell the control system when it can take over again. It is difficult to have effective automatic activation of household appliances unless both controllers, you and the computer, communicate directly. It sounds easier to do than it is.

Closing the Loop

Two immediate alternatives come to mind. One is to pull the plug on the computer when you walk in the house. Then you are the only one in command. Or, if you prefer to retain automated control, you can always command the control system directly through the computer. For a truly computer-controlled environment, this is the only possible solution.

The limiting factor in constructing remote-control devices lies more in the complexity of checking out the hardware than in the communication techniques employed.

The next question is "How do we indicate to the control system what actions it is to perform when we are not there sitting at the console?" There has to be some facility for remote communication. In its least complicated form, this facility might be nothing more than a single switch at the end of a long cable. This switch can be used to initiate execution of particular control programs on the computer, or to let the computer know that a specific, controlled event has occurred. While the idea of a 100-foot cable might sound rather questionable to most computer users, it is inexpensive and it will work. However, it is a rather cumbersome approach. Since I have an aversion to being attached to my computer by an umbilical cord, and since the actual feedback mechanism does not have to be especially complicated, I propose a less conspicuous connection using wireless communication. More on this later.

Handheld Remote Control

The most convenient communication mechanism is a handheld transmitter or controller. On it can be a button, or buttons, which you press to initiate various computerized activities, which can range from running a Star Trek game program automatically to activating and deactivating the house security system. Entire chains of events can be triggered by a single output command. And, by utilizing the simple radio-frequency (RF) transmitter I have designated, remote operation of AC-powered appliances can be carried out from much greater distances than presently accommodated with the standard BSR X-10 system.

The purpose of this article is to present a circuit for the construction of a handheld, transmitting communication device. With a receiver attached appropriately to an input port on the computer, and using software that coordinates its activities, we can effectively have a "handheld remote controller."

The limiting factor in constructing remote-control devices lies more in the complexity of checking out the hardware than in the communication techniques employed. I shall describe three different systems which can function as control communicators. They vary considerably in complexity of construction. Your choice of which to build should be tempered somewhat by a frank assessment of your engineering abilities. Use of the latest large-scale integrated circuits in these systems does not necessarily make them easier to check out. The three designs to be discussed are:

- biphase frequency-shift-keyed (FSK) transmitter/receiver
- complementary metal-oxide semiconductor (CMOS) large-scale integration (LSI) remote-control transmitter/receiver integrated circuits
- single-channel transmitter/receiver using inexpensive walkie-talkies

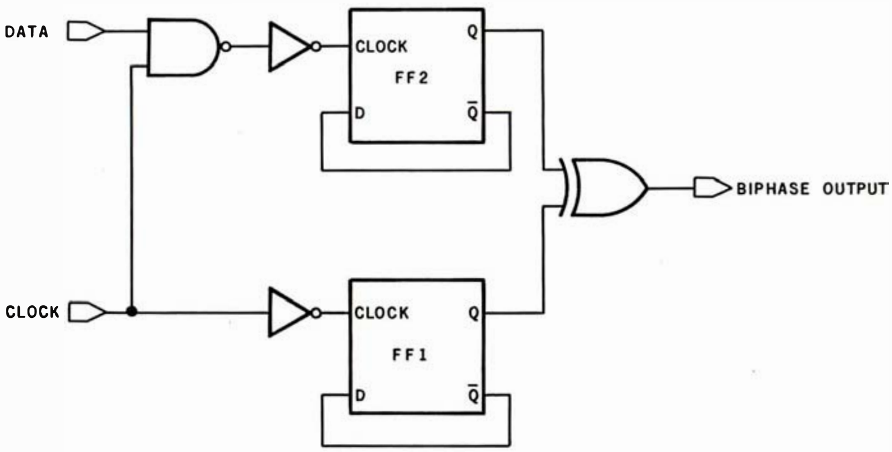

Figure 1a: *Diagram of a circuit that performs biphase encoding of data for transmission to the BSR X-10 Home Control System. Two type-D divide-by-two flip-flops are gated into an exclusive-OR, producing the output shown in the timing diagram of figure 1b.*

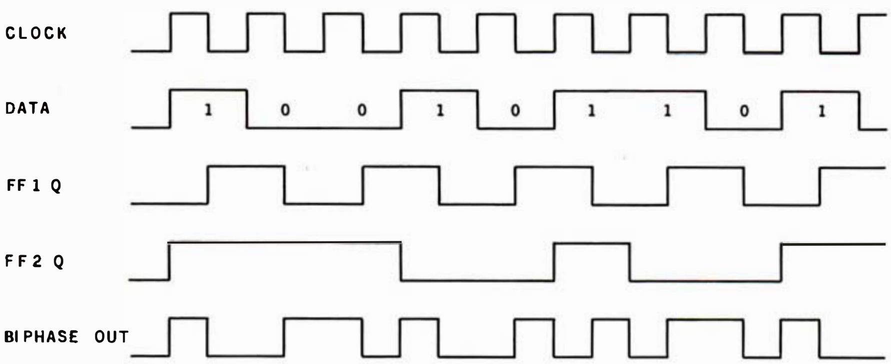

Figure 1b: *Timing diagram of the biphase encoder of figure 1a. The clock and data pulses are combined into the biphase output.*

Biphase Frequency-Shift-Keyed Communication

If we wanted to communicate an off/on signal through wires to a computer we would simply use two voltage levels. "On" could be a +5 V potential and "off" could be a ground (0 V) potential. Does it sound familiar? In a wireless communication link, we cannot use DC voltage levels. The simplest alternative is to use two bursts of tones at different frequencies instead. Communicating more than a single control function over this same link is accomplished by serializing the data and time-multiplexing its transmission.

Usually when we hear the word

"serial" we think of the standard serial-communication system protocol employing universal asynchronous receiver/transmitters (UARTs), etc. This form of serialization is but one of the many possible techniques and is not necessarily the most convenient for our purposes.

Figures 1 and 2 demonstrate *biphase encoding* and *decoding* of clock and data signals. This method uses relatively few components and allows recovery of the clock signal as well as the data.

To encode data we use the circuit of figure 1a. It consists of two type-D divide-by-two flip-flops sending their outputs into an exclusive-OR gate. The resulting output is demonstrated in the timing diagram of figure 1b. Close comparison of the input data and the biphase-encoded output shows how the process works. You will notice that if the data input is at a 0 level during one clock period, the output level changes *once*, but if the input is at a logic-1 level during the clock period, the output changes *twice*. These changes are called *transitions* and can be either 1-to-0 or 0-to-1 logic changes.

Simply stated, during a clock period there are two transitions for a logic-1 data input and only one transition for a logic-0 input. Biphase encoding relies upon timing between transitions rather than absolute voltage level. This makes the method relatively immune to power-line transients, power-supply fluctuations, and filter phase shifts.

Recovering the biphase-encoded data is done with the decoder circuit of figure 2a. It consists of an edge detector which produces a 1 μs pulse upon detecting any transition in the input voltage, a nonretriggerable one-

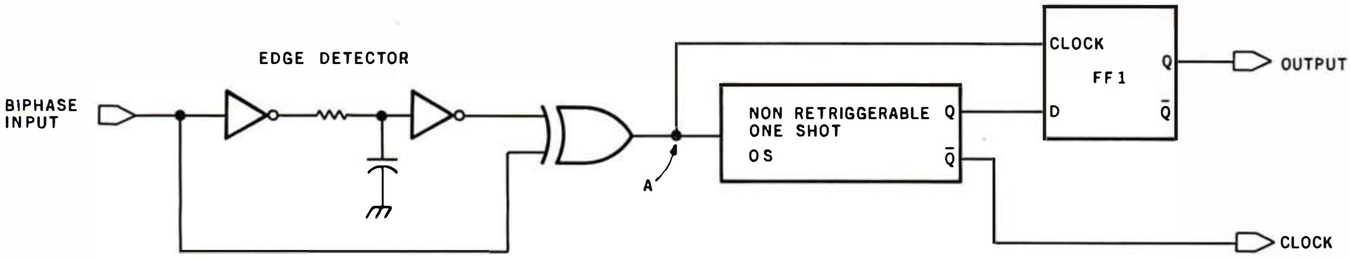

Figure 2a: *Diagram of a possible circuit for a biphase data decoder. The cycle time of the nonretriggerable one-shot (a monostable multivibrator) is set equal to about three-quarters of the duration of a bit in the incoming data stream. The corresponding timing diagram is presented in figure 2b.*

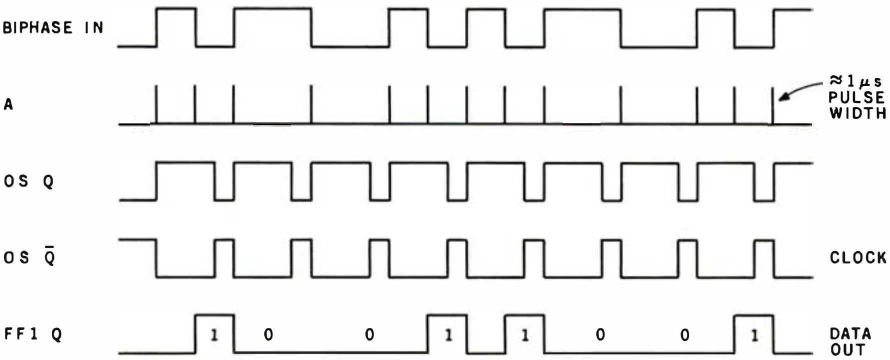

Figure 2b: *Timing diagram of the biphase data decoder of figure 2a.*

It isn't necessary for you to spend much money and time on an elaborate circuit, if you can be satisfied with a less sophisticated control system.

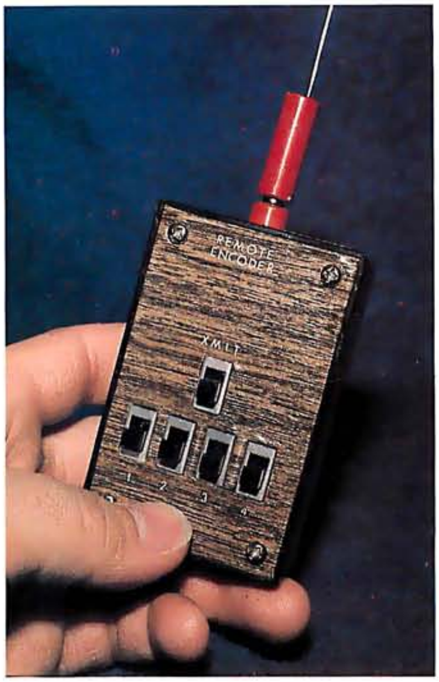

Photo 1: *The handheld biphase FSK remote-control transmitter, which uses the circuit shown in figure 3. The transmit (XMIT) switch is a momentary power switch; the other four switches are used to set a 4-bit control-channel code.*

shot (that is, a monostable multivibrator) set for a period equal to approximately three-fourths of the clock period of the originating transmission, and a flip-flop. As biphase data is presented to the circuit, it produces the edge-detector pulses shown as line A on the timing diagram of figure 2b.

When the first input pulse comes along, it fires the one-shot. (For a clock rate of 35 Hz, the one-shot period is set for 21 ms). If another edge is detected before the one-shot times out, it clocks a logic 1 out of the flip-flop. If a second pulse does not occur during the one-shot period, the output stays at a logic-0 level. Also, since voltage transitions in the received data coincide exactly with the transmitter clock, the receiver's one-shot becomes synchronized to the transmitter. Neglecting duty cycle, this clock rate is exactly the same as the transmitter's clock rate.

This technique has a few advantages that experimenters will appreciate. Since the one-shot is set at 75% of the optimum clock period, it essentially allows up to a 25% variation in timing between the transmitter and receiver while still maintaining synchronization. Compare this to about a 5% tolerance for the usual methods of serial data transmission! No crystals or elaborate clock generators are necessary for low-speed transmissions, either.

A Functional Biphase Remote-Control Unit

Figure 3 and figure 4 are the com-

Number	Type	+5 V	GND	−12 V	+12 V
IC1	74LS151	16	8		
IC2	74LS93	5	10		
IC3	74LS00	14	7		
IC4	74LS04	14	7		
IC5	74LS74	14	7		
IC6	74LS86	14	7		
IC7	CO4049	14	7		
IC8	CO4027	14	7		
IC9	NE555	8	1		
IC10	74LS04	14	7		
IC11	74LS86	14	7		
IC12	74121	14	7		
IC13	74LS74	14	7		
IC14	74LS95	14	7		
IC15	74LS95	14	7		
IC16	74LS20	14	7		
IC17	74LS75	5	12		
IC18	LM741			4	7
IC19	LM741			4	7
IC20	LM741			4	7
IC21	LM741			4	7

Table 1: *Power connections for integrated circuits of figure 3.*

plete schematic diagrams of a functional sixteen-channel biphase FSK remote-control unit. The transmitter circuit of figure 3, including an RF transmitter, is packaged in the unit shown in photo 1. The circuit includes a switch- and sync-word scanner, an FSK modulator, and a biphase encoder. The four switches are used to set a 4-bit control code.

Because this unit is handheld, I have chosen to use a very low clock rate to reduce possible data errors. At 35 Hz, it takes approximately one quarter of a second to send the 4-bit switch status. Functionally, IC2 (a 74LS93) counter is attached to an 8-input multiplexer (IC1, a 74LS151 device). The first 4 bits of the multiplexer input are hardwired to a binary code of 1001 and the last 4 bits are connected to the data-input switches. As the counter (IC2) increments, IC1 steps through the binary sync word 1001 and then the four switch settings. This process keeps repeating for as long as power is applied to the circuit. This data is in turn encoded and modulated so that

Text continued on page 32

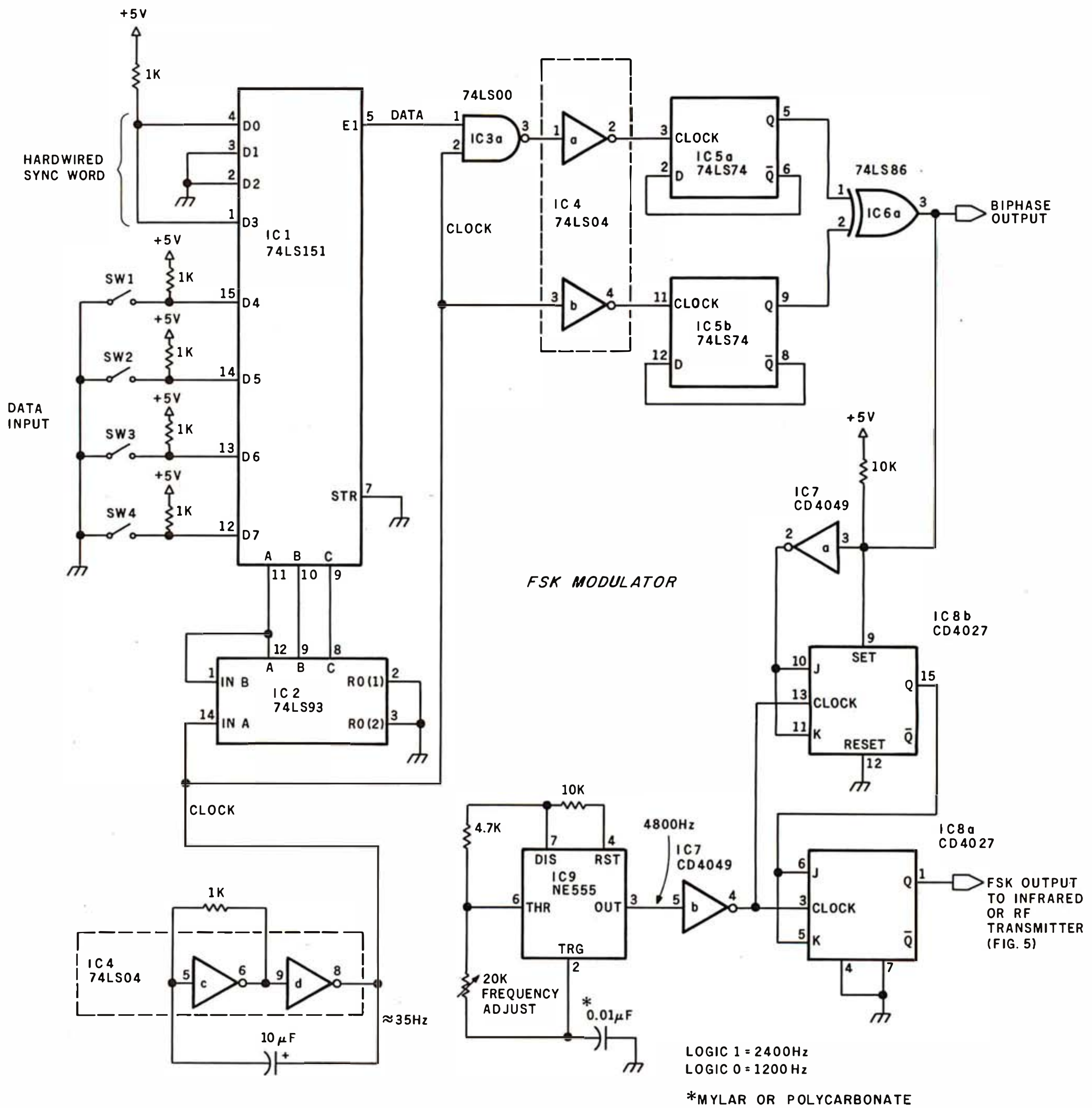

Figure 3: *Schematic diagram of a functional sixteen-channel biphase FSK remote-control transmitter. This circuit, with the addition of an RF modulator, is packaged in the handheld unit illustrated in photo 1.*

Power for the handheld device is provided by a rechargeable nickel-cadmium (ni-cad) battery of 4.8 V potential. If the transmitter is to be used for extended periods without recharging, CMOS parts may be substituted for the transistor-transistor logic (TTL) parts listed here.

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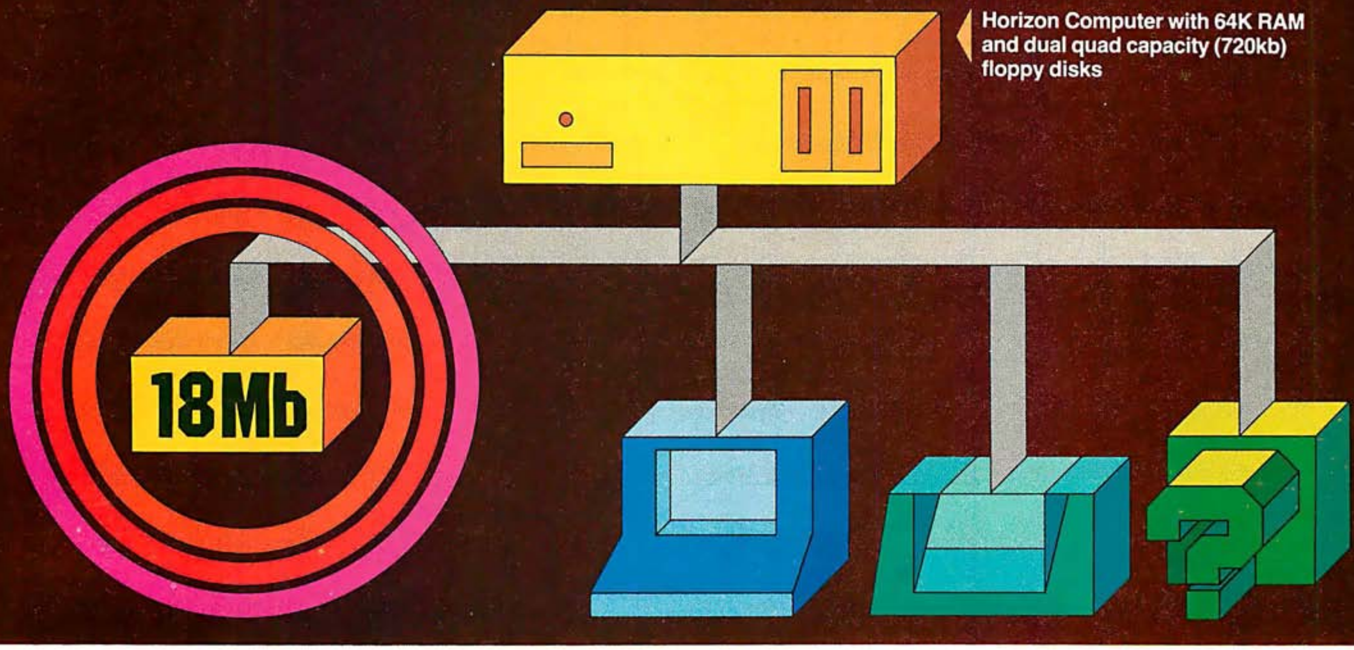

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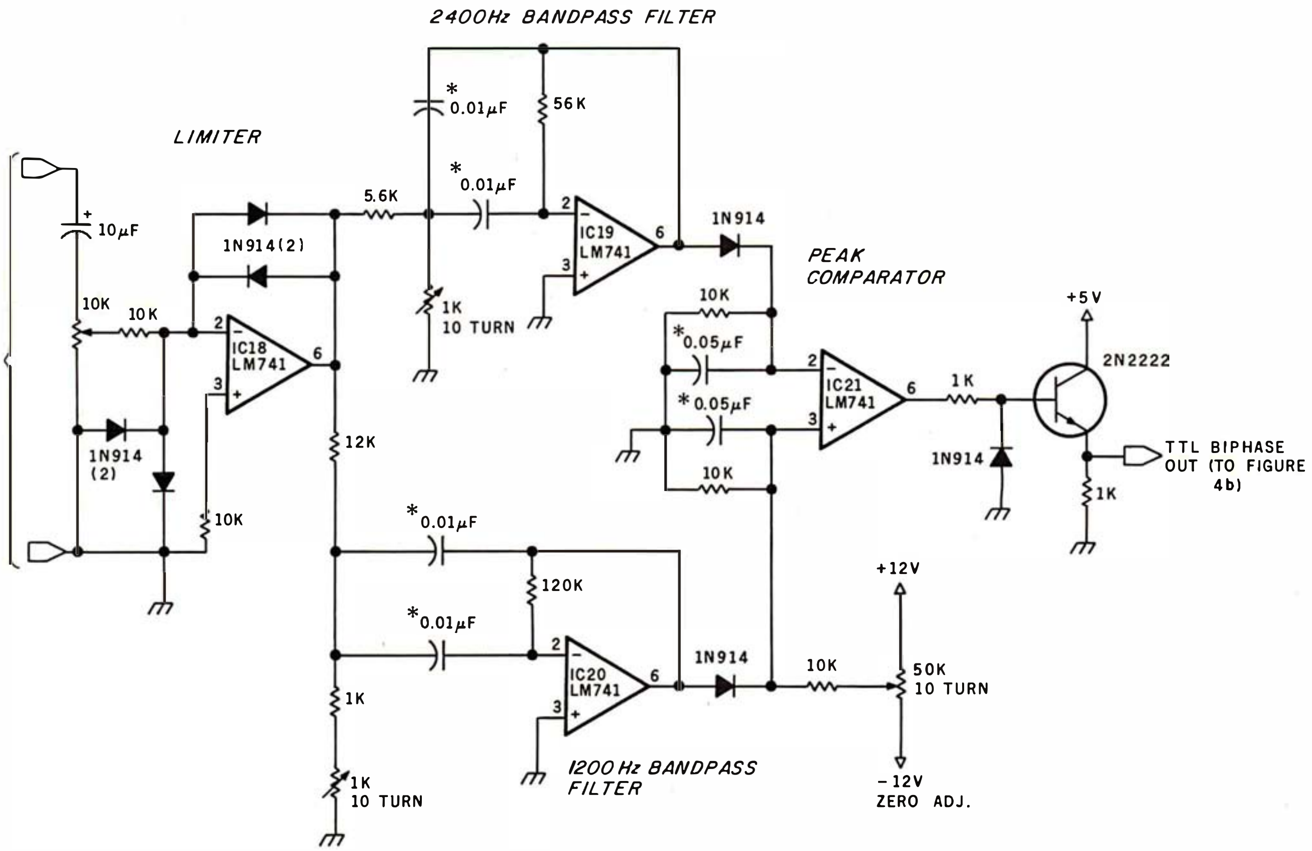

Figure 4a: *Section of schematic diagram of the biphase FSK remote-control receiver. Here is the FSK demodulator, which connects to the audio output of an FM radio receiver and produces a TTL-level biphase output, which is further processed by the circuit in figure 4b. The capacitors marked with asterisks (*) should be mylar or polycarbonate types.*

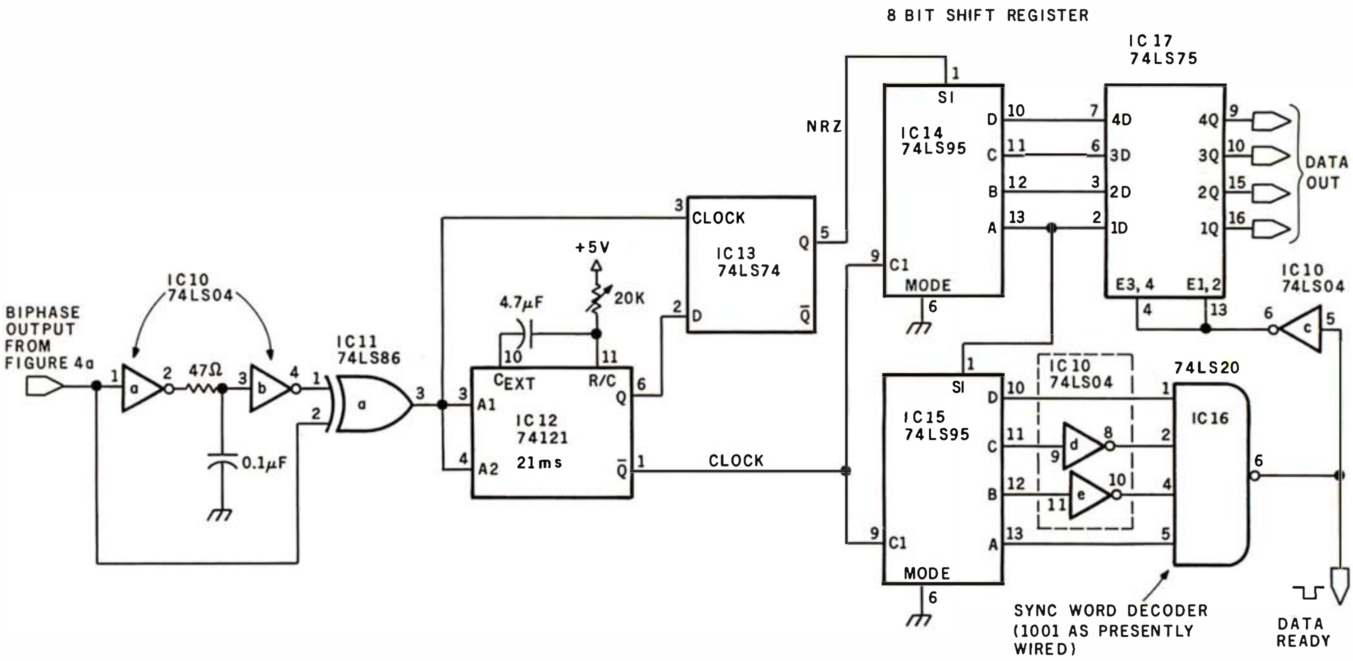

Figure 4b: *Section of schematic diagram of the biphase FSK remote-control receiver; here is shown the biphase decoder and data discriminator, which decodes 4 bits of data and sends them to an input port on the computer. The period of the one-shot is set approximately equal to three-quarters of the transmitter clock period.*

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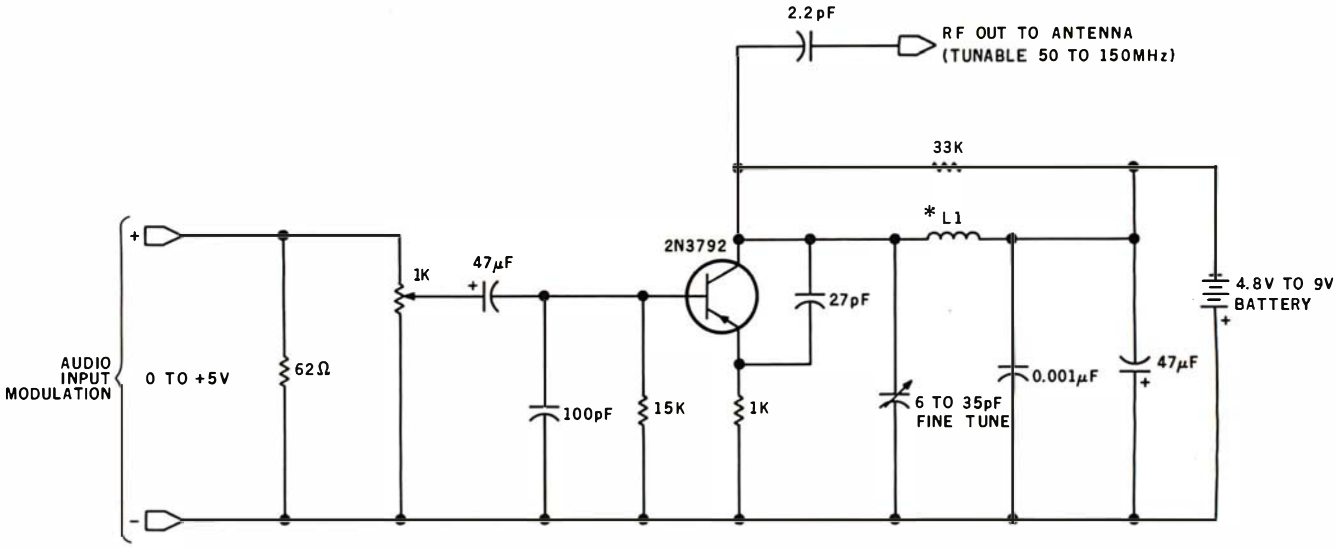

Figure 5: *Schematic diagram of a VHF (very high frequency) transmitter, tunable 50 to 150 MHz, for use in the wireless remote-control system. This circuit is also suitable for use in wireless microphone systems. The coil L1 consists of eight turns of number-26 wire wrapped around a coil form with one-quarter-inch inside diameter.*

Text continued from page 28:
it can be conveniently transmitted on a frequency-modulated (FM) RF carrier using the transmitter circuit of figure 5 or sent as an infrared-light pulse train using the circuit of figure 6. In either case, a logic 1 is encoded as a burst of 2400 Hz signal and a logic 0 is 1200 Hz. These tones can be easily received on an ordinary FM radio if the transmitter is set to a frequency between 88 and 108 MHz.

At the receiving end, the FM-radio audio output is first processed through an FSK demodulator. (See figure 4a.) This consists of an amplitude limiter, two bandpass filters, and a peak comparator. The resultant output should be the same as the biphase signal being transmitted. IC10, IC11, IC12, and IC13 separate this output into data and clock signal as I previously outlined and as shown in figure 4b. This data is in turn shifted into an 8-bit shift register. When the sync word gets to the end of the shift register (IC10 and IC16 decode a binary 1001) the contents of the last 4 bits shifted in will be clocked into holding register IC17. These 4 bits reflect the switch settings on the transmitter. They will be updated every one-quarter of a second if the transmitter remains on. The data-out lines in figure 4b are connected to the computer.

The transmitter circuit as I have shown it uses low-power Schottky (LS) transistor-transistor logic (TTL) devices. If powered by a 4.8 V rechargeable nickel-cadmium bat-

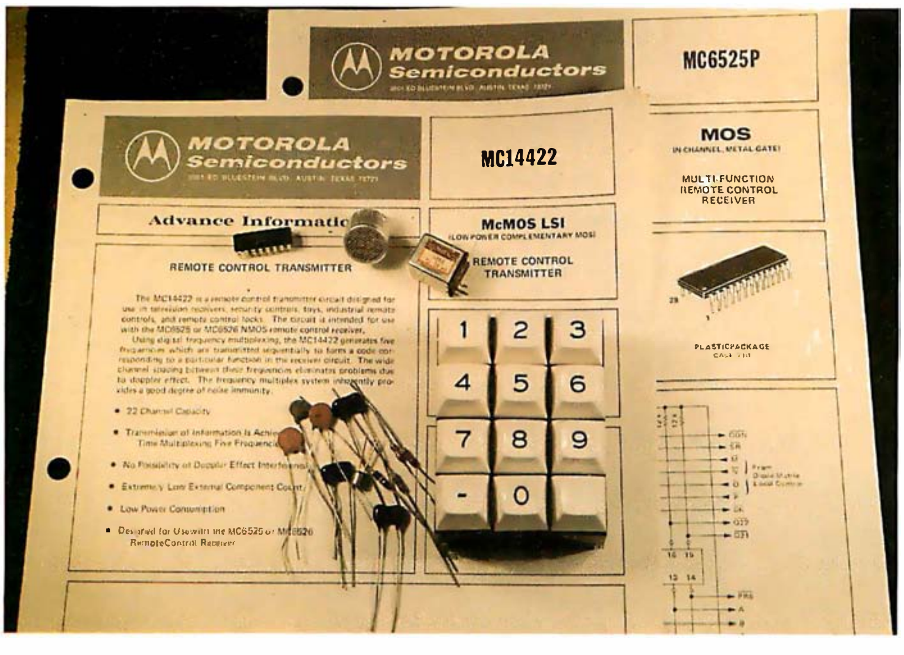

Photo 2: *Assembled here are the parts needed to build a remote-control unit that uses the Motorola MC14422 CMOS LSI remote-control transmitter and MC6525 receiver.*

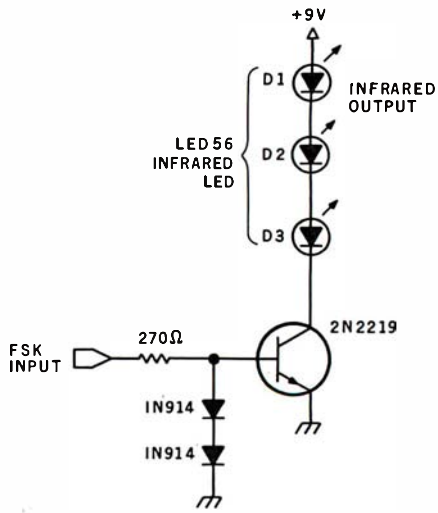

Figure 6: *Schematic diagram of an infrared-light transmitter for use in the wireless control application, where use of the radio-frequency transmitter is impractical or undesirable. A series of LEDs emits bursts of infrared light that carry the control information to the phototransistor receiver illustrated in figure 9.*

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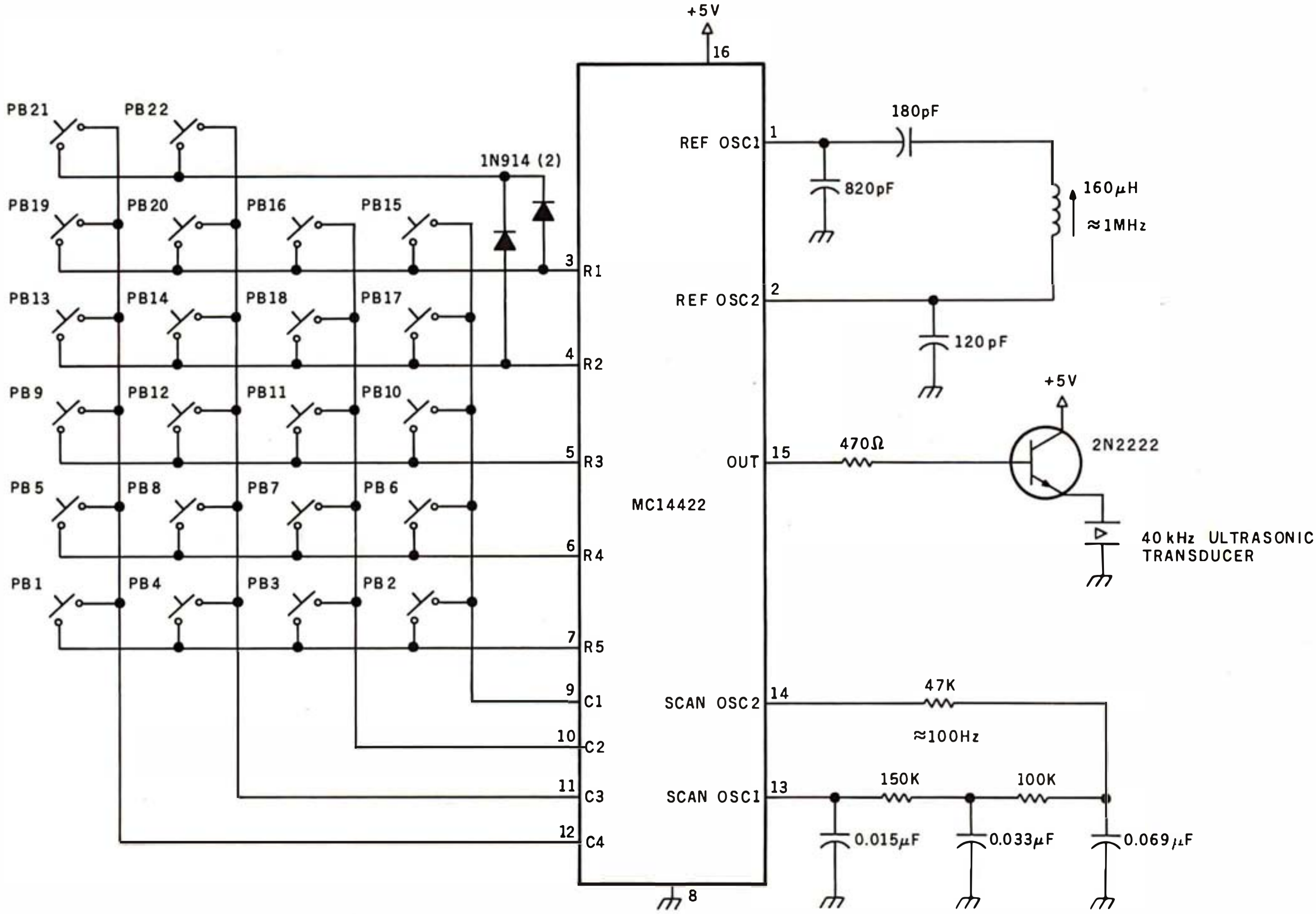


Figure 7: *Schematic diagram of a remote-control transmitter that incorporates a specialized integrated circuit, the Motorola MC14422 (a device mostly used in remote controls for television sets). Signals are transmitted as ultrasonic sound. The frequency-encoding scheme is presented in tables 2 and 3.*

Channel	Matrix Connections Pin to Pin		Transmitted Frequencies t1	t2	t3	t4
1	7	12	fe			
2	7	9	fe	fa		
3	7	10	fe		fb	
4	7	11	fe	fa	fb	
5	6	12	fe			fc
6	6	9	fe	fa		fc
7	6	10	fe		fb	fc
8	6	11	fe	fa	fb	fc
9	5	12	fe			fd
10	5	9	fe	fa		fd
11	5	10	fe		fb	fd
12	5	11	fe	fa	fb	fd
13	4	12			fb	
14	4	11		fa	fb	
15	3	9				fc
16	3	10		fa		fc
17	4	9			fb	fc
18	4	10		fa	fb	fc
19	3	12				fd
20	3	11		fa		fd
21	3,4	12			fb	fd
22	3,4	11		fa	fb	fd

Table 2: *Control channels, key closures, and corresponding transmitted tone frequencies used by the Motorola MC14422 remote-control transmitter used in the circuit of figure 7. See table 2 for the exact frequencies used. The column headers "t1", "t2", "t3", and "t4" refer to the sequential time segments during the total transmission; this is part of the transmission protocol.*

Frequencies	Output Frequency	Division Ratio
fa	34.688 kHz	f2/26.5
fb	36.048 kHz	f2/25.5
fc	37.519 kHz	f2/24.5
fd	39.116 kHz	f2/23.5
fe	42.755 kHz	f2/21.5

Table 3: *Frequencies of control tones used in the Motorola MC14422 remote-control transmitter in figure 7.*

tery, it consumes less than 50 mA. In this unit, the transmit switch is in fact a power switch. Sending a remote command requires only 1 or 2 seconds of transmitter operation. While CMOS devices *could* be substituted, it isn't necessary, considering the low duty cycle of the unit.

CMOS LSI Remote-Control Integrated Circuits

The idea of handheld remote control isn't new. The television industry

Photo 3: *Two walkie-talkies can be used in a simple remote-control scheme. One walkie-talkie, used as the receiver, is modified by connection to the circuit illustrated in figure 10a. The new circuit is attached to the rear of the walkie-talkie's case, as shown. These walkie-talkies are sold by Radio Shack as catalog number 60-4001; they incorporate a Morse-code tone oscillator necessary to the control scheme. Transmission is on a frequency of 49.86 MHz.*

has had it for years. To meet the demand for remote-controlled TV sets, special CMOS remote-control integrated circuits were designed, employing LSI. It is possible to use a pair of these for computerized remote control as well. Figure 7 shows the Motorola MC14422 remote-control transmitter part and a typical application circuit. Photo 2 illustrates the number of components necessary to implement this circuit. Figure 8 outlines the receiver circuit which uses the Motorola MC6525 receiver.

These specialized devices are very powerful. They use digital frequency multiplexing and transmit any or all of the five different frequencies sequentially to form a code corresponding to the particular selected function. These frequencies range from 34 to 43 kHz and accommodate twenty-two control channels including the ability to remotely adjust three analog-output signals in the receiver.

My experience in building these circuits warrants some mention. While the transmitter section (figure 7) went together easily, the receiver portion (figure 8) is a bear, and entailed difficulty in alignment. Even though it finally worked quite well, I don't recommend it for the novice builder. I'm presenting it in this article because it is a high-level controller and may be "just what the doctor ordered" for some individuals. Anyone interested

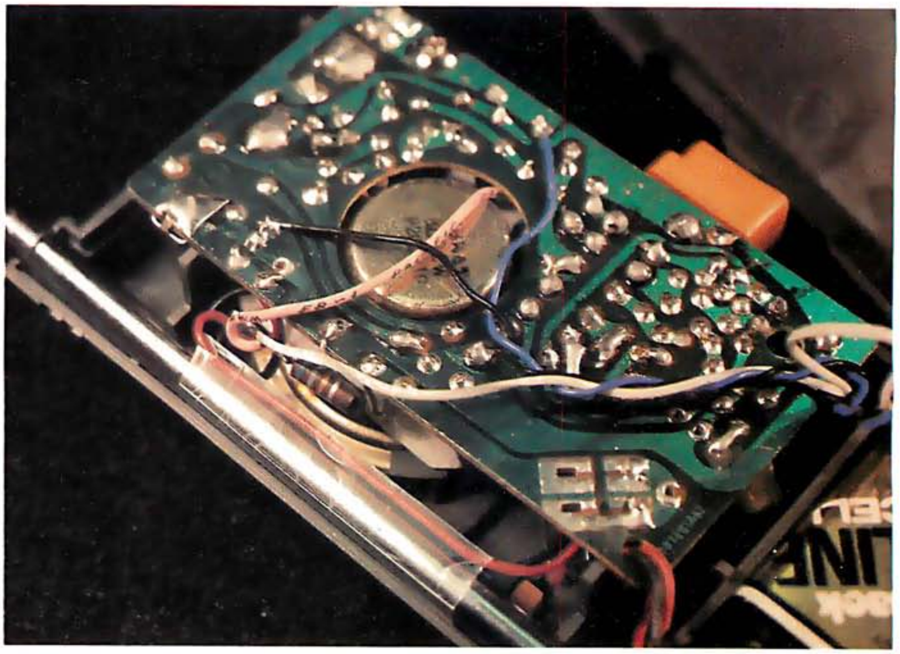


Photo 4: *Three wires and an optional resistor are needed to attach the remote-control modification to the receiving walkie-talkie.*

in further information on these devices should contact a Motorola distributor directly.

Single-Channel Walkie-Talkie Remote-Control Interface

It isn't necessary for you to run out and spend much money on expensive integrated circuits or to spend 3 weeks building an elaborate circuit, if you can be satisfied with a less sophisticated control system. My final offering consists of two Radio Shack walkie-talkies (catalog number 60-4001) and a two-chip circuit. When I bought them, they were $10 each. Other walkie-talkies can be used, but the Morse-code tone generator built into these units is necessary for the operation of my circuit design.

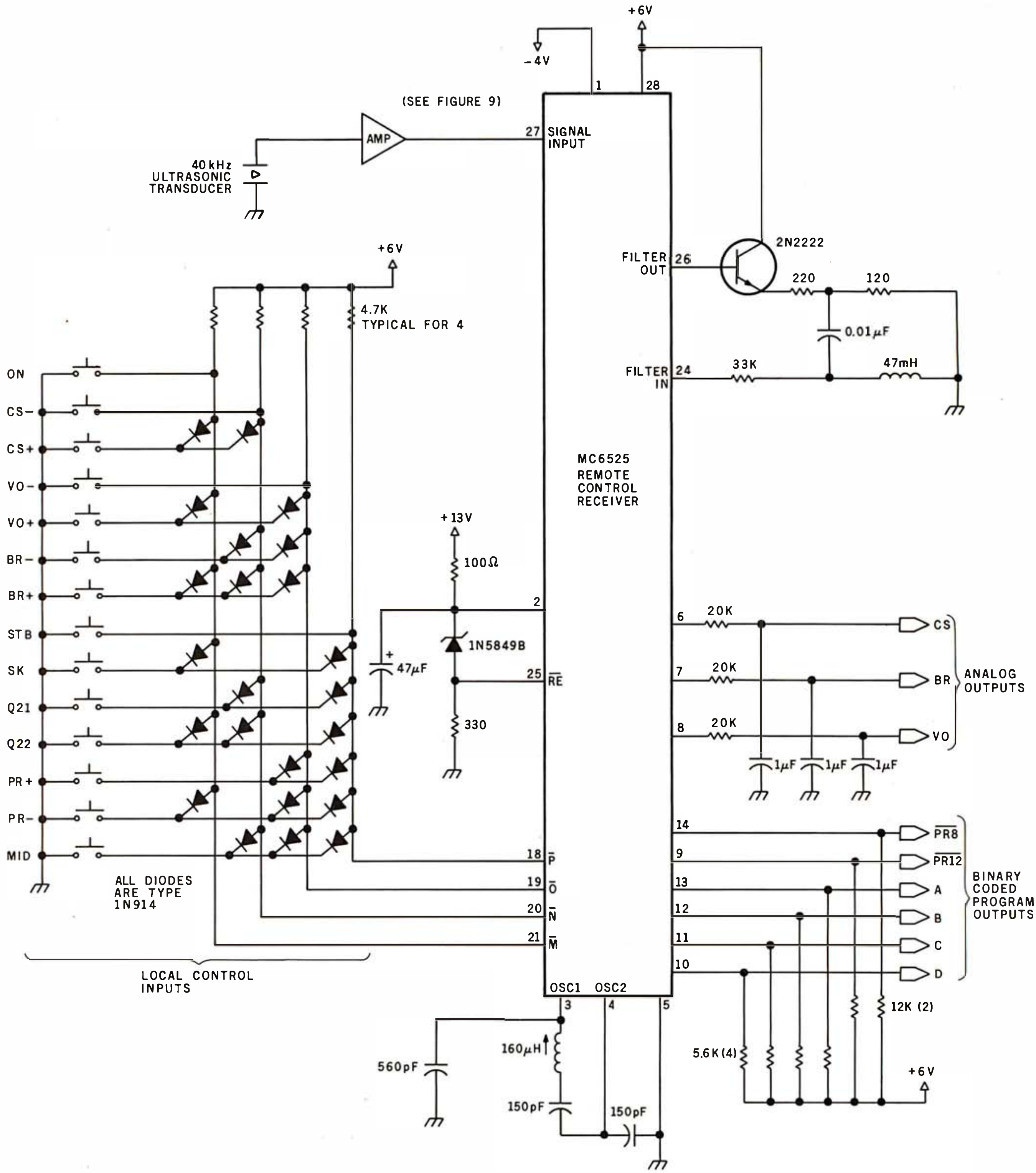


Figure 8: *Schematic diagram of a remote-control receiver that employs the Motorola MC6525, a part chiefly used for television remote control.*

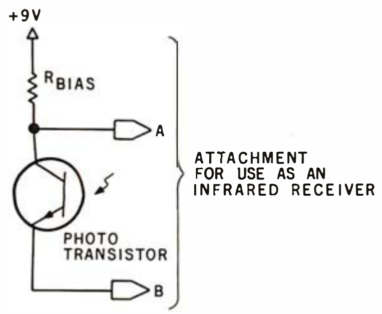


Figure 9a: *This phototransistor circuit can be substituted for the ultrasonic transducer in figure 9b to change the preamplifier circuit into a receiver for the infrared transmitter shown in figure 6.*

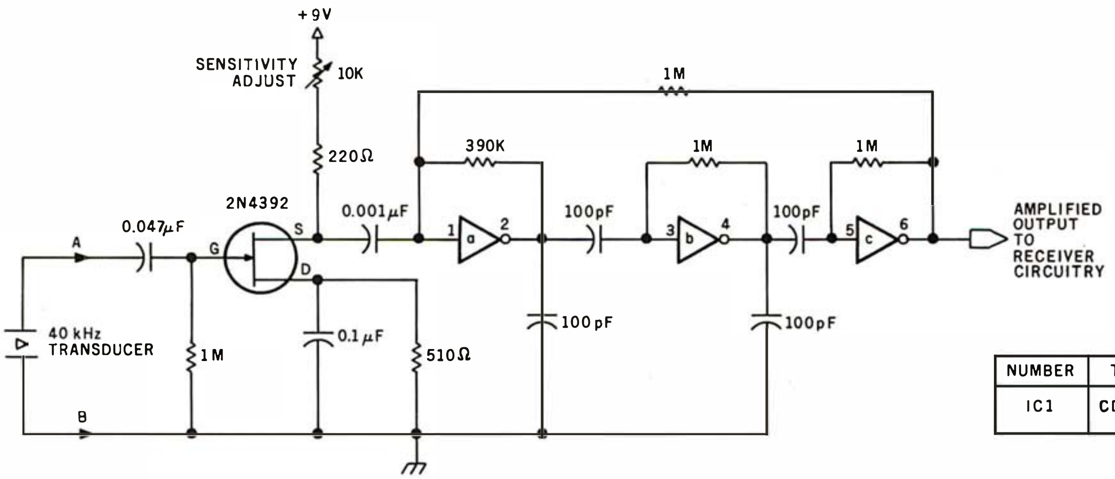
This interface, shown in figure 10, is terribly simple. To transmit a command, turn on the transmitter and press the Morse-code button. This transmits a tone. At the receiving end, the circuit just signals the computer that it has received a tone.

The circuit of figure 10 is an AC amplifier with some bandpass characteristics. The tone frequencies on these walkie-talkies vary all over the lot. A narrow bandpass filter is useless. Instead, the circuit detects a minimum threshold of a midfrequency AC signal. More often than not this is from the tone generator and is the signal we want.

The circuit can be assembled on a piece of perforated circuit-layout board and screwed to the back of the walkie-talkie. (See photo 3.) Connections to the board are made from inside the walkie-talkie case and consist of only three wires. The blue wire picks up +9 V power and the black is walkie-talkie ground. A pink wire is either attached to the speaker or disconnected and soldered to a 6.8 to 10-ohm resistor connected to ground. The white wire in my circuit is tied to the pink-wire-and-resistor junction. Finally, the filter/amplifier (IC1) output goes to an opto-isolator. This device shields the walkie-talkie from the high-frequency electrical noise present on the computer input connections. Without it, walkie-talkie reception is so poor as to be useless.

The receive walkie-talkie is connected to 1 bit of a parallel input port on the computer, as shown, and is switched on. The Data-Received light-emitting diode (LED) will be off; the input to the computer will be a logic 1. The LED will remain off as the transmitter is switched on. When

Text continued on page 42



NUMBER	TYPE	+9V	GND
IC1	CD4069	14	7

Figure 9b: *Schematic diagram of a preamplifier circuit to be used with the ultrasonic remote-control receiver.*

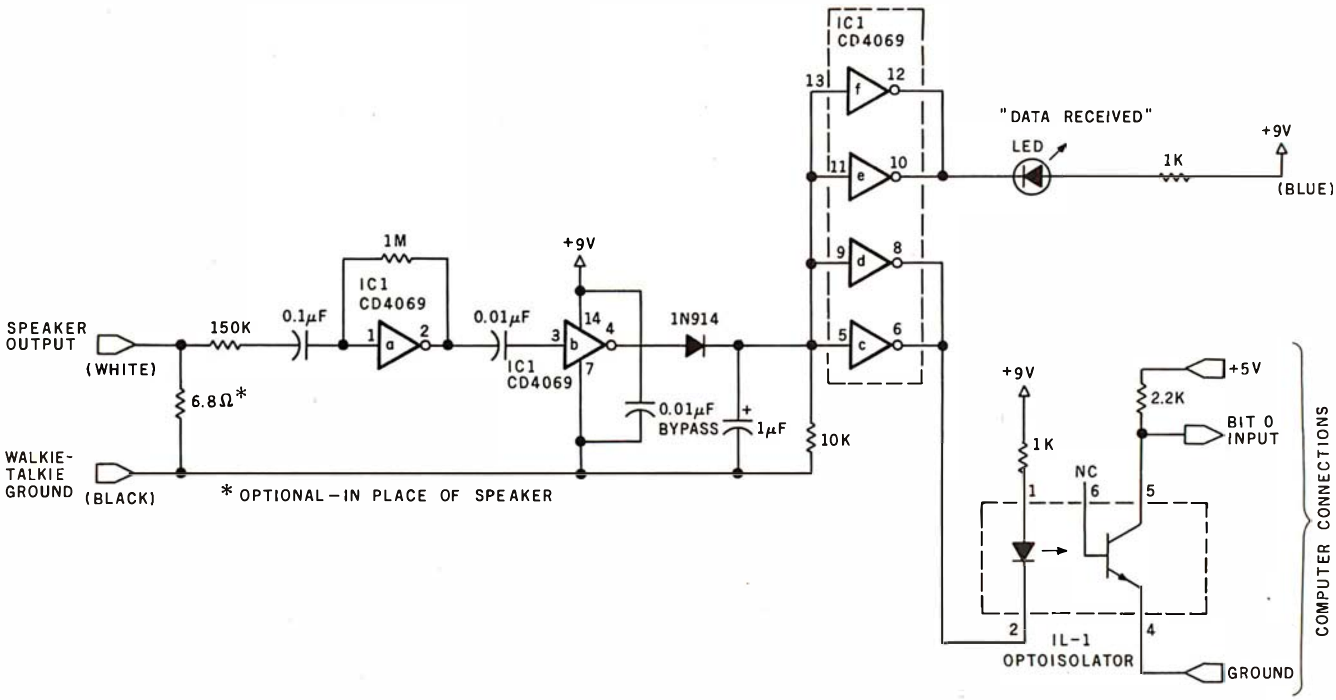


Figure 10a: *A receiver circuit that allows use of inexpensive walkie-talkies for the transmission of control data. The two walkie-talkies used in this application were Radio Shack catalog number 60-4001 types, which have an integral Morse-code audio oscillator. One walkie-talkie is used as the handheld remote transmitter, the other as the receiver.*

This arrangement allows transmission of only a single bit of control information, but this 1 bit can be modulated in various ways (even in Morse code) to control various functions. Decoding of this modulation must be carried out by a program running on the host computer.

A 0.01 μF bypass capacitor must be soldered directly to pins 7 and 14 on the CD4069.

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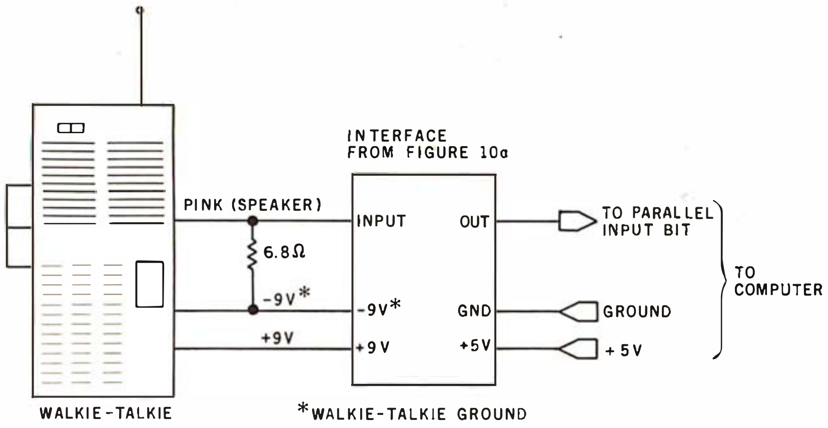

Figure 10b: *In the walkie-talkie remote-control scheme, one walkie-talkie is used as the receiver for the RF transmission of the other. The circuit of figure 10a is attached to the receiving walkie-talkie.*

Listing 1: *A BASIC program that monitors the walkie-talkie interface of figure 10a, waiting for a logic 0 on bit 0 of input port 3. When the logic 0 appears, the program starts a 10-second sampling period. During the period, the program counts how many times the tone button on the transmitter is pressed (that is, how many times a logic 0 is detected at the input port). The number of pulses received can be used to indicate which of the various control routines is to be activated. A more sophisticated program could decode more complex information from the transmitter, even information encoded in Morse code.*

```
100 REM  TIME SEQUENCED REMOTE CONTROL INTERFACE
110 REM
120 REM  THIS PROGRAM MONITORS THE STATUS OUTPUT OF A
130 REM  WALKIE-TALKIE (W/T) CONNECTED TO BIT 0 OF PORT 3
140 REM  AND DEMONSTRATES HOW IT CAN BE USED TO VECTOR
150 REM  TO VARIOUS CONTROL PROGRAMS BY REMOTE ACTIVATION
160 REM
170 REM
180 REM READ PORT 3 AND CHECK FOR AN OUTPUT FROM THE W/T
190 X=INP(3) :Y=X-1
200 IF INP(3)=X THEN GOTO 200
210 IF INP(3)=Y THEN GOTO 220 ELSE 200
220 PRINT"START":FOR D=25000 TO 25100
230 REM SET MEMORY LOCATIONS 25000 TO 25100 FOR BIT MAP
240 REM ANY 100 BYTE SEGMENT CAN BE DESIGNATED
250 GOTO 440
260 POKE D,M :REM STORE A BIT MAP OF W/T OUTPUT FOR GATE TIME
270 GOSUB 520
280 NEXT D
290 PRINT"END":REM SIGNIFIES END OF GATE TIME
300 Z=0:T=0 :A=0
310 FOR D=25000 TO 25100 :REM EXAMINE BIT MAP
320 IF PEEK(D)=0 THEN GOTO 560
330 A=0
340 NEXT D
350 REM T= TOTAL PULSES DURING GATE TIME
360 REM AT THIS POINT BRANCH TO OTHER PROGRAMS BASED UPON
370 REM THE VALUE OF T.  IF T=2 THEN GOTO APPLICATION PROGRAM #2
380 PRINT"BRANCH TO APPLICATION PROGRAM ";T
390 GOTO 190 :REM RETURN TO BEGINNING
400 REM
410 REM
420 REM READ INPUT TWICE AND VERIFY THAT IT IS TRUE
430 REM IF TRUE THEN MEMORY BIT IS A 0. IF NOT TRUE THEN M=1
440 H=INP(3)
450 GOSUB 520
460 H1=INP(3) :IF H<>H1 THEN GOTO 270
470 IF H=Y THEN M=0 ELSE M=1
480 GOTO 260
490 REM
500 REM
510 REM READ SAMPLE DELAY --- 10 SEC. GATE TIME
520 FOR W=1 TO 20: NEXT W :RETURN
530 REM
540 REM
550 REM INCREMENT PULSE TOTAL AT 1 TO 0 TRANSITIONS OF BIT MAP
560 IF A=0 THEN A=A+1 :T=T+1
570 GOTO 340

READY
```

Text continued from page 39:
the Morse-code tone button on the transmitter is pressed, the LED will light and the computer input will go to a logic 0. That is the simple principle by which the whole interface operates.

You are not limited to a single on/off remote-control operation (as with our switch on the cable) if you want to consider adding a little software such as that in listing 1. This simple BASIC routine monitors the walkie-talkie interface, waiting for an input signal (here, a logic 0 on bit 0 of port 3). When the computer detects an input signal, the program simply starts a 10-second sampling routine and counts how many times the tone button is pressed during the sample period. Three pulses could mean "go to application program 3," and six pulses could mean "go to program 6." Using this sampling technique, it would not be difficult to actually send remote-control instructions in Morse code. (You may consult the code table imprinted on the front of the walkie-talkie.) That would provide twenty-six or so control functions with a maximum number of only four pulses on the key. [*See the October 1976 BYTE for several discussions of how to decode Morse code using computer software....***RSS**]

In Conclusion

There are many other ways to remotely activate control programs through a computer. I have outlined only three. Other special LSI integrated circuits exist that are equally as powerful as the two discussed here. But it is impossible to cover them all. Perhaps one of the three designs I have presented is suitable for use on your system.

In the meantime, I have a few other applications in mind for these remote-control devices. As soon as I get the interfaces designed and tested, I'll be back with an article on a remote-controlled whatchamacallit.

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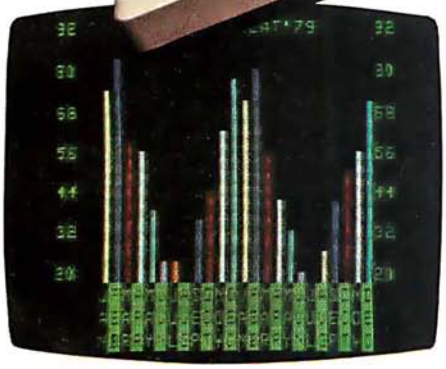

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Photos by Chris Morgan

The 1980 West Coast Computer Faire:

A Watershed Year for Personal Computing

Photo 1: *Studying a Computhink Minimax small-business computer system at the Matthews Computer Connection booth.*

Photo 2: *The West Coast show in high gear.*

Photo 3: *Artist Saul Bernstein (creator of the Einstein image for the Apple II) of Thousand Oaks, California, created this image of Sally Ann Londer using a digitizing pad.*

Photo 4: *The CompuServe booth. CompuServe's MicroNet is a computer time-sharing and software-distribution service similar to The Source.*

Photo 5: *Cromemco's new SDI Super Dazzler high-resolution color graphics system.*

Photo 6: *Here's a Japanese Kana character-set generator for your TRS-80 from Ron Johnson, Racet Computes, 702 Palmdale, Orange CA 92665. Price: $150.*

Photo 7: *No, this computer was not left out in the sun. It's the work of Elaine Pura, of Computer Service Systems Network. This "malleable mainframe" is actually a soft sculpture of CSSN's System 1000, a computer system featuring a Winchester hard-disk system and tape backup in one package, shown in photo 8.*

Photo 8: *CSSN's System 1000 in real life.*

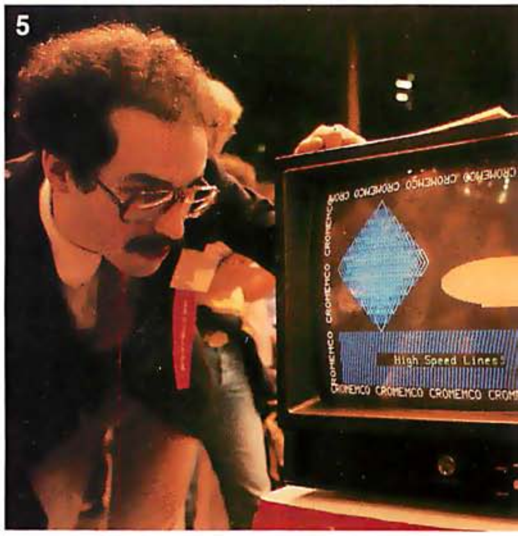
Photo 9: *Studying hardware at the Heath Company booth.*

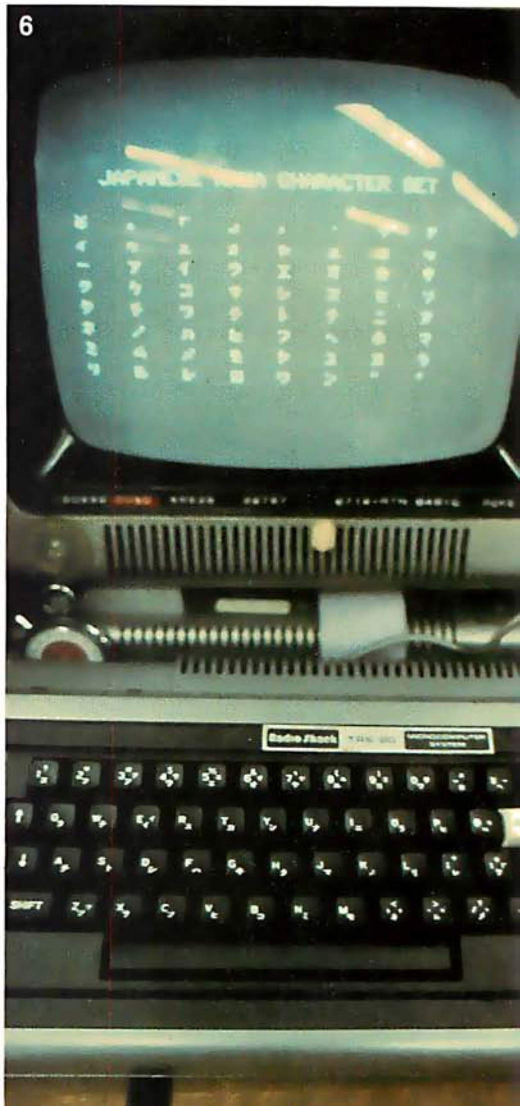
Photo 10: *Shopping for floppy disks.*

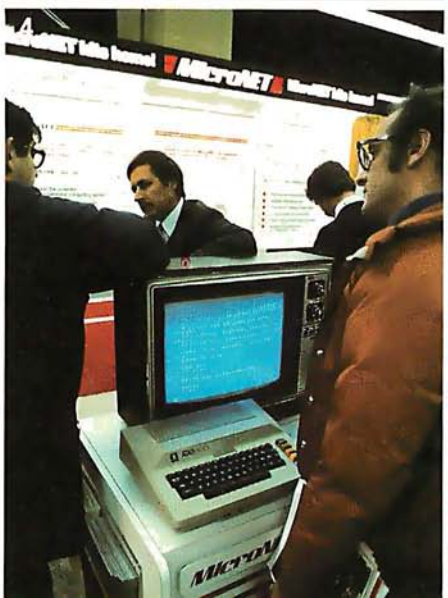
Photo 11: *The Computer Faire attracted a good number of handicapped people who use personal computers in their everyday lives. BYTE author Mark Dahmke is at left.*

Photo 12: *Ithaca Intersystems' new Z8000 processor board gets a close inspection from show-goers.*

Photo 13: *Sally Ann Londer sits for her computerized portrait.*







Chris Morgan
Editor-in-Chief

CP/M programs running on your Apple computer? How about a Japanese character set for your TRS-80 — or maybe a $298 pocket computer from Sharp that runs Tiny BASIC?

These are no fantasies because the future was definitely on view at this year's West Coast Computer Faire, and a record audience of about 20,000 people jammed San Francisco's Civic Center last March to get a good look at it. What they saw was encouraging to hobbyists, business people, and computer scientists alike. The industry is rapidly maturing, and products only dreamed of a short time ago are now being offered matter-of-factly for sale.

As expected, one of the hottest areas of growth on view at the show was the small business computer, but the Faire proved that this is not the only area of growth by far: MicroNet and The Source both exhibited their telecommunication-based information services for personal computers. New, highly sophisticated computer games were on display from Atari and Apple (to name only two). Software is growing in several directions at once, and Pascal made a strong showing. However, new BASIC compilers were also in evidence, and the FORTH language is gathering momentum. (The August 1980 BYTE's theme will be FORTH.)

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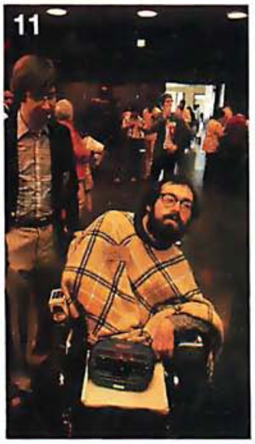

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Another trend is the multi-user computer system. Micromation's Multi-user Z System Computer offers separate memory and a separate processor for each user. The system also features the CP/M operating system and a Shugart SA4000 Winchester hard-disk drive. With the Nestar Clusterbus system, anyone can connect as many as 64 Apple IIs together in a resource-sharing network.

The Japan Microcomputer Club rented booth space at the Faire to promote their organization of Japanese microcomputer enthusiasts, now 3000 strong. Industry watchers will definitely want to keep in touch with this organization. Their address is: Japan Microcomputer Club, c/o Japan Electronic Industry Development Association, 3-5-8, Shibakoen, Minato-ku, Tokyo 105, Japan.

Microsoft announced the Z80 Softcard, a plug-in processor card for the Apple II computer that enables users to run software written for Z80-based computers. Included with the package is the CP/M operating system and Microsoft's Disk BASIC. The Softcard, which costs $349, allows the user to select either the Apple's 6502 processor or the Z80 processor using a keyboard command. Both processors cannot run at the same time. Products like the Softcard point the way to CP/M's emergence as a de facto industry standard.

On the educational front, sad to say, there was little evidence of growth in the industry. Most of the "educational" programs I saw were trivial drill-and-practice exercises. (See the BYTE Education Forum in this issue.) Perhaps matters will improve in the coming year. There is some interesting work going on now at Texas Instruments in the area of secondary-school use of personal computers.

Photo 14: *Digitized images of attendees at the Faire generated by Digital Graphics Systems' CAT-100 color image system, which consists of two S-100 boards. It can capture an image in 1/60 of a second and store it in its on-board 32 K-byte memory.*

Photo 15: *Two young chess players take turns vying with a computerized chess-playing unit made by Chafitz.*

Photo 16: *Micro Matrix's $19.95 light pen for the TRS-80.*

Photo 17: *Mychess, the winner of the computer chess tournament at the Faire, was written by Dave Kittinger, proprietor of Computer Services, 2431 Lyvona Ln, Anchorage AK 99502. The program is available on either 5-inch or 8-inch floppy disk for the TRS-80, North Star CP/M, or Cromemco CDOS for $50.*

Photo 18: *Book business was brisk at BITS Inc.*

Photo 19: *Playing games on an Atari 800.*

Photo 20: *The easy way to program — with a giant TV screen.*

Photo 21: *Sharp's new PC-1210 pocket computer, price: $298. The main processor unit, which can run Tiny BASIC programs up to 400 bytes long, is shown being plugged into the cassette interface. A new version, the PC-1211, is due out next month; it will have a capacity of 1424 bytes of user memory.*

Photo 22: *Ten colors in Apple II high-resolution mode? You can get them with Synergistic Software's Higher Text package, which lets you design your own character set, mix text and graphics, and change the shape of letters.*

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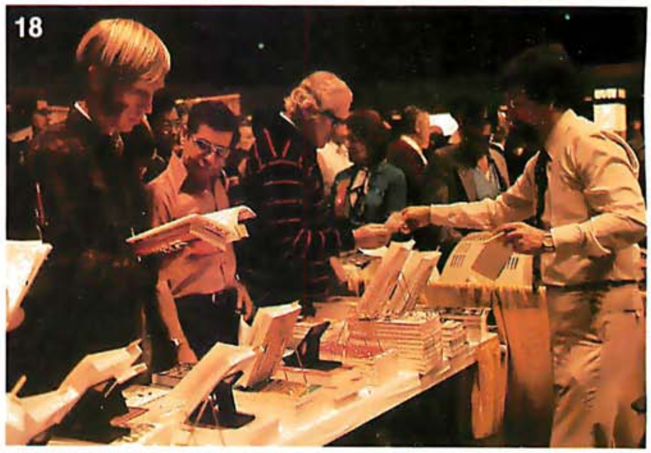

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Probably the most important trend at the show was that the software industry is beginning to catch up with the hardware industry. A new sophistication is very apparent, and we'll be seeing many new developments in the areas of word processors, music systems (like Syntauri Ltd's alphaSyntauri Apple II-based synthesizer on view at the show), adventure games (watch for our special issue on Adventure and its offspring coming up in BYTE), high-resolution color graphics, and ultra-small personal computers.

We're looking forward to a very exciting time in personal computing in the new few months, and we hope the pictures in this photo essay will convey some of that excitement. ■

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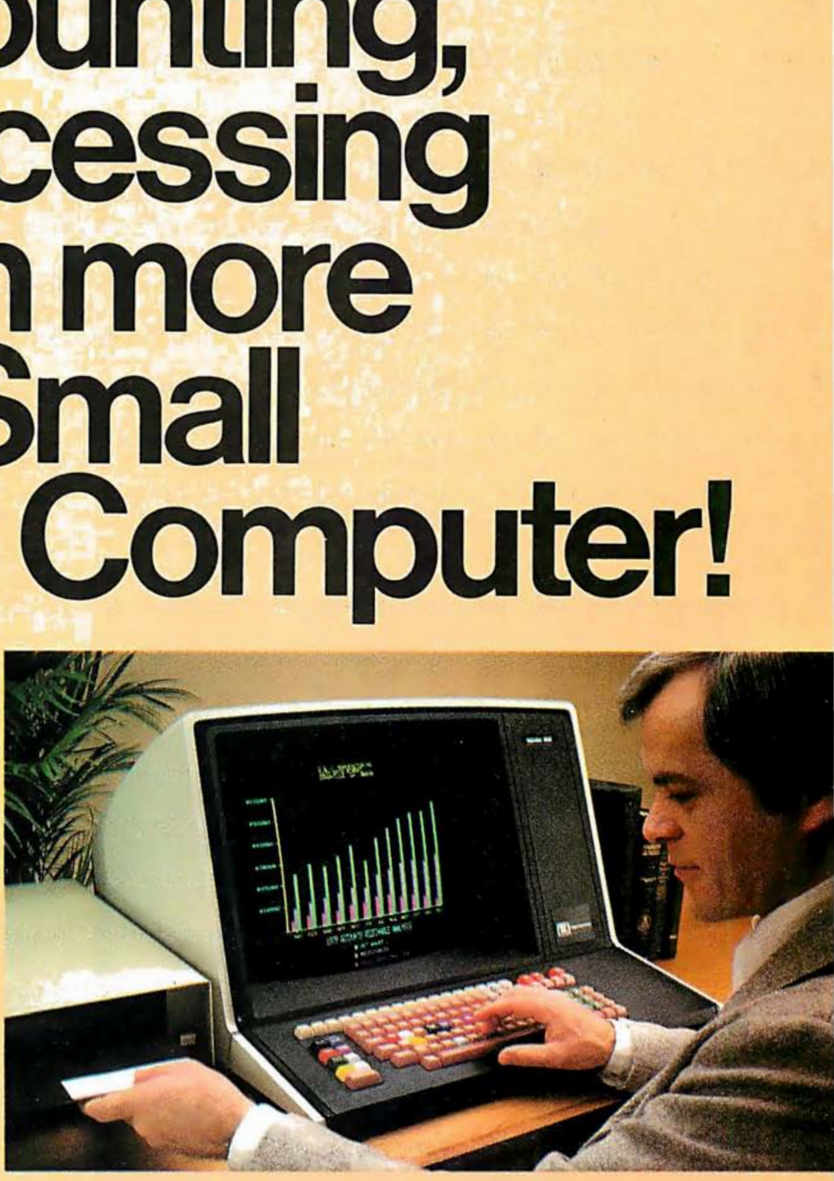

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The Apple III

Christopher Morgan
Editor-in-Chief

This past May at the National Computer Conference in Anaheim, California, the Apple Computer Company introduced "Sara" (its code name for the Apple III), the long-awaited new computer from this closely watched company.

We spent some time recently at Apple getting a first-hand look at a product that has been the object of industry speculation and anticipation for nearly a year.

Personal computer designers are fond of using feminine names for computers during the development stages. The Atari 800, for instance, was referred to as "Colleen," within the company, for security purposes. A similar veil of secrecy surrounded "Sara." This led to speculation that the Apple III would use the Motorola 6809 processor, or that it would use bit-slice architecture, and that it would cost anywhere from $700 to $10,000.

The rumors were mostly off-base. In fact, the Apple III is a logical upgrade of the Apple II for use in professional applications like word processing and information management.

"It's also the ultimate hobbyist computer," says Apple vice-president Steve Jobs, lightheartedly. "The Apple III was conceived primarily to fill in gaps in the Apple II. It will not replace the Apple II by any means. It's designed to enhance it."

The price of the Apple III ($4500 to $8000) buys a lot of computer power. For these prices, the company will be selling not just a computer but a total system, including software and peripheral devices.

Photo 1: *The Apple III, a new 6502A-based personal computer with built-in 5-inch floppy-disk drive, up to 128 K bytes of memory, and high-resolution color graphics. Pascal and Apple Business BASIC are built-in, and the machine features a new Sophisticated Operating System called SOS. The Apple III will sell in the premium price range of $4500 to $8000, which includes a complete software and hardware system with peripherals. Reportedly FORTRAN will be available for the unit later in the year. Although the Apple III can be used for a wide range of general applications, the keyboard has been designed with financial, small-business, and word-processing applications in mind. An Apple II-emulation mode is included to enable Apple II software to run on the Apple III.*

Hardware Features

First, the basics. The Apple III uses a 6502A processor running at 2 MHz. Custom large-scale integration (LSI) circuitry enables the computer to address up to 128 K bytes of memory. The circuitry is housed in an aluminum chassis that keeps radio-frequency interference (RFI) *in* and conducts heat *out* (no cooling fan is required). The chassis is housed in a plastic shell. The Apple III looks like the Apple II, with its distinctive white plastic case; however, the aluminum chassis adds some weight to it.

One important feature is the addition of an on-board, 5¼-inch floppy-disk drive.

"We no longer consider the floppy-disk drive to be a peripheral device. It's an integral part of today's computer systems," says Apple's Product Marketing Manager, Don Bryson. The decision to keep the video monitor as a separate, off-board unit was dictated by the fact that the computer would otherwise not be portable enough. "We wanted Apple III users to be able to take their machines home from the office at night," says Bryson.

The Keyboard

The Apple III shows signs of careful design throughout. The keyboard is a particularly good example of this care, being an outgrowth of the Apple II's popular keyboard. A numeric keypad has been added to the sculpted, Selectric-like keyboard. In fact, it has the same layout as an IBM Selectric typewriter, to make it as easy as possible for office workers to use the machine. Refinements include moving the Reset key off the keyboard. It is now located above and to the right of the keyboard; a reset operation now requires that the Control key be pressed along with Reset, thus eliminating a minor but irritating problem on the Apple II keyboard.

There are four cursor-control keys on the keyboard for applications such as word processing, and raised "dimples" on the D, K, and 5 keys to help the user locate those keys by feel. The Alpha-Lock key enables the entry of numerals in uppercase mode, and there are two user-definable keys for various software applications. Other handy features include built-in repeat on each key (there is no repeat key), and a fast-repeat feature useful for filling the screen with characters. The Shift-Tab and Shift-Space operations can be programmed to act as Back-Tab and Back-Space, respectively.

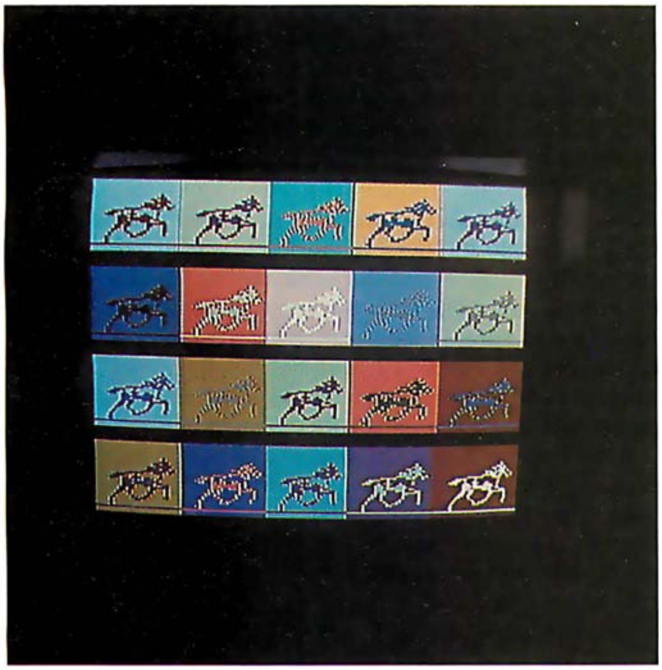

Photo 2: *An example of the Apple III's high-resolution color graphics (290 by 192 lines of resolution with sixteen colors) displayed on an RGB (red, green, blue) color monitor. This particular demonstration is an animation program: the horses gallop on the screen.*

Photo 3: *The Apple III with its plastic case removed to reveal the shielded aluminum chassis, designed for heat dissipation and RFI (radio-frequency interference) containment.*

There are four slots inside the Apple III for insertion of peripheral cards, compared with eight in the Apple II. This is not a disadvantage, because many of the applications that require the use of special peripheral cards on the Apple II are either built into the Apple III, or are taken care of by the very complete array of connectors on the back of the computer. These include a special 26-pin flat ribbon connector for daisy-chaining up to three additional floppy-disk drives into the unit; two DB-9 connectors for a silent dot-matrix thermal printer, joysticks, etc; a DB-15 video-out connector with a choice of black-and-white, NTSC-color, or RGB (red, green, blue) outputs, plus power supply voltages; an RCA video-out connector (black-and-white only); an external speaker jack that disables the internal speaker when in use; and an RS-232C serial I/O (input/output) port for a letter-quality printer, modem, etc. The Apple III also features an event timer and a battery-driven clock calendar.

Can Apple II peripheral cards be used in the Apple III? First a word about the design of the new peripheral cards. In order to meet Federal Communications Commission (FCC) RFI emission guidelines, new Apple III peripheral cards will have special shielded connectors and shielded cables going to the outside world. The new cards use the same bus structure and the same timing as the old cards, so an update to the new format will be straightforward for manufacturers. You *can* plug Apple II peripheral cards into the Apple III, but this might violate the RFI guidelines in some cases. The legality of the matter is somewhat up in the air at present.

The built-in 5¼-inch floppy-disk drive is manufactured by Shugart and is being second-sourced to Apple. It should be considerably faster than the Apple II drives both because of its mechanical design and because of the more efficient disk controller and operating system built into the Apple III.

Graphics

The Apple III's graphics capabilities go considerably beyond the Apple II's, offering 80 columns by 24 lines of text on the monitor screen—a must for serious word processing. The character dot-matrix is 8 dots high by 7 wide. Graphics modes include 560 by 192 lines (black

and white only) and 280 by 192 lines featuring sixteen high-resolution colors or sixteen shades of gray. (Compare this with the 280-by-160-line resolution in the limited-color, high-resolution mode of the Apple II.) Another mode offers forty characters with color-on-color; moreover, the Apple III offers the three Apple II graphics modes (yes, Apple II programs will run on the Apple III—more about this later).

Software Features

At the heart of the Apple III is the SOS (Sophisticated Operating System), designed to handle multiple languages and peripherals. (Speaking of languages, the Apple III offers Pascal as a built-in feature, along with Apple Business BASIC. Although not officially announced, Apple will probably be offering FORTRAN later in the year for the Apple III.) The system architecture offers several new features, including extra instructions in the instruction set, a relocatable stack, relocatable base register, and extended addressing.

Floppy disks for the Apple III will have sixteen sectors, and the power supply has been made more "robust" to better handle multiple drives. The Apple III's designers believe that this will also clear up the occasional problems encountered in the past in trying to copy from one disk to another on the Apple II. Total capacity on a disk will be 143 K bytes. Pascal should also run considerably faster on the Apple III because it is built-in.

Compatibility with the Apple II

Considerable effort has been expended to make the Apple III as compatible as possible with the Apple II. In fact an Apple II-emulation mode has been built into the Apple III. Thirteen-sector Apple II floppy disks can be quickly updated to the new 16-sector format (there is a problem, however, if the old disks are protected against copying). Some older BASIC programs with PEEKs and POKEs may not run on the Apple III without modification, but the great majority should work unchanged.

"The Apple II emulation is a true emulation," says Don Bryson. "You'll be locked into the 40-character uppercase mode."

Photo 4: *Back view of the Apple III, showing (from left to right) the 26-pin flat-ribbon connector for daisy-chaining up to three additional floppy-disk drives into the computer; two DB-9 connectors for joysticks, etc; a DB-15 video-out connector with black and white, NTSC color (the standard North American color-television system), and RGB (red, green, blue); an RCA-type video-out connector (for black and white only); an external speaker jack; and an RS-232C serial I/O (input/output) port for a letter-quality printer, modem, etc.*

System Configurations and Availability

The Apple III will be sold as a *system*. This is central to the company's philosophy that a computer is more than just hardware, and that professional customers want a complete working package with software and documentation. The initial offering will be the $4500 "Information Analyst" package, consisting of an Apple III with a Trendcom silent 80-column dot-matrix thermal printer; 96 K bytes of memory; black-and-white monitor; a special version of Visicalc, called Visicalc III, featuring 80 columns (Visicalc is a general-purpose, matrix-oriented program for handling financial and general data); SOS (Sophisticated Operating System); and Extended BASIC. This system will be available starting this month, July, at Apple dealers; widespread availability should occur in another few months.

Starting in the fall, Apple will offer another version of the Apple III, called the Software Development System, ranging in price from $4500 to $8000. The $8000 version will be a word-processing package featuring a letter-quality printer (such as Qume or Diablo); an extra disk drive; a high-quality monitor; a word-processing software package; and a training course offered through Apple dealers. A less expensive version of the word-processing package will be available for $4500; it will use the thermal printer.

The Market

Apple is banking on the fact that the Apple III can compete head-on with a wide variety of computers. Steve Jobs believes it will give a product like the Wang word processor a run for its money.

"It's easier to use than the Wang and costs less," Steve points out.

Its color graphics are another strong feature. We were treated to a beautiful demonstration of high-resolution color graphics using an RGB color monitor. Apple plans eventually to market an RGB color monitor with the Apple III.

"The Apple III was conceived to fill in the gaps in the Apple II. One small technical deficiency (40 columns instead of 80 columns on the Apple II) prohibited us from entering some of the markets we wanted to go after," said Jobs. "The Apple III complements the Apple II, but the Apple II is still better for some things. I see it continuing to carry the educational and low-end professional markets."

Apple is confident that outside suppliers of peripheral cards and software will be encouraged to offer products for the Apple III because of its evolutionary approach to product design. We applaud the careful design of the Apple III and the commitment of the company to making it as compatible as possible with the Apple II.

We look forward to examining the potential of the Apple III in future issues of BYTE.■

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The world champion intently surveys the chessboard. Two thousand spectators expectantly wait in reverent silence. Finally, the champion reaches forward and moves his dark-squared Bishop; his opponent blinks with astonishment. The crowd is aghast with disbelief. Has the champion committed a fatal blunder? His Bishop is attacked by three different pieces and appears to be defenseless. The onlookers solemnly analyze the position. The room begins to rustle with excitement. The move is not a blunder at all! There is a hidden defense for each assault and the Bishop in its new position is devastating. The opponent's look of surprise slowly fades and is replaced by one of dejection. There is no escape; the position is hopeless. After a protracted delay, the challenger overturns his King, congratulates the champion, and quickly departs from the hall.

To a serious chess enthusiast, there is nothing more sensational than the startling change in fortune which is produced by a chess brilliancy. A single move transforms a seemingly even position into a one-sided contest. The move is one which most players would ordinarily dismiss at first glance. Only deep analysis unveils its magical power.

Scientists attempting to develop intelligent machines have regarded chess as an ideal test environment. Computer-chess devotees are gratified when a program plays a respectable game against a good human player. Even more pleasing, however, would be a victory involving a bona fide chess brilliancy. Such an event would be impressive to even the most intransigent critic.

Recent developments in computer chess have led to steady improvement in the quality of play. The ironic circumstance, however, is that this newly evolved machine intelligence has not resulted from a more sophisticated simulation of human thought processes. Instead, the quest for the elusive chess brilliancy has focused on a purely mechanical strategy: fine-tuning the α-β (alpha-beta) minimax algorithm to run at an incredible speed on advanced hardware. Computer programs making an exhaustive search of many thousand potential positions have consistently outplayed rival programs which are designed to emulate the selective search process used by humans.

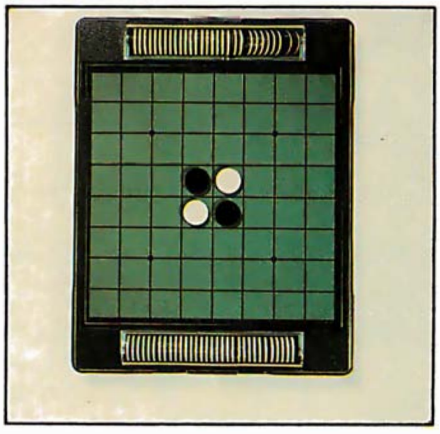

Photo 1: *The initial board layout for Othello. Shown here is the commercial version of Othello manufactured by Gabriel. Othello is a trademark of Gabriel Industries Inc.*

This surprising turn of events probably is more a reflection of our present programming limitations than an indication of the strategy which will ultimately be most productive. There are many knowledgeable individuals who believe that chess programs must more closely emulate human playing techniques if they are to become serious contenders for the world championship. It takes many years of experience before humans can excel at chess. This slow learning process involves the assimilation of thousands of complex patterns and the acquisition of detailed knowledge regarding appropriate goals and playing strategies for each of these. It is very difficult to fully embody such a complex data base in a computer program. Many man-years of effort would be required by a highly knowledgeable team. Such an enterprise is beyond the capacity of isolated individuals working in their spare time. Consequently, it is improbable that we will ever see a quality chess program that mirrors human thought processes unless some wealthy individual or government agency initiates a large-scale computer chess effort.

The artificial-intelligence community has also displayed considerable interest in the game of Go. This game surpasses chess in the depth and complexity of its strategic ideas. Because of its enormous branching factor, Go cannot use the mechanical tree-searching strategy which has worked well in chess. Instead, Go programs have to be patterned after human playing strategies. Since this approach is an enormous

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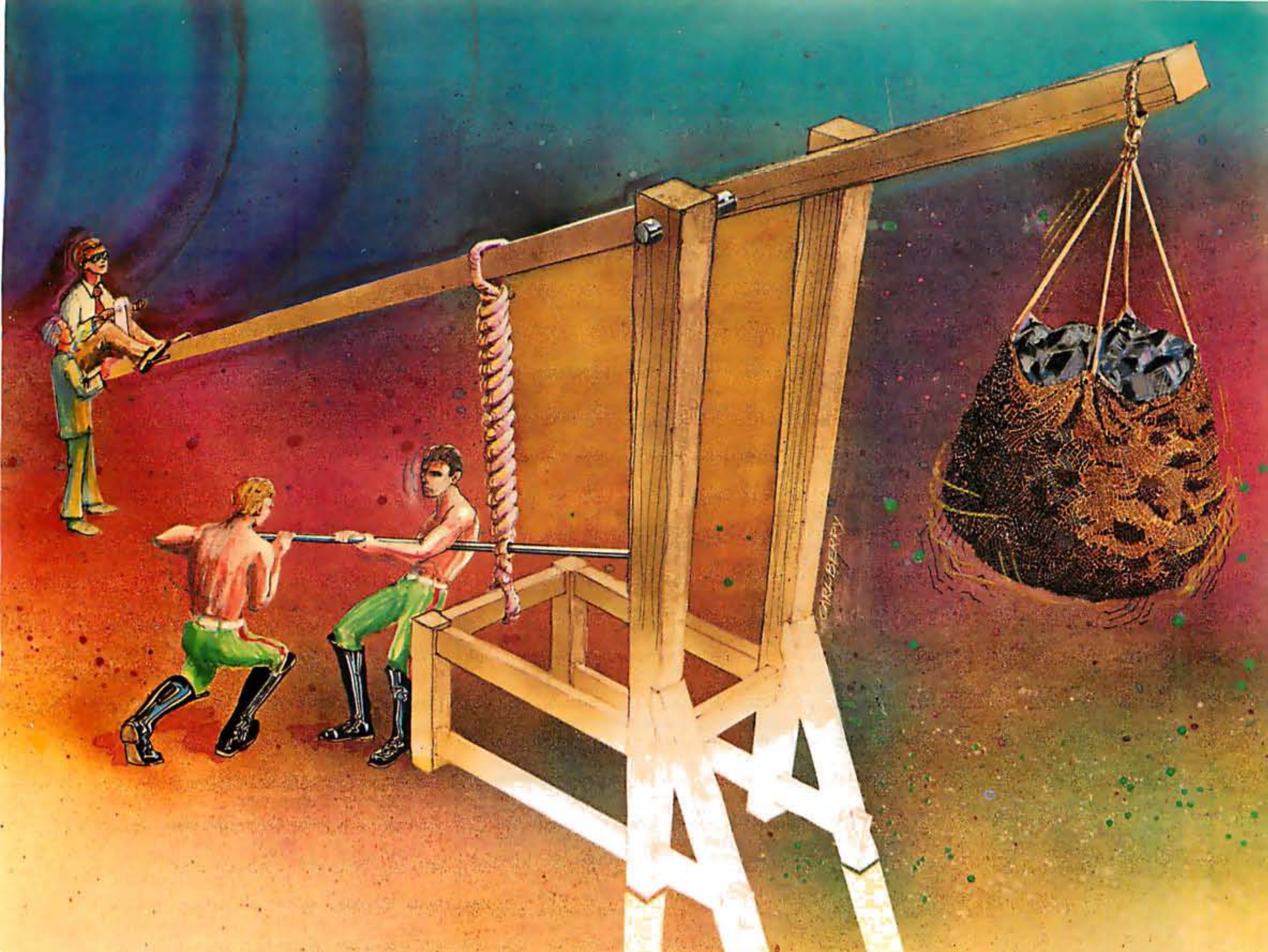

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Othello is played on an 8 by 8 grid with sixty-four flat pieces colored differently on each side.

challenge even with chess, it is unlikely that we will see a competitive Go program for some time.

This assessment does not provide encouragement for personal computing enthusiasts who wish to develop their own intelligent programs. Very few of us have the time, skill, or resources which are needed to write a chess or Go program. Therefore it is reasonable to search for a more manageable challenge. We need a game which is less complex than either chess or Go. The elusive machine brilliancy may be more attainable if we focus our efforts on a task compatible with the resources at hand.

The Game of Othello

About a year ago I was introduced to the game of Othello, produced and marketed by Gabriel Industries. This game is a minor modification of one which was quite popular in England in the 1890s. The English game was known as Reversi, and there are accounts of a similar game in Hungary that goes back at least several hundred years under the name Annexation. Early manuscripts on the game seem to be as sophisticated as contemporary documents.

Othello is played on an 8 by 8 grid with sixty-four flat, circular pieces that are colored differently on each side. The exposed color of a piece (ie: the top surface) indicates which of the two players controls the particular square on which the piece is sitting. A change in control is denoted by flipping the piece and thus exposing the opposite color. The contest begins with four pieces (two of each color) occupying the four central squares. (See photo 1.) The two players alternate in placing one piece on the board at each turn. If one contestant has no move, his opponent plays again. The game ends when all sixty-four squares are occupied or when neither competitor can move. The winner is the contestant who controls the most territory (ie: the most squares) at the conclusion of the game.

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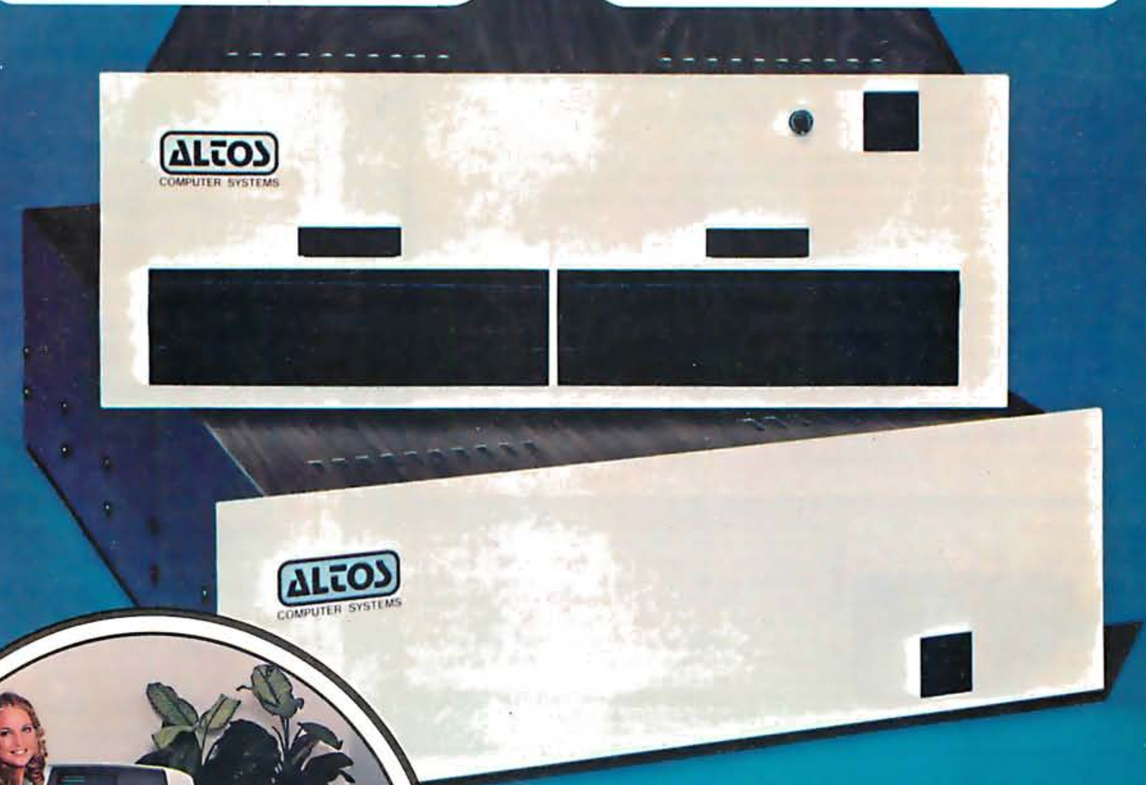

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There are a number of ways for the computer to recognize and store values for specific edge patterns.

A player can legally place a piece on a square if: the square is presently empty; the square is immediately adjacent to one controlled by the opponent; and the new piece *outflanks* one or more of the opponent's pieces. *Outflanking* means that a row (one or more pieces without an intervening empty square) of the opponent's pieces must be bordered by the new piece and one of the player's existing pieces.

When an opponent's piece is outflanked, it changes color and becomes the property of the player. If a newly placed piece simultaneously outflanks two or more rows, all of these pieces are flipped. This characteristic of the game is probably the rationale for both of the earlier names, Reversi and Annexation. Readers who are new to the game might consider purchasing the commercial version marketed by Gabriel, which includes a descriptive pamphlet with examples and playing hints.

Othello Strategy

Many of the strategic ideas in Othello are delightfully counter-intuitive. To be proficient, a player must learn many complex principles. As in chess and Go, there are many levels of competency. Individuals who think they have mastered the game usually discover that their skill level is only at one of the lower plateaus. In my experience with the game, I have yet to meet a modern Othello player who is aware of strategic ideas that were known in the 1890s.

In writing a computer program to play Othello, I was determined to follow a specific set of guidelines. As a psychologist, I wanted to write a program which simulated the cognitive processes used by humans. In addition, I wished to avoid using a multi-million-dollar computer which could simply "crunch out" a solution in a mindless, inefficent manner. The more powerful the machine used, the less likely it is that a human-type

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algorithm will be selected. I decided to use a small microcomputer, the Radio Shack TRS-80.

The project was initiated by examining the playing strategies used by humans. A Northwestern University student, Steven Grady, recruited five volunteers and asked them to report their thoughts as they were learning to play Othello. All of these subjects were unfamiliar with Othello at the inception of the project. This research strategy is similar to the one used by De Groot in his pioneering work on chess skill. Our subjects were asked to examine a series of positions and to select the best moves. During the decision process, they reported their thoughts and indicated why the chosen move was better than the alternatives. This pilot research provided a number of valuable observations.

The most interesting general finding was that the subjects displayed a remarkable uniformity in the order in which they developed various playing strategies. After learning the rules for the game, every subject adopted an initial tactic of selecting the move in each position which flipped as many as possible of the opponent's pieces. The unanimous choice of this strategy by our subjects speaks to its apparent rationality. This approach was also used by Tim Quinlan when he wrote an Othello program for Mad Hatter Software. If you have played that program, you are probably aware that this is a poor strategy. Our subjects began to realize this after one or two games.

The first major revelation for them was that control of the squares on the edge, and especially the corners, is important. The subjects quickly realized that pieces placed on the edge of the board are more stable than those placed in the middle of the board. In addition, the players observed that a piece placed on a corner square can never be flipped. Our subjects seemed to acquire these two insights at about the same time. A short time after gaining this new perspective, they reported that an edge move was preferable to other moves even if it flipped fewer pieces. In essence, our subjects were overcoming their initial bias and were starting to play for territorial control rather than to immediately maximize their piece count.

Once these players had discerned the value of the edges and the corners, they rapidly acquired several other important ideas. They reasoned that if the corners are good, then the squares adjacent to a corner on the edges or on the diagonal are bad—the rationale being that an opponent can never play on the corner if you refrain from placing a piece on any of the squares adjacent to the corner. A similar line of reasoning led to the observation that it is dangerous to play on the squares one row in from the edge since such a move gives the opponent an opportunity either immediately or in a few turns to play to the edge.

Our subjects also gained several specific insights about positioning pieces on the edge. These included some easily stated principles: the square two-removed from the corner is very desirable because it is a launching point for gaining the corner; it is bad to play a piece on an edge square between two enemy pieces when they are separated by

1	49	5	17	18	6	50	2
51	57	41	33	34	42	58	52
7	43	13	25	26	14	44	8
19	35	27			28	36	20
21	37	29			30	38	22
9	45	15	31	32	16	46	10
53	59	47	39	40	48	60	54
3	55	11	23	20	12	56	4

Figure 1: *Priority values for each of the sixty potential move squares on the 8 by 8 playing board. A move is selected by choosing the lowest numbered square that satisfies the rules for move legality.*

two empty squares, since the opponent can immediately reverse the piece; and it is good to play a piece on an edge square between two enemy pieces when they are separated by one empty square because the opponent cannot reverse the piece. Although these strategic ideas are quite rudimentary from the perspective of an experienced competitor, we were encouraged by the speed and ease with which our subjects learned them. After only a few games they had completely altered their initial strategy and were playing much more skillfully.

A Simple Othello Strategy

In order to examine the importance of these ideas, we set up an interesting demonstration. A simple algorithm was designed which selected Othello moves based only on the location of the squares. This algorithm was pitted in a game against Tim Quinlan's program, which employs a "flip-the-most-pieces" strategy. Our algorithm was based on a square-priority scheme in which each square is assigned a priority number. A sequential search is made, in which the squares are visited in order of their priorities and a determination is made to see if a piece can be legally played on that square. The first square considered which permits a legal move is selected. Our choice of priority assignments was based on the strategic ideas developed by our subjects. These assignments are summarized in figure 1.

When implemented appropriately in a BASIC program, this algorithm selected moves on the TRS-80 in about one-fifth the time of Tim Quinlan's program and easily defeated it by the lopsided score of 57 to 7. This demonstration provided convincing evidence that territorial considerations are of much more consequence in Othello than immediate material gain.

To implement our algorithm, it was necessary to solve two additional problems. How should the machine represent the current status of the playing board? How should it determine move-legality? After a lot of thinking, we developed a simple solution for each of these questions.

To represent the current status of the board we borrowed a technique commonly employed in computer chess. A one-hundred-item array was utilized to represent the sixty-four squares on the board and thirty-six imaginary squares which border the board. The array was arranged in the manner depicted in figure 2. This arrangement creates consistent algebraic relationships among the squares. For example, the number of the square to the right of square A is always the value of square A plus 1. The square above is always A plus 10. By inspection you will note that consistent numerical relationships exist for movement in all eight directions.

To represent the pieces on the board, the following convention was used. An empty square was labeled as a 0. A square off the board was a 9. A square controlled by the machine was a 1 and an opponent's square was a 2. The starting configuration for Othello is depicted by the array values presented in figure 2. As the game proceeds and pieces are placed, values of 1 and 2 are substituted ap-

Listing 1: *Algorithm for determining whether a piece can be legally placed on a square. See text for an explanation of the notation.*

```
100  DIM B(99), O(7), F(20)
110  N=0                              (Set the flip count to 0.)
120  IF B(I) <> 0 THEN 250            (Is the square empty?)
130  FOR J = 0 TO 7                   (Select a direction.)
140  K = I + O(J)                     (Move one square over.)
150  IF B(K) <> 2 THEN 230            (Opponent's square?)
160  K = K + O(J)                     (Check for a row of opponent's pieces.)
170  IF B(K) = 2 THEN 160
180  IF B(K) <> 1 THEN 230            (My piece on the end?)
190  K = K - O(J)                     (Back-track.)
200  IF K = I THEN 230
210  N = N + 1: F(N) = K              (Record flip square.)
220  GO TO 190
230  NEXT J
240  IF N > 0 THEN 260
250  PRINT "NO MOVE POSSIBLE.": STOP
260  PRINT "LEGAL MOVE WHICH FLIPS"; N; "PIECES.": STOP
```

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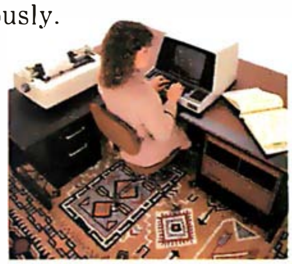

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B(80) = 9	B(81) = 0	B(82) = 0	B(83) = 0	B(84) = 0	B(85) = 0	B(86) = 0	B(87) = 0	B(88) = 0	B(89) = 9
B(70) = 9	B(71) = 0	B(72) = 0	B(73) = 0	B(74) = 0	B(75) = 0	B(76) = 0	B(77) = 0	B(78) = 0	B(79) = 9
B(60) = 9	B(61) = 0	B(62) = 0	B(63) = 0	B(64) = 0	B(65) = 0	B(66) = 0	B(67) = 0	B(68) = 0	B(69) = 9
B(50) = 9	B(51) = 0	B(52) = 0	B(53) = 0	B(54) = 1	B(55) = 2	B(56) = 0	B(57) = 0	B(58) = 0	B(59) = 9
B(40) = 9	B(41) = 0	B(42) = 0	B(43) = 0	B(44) = 2	B(45) = 1	B(46) = 0	B(47) = 0	B(48) = 0	B(49) = 9
B(30) = 9	B(31) = 0	B(32) = 0	B(33) = 0	B(34) = 0	B(35) = 0	B(36) = 0	B(37) = 0	B(38) = 0	B(39) = 9
B(20) = 9	B(21) = 0	B(22) = 0	B(23) = 0	B(24) = 0	B(25) = 0	B(26) = 0	B(27) = 0	B(28) = 0	B(29) = 9
B(10) = 9	B(11) = 0	B(12) = 0	B(13) = 0	B(14) = 0	B(15) = 0	B(16) = 0	B(17) = 0	B(18) = 0	B(19) = 9
B(0) = 9	B(1) = 9	B(2) = 9	B(3) = 9	B(4) = 9	B(5) = 9	B(6) = 9	B(7) = 9	B(8) = 9	B(9) = 9

Figure 2: *Representation of the starting position in Othello by placing specific values in a 100-item array. The number 0 represents an empty space. The number 9 represents an imaginary square that borders the 8 by 8 playing field. The number 1 represents a square controlled by the computer and the number 2 represents a square controlled by the opponent.*

propriately in the array in place of the initial values of 0.

Determining whether a piece can legally be placed on a square is straightforward. The algorithm presented in listing 1 accomplishes this goal in a reasonably efficient manner. The notation employed in this algorithm represents the following variables. The one-hundred-item B array is the playing board organized in the manner depicted in figure 2. The eight-item O array provides a set of eight offset values which are used to move in each of the eight possible directions around a square. The values are: O(0)=1, O(1)=9, O(2)=10, O(3)=11, O(4)=−1, O(5)=−9, O(6)=−10, and O(7)=−11. The variable I represents the square being considered for move legality. The variable N counts the number of pieces (if any) which will be flipped by the move. The F array provides a list of the flip squares. The variables J and K are used to index the O and B arrays, respectively. If the various squares on the board are visited in the order prescribed by the priority values listed in figure 1 and the algorithm in listing 1 is applied to each square in sequence, selection of the first square that is legal will produce surprisingly decent Othello moves. Such a program will regularly defeat experienced children, beginning adults, and many commercial computer Othello programs. A little knowledge can go a long way if it is applied appropriately.

Our success with this simple territorial strategy provided encouragement to investigate more complex human tactics. Our initial effort might challenge a beginner, but it would be no match at all for a serious player. We proceeded to learn more about human Othello and to implement these ideas in BASIC on the TRS-80. Our human subjects varied greatly in the speed with which they discovered the relative values of different areas of the playing board. One subject acquired most of the ideas summarized in figure 1 by the third game. Another subject required eight games to grasp these fundamental principles.

Once these basic territorial concepts were mastered, our subjects showed further improvement in highly individualistic ways. Each person seemed to concentrate on one or more specific ideas which had not occurred to the others. These idiosyncratic developments are probably a reflection of Othello's character. Many of the deeper strategic considerations in Othello are not particularly obvious. Several of our subjects at this stage even developed notions which were totally erroneous.

Advanced Analysis

To continue our analysis of Othello I will concentrate on specific strategic ideas which have been acquired by experienced players. No attempt will be made to provide an exhaustive analysis of the game. Instead, several important concepts will be examined to emphasize the ways in which human decision strategies can be made compatible with relatively simple computer algorithms.

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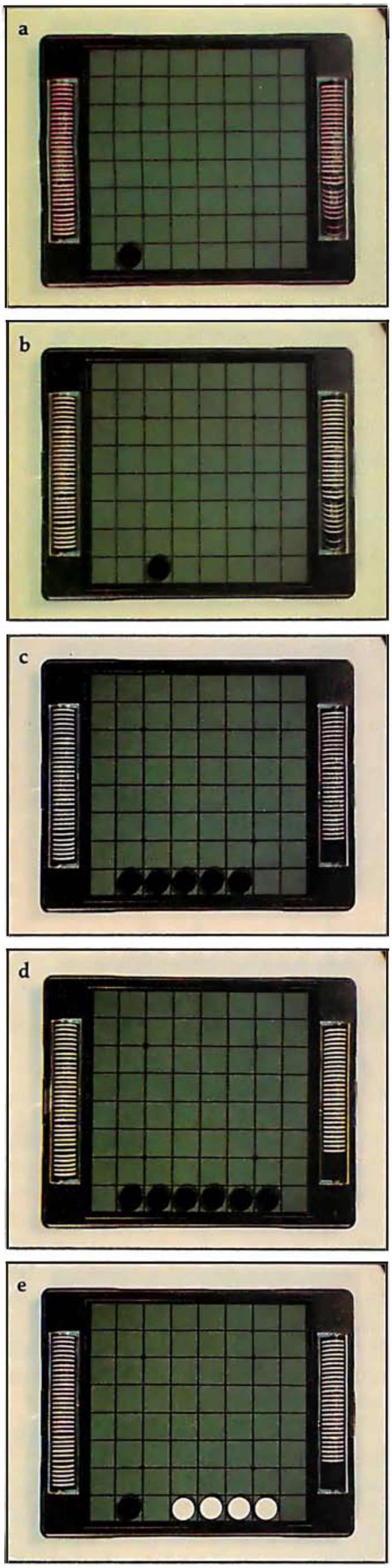

Photo 2: *Specific edge configurations that have important strategic implications in Othello. See text for details.*

between the two contestants for control of the edges. To win this battle, it is necessary to comprehend several significant strategic ideas. Since a reasonably adroit opponent will not willingly make moves which give you an opportunity to play to the edge, it is necessary to create situations which force your opponent to provide such opportunities. An important principle which is relevant to this goal is that you should select moves which result in an increase in the number of move options you have on future turns and decrease the number of move options available to your opponent. The greater your move options (somewhat akin to the notion of mobility in chess), the less likely it is that you will have to select an undesirable move. The fewer options your opponent has, the more likely it is that he will be forced to select an unwanted move which gives you access to the edge.

Which piece placements are most effective in reducing your opponent's options? The answer may come as a surprise. To increase your future move potential and decrease your opponent's, you should make piece placements which keep a minimum number of your men on the board (ie: flip as few as possible on each of your turns) and keep them in the middle of the board as much as is feasible (ie: try not to have your pieces on the outside of the game). Note that this advice is exactly the opposite of the strategy which was intuitively selected by each of our subjects when they initially played the game. Also note that this principle helps to explain why the "flip-the-most-pieces" strategy used by Tim Quinlan led to a lopsided defeat when his program was pitted against our simple territorial strategy.

To implement the move option concept in a computer program, a player need only keep a count of the number of pieces flipped by each move and then give preference to moves which flip the smallest number of the opponent's pieces. This idea can be combined with the territorial principle by using the number of pieces flipped as a tie-breaker among moves which are equally good from a territorial perspective. An even more sophisticated implementation would consider the location of the pieces and give preference to placements which affect pieces on the inside of the gamefield. This latter plan is not easily implemented since the notion of *inside region* is difficult to define in terms of a brief algorithmic rule. Following a tradition begun years ago by textbook writers, I will leave the specific implementation of this idea as an exercise for the reader.

Edge Configurations

If you are successful in forcing your opponent to make a move which gives you access to the edge, you will soon discover that you need information concerning which piece patterns on the edge are most useful for launching a successful campaign to win the corners. Experience shows that in this endeavor also, the best strategies are not necessarily the most obvious ones. In fact several key ideas are a bit devious. To gain the flavor of this aspect of the game, let us consider the five edge configurations presented in photo 2. In these photos, the machine is playing black and the opponent is playing white. Which of these positions is favorable to the machine, favorable to the opponent, or of equal advantage to both players? To convince yourself that Othello is not a trivial game, consider each position with this question in mind before reading on. See if your analysis agrees with the information which follows.

Two of the positions are good for the machine, two are very bad for the machine, and one is about equal for both players. Positions b and d are the good ones, a and c are the bad ones, and position e is equal. Since you may doubt these answers, let me explain the rationale for my classifications.

Position b is good because the machine has gained an undisputed foothold on the edge and is in a position where it may eventually force its opponent to move adjacent to the corner and thus surrender the corner to the machine. When a player has an opportunity to make the first move to an empty edge, the square two from the corner, as in position b, is the most desirable one to obtain.

Position d is favorable because the machine is in a position to permanently retain all six of the interior edge squares if it can gain control of either corner. The position does have the disadvantage of permitting the opponent to gain control of the entire edge if he is first to gain one of the

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corners and the machine cannot reply by immediately taking the remaining corner. The double-edged character of the position (no pun intended) is more apparent than real since careful play by the machine should permit it to maintain control of the edge.

The position in e is essentially even. Neither player can move to square 3 without immediately giving up a corner and subsequently the entire edge. Thus a stalemate exists in respect to play on this edge. This same conclusion would hold if black controlled two adjacent squares and white controlled three adjacent squares as long as a single empty square separated the two antagonists. Positions like e are quite common in Othello and the eventual outcome for the edge usually depends on which player is forced to play on the empty square for lack of a better move. In this respect the end game in Othello is similar to that in chess, because the person with the move sometimes wishes that it were the other player's turn.

The positions in a and c are very bad for the machine since the opponent can force the surrender of important real estate. In position a, the opponent, if he plays skillfully, can almost always win the left-hand corner. The strategy is not a simple one, and therefore it should be educational to examine it in some detail. A seemingly good move for the opponent in this situation would be to square 5. If the machine fails to defend properly, the opponent can then move to square 3 and force a win of the corner since the machine has no means of defense. If the machine replies by moving to square 4, this will flip the opponent's piece at square 3 but will leave the opponent's piece at square 5 untouched. This piece at square 5 will then serve as the necessary anchor for the capture of the corner.

The move to square 5 by the opponent is good, however, only if the machine is unable to reply by a move to either square 3 or 4. If it can, the plan misfires and the opponent gains nothing. A more sophisticated strategy can be seen if the opponent's first move is to square 6, establishing the position depicted in photo 3. The machine then has several options: make a non-edge move; move to square 3; move to square 4; or move to square 5. None of these replies can save the corner. If the machine makes

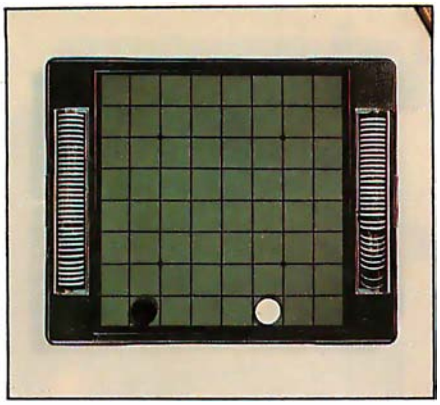

Photo 3: *An edge position that leads to a forced win of the corner.*

a non-edge move, the opponent responds by playing to square 4 and then eventually to square 3. There is no defense for the machine, and the corner is lost. If the machine replies to the position in photo 3 by moving to square 3, the opponent moves to square 4 and wins the corner. If the machine replies to the diagrammed position by moving to square 4, the opponent moves to square 3 and wins the corner. The last potential defense for the machine is a move to square 5. This is effective if the opponent replies by moving to square 4 and flipping the machine's piece at square 5. However, the opponent can move to square 3 instead, and this forces a win of the corner because the machine lacks an effective reply. The moral of this short presentation is that you should never move to the edge square adjacent to the corner when the edge row is empty. Such a move is tantamount to throwing the game away.

Creative Computing (November-December, 1977, pages 140 thru 142) presented a FORTRAN program written by Ed Wright which plays Othello using a tree-searching approach. This program seems to be unaware that the edge square adjacent to the corner is dangerous, and it will readily place a piece on this square given the opportunity. For this reason, it regularly loses to my TRS-80 even though the FORTRAN program has been implemented on the Control Data 6600. In a game that requires long-range planning like Othello, there is no substitute for essential strategic knowledge.

The edge pattern depicted in position c in photo 2 is also very bad for the machine. The disadvantage of this pattern is that the opponent is free to make a move which offers the right-hand corner to the machine. If the machine takes the corner, however, the opponent can then move to square 7, permanently winning the left-hand corner and seven of the eight squares on that edge. If the machine does not take the corner, the opponent has gained an important *tempo* (ie: an additional move). In either case, this particular edge pattern turns out to be a major disadvantage when the game reaches its final stages with only a few moves remaining for each side.

Although I have discussed only a few edge patterns, an accomplished Othello player must know the significance of many. My Othello program, which plays a fairly decent game on the TRS-80, has evaluation scores for several hundred edge patterns. It would play an even stronger game if more edge information were included.

The edge-information part of the program consists of a neatly organized catalog of human knowledge. The program is given a specific score for each pattern and uses this information in making decisions about when it should or should not make an edge move. The instructions the machine receives are not that different from those one might give to a beginner, ie: this configuration gives you a slight advantage, that one is terrible, this one is about even, that one is very good for you, etc.

Pattern Recognition

There are a number of ways for the computer to recognize and store values for specific edge patterns. A powerful technique which has been used with considerable success in chess is the bit-map idea. This strategy involves the representation of specific edge patterns in terms of particular bit configurations, and recognition occurs when an edge configuration (represented as a bit map) matches one of the configurations permanently stored in the computer's memory. In Othello, this technique would require two 8-bit words for each edge pattern, since each of the eight squares has three possible states: empty, machine control, or opponent control. If only two states were involved, a single 8-bit word could represent each pattern.

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A second strategy is to generate information for the edge configurations on each side of a particular edge square at the time when a move to that square is being considered. Sets of n patterns for the short side and m patterns for the long side can be identified and an n by m array of values for each combination can be stored in memory. This array is consulted each time a move decision is made.

During the early and middle stages of an Othello game, skillful players are very careful to minimize the number of pieces flipped. At the end of the game, however, this strategy is no longer viable since the object of the game is to finish with more pieces than the opponent. Even at this stage, however, indiscriminately flipping as many as possible can often be disastrous. Thoughtful play requires a detailed lookahead search in which the number of pieces flipped for each side in each potential sequence of moves is carefully counted. It is not feasible to make these calculations until only a few (eg: 6 to 8) empty squares remain. The limitation on this forward search process is caused by the combinatorial explosion which characterizes lookahead trees. The number of end positions in the tree is an exponential function of the number of empty squares. This lookahead procedure is very different from that used in chess because it is invoked only when each and every limb can be analyzed to a final position. If the calculations are made correctly, this search accurately foretells the eventual winner.

It is not difficult (at least conceptually) to create a mechanical imitation of this human lookahead process. A player can implement the same minimax algorithm which is used in chess or checkers and painstakingly examine all possible move combinations. The algorithm can be advanced considerably by using the α-β cut-off procedure in conjunction with other sophisticated searching techniques. Getting this part of the program running correctly, however, is quite a challenge. I have yet to see a textbook description of the technique which clearly presents the essential ideas. Many of the relevant publications, in fact, present the algorithm incorrectly. If you can unravel this algorithm on your own, you will have accomplished something special.

Conclusion

Let us summarize our major observations. Othello is a game which offers a worthwhile challenge to the personal computing enthusiast who is interested in artificial intelligence. The game can be programmed by simulating human playing strategies such as those discussed in this article. These include territorial priorities, move-option considerations, knowledge about specific edge configurations, and a lookahead search which is triggered during the last few moves of the game. Each of these ideas can be implemented in BASIC in a fairly straightforward manner on most personal computers.

Artificial intelligence is a murky uncharted sea. Many ambitious young programmers have attempted to get their feet wet by writing a chess program. In most cases, this endeavor has been a sobering experience. Those who have avoided drowning have done so at the price of many harrowing experiences in deep waters. Only a handful of these intrepid sailors have returned to port with a respectable chess program in their grasp.

If you are new to these waters and wish to avoid a punishing experience, I heartily recommend that you start with a manageable enterprise. With Othello you can gain the satisfaction of creating an impressive player while simultaneously developing valuable programming skills. If you have a Level II 16 K TRS-80, you can get a head start on this project by sending for a copy of my Othello program. With Othello you have an opportunity to create your first truly intelligent program. After all, an Othello brilliancy is almost as impressive as a chess brilliancy. ■

My Othello program is available on cassette for the TRS-80 (Level II, 16 K) for $12 and for the Apple (integer BASIC, 32 K) for $16. The program has five levels of play, neat graphics, and selects a move in 30 seconds or less. Write to Peter Frey, 2407 Prospect Ave, Evanston IL 60201.

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2. Maurer, W D, "Alpha-Beta Pruning," BYTE, November 1979, page 84.

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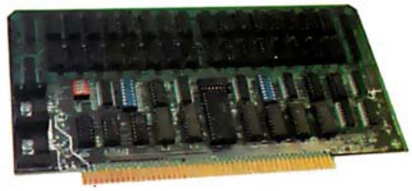

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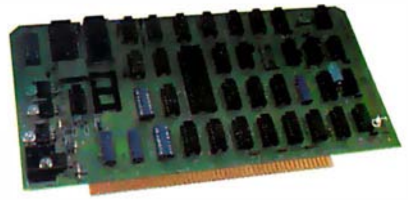

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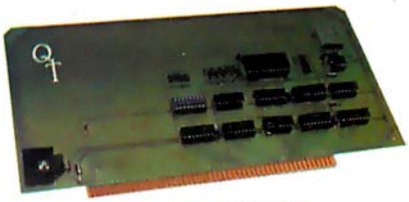

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There are a number of predictions being made about the future of computers in education. One goes something like this:

- By the year 1984 there will be millions of general-purpose microcomputers in schools, colleges, and universities, with an even greater number available for educational use in the home.

... 1: The Pascal Microengine is shown here in a system ... cludes two Shugart 8-inch disk drives in an Integrand cabinet a... oroc IQ120 terminal. The computer uses a 16-bit processor chip ... and it executes p-code directly through the use of three Mic... integrated circuits on which the processor microinstruc-tion... e stored. The Microengine also includes 64 K bytes of men... , a 24-bit parallel port, and two RS-232C serial interfaces. The ...tware provided is the UCSD extended Pascal system.

A second common—but somewhat less optimistic—statement about the future of educational computing can be paraphrased as follows:

- The potential of microcomputers for education will never be realized unless a massive effort is immediately undertaken to produce educational software and courseware.

The first prediction will undoubtedly become fact. To anyone who has been following the dramatic technological breakthroughs of the last few years, the image of millions of microcomputers in schools and homes must seem a conservative one. There is also little doubt that more educators and parents will acquire microcomputers because of the promised educational benefits.

But what about the second prediction? Is it true that the missing ingredient in all of this is going to be educational *software* and *courseware*? Does it follow that the production of this courseware is a task of such monumental proportions that only the largest publishing corporations can manage it? Will the track record of some publishers for favoring and marketing low-level, committee-produced texts carry over into the educational computing field? In short, will the "small is beautiful" effect that made microcomputing possible in the first place be undone by a "big means mediocre" syndrome that measures success in terms of mass acceptance at the lowest possible denominator?

Before attempting an answer to these questions, it is important to define—or at least clarify—a few terms. In educational circles, the words *software* and *courseware* refer to materials meant to help teachers use computers for instruction. The bad news is that this material often takes the form of prepackaged "teaching" programs that ignore the built-in inventive streak found in most students. The good news is that there are refreshing exceptions to this rule, and there is a growing underground of exceptional ideas developed by teachers and students with both imagination and daring.

The purpose of this article is to elaborate on the reasons why this kind of imagination needs to be supported, and in doing so clarify both terminology and concepts. A second goal is to enlist as many readers as

Books, Learning, and Machines: The Case of the Pascal Microengine

Solo-mode learning, whether it is connected with flight in an aircraft or with analogous explorations of the mind, can be a risky business. There is more chance of failure than in a dual-mode situation, especially when the solo exploration tries something brand new. This same principle holds when it comes to buying a microcomputer. It's usually very risky to be the first one on your block to own the latest computing marvel, no matter how enticing the specifications. It's for this reason that newcomers should select a machine that's been out for some time and for which lots of dual-mode hand-holding and support are available.

About a year ago I decided to ignore this advice and became the first one on my block to own a Pascal Microengine. And as expected, there were problems with both hardware and software. But the one problem that did not materialize was lack of vendor support. The manufacturer, Western Digital Corporation, bent over backwards to work with the group that had decided to buy the first models off the line. The effect was like having a long-distance community of learners sharing ideas, frustrations, and (happily enough) eventual fixes.

The reason for relating this story is that, overall, I would rate my first year with the Pascal Microengine as one of the best learning experiences I have ever had. The key factors that made this learning possible were:

- *an ingenious idea embedded in the form of a manipulatable "thing" (the Microengine itself)*
- *people willing to share ideas and think problems through*
- *the availability of books (particularly those derived from the Pascal software project at UCSD, including the* Pascal Microengine Reference Manual *and the new Ken Bowles book,* Beginner's Guide to the UCSD Pascal System*).*

The postscript to all of this is that the Microengine now seems to have entered the domain of "solid citizen" computers, and new owners will miss all the fun we "pioneers" had! Of course this is as it should be for most purchasers of computers. But I think the correspondence between learning and personally elected struggle brought out by this example is an important one. The real challenge to educators is to find ways of embedding analogous solo experiences within more normal classroom activities. I believe that the triad "computers + people + books" will be the real key to making this happen. ■

possible in an informal lobby group that will help publishers recognize the need for building on such imaginative ideas. The tools I will suggest for conducting this lobby will range from the luncheon-type contact suggested by the title to direct involvement as both contributors and critics to the world of publishing.

Before explaining how you can sign up for this "tilt with city hall" (or whatever the analogous term is in the world of educational publishing), let me explain why it's important to use the word *publish* in its old-fashioned sense of "print on paper," and not muddy the waters by adding the complexities of *electronic publishing* to those of computer-enhanced learning.

Computers, Publishing, and Learning

The word *publishing* has taken on an enlarged meaning in recent years. In particular, the term electronic publishing now includes such things as radio and television, special services based on data-based retrieval systems, and digitally encoded data-communication networks. The recent interest in piggybacking home data-retrieval services on cable television systems stems from a belief that future fortunes are to be made in this market. Significantly, a number of newspaper publishers and other media giants are prime investors in these developments.

The term electronic publishing is also applied to the production, distribution, and sale of computer software. Again, many publishing houses that now deal in conventional media, principally book publishers, are asking if tapes and disks are the wave of the future. This question seems to be on the minds of educational publishers in particular. Publishers are also reevaluating the future of their traditional products: books, journals, and magazines. They are asking what place these will hold in the computer age, particularly in computer-based instruction and/or learning systems.

To anyone reading this journal, the answer should be obvious: the print medium is indispensable. For anyone who has compared the information in a set of good books to that available on even the fanciest computerized information-retrieval system, the winner is crystal clear. Printed media —including the use of good graphics —represent the pinnacle of a sophisticated heritage that has taken centuries to perfect. The nuances of style developed over the years are considerable. Style is a difficult concept to define, but its importance in even such prosaic areas as technical documentation has long been recognized. Today, more than ever, paper and ink are the best, and often only, means for providing that documentation. There is a digestibility and mental maneuverability associated with the printed media that is just what the thinking and learning person needs.

It is important to point out that my unabashed enthusiasm for good books and journals does *not* imply a rejection of newer media. Ours is not an exclusive-OR world; one must be careful to avoid the fallacy "if X is good, Y must be bad." It is also important to remember that these enthusiasms apply to the cream of the crop in publishing; certainly, all is not cream. I have already implied that much school publishing today is mediocre. In particular, the pabulum-like content of contemporary "back to basics" textbooks is being recognized more and more as an insult to the intellects of both students and teachers.

This situation may be beyond redemption for conventional subjects. Right now, the realistic question to ask is whether we can prevent

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the same mindless spirit from taking over computer-related publication. The answer we can just as realistically offer is, "yes indeed"—provided that the growing body of knowledgeable users of microcomputers employ the leverage of their expertise and common sense to point educators and publishers in the right direction.

Let me start by showing that you already know far more about the subject of computers and learning than many of the so-called experts. In particular, allow me to demonstrate that even if you think the letters CAI stand for a secret government organization, you may still be the person to set educators and publishers straight on what the letters *should* mean.

What Is CAI and Why Is It Confusing the Issue?

It has been noted elsewhere (see for example the interview with Don Knuth in the January 1980 issue of *Creative Computing*) that new users of microcomputers are spending much time reinventing the wheel of computer science. This isn't really all that bad a thing; what is to be deplored more is the situation in which newcomers spend most of their time reinventing and *perpetuating* the mistakes of the past.

Judging from the questions asked by educators and publishers, many of the pre-microcomputer errors in educational computing are also being reinvented and perpetuated. There seems to be a built-in trap in the phrase computer-aided instruction (CAI) that leads even the best-intentioned educators astray.

The errors in the CAI trap are derived from a doubly false logic that assumes (1) what we now call *instruction* is the best way to promote human learning, and (2) the role of technology is to automate this instructional process so that it becomes cost-effective, mechanically reproducible, and "teacher-proof."

The fallacy of this view has long been noted in other applications of computers. The pioneer George Forsythe reminded his colleagues of the dead end that such thinking represented in numerical analysis by comparing the invention of computers to airplanes. He noted that viewing a computer as a new and super-efficient way to do the same *kinds* of things that were once done with pencil and paper is like viewing an airplane as a faster version of the bicycle. True, you *could* taxi a Lear jet down many of the roads used by bicyclists, but—well, the point is obvious. Yet, all too many educators and publishers are blithely pedaling their newfound microcomputer marvels down the same old paths of drill and practice, multiple-choice tutoring, and other equally uninspired dead ends.

What then is the new kind of thinking we need if the real potential of computers in learning is to get off the ground? There are many good answers to this question; in fact, one of the best answers is *diversity*. Just as a uniform formula for using the power of the printing press would have killed all of its potential, so too will a uniform use of computers as Skinnerian teaching machines—even when it is disguised with such sleight-of-hand phrases as "customized adaptive branching" or "learner-initiated information retrieval"—destroy the power of computing for learning.

Diversity does not mean vagueness; it is a principle that invites a continual uncovering of the unknowns in computer-enhanced

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learning. The danger of a uniform view of CAI is that it (like the other "big brother" uses of computers predicted for 1984) will make computer control of learners the accepted norm. Diversity insists that the norm should be learner control of computing.

Let me illustrate why diversity in educational computing is centrally important by introducing some of the terminology developed by Project Solo. This project started in premicro days (1969) with the goal of finding out what teachers and students could do when they, not the authors of CAI programs, were in charge of computing. The terminology of *solo* versus *dual* that was developed to explain this goal seems more appropriate than ever for the 80s.

Solo versus Dual Learning

One reason why the term CAI causes confusion is that it has no useful definition. The words are clear enough, but the interpretation of what it means to assist instruction depends entirely on one's view of *instruction*. To help people see the range of possibilities, I have found that examples drawn from adult experiences with learning are best. Here are three that illustrate some of the nuances that underlie words like instruction and learning.

The first example, which also explains our use of the word solo, has to do with flight instruction, where a distinction is made between dual and solo mode training. Dual mode involves an instructor; much of it is authoritarian. The student must use a certificated aircraft, must obey air traffic control, must use the right airspeed to optimize climb, and so on. However, he knows that he is moving to a solo flight where he can succeed only if he develops his own models of how to use all this past experience. The student alone can build the *right* model for solving a given problem (eg: making a landing). The instructor knows how to land an airplane in the sense that he can do it; he can also theorize about how he does it. But he will never know much about the student's internalization of this information. So the instructor's primary task is really not to tell the student how to land the aircraft, but to help the student build his own model of the process.

A second example—really a group of examples—comes from the problem of communicating with students who must clearly use a mode of learning different from that of the instructor. For example, the importance of helping students build their own models of the world comes home in a striking way when one observes experienced teachers of blind children at work. These teachers know that the manner in which the children *see* the world will forever be a mystery to the instructor. Such instructors become educators only when they respect this mystery, and organize their instruction accordingly. As one teacher put it, "You don't help them do it—you help them do it for themselves." I submit that adding the sense of sight does not change the essential rightness of education based on this important distinction.

The third example is a much more familiar one. Imagine that you have just arrived at an airport in a strange city, and now need to reach your final destination by way of unfamiliar roads. One possibility is to take a taxi. This option is direct and efficient, and it can have the bonus of being a personalized tour along a tried and proven route. It has all the potential for being a first-rate educational experience. Yet it is not likely that upon arrival you could pass a test asking for an accurate description of the route just taken. Your individualized treatment will have gotten you to your destination, but you will still be a stranger to the territory. The ingredients for a true adventure were missing.

Consider another option. Suppose that you rent a car and drive yourself. The simple act of moving into the driver's seat will have a profound effect upon the hundreds of interactions about to take place as you move into the role of problem solver, becoming an adventuresome and necessarily creative learner. This option comes at a price, of course. There will be the need to find and negotiate for a car, ask directions, study a map, and choose between alternatives. There are also likely to be mistakes—*inefficiencies* by some standards. Landmarks missed or instructions misunderstood will mean backtracking and revised planning. Questions will have to be asked and time lost. And the cost of having exclusive use

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of a car will be higher. But in the end, the person who goes solo will have learned things about getting from A to B that are accessible in no other way.

The paradox we see from this illustration is this: the guidance of others may very well inhibit the best kinds of human learning. The conclusion it suggests is that people have far more intrinsic talent for the business of learning than they have for the business of describing it, or bringing it about in others through institutions organized expressly for that purpose. Placing students within the structure of scientifically designed CAI programs—meant to be the electronic equivalent of scientifically designed schools—would certainly appear to be the best way of assuring that they are transported along curricula paths that visit many important educational points. The predicament faced is that for most students these are *only* visits, and dimly remembered ones at that. They never get to know the territory.

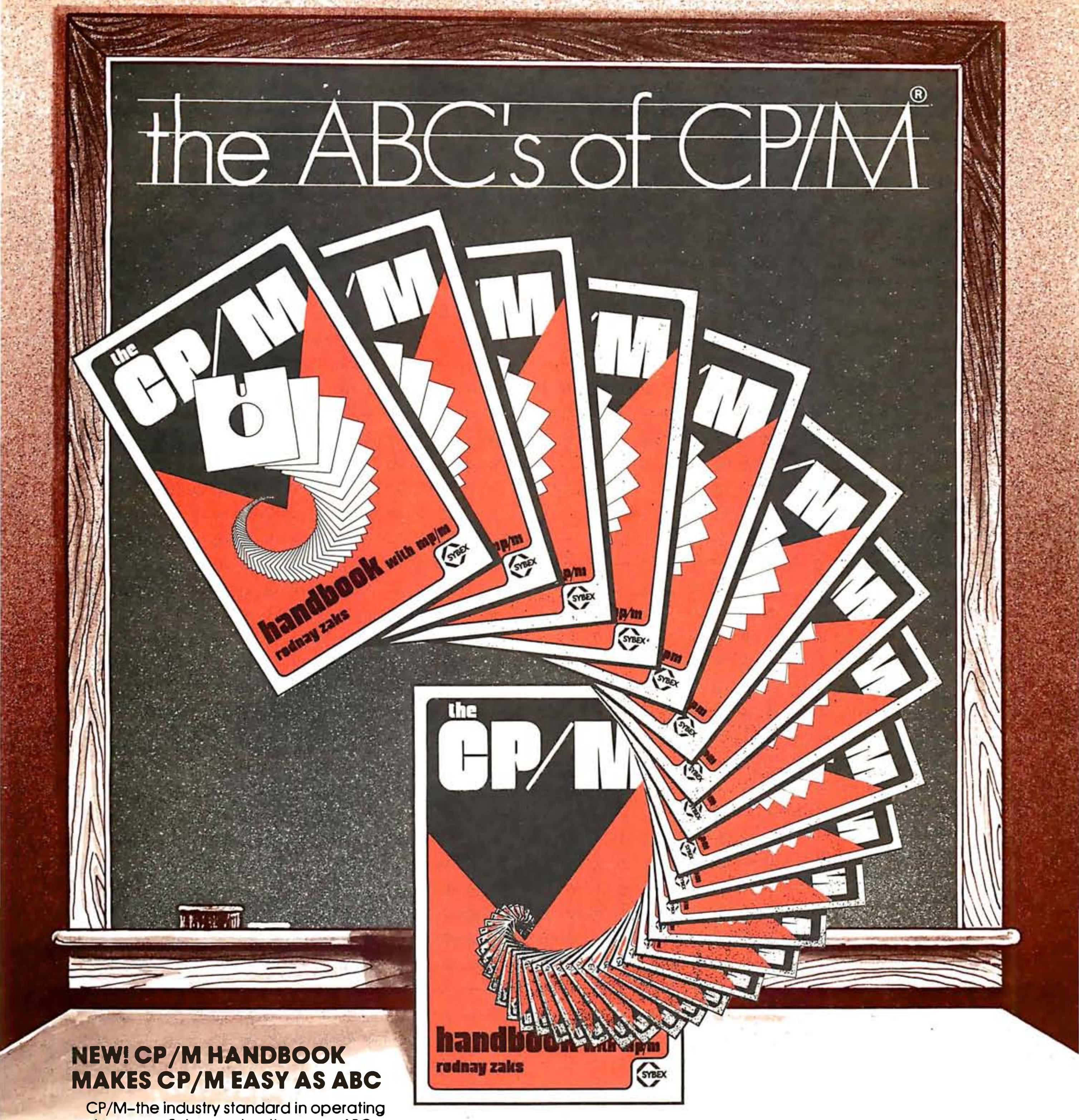
The Connection with Publishing

The conclusion that can be drawn from these examples is that words like education, instruction, and learning represent some of the most challenging problems ever faced by society. But as anyone who has worked in real school environments knows, the educational strategies teachers have been forced to adopt fall far short of a thoughtful solution to these problems. The mistake that is easy to make in connection with use of computers is to assume that, because microcomputers represent one of the most ingenious inventions developed by man, coupling these inventions with old instructional practices will cancel out the errors in these practices.

In particular, publishers might assume that what educators need are materials that make it easy to couple old practices with the new technology. The challenge to all of us is to say no to this; to insist on materials that bring out the ingenuity found in all learners, both young and old.

The form these materials should take is again expressed by the word "diversity." The best proof that this is the right approach is found in the new computing literature that has arisen over the past few years. Certainly not all of it can be recommended, but the quality is improving. More importantly, there is a spirit about the new writing that invites inventiveness on the part of the reader. Often this means digging and cross-digging, experimenting and reexperimenting. But even as you think black thoughts about the frustrations of not being handed simple ABC directions on a platter, you begin to realize that you have become the best kind of learner —an inventive one. (For an example of this phenomenon, see the text box entitled "Books, Learning, and Machines: The Case of the Pascal Microengine.")

The new computing literature has a second plus: it invites you to look at the more theoretical works written by scholars, especially books published by the quality textbook firms. I am continually amazed and delighted to see sets of Donald Knuth's *The Art of Computer Programming*, Volumes 1, 2, and 3 sitting on shelves next to the most elementary books on BASIC programming. I am even more delighted to see clearly written articles and books that not only prepare, but *motivate* one to read more theoretical treatises.



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Should You Become a Writer?

Most of the articles in this and similar journals are written by their readers. One of the best things that could happen to educational computing is a similar infusion of fresh thinking in the world of education.

The best advice to give to anyone harboring the idea of becoming an author is to try it, but allow time to learn your trade. I estimate that the time required to write a good book is at least two years for an experienced author. A beginner should plan on an additional few years to learn by trying different styles. Write articles for your local computer club newsletter. Then try some of the computer magazines. Write and give papers at the personal-computer conferences. You've got to try your material on the road before going big time. And of course you must have something to say, which also takes time and experience.

Teachers have a particular advantage, provided they really *do* prepare for class, and provided they basically write a fresh set of notes each time around. Teaching exclusively from a textbook will not develop one's talents as an author. The same advice applies to those who may teach informally, whether in the home, at work, or at a club.

There are, of course, many technical questions to be considered, ranging from writing style to selection of a publisher. My advice in this latter matter is to talk to other authors. Their experience with publishers is valuable information, and most of them are willing to share it, provided they know something about your writing. And once you've got a good manuscript ready to sell, just think: if the publisher likes it, he or she will take *you* to lunch.■

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The Personal Computer—Last Chance for CAI?

Lou Frenzel
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Education is rapidly emerging as one of the most important applications of personal microcomputers. Microcomputers are showing up both in schools and in homes, and they are becoming the central focus in school courses that teach computer operation, programming, and applications. But perhaps just as important, the computer is being used as an effective tool to teach varied subjects in schools and in the home. One term that has been used to describe the process of teaching by computer is *computer-aided instruction*, or CAI. CAI is a system of individualized instruction that uses a program presented by a computer as the learning medium. While computer-aided instruction is widely known and acclaimed as an effective teaching technique, it has never been extensively used nor has it lived up to its expectations. But now, thanks to the small, low-cost personal computer, CAI is getting a new lease on life. Personal computers may be what is needed to make computer-aided instruction practical.

Editor's Note:
*Computer-Aided Instruction (CAI) has come under fire over the years. Some claim that it is an unimaginative and wasteful use of computers in the classroom. Others contend that the system was maligned because of poor management on the part of those who attempted to introduce CAI systems into the schools during the 1960s, and that CAI still has potential usefulness in the educational system. Author Lou Frenzel presents the case for CAI....***ed**

About the Author
Lou Frenzel is the vice-president of Heath Company's recently formed Education and Publishing Division. Formerly a product manager, Lou conceived and helped establish Heath's personal computer product line. Previously with McGraw-Hill, Lou received his Bachelor's degree in electronics from the University of Houston and his Master's degree in education from the University of Maryland. Lou is the author of numerous books and articles on personal computing.

What Is CAI and From Where Did It Come?

Computer-aided instruction is the process by which written and visual information is presented in a logical sequence to a student by a computer. The computer serves as an audio/visual device. The student learns by reading the text material presented or by observing the graphic information displayed. The primary advantage of the computer over other audio/visual devices is the automatic interaction and feedback that the computer can provide. Multiple paths through the course material can be taken, depending upon the individual student's progress.

The concept of computer-aided instruction has existed for many years. Its origins are traceable to a machine invented by Dr Sidney Pressey in 1924 for grading multiple-choice examinations. His machine was proven to be quite effective in teaching. The concept of teaching by machine was later improved and expanded by B F Skinner at Harvard University in the late 1950s.

The teaching machine is an outgrowth of the programmed-instruction concept. Programmed instruction (PI) is an approach in which material to be learned is divided into many small, logically linked sequential segments called *frames*. Each fact or concept to be learned is presented sequentially in frames. Each frame ends with a question which the pupil answers by filling in a blank or selecting the correct answer from several choices. The student reads a fact or concept and is immediately questioned. If the question is correctly answered, the student automatically proceeds to the next frame. If the answer is incorrect, the student will be told the correct answer, or in some forms of programmed instruction, will branch to a review or remedial frame before proceeding further.

Most early programmed instruction was available in printed form, but soon many special teaching machines using film were invented to present the material. Teaching machines were used in the late 1950s and mid-1960s, but never became popular or widely used because of the lack of standards and teaching materials. It was soon discovered that a computer could present programmed instruction frames with greater flexibility. In the early 1960s, programmed-instruction teaching programs were often implemented on computers.

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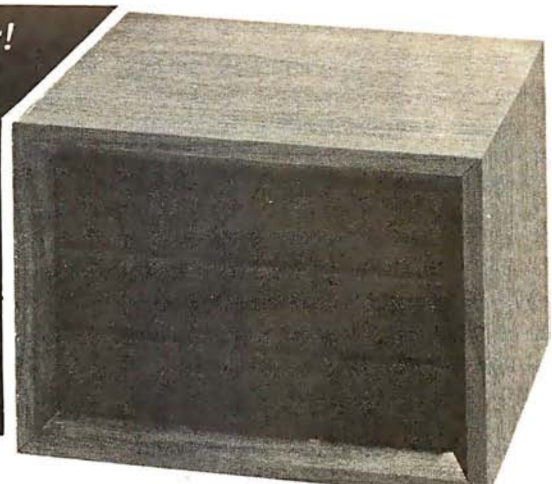

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Thus computer-aided instruction was born.

Many computer-aided instruction research projects were initiated in the 1960s through government funding. Although a lot was learned about CAI, it was still considered an impractical way to teach. The size and cost of computers in the 1960s were such that few institutions or companies could afford them. Two computer companies, IBM and RCA, did an extensive amount of work in an attempt to produce commercially viable computer-aided instruction systems. Many people predicted that this would revolutionize education. Others felt that this was *the* major breakthrough in learning that everyone was waiting for. But the cost was still far beyond what most schools and companies could afford. Therefore, computer-aided instruction was not widely used, and interest waned.

In the mid and late 1960s, minicomputers inspired a spurt of interest in CAI. The technique became more practical with the lower cost of computers. While CAI techniques were more widely implemented, they still did not become a significant teaching technique. Computer-aided instruction was not living up to its reputation and again fell into a state of limbo.

However, during the late 1960s and early 1970s, a major project called PLATO was developed. Sponsored by Control Data Corporation, funded by the National Science Foundation, and developed at the University of Illinois, PLATO is a CAI system implemented on a very large timesharing computer. Special terminals with touch-sensitive video screens and superior graphics capability are used to communicate with the computer. A considerable amount of courseware has been developed for PLATO, and today it is probably the most successful CAI project in existence. Less well-known but just as effective is Mitre Corporation's TICCIT system using a Data General minicomputer and a color television set. TICCIT was developed during the same period as PLATO.

The newest surge of interest in CAI was sparked in 1975 by the introduction of low-cost microcomputers. The same rhetoric about CAI being the ultimate teaching technique is again being heard. The question remains whether microcomputers will indeed make CAI practical and more widely used than ever. A partial answer is yes. Because microcomputers are small and relatively inexpensive, their use will expand. However, there is some doubt among educators whether CAI will ever become the ultimate teaching method. It is certainly not the panacea everyone expected.

Pros and Cons

Computer-aided instruction has many advantages and disadvantages that tend to offset or cancel one another, thus making CAI the enigma that it is. Let's take an in-depth look at the good and bad points.

First, the bad news. Why is computer-aided instruction not more widely used? The answer to this question lies in several key—but not so obvious—points. First, while it has proven to be an effective teaching technique, it has never demonstrated any superiority over other teaching techniques. Computer-aided instruction is essentially self-instruction with a computer, using materials prepared for the purpose. While individuals do indeed learn from computer-aided instruction, they learn just as well from other techniques (ie: reading books, attending lectures, watching television, participating in lab experiments, etc). As a result, computer-aided instruction is no better or worse than any other teaching techniques. Its main value is as an effective technique for individual rather than group instruction. With this approach, students can learn at their own pace and convenience.

Second, most computer-aided instruction is an extremely expensive and inefficient form of programmed instruction. Programmed instruction can be presented in a very low-cost, printed-book format. On the other hand, CAI still requires an expensive computer. It seems almost ridiculous to resort to a computer for the presentation of programmed instruction material when the material to be learned can be printed at a significantly lower cost. Even when low-cost microcomputers are used, it is inefficient to present material on a \$500 to \$1000 machine when a low-cost book can be used to present the same material with the learning outcome being equal.

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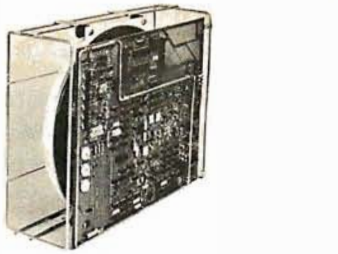

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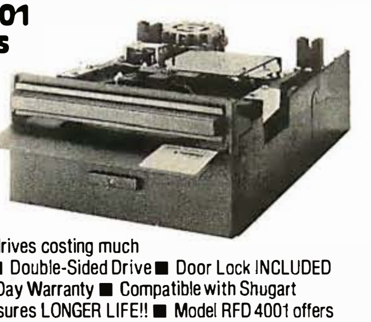

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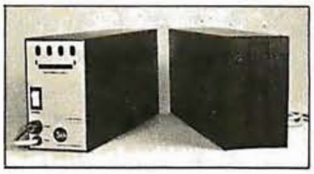

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computer itself, the programmed-instruction material to be learned must also be converted into a format suitable for presentation on the computer. This means that some programming is involved. Some special programming languages have been developed to write and present CAI (IBM's Coursewriter, Digital Equipment Corporation's DECAL, etc). With microcomputers, the BASIC and PILOT languages are widely used for this purpose. Because of the time and effort required to convert the programmed-instruction material into a computer program, the cost of preparing CAI rises considerably.

Computer-aided instruction may be the *least* efficient form of learning in terms of development time and cost. Many other techniques are just as effective and significantly lower in cost. The common textbook is the lowest cost and most efficient form of presenting material to be learned. Audio tutorial material (cassette tapes), printed visuals, and workbooks are also effective yet very inexpensive. Audio/visual materials presented by slides, filmstrips, and audio cassettes are far less expensive. Video material produced for video cassettes or disks is expensive to develop and is probably equivalent in cost to CAI. With video materials, development costs are high and relatively expensive video-tape players are required to present the material. The situation is not unlike computer-aided instruction. However, the video format offers a tremendous advantage over material presented on a computer. Computer presentation is limited primarily to text and simple graphical information. In video productions, virtually any form of presentation can be made. Certainly video with its color, sound, and variety offers improved presentation of material and better learning. Video materials are more effective at the same cost as computer-aided instruction. The new random-access video disk gives video the same interactive and feedback capability as a computer.

A third reason why computer-aided instruction has never become extremely popular is that author sources are severely limited. Producing the "courseware" for a computerized presentation requires a subject-matter specialist who is totally familiar with the material to be presented. This individual must also be familiar with programmed-instruction techniques (ie: breaking the material down into the small frames of logically sequenced information). Finally, the author of the courseware must be able to adapt the material to the computer by programming it in one of the available computer languages. There are very few individuals who have this combination of skills and capabilities. With limited author sources, few good course programs have become available. What computer-aided instruction is available is only fair to poor, and most of it is too simple.

However, this problem is *not* insurmountable. It is relatively easy to take subject-matter experts and teach them concepts of programmed instruction and programming languages. But, this has not been done. One of the greatest needs and opportunities existing today is to develop materials that will teach individuals how to write learning programs.

Another reason for the lack of widespread use of computer-aided instruction techniques is distribution. Most computer-aided instruction programs have been developed by interested individuals for their own specific computers. As a result, standardized materials have never become commercially available.

While a lot of computer-aided instruction has been developed, most of it is very specialized. Also, since most of it is buried in many hundreds of university computers, it is almost impossible to get at. There has never been any serious attempt to collect significant amounts of this material and disseminate it on a large-scale basis. In other words, there has never been a computer-aided instruction publisher as such. It appears practical and realistic as a business opportunity, yet locating the sources of courseware and providing that courseware in a wide variety of computer formats makes the task difficult.

Compounding the situation is the lack of standards. A program developed on one computer typically cannot run on another. Because of the wide differences in computer hardware, software, and peripherals, programs for instructional use cannot be easily transported from one machine to another. Some attempt to develop

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standard programming languages and input/output (I/O) formats would help overcome this problem.

The closest anyone has come to providing computer-aided instruction on any large-scale basis is CONDUIT. CONDUIT is a nonprofit educational organization whose job it is to accumulate CAI information and distribute it to interested individuals and educational institutions. It has established standards for presenting the material. Virtually all materials available through CONDUIT have been written in BASIC or FORTRAN. Because these languages are generally the same on a wide variety of computers, some measure of transportability is attained. CONDUIT makes available printed listings as well as computer tapes and disks for selected widely-used machines. CONDUIT also publishes a magazine called *Pipeline* and a variety of helpful CAI books. Despite this significant effort, distribution is still not large. Prices are high and CONDUIT is basically unknown. Most of the programs are on high-level esoteric subjects and are generally too large to be accommodated by the average microcomputer. Most materials have been designed for minicomputers and large-scale time-sharing and batch processing machines which are widely used in educational institutions. CONDUIT has recently established a program to collect and disseminate CAI for microcomputers. So some progress is being made. (Readers interested in *Pipeline* may contact CONDUIT, POB 338, Iowa City IA 52240.)

The single greatest reason why computer-aided instruction has not succeeded in schools or in the home is the lack of "canned" or prepared courseware. The computer manufacturers do not supply it nor are there publishers for developing, accumulating, and disseminating such material. [*Atari and Texas Instruments, among others, have begun to distribute educational programs. . . .***ed**] As a result, most computer-aided instruction is created by instructors for use in their own classrooms. Needless to say, few instructors have the desire or capability to do this. Computers would become much more widely used if standard computer-aided instruction programs were available. Teachers and individuals could then justify the purchase of computers, just as they can justify the purchase of a slide projector or video-tape player.

There have been only limited attempts to develop microcomputer courseware. Some manufacturers do offer a few computer-aided instruction programs. Most notable are Radio Shack, Apple, and Commodore. It is doubtful that the computer manufacturers will ever become major courseware suppliers.

There is one positive trend which could help the CAI cause. A number of software houses are beginning to produce a variety of application programs for microcomputers. Perhaps some of them will discover CAI.

Now the good news. Computer-aided instruction is obviously not the world's final answer to education. It has problems and disadvantages. But these can be overcome. It also has some very positive qualities. For example, computer-aided instruction is a very popular and visible topic. People are highly interested in it. It is a proven self-instruction technique. Computer-aided instruction is also

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one more thing you can do with a computer. People like and want computers. Therefore, they support CAI as yet another useful computer application, among many. Even though there are better and more efficient ways to learn, computer-aided instruction will survive because it is an interesting, exciting, and valid use of a computer. When the personal computer is purchased and used for a broad spectrum of practical purposes, computer-aided instruction fits in as one of these purposes. The marginal cost of adding computer-aided instruction capabilities to the software libraries of a small computer will be quite low.

Learning by computer is fun. You do not have to read a large, imposing book nor do you really have to study. In fact, most people find it hard to associate "study" with computer learning. Most computer-aided instruction is interactive and fast-paced. The computer presents material, you learn it; the computer tests you, you respond; moreover, the computer provides immediate feedback. You become part of the learning process. In simulations, you are in full control and are totally involved with the action. It is hard *not* to learn. Even though computer-aided instruction may not help you to learn any faster or better or allow you to retain your learning longer, it is certainly just as good as other methods and often a lot more entertaining.

The best way to sum this up is to say that there is a "mystique" to computer-aided instruction that makes it popular. It just seems like a good and logical thing. As long as there are computers, there will be an interest in computer-aided instruction. Computers will not replace teachers, but will provide teachers with another tool to supplement and enhance education.

Conclusions

- Computer-aided instruction is a viable and effective technique for self-instruction in the home, industry, or schools. It is more costly and no more effective than printed programmed instruction, audio/visual, video, or other self-instruction techniques. But CAI works, it is fun, and more interesting than other teaching methods.
- Many professionals, hobbyists, teachers, and industry/government trainers are interested but lack the difficult and costly courseware development skills.
- Computer-aided instruction is not more widely used because there is little or no "canned" or commercially available courseware; nor are there any standards in languages, formats, and media.
- Low-cost microcomputers may make CAI potentially more practical.
- There are business opportunities for publishers, computer manufacturers, and software houses that accumulate and develop computer-aided instruction systems.

Glossary

CAI: Computer-aided (assisted or administered) instruction, sometimes referred to as computer-aided learning (CAL). A process of teaching by computer. A technique for individualizing instruction. Also called computer-based learning or instruction (CBL or CBI).

Courseware: A combination of the terms course and software. Courseware is the material to be learned written with a computer language to form a program or a special piece of application software.

PI: Programmed instruction. A technique for presenting material to be learned in short sequential segments called frames. Each frame presents a fact or concept to be learned, then ends by testing the learner with a question. PI can be printed or put into other media. Most CAI is essentially PI on a computer.

Linear PI: The most common form of programmed instruction. The material to be learned is divided into many short frames of information which are presented sequentially. Each frame tests the student on the facts or concepts presented by requiring them to write in the correct answer before proceeding to the next frame.

Branching PI: A sophisticated form of programmed instruction in which the information to be learned is presented in a sequence of frames similar to linear PI. However, in

…g, a multiple-choice question …ed; the student chooses the …ct answer. If the correct answer is selected, the program branches to the next frame, where the correct answer is verified and more information is presented. If an incorrect answer is chosen, the program branches to a frame where the student is informed of his or her incorrect choice and given remedial information before being sent back to the original frame.

PILOT: An interactive, conversational programming language developed at the University of California, San Francisco by Dr John Starkweather. PILOT was designed as a CAI author language to simplify courseware development. PILOT is usually implemented as an interpreter and is available for many microcomputers. PILOT is faster and easier to learn and use than BASIC.

Types of CAI

Testing: Perhaps the first use of a computer in education. Computers are ideal test givers, particularly for true or false, multiple-choice, and matching tests. The computer presents the question and the student responds. The computer determines whether a correct answer is given. A record of the number of correct and incorrect answers is kept, and a score or grade is computed and displayed. Other functions include student feedback on individual test items and examination evaluation to determine which questions are most often missed. A good application for microcomputers.

Drill and Practice: The most widely used type of computer-aided instruction, the presentation of practice problems and exercises to reinforce learning gained from another source. In addition to keeping track of right and wrong answers, the computer can provide useful student feedback and remedial information. An ideal use of microcomputers.

Tutorial: Second most widely used form of computer-aided instruction. This is individual instruction via a computer. Tutorial CAI is essentially programmed instruction implemented on a computer. The computer presents the material to be learned in sequential frames. Either the linear or branching modes of programmed instruction can be used. Most computer-aided instruction for microcomputers is of this type.

Dialog: The least used form of computer-aided instruction. This is a sophisticated form of teaching where the computer and the student carry on a conversation. The interaction between student and computer leads to the learning or understanding of a subject. The student may ask unstructured questions or provide data to the computer. The computer answers the questions and supplies additional data, practice problems, and the like. Dialog computer-aided instruction is complex and difficult to write. It requires a huge data-storage facility. Impractical for microcomputers.

Simulation: A mode of learning in which the computer imitates a real situation or environment. The computer is programmed to act like some physical or social system. In most applications, mathematical equations describing the system are written, then solved on the computer. Simulations allow the student to test various input conditions and make changes in various parameters to see the outcome. Simulation is widely used in science and engineering for design, and in business for constructing models to predict profitability or make decisions based on dissimilar economic conditions. Many computer games are simulations. (For example, the popular game Hammurabi is the simulation of a small country.) Difficult to develop, but great potential for microcomputers.■

Product Note: CAI for LSI-11 Systems.

Readers interested in a general-purpose multi-user interactive operating system for computer-aided instruction courseware development on the Digital Equipment Corporation PDP-11/03 or Heath H11A computer systems should contact Advanced Interactive Systems Inc about their AVID system. Write to Advanced Interactive Systems Inc, POB 7, Dresher PA 19025.

Computer Illiteracy—A National Crisis and a Solution for It

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The Problem

Computing plays such a crucial role in everyday life and in the technological future of this nation that the general public's ignorance of the subject constitutes a national crisis.

The ability to use computers is as basic and necessary to a person's formal education as reading, writing, and arithmetic. As jobs become increasingly oriented toward the use of information, society demands and rewards individuals who know how to use information systems. The American computer industry, which leads the world today, depends for its future upon a mass market of computer-literate workers and consumers.

Yet, despite computing's critical importance today, the overwhelming majority of this country's general public is woefully ill-prepared to live and work in the Age of Information, as some have called it. How many high-school graduates have taken a hands-on course in computer use? How many teachers are prepared to teach such a course? How many company presidents can operate their own computer departments? Yet, they could probably do a respectable job with most other departments. How many legislators can interact with a computer-based information-retrieval system? How many office workers are ready for office automation—or even know what they want from office automation? How many consumers are ready for general-purpose home computers that they can program themselves?

The answer to all these questions is the same: very few such people exist today.

Why is this true? Vocational incentives are powerful enough. People with programming skills command jobs with far higher salaries than are average for people with similar education; and word-processing specialists earn more than clerk-typists. Corporate profitability incentives are equally strong, because the success of businesses depends as much on the creative use of information as upon the efficient use of material and energy resources. Personal incentives are also great. The children and adults I see learning to use computers display an unusual intensity of concentration and an evident satisfaction with their results.

Clearly, it takes more than incentive to cause things to happen. There must also be a mechanism—an educational mechanism, in this case—if our society is to emerge from our preliterate state of computer ignorance. *The present educational mechanism is grossly inadequate to the task—a situation that must change and change quickly.*

Two kinds of computer education are needed. First, all future students should acquire basic skills in computer use, including hands-on operation, programming, and problem solving, during their early secondary-school years. They should also make further use of these skills in other courses in mathematics, science, language, etc, and in vocationally oriented courses in word processing, accounting, and the like.

The need for a second kind of computer education is dictated by the fact that most of us have finished our formal education. School-based programs will take care of future needs, but today's adults have pressing incentives to develop their own computer skills. How can that be done?

Obstacles to Computer Education

While computer *awareness* can be arrived at by means of books, lectures, films, and television shows, computer *literacy* can be reached only by practice. Therefore, if schools are to provide students with basic computer literacy, they must give each student many "laboratory hours" at the keyboard of an interactive computer system. While surveys show that most secondary schools have some sort of computer, nevertheless, the average student probably spends less than an hour at a computer keyboard during all of his or her precollege years. *With a very few exceptions, therefore, it is fair to say that computer literacy is not now a part of the curriculum.*

To provide computer literacy, four specific needs have to be met:

- adequate and appropriate equipment in every secondary school
- an available, usable curriculum with materials for students and teachers
- one or more teachers in each school trained in teaching computer use
- community, political, and financial support for such school-based programs

Each of these needs can be satisfied rather easily; that should be grounds for optimism. Nevertheless, each need is currently faced with a significant obstacle.

The inexpensive microcomputer, more than any other event, has made school-based computer education a possibility. The development of small time-sharing systems about ten years ago brought hardware costs per student terminal down to about $10,000 —a major breakthrough, but still far too costly for most schools. Worse yet, time-sharing systems lack robustness against hardware failure:

Text continued on page 101

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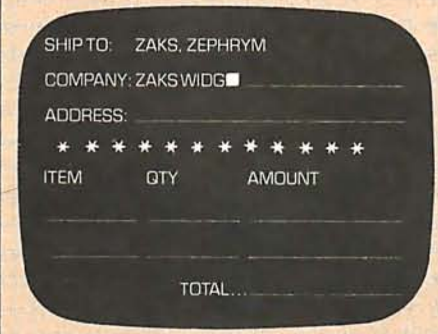
With Microsoft's compiled languages you get a complete program development system, including our standard MACRO-80 Assembler and LINK-80 Linking Loader. Your compiled programs are relocatable modules that can be linked to each other or to Z80 assembly language subroutines.

COBOL-80 Compiler

Microsoft's COBOL-80 is an ANSI-74 standard COBOL that supports such advanced data manipulation verbs as COMPUTE, INSPECT, STRING, UNSTRING, and SEARCH. Plus three-dimension arrays, full COPY facility, compound and abbreviated conditions, and an optional packed decimal format that saves on mass storage by as much as 40%. In addition to Sequential and Relative files, COBOL provides Indexed files, allowing records to be retrieved with a user-specified key instead of a record number.

Interactive Screen Handling Most business applications require machine interaction, formatted screen displays, and the ability to insert and delete information as the machine prompts the user. The COBOL ACCEPT/ DISPLAY verbs are implemented for this purpose—to DISPLAY formatted screens and ACCEPT operator input.

CHAIN and Segmentation Ideal for menu-driven application programs is COBOL-80's CHAIN feature. With



COBOL-80 formatted screen display

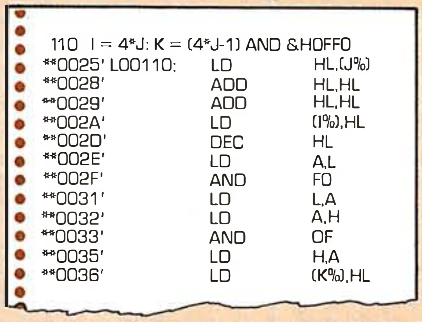
CHAIN, control is transferred from the menu program to any executable module as specified at runtime. COBOL-80 also supports Segmentation to make maximum use of memory when large programs are executing.

BASIC Compiler

The Microsoft BASIC Compiler has the fastest execution times of any BASIC available. It is language compatible with the Model II's interpreter so you can write and test your programs using the interpreter, then compile them for secure storage and efficient execution.

New BASIC Features In addition to those language features provided with the interpreter, the BASIC compiler supports all the latest features of Microsoft BASIC 5.1: WHILE conditional statement, CALL, long variable names, and ANSI compatibility. Plus the compiler has double precision transcendental functions (SIN, COS, TAN, ATN, LOG, EXP, SQR).

Secure Besides being an indispensable system software tool for developing your own utilities and application programs, the BASIC compiler is ideal for producing programs for resale. The machine code for any application program may be placed on a diskette, ROM, or other media, but the BASIC source program need not be distributed. Thus the original application program is protected from unauthorized alteration.



```
110  I = 4*J: K = (4*J-1) AND &HOFF0
**0025' L00110:   LD     HL,(J%)
**0028'           ADD    HL,HL
**0029'           ADD    HL,HL
**002A'           LD     (I%),HL
**002D'           DEC    HL
**002E'           LD     A,L
**002F'           AND    F0
**0031'           LD     L,A
**0032'           LD     A,H
**0033'           AND    0F
**0035'           LD     H,A
**0036'           LD     (K%),HL
```

BASIC compiler object code listing

Optimized Machine Code Compiled BASIC programs are fast and compact due to extensive optimizations performed during compilation: **1.** Expressions are reordered to minimize temporary storage and eliminate common subexpressions **2.** Constants are folded wherever possible **3.** Peephole optimizations are performed **4.** The code generator is template-driven, allowing optimal sequences to be generated for the most commonly used operations **5.** String operations and garbage collection are extremely fast

Get Microsoft BASIC Compiler or Microsoft COBOL-80 and get serious with your Model II. After all, who's running this show?

Prices for COBOL-80 and BASIC Compiler include the MACRO-80 Assembler and LINK-80 Linking Loader and all documentation. Documentation purchased separately, $20.

COBOL-80	$750.
BASIC Compiler	$395.

For TRS-80 Model I software, contact Microsoft Consumer Products.

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iCOM 3712	1.4	170/25 v*
ICOM 3812	1.4	170/25 *
Mits 3202/Altair 8800	1.4	145/25
Heath H8 + H17	1.4	145/25 Ⓜ
Heath H89	1.4	145/25 Ⓜ
Heath H89 by Magnolia	1.4	250/25◊
TRS-80 Model I	1.4	145/25 Ⓜ
TRS-80 Model II	2.x	170/25
TRS-80 Model II + Corvus	2.x	250/25
Processor Technology Helios II	1.4	145/25
Cromemco System 3	1.4	145/25
Intel MDS Single Density	1.4	145/25
Intel MDS Single Density	2.x	170/25
Micropolis Mod I	1.4	145/25 v
Micropolis Mod II	1.4	145/25 v

The following configurations are scheduled for release soon:

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Apple II	2.x	350/25◊
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Ohio Scientific C3-C	2.x	250/25
Micropolis Mod II	2.x	200/25
Mostek MDX STD Bus System	2.x	350/25 **
iCOM 3812	2.x	225/25 *
ICOM 4511/Pertec D3000	2.x	375/25 * +
Durango F-85	2.x	170/25

*Software consists of the operating system, text editor, assembler, debugger and other utilities for file management and system maintenance. Complete set of Digital Research's documentation and additional implementation notes included. Systems marked * and ** include firmware on 2708 and 2716. Systems marked + include 5440 media charge. Systems marked Ⓜ require the special Ⓜ versions of software in this catalog. Systems marked v have minor variants available to suit console interface of system. Call or write for full list of options. ◊ includes hardware additions to allow our standard versions of software to run under it.*

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Text continued from page 98:

97% uptime is achievable and sounds good, but it means that there is no computer one day per month, and no computer class. The new personal computers have brought the cost down to from $1000 to $2000 and have increased robustness dramatically: 97% uptime for personal computers means that out of a collection of ten machines, nine are working all the time and all ten are working most of the time. Class goes on.

On the other hand, the use and administration of a collection of separate personal computers is often extremely difficult. Since personal computers are not linked to a shared-file system, it falls to the teacher to make duplicate cassettes or floppy disks for each machine, to shelve the copies, to retrieve them, to check them out, to check them in, and to periodically revise all copies when a program change is made. Furthermore, loading a program from a cassette is both time-consuming and unreliable. We have found in our Lawrence Hall of Science computer classes that it takes 5 to 10 minutes to succeed in loading ten program tapes into ten computers.

Adding floppy-disk drives cuts the loading time down, but only at great monetary cost. Furthermore, it does nothing to alleviate any of the problems of maintaining a library of hundreds of floppy disks.

Although there have been a few steps in the right direction, some good enough right now for school use, the industry has not yet solved the relatively simple problem of combining a set of microcomputers with a large, centralized, tree-structured file system of the sort found on any decent time-sharing system. That is what schools need, and probably many businesses, also.

The lack of curriculum is another major obstacle to computer education. We simply cannot expect 25 to 50 thousand school teachers to invent curricula and prepare materials for students to use. The fact that anyone is teaching computing today is powerful testimony to their commitment and to the interest computing seems to generate among teachers.

The traditional secondary-school book publishers have nothing to offer schools; instead, they resort to peddling books designed for the college market or the hobbyist market—usually programming manuals full of syntax rules and definitions but with little relevant problem-solving semantics. Specific new materials are needed for the schools.

Another obstacle is the lack of trained teachers and educational opportunities to learn to teach computing. I know of only a few schools of education that offer content courses appropriate for a future computer teacher, and they are usually pre-service courses for new teachers. In this job market, what is needed is in-service training for existing teachers who are in the process of becoming computer teachers.

The lack of such a program in schools of education is difficult to explain, especially in these times. It represents just about the only economically viable possibility for an in-service program. The teachers I know would willingly pay for a good program, even if they are at the top of the ladder in their current field.

The last significant obstacle to school-based computer education is the lack of public clamor for such a program. Evidently, if the school is to teach computing, members of the community must foot the bill. Parents who see computer education as little more than game playing are bound to treat it as a frill and give it a lower priority than what they perceive as "the basics." They need to understand that computer problem solving is itself a basic intellectual skill with academic and vocational payoffs.

My recent experience in consulting with schools in several districts in California has given me grounds for optimism about the state of community awareness and concern. I find, for example, many parents whose work involves computer use and who speak convincingly about the need for school-based programs. Other parents are simply impressed that their children are visibly excited by the computer class at school. Although concerned about rising costs and the general quality of education, they seem to recognize that computer education needs to be evaluated on its merits.

Who Will Take the Necessary Steps?

There is a role for everyone: the computer industry, textbook publishers, universities, teachers, parents, and government agencies.

The computer industry has to recognize that there is a billion-dollar market for computer equipment in secondary schools (26,000 schools, times fifteen computers per school, times $2500 per computer). After that soaks in, they have to design and produce an appropriate computer *system* for school use, along the lines suggested earlier: microcomputers connected in a network to a hard disk and printer, plus a tree-structured file system with account security and cross-account access.

The textbook publishers need to support—perhaps in combination with computer manufacturers—one or two substantial curriculum-development projects aimed at producing materials that concern not just the syntax rules of a programming language, but which also focus on general problem-solving applications. I used to think that this was too big a job for the private sector, but the potential $50 million annual sales volume changed my mind (26,000 schools, times 300 students per year, times $6 per student manual). A proper job of writing, evaluating, rewriting, field trials, and more rewriting would cost a few million dollars, perhaps, but that can be easily recovered in short order.

University schools of education need to gear up to handle both pre-service and in-service training needs of future schoolteachers of computer classes.

Teachers with an active or latent interest in computing need to inform themselves of career opportunities in this emerging field, find out what other teachers are doing, and put pressure on the schools of education to satisfy their training needs.

Parents need to know why Johnny and Janey should learn to compute as well as read and write. Then they need to develop community support for programs in their junior high schools and high schools.

Finally, government agencies have to keep a close watch on the way computer education develops and evolves in the schools, and possibly to intervene at critical points. In particular, if the private sector is unwilling to risk investment in curriculum, or if certain communities cannot afford to pay for equipment, the federal government should help to do so, for compelling reasons. Possession of basic computer skills is a distinct vocational and intellectual advantage to the possessor. Declining prices of personal computers put them within easy reach of people who now have the advantages of above-average income and the education to recognize the benefits of knowing about computers. The disadvantaged will be *left* behind. It is an entirely appropriate use of federal funds to provide broad social access to new and powerful skills.

What About the Adults?

It is probably true that most of the people who need to know about computers and their uses during the next five to ten years are already in the work force. They are, quite frankly, at the mercy of the "U S system of continuing education"—which is no system at all. Among their options are going back to school, evening classes at a community college or university, extension courses, technical training institutes, topical professional seminars, and self-study.

My standing advice to persons faced with such alternatives is to first enroll in a course that will teach them to write computer programs,and to run and debug them by means of hands-on use of an interactive computer system. Such a course should offer both formal instruction and at least ten hours of computer use by the individual. (Beware of lecture and reading courses alone, as well as those using punch-card equipment.)

Such a course should cost less than a hundred dollars and will determine pretty clearly what the next step should be. If the experience has been a good one, then the person may want to take more advanced courses, or to look for specific career-oriented programs in the computer field, or to buy a personal computer and study on his or her own.

Summary

As a nation we depend more and more on computer technology, on computer applications, and on the success of our computer industry. However, we are also a nation of computer illiterates. The means exist to set in motion education programs that will change the situation.

All we have to do is decide to do it. ■

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The MAGIC WAND™ is the most powerful, most flexible, most reliable, *most usable* word processing software available for a CP/M®-based computer.

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Book Reviews

Introduction to Microprocessor System Design

by Harry Garland
McGraw-Hill Book Company, 1979
Textbook, $10.95

One of the most important pieces of hardware in any microprocessor system is an intelligent human user. This book, by one of the country's leading small-systems manufacturers, assumes that the reader has a supportive background in both hardware and software. If basic logic circuits and the binary number system are familiar topics to you, *Introduction to Microprocessor System Design* is the next logical step into the world of small systems. Despite its textbook format, nowhere does the author leave the discovery of an important concept as "an exercise for the student."

The book is very logical and precise in its layout. It differs from the popular "cookbooks" in that it deals with a wide variety of microprocessor integrated circuits, devoting the whole introductory chapter to a discussion of their similarities and common principles. The following chapters discuss the relative advantages and shortfalls of the various technologies used in implementing microprocessors. The speed-versus-power trade-offs of saturated-bipolar and complementary metal-oxide semiconductor (CMOS) technology are covered, as well as design considerations for N- and P-channel MOS, emitter-coupled logic (ECL) and Schottky bipolar technologies. The short summary at the conclusion of each chapter should help any design engineer select the proper integrated-circuit technology for a particular application, whether it is for industry or for a hobby.

Throughout the book, the author stresses the need for any designer to understand not only the hardware behind the system he is working on, but also the software that will be required. With this in mind, successive chapters explore the evolution of the microprocessor from an architectural standpoint, which necessarily includes the increased power of new software as well as simplified design considerations, such as number of power supplies required and maximum memory-addressing capacity.

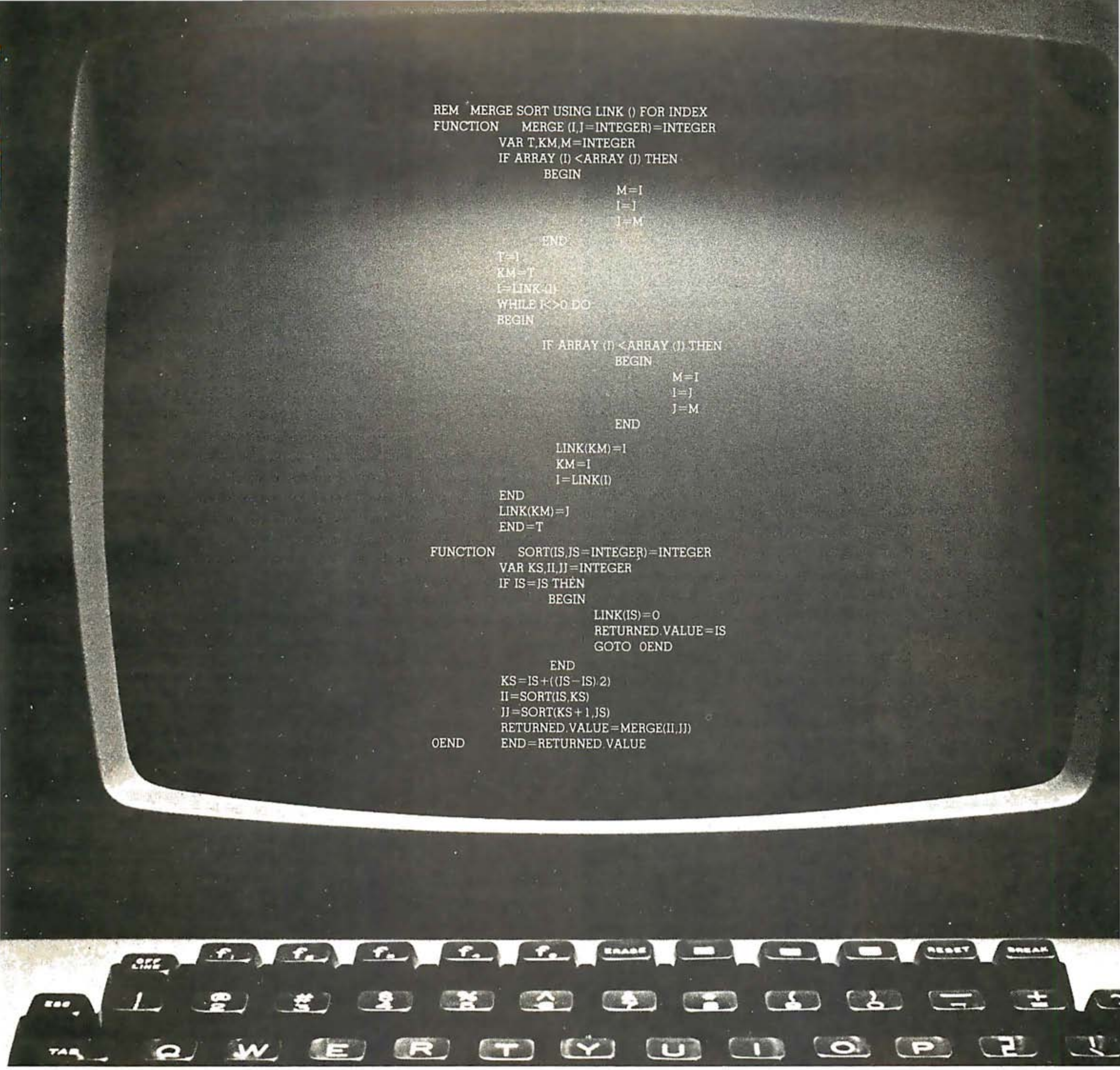
The student is exposed to detailed information on each of the evolutionary steps in microprocessor development (from the 8008 microprocessor through the Z8000) early in the book. This helps to familiarize the student with microprocessors and demonstrates how both hardware and software design have actually become easier despite the increase in complexity. It is here that the reader learns how the increased data processing capacity of the latest generation of 16-bit processors has been accomplished.

Of course, even the latest microprocessor requires support circuitry. Power-supply circuitry, for example, is needed to deliver proper voltages at adequate current levels to both the microprocessor and its associated logic. Power supplies, clock circuitry, external memory, various signal buffers, and additional logic are covered in detailed circuit diagrams. Specific components are labeled, so that by the end of Chapter 4 the reader can construct his own microcomputer.

Even after this point, however, the reader can continue his studies. Later chapters contain i formation on expanding the basic single-board computer by adding memory and interfacing to peripherals. Important concepts such as synchronized data transfer and the uses of interrupts are covered in detail. Direct-memory-access (DMA) and memory-mapped input/output (I/O) information is presented along with basic and advanced binary arithmetic and assembly and high-level languages.

The final chapters include such topics as interfacing to analog systems and the various bus standards. This last topic emphasizes the flexibility of microprocessor designs and shows how various portions of a single system may be designed by different members of a team, while avoiding the problems of "design by committee."

By following the outline of this text and completing the numerous exercises presented, the reader should be able to pick up information usually found only in college-level courses.



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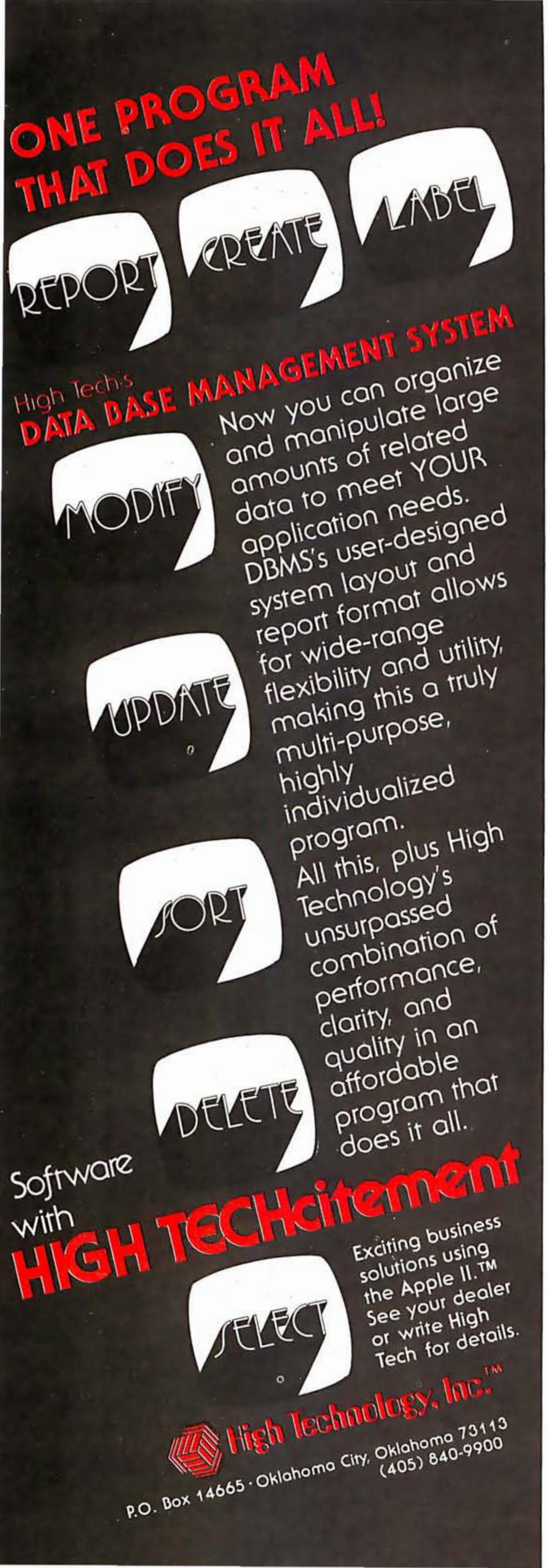

Introduction to Microprocessor System Design will continue to be useful after the first reading, because it makes an excellent reference book.

Curtis P Feigel
Editor

The Nature of Human Consciousness

Robert E Ornstein, Editor
W H Freeman, 1973
Softcover, $8.95

The Nature of Human Consciousness is a book of readings on the workings of the mind. As such, it is valuable for two groups of readers in the computing field: those involved in artificial-intelligence research and development, and those who are trying to design "user-friendly" computer systems. That the book is of interest to the former is probably obvious; it is of interest to the latter group because of the difficulty of designing good user interfaces without knowing how users will perceive sensory inputs and react to them. A working knowledge of how the human information processing system (IPS) functions is a good antidote to batch mentality and to abominations like IBM Job Control Language (JCL).

In *The Nature of Human Consciousness*, Robert Ornstein has drawn together readings from several fields: psychology, medicine, anthropology, and oriental philosophy. The last may seem out of place to those who regard oriental thought as so much mumbo jumbo. It is not. (Since I have a Master of Arts degree in Chinese philosophy, I confess the possibility of prejudice here.) While reading several of the earlier medical studies on brain functions, I was impressed to see that the results of these studies differed from standard Western thought, and that they were compatible with the classical Chinese point of view. Having marked up my copy of the book with comments on this, I was delighted to find that the next section contained a concise summary of the Chinese point of view on the dual nature of the mind. Of course, the book is dominated by current Western studies on the nature of mind and consciousness. The major advantage of reading this collection is that the editor has made an extremely good choice of articles. Unless you are trying to do original research in the area, this book provides a very time-efficient way of getting "on-line."

The main theme of the book seems to be the dual nature of the brain (right-hand and left-hand) and its impact on the way we perceive things. Consideration of these implications would be valuable for anyone working with computer graphics, since the "unknown" right side of the brain is the one that deals more with shapes and forms rather than with words. The various articles in the book might also provide inspiration for those who want to use computers to expand creativity and self-awareness.

In short, this is a good sourcebook for modern theories of human consciousness, useful for anyone who needs to better understand how people think. ■

John A Lehman
716 Hutchins #2
Ann Arbor MI 48103

Text continued from page 10:

proved. This covers skills in elementary mathematics and in the language arts.

An additional review of thirty-two studies in simulation and adaptive testing provides further support for the notion that computer-based education can be an improvement over conventional educational methods. This study (see reference 7) performed by HumRRO for the Office of Technology Assessment is summarized in table 1. The majority of these studies show savings in the learner's time to complete a course of study (as much as 50% savings), greater efficiency in terms of achievement per unit of time, improved skills, and the provision of instruction not previously available by the conventional method. As noted in the review, the studies cut across all levels of education and include training as well.

B. *Because we are moving into an information age, and because computers are becoming ubiquitous in our society, it is essential that we develop a computer-literate society.*

Licklider (reference 8) makes the observation that:

The world is rapidly moving into the information age. In order to make the transition

	Source	Time saved	Cost saved	Greater efficiency	Improved skills	Provision of training not previously available
S	Abernathy and McBride, 1978	+	+	+	+	+
S	Allen, 1976	+	+	+	+	+
T	Bejar et al., 1977	+	0	+	+	+
S	Bentz, 1975	+	–	+	+	+
S	Brown et al., 1977	+	0	+	+	+
S	Brown, 1977	+	0	+	+	+
T	Brown and Weiss, 1977	+	+	+	+	+
S	Buchanan, 1978	+	+	+	+	+
S	Ellis, 1978	+	–	+	–	+
S	Gregory, 1975	+	–	+	+	+
T	Guerra et al, 1977	+	0	+	+	+
T	Hansen et al., 1974	+	+	+	+	+
S	Johnson, 1976	0	0	0	+	+
T	Lippey and Partos, 1976	+	0	+	0	+
T	McLain and Wessels, 1975	+	0	+	+	+
S	Misselt and Call-Himwich, 1978	–	–	–	–	–
S	Mockovak et al., 1974	+	–	+	+	(conventional – superior)
S	Orlansky and String, 1977	+	+	+	+	+
S	Puig, 1976					
	Tanks	0	+	0	0	–
	Aircraft carrier	+	0	+	+	+
	Weapons trainer	+	+	+	+	–
	Air traffic controller	+	0	+	+	–
	Automobile	0	+	+	+	–
	Airborne ECN system	+	+	–	+	–
S	Roberts, 1977	+	+	+	+	+
T	Sealy, 1975	+	0	+	0	+
T	Vale, 1977	+	+	+	+	+
S	Willey, 1975					
	Dartmouth	+	0	+	+	+
	Ohio State	+	–	+	–	+
	University of Wisconsin	0	–	+	+	+
	University of Illinois	+	0	+	+	+
	University of Michigan	+	+	+	+	+
	Totals	+ = 27	13	28	26	25
		– = 1	7	2	3	7
		0 = 4	12	2	3	0

Key: S = simulation
T = testing
+ = positive results
– = no significant difference
0 = no results

SOURCE: Human Resources Research Organization, 1978.

Source: *Computer Technology in Medical Education and Assessment*, page 25.

Table 1: *Summary of the results of thirty-two studies on the effectiveness of computerized simulations and testing in the classroom. The majority of these studies show savings in the learner's time to complete a course of study (as much as 50% savings), greater efficiency in terms of achievement per unit of time, improved skills, and the provision of instruction not previously available by conventional methods.*

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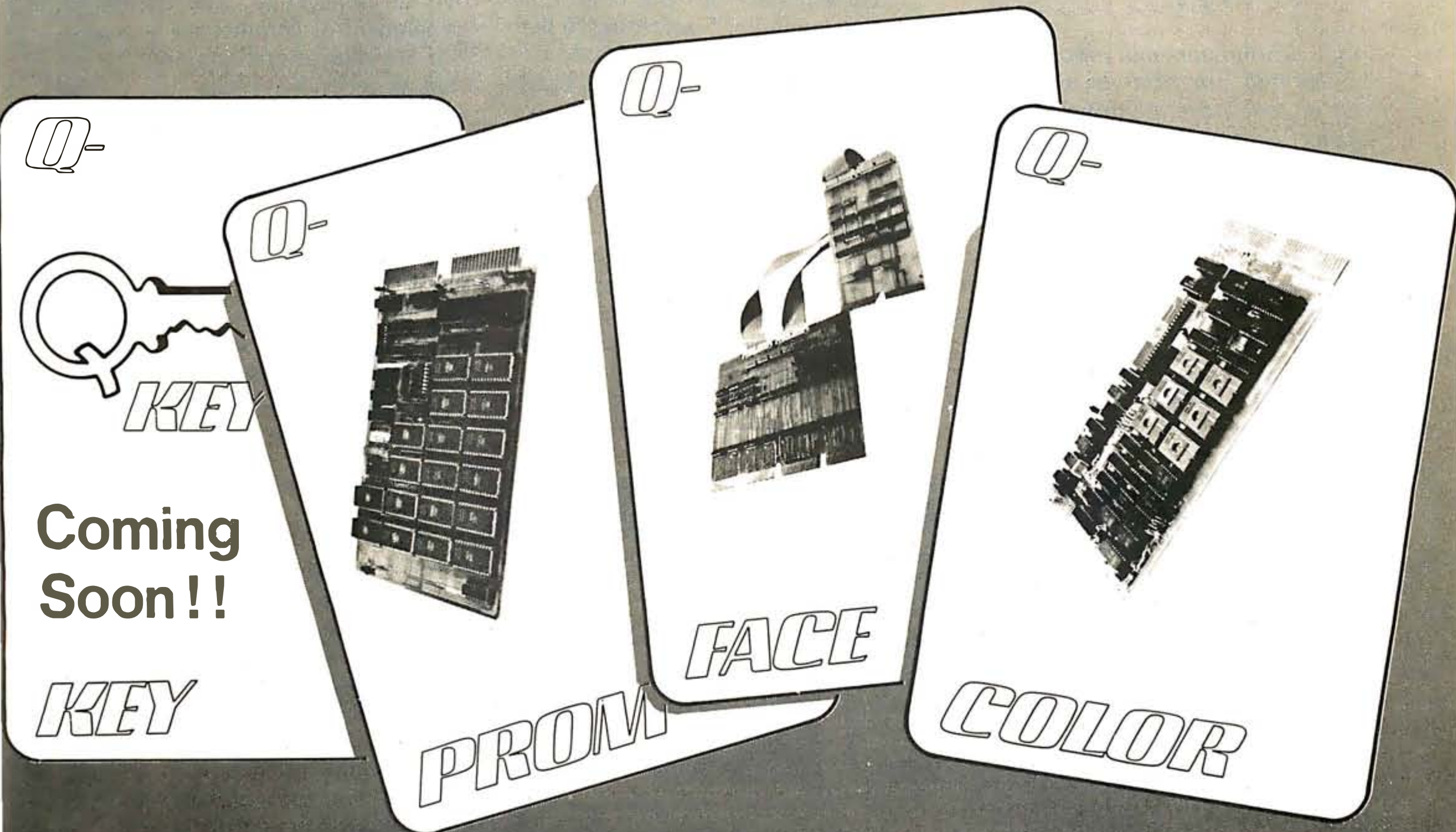

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wisely and well, the public must understand information science and technology. People must master the technology or be mastered by it.

Molnar (reference 9) comments:

A nation concerned with its social needs and economic growth cannot be indifferent to the problems of literacy. If we are to reap the benefits of science-driven industry, we must develop a computer-literate society.

C. *Computers will move into our homes and our schools whether or not anyone does anything to ensure their effective use.*

This contention is underscored in a recent survey (reference 10) by Creative Strategies Inc, a market research firm, which indicates that school purchases of microcomputers will quadruple in the four years between 1978 and 1982. Their projections are that the unit purchases by

Computers will move into our homes and our schools whether or not anyone does anything to ensure their effective use.

schools on a national basis will grow from 26,700 in 1978 to 105,000 in 1982. Secondly, the estimates are that 70% of the demand will originate in elementary and secondary schools. Thirdly, a justification for the use of the microcomputer as opposed to the "maxicomputer" (ie: the large time-sharing computer), according to their survey, is based upon decreased cost and increased ease of use. Control Data Corporation's PLATO system (the major one that is being marketed today as a system in the maxicomputer field for education) costs $10,000 per terminal and roughly an additional $800 a month for usage fees. A typical microcomputer system costs in the range of $500 to $2500, depending on the peripheral devices purchased with it.

It is imperative that computers enter our educational system in an orderly, intelligent manner, in contrast to our experience with television. In its infancy, television offered educators an excellent learning tool. Unfortunately, we did not capitalize on its potential. It was dominated by commercial interests and became the "wasteland" many people decry. Massive efforts by the Public Broadcasting Service (PBS) with series like *Nova*, and the Children's Television Workshop with *Sesame Street*, although excellent demonstrations of the role that television *could* play in education, have little overall impact because of the entrenchment of commercial interests.

If the educational community (including federal agencies and private foundations interested in education) does not move forcefully *and soon* to ensure proper support for teachers and students in making intelligent use of personal computers, computers will become the "wasteland" of the 1980s, being used for playing more and more sophisticated versions of "Star Wars" games, instead of helping our young people to develop their intellects to the fullest extent possible.

D. *There is an inequality of opportunity across the spectrum of our society.*

For a wide variety of reasons, young people from our lower socioeconomic levels currently do not obtain the same benefits from our educational system as do their contemporaries in middle- and higher-income communities. Already schools in the latter category are purchasing personal computers in large numbers (eg: in several Long Island school districts there is at least one personal computer *in each elementary school*), while inner-city schools are unable to find the funds to participate in this "revolution."

Every year that goes by widens the gap in the preparation between the young people in these two groups at social, human, and economic costs which cannot be tolerated in a modern democratic society.

E. *Our present educational system is a mature industry which cannot be improved even with massive infusions of funds.*

The urgency of the need of our


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educational system for help is presented very effectively by Dr Dustin Heuston, Chairman of the World Institute for Computer-Aided Teaching (reference 11). He points out that:

- Our current educational-delivery system is mature—ie: it is insensitive to additional investment. He feels that the system cannot be improved without the dramatic change producible only with new technologies.
- The current educational-delivery system provides about 15 seconds of personal attention per hour. With computers, that proportion can reach almost 100%.
- Dr Heuston describes an interesting analogy which is instructive for all educators: "If this were 1478, the business of foundations and government would be to encourage the introduction of the book into the educational system, not to work with monks in monasteries to improve their manuscript production abilities by funding studies on handwriting legibility, the placement of candles for lighting, or the design of better pens or superior ink."
- After many years of expensive efforts to improve teacher productivity and other aspects of the educational system, the system seems to have achieved its maximum effectiveness.

What Must We Do?

The evidence in favor of placing computers in our schools in massive numbers is already compelling and growing stronger every year. In addition, there is danger that the United States will lose its world leadership in this field. Most of the countries represented at the International Federation for Information Processing (IFIP) Working Conference on Computer-Assisted Learning in September 1979 have a national effort in place to bring computers into their schools (eg: France has a program called "Ten Thousand Computers in the Schools").

Dr Sylvia Charp, of the Philadelphia School System, points out that for at least a decade, visitors have come from many foreign countries, learned about our successes and failures, and have gone home to implement programs of their own. Especially within the past three to five years, these programs have been national in scope and have been funded at significant levels. During this same period, little funding has been available in the United States for such activities, and what has been available has had no focus.

Despite this lack of national commitment, there are a number of active efforts around the United States, including:

- Bob Albrecht (the Dragon and Friend of Children), who is well on his way to turning Menlo Park, California, into Computer Town USA.
- Karen Billings and her Microcomputer Resource Center at Columbia Teachers College, which provides advice and hands-on experience for New York area educators.
- This author and Jo Ann Comito and their Laboratory for Personal Computers in Education, which has been in existence for five years providing advice for educators nationally, and which has developed a graduate program in computers in education as well as a large number of courseware units.
- Sylvia Charp, the "grand lady" of educational computing, who has more experience with the *real* world of computers in education than anyone else in the world.
- Tom Dwyer, who, for over a decade, has been developing novel ways of using computers to provide learning environments for our young people. [*See his article on page 74 of this issue....***CM**]
- Judy Edwards of the Northwest Regional Educational Laboratory in Portland, Oregon, who recently received a federal grant to establish a clearinghouse for microcomputer-based courseware.
- Joyce Hakansson of Children's Television Workshop, who, in conjunction with the Busch Gardens people, is developing neighborhood parks with micro-

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computer halls to make such equipment easily accessible to children.

- Arthur Luehrmann of the Lawrence Hall of Science, who has developed a variety of innovative ways of using microcomputers in a museum setting. [*See his article on page 98 of this issue....*CM]
- The staff of the Minnesota Educational Computing Consortium, which has established a statewide network of microcomputer users and has developed a large library of courseware.
- Seymour Papert (the father of the LOGO language), who is conducting an exciting experiment with a group of children who are in an environment where each child has instant access to a personal computer at home and at school. [*Look for his article in a future issue of BYTE ....*CM]
- Michael Zabinski, who runs a summer overnight camp where children learn about computers.
- Karl Zinn of The Center for Research on Learning and Teaching at the University of Michigan at Ann Arbor, who serves as a source of information, courseware, and advice to school people all over the US.

Although these groups are making important and continuing contributions to the field, and although there is informal communication among these people, there is no national focus and, in toto, inadequate funding to accomplish the tasks that must be carried out to achieve the goal of improving education using the computer.

The essential problem here is that the private sector (ie: publishers and computer manufacturers) is unwilling to commit resources at the level required because the market has not developed sufficiently to ensure profitability in courseware production. Consequently, until courseware is developed in sufficient quantities, school people are unwilling to commit *their* resources to the provision of computing power for their students—thus establishing a "vicious cycle" which will dissipate very slowly unless there is substantial intervention. Because of the magnitude of funding required to develop a market of sufficient size that the private sector will take over, such funds must come from the federal government.

This problem was recognized a decade ago, and efforts have been under way for several years to obtain federal funding to establish one or more national centers for computers in education. The earliest of these arose as a set of recommendations by the Carnegie Commission on Higher Education in 1972 (reference 12), while the most recent is a bill (reference 13) introduced into the House of Representatives by Long Island Congressman Thomas Downey. [*The text of this bill was published in the June 1980 BYTE, beginning on page 186....*RSS]

Such national centers will serve the educational community by:

1. Keeping abreast of developments in information technology.
2. Advising educators about capabilities and limitations of hardware and courseware.
3. Training teachers in the uses of computers in learning environments.
4. Developing large amounts of high-quality courseware and training teachers to develop their own.

A serious look at the amount of effort required to accomplish these purposes at a significant level reveals that the funding levels of these centers must be 1 to 3 million dollars per year.

In the present economic climate, such sums appear to be difficult to obtain. But when we weigh these sums against the cost to individuals and to the nation of lost educational opportunity and inadequate intellectual development of many of our young people, the choice is clear. ■

Acknowledgements

Although this author takes full responsibility for the content of this article, the ideas expressed herein emerged, in part, from a series of discussions during the fall of 1979 with Dr Normal Kurland of the New York State Education Department, Dr Robert Seidel of HumRRO, and Dr Karl Zinn of The Center for Research on Learning and Teaching at the University of Michigan at Ann Arbor. This author gratefully acknowledges their contributions of ideas which helped him to formulate his own.

The author wishes also to acknowledge the assistance of the Alfred P Sloan Foundation, which provided partial support for the development of the ideas expressed here.

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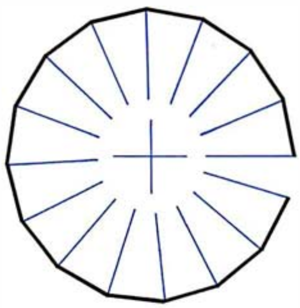
in BASIC

"This is easy . . ."

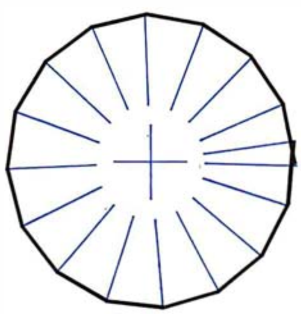
```
100 MOVE R,0
110 FOR T=0 TO 360 STEP 25
120 DRAW R*COS(T), R*SIN(T)
130 NEXT T
```



"Oops, didn't quite meet . . .

. . . but that's easy to fix."

```
100 MOVE R,0
              +25
110 FOR T=0 TO 360 STEP 25
120 DRAW R*COS(T), R*SIN(T)
130 NEXT T
```



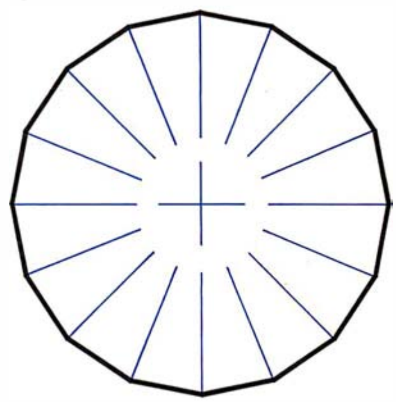
"Oh, now it closes . . .
in fact, it overlaps."

Programming by trial and error

in Pascal

"The simplest circle drawn with line segments is a regular polygon . . ."

```
procedure Circle (X, Y, Radius: real);
const Sides = 16; Pi = 3.14159265;
var    N : integer; Theta : real;
begin
   Move (X+Radius,Y);
   for N : = 1 to Sides do begin
      Theta : = 2 * Pi * (N/Sides);
      Draw (Radius * cos (Theta) + X,
            Radius * sin (Theta) + Y);
      end;
end;
```



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Interactive Control of a Videocassette Recorder with a Personal Computer

Dr Richard C Hallgren
Dept of Biomechanics
Michigan State University
East Lansing MI 48823

The use of computers in education is not a new concept. Many colleges have effective time-sharing systems for use by both students and faculty. However, the recent widespread acceptance of small personal computers has opened up many opportunities for increased use of computers in education. One such use is for computer-aided instruction (CAI).

This article describes the method used to interface a Sony Betamax videocassette recorder, Model SL0-320, to two popular computers, the Radio Shack TRS-80 and the Apple II computer, so that a low-cost, lecture-supplemented, computer-aided instructional system is achieved. The system was originally designed for medical students, but it has a wide range of applications.

Medical colleges make considerable use of videotaped lectures. These allow a student to review material presented at a lecture which the individual was not able to attend, or to review material in preparation for examinations. Often the student does not need to review an entire lecture, but needs to be concerned only with specific segments.

If a computer could be used to control the presentation of videotaped material to a student, perhaps learning could be more efficient.

The Sony SL0-320 videocassette recorder has the capability of selectively searching for and playing specific segments of a videotape through the use of an RM-300 Auto Search control. The operator can enter a number representing a specific location on the tape. The recorder will move the tape to that location and begin playing. This search process uses a timing signal which is placed onto the tape during the recording process. The autosearch function allows students to review or examine material without having to sit through a whole lecture.

As part of any learning experience, it is important that the student know whether he or she has retained facts and understood concepts. This question is usually answered at examination time, often to the dismay of the student. If a computer could be used to control the presentation of videotaped material to a student, perhaps learning could be more efficient.

For example, if a student wants to review the symptoms of the disease hypercalcemia, the computer can not only control the presentation of the material, but after the material has been reviewed, the computer can *ask* the students *questions* related to the material. If the student retains the material and answers the questions correctly, new material can be covered.

However, if the student cannot answer the questions correctly, the videotape is rewound, and the material on the tape is presented again. By doing this, the student gains confidence that he or she is really learning the material.

It is a relatively straightforward

About the Author

Richard C Hallgren is an assistant professor in the Department of Biomechanics at Michigan State. He works on applications of microprocessor-based systems to scientific research. *This project was supported by Independent School District #196, Rosemount, Minnesota.*

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Betamax Connector Pin	Signal	Source/ Destination	BASIC Command	Machine-Language Command
CN1-20	BEGINNING OF TAPE	from Betamax	PEEK(– 16137)	LDA $C0F7
CN1-7	CASSETTE IN	from Betamax	PEEK(– 16133)	LDA $C0FB
CN1-11	REWIND	to Betamax	POKE – 16142,3	LDA #03 STA $C0F2
CN1-8	STOP	to Betamax	POKE – 16142,0	LDA #00 STA $C0F2
CN1-13	PLAY	to Betamax	POKE – 16142,1	LDA #01 STA $C0F2
CN1-12	FAST FORWARD	to Betamax	POKE – 16142,2	LDA #02 STA $C0F2
CN1-15	COUNT	from Betamax	PEEK(– 16141)	LDA $C0F3

Table 1: *Videocassette recorder functions controlled through the Apple II interface of figure 1. The recorder being controlled is the Sony Betamax SL0-320 videocassette recorder; this is done through the pins that connect the recorder to the RM-300 Auto Search control unit. The software commands necessary to activate these functions are given in both BASIC and 6502 machine-language forms.*

task to interface either the Apple II or the TRS-80 to the Betamax SL0-320 recorder. This article will describe both the hardware and software necessary to interface the Apple II computer to the Betamax, followed by the necessary changes to translate this to the TRS-80.

Interface Implementation—Apple II

The Apple II, with its eight peripheral-board connectors, makes the job of designing and implementing interface cards relatively simple. Since these connectors are on the main computer board, any interface cards will be inside the computer, using the computer's power supply.

Figure 1 shows the Betamax to Apple II interface in schematic diagram form. The left side of the schematic shows connections made to the Betamax through the connector normally used for the RM-300 Auto Search control. The right side of the diagram shows the connections made to the Apple II through the interface connector.

It is a relatively straightforward task to interface either the Apple II or the TRS-80 to the Betamax recorder.

Connector pin CN1-20 from the Betamax goes low when the videotape has been completely rewound. Connection CN1-7 from the Betamax goes low when the videotape has been loaded into the player. These two signals are sampled at the beginning of the program to assure that the videocassette starts from a predetermined point. Connection CN1-15 from the Betamax carries the timing signal that has been formatted onto the videotape. This signal is divided by a factor of 60 by IC1 and IC2.

IC3 is an 8-channel data selector which is used to selectively connect signals from CN1-20, CN1-7, or the divided timing signal, to data-bus line seven (D7) in the Apple II. D7 was chosen because its state can be easily

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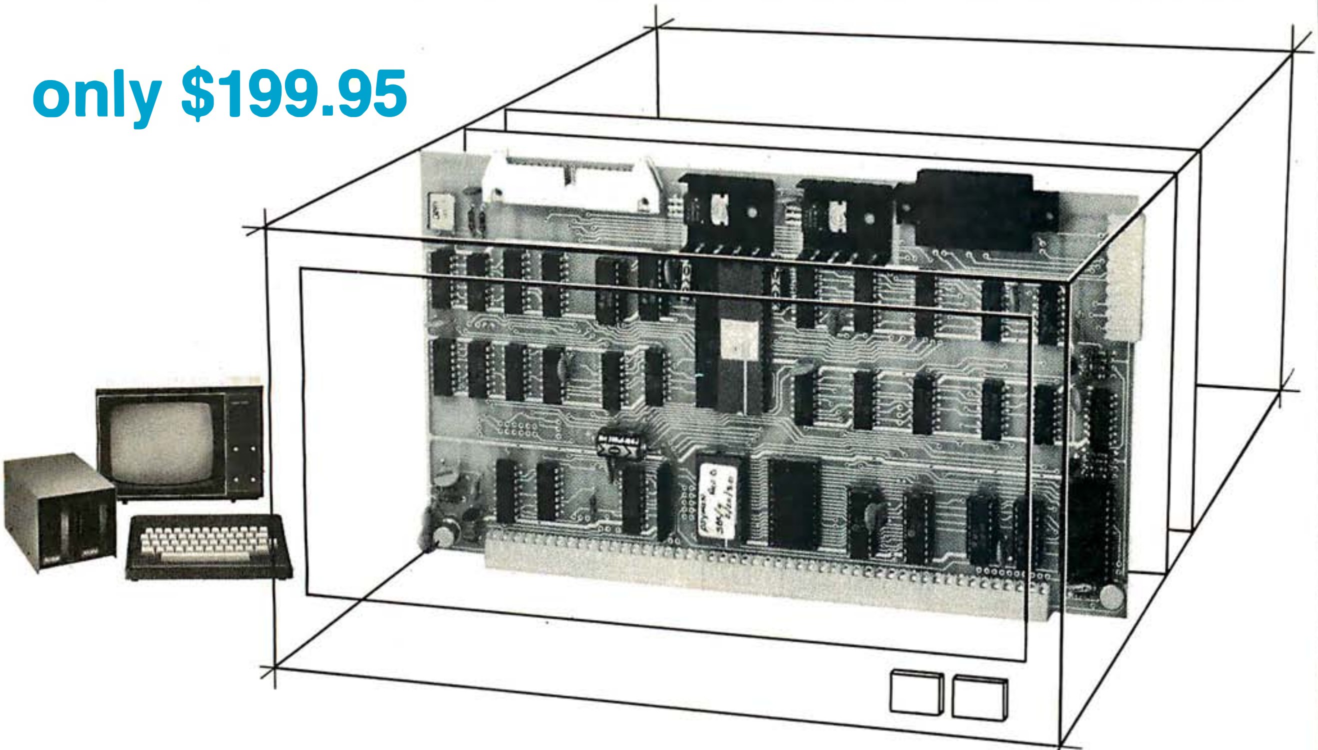

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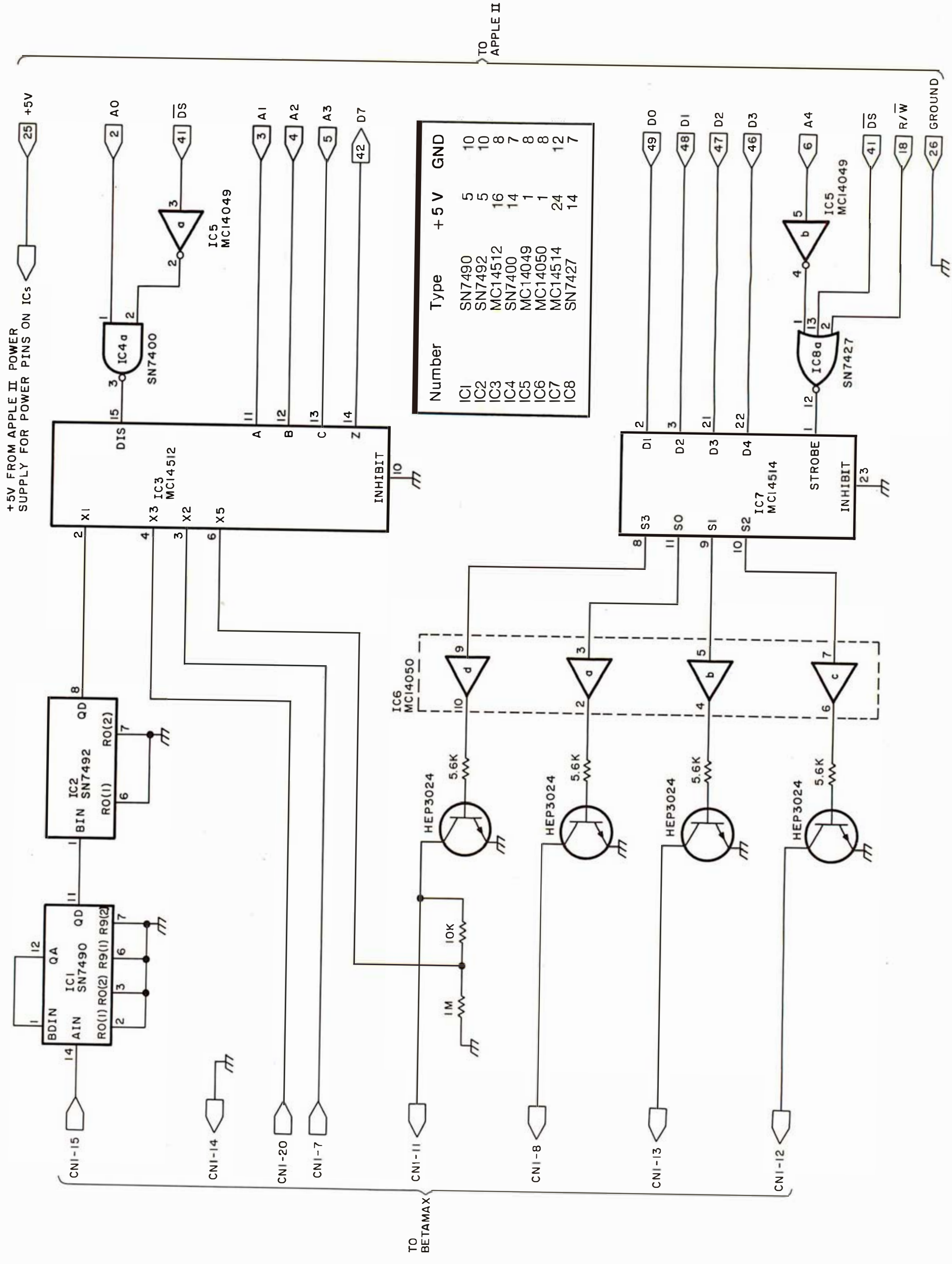

Figure 1: *Schematic diagram of the videotape control interface used to connect the Apple II computer to the Sony Betamax SL0-320 videocassette recorder. Connection to the Betamax unit is made through the RM-300 Auto Search control connector. Connection to the Apple II is made through one of the input/output card slots on the main computer circuit board. Connections to the videocassette machine are shown on the left side of the diagram; connections to the computer are shown on the right side. The* $\overline{DS}$ *line of the Apple II is a device-select line that is active when in a low logic state.*

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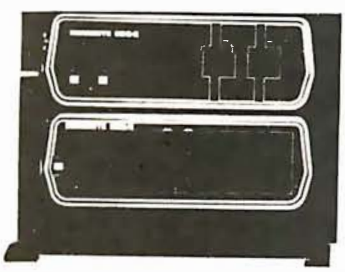

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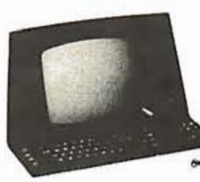

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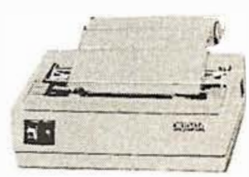

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tested by rotating it left from the accumulator into the carry bit.

Apple has conveniently provided an internal decoding scheme that forces a DS (Device Select, active low) line to go low whenever certain

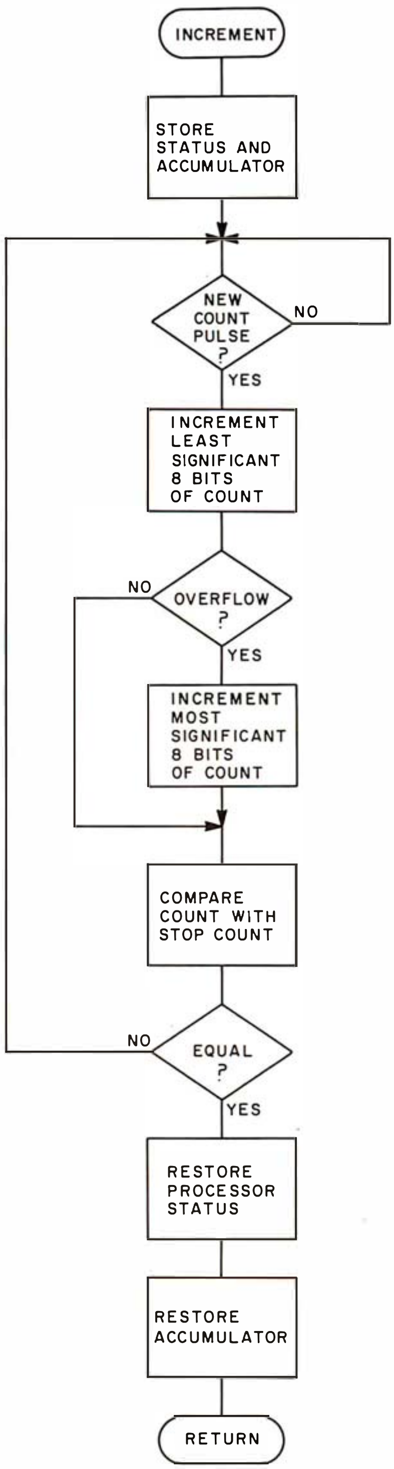

Figure 2: *Flowchart of the increment machine-language subroutine that monitors forward motion of the videotape. See listing 1 for the 6502 code; see listing 4 for the Z80 code.*

address locations are accessed. The Betamax interface card was designed to reside in input/output (I/O) card slot 7. This means that the DS line (pin 41) will go low whenever hexadecimal memory locations C0F0 thru C0FF are addressed. Table 1 shows the Betamax connections and functions that will be accessed for a given BASIC statement or a given machine-language command.

The Betamax can be commanded to move the tape in any of the play, rewind, fast forward, or stop modes by dropping the appropriate line from connector CN1 to ground logic state. IC7 is a 4 to 16 line decoder latch which is used to selectively turn on one of the four transistors that control the function of the videocassette recorder.

Software Control of the Video Recorder—Apple II

The software portion of the project was handled in two parts:

- A machine-language routine was written to count the pulses coming from the timing track on the videotape and to determine when the desired destination location along the videotape is reached.
- A routine written in Applesoft floating-point BASIC loads the videotape destination location and controls the video recorder. In addition, all of the routines used to quiz the students were written in Applesoft BASIC, but are not shown in this article.

Figures 2 and 3 show the flowcharts for the machine-language routines. Listings 1 and 2 show the actual program code in assembler format with comments. The programs are quite similar. The *increment* routine in listing 1 is used when the videotape is being moved forward (play or fast-forward modes) and the *decrement* routine in listing 2 is used when the videotape is being moved in reverse (rewind).

Upon entering the appropriate subroutine from the BASIC program, the processor status and the accumulator are pushed onto the stack. The line carrying the pulses from the timing track on the videotape is then sampled until it has been determined that the tape has moved a distance equal to 1 pulse width. A present-location register consisting of two 8-bit words is then incremented or decremented depending on whether the tape is being moved forward or reverse.

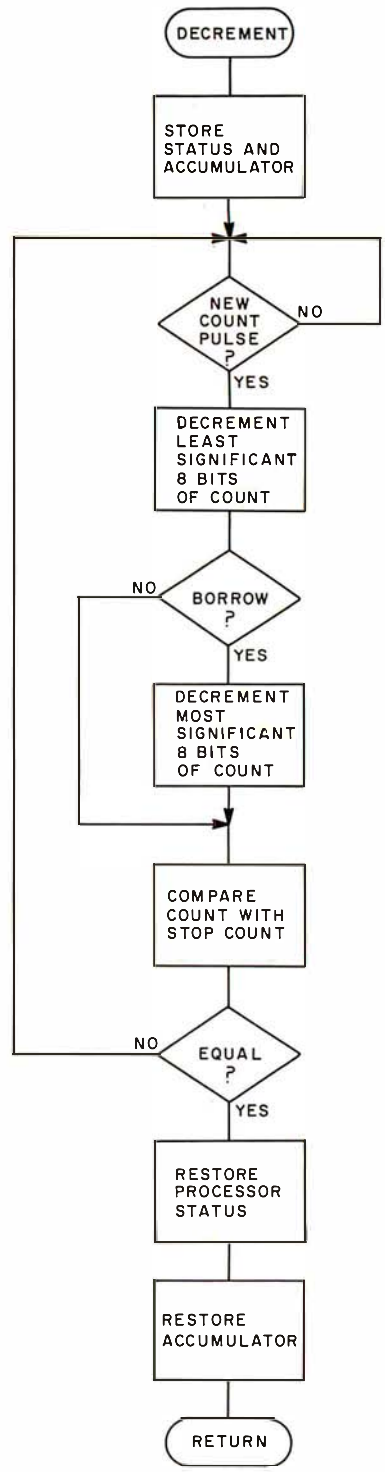

Figure 3: *Flowchart of the decrement machine-language subroutine that monitors reverse motion of the videotape. See listing 2 for the 6502 code; see listing 5 for the Z80 code.*

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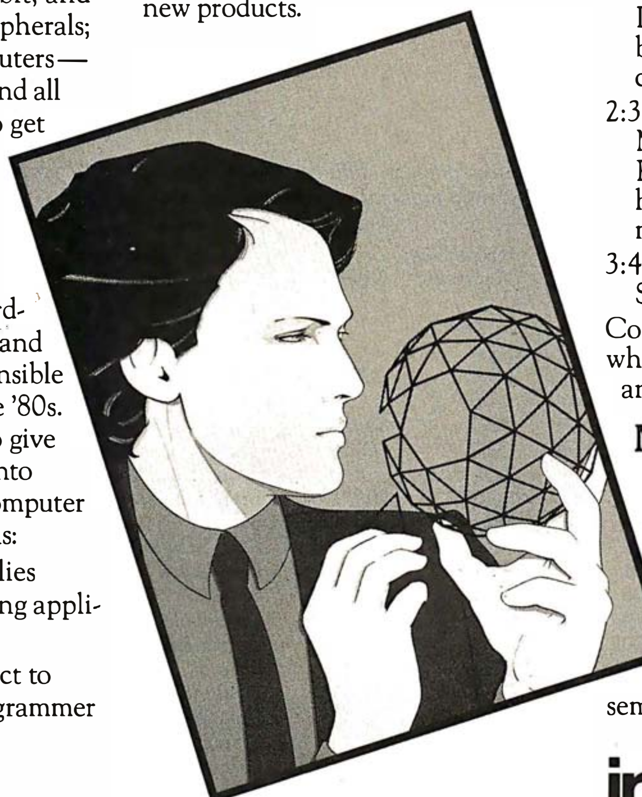

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New Microprocessor Products
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12:00 Noon—Lunch

1:00 p.m.
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Discussion of new peripheral building blocks and system interconnects

2:30 p.m.
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Listing 1: *Assembly-language subroutine for the 6502 processor. This routine, used in the Apple II, monitors the forward motion of the videotape by counting timing pulses derived from the videotape and sent over connector pin CN1-15 of the RM-300 Auto Search control connector.*

Hexadecimal Address	Hexadecimal Code			Instruction Mnemonic	Operand	Commentary
0310	08			PHP		Save processor status
0311	48			PHA		Save accumulator
0312	AD	F3	C0	LDA	$C0F3	Sample count line
0315	2A			ROL		Rotate bit 7 into carry
0316	B0	FA		BCS	$0312	Branch if carry set
0318	AD	F3	C0	LDA	$C0F3	Sample count line
031B	2A			ROL		Rotate bit 7 into carry
031C	90	FA		BCC	$0318	Branch if carry clear
031E	EE	03	03	INC	$0303	Increment least significant 8 bits
0321	D0	03		BNE	$0326	Branch if no overflow
0323	EE	04	03	INC	$0304	Increment most significant 8 bits
0326	AD	03	03	LDA	$0303	Load least significant 8 bits
0329	CD	05	03	CMP	$0305	Compare with least significant stop count
032C	D0	E4		BNE	$0312	Branch if not equal
032E	AD	04	03	LDA	$0304	Load most significant 8 bits
0331	CD	06	03	CMP	$0306	Compare with most significant stop count
0334	D0	DC		BNE	$0312	Branch if not equal
0336	68			PLA		Restore accumulator
0337	28			PLP		Restore processor status
0338	60			RTS		Return from subroutine

Listing 2: *Assembly-language subroutine for the 6502 processor. This routine is called from the Applesoft BASIC program to monitor the reverse motion of the videotape by counting timing pulses derived from the tape.*

Hexadecimal Address	Hexadecimal Code			Instruction Mnemonic	Operand	Commentary
0360	08			PHP		Save processor status
0361	48			PHA		Save accumulator
0362	AD	F3	C0	LDA	$C0F3	Sample count line
0365	2A			ROL		Rotate bit 7 into carry
0366	B0	FA		BCS	$0362	Branch if carry set
0368	AD	F3	C0	LDA	$C0F3	Sample count line
036B	2A			ROL		Rotate bit 7 into carry
036C	90	FA		BCC	$0368	Branch if carry clear
036E	38			SEC		Set carry
036F	AD	03	03	LDA	$0303	Load least significant 8 bits
0372	E9	01		SBC	#$01	Decrement least significant 8 bits
0374	8D	03	03	STA	$0303	Save
0377	AD	04	03	LDA	$0304	Load most significant 8 bits
037A	E9	00		SBC	#$00	Decrement if borrow
037C	8D	04	03	STA	$0304	Save
037F	AD	03	03	LDA	$0303	Load least significant 8 bits
0382	CD	05	03	CMP	$0305	Compare with least significant stop count
0385	D0	DB		BNE	$0362	Branch if not equal
0387	AD	04	03	LDA	$0304	Load most significant 8 bits
038A	CD	06	03	CMP	$0306	Compare with most significant stop count
038D	D0	D3		BNE	$0362	Branch if not equal
038F	68			PLA		Restore accumulator
0390	28			PLP		Restore processor status
0391	60			RTS		Return from subroutine

The contents of this present-location register are then compared to the contents of a register containing the two 8-bit words representing the destination. If the two registers are equal, the tape has reached its destination, and the computer returns control to the BASIC routine. If the two registers are not equal, the routine loops back to wait for the next timing pulse.

Figure 4 shows the flowchart of the BASIC program, and listing 3 shows the BASIC program code with comments. (Only the tape-control routines are given here.) During execution the program first sets the physical location of the videotape to 0. If the cassette has not been loaded into the machine, a message is printed on the video display and the program waits until the cassette has been loaded. The program then checks to see if the tape has been rewound to the beginning; if not, it rewinds the tape. The tape is now at its beginning and the count register has been set to 0.

Next, the number representing the destination location of the desired program material is loaded into the destination register, and the present physical location is compared with the desired location. If the present

Listing 3: *Tape control routines from the Applesoft floating-point BASIC computer-aided instruction program. The routines that ask questions of students have been omitted from this listing. This program calls the machine-language subroutines of listings 1 and 2 (for the Apple), listings 4 and 5 (for the TRS-80).*

```
50       REM  START
52       POKE 771,0:  POKE 772,0:  REM INITIALIZE COUNT REGISTER
54     X  = PEEK ( - 16133): REM SAMPLE LINE CN1-7 FROM BETAMAX
56       IF X < 127 THEN GOTO 70: REM IF CASSETTE LOADED THEN GOTO 70
58       VTAB 10: REM SET VERTICAL TAB TO 10
60       PRINT "!!!!!!!!!LOAD TAPE!!!!!!!!!!"
62       GOTO 54
70     X  =PEEK ( - 16137): REM SAMPLE LINE CN1-20 FROM BETAMAX
72       IF X < 127 THEN GOTO 80: REM IF TAPE REWOUND THEN GOTO 80
74       POKE - 16142,3: REM REWIND TAPE
76       GOTO 70: REM RETURN TO C IF TAPE REWOUND
80       SR=92:SP=114: REM LOAD DESTINATION COUNT
90       GOSUB 10000: REM JUMP TO CONTROLLER ROUTINE
99       END

10000    REM  CONTROLLER ROUTINE
10002    R1 = 0:R2 = 0:P1 = 0:P2 = 0
10010    X = PEEK (771) + 256 * PEEK (772): REM GET ACTUAL LOCATION
10020    R1 = SR: REM DETERMINE DESTINATION COUNT
10021    R1 = R1 - 256
10022    IF R1 = 0 THEN GOTO 10030
10023    IF R1 > 0 THEN GOTO 10032
10024    IF R1 < 0 THEN GOTO 10035
10030    R2 = R2 + 1: GOTO 10090
10032    R2 = R2 + 1: GOTO 10021
10035    R1 = R1 + 256
10050    P1 = SP: REM DETERMINE NEW DESTINATION COUNT
10051    P1 = P1 - 256
10052    IF P1 = 0 THEN GOTO 10080
10053    IF P1 > 0 THEN GOTO 10082
10054    IF P1 < 0 THEN GOTO 10085
10080    P2 = P2 + 1: GOTO 10090
10082    P2 = P2 + 1: GOTO 10051
10085    P1 = P1 + 256
10090    IF X < SR THEN GOTO 10100: REM DETERMINE RELATIONSHIP OF ACTUAL COUNT TO DESTINATION COUNT
10091              REM
10092    IF X > SR THEN GOTO 10200: REM COUNT
10094    IF X = SR THEN GOTO 10300
10100    REM  FAST FORWARD
10110    POKE 773,R1: POKE 774,R2
10112    POKE - 16142,2: CALL 784
10114    POKE - 16142,0
10116    GOTO 10300
10200    REM  REWIND
10202    R3 = 0:R4 = 0
10210    R3 = SR + 2
10211    R3 = R3 - 256
10212    IF R3 = 0 THEN GOTO 10220
10213    IF R3 > 0 THEN GOTO 10230
10214    IF R3 < 0 THEN GOTO 10249
10220    R4 = R4 + 1: GOTO 10250
10230    R4 = R4 + 1: GOTO 10211
10240    R3 = R3 + 256
10250    POKE 773,R3: POKE 774,R4
10252    POKE -16142,3: CALL 864
10254    POKE -16142,0
10256    POKE 771,R1: POKE 772,R2
10300    REM PLAY
10310    POKE 773,P1: POKE 774,P2
10320    POKE -16142,1: CALL 784
10400    REM STOP
10410    POKE -16142,0: POKE -16142,10:RETURN
99999    END
```

physical location value is less than that of the desired location, the videocassette recorder is commanded to move the tape in fast-forward mode. The BASIC program calls the machine-language subroutine which monitors the forward motion. When the destination is reached, the machine language returns to the BASIC program.

If the present physical tape location is greater than the desired location, the Betamax is commanded to rewind, and the program jumps to the machine-language subroutine which decrements the count, monitoring the reverse motion. When the destination is reached, the machine-language routine returns to the BASIC program. If the present physical location

Text continued on page 132

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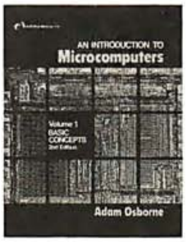

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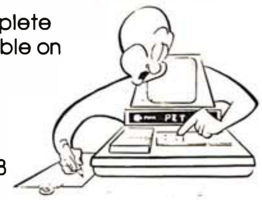

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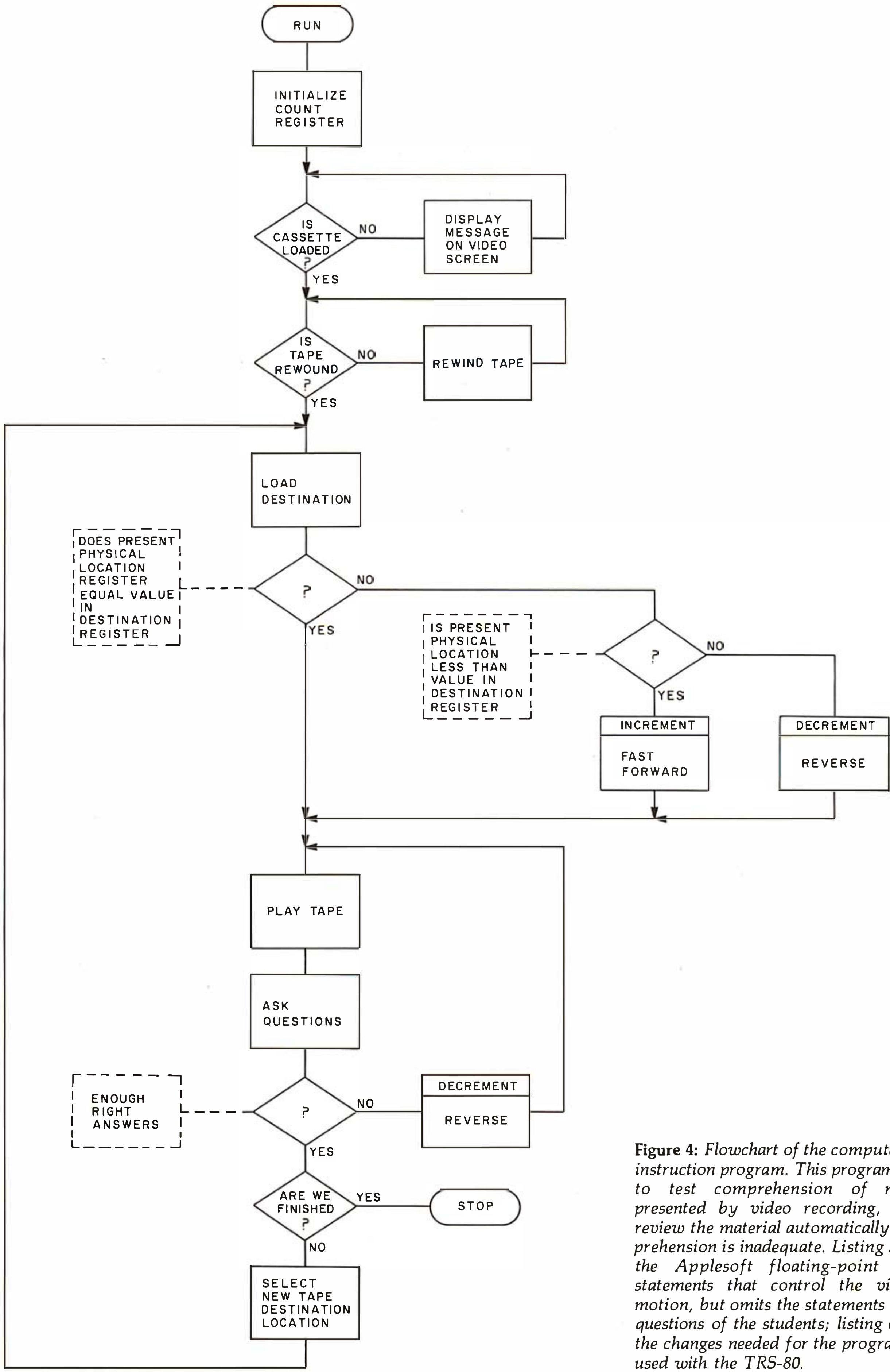

Figure 4: *Flowchart of the computer-aided instruction program. This program is used to test comprehension of material presented by video recording, and to review the material automatically if comprehension is inadequate. Listing 3 shows the Applesoft floating-point BASIC statements that control the videotape motion, but omits the statements that ask questions of the students; listing 6 shows the changes needed for the program to be used with the TRS-80.*

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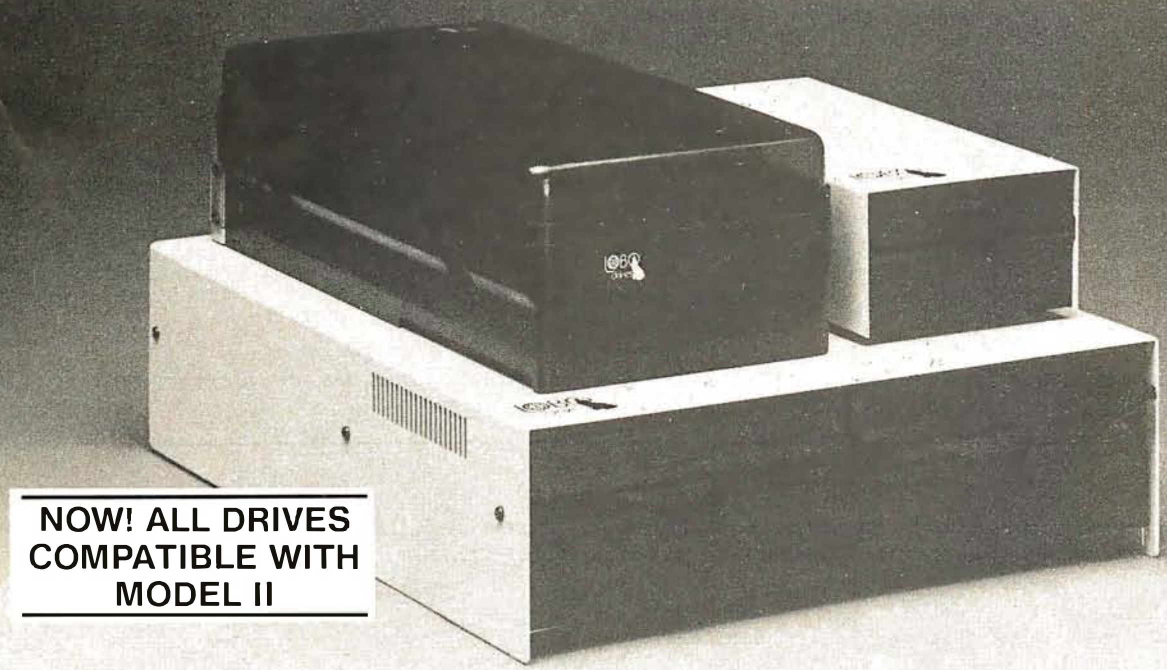

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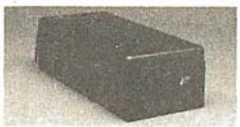

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CN1-20	BEGINNING OF TAPE	from Betamax	PEEK(– 9)	LDA $8007
CN1-7	CASSETTE IN	from Betamax	PEEK(– 11)	LDA $8005
CN1-11	REWIND	to Betamax	POKE – 1, 3	LDA #03 STA $8001
CN1-8	STOP	to Betamax	POKE – 1, 0	LDA #00 STA $8001
CN1-13	PLAY	to Betamax	POKE – 1, 1	LDA #01 STA $8001
CN1-12	FAST FORWARD	to Betamax	POKE – 1. 2	LDA #02 STA $8001
CN1-15	COUNT	from Betamax	PEEK(– 13)	LDA $8003

Table 2: *Videocassette recorder functions controlled through the TRS-80 interface of figure 5. The software commands necessary to activate these functions are given in both BASIC and Z80 machine-language forms.*

Listing 4: *Assembly-language subroutine for the Z80 processor. This routine, written for the TRS-80, monitors the forward motion of the videotape by counting timing pulses derived from the videotape and sent over connector pin CN1-15 of the RM-300 Auto Search control connector.*

Hexadecimal Address	Hexadecimal Code			Label	Instruction Mnemonic	Operand	Commentary
7B00	F5				PUSH	PSW	Save accumulator and processor status
7B01	3A	02	80	RESTR:	LDA	$8003	Sample count line
7B04	17				RAL		Rotate bit 7 into carry
7B05	DA	01	7B		JC	RESTR	Jump if carry set
7B08	3A	02	80	AGAIN:	LDA	$8003	Sample count line
7B0B	17				RAL		Rotate bit 7 into carry
7B0C	D2	08	7B		JNC	AGAIN	Jump if carry not set
7B0F	21	03	7F		LXI	H,$7F03	Load H,L registers
7B12	34				INR	M	Increment least significant 8 bits
7B13	C2	1A	7B		JNZ	AHEAD	Jump if no overflow
7B16	21	04	7F		LXI	H,$7F04	Load H,L registers
7B19	34				INR	M	Increment most significant 8 bits
7B1A	21	05	7F	AHEAD:	LXI	H,$7F05	Load H,L registers
7B1D	3A	03	7F		LDA	$7F03	Load least significant 8 bits
7B20	BE				CMP	M	Compare
7B21	C2	01	7B		JNZ	RESTR	Jump if not equal
7B24	21	06	7F		LXI	H,$7F06	Load H,L registers
7B27	3A	04	7F		LDA	$7F04	Load most significant 8 bits
7B2A	BE				CMP	M	Compare
7B2B	C2	01	7B		JNZ	RESTR	Jump if not equal
7B2E	F1				POP	PSW	Restore accumulator and processor status
7B2F	C9				RET		Return

Number	Type	+5 V	GND
IC1	SN7490	5	10
IC2	SN7492	5	10
IC3	MC14512	16	8
IC4	SN7400	14	7
IC5	MC14049	1	8
IC6	MC14050	1	8
IC7	MC14514	24	12
IC8	SN7427	14	7

Text continued from page 126:
is the desired location, there is no need to move the tape and the BASIC program continues.

After the present physical tape location is made equal to the desired location, the Betamax is instructed to play, and a new value representing a new destination at the end of the instructional segment is loaded into the destination register. After the desired length of tape has been played, the tape is stopped and the program jumps to the subroutines which quiz the students on the material.

Interface Implementation — TRS-80

The concept of controlling a videocassette player with a personal computer is equally applicable to other systems such as the Radio Shack TRS-80. The TRS-80 has a number of subtle niceties such as low cost and distributed service centers which make it very popular with educators; and the existence of an external bus connector makes the design of specialized interface circuitry relatively easy. The TRS-80/Betamax combination can provide all of the educational benefits that have been discussed in the Apple/Betamax section; in addition, the TRS-80 has a bold 32-character format that makes reading text on the video monitor very easy.

Figure 5 shows the TRS-80/Betamax interface schematic. Lines CN1-20 and CN1-7 from the Betamax are sampled at the beginning of the program to ensure that the cassette has been inserted into the player and that the tape has been rewound. Once

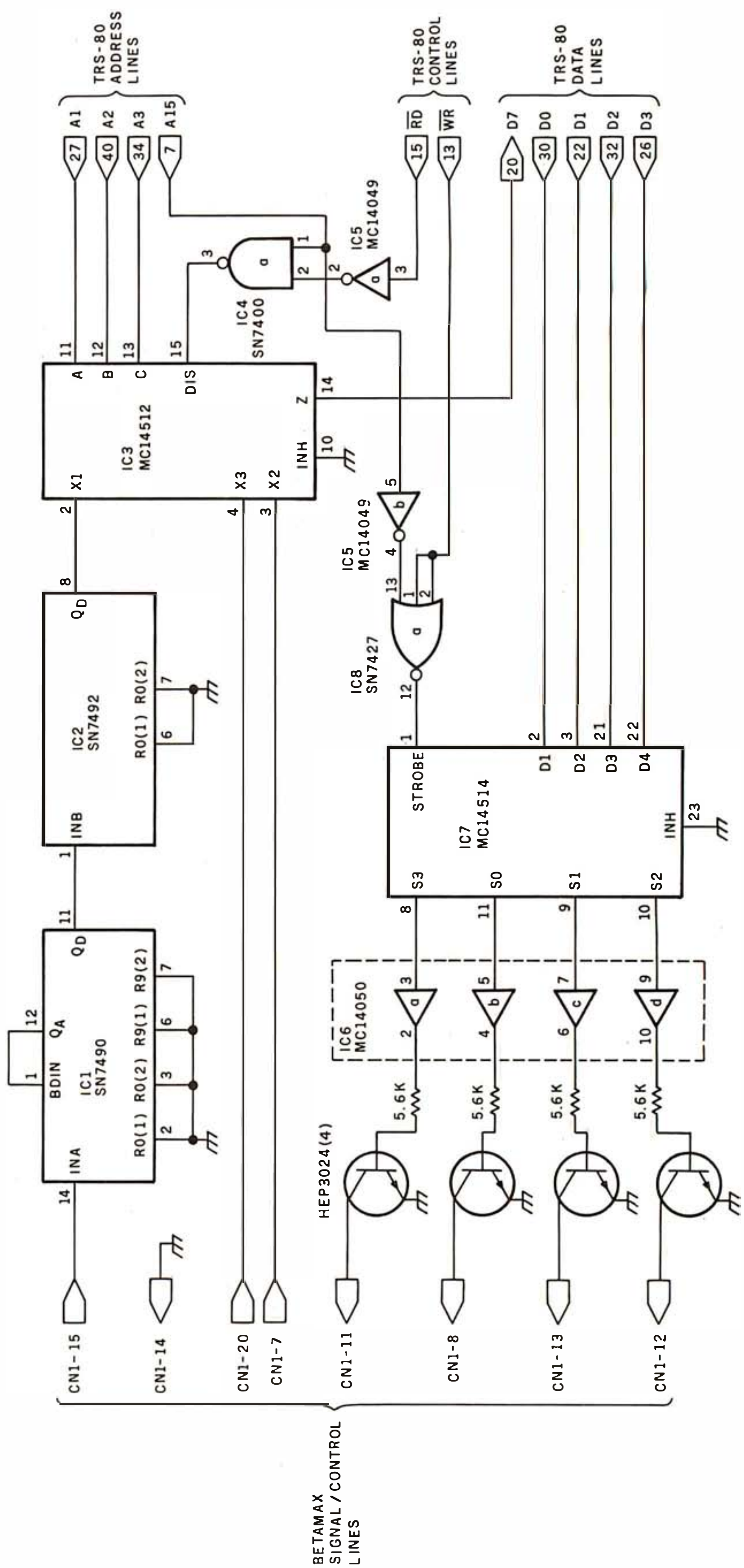

Figure 5: *Schematic diagram of the videotape control interface used to connect the TRS-80 to the Sony Betamax SLO-320 videocassette recorder. Connection to the Betamax unit is made through the RM-300 Auto Search control connector. Connection to the TRS-80 is made through the external bus connector on the rear left-hand side of the TRS-80.*

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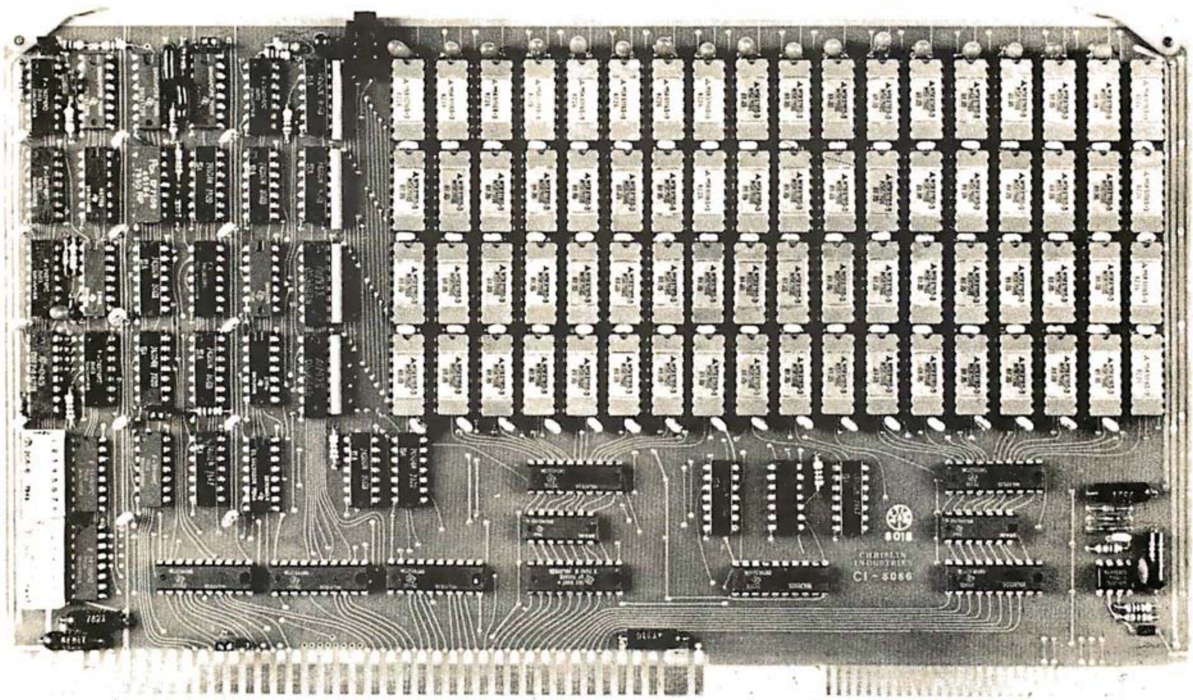

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Listing 5: *Assembly-language subroutine for the Z80 processor. This routine is called from the Level II BASIC program to monitor the reverse motion of the videotape by counting timing pulses derived from the tape.*

Hexadecimal Address	Hexadecimal Code			Label	Instruction Mnemonic	Operand	Commentary
7B60	F5				PUSH	PSW	Save accumulator and processor status
7B61	3A	02	80	REST:	LDA	$8003	Sample count line
7B64	17				RAL		Rotate bit 7 into carry
7B65	DA	61	7B		JC	REST	Jump if carry set
7B68	3A	02	80	AGANE:	LDA	$8003	Sample count line
7B6B	17				RAL		Rotate bit 7 into carry
7B6C	D2	68	7B		JNC	AGANE	Jump if carry not set
7B6F	37				STC		Set carry
7B70	3A	03	7F		LDA	$7F03	Load least significant 8 bits
7B73	DE	01			SBI	01	Subtract one
7B75	32	03	7F		STA	$7F03	Store result
7B78	3A	04	7F		LDA	$7F04	Load most significant 8 bits
7B7B	DE	01			SBI	00	Subtract one if borrow occurred in previous SBI
7B7D	32	04	7F		STA	$7F04	Store result
7B80	21	05	7F		LXI	H,$7F05	Load H,L registers
7B83	3A	03	7F		LDA	$7F03	Load least significant 8 bits
7B86	BE				CMP	M	Compare
7B87	C2	61	7B		JNZ	REST	Jump if not equal
7B8A	21	06	7F		LXI	H,$7F06	Load H,L registers
7B8D	3A	04	7F		LDA	$7F04	Load most significant 8 bits
7B90	BE				CMP	M	Compare
7B91	C2	61	7B		JNZ	REST	Jump if not equal
7B94	F1				POP	PSW	Restore accumulator and processor status
7B95	C9				RET		Return

the cassette has been inserted, the tape will be automatically rewound if necessary.

Line CN1-15 from the Betamax carries the timing signal formatted onto the videotape. The signal is divided by a factor of 60 by IC1 and IC2. IC3 is an 8-channel data selector used to selectively connect line CN1-20, CN1-7, or the divided timing signal to data line seven (D7) in the TRS-80. D7 was chosen because its state can be easily tested by rotating it left into the carry bit.

Address line A15 from the TRS-80 is not normally used because of memory size restrictions. It was therefore pressed into service to provide a signal line for addressing the interface board. IC7 is a 4-to-16 line decoder latch that is used to selectively turn on one of the four transistors, causing the Betamax to either play, rewind, fast forward, or stop. Table 2 shows the Betamax pin connections and the function that will be accessed for a given BASIC statement or a given machine-language command.

Listing 6: *Modifications of listing 3 needed to create a tape control Level II BASIC computer-aided instruction program for the TRS-80. The lines in this listing should replace their counterparts in listing 3 to create a program that will run on the TRS-80 and its associated interface board.*

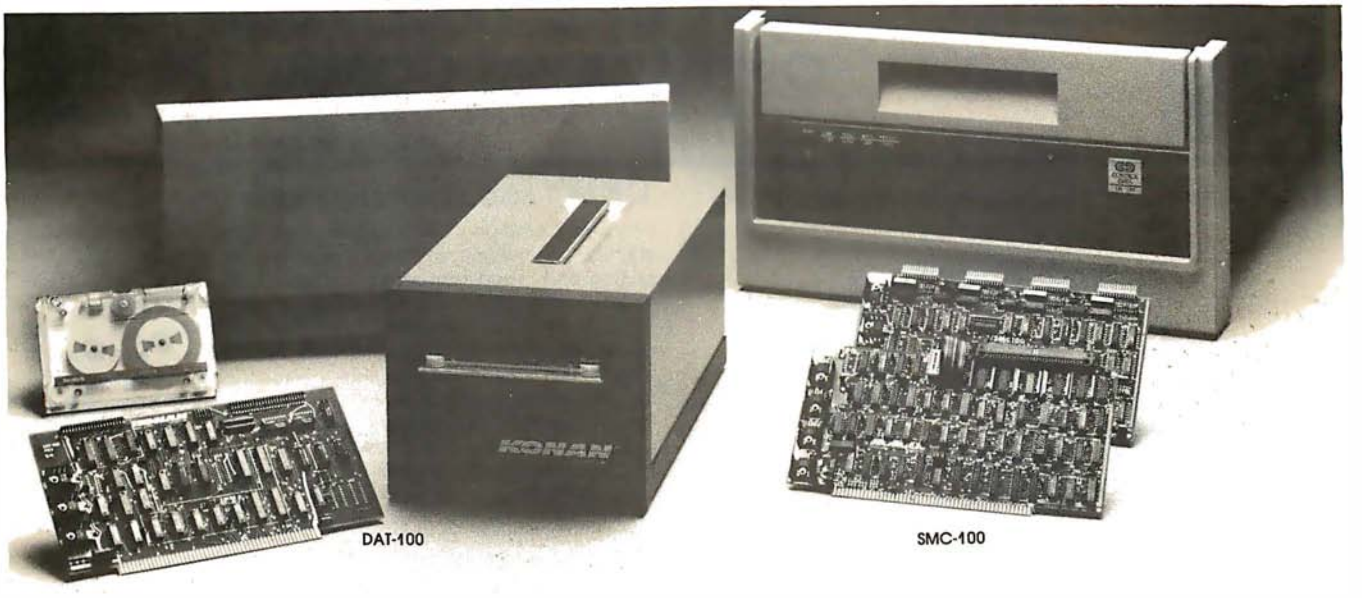
```
52      POKE 32515,0: POKE 32516,0: REM INIT COUNT REGISTER
54      X=PEEK(-11): REM INITIALIZE COUNT REGISTER
70      X=PEEK(-9): REM SAMPLE LINE CN1-20 FROM BETAMAX
74      POKE (-1,3): REM REWIND TAPE
76      GOTO 70: REM RETURN TO SEE IF TAPE REWOUND
99      END

10010   X=PEEK(32515)+256*PEEK(32516): REM GET ACTUAL LOCATION
10110   POKE 32517,R1: POKE 32518,R2: POKE -1,2
10112   POKE 16526,0: POKE 16527,123: X=USR(0)
10114   POKE -1,0
10250   POKE 32517,R3: POKE 32518,R4: -1,3
10252   POKE 16526,96: POKE 16527,123: X=USR(0)
10254   POKE -1,0
10256   POKE 32515,R1: POKE 32516,R2
10310   POKE 32517,P1: POKE 32518,P2: POKE -1,1
10320   POKE 16526,0: POKE 16527,123: X=USR(0)
10410   POKE -1,0: POKE -1,14: RETURN
```

The software used by the TRS-80 is virtually identical in design to that of the Apple. Figures 2 and 3 are still valid as flowcharts for the routines that position the videotape during forward and backward tape movement, respectively. The implementation of these routines in Z80 machine code (designed specifically for the TRS-80) are in listings 4 and 5, respectively.

The BASIC driver program, given in figure 4 (flowchart) and listing 3, is valid as written for the TRS-80, with the exception of lines containing the PEEKs and POKEs specific to the TRS-80 interface (see table 2). The BASIC program for the TRS-80 is obtained by substituting the lines given in listing 6 for their counterparts in listing 3.

User Reaction

Initial response to the system has been enthusiastic. Since immediate feedback is an important part of an educational experience, it is expected that the system will enhance retention and understanding. At present, lectures and program materials for medical students are being generated for use in the College of Osteopathic Medicine. Upon completion of the material, experiments will be conducted to see if the system does enhance learning capabilities. ■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A Personal Computer on a Student's Budget

J C Johnston
26481 Shirley Ave
Euclid OH 44132

About four years ago I decided that I wanted to obtain a microcomputer. I had done some programming on an IBM 370 and on a Texas Instruments 960 minicomputer at Cleveland State University.

Those who are starting in microcomputers have a problem in deciding what equipment they want, what to get, and how much to spend. When I began to obtain my machine, I figured on building the SwTPC (Southwest Technical Products Corp) CT-1024 video terminal for about $200, and spending only about $400 on the minimum computer system. As it turned out, I spent:

$120	processor board
90	4 K memory board
60	I/O (input/output) board
45	mother board
25	power supply
40	enclosure
+12	power supply extension
$392	Total

I have since expanded the system, but I kept within my original budget fairly well.

I started by buying the printed circuit board set for the SwTPC CT-1024, figuring that any machine would require some type of terminal, and this was the only affordable one I could find. Considering the problems I had getting parts, the CT-1024 turned out to be a good choice.

This article was written bearing in mind the things I wish I had known four years ago, when this adventure started. It *is* possible to put together a good system on a limited budget.

As I built up the terminal, I looked for the right computer. We were using some of the original Altair 8800s in the Chemistry Department and I learned about some of the problems involved in making them operational. It took fifteen fuses to track down one problem in the power supply in which a bad bridge was shorting out the +8 V supply. My opinion of the Altair 8800 has since risen, but I was wary at the time.

I was attracted to the Southwest Technical Products 6800. The kit was more nearly complete, requiring only the terminal to make a functional system. The SwTPC 6800 was also inexpensive. I could not touch its price with any 8080-based system then available. The monitor in read-only memory was a great convenience. My reservations about getting the system came from the vagaries of mail order kit building.

During my consideration of the SwTPC machine, a friend showed me the instruction set of the just introduced Z80 microprocessor. I was enchanted, but the problem remained of building an affordable system.

Having no idea of which computer system I wanted, I went to the MACC (Midwest Affiliation of Computer Clubs) Computerfest. Amid the fascinating computer equipment that I knew I could not afford, I discovered the display booth of the

About the Author

Chris Johnston is a graduate chemistry student at Cleveland State University in Ohio. Exposure to FORTRAN in undergraduate chemistry courses sparked his interest in computers. Writing simple software for computer-controlled laboratory experiments led him to an interest in minicomputers and microcomputers, and "things snowballed from there."

Ithaca Audio company (now Ithaca Intersystems Co). They were showing their Z80 processor circuit board for the S-100 bus. This board was the key to building an affordable system.

It is a Z80 processor board, but to the system bus it appears to be an 8080 processor board. It carries memory-write circuitry and a power-on jump vector. One of the nicest things about it is the provision for a 2708 erasable programmable read-only memory. Here in one board was the answer to a big problem. I could not afford an IMSAI front panel, and I did not want to spend all of the extra money on a read-only memory board. The 2708 capability was convenient because I could program it using the Cromemco Bytesaver board in one of the Altair systems at school. Finally, the prices were excellent—$35 for the board, $25 for the Z80 processor, and $20 for the 2708 programmable read-only memory. I estimated that the rest of the board could be built for around $40.

The Ithaca Audio Z80 board is neat in appearance, and is solder-masked and silk-screened. An impressive, twenty-seven-page documentation package comes with it. There were many components to put on the board, but the soldering was not too difficult. The board had one minor, but annoying, problem: there was no component placement diagram. The position of only one end of each resistor or capacitor was marked with the silk screening.

This helped me detect one other problem with the board. While tracing the circuitry near the 8224 clock generator and driver, I noticed a mix-up in the silk screening where the schematic and parts list did not match the silk screen. I examined my Intel 8224 data and found the problem. The capacitor in the circuit with the crystal should be a 10 pF-type (C7 on the schematic, C9 on the board). To make everything agree, I changed C7 to C9 (and vice versa) on the schematic and parts list. Now the board, the schematic, the parts list, and page two of the documentation agreed. More recent revisions of this board have corrected this problem.

One inconvenience for me was that the front-panel connector is a 16-pin dual-in-line socket. This is fine for those lucky enough to own an IMSAI, or another machine with this type of connector. I found it necessary to construct an adapter to connect the board to one of the Altair systems for checkout.

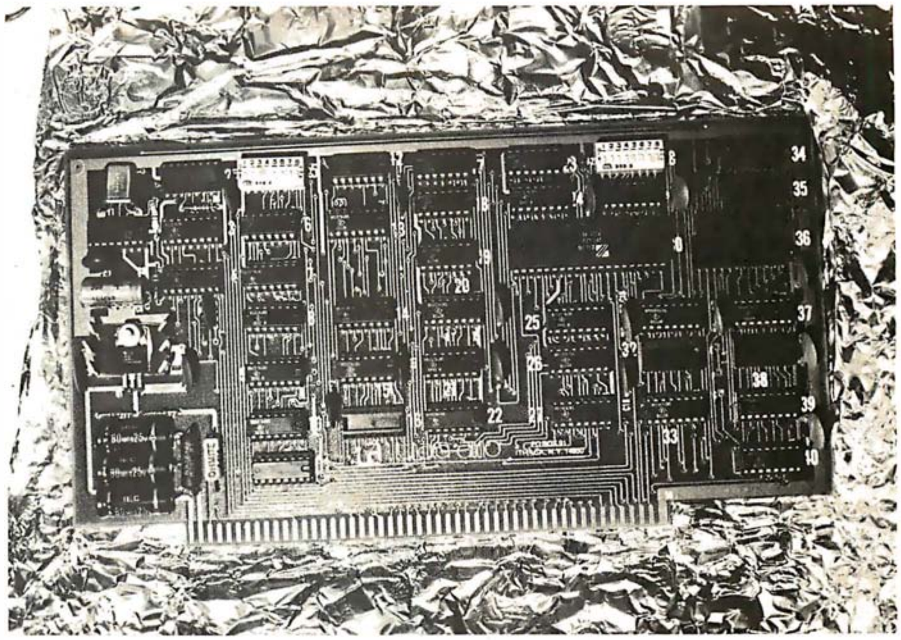

Photo 1: *Ithaca Audio Z80 processor board for the S-100 bus.*

The Ithaca Audio Z80 processor board was precisely the board I needed to build an affordable system.

Diagnosing Problems

I followed the checkout procedures outlined in the documentation package and encountered my first problem. The Z80 board would not reset the A0 and A2 address lines of the S-100 bus. I spent a long time searching for the cause of this problem and finally decided that it had to be a bad integrated-circuit socket. When replacing the socket did not help, I was almost ready to give up for the day. However, it occurred to me that the problem might be with the plated-through holes. I tried sticking a wire through the holes on the afflicted address lines. This cured the reset problem, but identified a more serious problem: that of insufficiently plated-through holes. I eventually traced all of the problems with this board to bad holes in one area. The rest of the board appeared to be all right, so I patched the holes in the bad area.

At first the processor would not run, but later it would not stop when it began running. The reason for this was that the 8080-style status signals are not available on the data lines. The Altair 8080a front panel looks at the data lines so it can stop on an M1 cycle (fetch cycle for first byte of instruction). If data bit 5 is high during the time that you are trying to stop the computer, it stops, but not on an M1 cycle. If this bit never goes high, the processor never stops. There is an explanation of this situation in the documentation.

I do not know the situation for other S-100-type computers, but you cannot examine the on-board 2708 read-only memory with the 8800a front panel. This is caused by the lack of buffering betwen the 2708 and the front panel. The 2708 simply cannot drive it. This is the only design error I found that I thought was objectionable.

I spent about fifteen hours debugging the board. Most of the time was spent tracking down problems on the board itself. A call to Ithaca Audio for assistance was reassuring in two ways. First, they were willing to provide the type of information necessary to service their boards. Second, I got the impression from our conversation that the problem with the plated-through holes was not common. The chances are reasonably good that any board you purchase from them will be suitable.

I consider myself lucky to have found this board at the Computerfest, where I could see it. I probably would not have purchased a processor board from a company with which I had not had contact.

This illustrates one of the greatest advantages in joining a local computer club — you can talk to people who have seen or built a large number of different computer kits. I am a member of the Cleveland Digital Group; it has been more helpful to me than I had ever imagined. My friends at school, who ordered some of the first Altairs several years ago, have been similarly helpful.

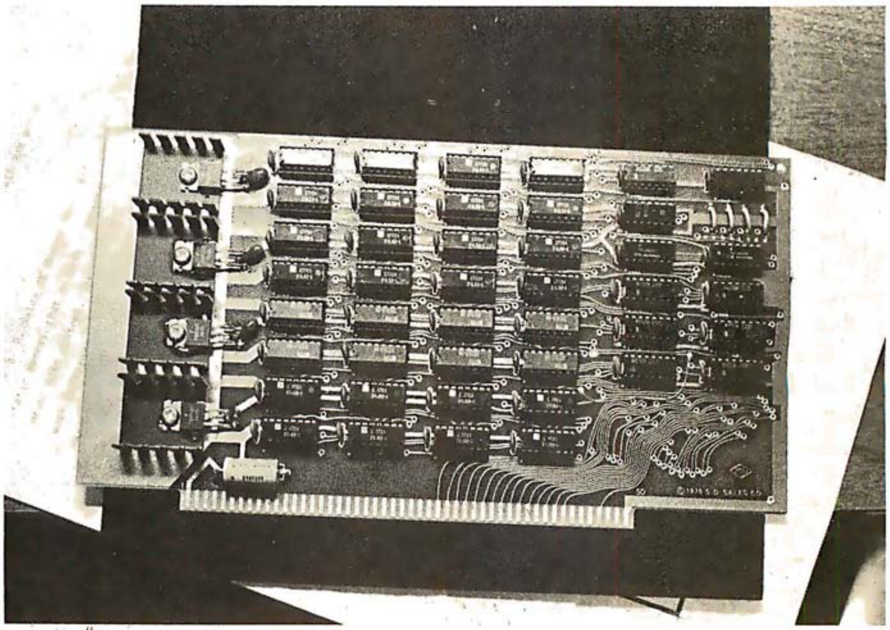

Photo 2: *SD Sales 4 K static memory board. The jumper and cut trace were factory modifications.*

Memory

My efforts now turned to finding a memory board I could afford. I had heard good things about the SD Sales 4 K board, so I ordered one. I was told they were shipping immediately. However, the normal shipping delay was two weeks; the memory board came two weeks after my order.

Like all memory boards, this one can be somewhat tedious to build, but the instructions are clear and complete. The documentation even included instructions on how to insure that all of the sockets are down tight on the board. The sockets included were good-quality, low-profile devices.

The board took about a half hour to debug with some expert help. The two problems I had were trivial: one was a folded-under integrated-circuit pin, the other a solder bridge. The solder bridge occurred in the tightest part of the board — the back side above and outside of bus pin 51.

The only construction problem occurred during the installation of the voltage regulators. With the heat sinks in place, there is just enough lead length on the regulators to solder them to the back of the board. The problem was not in the kit, however. Fairchild has evidently found some new alloy for coating leads that renders them completely unsolderable. Ten minutes' worth of filing removed enough of the alloy to make reasonable solder connections.

I am still constructing an 8 K dynamic memory board of my own design. It will depend on the Z80 for refresh operations. The board uses sixteen Texas Instruments 4060 4 K by 1 dynamic memory circuits or the equivalent. This board has major power consumption advantages over

It is necessary to use the white plastic wiring spacers.

a similar board using 2102 static memories (even the low-power versions). It should also have major advantages over the newer 4 K by 1 static memory devices in terms of cost. The 4060s are easy to design with, especially when you have the Z80 Refresh register and the Refresh signal available on the bus. Bus pin 67 on the Ithaca Audio processor board is RFSH (an inverted version of the RFSH signal available on pin 28 of the Z80 package).

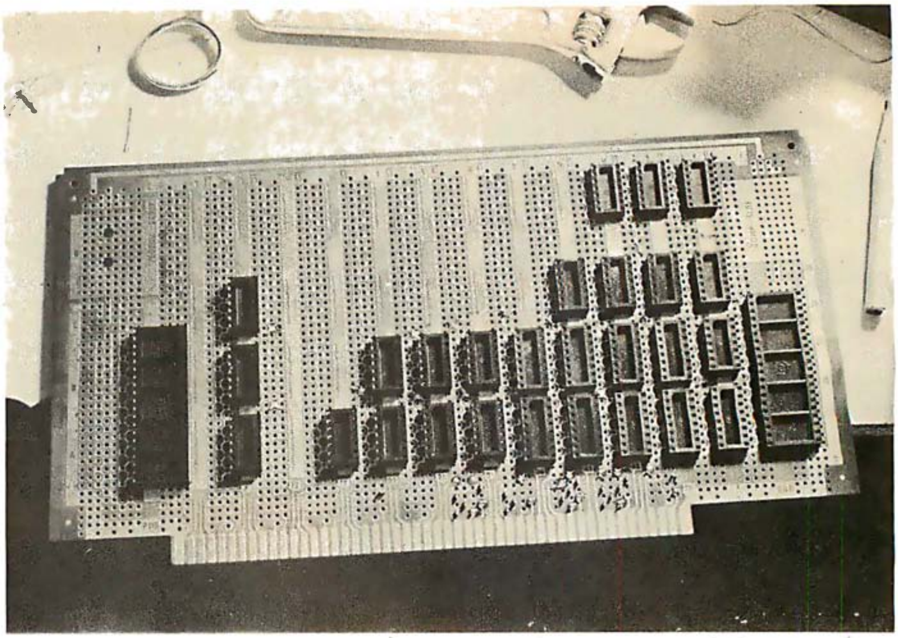

Photo 3: *The parallel and serial I/O (input/output) board under construction. The sockets are attached with Eastman 910 adhesive.*

Input and Output

The next major part of my system was an I/O (input/output) board. After shopping around I realized these boards were expensive, especially in view of what they do. I needed a board with some type of parallel port and a serial port including a universal asynchronous receiver-transmitter (UART). A friend with a similar need designed a circuit board containing both serial and parallel I/O. We constructed two boards by wire-wrapping procedures. I used the Vector 8800V prototyping board and had some trouble with shorting the little wiring-pencil wires to the ground plane when I soldered the pins of the integrated-circuit sockets. The next time I build a board, I will build it on a Vector 8801 which has a solder pad on every hole in the board. An absolute necessity when working with the wiring pencil is Vector's white plastic wiring spacers. I built the board without them and had so many problems that I spent an entire evening taking all of the little wires back off the board, installing the spacers, and, during the following nights, rewiring the board.

The wire used in the pencil has insulation which melts or decomposes at temperatures over 750° F. If you accidently touch a wire or a bundle of wires with a hot soldering iron, it will go "poof," leaving you with a bare wire or a major short. I did this at one especially congested point and had to replace twenty-five wires.

Some techniques which help when you work with a wiring pencil are:

- Leave as much room as possible between integrated circuits. Try to arrange the layout so that wire runs do not cross over component pins.
- If you have to cross over or near a component pin, make sure the pin is soldered before you begin to run wires over it. Failure to do so invites touching the wire bundle and causing a big short.
- Color code if possible. I used red wires for the parallel port, green for the serial port, and blue for repairs.

Again, make sure that you use the wiring spacers. Little metal pins used as substitutes may scuff off the insulation to the point of creating nearly undetectable shorts. The wiring spacers are Vector part number P179WS-3.

The parallel port output from the board is done through a 24-pin dual-in-line socket. The 6820 peripheral interface adapter (PIA) used in the port is what we needed to handle a paper-tape reader and, more important to our systems, a card reader.

Mother Board

I am using the SSM (formerly Solid State Music) 15-slot mother board as the backbone of my system. The board fits well within my budget. It has provision for filter capacitors on all power lines and for passive termination of the bus lines. From what I have read, termination is probably not necessary for this board.

The big Altair system at school is completely filled out with the infamous MITS 3-slot extension mother boards. It has never presented any problems that bus termination would fix. If I suspect that the system needs

If you accidently touch the wrapping wire with a hot soldering iron, the insulation will go "poof" and you will have a bare wire or a short.

to be cleaned up, I will get the Godbout active termination card. While this will take up one slot, I have enough available room to extend the mother board if I have to.

Read-Only Memory

The systems in the chemistry department all needed some read-only memory, so an 8 K 2708 board was designed. A friend and I each made one of these boards for our own systems, so I now have room for a great deal of permanent software

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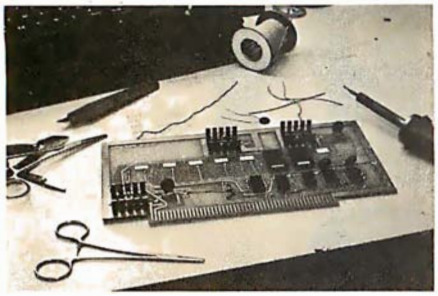

Photo 4: *Our homebrew board for housing the 2708 programmable read-only memory.*

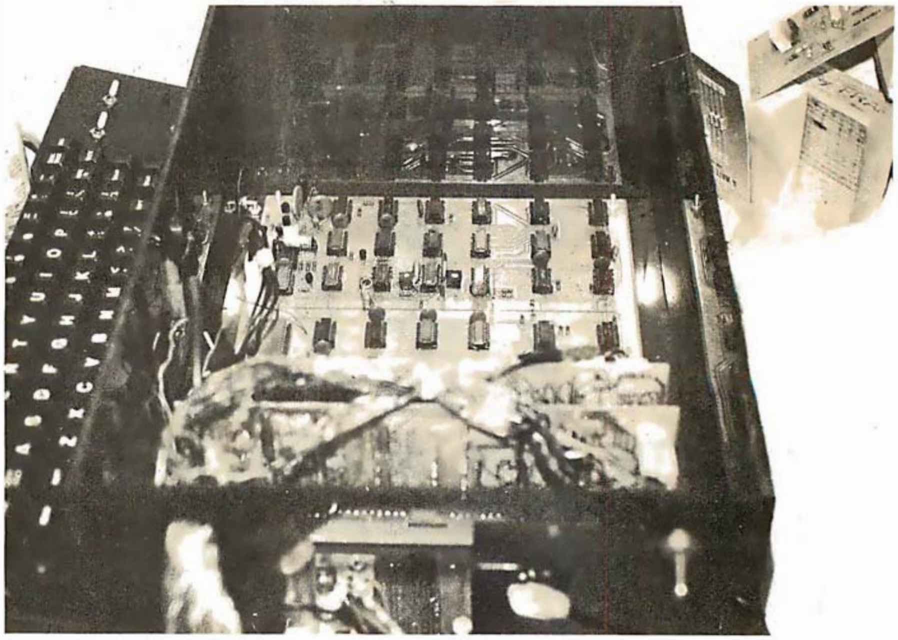

Photo 5: *Logic (under Plexiglas) and separate keyboard for the Southwest Technical Products Corp CT-1024 video terminal.*

(firmware). The printed circuit board without parts cost us about sixty cents. The reasons for this were that the negative had already been made, we had everything we needed to make printed circuit boards in our electronics shop, and we did the work ourselves.

From a large (6 by 44 inch) two-sided blank bought at a surplus electronics store, we cut four S-100-sized printed circuit blanks. We obtained two good boards on the first try. We could not make plated-through holes, but the board was designed to use a small number of "jump-throughs," and to have no places where it was necessary to solder to both sides of a component pin.

The board holds only 7 K bytes in my system, because the 2708 circuit on the Z80 board can be located in the first 1 K segment of any 4 K address block in the upper half of memory. If the address segment of the 2708 on the processor board is not coincident with the address space of the bottom (or middle) 2708 on the read-only memory board, I have an almost unusable 3 K "hole" in memory. There is no problem addressing two boards at the same place at the same time: whenever the 2708 on the processor board is addressed, the data input drivers are placed in the high-impedance state, so it does not matter what is in the socket on the firmware board that has the same address.

The read-only memory board does not have provisions for the generation of a wait state. This is not a major problem, as long as full-speed 2708 devices are used. The processor board, however, has extensive wait-state capabilities. A wait state can be put into any input cycle, any output cycle, any on-board read-only memory cycle, the first-byte instruction-fetch (M1) cycle, or any memory request cycle. Being able to put a wait state in only the M1 cycle allows for the use of marginally slow memory.

Enclosure and Power Supply

My power supply provides a maximum of 13 A on the +8 V line and 2.5 A each on the +16 and −16 V lines. A split 10 V supply caused me to split the 8 V power bus. The split was made reversible, so if I need to upgrade my power supply, I can reconnect the bus.

The computer's enclosure is another bow to economics. I liked the commercially available enclosures, but could not justify spending the money required for microcomputer-sized boxes. I bought an aluminum rear-panel plate with connector cutouts from Vector. This panel has cutouts for ten DB-25S connectors. I also bought some of their TS series T-slot struts, some plain and some with printed scales. I bought enough plastic card guides for twelve cards, and some of the square 4-40 nuts that fit into the T-struts. This was enough material for the entire box, except an aluminum panel for the front and the plastic trim panels.

I tried to obtain the aluminum from a dealer who sells scrap sheet metal, but he had just emptied his bins, so there was nothing usable. I finally bought a rack panel (8¾ inch, 22.2 cm) and cut it to size. I went to a plastics dealer who also sells scrap for the plastic that I needed. The power supply is built on a separate sheet that mounts in the main box. With this setup, any future power supply upgrades will be built on a similar sheet and bolted into place.

Serendipitaurus Card Reader

The eighty-column card reader mentioned before is, without a doubt, the neatest I/O device I have ever seen, with the possible exception of the floppy disk (which I could not afford at the time the computer was brought up). The unit in question is a small tabletop unit that I found at a surplus house. The chemistry department bought an entire set of them, and most of my friends bought one. Luckily, one friend bought several readers, and supplied me with one.

The units were built by Taurus Corporation and appear to have sold for several hundred dollars originally. We got ours for $20 each. The card reader works very simply: you feed it 110 VAC and a card, and it feeds you transistor-transistor logic (TTL) level data. It reads all twelve columns, but it cannot see blanks. Our TI 960 minicomputer has an 8080/Z80 cross assembler. We use the

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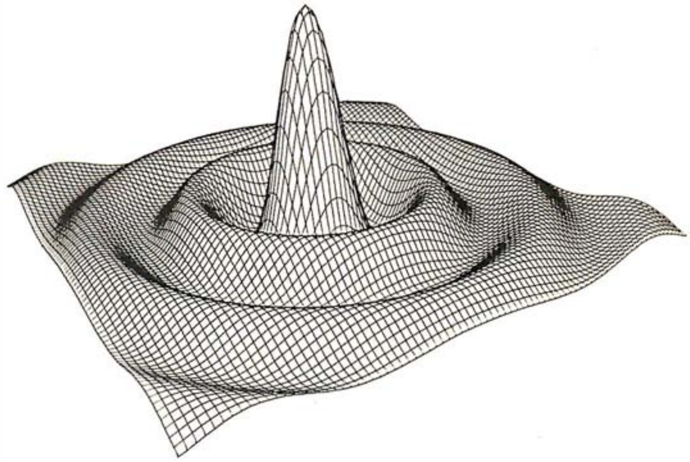

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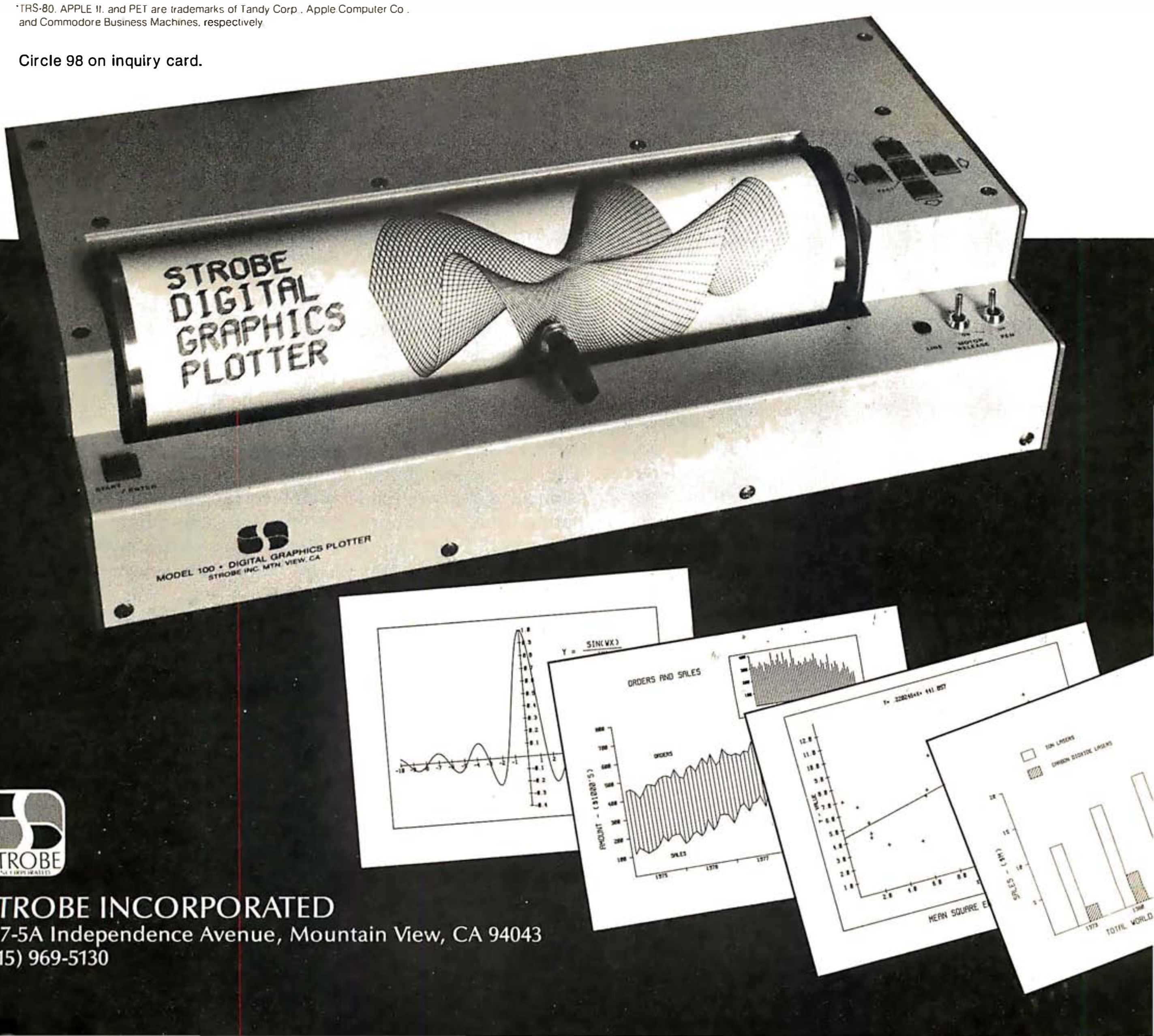

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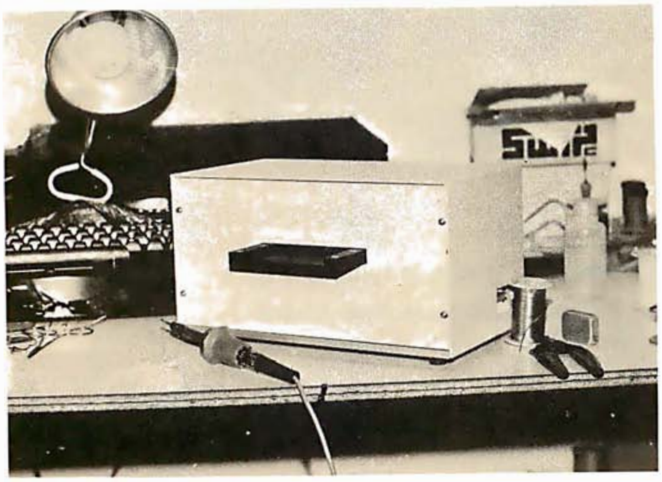

Photo 6: *Taurus card reader. Cards are inserted through the slit above the black shelf on the front. Output is through the DB-25 connector on the side (partially obscured by roll of solder).*

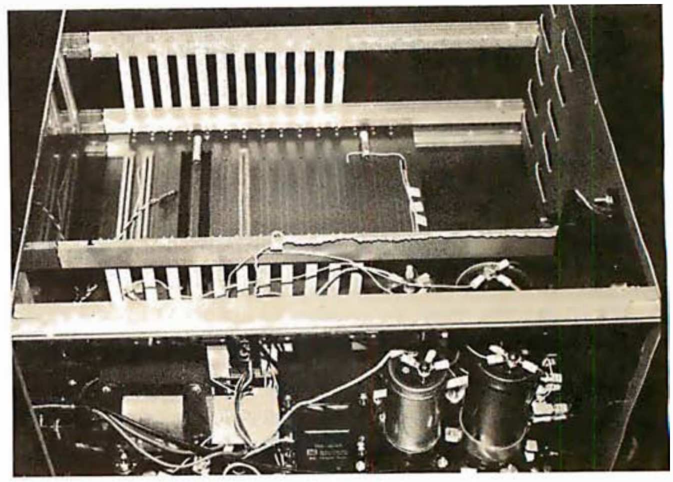

Photo 7: *Side view of the system enclosure, showing the power supply and card cage.*

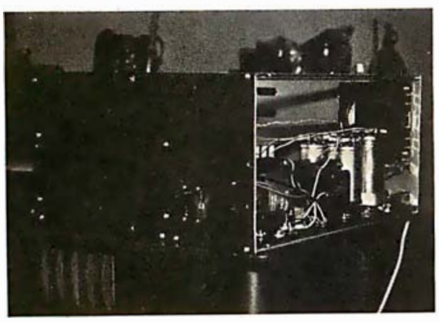

Photo 8: *Front view of computer enclosure. The only switches are for power, run/stop, and system reset. The monitor in read-only memory handles other functions of a front panel.*

faster 16-bit TI machine to assemble software to run on the 8080 or Z80.

The cross assembler can punch object code onto cards. Each card carries its own load address and checksum. The cards may be read in any order. The storage capacity is sixty-four object bytes per card. Cards allow for easy maintenance of an object program. Cards may be easily and individually duplicated, seem tougher than paper tape, and are cheaper than cassettes; of course, you do need a keypunch. We built a cassette board to provide a more portable system.

Software

I had to provide some type of software monitor to be placed in the 2708 on the processor board. I started with an octal monitor. I converted from octal to hexadecimal notation, partly for convenience, and partly to save on line width on the terminal.

One of the next major changes in the monitor was the inclusion of the binary card loader which lets the card reader talk to the computer. I modified the cassette tape routines to reflect the specific requirements of our tape interface and my own preferences. The last major change was the inclusion of a register load and dump routine, and a memory dump routine. Several other more minor changes were made in the monitor to support my other major software project, a Z80 assembler.

The next step in software is to obtain a BASIC interpreter to satisfy my need for system software until I expand the hardware. Eventually I want to get a floppy disk system and a video graphics display.

Closing Thoughts

I have described the process of building and operating my machine. One of the most important things about building my computer was that I could build a customized system while staying within a limited budget. It has many of the features that are important in a microcomputer, and it is expandable. I have tried not to limit the evolution of this system in terms of hardware or software, and have succeeded to some extent. I chose the S-100 bus chiefly because of its popularity and wide support.

When I decided to experiment with personal computing, I was faced with making a major purchase of something I knew very little about, and a limited budget within which to work. My previous experience with computers had been in the remote use of a high-level language. (I could not even get into the same room with the computer I used to learn FORTRAN.)

Although the delay involved in waiting for parts was frustrating, I can honestly say that with one exception, I had very good luck. The majority of people from whom I purchased parts went out of their way to make sure that I got what I wanted.

Despite the number of frustrations, I still recommend building up your own system piece by piece. There is a certain satisfaction in building *everything* in your machine, and in knowing that your system is configured the way it is because *you* want it that way, not because it was part of a package you bought.■

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DIGITAL PATHWAYS

BYTELINES

NEWS AND SPECULATION ABOUT PERSONAL COMPUTING

Conducted by Sol Libes

More Companies Jumping On UNIX Bandwagon: Bell Laboratories developed the UNIX software system originally to run on Digital Equipment Corporation's larger PDP-11 minicomputer systems. Now UNIX has been adapted to run on at least a dozen other systems. One of the reasons many companies are implementing UNIX on their systems is that American Telephone and Telegraph's planned Advanced Communications Service (ACS) requires UNIX to incorporate computers into the system.

Western Electric has licensed Onyx Systems Inc of Cupertino, California, to develop a microcomputer version of UNIX. Onyx will offer UNIX on its C8002 microcomputer system. It will support eight terminals and several high-level languages. MicroSoft Inc of Bellevue, Washington, has disclosed that it is close to signing an agreement on a UNIX license. Microsoft plans to implement UNIX for Z8000-, 8086-, and 68000-based systems. Zilog Inc has reportedly already signed a UNIX license. In all cases, these companies are implementing UNIX on 16-bit microcomputers.

(UNIX is a registered trademark of Bell Laboratories.)

Microcomputer Makers Changing Marketing For 1980s: The 1980s are seeing significant changes in microcomputer marketing, as sales may soon pass the $1 billion mark. The 1970s were dominated by a large number of cottage-type sales operations trying to make general-purpose systems for sophisticated hobbyists.

Already we are seeing the personal-computer market being dominated by a few large manufacturers —Radio Shack, Commodore, Apple, Texas Instruments, and Atari—and soon possibly IBM and Digital Equipment Corporation. Further, these companies are starting to move toward specialized computers that focus on specific customer needs, even computers which are immediately useful to less knowledgeable users. These companies are planning to have several computers oriented toward specific vertical markets and thus cover a broad spectrum of users.

In some markets, the change will concern only software and peripherals. In others, it may require an entirely new machine (eg: TRS-80 Model I versus TRS-80 Model II). Thus we can expect to see similar processors packaged and promoted differently. For example, Apple Computer Company has introduced the Apple III, a larger and more powerful machine than the Apple II, designed with the business and professional user in mind. (*See the preview in this issue on page 50....***CPM**)

Another example of the specialization of the microcomputer market is the introduction of the HP-85 by Hewlett-Packard. This $3250 personal computer is aimed at scientific, engineering, and financial users. HP has also disclosed that it plans to introduce other personal computers.

Thus, I am sure that ,as we move further into the 80s, we will see computer manufacturers with a broad line of different microcomputers which are tailored to the small-business, educational, scientific, process-control, and financial markets.

The computer that is proving the most elusive for manufacturers is the true home computer. Not the hobbyist computer, but the home computer. Several are quite close (eg: Texas Instruments, Atari, and Apple), but the primary problem is still that the price is too high. The home computer may prove to be the last market to be cracked. Texas Instruments (TI) introduced its 99/4 as a "home computer"; however, because of disappointing sales TI is now reorienting the sales campaign to the small-business market. Possibly the small business is in the home.

The retail sales business is also changing. Digital Equipment Corporation (DEC) and IBM are changing the retail marketing of computers. DEC presently has 21 stores and at least 6 more are planned. IBM is also retailing through its 50 "Business Computer Centers," which have doubled in number from last year.

DEC is now selling its popular LA34 terminal at a discount through its stores. This move is viewed as undercutting by DEC's regular dealers and they are up in arms. IBM is selling its new video terminal on a cash-and-carry basis also.

There is no doubt that we will see an increase in the retail cash-and-carry market as the traditional mini- and large-computer makers realize the possibilities. I am sure that we will soon see IBM stores in shopping malls just as we now see Bell Telephone stores. These companies realize that if they are to continue their high growth rates, they must move into new markets— and the personal-computer retail market is a prime candidate.

Bell System Testing Home Data-Base System: The Bell System is testing a two-way home data-base service, called "Viewtron," in Coral Gables, Florida. Television terminals, operating at 1200 bits per second (bps) over conventional telephone lines, have been placed in 160 homes. The test is sponsored by the Viewdata Corporation of America, a Knight-Ridder Newspaper Inc subsidiary. Thirty of the terminals will be rotated among test homes over a 6-month period. The terminals provide a 20-line by 40-character color display.

The services include Sears "Teleshop," which allows users to order consumer items, and Grand Union grocery ordering for home delivery. Access to Associated Press (AP) news reports, weather informa-

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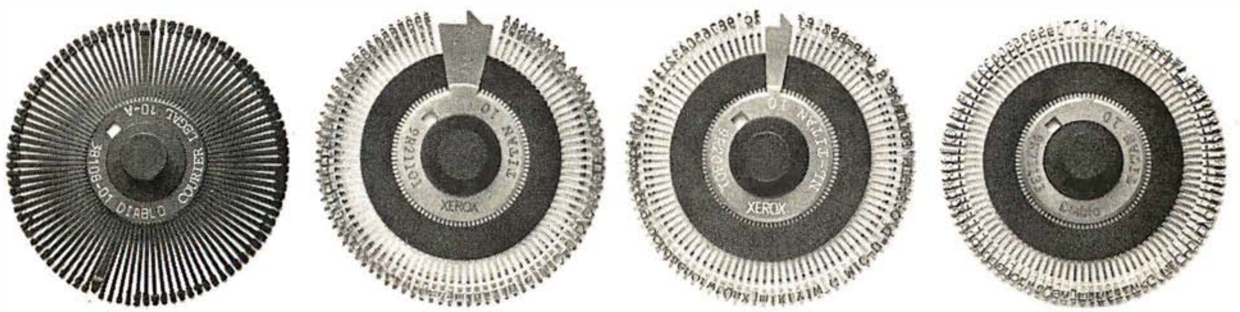

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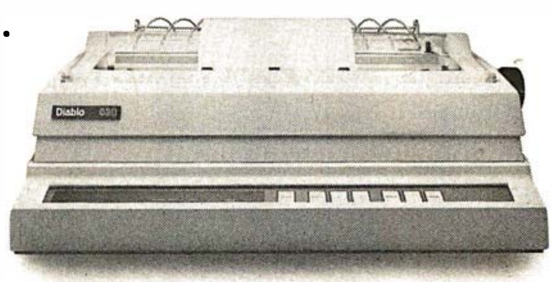

Diablo Systems

XEROX

Circle 100 on inquiry card.

tion, stock market reports, airline travel information, educational, and other data is also planned.

ROM Programs Held Not Copyrightable: A decision made in a federal court has held that object-code programs in read-only memory cannot be copyrighted, even though the source code was copyrighted. One of the bases for the decision was that the object code is not a true copy of the source code, because it is not in a human-readable form.

The decision was made in a case involving two competing computerized chess-game manufacturers. Data Cash Systems Inc sued J S & A Group Inc for producing a chess game that uses read-only memory code identical to its chess-game program, which was copyrighted in source code.

Personal Computers Are In For Another Banner Year: According to a report by the well-known market-research firm Arthur D Little Inc of Cambridge, Massachusetts, sales of personal computers will double this year. The company predicts that sales will reach $950 million, with 600,000 units produced, up from $500 million last year. 1979 showed a 67% increase over 1978, which was not up to the experts' expectations.

The firm predicts that a large part of the personal-computer sales increase will be due to products from Texas Instruments, Mattel, Atari, and Canon, plus the mass merchandising by Sears Roebuck, J C Penney, Montgomery Ward, and Foleys.

Computer Communication Via Amateur Radio Growing: With the Federal Communications Commission's (FCC) approval of ASCII (the American Standard Code for Information Interchange) for transmission over the airwaves, more computerists are turning to amateur radio for computer-to-computer communication. All that is needed is a terminal with (or without) a computer, a modem, and a 2-meter FM transceiver. Articles on how to accomplish this have appeared in the *AMRAD Newsletter* published by an extremely active amateur-radio group, the Amateur Radio Research and Development Corporation. To join AMRAD and receive their newsletter, write: AMRAD, 1524 Springvale Ave, McLean VA 22101.

The protocol used in computer-to-computer transmission is the CBBS (computerized bulletin board system) protocol developed by Ward Christensen and Randy Suess of the Chicago Area Computer Hobbyist Exchange (CACHE). Ward wrote an article on this topic which appeared in November 1978 BYTE (page 150).

CBBSs Increasing Rapidly: The number of Computerized Bulletin Board Systems in operation is now approaching 100. Some provide mailbox facilities, and some have the ability to transmit and receive software. AMRAD will soon publish a listing of CBBSs. To obtain a copy send $1 to AMRAD, 1524 Springvale Ave, McLean VA 22101.

AI Association Formed: The American Association for Artificial Intelligence (AAAI) has been formed. The AAAI is headed by Allen Newell from Carnegie-Mellon University and Edward A Feigenbaum of Stanford University. The association will have its first annual conference August 19th thru 21st and also hopes to publish a regular magazine. For information write AAAI, Stanford University, Box 3036, Stanford CA 94395.

CP/M On The Apple: Apple computer owners suddenly have the whole CP/M (by Digital Research) software world available to them. Microsoft Inc , the recognized leader in developing microcomputer software, has introduced a plug-in card for the Apple which makes it able to directly execute 8080, 8085, and Z80 programs. The card contains a Zilog microprocessor. The Z80 processor executes the application program while the Apple's processor (a 6502) handles the input and output of the keyboard, display, disk, etc. With the Z80 Softcard many powerful languages (eg: FORTRAN, COBOL, APL, etc.), word-processor systems, and business application packages can be run on an Apple. Provided with the card is Microsoft BASIC Version 5.0 and CP/M for $349.

IEEE Forms Network Standards Committee: The first meeting of the IEEE (Institute of Electrical and Electronics Engineers) Local Network Standards Committee took place in March and switched the new network-standards project into high gear. The committee will develop a computer-communications standard that will define, among other things, physical media and line-access methodology. For more information write: Local Network Standards Committee, IEEE, POB 500, Beaverton OR 97077, or call (503) 644-0161.

Gold Cost Causing Computer Prices To Rise: One S-100 computer-board supplier has reported to me that it now costs him $30 to flash gold onto the printed circuit contacts that are inserted into mainframe motherboard connectors. That manufacturer is now seriously considering doing away with gold plating and living with the resulting oxidation problems.

This indicates to me that the days of substantial price cuts on computer equipment appear to be over. Until now the improvements in integrated circuit technology have resulted in either price cuts or increases in computing power. But now the price increases of gold and other materials, added to the increased costs of doing business, are more than offsetting technological gains. IBM, DEC, Datapoint, Univac, and many other computer makers recently increased prices by 4 to 20%.

Programs That Write Programs: Watch out, programmers! Computers may soon take over your job. The only question is how well will they program? These programs include data field, edit, and I/O facilities. For example, Computer Pathways Unlimited, of Salem, Oregon, has introduced a program called PEARL (Producing Error-Free Automatic Rapid Logic) which purports to generate customized business software. PEARL produces a program which is a combination of precoded BASIC utility routines. PEARL does its job by presenting the user with a series of menus and prompts which define the controls and interrelationships between data elements and files. PEARL runs under CP/M and CBASIC. The supplier boasts that little or no programming knowledge is needed to create programs. Now we need a program to write system-level programs, so all of us can retire!

FCC Extends Radio Interference Deadline: The Federal Communications Commission (FCC) has extended the deadline for compliance with regulations concerning radio-frequency interference (RFI) by personal computers. Originally set for July 1,

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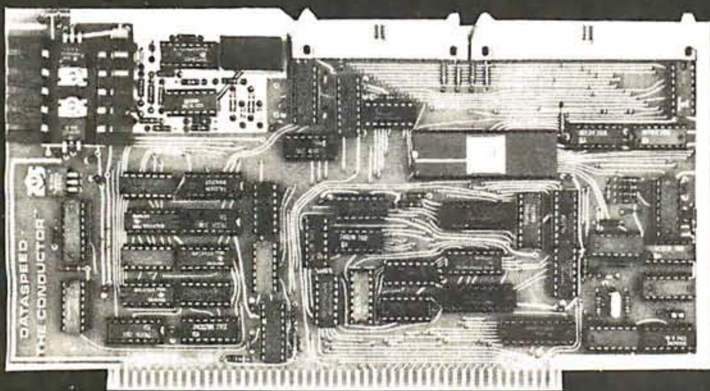

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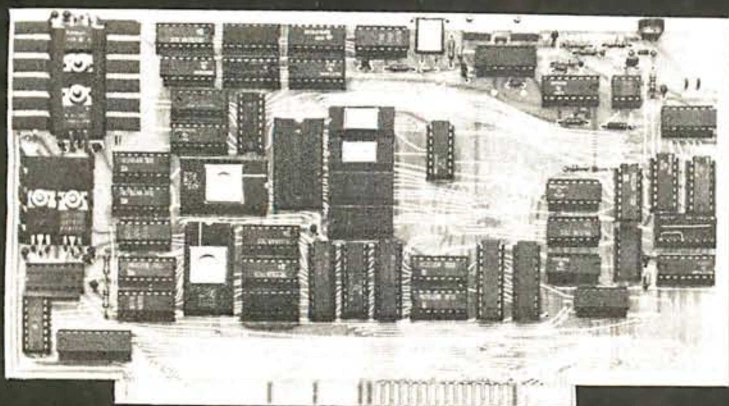

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1980, the deadline has been extended to January 1, 1981. The change was due to widespread industry opposition to the July 1st date.

The regulations are aimed at stemming the interference with radio and television reception caused by computers and other electronic equipment.

CDC To Offer Home PLATO Service: The PLATO educational computer service will soon be made available to home-computer users by Control Data Corporation (CDC). CDC calls the service "Homework." It will provide programs for people with medical disabilities who wish in-home job training. A special video terminal with a touch-sensitive screen is used.

IBM Reports Record Backlog: IBM has disclosed that at the start of 1980 it had an order backlog of $450 million per month, up from $375 million in 1978 and $285 million in 1977. On the other hand, IBM disclosed that computer revenue for the year rose only 0.4% in the US and 6.5% overseas.

Frank T Cary, Chairman and Chief Executive Officer of IBM, took a pay cut for 1979 due to a decrease in company earnings. However, he did get an increase in benefits. His effective earnings for 1979 were $927,902 compared to $892,540 the previous year, an increase of only 4%. Well, times are hard for all of us...I guess.

Random News Bits: Tandy Corporation will soon start a lease plan for the TRS-80 Model II computer that will include a 90-day "warranty" period during which customers can evaluate the machine before committing to a 3-year lease. At the end of 90 days the customer can cancel the lease and pay only for the time used. No figures have yet been released on costs, but it sounds like a good way to find out if the machine will do the job for the customer....A recent DEC advertisement run in a newspaper advertised "cash-and-carry" prices for terminals at its local computer stores. Who knows, we may soon see DEC "Washington's Birthday Specials."...CIS COBOL, from Micro Focus Inc, Santa Clara, California, is the first microcomputer COBOL to be certified by the General Services Administration (GSA) as conforming to ANSI-74 Specifications, Levels 1 and 2. It runs under CP/M or RT-11 DOS...Godbout Electronics, Oakland, California, will soon make available an S-100-bus programmable-memory card that will operate with processors having clock rates as high as 10 MHz, without wait states....Apple Computer Company is enlarging its marketing capability. It recently purchased one of its distributors and discontinued four other distributors. Apple will set up its own regional distribution centers, where it will stock and service Apple products. Dealers will do business directly with Apple via these distribution centers....More details are being made available on the Micro-Winchester hard-disk drive due from Tandon Magnetics Corporation, Chatsworth, California (reported in a previous BYTE News column). The drive will contain two 5-inch platters storing a total of 5 to 6 megabytes and will take up about the same space as a 5-inch floppy. Samples were shown at the NCC (National Computer Conference) in May, and production units are expected by year's end. Two other companies also are rumored to be developing 5-inch hard-disk drives....The Wang Institute, Tyngsboro, Massachusetts, will be the first school to offer a "Master of Software Engineering" degree....General Telephone and Electronics (GT&E) expects to soon begin operation of an intelligent mail/message service via data terminals. Called "Telemail," it will operate 24-hour interoffice communications....Financial users of microcomputers may be interested in a new publication called *The Financial Systems Report.* For a free sample copy, write (on business letterhead): Vernon Jacobs, POB 8137-B, Prairie Village KS 66208.

Random Rumors: Data General (DG, number 2 in the minicomputer field) may introduce a personal computer soon. Actually, DG has been marketing its 16-bit microNova computer for about two years through a few select retail outlets. Now apparently, DG is ready to expand its activities into the personal system marketplace. There still is no word as to whether DEC (number 1 in minicomputers) plans a personal computer....I heard a rumor that one of the large computer-component direct-mail sellers will soon set up a Computerized Bulletin Board System (CBBS) for answering calls and taking orders....Lastly, it is rumored that Texas Instruments is about to introduce two new microcomputer systems. One will be a business-oriented system, while the second will be engineering-oriented and will compete with the recently introduced Hewlett-Packard machine.

Apple And Dow Jones Together Again: Following the success of Apple Computer Company's portfolio-evaluator program — developed with the cooperation of Dow Jones — the two companies have teamed up again to present a new offering, the *News and Quotes Reporter.* Announced by Apple in May at the National Computer Conference in Anaheim, California, *News and Quotes Reporter* is priced at $95, and will be available this month, through Apple dealers.

News and Quotes Reporter has been written for the Apple II personal computer system. Through communication over telephone lines, it allows the user to retrieve past and current news stories and editorials from the *Wall Street Journal, Barron's,* and the Dow Jones news service, as well as quotations for more than 6000 securities traded on the major exchanges. Users access the Dow Jones data base under password protection, and can request news by category (eg: computer industry) or by company name. According to Apple, *News and Quotes Reporter* can be used in conjunction with the portfolio evaluator for sophisticated portfolio creation and management.

Look for more details in the Fall issue of *onComputing.*

MAIL: I receive a large number of letters each month as a result of this column. If you write to me and wish a response, please include a stamped, self-addressed envelope.

Sol Libes
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PILOT/P: Implementing a High-Level Language in a Hurry

David Mundie
104B Oakhurst Cir
Charlottesville VA 22903

PILOT is a simple but entertaining language which is useful for introducing beginners to computing and for writing computer-aided instruction (CAI) programs. I recently decided to add it to the repertoire of languages available for UCSD Pascal systems.

Larry Kheriaty has written a "tiny-PILOT" interpreter in Pascal. (See "WADUZITDO: How To Write a Language in 256 Words or Less," September 1978 BYTE, page 166.) However, I wanted a more powerful language. My goals were rather ambitious:

- implement all of the standard PILOT commands in their most powerful forms
- allow easy extensions to the language without modifying the standard PILOT syntax
- provide a powerful editor for preparing PILOT programs
- spend an absolute minimum of time and effort on the implementation

After a few hours of programming and debugging, I achieved all of these goals and ended up with a new language called PILOT/P.

PILOT/P has the following features:

- a complete battery of built-in functions, including trigonometric functions, logarithms, set manipulations, and string functions
- the use of real variables, arrays, files, and other advanced data structures from within the PILOT/P program
- sophisticated control structures such as CASE statements, REPEAT statements, and FOR loops
- subroutines and parameter passing
- only standard PILOT commands
- a very powerful screen-oriented editor with find, replace, copy, insert, jump, and other commands, including an automatic indent feature which allows painless formatting of PILOT programs

By now you are probably wondering how I accomplished this magic in less than a day of development effort. The trick was actually quite simple. Instead of writing a PILOT/P interpreter or compiler, I wrote a *preprocessor* that accepts PILOT/P source code and translates it into Pascal source code. The translated program may then be run like any other Pascal program.

The advantages of this technique are numerous. All of the drudgery of parsing expressions, handling subroutine calls, allocating memory, and so forth is passed on to the Pascal compiler and pseudocode (p-code) interpreter. Any Pascal feature may be added to PILOT/P simply by adding a WRITE statement to the translator. Because the PILOT/P programs are ultimately compiled into p-code, they probably run faster and use less memory than any interpretive approach I could have implemented. Finally, programs may be edited simply by using the UCSD system text editor, which is far more convenient to use than any editor I could have written.

Using the Preprocessor

Once a PILOT/P program has been edited and saved, the preprocessor is invoked by executing the file PILOT.CODE. The preprocessor then prompts for the name of the file containing the PILOT program to be processed (for example, DEMO). The preprocessor then writes its translation onto a text file whose name is the input file name preceded by a slash—for example, /DEMO.TEXT.

If a syntax error is discovered, the line containing the error is displayed along with an error message, and processing is interrupted until the user signals the program to continue. If errors are discovered, the output file is purged; otherwise, the output file may be compiled and executed in the normal manner.

It would be more convenient to have the preprocessor translate directly into the system work file, which could then be run with a single command. However, the North Star system on which I developed the program does not allow the use of work files.

PILOT/P

The syntax diagram in figure 1 defines PILOT/P. Tables 1 and 2 give the standard and extended uses of the PILOT commands, respectively. Listing 1 is a trivial demonstration program illustrating the standard use of PILOT commands, while listing 2 shows how the same program looks after being preprocessed. Listing 3 is a

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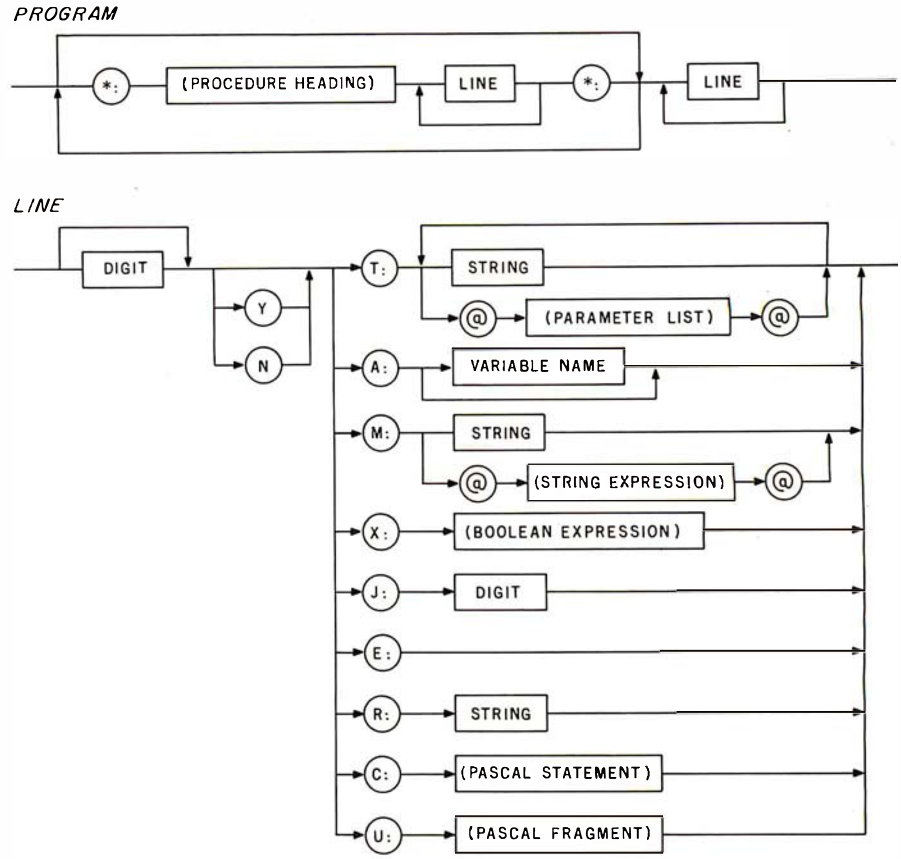

Figure 1: *PILOT/P syntax diagram. Items in circles are terminal symbols that appear in the program as shown. Items in rectangles are metalinguistic constructs. The preprocessor does not check the syntax of the constructs in parentheses.*

program illustrating a few of the language's extended features.

In spite of my commitment to standardization, I made three minor changes in PILOT syntax. I made them basically for aesthetic reasons, although I cannot deny that they made the translation process somewhat simpler.

The first change is that the assignment operator is Pascal's ":=" rather than BASIC's "=". I think the equals sign in standard PILOT is contamination from BASIC.

The second change is that the tokens "Y" and "N" must precede, not follow, their related commands. This is the only order that makes sense to me. As listings 1 and 3 show, this allows all of the commands to be aligned vertically, with a neat row of colons setting them off.

Finally, I have always hated the use of dollar signs ($) in string variable names. PILOT/P, as it stands now, offers the twenty-six integer variables "A" to "Z" and the twenty-six string variables "AS" to "ZS". Of course, other variables may be added as needed by making trivial modifications to the preprocessor.

Users should be aware that at certain places indicated in figure 1, the translator simply copies the PILOT/P source code into the Pascal program. This means that powerful Pascal statements may be embedded directly into the PILOT/P program. It also means that syntax-checking is put off until compile-time. To be safe, those who are unfamiliar with Pascal would be wise to limit themselves to the simpler forms of the commands concerned.

The Preprocessor Program

Program "pilot", shown in listing 4, is the preprocessor. It should be fairly self-explanatory to anyone conversant with Pascal, although source code that generates source code can seem very strange at first sight. (You should remember that Pascal uses two apostrophes to represent an apostrophe inside a string constant.)

Procedure ERROR handles errors, as described above. Procedure SKIP skips leading blanks, so that PILOT/P programs may be indented for maximum legibility. Procedure HEADING writes the heading for the target program, including declarations for all global constants, variables, types, procedures, and functions. It is here that PILOT/P's features may be expanded indefinitely. As a trivial example, the real variable "r1", the file "f1", and the array of strings "a1" may be added to PILOT/P's variables by simply adding:

```
writeln(o,'r1:real; f1:text; a1: array 1..10 of string');
```

after the other declarations in HEADING.

T is a special procedure to handle the messy transformation of a PILOT "type" (T) command into a Pascal

Text continued on page 170

Symbol	Use
*:	Identifies and delimits subroutines. The first occurrence is followed by the subroutine name, while the second occurrence marks the end of the subroutine.
Y	Execute the following command if the flag is true.
N	Execute the following command if the flag is false.
A:	Accept input from the terminal. If followed by a variable name, input is assigned to that variable. If not, input is assigned to the special string variable ANS.
J:	Jump to the following label. Labels must be single digits.
E:	Exit from the main program (or the current subroutine).
R:	Remark.
T:	Type remainder of the line to the terminal. Variables may be displayed if their names are surrounded by at-signs (@).
	Example: T: Very good, @ns@, I'm proud of you.
M:	Match ANS to the following string. A string variable may be used if its name is included between at-signs.
	Example: M: yes,y,ok,sure,fine,swell,great
X:	Examine the following boolean expression and set the flag accordingly. Operators are +, −, *, /, =, < =, > =, < >, AND, OR, and NOT.
	Example: X: (c>0) AND (c<11)
C:	Compute or Call. Perform the following assignment statement, or invoke the following subroutine.
	Examples: C: i:=i+1 C: GETCHOICE
U:	Not needed. The compute command fulfills the function of the standard U command.

Table 1: *PILOT/P implements the standard command set for PILOT.*

Symbol	Use
*:	Parameters may be included Pascal-fashion after the procedure name. Example: *: TEST(s:string)
T:	Any Pascal write-parameter list may be included between the at-signs (@). This facility gives the PILOT/P programmer full control over the display, and eliminates the need for such commands as 1802 PILOT's K command. Example: T: @char(12)@ clears the screen on many video terminals.
M:	Any Pascal string expression may be used if it is surrounded by at-signs. Example: M: @concat(vs,'ing')@
X:	Any Pascal boolean expression may be used, whether arithmetic or not. Examples: X: copy(ns,1,1) = 'T' X: length(ans)> 10
C:	Any Pascal statement or series of statements may be used. (The preprocessor automatically adds a trailing semicolon as a statement separator.) Examples: C: for i: = 1 to 25 do write(ts[i*2]) C: ns: = 'David'
U:	Any Pascal statement or statement fragment may be used. (The preprocessor does *not* add a trailing semicolon.) The following example shows how Pascal's REPEAT statement may be used in PILOT/P:

```
 *:  GETCHOICE( var c:integer)
 R:  Accepts a number and checks its value
 R:
 U:  REPEAT
 T:  What is your choice (1 to 10)?;
 A:  c
 X:  c in [1..10]
NT:  @c@ is out of range
 U:  UNTIL flag
 *:
```

Table 2: *Several of the commands used by PILOT have extensions in PILOT/P.*

Listing 1: *A trivial PILOT/P program intended to show the use of simple PILOT/P commands.*

```
 R: Tests the ability to find a verb.
1C: t:=t+1
 T: What is the verb in "Peter Piper picked pickled peppers."?
 A:
 M: picked
YT: Right!
YE:
 X: t>3
NT: Wrong! Try again.
NJ: 1
 T: The verb was "picked"
 E:
```

Listing 2: *The preprocessed (or translated) version of the PILOT/P program in listing 1. Except for the program heading, the declaration part has been omitted. Since the Pascal source code is meant to be invisible to the PILOT/P user, no attempt has been made to construct a more readable listing format.*

```
PROGRAM demo;
BEGIN initialize;
{ Tests the ability to find a verb. }
1:t:=t+1;
writeln('What is the verb in "Peter Piper picked pickled peppers."?');
readln(ans);
match('picked');
```

Listing 2 continued on page 162

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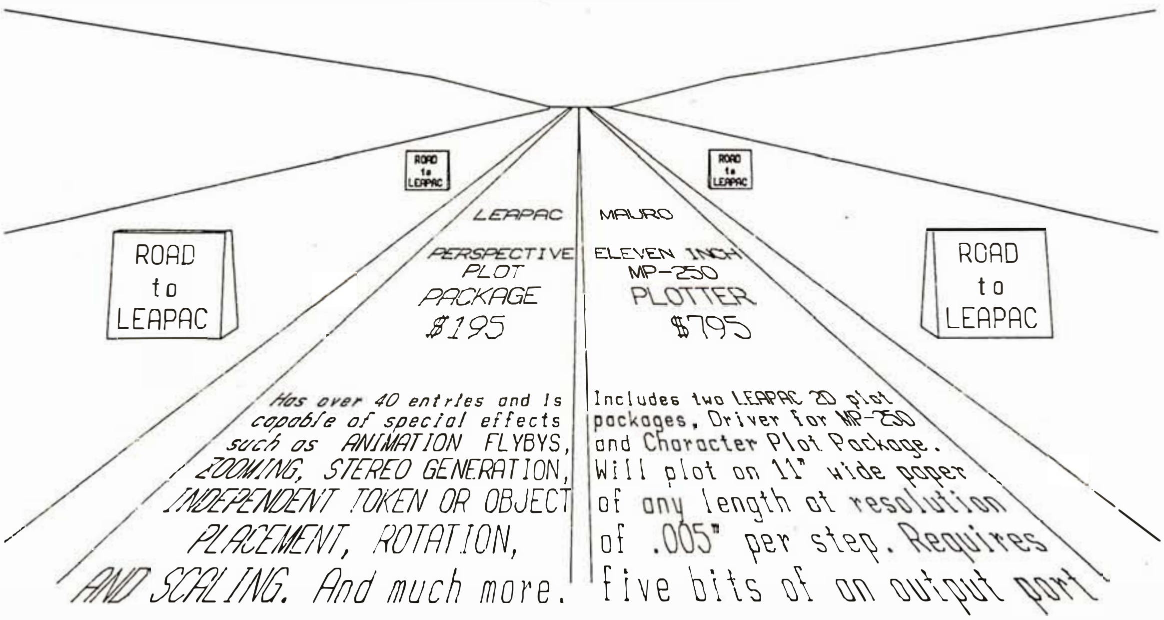

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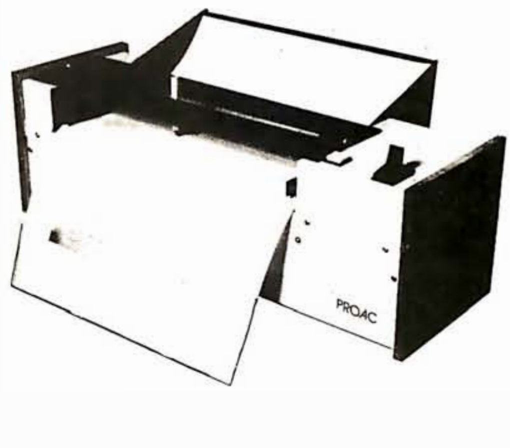

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Listing 2 continued:

```
IF flag THEN writeln('Right!');
IF flag THEN GOTO 10;
flag:=t>3;
IF not flag THEN writeln('Wrong! Try again.');
IF not flag THEN GOTO 1;
writeln('The verb was "picked"');
GOTO 10;
10:END.
```

Listing 3: *A more useful PILOT/P program showing several of PILOT/P's more advanced features. The program tests the user's knowledge of four phonetic terms.*

```
  *: TEST(x:string; y:charset)
  T: Name as many @x@ as you can.
  A:
  C: i:=1
 1X: ans[i] in y
 YC: s:=s+1
 NT: @ans[i]@ is wrong
 YC: y:=y-[ans[i]]
  C: i:=i+1
  X: i<length(ans)
 YJ: 1
  *:
  C: test('stops',['d','t','p','b','k','g'])
  C: test('bilabials',['p','b','m'])
  C: test('labio-dentals',['f','v'])
  C: test('apico-alveolars',['t','d','s','z','l','r','n'])
  T: Your score was @s@ out of 18.
```

Listing 4: *The PILOT/P preprocessing program, "pilot", written in Pascal.*

```
PROGRAM pilot;
CONST
  apostrophe='''';
  el=10;              { label for end of procedure or program }
VAR
  badsyntax:BOOLEAN;
  zzz,                { snooze string to interrupt translation }
  ws,                 { the work string }
  name:STRING;
  i,o:TEXT;
  variables,digits,letters:SET OF CHAR;
  c:CHAR;
  j:INTEGER;

PROCEDURE error(message:STRING);
BEGIN
  writeln(ws);
  writeln('ERROR: ',message);
  writeln('Type anything to continue');
  readln(zzz);
  badsyntax:=true
END;
```

Listing 4 continued on page 164

Listing 4 continued:

```
PROCEDURE skip;
BEGIN
  WHILE i^=' ' DO get(i)
END;

PROCEDURE translate;

PROCEDURE heading;
BEGIN
  writeln(o,'PROGRAM ',name,';');
  writeln(o,'(*$G+*)');
  writeln(o,'LABEL Ø,1,2,3,4,5,6,7,8,9,1Ø;');
  writeln(o,'TYPE charset=SET OF CHAR;');
  writeln(o,'VAR a,b,c,d,e,f,g,h,i,j,k,');
  writeln(o,'l,m,n,o,p,q,r,s,t,u,v,w,x,y,z:INTEGER;');
  writeln(o,'as,bs,cs,ds,es,fs,gs,hs,is,js,ks,ls,');
  writeln(o,'ms,ns,os,ps,qs,rs,ss,ts,us,vs,ws,xs,ys,zs:STRING;');
  writeln(o,'ans:STRING; flag:BOOLEAN;');
  writeln(o,'PROCEDURE match(s:STRING); VAR x,y:STRING;');
  writeln(o,'BEGIN x:=concat('''',''',ans,''',''''); y:=concat('''',''',s,''',''');');
  writeln(o,'flag:=pos(x,y)>Ø ');
  writeln(o,'END;');
  writeln(o,'PROCEDURE initialize;');
  writeln(o,'BEGIN');
  FOR c:='a' TO 'z' DO
    BEGIN
      write(o,c,':=Ø;',c,'s:='''';');
      IF ord(c)mod 4 =Ø THEN writeln(o);
    END;
  writeln(o,'END;');
END;
PROCEDURE T(ws:STRING);
VAR
  i:INTEGER;
  b:BOOLEAN;
BEGIN
  write(o,'write');
  IF ws[length(ws)]=';' THEN
    ws:=copy(ws,1,length(ws)-1)
  ELSE write(o,'ln');
  i:=1; b:=true;
  WHILE i<=length(ws) DO
    BEGIN
      IF(ws[i]=apostrophe) and b THEN
        BEGIN
          insert(apostrophe,ws,i); i:=i+1
        END
      ELSE
        IF ws[i]='@' THEN
          BEGIN delete(ws,i,1);
          IF b THEN insert(''',',ws,i)
          ELSE insert(',''',ws,i);
          i:=i+1; b:=not(b)
          END;
      i:=i+1
    END;
```

Listing 4 continued on page 166

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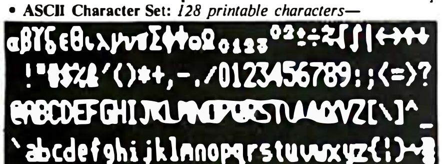

BAUDOT Character Set: *A B C D E F G H I J K L M N O P Q R S T U V W X Y Z - ? : • 3 $ # ( ) . , 9 0 1 4 ! 5 7 ; 2 / 6 8* • **Cursor Modes:** *Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing* • **Cursor Control:** *Erase, End of Line, Erase of Screen, Form Feed, Delete* • **Monitor Operation:** *50 or 60Hz (jumper selectable.*

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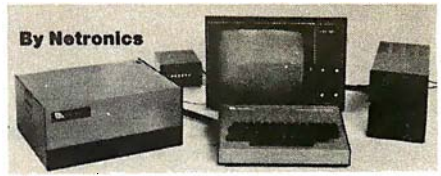

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Listing 4 continued:

```
  writeln(o,'(''',copy(ws,3,length(ws)-2),''');');
  IF not b THEN error('Unmatched @')
END;
PROCEDURE line;
VAR
  j:INTEGER;
BEGIN
  skip;
  IF i^ IN digits THEN
    BEGIN read(i,c); write(o,c,':');
    skip; IF i^IN digits THEN error('Label must be single digit')
    END;
  readln(i,ws);
  IF ws[1] IN['Y','N'] THEN
    BEGIN
      IF ws[1] ='Y' THEN
        write(o,'IF flag THEN ')
      ELSE write(o,'IF not flag THEN ');
      ws:=copy(ws,2,length(ws)-1)
    END;
  IF length(ws)>2 THEN IF ws[3]=' ' THEN delete(ws,3,1);
  IF length(ws)<2 THEN
    error('Line too short')
  ELSE
    IF ws[2]<>':' THEN
```

Listing 4 continued on page 168

ANNOUNCING
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BYTE COVERS

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November 1979

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Listing 4 continued:

```
      error('Colon expected')
    ELSE
      IF not(ws[1]IN ['T','R','A','M','J','E','C','U','X']) THEN
        error('Illegal command')
      ELSE CASE ws[1] OF
     'R': writeln(o,'{',copy(ws,3,length(ws)-2),'}');
     'T': T(ws);
     'M': BEGIN IF ws[3]='@' THEN
            writeln(o,'match(',copy(ws,4,length(ws)-4),');')
            ELSE writeln(o,'match(''',copy(ws,3,length(ws)-2),''');');
          END;
     'J': BEGIN
            IF not (ws[3] IN digits) THEN error('Digit expected');
            writeln(o,'GOTO ',ws[3],';')
          END;
     'E': writeln(o,'GOTO ',el,';');
     'C': writeln(o,copy(ws,3,length(ws)-2),';');
     'U': writeln(o,copy(ws,3,length(ws)-2));
     'X': writeln(o,'flag:=',copy(ws,3,length(ws)-2),';');
     'A': IF length(ws)>4 THEN error('Ask statement too long')
          ELSE CASE length(ws) OF
         2: writeln(o,'readln(ans);');
         3: IF ws[3] IN variables THEN writeln(o,'readln(',ws[3],');')
            ELSE error('Variable expected');
         4: IF(ws[3] IN variables)and(ws[4]='s') THEN
              writeln(o,'readln(',copy(ws,3,2),');')
            ELSE error('String variable expected')
          END
      END; skip
END;
BEGIN{translate}
   writeln('Translating...');
   heading; skip;
   WHILE i^='*' DO
```

Listing 4 continued on page 170

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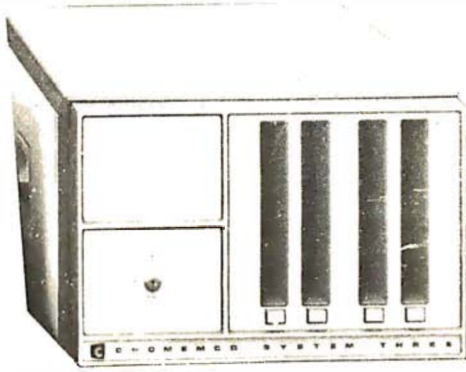

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Listing 4 continued:

```
     BEGIN readln(i,ws); writeln(ws);
       writeln(o,'PROCEDURE ',copy(ws,3,length(ws)-2),';');
       writeln(o,'LABEL Ø,1,2,3,4,5,6,7,8,9,1Ø;');
       writeln(o,'BEGIN');
       WHILE (i^<>'*') and (not(eof(i))) DO
         line;
       writeln(o,el,':END;');
       readln(i)
     END;
   writeln('*:',name);
   writeln(o,'BEGIN initialize; ');
   WHILE not eof(i) DO
     line;
   writeln(o,el,':END.')
END;

BEGIN {pilot}
  variables:=['a'..'z'];digits:=['Ø'..'9']; letters:=['A'..'Z'];
  badsyntax:=false;
  write('Translate what file?');
  readln(name);
  reset(i,concat(name,'.TEXT'));
  rewrite(o,concat('/',name,'.TEXT'));
  translate;
  IF badsyntax THEN
    close(o,purge)
  ELSE
    close(o,lock)
END.
```

Text continued from page 156:

"write" or "writeln" statement. The last character in the work string WS is examined to determine whether or not to suppress the carriage return at the end of the line. The preprocessor then goes through the work string removing the PILOT delimiter "@" and inserting apostrophes as needed. Procedure LINE is the heart of the program; it converts one line of PILOT code into one line of Pascal code. The main program opens the input file, calls TRANSLATE, and performs appropriate actions on the output file depending on whether or not syntax errors were encountered.

Because the preprocessor is written in Pascal, it should be easy to modify and add still more features. For example, PILOT/P's labels are currently restricted to the ten digits 0 thru 9. This is because I wanted to keep the preprocessing down to one pass; so to get around UCSD Pascal's restrictions on labels, I simply had the preprocessor predeclare ten labels for every program block. It is easy to modify the program to declare only needed labels. It would also be easy to make listings. By modifying the procedure TRANSLATE, you could allow the PILOT programmer to declare local variables, types, procedures, and so on. However, I feel that would be going too far. Anyone feeling restricted by PILOT/P's facilities ought to be programming in Pascal to begin with.

Conclusion

Implementing PILOT/P has been an interesting experiment for me, and has given me an immense respect for the possibilities of preprocessors. They represent a tempting approach for anyone wishing to dabble in language design without going to all of the trouble of implementing a language from the ground up.■

The Origin of PILOT

The PILOT language was developed in 1969 by John Starkweather, who was then the director of the computer center at the University of California at San Francisco. He now works for the Langley-Porter Institute at UCSF.

The name of the language is an acronym for Programmed Inquiry, Learning Or Teaching.

Author's Note

I wish to thank Joe Berman, the University of Virginia department of computer science, and NASA contract #NASA-14862 for the use of the equipment on which the preprocessor was developed.

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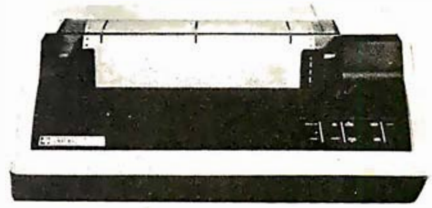

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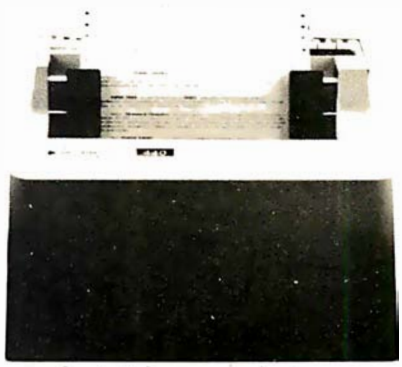

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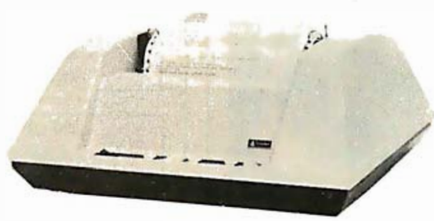

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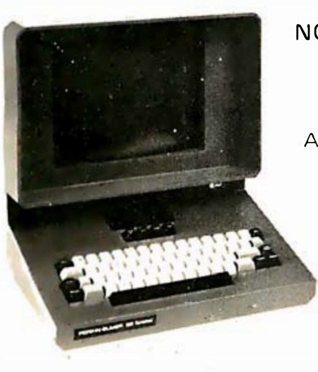

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The Microcomputer in the Undergraduate Science Curriculum

W N Hubin
Associate Professor of Physics
Kent State University
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The inevitable confrontation between science student and computer is occurring in today's colleges and universities. In this article I provide a biased perspective on the current use of computers in science education, try to awaken any latent interest you might have in number crunching (by presenting formulas that could be used to construct a realistic race track simulation), describe a simple microprocessor interface project for the student laboratory, and summarize the action at a recent conference on the use of computers in education. Since I teach physics, a physics flavor is inevitable, but other disciplines will be granted honorable mentions.

Computer-Aided Instruction

CAI (computer-aided instruction) remains a rainbow in the sky that continues to promise gold but has so far delivered little. The major obstacles are probably two: equipment cost and software transportability. Advances in solid-state technology give some promise of surmounting the first obstacle.

The computer can clearly help the student in rote memorization. At the Kent State University's Kent campus (containing about 15,000 students), CAI is growing up in a huge 12-story library building, fathered by a psychology professor who was able to capture the requisite outside funding for the hardware (photo 1). Eleven stations containing six video terminals and five DecWriters are readily available to students and faculty. Their major use may well be that of a computer center substation, though, because only six drill programs are currently available (three languages, general psychology, statistics, and nutrition), six tutorial programs (algebra, climatology, Esperanto, marketing, psychology, nutrition), and 15 manufacturer supplied simulations (mostly ecological and biological systems). The paucity of pedagogical offerings clearly illustrates the transportability problem and a faculty awareness problem. With some notable exceptions, most other large or small schools are in the same predicament, and the outlook isn't very encouraging.

How can computers help science students learn the art? The problem is that science (and particularly physics) seeks to convey physical principles and then asks its inquirers to solve new problems by using these general principles. Such a level of understanding is new and difficult for many students; in this case, intense concentration at a quiet desk is probably the best approach. But where the computer really provides a unique contribution is in extending the physical insight of the students. It gladly shows them the electric or magnetic field caused by a rather arbitrary collection of sources. It happily pictures the changing planetary orbits as the gravitational force law or orbital speed is changed. Astrophysics students can watch the evolution of stars and star systems and test the properties of evolving black holes. Computer-generated rays of light reveal the focal lengths of arbitrary lens shapes and combinations of lenses and pictorialize lens aberrations. Transfer functions for various active filter designs are displayed as fast as parameters can be altered. Radioactive decay and the flight paths of interacting elementary particles can be watched. What's more, these computer-aided instruction programs

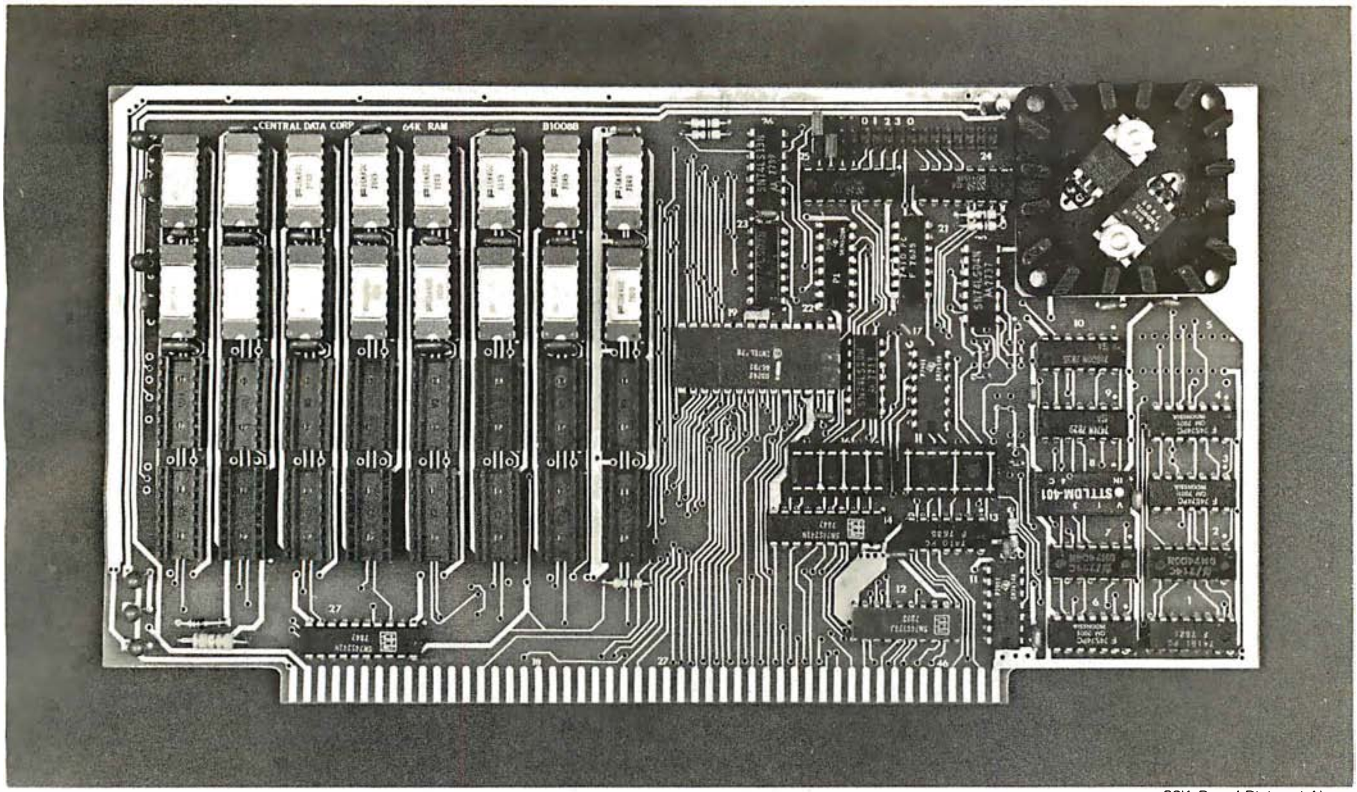

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Photo 1: The computer-aided design laboratory at Kent State University.

can be just as interactive as the student is willing to be inquisitive.

Data Analysis in the Science Laboratory

The computer was quickly accepted by the sciences for its number-crunching powers. But it grew up in an air-conditioned computer center, and there it did its batch mode "thing". When programmable calculators and minicomputers arrived, they were promptly ensconced in computer rooms in the physics, chemistry, or engineering building. With the proliferation of low-cost microcomputer systems there is no longer any good excuse for keeping computers out of the student science laboratory. Computers can help to teach good laboratory practices, of course, but the intention here is to take some of the drudgery out of repetitive calculations and to provide new information on the significance of the student's laboratory data. The following are some examples.

Application Examples

One of the first experiments in a typical college physics course is two-dimensional vector addition. Each pair of students is assigned two hypothetical forces and is asked to obtain the direction and magnitude of the single force that will precisely balance any object that might be subjected to the first two forces. This is to be accomplished both graphically and analytically and then the results are tested on a "force table" where failure produces a noisy collapse


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of the simulated object. Here is one good example of an experiment in which the computer quickly provides an unbiased and friendly second or third opinion for the students.

There are many experiments in which theory predicts a linear functional relationship and students are asked to draw the "best possible" straight line through a set of data points and calculate something of significance from the slope and the intercept of that line. As examples, the average speed of a falling body increases linearly with time (in the absence of significant air drag), and the proportionality constant (the slope of the line) is the acceleration of gravity, g. Second, if the $(\text{period})^2$ of various pendulums is plotted as a function of pendulum length, then the slope of the line (for small angular displacements of the pendulum bob) should be equal to $(4\pi^2/g)$. Third, the EMF (electromotive force) and internal resistance of a battery are the intercept and the slope, respectively, when the voltage at the terminals is plotted as a function of current drawn by an external circuit. Fourth, the natural logarithm of the voltage across a capacitor C that is discharging through a resistance R will, when plotted versus time, yield a straight line whose slope is $(-1/RC)$. In all of these examples, students are to use their own judgment (or fertile imagination) in deciding how to average the scatter in the data and draw the line. A simple, linear, least-squares fitting program (that produces the equation of a line that has a minimum average distance from the data points) provides a second opinion from the computer. Then the student or the computer must plot the data and the straight line to visually gauge the linearity of the relationship and to ensure that one bad data point hasn't exerted an overbearing influence.

The data for this example was collected from a free-falling body apparatus. Here's how the computer analysis is set up: Operation of the apparatus consists of letting a small, metal plumb bob fall freely between two precisely vertical, parallel wires. A 60 Hz spark generator produces sparks that jump from one wire, through the falling object, then through a thin, colored, paper tape, and finally to the other wire. Students carefully measure the separation of the spark dots on the colored tape to obtain position-time data such as the following:

Vertical Height (cm)	Time (seconds)
Y(1) = 0.00	T(1) = 0
Y(2) = 0.33	T(2) = 1/60
Y(3) = 0.93	T(3) = 2/60
Y(4) = 1.73	T(4) = 3/60
Y(5) = 2.82	T(5) = 4/60
Y(6) = 4.23	T(6) = 5/60
Y(7) = 5.87	T(7) = 6/60
Y(8) = 7.75	T(8) = 7/60
Y(9) = 9.96	T(9) = 8/60
Y(10) = 12.41	T(10) = 9/60
Y(11) = 15.13	T(11) = 10/60
Y(12) = 18.18	T(12) = 11/60

It is pretty obvious that this object is accelerating because the distance intervals are getting progressively larger. The question is whether or not the acceleration is constant and, if so, what is it?

After the data is entered, the computer must calculate the average speed during each distance interval. Thus:

$$V(1) = [Y(2) - Y(1)]/(1/60)$$
$$V(2) = [Y(3) - Y(2)]/(1/60)$$
$$\vdots$$
$$V(11) = [Y(12) - Y(11)]/(1/60)$$

These average speeds, eleven of them, were the *instantaneous* speeds at the *midpoints* of the distance intervals *if* the acceleration was constant, as we expect. However, the

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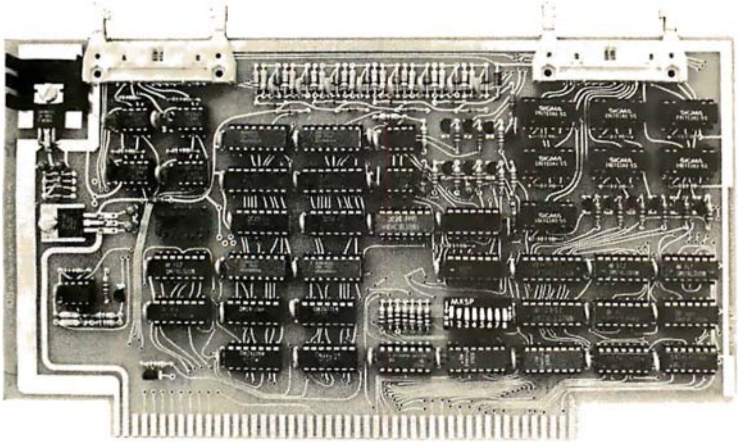

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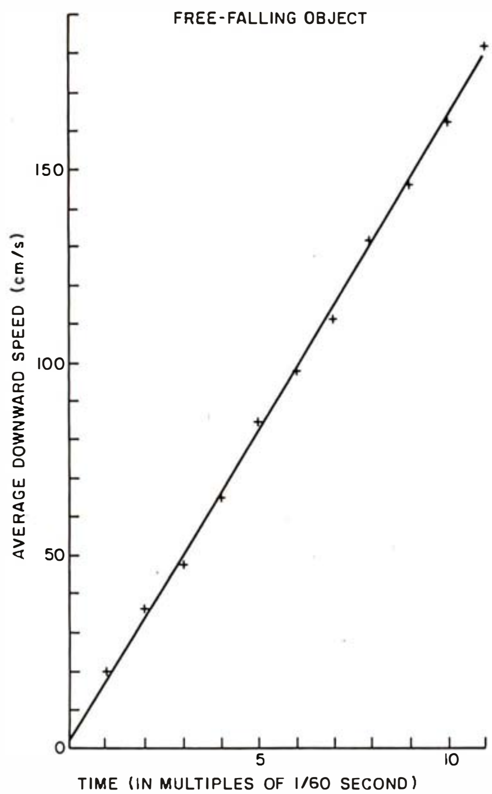

Figure 1: Data points from a free-falling body experiment (see text).

difference in times is still 1/60 second, so we can redefine our zero time to be the midpoint of the first interval and the data points which should then yield a straight line are V(I) and T(I) for I = 1 to 11.

The equation of a straight line is:

$$V = (A1)(T) + A2$$

where A1 and A2 are calculated to bring the straight line as close as possible to the data points. The derivations of formulas for A1 and A2 appear in many texts, so I will just quote the results:

$$A2 = \frac{N \times \overline{VT} - \overline{V} \times \overline{T}}{N \times \overline{T2} - \overline{T} \times \overline{T}}$$

$$A1 = \frac{\overline{V} - A2 \times \overline{T}}{N}$$

In these equations, N is the number of data points and is equal to 11 for the sample data. The other variables are defined as follows:

$$\begin{aligned} \overline{T} &= \Sigma T(I) = T(1) + T(2) + \ldots T(N) \\ \overline{V} &= \Sigma V(I) = V(1) + V(2) + \ldots V(N) \\ \overline{VT} &= \Sigma V(I) \times T(I) = V(1) \times T(1) \\ &+ V(2) \times T(2) + \ldots V(N) \times T(N) \\ \overline{T2} &= \Sigma T(I) \times T(I) = T(1) \times T(1) \\ &+ T(2) \times T(2) + \ldots T(N) \times T(N) \end{aligned}$$

The average vertical deviation of the data points from the straight line, which has been minimized with this choice of A1 and A2, is given by:

$$S = \text{Average deviation} = \sqrt{\frac{\Sigma[V_{calc} - V_{exp}]^2}{N}}$$

This expression means that we add up the sum of the *squared* deviations of the speeds obtained from the data $[V_{exp} = V(I)]$ from the speeds calculated for the same times using the derived equation of the straight line $[V_{calc} = A1 \times T(I) + A2]$, divide this sum by the total number of experimental speeds, and then take the square root. By squaring the vertical deviation we have ensured that points above and below the line are treated equally. See if you can obtain A1, A2, and S. For comparison, I obtained A1 = 973.309 cm/s^2, A2 = 1.83276 cm/s, and S = 1.75428 cm/s. This means that the acceleration of gravity was a measured 973 cm/s^2. The uncertainty in this measurement can be estimated by dividing the average vertical deviation by the total time interval, thus:

$$g = \text{experimental value of acceleration of gravity} = 973 \pm 11\ cm/s^2)$$

The actual acceleration due to the gravitational force depends on one's location on the earth; specifically, it depends on one's angular distance from the equator, the distance from the center of the earth, and local nonuniformities in the density of the earth. The first two effects are easily taken care of by using Helmert's equation:

$$\begin{aligned} g \text{ in } cm/s^2 &= 980.616 - 2.5928 \cos 2\phi \\ &+ 0.0069 \cos^2 2\phi \\ &- 3.086 \times 10^{-6} H \end{aligned}$$

where ϕ is the latitude in degrees and H is the elevation above sea level in centimeters. This equation gave a value of 980.27 cm/s^2 for the laboratory where the sample data was taken, and thus there is comfortable agreement between laboratory and handbook values. The experimental data and the derived straight line are shown plotted in figure 1.

Many physical properties exhibit a more complex functional relationship than the simple linear one. As one example, in *Cooke titration* the acidity is a parabolic function of the carbon dioxide added and a computer is invaluable to make the fit. As another example, a resistance thermometer (just a carbon or germanium resistor) at very low temperatures exhibits a complex logarithmic dependence of resistance on tem-

perature; a computer fit is needed in order to obtain temperatures between the calibration points.

For me, the really exciting and new aspect of computer analysis in the introductory student laboratory is the possibility of determining the validity of experimental data and calculated quantities. In the days of the slide rule there was little need to stress significant figures because both the measurements and the calculating device were good to at best three significant figures. The electronic pocket calculator has changed one part of that and has showed us how very hazy and difficult is the concept of significant figures. We now commonly observe students taking the distances they have measured to three significant figures (eg: 8.45 cm), dividing this by a time accurate to two significant figures (eg: 0.73 seconds), and proudly presenting a calculated speed with apparently seven significant figures (eg: 11.575342 cm/s) because that is what their calculators indicated!

There are two methods by which I try to get students to be more thoughtful and to throw out numerical garbage. One method is the "rules of significant figures," from which they should learn that the answer after a multiplication or division is limited by the accuracy of the least accurate factor; the rules for addition and subtraction are a little more difficult. Thus, in the example above, 11.6 cm/s would be a reasonable and accurate answer.

The second method is a powerful one and relatively easy to understand, but can become tedious rather quickly. It is therefore not usually employed in introductory laboratories. This method is "worst case error analysis" and is based on the reasonable assumption that Murphy's Law will certainly prevail. It suggests that we calculate the possible *range* of values for an answer by asking how our estimated inaccuracies could possibly combine to give a maximum deviation from the nominal value. In our previous example we probably could have estimated the accuracy of our distance measurement (eg: ±0.05 cm) and of our time measurement (eg: ±0.03 seconds). The speed could then have been as large as the *maximum* possible distance divided by the *minimum* possible time [(8.45 + 0.05)cm/(0.73 – 0.03) s = 12.1 cm/s], or it could have been as small as the *minimum* possible distance divided by the *maximum* possible time [(8.45 – 0.05)cm/(0.73 + 0.03) s = 11.1 cm/s] and we could safely report that we determined the speed to be 11.6 ± 0.5 cm/s for this example. In the actual research laboratory, we can often repeat our measurements and apply statistical tests to determine validity, but worst case analysis is useful whenever a measurement is not or cannot be repeated, for measurements in any field.

After doing this type of error analysis with a pocket calculator a couple of times, the students understand the logic of the process and are quite ready to let the computer do it. They still reap the benefits of having to estimate their experimental accuracy and of reconciling their answers with the "known" value, but are spared the drudgery of the repeated calculations. In the student laboratory the measurement technique, the analysis technique, and the reinforcement of physical concepts, are all important — the actual answers obtained are not.

A surprising number of personal computers are used for laboratory calculations throughout the United States, particularly for those schools or departments that haven't been able to tap into a large computer. More and more, microcomputers will be telling mainframes to keep their terminals to themselves!

Data Acquisition in the Science Laboratory

Meter sticks, stopwatches, multimeters, and thermometers have been standard laboratory equipment for a long time. Here is an enclave ripe for microprocessor invasion. Two reasons suggest that only a mild invasion will occur in the near future: education's sensitivity to cost, and the fact that intelligent laboratory equipment may be less instructive for the student than the traditional tools.

Modern digital components should certainly be exploited much more than they are presently. Photo 2 shows an example of a home project design that does more than the available commercial equipment. A forensic physics class is shown in the process of making distance-time measurements on an air track with a 16-memory digital timer. Front-surface mirrors bounce a laser beam down and across the track at intervals just equal to twice the length of the air track glider and finally to a FPT-100 phototransistor detector. Times are recorded whenever the beam is broken or unbroken so that the times correspond to equal increments of traveled distance. (The laboratory air track was the progenitor of the air hockey table: air is blown through many small holes in the track so that the glider rides on a layer of air and can move along the track with almost negligible friction.) The timer uses 7489 integrated circuits for memory but the times are first latched into

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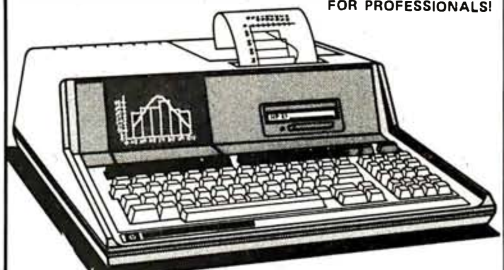

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Photo 2: Forensic physics students taking data with a multimemory digital timer and an air track.

7475 integrated circuits so that the last time is displayed until a new time is recorded. (Physics labs around the country generally use only two photocell timers on their air tracks, or, if they are still in the Stone Age, measure the spacing of dots burned into a sensitized paper tape by a sparker mounted on the glider.) With this timer a single, long air track serves a whole class; each pair of lab partners obtains unique, high-quality data. The fundamental mechanical concepts of speed and acceleration are most easily understood through graphs, and the data from this timer yield smooth curves with many points on them.

Should this timer be given intelligence? I think it will happen. It isn't clear, though, how much more instructional good will result: a microprocessor could very flexibly calculate speeds from distance and time data, but the students (in this case at least) need to do that calculation themselves if they are to understand the concepts involved.

This particular timer, only a few months old, has done some other useful things, too. It has directly measured the muzzle velocity of a 0.177 pellet pistol. It has measured pendulum periods and, thereby, simply and quickly provided highly accurate values for the acceleration of gravity. It will even try to outdo Galileo as it records balls being dropped down an intimidating 12-story stairwell in our university library.

One university recently reported the widespread possibilities of an interactive terminal in the lab: the computer was programmed to give simulated, randomly generated, experimental data to supplement data taken by the student in the laboratory. Students are asked to discover for themselves, from the data, the nature of the functional relationship between the experimentally measured quantities.

Thermodynamics laboratory experiments are so inaccurate that many professors fear for their credibility during that time of year. Thermistors and resistance heaters and microprocessors could change all that. So far there is little inkling of it happening.

Upper division science labs can potentially make the most use of "smart" equipment because students are much better prepared for mathematical and instrumental sophistication by that time. Some commercial equipment, sometimes borrowed from a research laboratory, is now being used. The same problems of commercial feasibility, cost effectiveness, and transportability are present to inhibit the development of smart equipment optimized for the instructional laboratory. A most promising area is the senior project: a microcomputer teamed with some analog-to-digital converters has almost limitless possibilities.

Computers in Chemistry is a separate division of the American Chemical Society. Most of the society's publications are concerned with data analysis; a lot of minicomputers and microcomputers have turned up in their labs for experiment and process control. Other departments in the universities are realizing the advantages of dedicated resident computer systems, too. At Kent State University the psychology and sociology departments have purchased turnkey microprocessor systems so that they can directly record and analyze data.

Today's physics departments are searching for relevant courses for nonscience students. In such courses the experimental technique does not have to be understood by the student; real-time analysis of physical phenomena is the goal, and microprocessors are the appropriate tool. Cleveland State University recently reported an excellent example of such use in their acoustical physics laboratory. Aided by a National Science Foundation grant, they have interfaced a Texas Instruments TI 980 computer to eight stations in the laboratory. Each station has on-line voltage and time measurement capability, a keyboard, a video display, and a printer. In one experiment the reverberation time for the room is first calculated by the student and then measured with a microphone hooked to the voltage interface. In another experiment the harmonic spectrum of a student-selected sound source (eg: voice, violin, frog) is

obtained. At yet another school, the music department is using a SwTPC 6800 system to generate a wide variety of musical sounds and thereby help very large numbers of music students develop ear training skills.

Computer Science Courses

Computers have been traditionally associated with computer centers and with mathematics or computer science departments. Outsiders have been welcomed but it has sometimes been made clear that computer and programming courses were the sole province of the center. This has unfortunately tended to stifle the development of courses taught by engineering or science faculty in which the computer is simply a powerful tool for deeper penetration into nature's secrets.

There are many topics in science that are conceptually within the grasp of undergraduate students but are not even mentioned to them because of calculational complexity. A good example is projectile motion. Students dutifully calculate the range of a batted baseball from the equation $R = (v^2 \sin 2\theta)/g$, but they are almost never told that a real home run travels about 1/5 the distance they calculate from this formula! Air drag is the reason and a great deal of fascinating insight into the real world of projectiles emerges when it is included.

If computer scientists love the computer for what it is, then physical scientists love the computer for what it can do for them. That is, there exists a powerful joy of number crunching.

Few introductory computer texts go beyond games or business applications. Alan Grossberg's *FORTRAN for Engineering Physics* (McGraw-Hill Inc, 1973) is a very early attempt to make computer analysis an integral part of an introductory lab. Robert Ehrlich's *Physics and Computers: Problems, Simulations, and Data Analysis* (Houghton Mifflin Co, 1973) is an effort to supplement the material of advanced undergraduate courses in a *separate* FORTRAN based physics course. He introduces FORTRAN and then gives applications in electrostatics and electric circuits, in classical and quantum waves, in Monte Carlo simulations, and in experiment data analysis.

The language that the student uses must be friendly and easily learned. Structured programming isn't necessary; we aren't trying to train systems programmers. Herbert Peckham's *Computers, BASIC, and Physics* (Addison Wesley, 1971) pointed out the BASIC way. This text is a self-contained book that covers Hewlett-Packard BASIC, numerical analysis including differential and integral equations, and some data analysis.

A recent and very impressive effort is the nearly 500 page tome produced by William Ralph Bennett Jr, *Scientific and Engineering Problem-Solving with the Computer*, (Prentice-Hall Inc, 1977). Bennett introduces BASIC in the first thirty pages and then launches into a bewildering and enticing variety of topics. One chapter is on languages: the probability of monkeys typing poetry; computer identification of literary authors; cryptography; etc. Another chapter is on dynamics: footballs and slicing ping-pong balls in flight; space travel; and charged particle motion. Yet another chapter is on random processes: statistical distributions; diffusion; and the spread of contagious diseases. (Hardware enthusiasts take note: You can save a great deal of money if you buy this book and don't buy additional memory or another peripheral until you've solved all of Bennett's problems.)

My own book, *BASIC Programming for Scientists and Engineers* (Prentice-Hall, Inc, 1978) is a more modest effort that is directed toward the more traditional education of the scientist or engineer. Sample answers are provided throughout the book

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to encourage self-study. There is a formula oriented introduction to BASIC, a chapter on flowcharting based on a typical aircraft loading problem, language-independent methods for data analysis, and some 50 pages of science problems for computer solution. The problems include predicting a car's top speed from low speed data, the cost of heating a home, simulation of ground-based, collision-avoidance radar, circuit analysis, motorcycle jumping, Mars orbit insertion and landing, and a simulation of a smart temperature controller.

Here is a new example of a problem that is easily programmed and yet provides new insight into the problems of keeping a vehicle on the road. You might wish to use the provided equations to implement a dandy game that will tell you reliably how fast you could drive your fantasy automobile at your local race track, at Indianapolis, or at Monte Carlo.

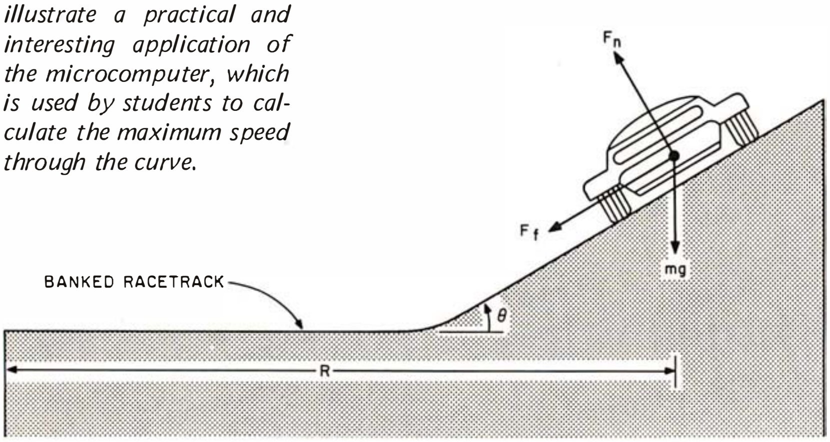

Figure 2: Physics of a race car rounding a banked curve. This example is used by the author to illustrate a practical and interesting application of the microcomputer, which is used by students to calculate the maximum speed through the curve.

Consider the speedy sports car of figure 2 that is trying to round a banked curve with a radius of turn equal to R. A positively cambered, banked curve with angle of bank given by θ is shown. Assume also that the curve is on a hill whose angle above the horizon is β, where β is positive if the car is going up the hill. Newton's equations of motion for the vertical (y) and horizontal (x) directions are:

Sum of vertical forces

$$= \Sigma F_y = F_n\cos(\theta) - F_f\sin(\theta) - mg\cos(\beta) = 0$$

Sum of horizontal forces

$$= \Sigma F_x = F_n\sin(\theta) + F_f\cos(\theta) = \frac{mv^2}{R}$$

in which F_n is the perpendicular component of the force of the road on the car and F_f is the parallel (ie: frictional) component of the force of the road on the car. The weight of the car is equal to mg, where m is the car's mass and g is the acceleration of a free-falling object due to the gravitational force. The value of g is about 32.2 ft/s^2, but a more precise value for a particular location on earth can be obtained from the *Handbook of Chemistry and Physics* or from Helmert's equation given earlier.

If we make the usual assumption that the maximum frictional force F_f is proportional to the normal force F_n and that the constant of proportionality is the coefficient of static friction, μ (so $F_f = \mu F_n$), then we can solve these equations for maximum and minimum speeds. A first result is for the maximum speed through the curve:

$$V_{max} = \sqrt{\frac{gR(\mu\cos\theta + \sin\theta)\cos\beta}{(\cos\theta - \mu\sin\theta)}}$$

This equation is valid for bank angles θ that are greater than $-\arctan\mu$ and less than $\arctan(1/\mu)$. This means that the equation also is valid for negatively cambered turns (banked the wrong way; θ is a negative angle). If the angle of bank isn't greater than this negative minimum of $-\arctan\mu$, then the car will slide off the curve even if it isn't moving! For bank angles greater than $\arctan(1/\mu)$, frictional considerations do not limit the maximum speed at all, so a maximum speed does not exist for those angles either.

When the angle of bank gets large or the road gets very slippery, then there is also a minimum speed at which the turn can be negotiated. This is given by:

$$V_{min} = \sqrt{\frac{gR(-\mu\cos\theta + \sin\theta)\cos\beta}{(\cos\theta + \mu\sin\theta)}}$$

A V_{min} will exist and can be calculated from this equation for any bank angle greater than $\theta = \arctan\mu$.

The load factor, which is the ratio of the net force of the road on the car to the weight of the car, or the ratio of the net force of the car on the driver to the driver's weight, tells us a lot about the comfort of the driver. In fact load factors approximately greater than 5 cause blackouts if they last for more than a few seconds. Here is a formula for the load factor for our racing car, also derived from the equations of motion:

$$\text{load factor} = \frac{\sqrt{\mu^2 + 1}\,\cos\beta}{(\cos\theta - \mu\sin\theta)}$$

This equation is valid over the same bank angles as for V_{max}.

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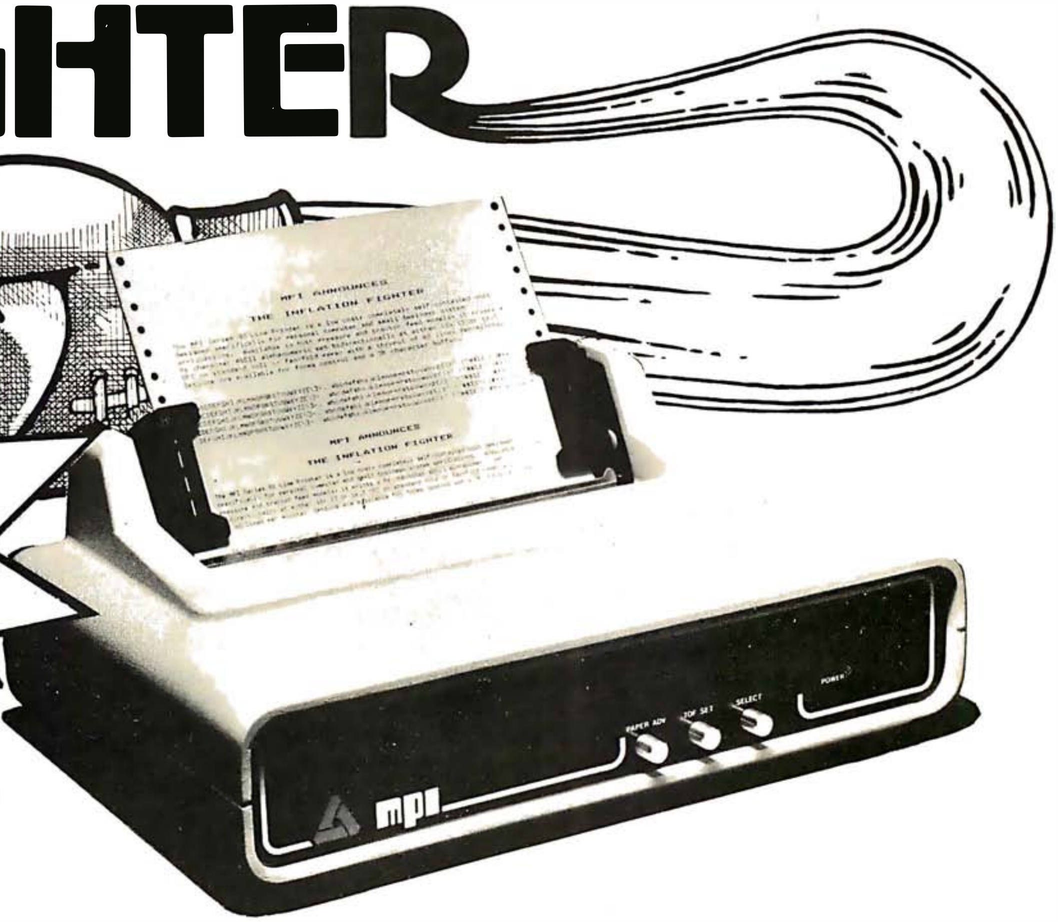

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The first two equations yield speeds in ft/sec for g in ft/sec^2 and for the radius R in feet (88 ft/s = 60 mi/hr, so multiply by 60/88 to convert from ft/s to mi/hr). The load factor is a dimensionless quantity but is often reported as so many gs.

Good values for the coefficient of friction can be obtained from the tests made by car magazines because the coefficient is numerically equal to the maximum lateral acceleration (expressed in gs) that they measure in their skid pan tests. For example, recent tests yielded a μ of 0.653 for an American station wagon and 0.820 for an English sports car. Assume now that these vehicles are at the Daytona Speedway and are going into the high-speed 31° banked turn. The radius of the turn is about 1100 feet. The track is fairly flat so we'll consider β to equal 0. The equations (use g = 32.2 ft/s^2) then tell us that the station wagon would skid off the track at 184 mi/hr, but the sports car could get up to 215 mi/hr. The load factor would be 2.29 for the station wagon and 2.97 for the sports car. The sports car could make it around a curve having off-camber up to 39°. If water or oil should reduce the coefficient of friction to 0.45, there would be a minimum speed of 44 mi/hr on the 31° banked part of the track.

The effective coefficient of friction for maximum braking is generally different than the coefficient for turning, because complicating factors such as the extra heat build-up and tire deformation are different. The effective coefficient for braking is easily calculated from the braking performance tests performed by the car magazines, although this calculated coefficient does depend somewhat on the beginning speed. Physically, the derivation proceeds from the assumption that all the kinetic energy of the car is transformed into frictional (ie: heat) energy; this is nearly true but does neglect air drag and tire heating. The result of such a derivation is:

$$\mu_{braking} = \frac{v^2}{2gd}$$

where v is the beginning speed in ft/s and d is the distance in feet required to come to a complete stop. For example, one test found that a Ferrari 308 GTB could sustain a maximum lateral acceleration of 0.804 g and could brake from 80 mi/hr to a stop in 288 feet. Our equation tells us that the braking coefficient was

$$\mu_{braking} = \frac{(80 \times 88/60)^2}{2 \times 32.2 \times 288} = 0.742$$

To really use this coefficient, we would like an expression for the maximum deceleration on a hill with slope β and/or a maximum-speed turn on a curve with bank θ. Newton's equation of motion yields:

$$\text{maximum braking deceleration} = -g \cos\theta \left[\sin\beta + \frac{\mu_{braking} \cos\beta}{\cos\theta - \mu \sin\theta}\right]$$

From this you can calculate a maximum deceleration of −33.5 ft/s^2 if the Ferrari is going *up* a 20° hill without turning; going down the hill would produce only −11.4 ft/s^2. On a Daytona-type curve these values would be −52.9 ft/s^2 and −34.0 ft/s^2, respectively. (The impressive performance on a banked track at maximum speed is because the car is pushing much harder on the ground. This is the reason that wings can be so helpful to racing cars.)

The distance traveled while a car is steadily decelerating from v_o to v_f is given by:

$$\text{slowing distance} = \frac{(v_f^2 - v_o^2)}{2a}$$

where a is the calculated deceleration. On a flat Daytona banked curve the maximum speed for the Ferrari is about 212 mi/hr and its maximum deceleration is about −46.2 ft/s^2. It would therefore travel about 446 feet in a maximum performance deceleration from 212 mi/hr to 160 mi/hr.

Finally, the maximum accelerations of which a car is capable can be determined from the speed-time graphs presented by the car magazines. Combine all these formulas with a video display of the bank, the curve, and the slope and have joysticks for throttle, brakes, and steering, and a very realistic simulation of a race could be made. Add some oil on the track from a blown engine ahead of you (μ down to perhaps 0.3) or ice (μ down to perhaps 0.1) for some randomly generated, additional excitement.

To my way of thinking, the programming of a problem of physical interest is half the fun. I derive no pleasure from copying someone else's program and so I can't understand why so many complete BASIC programs appear in the periodical literature. If a difficult algorithm is involved, then it might be desirable to provide a flowchart of the logic. But the fundamental problem of most students is that they can't think of ways to utilize the power of a computer. Therefore my approach is to provide physical problems of significant interest with sample answers

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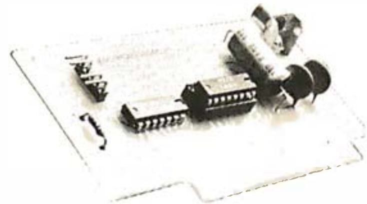

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Photo 3: The digital design laboratory at Kent State University.

so that programming skills, analysis techniques, and physical insight can be developed together.

Hardware Courses

In a recent survey of eighteen colleges and universities in northeast Ohio, fifteen departments reported offering microprocessor hardware courses. There were four electrical engineering and electrical engineering technology departments, four other engineering technology departments, five physics departments, and two chemistry departments! Microprocessor systems can be purchased as "electronic equipment," "calculators," or as "data processors"; they can be hidden in closets, and their proud owners are going to teach their students how to use them!

There are plenty of turf disputes still to come, particularly when format courses come up for college approval. In the survey, four computer science/mathematics departments reported courses in the programming of microprocessors. (It would be nice, but above par, if the programming faculty would use the same types of microprocessors as the application faculty.) The other science departments, at least to some extent, were offering both hardware and software material in their courses. Some of the offered courses are undoubtedly quite shallow, consisting of little more than a discussion of Boolean logic, a description of system components, and a few machine or assembly language programs. (Computer experimenters tend to forget how much terminology and how many concepts they have learned through osmosis; most students possess little more than what they have learned from their formal coursework.) This kind of trivial introduction to microprocessors is particularly likely at the two-year or technical degree level, but it can be argued that a general knowledge of microprocessor systems is still worthwhile. On the other extreme, some electrical engineering departments are equipping themselves with elaborate microprocessor development systems and are fully prepared to generate serious process control designs.

Most professors are learning the material themselves as they develop and teach their new microprocessor courses. Outside of electrical engineering departments, there is so little room in the curriculum for the new courses that it is doubtful that very many undergraduate students are going to be proficient with either software or hardware practices when they graduate. But industry will still find them much better prepared than graduates of just a few years ago.

Physics departments have always taught electronics courses but the curriculum will burst if more than two or three are offered. At schools where there is no electrical engineering department, as is true of most private colleges, physics usually does all the electronics teaching. Photo 3 shows the physics digital electronics laboratory at Kent State. It has been found that there is no time left to do interfacing if an attempt is made to teach machine-language programming in this digital electronics course, and so present plans are to develop interfacing experiments under BASIC control.

Most educators began their own education in microcomputers with hobby kits. That survey mentioned earlier turned up 13 KIM-1s, 13 Intel development boards or systems, four Ohio Scientific systems, four MMD-1s, three Heath microprocessor trainers, two Digital Group systems, one Altair, one IMSAI, one SwTPC system, and several lesser known systems. One school had six programming stations mothered by a minicomputer that simulated the M6800 instruction set. If there is a perceptible trend, I would perceive it to be in three directions: bare trainers like the MMD-1, the Heath, or the KIM-1 for introductory courses; well-supported microcomputers that can number crunch, teach system theory, do some process control such as digital filtering, and teach programming; and complete development systems to emulate the designing being done in industry.

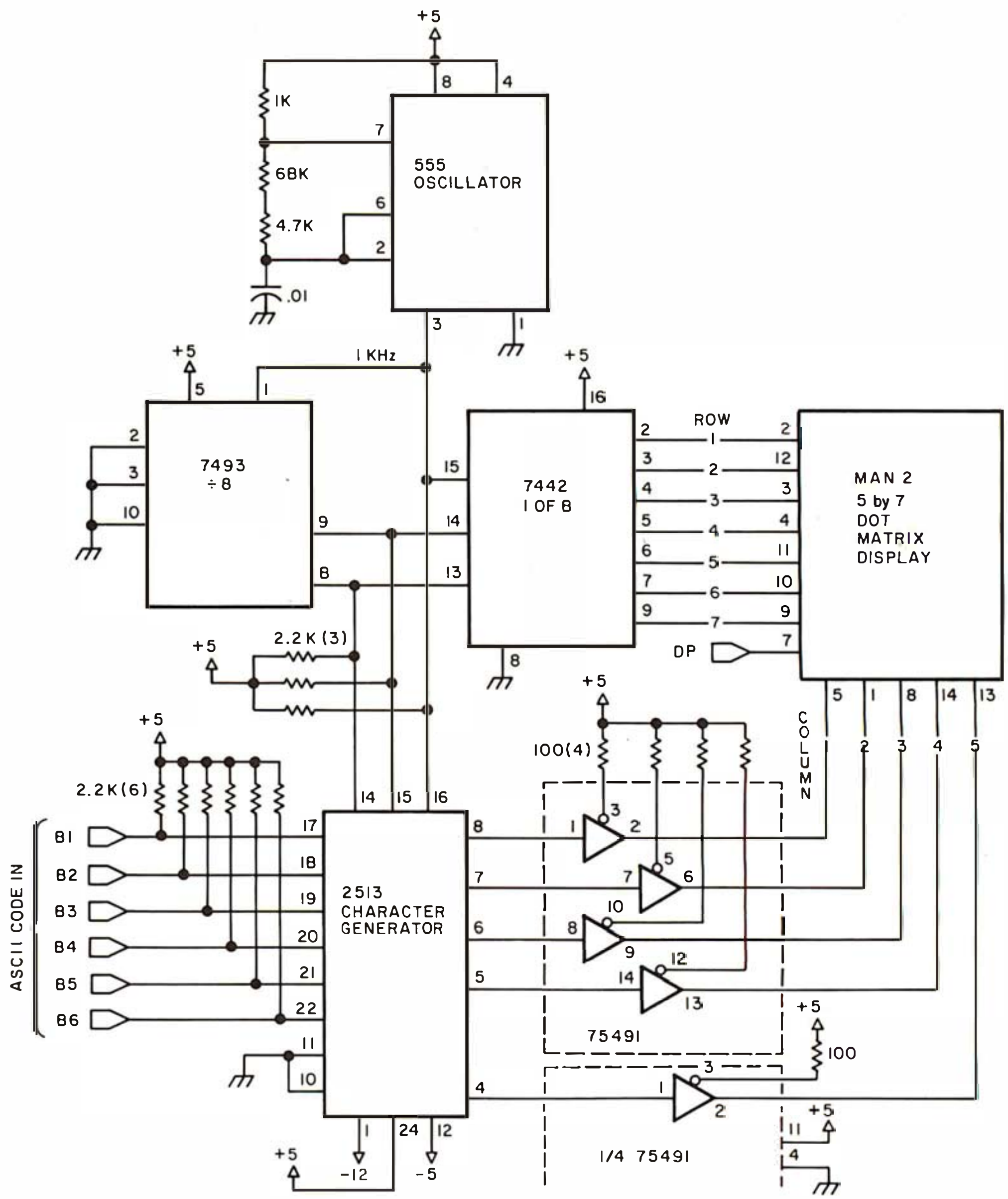

Figure 3: An LED (light-emitting diode) light display circuit designed by the author as a student project.

I recently built and interfaced a 12-character alphanumeric display to the Heath ET-3400 microprocessor trainer. Figure 3 shows the basic circuit, which uses a 0.3 inch (0.76 cm) 5 by 7 dot matrix display. In its single character form it makes a nice project for the student laboratory, where it presents many aspects of digital design: multiplexing, two logic families, ASCII encoded read-only memory, latches, and address decoding. Particularly in a multicharacter display, it provides an enticing excuse for doing some challenging machine-language programming. It also could be used as the primary display for a microcomputer on a board used to control some process. It has been used as a promotional display and then it is usually programmed in both a sweep mode and a flashing mode. (Circuit and programming details are available from the author. For one who simply wants to quickly construct an alphanumeric display, I would recommend the 4-character modules made by Litronix. These are the DL-1414, the DL-1416, and the DL-2416 and they come complete with latches, ASCII decoder, and multiplexing circuitry. They are only half the height of the MAN3, though, and the cost would be about the same.)

Educational Displays

There is no reason why all the world's wild light displays have to be in baseball parks or in night clubs! Even the modest display of figure 3 has attracted considerable interest whenever it has been displayed. Such displays seem to help the general

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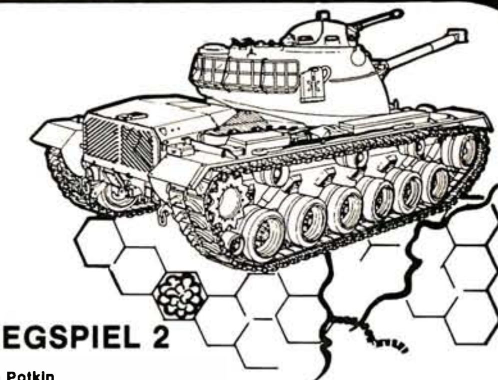

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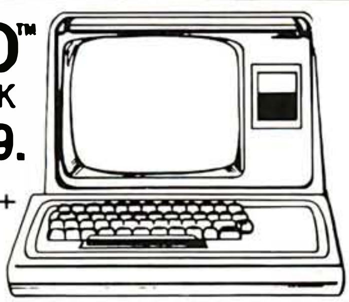

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public and nonscience students to realize that computers can be small and friendly rather than just intimidating storehouses for secrets.

There are also some exciting possibilities for interactive displays outside departmental offices and for educational displays in student unions. Many schools are recruiting in shopping malls these days and a good smart display is a real winner there. Visitor aids on campus badly need updating. In fact, schools need all the help they can get in presenting a favorable image to the public, who are footing the growing bill.

Computer Conference

One year I went to the Ninth Annual Conference on Computers in the Undergraduate Curricula. I hoped to observe the leading edge of the computer invasion into education. No such luck.

It started very well with a scintillating opening talk by Portia Isaacson (computer scientist, computer store owner, and writer). She provided a list of reasons that induce people to buy computers. Inventory control is one such common application, of course, but she was surprised one day to find out (after the fact) that one of her customers was a fence who used his microcomputer to organize his inventory of stolen goods.

There are some interesting, if not startling, papers. The US Naval Academy presented their development of an interface between a Honeywell 635 computer and video cassettes, and described applications to chemistry laboratory exercises, chemistry problem-solving drills, economics, and physics laboratory practice drills. Duke University presented a program that served as a general problem solver for mathematics courses. Other mathematics applications included mathematics for liberal arts students and graphical aids for calculus courses. Nonscience applications included computer-aided instruction English programs, computer-aided musical theory drill and musical composition (a most tuneful paper), sociology and psychology computer-aided instruction. Simulation and modeling programs for business courses and for ecological systems were presented. Cleveland State University described the musical acoustics laboratory discussed earlier.

There were *no* papers describing computer courses designed to provide new physical insights and there were *no* papers on microcomputer/microprocessor programming/design courses! Apparently the controlling group prefers to listen to reinventions of a better wheel on an annual basis. For excitement I'll try a personal computing conference next time.■

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Editor's Note

The other day we were sitting around the BYTE offices listening to software and hardware explosions going off around us in the microcomputer world. We wondered, "Who could cover some of the latest developments for us in a funny, frank (and sometimes irascible) style?" The phone rang. It was Jerry Pournelle with an idea for a funny, frank (and occasionally irascible) series of articles to be presented in BYTE on a semi-regular (ie: every 2 or 3 months) basis, which would cover the wild microcomputer goings-on at the Pournelle House ("Chaos Manor") in Southern California. We said yes. Herewith the first installment ....**CM**

About the Author

Jerry Pournelle spent 15 years in the aerospace business before he became a full-time writer of science fact and fiction. He is the former director of the Human Factors Laboratories for the Boeing Company, and he worked on projects Mercury, Gemini, and Apollo, as well as military space systems.

Together with Larry Niven, Jerry Pournelle is coauthor of Lucifer's Hammer *and* The Mote in God's Eye; *he has also written a dozen novels on his own, including* The Mercenary, Birth of Fire, *and* West of Honor.

Dr Pournelle holds degrees in engineering, psychology, and political science. He succeeded the late Willy Ley as science editor for Galaxy Science Fiction Magazine; *recently he has moved his science-fact column to the magazine* Destinies, *published by Ace Science Fiction.*

My mad friend was raving again. "What this world needs," he said, "is some computer reviews by *users*."

"There are a lot of good reviews," I said.

"Yeah, some," he admitted. "But a lot more of them read like rewrites of the manufacturer's spec sheets. What I want is reviews by people who've really used the stuff."

I thought about that for a while and called BYTE. You're looking at the result. This will be a column by and for computer users, and with rare exceptions I won't discuss anything I haven't installed and implemented here in Chaos Manor. At Chaos Manor we have computer users ranging in sophistication from my 9-year-old through a college-undergraduate assistant and on up to myself. (Not that I'm the last word in sophistication, but I do sit here and pound this machine a lot; if I can't get something to work, it takes an expert.)

Fair warning, then: the very nature of this column limits its scope. I can't talk about anything I can't run on my machines, nor am I likely to discuss things I have no use for. Fortunately, that latter category is not so limiting as you might suppose. An author is most certainly running a small business, and I have accounting, mail-handling, and filing problems that you wouldn't believe. (Try sorting out data on subjects ranging from solar-power satellites and general relativity, on one end, to a concordance of the *chansons du geste* (French poems from the time of Charlemagne) on the other, coming from sources ranging from books and journals to letters from readers.)

The equipment limitations are more severe.

Primarily, I use my friend Ezekiel, who happens to be a Cromemco Z-2 with iCom 8-inch soft-sectored floppy-disk drives. He talks to me through a Processor Technology VDM direct-memory-address (DMA) video-display board, driving a 15-inch Hitachi monitor. However, I can fool him into believing he's no more than a smart terminal to drive a Novation modem at 300 bits per second (bps); in that case he talks to me through an IMSAI VIO video board on a Sanyo 15-inch monitor because most of my network contacts prefer a 24 by 80 screen format. Incidentally, the VIO is set up for address hexadecimal B000 in memory-address space and routinely shares memory with the regular Industrial Micro static memory that fills Ezekiel from top to bottom. If I turn on the VIO screen I get a picture of what is in memory from location B000 to B780, and a weird picture it can be when we're running a long command file...

Zeke also turns out hard copy on a Diablo 1620 daisy-wheel printer running at 1200 bps. The Diablo is easily the most expensive part of my system, but in my business — writing books and articles, I require top manuscript quality, and the Diablo certainly delivers it reliably and efficiently (if noisily; sometimes it's a bit like being in the same room with a machine gun).

Ezekiel's main operating system is CP/M version 1.4, although we're

putting up version 2.0 *real soon now*.

In addition to Ezekiel, I have a TRS-80 Model I Level II with expansion interface and a full 48 K bytes of memory. The TRS-80 will run 5-inch disks on the TRSDOS or NEWDOS+ disk operating systems. It will also run 8-inch disks on CP/M, and therein lies a tale.

> This will be a column by and for computer users, and with rare exceptions I won't discuss anything I haven't installed and implemented here in Chaos Manor.

In fact, my TRS-80 will run both 8-inch and 5-inch disks on CP/M, and programs created on Ezekiel will run on the TRS-80, or vice versa. Moreover, I can take programs written for the TRS-80 on cassette tape or TRSDOS and bring them up onto the CP/M system, then carry the disks in,and run them on the Cromemco. All this happens painlessly and without glitches, which sounds miraculous.

When George Gardner of Omikron Systems (1127 Hearst St, Berkeley CA 94702, (415) 845-8013) told me about the possibility of full CP/M on the TRS-80, I admit I was skeptical. I'd originally intended to let the TRS-80 talk to the Cromemco through serial RS-232C ports, thus allowing my assistants to prepare text on the TRS-80 and then squirt it over at day's end. I'd already started on the program: get files off the TRS-80 5-inch disks into TRS-80 memory, then send them with handshaking over to Ezekiel where they would be put onto 8-inch disks in CP/M format. The code isn't very complicated, but the whole thing would have been w*o*r*k, and I am as lazy as the next man. Fortunately, Omikron saved me all that trouble.

The Omikron system consists of a pair of neatly constructed circuit boards, comprehensible documentation, the CP/M operating system with a number of *excellent* additional utility programs, and, optionally, a pair of 8-inch floppy-disk drives (you can use your own drives if you like). The boards, which Omikron calls *Mappers*, fit neatly inside the TRS-80 and can be installed by totally unskilled personnel in about 1 hour.

Omikron's Mapper I ($199; specify memory size when ordering) fits into the TRS-80 keyboard unit. The installation instructions are exceptionally clear, at the level of "orient the unit so that the space bar is nearest yourself." They proceed step by step and end by telling you exactly how to reassemble the TRS-80. Omikron even tells you which length of screws go in which holes.

Although in theory you will have voided your Radio Shack warranty by breaking the seal (a dab of paint on one of the screws holding the TRS-80 case together), the Omikron Mapper requires no soldering, trace cutting, or any other alteration. What happens is that you pull out the Z80 processor, insert Omikron's board, and put the Z80 into a socket on the Omikron board.

When that's accomplished you can turn on the TRS-80; you get the message "T = TRS-80 C = CPM". If you hit T you will have a normal TRS-80; the Omikron equipment is totally invisible to both BASIC and assembly-language programs. (We've had our Mapper installed for weeks, and we have run some very sophisticated programs, without a glitch.)

If you hit C you have CP/M operating on your 5-inch disks. My disk drives happen to be forty-track Matchless units (Matchless Systems, 18444 South Broadway, Gardena CA 90248 (213) 327-1010), and they work about eight times as fast as Radio Shack's standard 5-inch disks. They have caused absolutely no problems with the Omikron Mapper and CP/M. Incidentally, my TRS-80 has Radio Shack's lowercase modification, and that has caused no problems either.

Omikron's Mapper II ($99 plus $10 per cable connector) installs in the TRS-80 expansion interface; installation is even simpler than Mapper I, and again involves no soldering, trace cutting, or other alteration of the TRS-80. If the Mappers are removed there is no way to know they were ever there.

The Mapper II in the expansion interface works under both CP/M and TRSDOS. In TRSDOS it acts as an external data separator for the floppy-disk drive, eliminating sector retry errors — those mysterious

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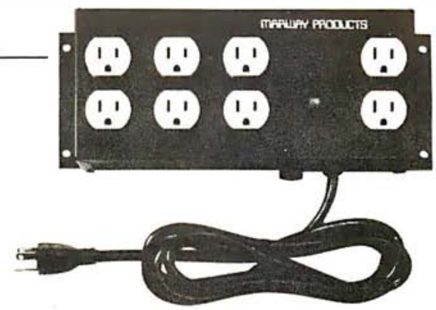

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OMIKRON offers the manuals for $15 each with a two week return for full credit. The software requires a 48K CP/M system with two eight inch disk drives. Microsoft Basic Version 4.51 is also required and may be purchased for $350. The complete package of four is available for $350 including manuals. Versions for both the Radio Shack Model I and Model II are also available.

*CP/M is a TM of Digital Research. TRS-80 is a TM of Tandy Corporation.

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glitches that lose files.

With Mapper II installed I now run both 5-inch and 8-inch disks under CP/M, and I can transfer programs from 5- to 8-inch disks using the CP/M utility program PIP. George also furnishes a program to take files (including programs) from TRSDOS to CP/M format. My own operates with the Omikron disks. (Omikron sells a single 8-inch drive with both Mappers for $1195; dual drives with Mappers are $1795. Cables are included.) Omikron also furnishes the required software; we ran CP/M instantly after installing the Mapper boards.

The bottom line is that my TRS-80 with Omikron's additions has become a perfectly normal 48 K-byte Z80 computer, and yet can continue to function as a standard TRS-80 as well. It's as if I had both Model I and Model II TRS-80 in the same package. For those not familiar with the TRS-80 this may not seem so miraculous, but believe me, it is.

Nor is it hard to operate: my 9-year-old son is in the other room playing Temple of Aphsai (an excellent real-time dungeon game) under TRSDOS, while his older brother (age 11) is impatiently champing to get on and run Adventure under CP/M. My secretary runs Electric Pencil on the TRS-80, then translates the files to CP/M format so that Ezekiel can read them.

Sure, Zeke is a better machine; but he cost a lot more than the TRS-80 plus the Omikron modifications. Omikron has made the TRS-80 a very convenient way to add a second computer without going bankrupt. Any TRS-80 owner feeling left out because all the good programs are written in CP/M (or who's using 5-inch disks for business systems and going mad because of the limited storage capacity of the little beasts) should get in touch with Omikron immediately. [*Another device, the Maxi-Disk, that allows a user to run CP/M on both 5-inch and 8-inch floppy disks on the TRS-80 Model I is offered at a comparable price by Parasitic Engineering (1101 9th Ave, Oakland CA 94606). Although I have no direct experience with their product, the company is known for the soundness of their hardware design*....**GW**]

"Impossible," my mad friend told me when I described the Omikron system. "The TRS-80 has BASIC in read-only memory down in low memory-address space; CP/M can't run because hexadecimal locations 0 thru 0100 are full of BASIC. Radio Shack gave up on CP/M."

"But you see it does work," I said smugly. "Not only that, but you see the programs you brought from your machine work just fine on the TRS-80."

"Hmm," said he. "There's only one way he could do that."

And he was right. What Omikron's board does is "phantom out" all those read-only-memory parts down in low memory. It also re-addresses the TRS-80's memory-mapped video-display screen to hexadecimal FC00. The BIOS that Omikron furnishes does the rest. [*BIOS is the module of CP/M that controls the transfer of data to and from the peripherals*....**RSS**] George Gardner says there are some obsolete CP/M programs that might not run on the modified TRS-80, but I haven't found any. CBASIC and programs written in CBASIC run fine. So do all the various versions of Microsoft Disk BASIC, Tarbell BASIC, the BDS C Compiler, four programs written in Microsoft Compiling BASIC, the Vulcan data base, Microsoft's FORTRAN, Adventure, DDT, and a lot of utility programs obtained from the CP/M User's Group.

Omikron also furnishes utilities: a disk test, a memory test, programs to reformat 8-inch floppy disks as well as a formatter for 5-inch disks, copy utilities for both 8-inch and 5-inch disks, and some software to make the TRS-80 keyboard more convenient (allows absolute cursor addressing by emulating a Soroc IQ-120 terminal with all control characters plus square brackets), an initialization routine, and a program to set up your TRS-80's RS-232 port for serial input/output (I/O). All in all, it's quite a package. It's not often that I can recommend something without reservations, but I'm happy to say that Omikron (all equipment guaranteed for 6 months, parts and labor) is a real bargain that for a wonder works just as advertised. It really will make a TRS-80 Model I into a serious computer.

The basic TRS-80 is a lot of computer for the money. It comes ready to run right out of the box, and it can be set up by three boys — ages 9, 11, and 13. (At least mine was, not

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without threats of mayhem which weren't the computer's fault.) The Tandy/Radio Shack documentation is excellent, and there are a lot of good programs available for the TRS-80. The Radio Shack service is speedy, efficient, and uncomplaining.

Just about every component of my TRS-80 has taken a trip to the local store to be fixed. None of that cost me anything; it wasn't even inconvenient, especially with local Radio Shacks all over the place. It *was* annoying (between my secretary and my boys, a day without the second computer can be an, uh, *interesting* day). Still, all computers have infant mortality problems. When Ezekiel was first installed, I thought Tony Pietsch of Proteus Engineering in Pasadena, California (the man who set up Ezekiel) was going to wire himself in as an integral component. Although each major part of my TRS-80 has been to the shop, my neighbor down the street has had a full system running from the first day with no glitches whatsoever. Given the price of the TRS-80, Tandy's quality control is better than you'd expect.

But there are some problems. The Tandy disk operating system, TRSDOS, is needlessly complex; the editor/assembler and T-BUG monitor aren't that good, and most of their business programs are simply not in the same class with their competition. Although Fort Worth (Tandy headquarters) lately seems anxious to fix up their act and send out revisions of both software and hardware, they remain secretive. For the moment, the best disk operating system for the TRS-80 is Apparat's NEWDOS+, a much better operating system than Radio Shack's, and it's upward compatible with TRSDOS. In fact, Tandy ought to be marketing NEWDOS+ themselves.

NEWDOS+ not only works better than TRSDOS, but also has Superzap: a routine which lets you go out to a disk file and examine and change it as easily as a good monitor will let you twiddle bits in memory! It's incredibly convenient. That's the good news. The bad news is that the documentation is nearly incomprehensible. Fortunately, though, there's a fix for that too: H C Pennington's book *TRS-80 Disk and Other Mysteries*, also available from Apparat (7310 E Princeton Ave, Denver CO 80237) tells all you'll ever need to know about Superzap and the TRS-80 disk system.

NEWDOS+ and Superzap will let you read and write disk files sector by sector, change bits, defeat the TRS-80's silly "protection" systems, etc. It won't make TRSDOS as convenient as CP/M, nor will anything else except Omikron and CP/M itself; but they will make the TRS-80 operating system tolerable.

NEWDOS+ also has a disassembler. I haven't gotten around to aiming it at the TRS-80's read-only memory, but I'm about to; people I trust tell me it works fine. I already have Fuller Software's Supermap, which is an extensive set of comments to add to a disassembly of the TRS-80's Level II system firmware. Supermap has its problems, and strange lacunae; its author doesn't seem to know where the TRS-80 memory-mapped screen is addressed, as an example. Still, it's worth the price (about $18) for anyone who wants to understand his TRS-80 (and there are some really nifty bit-twiddling routines in those read-only memories; with a good disassembly you can patch into them when writing your own assembly-language programs, thus saving a lot of memory and code).

I must admit I fail to understand Tandy's philosophy. Radio Shack charges about $100 more for a 35-track 40 ms-access-time disk drive than Matchless, or Percom, or Vista is charging for the same type of equipment (which works better than Radio Shack's).

(Incidentally, most companies manufacturing disk drives for the TRS-80 write confusing advertising copy. For the record, the disk controller is in the TRS-80 expansion interface, and Matchless, Vista, or Percom 5-inch disks will work as either add-on drives or as the *first* disk drive. You will have to spend about $20 at Radio Shack for a copy of the TRSDOS operating system and documentation, but I don't recommend Radio Shack disk drives.)

The TRS-80 with Omikron's Mappers is a truly competitive machine. You can buy a TRS-80 Model I with Level II BASIC, equipped with expansion interface, for under $1500; fill it with memory for about $200 more; add a pair of Omikron 8-inch disk drives for $1795, and Matchless

5-inch drives for $400 each; get a good line printer (again, I have Matchless at $750). For a total cost of under $5000, you have a 48 K-byte machine capable of running all the TRS-80 programs, CP/M software, *and* top-grade text editors like Word Master, Magic Wand, Electric Pencil, and the Proteus editor—and run both 5-inch and 8-inch disks in the bargain, all without building a single kit. And I can guarantee that a 9-year-old can use it.

I started off describing my system, and ended up talking a lot about the TRS-80. I don't use the TRS-80 all that much—it is the secondary system. So what *does* get run around here?

Well, first of course, text editors. I've written five or six books using Ezekiel, as well as countless articles and letters. Most of that has been described in articles in BYTE's companion magazine *onComputing*, but as Alice said in Wonderland, "things *flow* here so!"

In particular, there are at last a whole flock of new text editors, some excellent, some not as good as the old standards. One, unfortunately not quite finished, promises to be better than anything available for the biggest machines. My next column will dissect a number of editors to show their good and bad points. (Also see my article, "A Writer Looks at Word Processors," in the Summer 1980 *onComputing*.) We'll not only include the big ones like Electric Pencil, WordStar and WordMaster, Magic Wand, Proteus, and the like, but even bigger ones like MIT's EMACS.

Secondly, here at Chaos Manor we have a file-management problem like nothing you have ever seen, and thus we have a plethora of file handlers and data bases. For quick and dirty work I use a simple (and inexpensive) data-base system from Workman Associates (112 Marion Ave, Pasadena CA 91106, for about $75); it's far more than adequate for Christmas cards, telephone numbers, meal plans, and cooking-duty assignments for long-term Boy Scout hikes, and such statistics as mean, standard deviation, and two-variable correlations.

For more complicated work we use Vulcan (available for $490 from SCDP Systems, 6542 Greeley St, Tujunga CA 91042). Vulcan is a program that falls into a category I call "infuriatingly excellent"; that means it does everything you'd like it to, and perhaps a lot more, but the documentation is plain lousy. Vulcan will let you very quickly and easily structure a complex data base and enter data. You can add to it as you will, including taking files off other data bases like Workman's. Since Vulcan makes random-access disk files, the data base can be as large as you like.

It's much faster than any other disk-storage data base I've ever seen, and lets you do really complex things like: find all items with keywords "Solar" OR "Conservation" but NOT "Wind" AND NOT "Windmill"; sort by AUTHOR and create a new file; add the PRICE of all those items and INCREASE the price by 10%.

Actually, that wouldn't be a very complicated task for Vulcan, which is as much a language as a program; in fact, Vulcan has a limited BASIC-language system built into it. Vulcan can also execute command files (very handy if you have operations to be done at regular, say weekly or monthly, intervals). It will drive both

console and hard-copy devices. It is really useful.

But it drives you mad, because Vulcan's author didn't include enough examples in the instructions. We find Vulcan worth the effort, because it is fast, and comprehensive, and allows you to change the field structure of the data base at will, or create new data bases selectively out of the master; but we do a lot of pounding on the table and screaming in rage at the documentation.

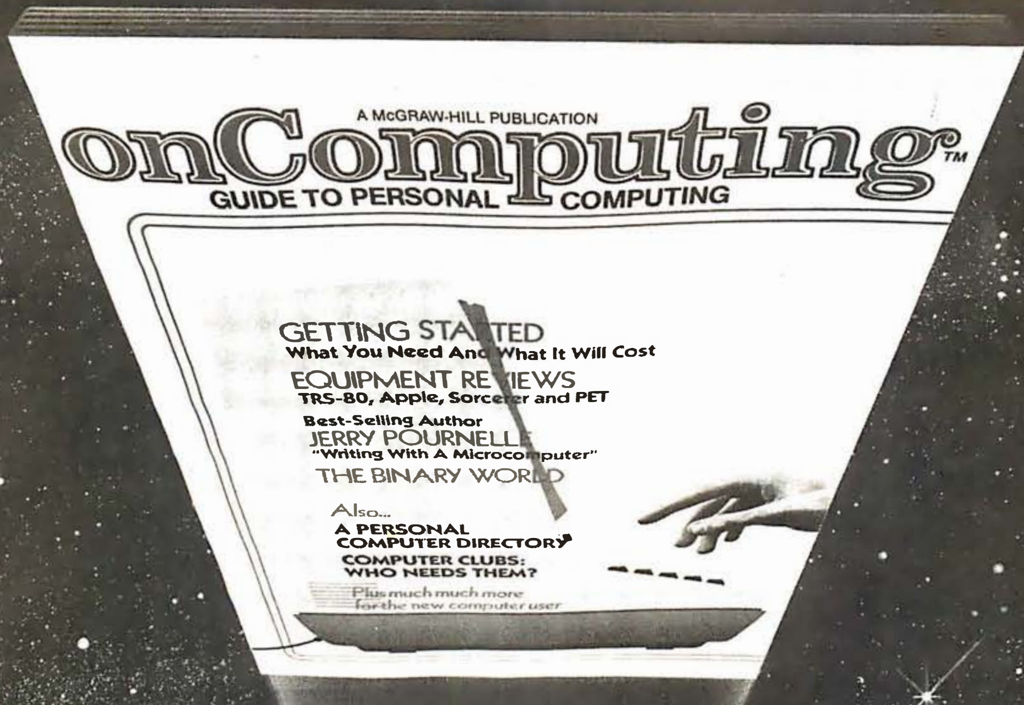
There's a lot of software like that: infuriatingly better than its competition, but hampered by instructions meaningful only to the software's author. I sometimes think there is a secret school that teaches the black art of writing a document such that the author can prove conclusively that every bit of needed information is contained in the book — but it is guaranteed to be useless to anyone who doesn't already know it to begin with. In fact, I am sure there is such a school, and someday I'm going to find it and put it out of business. Until then, though, we'll have "infuriatingly excellent" software with us and there's not a lot to be done about it.

An upcoming "User's Column" will discuss a number of data bases, including some I've been promised but haven't received, and go over their strengths and weaknesses.

We'll also look at languages, including the BDS and Whitesmith C compilers (see *The C Programming Language* by B Kernighan and D Ritchie, Prentice-Hall 1978; C is a really marvelous language); BASICs that run source code interpretively and can then compile it (easily the best way to write quick and dirty programs that have to run this afternoon); FORTH; SMAL-80 if we can ever get a copy that runs; LISP (want 800-digit precision? cryptographers do!); and other alternatives to BASIC and FORTRAN.

I'm collecting accounting systems and other business software, and we'll have a column on those also.

I'm also open to suggestions and always interested in programs that can run on my systems and would be valuable to BYTE readers; if you're curious about software, let me know. Chances are I'll be as interested as you are, and we'll both learn something. ■



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Creating a Fantasy World on the 8080

Robert T Nicholson
4920 Harmony Way
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Although personal computer owners have devised a remarkable number of applications for their machines, game playing probably still ranks as the number-one use. Besides providing entertainment, games can be challenging and educational; in addition, games are often fascinating programming problems.

The most mind-stretching computer games yet devised may be the fantasy-adventure games which have become popular in recent years. All of the current fantasy-adventure games, including Adventure and Zork, seem to be based on Dungeons and Dragons. Dungeons and Dragons is a noncomputerized game developed by Gary Gygax and Dave Arneson in the late 1960s. In Dungeons and Dragons, as in its computerized counterparts, the player represents a character in a fantasy world, taking part in great adventures, slaying monsters, and accumulating treasures.

The success of such a game, of course, depends upon the program's ability to produce a *rich* fantasy world; that is, an environment which poses many interesting problems for the player, and which responds in a reasonable way to the player's attempts at problem solving. For example, if the player finds matches and a candle in the course of the game, then the program should allow the player to light the candle when entering a dark chamber. A richer environment would also react appropriately to the player's attempts to light other objects with the matches ("DON'T BE SILLY... SWORDS DON'T BURN!"), or to use the candle in some unintended manner.

Creating such a rich world requires a program which possesses a relatively large vocabulary and a great deal of logic to determine whether or not the player's actions are reasonable. It is also necessary for the program to have thousands of words of text to describe places, objects, and the results of any given action. These requirements are especially difficult to meet on a personal computer, where main memory is very limited and disk accesses are slow (by large computer standards). The problems, however, are certainly not insurmountable, as demonstrated by the existence of CASTLE, the author's 8080-based fantasy-adventure game.

Listing 1 shows a portion of a typical CASTLE session. The game is implemented in North Star disk BASIC and runs in 32 K bytes, with a response time of several seconds. Most of the program's time is spent in accessing its four major files. These files contain the vocabulary as well as descriptive text and details about the various props. The program itself is very simple, consisting of three basic sections: a command interpreter, a set of semantic routines, and an event routine.

The job of the command interpreter is simply to obtain a syntactically correct command from the player and translate it into a pair of numeric codes (a *semantic pair*). This is then passed on to the semantic routines. The syntax for CASTLE commands is very straightforward, as shown in listing 2; valid *action words*

are identified by searching a file called VERBS, while *object words* are found in a file called NOUNS. When a match is found for a word, a code contained in the word's record is placed in the semantic pair; thus, a complete pair will contain a verb code and a noun code. If no match is found, the command interpreter prints an error message ("I DON'T UNDERSTAND THAT") and reprompts the player.

The semantic routines actually carry out the player's command. There is one routine for each *action* which the program supports. The first number in the semantic pair (the verb code) is used as an index to the appropriate routine, and the second number (the noun code) is passed as a parameter. In the current version of CASTLE, each semantic routine must decide whether or not its particular action is allowable for the noun specified. For example, the BREAK routine knows that the crystal goblet (noun code 7) can be broken, but the sword (noun code 13) cannot. A better approach is to associate a bit string with each noun, using 1s to indicate allowable actions, and 0s to represent illegal actions.

Semantic routines currently have access to a number of item attributes. Most of these attributes are stored in a file called PROPS, which has one record for each noun code. The record contains:

- a *label*, such as "BEAUTIFUL STRING OF PEARLS", which routines may use in describing the object to the player
- the initial room *location* of the object, for use in CASTLE's initialization process (if this number is negative, CASTLE places the object randomly)
- the *value* of the object, which is used by the GET, WEAR, and DROP semantic routines for keeping track of the player's accumulated wealth
- the *weight* of the object, which is used by the GET, WEAR, and DROP routines to determine how much a player can carry.

CASTLE also maintains, in a large array, the current location of all objects.

Semantic routines may also require information on the player's location in the fantasy world. In CASTLE, the world consists of roughly one hundred rooms, each of which has a unique number. The numbers are used as keys into a descriptive file named MAP. Each record in the map file contains:

- the name of the room
- a one- to three-line description of the room
- a *transition array*, which lists the numbers of the rooms that can be reached by traveling in any one of the six directions which CASTLE understands. (The first number in the array is the room reached by going north, the second by going east, etc. A value of 0 in the array indicates that there is no path in that direction.)

The primary users of the MAP file are the GO and LOOK semantic routines. LOOK uses the text in the current room's record to describe the room, while GO uses the record's transition array to determine the next

Listing 1: *Portion of a typical CASTLE game.*

```
?LOOK
THIS IS THE KING'S CHAMBERS
THE ROOM IS DOMINATED BY A MASSIVE OAK BED, BUT ITS FURNITURE
ALSO INCLUDES A VARIETY OF LARGE CHAIRS AND CABINETS. STAIRS
IN OPPOSITE CORNERS LEAD UP AND DOWN, AND A DOORWAY LEADS WEST.

IN THE ROOM YOU SEE:
ERMINE ROBE

?GET THE ROBE
DONE.

?CLIMB THE STAIRS.
YOU ARE IN THE KING'S LOOKOUT
THE NORTH AND EAST WALLS OF THE ROOM CONTAIN A NUMBER OF SMALL
WINDOWS. A SMALL DOOR LEADS TO THE WEST. ON THE SOUTH WALL IS
A CURIOUS STONE INLAY, ROUGHLY THE SIZE OF A DOOR.

?OPEN INLAY
THAT WOULD TAKE MORE MAGIC THAN YOU CURRENTLY POSSESS.

?GO WEST
YOU ARE IN THE WIZARD'S WORKSHOP
THE ROOM IS FURNISHED WITH SEVERAL WOODEN TABLES AND BENCHES,
AND A GREAT FIREPLACE ON THE SOUTH WALL. DOORWAYS LEAD EAST
AND WEST, AND SMALL WINDOWS LOOK OUT TO THE NORTH.

IN THE ROOM YOU SEE:
GOLDEN RING

?WEAR THE RING.
AS YOU DON THE MAGIC RING, YOU ARE ENGULFED
IN A CLOUD OF THICK SMOKE. WHEN IT CLEARS...
YOU ARE IN THE DEEP FORTRESS
THIS ROOM WAS BUILT AS A 'LAST REFUGE' FOR THE INHABITANTS OF
THE CASTLE, SHOULD ITS OUTER WALLS EVER BE BREACHED BY ENEMIES.
THERE IS A MASSIVE WOODEN DOOR TO THE SOUTH, AND A DOORWAY EAST.

?EAST
YOU ARE IN THE SIEGE STOREROOM
THE LARGE ROOM IS EMPTY AND COVERED WITH DUST. ROW AFTER ROW OF
SHELVES ATTEST, HOWEVER, TO ITS ORIGINAL PURPOSE... AS A SOURCE
OF SUPPLIES IN TIMES OF SIEGE. DOORWAYS LEAD EAST AND WEST.

?EAST
YOU ARE IN THE UNFINISHED EXCAVATIONS
THE WALLS HERE ARE OF ROUGH-HEWN STONE. THE FLOOR IS UNEVEN AND
COVERED WITH BROKEN ROCKS AND RUBBLE WHICH HAVE FALLEN FROM THE
CEILING.

IN THE ROOM YOU SEE:
NASTY RED DRAGON
JEWELLED COLLAR

?ATTACK!
WITHOUT WEAPONS, THAT IS A VERY BAD IDEA!
THE NASTY RED DRAGON ATTACKS, BUT YOU ARE ONLY SLIGHTLY WOUNDED.
(COMFORTING, ISN'T IT?)
```

Listing 2: *CASTLE command syntax, including examples of valid commands. "Action words" and "object words" are any words which appear in the appropriate files. Square brackets denote an optional word; vertical lines denote a choice of one object from several.*

```
<command> ::= <action word> [<object phrase>] [<punctuation>]

<action word> ::= (from VERB file)

<object phrase> ::= [<article word>] <object word>

<article word> ::= A | AN | THE

<object word> ::= (from NOUN file)

<punctuation> ::= . | !

EXAMPLES: GET THE GOLD!   GO NORTH

          DON ARMOR       LISTEN.
```

room that the player will enter.

For purposes of the GO routine, the words NORTH, SOUTH, EAST, WEST, UP, and DOWN are defined as object words and stored in the noun file. The routine can therefore decide which entry in the transition array to use, based on the noun code.

After the player's command has been executed by a semantic routine, CASTLE enters the event routine, which handles all periodic and random events in the fantasy world. Events are currently limited to the movements of creatures in the castle, and possible attacks by hostile creatures in the same room as the player. Other possible events include: candles burning out, magic visions which occasionally appear, or reduction of the player's load-carrying and fighting capacities due to fatigue. Depending on their type, events may occur either randomly or periodically (once every *n* turns).

Once the event routine has completed its job, control is returned to the command interpreter for the player's next command. This control loop may be exited, and CASTLE terminated, by entering a QUIT command. QUIT is simply another semantic routine which closes files, prints the player's final accumulation of wealth, and stops.

CASTLE currently has twenty-five semantic routines, the largest of which contains twenty-four lines of code. Coding was greatly simplified by the fact that the most important information is contained in the files described previously rather than being embedded in code.

Unfortunately, the heavy dependence on file access is somewhat of a disadvantage on a typical microcomputer system. The CASTLE command interpreter currently performs sequential searches of the NOUN and VERB files. For this reason, the command vocabulary has been limited to approximately one hundred object words and sixty action words. Note that many of these words are synonyms and that the actual number of props and actions is more limited. A more sophisticated command interpreter might be designed to perform binary searches on the vocabulary files, thus allowing more words to be searched in the same amount of time.

Frequent accesses to the PROPS file also cause a noticeable delay. With sufficient main memory, a fantasy-adventure game could keep the prop information in memory-resident arrays.

In addition, more fundamental changes in the implementation could be made to greatly expand the possibilities of the game. The command interpreter could be made more sophisticated to accept a more general set of commands. The game could be modified to allow several players, who could either work together as a team, or compete for treasure. Also, the information content of the various files could be expanded, eliminating the need for game-specific logic in the program. Using such a scheme, new fantasy adventures could be created simply by replacing the files.

The real pleasure in fantasy-game development, however, is not simply the solution of programming problems, but the fact that the fantasy world the game portrays is limited only by the author's imagination. ■

Technical Forum

Some More on Performance Evaluation

Notes by Carl Helmers

In a recent issue of BYTE, there was an article by James R Lewis entitled "TRS-80 Performance, Evaluation by Program Timing" (March 1980 BYTE, page 84). The article reported on the speed of execution of a program that calculates prime numbers. The technique of calculation was admittedly simplistic and inefficient. However, such a brute-force method is often useful in checking performance. By obtaining a significant time interval, measurement becomes easy.

The article produced a flurry of letters on various subjects. First, readers should note that a typographical error was made in listing 3 (on page 84). Statement 100 should read:

```
100 IFINT(M/K)*K=MTHENNEXTM
```

This is a highly compressed statement chosen for optimal speed when the interpreter executes it. The published version of this program had a letter "M" substituted for the second letter "K." This typo was pointed out by R B Nottingham of Deerfield Beach, Florida, and several others.

Mr Nottingham was one of several people who suggested speeding up the algorithm in various ways. He suggested using the fact that a prime number is a number which does not have an integral divisor that is less than its square root. Since the square root of a number *N* is much less than *N*/2 for large *N*, this cuts down the time considerably.

But the goal of the exercise was not to code the most efficient algorithm. It was, rather, to code an algorithm that takes a measurable amount of time while performing a certain group of calculations. For the record, Mr Nottingham found that when he changed line 30 of listing 3 to:

```
30 FORM=3TOSQR(M)STEP2
```

the time requirements were reduced from the 6 hours, 31 minutes reported in Mr Lewis' article to approximately 20 minutes. However, this reduction is caused by a redesign of the program, not by any increase in computing power, which after all was the factor being measured. Similar reductions would be expected on any computer. This algorithm improvement was also suggested by John C Miller of New York, New York.

In another letter from New York, Donald Stevens reports on his findings running Mr Lewis' algorithm in FORTRAN and in the machine language of an ELF computer. The FORTRAN version was run on two Control

Data Corporation (CDC) machines with compiler optimization level 1. On a CDC 6600, the FORTRAN version took 17 seconds; on a CDC 7600 the FORTRAN version took 2.6 seconds. The machine-language program running on an ELF-II (ie: a CDP1802 microprocessor) took 37 minutes.

In the same vein, Charles H Porter, of Jackson, Michigan, provides us with listing 1, which was accompanied by the following letter:

I own a TRS-80 and found your March article by James R Lewis ("TRS-80 Performance, Evaluation by Program Timing") interesting. It answered my own questions about performance.

I disagree with the implications of his conclusion, however. By implication: if you need the speed, then code in assembler.

My point is this, if you need faster performance, examine first the program design. The program of listing 1 lists all prime numbers less than 10,000. I wrote it from scratch in less than an hour. It is written in BASIC and executes in 6 minutes and 16 seconds as compared to Lewis's 22-minute execution of the assembler program.

Assembler code will undoubtedly execute the same logic faster than BASIC, but better logic is often the answer.

Listing 1: *This program, submitted by Charles Porter, is probably a better prime-number finder than that provided by James R Lewis on page 84 of the March 1980 BYTE. But the fact that it is more efficient (qua prime-number finding) is a side issue to benchmarking with a known algorithm. Its 6-minute execution time compares very favorably with the 6.5 hours taken by one version of James Lewis' algorithm on the same Radio Shack TRS-80 computer.*

```
 10  S$=RIGHT$(TIME$,8)
 20  ON ERROR GOTO 120
 30  DEFINT A-Z
 40  L=10000
 50  L1=L+1
 60  DIM A(L1)
 70  FOR I=2 TO L : A(I)=1 : NEXT
 80  X=2
 90  FOR I=2*X TO L STEP X : A(I)=0 : NEXT
100  X=X+1
110  IF A(I)=0 THEN 100 ELSE 90
120  FOR I=2 TO L
130  IF A(I)<> 0 THEN PRINT I
140  NEXT
150  PRINT "START    ";S$
160  PRINT "STOP     ";RIGHT$(TIME$,8)
170  END
```

```
Note sample output below.
2
3
5
7
11
.
.
.
9973
START 00:45:48
STOP  00:52:04
```

Listing 2: *The Pascal version of James R Lewis' simple prime-number finder. This program was converted to Pascal by Jim Nelson, of Westlake Village, California. Jim measured a time of 1 hour, 17 minutes for the execution of this version.*

```
PROGRAM primes;

   VAR
      k,m : INTEGER;

   PROCEDURE is_it_prime;
      BEGIN
         k := 3;
         WHILE (m MOD k <> 0) AND (k <= m DIV 2) DO
            BEGIN
               k := k + 2
            END;
         IF (m MOD k <> 0) THEN WRITELN('Prime No. = ',m)
      END (is_it_prime);

   BEGIN (primes)
      m := 5;
      REPEAT
         is_it_prime;
         m := m + 2
      UNTIL m = 9999;
      WRITELN('Done Finally !!!')
   END. (primes)
```

This program employs a table to cut the number of iterations even further. Mr Porter's program takes a mere 6 minutes and 16 seconds. But again, this is a different algorithm and comparisons of time reflect on the quality of the algorithm, not the effectiveness of the computer.

Keeping this point in mind, we received a letter (including listings) from Jim Nelson of Westlake Village, California, which presents some timings for various Apple II system-software configurations. He found that a version similar to the program of listing 3 from Mr Lewis' March article ran in 3 hours, 56 minutes on an Apple II using Applesoft floating-point BASIC. A version of Mr Lewis' algorithm run in Apple Integer BASIC was measured at 1 hour, 49 minutes by Mr Nelson. And finally he measured a version written in Apple Pascal at 1 hour, 17 minutes. Mr Nelson's Pascal version of the algorithm is shown here in listing 2.

The comparison made by Mr Nelson is certainly valid within the context of a performance evaluation. He used the same algorithm under different systems. Here there is a realistic and objective measure of time required in different hardware and system software. Everything is kept as constant as possible, so that the difference in one particular area (here, speed of execution of the program) is highlighted. By keeping a known algorithm while varying the computer system's configuration, the effects of hardware and system software are truly measured.

What can we conclude from all this? For one thing, it is now about time to consider performance evaluation with a little more emphasis. The personal computing field has now become sufficiently large that serious comparison is possible. People who look into performance evaluation on a formal basis often create one or more sets of "typical" test programs which evaluate some aspect of computer performance. Mr Lewis' factorial algorithm is an example of such a test of the execution-time performance of various language tools on two examples of computer processors. It is an excellent quick test (especially if the iteration count is reduced to 1000), which can be incorporated into one's bag of tricks when trying out a computer system in a store or at a trade show.

There are many such simple performance evaluations possible. I, for one, have two favorites. First, for text editors, how long does it take (worst case) to execute 100 search-and-replace operations, changing a 10-character string into an 11-character string within a file of 10,000 characters? By "worst case" I mean starting the operation so that the maximum number of characters has to be "moved" in the first replacement. My second favorite performance evaluation is the time it takes for a floppy-disk system to copy a 10,000-character file using an operating-system file-handling utility program.

These are just examples of simple performance tests. To help us define a suite of such tests, I ask that you send us *your* favorite test. Each benchmark routine should be appropriate to the typical language and operating-system environment of the contemporary small computer. It should be easily adaptable to other comparable languages and systems. Using such reader interaction, we should be able to come up with a compilation of "favorite benchmarks." It is our intention to define such a group of favorite benchmarks as part of increased editorial attention to performance evaluation.

Let us know what you think about the idea by sending your comments to:

Favorite Benchmarks
Editorial Office
BYTE Publications, Inc
70 Main St
Peterborough NH 03458■

Clubs and Newsletters

Z80 Microfans

Z80 Microfans is a group of Sorcerer computer owners based in Portland, Oregon. The purpose of the club is to share skills and programs as well as software and hardware problem solutions. A monthly newsletter is published with emphasis on Sorcerer projects. The club meets twice a month, on the second and fourth Wednesday. Memberships are available to Portland area residents. Newsletter subscriptions are available to anyone for $8 per year. A program exchange library is also available to all members. Classes are offered in programming in BASIC and Z80 assembler languages. For further information,contact the Secretary, POB 12504, Portland OR 97212.

CHIP-S Club

The CHIP-S Microcomputer Club meets on the fourth Thursday of the month at 7:30 PM at Baker Hall, GE Electronics Park, Liverpool, New York. The club is open to anybody interested in microcomputers. All inquiries should be sent to CHIP-S Microcomputer Club, POB 504, Syracuse NY 13201.

TI 990/189 Users—Unite

Fernand Barbeau, 250 Blvd de la Colline, Neufchatel, Qué, G2A 2E3, Canada, is looking for other enthusiastic users of the Texas Instruments' 990/189 system. If anyone would like to form a club or simply exchange information, ideas, programs, and other information, please contact Monsieur Barbeau.

Apple Group in Indiana

Based in Lafayette, Indiana, The Greater Lafayette Apple User Group meets at 7 PM on the second Wednesday of each month at Digital Technology, 10 N 3rd, in Lafayette. The group supports a library of software and is interested in exchanging programs with other groups or individuals. One of the goals of the group is teaching its members about Apple II programming techniques. Programming workshops are held at each monthly meeting. There are no dues, but a small charge of $0.50 is assessed for copying a disk from the library. For details, write or call The Greater Lafayette Apple User Group, Digital Technology, 10 N 3rd, Lafayette IN 47901, (317) 423-2548.

Newsletter for Polymorphic Users

The Southeastern PolyMorphic Users Group announces their new publication, *PolyLetter*, a

newsletter for the PolyMorphic computer. *PolyLetter* features program reviews, program listings, helpful hints, PEEK and POKE locations, want ads, and articles written by users. *PolyLetter* is not affiliated with PolyMorphic Systems in any manner. It is available for $5 per year to nonmembers from *PolyLetter*, 207 Marray Dr, Atlanta GA 30341, (404) 458-9711.

Computer-Using Educators

Computer-Using Educators (CUE) has been in existence since early 1979. They now number nearly 300 and have a large executive committee to plan and implement activities. They are working on the coming Asilomar 1980 annual meeting of the California Mathematics Council. CUE is also utilizing the Computer Van from Commodore. The van is a traveling teaching aid that is outfitted with 12 computers. The van travels on a reservation basis between schools, allowing students the opportunity to work on computers. CUE is also busy setting up a software exchange center for educators. Their newsletter contains articles on current projects, events, notes from meetings, computer-aided instruction (CAI), reviews of products and educational journals that deal with the use of computers. There are a number of useful ads and notices for educators in the newsletter. CUE is an affiliate of the International Council of Computer Educators. The membership dues are $4 payable each September. For details, contact Computer-Using Educators, Mountain View High School, Mountain View CA 94041.

Computer Careers News

If you are a systems analyst, programmer, or computer scientist, you can receive a free subscription to *Computer Careers News*. Edited for working-level computer professionals, *Computer Careers News* is filled with advertisements from companies seeking programmers and data processing experts. There are articles that assist computer professionals to find the proper type of employment for their particular needs. For a subscription, write *Computer Careers News*, 708 Third Ave, New York NY 10017.

Computerists of the North

The Sault Ste Marie and Area Computer Hobbyist Group has recently been formed. It meets on the third Tuesday of each month at various locations. For information, contact Jack Decker, 1804 W 18th St, Lot# 155, Sault Ste Marie, MI 49783, (906) 632-3248.

Japan Micro-Computer Club

The Japan Micro-Computer Club was founded in 1976. There are now over 3000 active members. The club publishes a journal entitled *Micon Circular* eleven times a year. The newsletter contains summaries of club meetings, reports on new products, programs, technical reports, and tutorial papers on microcomputers. The club members wish to exchange ideas and newsletters and establish friendly relations with US clubs. Write to the Japan Micro-Computer Club, c/o Japan Electronic Industry Development Association, 3-5-8, Shibakoen, Minato-ku, Tokyo 105 Japan.

ELF of the Valley 1802 Users Group

The ELF of the Valley club is open to all users of RCA COSMAC ELF 1802 microprocessors. This group of about 60 members is interested in all types of 1802 systems. The club meets on the first Saturday of each month at a meeting place in the San Fernando Valley. Contact Richard Cox, 2670 Calle Abedul, Thousand Oaks CA 91360, (805) 492-4128

Newsletter for Heath H8 Users

H8SCOOP is a monthly publication, not affiliated with Heath in any way. The newsletter contains a trading post section, monthly hardware and software projects, non-Heath product reviews, and other articles. Henry E Fale, the publisher, is also offering projects that he has designed for the H8. He welcomes articles and information on the H8 for publicaton in the newsletter. Subscription rates are $12 per year with a yearly index compiled and supplied to subscribers. Contact Henry E Fale, 2918 S 7th St, Sheboygan WI 53081, (414) 452-4172.

Connecticut Computer Club

The Connecticut Computer Club meets on the first Thursday of each month at 7:30 PM at the Suffield Connecticut Library. The club now has 70 members using a variety of computer systems. Each meeting is highlighted by talks by club members. Dues are $6 per year or $3.50 for the newsletter only. Contact Leo Taylor, 18 Ridge Ct W, West Haven CT 06516, (203) 933-5918. ■

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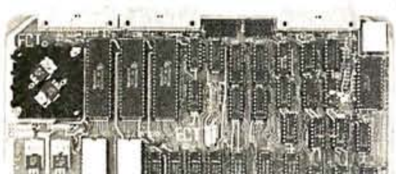

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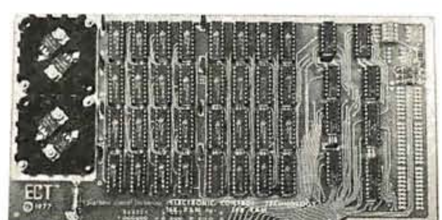

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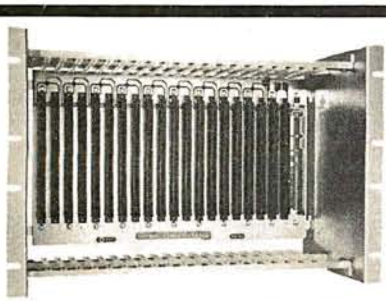

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Event Queue

JULY 1980

July

TRS-80 Interfacing and Application for Scientific Instrumentation and Motorola 6801 Single Integrated Circuit Microcomputer Design, Interfacing, and Applications, Virginia Tech Facility, Dulles Airport. These are hands-on workshops sponsored by Virginia Polytechnic Institute and State University. For more information, contact Dr Linda Leffel, CEC, Virginia Tech, Blacksburg VA 24061, (703) 961-5241.

July-August

Introduction to Microcomputers, Oklahoma State University, Stillwater OK. Approximately two-thirds of this workshop is devoted to hands-on instruction using the PET 2001 with one microcomputer station for every two participants. Contact Technology Extension, Oklahoma State University, Stillwater OK 74078, (405) 624-5714, for schedules of the two-day workshops.

July-September

Pascal Programming Workshop, Boston MA. These five-day courses will include application examples, lectures, informal sessions with instructors, and individual and group programming sessions. A preview of the Ada language will also be included. The fee is $750. For a schedule of the courses, contact Professor Donald D French, Institute for Advanced Professional Studies, One Gateway Ctr, Newton MA 02158, (617) 964-1412.

July-December

Intel Microcomputer Workshops. Intel is offering 13 different microcomputer workshops at its training centers in the Boston, Chicago, and San Francisco areas. They also have scheduled an introduction to microcomputers workshop which will be held in 33 cities in the US. To receive a brochure containing outlines and schedules, call in the Boston area (617) 256-1374; in the Chicago area (312) 981-7250; or in the San Francisco bay area (408) 734-8102; or write Intel Corp, Mail Stop: SV 3-1, 3065 Bowers Ave, Santa Clara CA 95051.

July 1

IEEE Indy Microcomputer Show, Sheraton Motor Inn East, Indianapolis IN. There will be exhibits, demonstrations, and technical seminars addressing applications of microcomputer systems. Contact Publicity Chairman, IEEE Indy Microcomputer Show, Naval Avionics Center, D/810, 6000 E 21 St, Indianapolis IN 46218, (317) 353-3047.

July 7-11

Computers and Related Products, Hyatt Regency Hotel, Seoul, South Korea. This show is limited to approximately forty firms for exhibition. For details, contact Robert Wallace, Rm 6015A, US Dept of Commerce, Industry and Trade Commission, Washington DC 20230.

July 13-19

Educational Applications of Microcomputers, Mt Herman Campus, Northfield-Mt Herman School, Northfield MA. This course is part of an on-going program for school and public librarians, teachers, and media specialists in the educational uses of microcomputers. Arrangements are being made for graduate level credit through Boston State College. Contact Stacey E Bressler, Field Coordinator, Massachusetts Educational Television, 54 Rindge Ave Extension, Cambridge MA 02140, (617) 876-9800.

July 14-16
Diagnostic Software: Planning and Design, Sheraton-Lexington Motor Inn, Lexington MA. This seminar is for design, test, and diagnostic engineers. Design examples, lectures, informal sessions, and programming are part of the course. The fee is $450. Contact Professor Donald French, Institute for Advanced Professional Studies, One Gateway Ctr, Newton MA 02158, (617) 964-1412.

July 14-18
Computers and Related Products, Furma Hotel, Hong Kong. See July 7 for details.

July 14-18
SIGGRAPH '80, Seattle Center, Seattle WA. Topics will include graphic displays, animation and dynamics, cartography, input techniques, video and color hardware, and more. Panel discussions and readings will be included in this conference. For general information, write to SIGGRAPH '80, POB 88203, Seattle WA 98188.

July 14-25
Introduction to Microcomputer Interfacing, Virginia Military Institute (VMI), Lexington VA. This hands-on laboratory-oriented course will feature the Radio Shack TRS-80 Level II computer with 16 K bytes of programmable memory. There will be one microcomputer for every two students. The tuition is $450 and academic credit is available. Contact Dr Philip B Peters, Dept of Physics, VMI, Lexington VA 24450, (703) 463-6225.

July 20
Hamfest, Computerfest, Electronics Fair, Franko's Farm, Bethlehem PA. This annual event is sponsored by the Lehigh Valley Amateur Radio Club and is aimed at ham radio users. A flea market will be featured and food will be available. Prizes will be given out. Contact Wayne Comstock WB3CDL, RR 1, Box 162B, Saylorsburg PA 18353, (215) 381-3674.

July 22-24
The 1980 Microcomputer Show, Wembley Centre, London, England. New products will be exhibited, along with presentations of papers. For information contact TMAC, 680 Beach St, Suite 428, San Francisco CA 94109, (800) 227-3477 or in Canada and California (415) 474-3000.

July 28-August 1
Microprocessors and Microcomputers, George Washington University, Washington DC. Designed for engineers and others without previous experience with digital systems and microcomputers, this course is intended to help individuals manage and conduct design work in microprocessor-based systems. The course fee is $635. For details, write Director, Continuing Engineering Education, George Washington University, Washington DC 20052, (202) 676-6106 or (800) 424-9773.

AUGUST 1980

August 4-6
Data-Entry Management and Supervision Seminar, Chicago IL. This seminar is designed for data-entry managers and supervisors. Topics will range from data-entry control techniques and improving data-entry operator productivity, to personnel communications and motivation. Contact MIC, 140 Barclay Ctr, Cherry Hill NJ 08034, (609) 428-1020.

August 12-14
Computer Graphics '80, Birmingham, England. Computer Graphics '80 will bring together experienced users and specialists to present applications experiences and research findings. In addition to the conference, there will be an equipment exhibition and an animated film festival. To register,

contact Paula Stockham, Online, Cleveland Rd, Uxbridge UB8 2DD, England, phone Uxbridge (0895) 39262.

August 14-24
Electronics/China 80, Guangzhou (Canton), China. This is the first exhibition of US electronic companies in the People's Republic of China. The United States-China Trade Consultants are the sponsors of the show. Products demonstrated will include circuit components, system elements, test instrumentation, product equipment, and materials. Details are available through Expoconsul Inc, Clapp and Poliak Inc, Princeton-Windsor Office Park, POB 277, Princeton Junction NJ 08550.

August 23-24
Personal Computer Arts Festival, Philadelphia Civic Center, Philadelphia PA. Tutorials, seminars, musical performances, and graphic extravaganzas will be featured in this show. Contact PCAF '80, c/o Philadelphia Area Computer Society, POB 1954, Philadelphia PA 19105.

August 25-27
Summer Computer Simulation Conference, Olympic Hotel, Seattle WA. Emphasis will be on computer networks, graphics tools for simulation, database management, and management science models, in addition to papers in such traditional areas as simulation. For details, write Simulation Councils Inc, 1980 Summer Computer Simulation Conference, POB 2228, La Jolla CA 92038.

August 25-28
Implementing Cryptography in Data Processing and Communications Systems, University of Southern California. For information on this conference, contact the University of Southern California, Continuing Engineering Education, Powell Hall 216, University Park, Los Angeles CA 90007, (213) 746-6708.

SEPTEMBER 1980

September 9-10
The 13th International Symposium and Exhibition on Minicomputers and Microcomputer Applications, MIMI'80, Montreal, Canada. This symposium will cover communications, signal processing, data acquisition, control, robotics, education, hardware, langauges, networks, and other topics. It is being held in conjunction with the first IASTED International Symposium and Exhibition on Office Automation. For more information, contact Professor M H Hamza, Dept of Electrical Engineering, University of Calgary, Calgary, Alberta, T2N 1N4 Canada.

September 11-13
Internepcon Semiconductor International Exposition and Conference, Republic of Singapore. Featuring an exhibition of production machinery, tools, hardware, materials, and test instruments, this show includes conferences keyed to the needs of the engineering, manufacturing, and support personnel of Southeast Asia. It is open to all persons engaged in electronics and semiconductor manufacturing. Contact Industrial and Scientific Conference Management Inc, 222 W Adams St, Chicago IL 60606, (312) 263-4866.

September 16-18
Wescon/80, Anaheim Convention Center, Anaheim CA. This year's show will include a large exhibition and a variety of talks covering communications, computers, microprocessors, consumer electronics, energy, office automation, semiconductor technology, and more. Contact Wescon, 999 N Sepulveda Blvd, El Segundo CA 90245, (213) 772-2965.

September 17-19
ACM Small/Personal Computer Conference, Rickey's Hyatt House, Palo Alto CA. This symposium will blend contributed papers, panel, and informal discussions. Included will be hardware and software topics involving theory, design, construction, marketing, and applications. Discussions will cover microcomputer applications in business, industry, education, and the home. Details are available from Conference Chairman, Philippe Lehot, PLA, 976 Longridge Rd, Oakland CA 94610.

September 22-25
Software INFO, Hyatt Regency, Chicago IL. This is the first national conference and exhibit on packaged software held in the US. For more information, or to reserve exhibition space, call (312) 263-3131 or write Software INFO, Suite 545, 222 W Adams St, Chicago IL 60606.

September 23-25
Compcon 80 Fall, Capital Hilton Hotel, Washington DC. Sponsored by the Institute of Electrical and Electronics Engineers (IEEE), this show explores distributed computing and related topics. Discussions will cover interfaces, standards, and protocols; data communications and networking; computer systems; data bases; security; office systems; and more. Details from Compcon 80 Fall, POB 639, Silver Spring MD 20901, (617) 879-2960 ext 3800.

September 24-27
The 10th Annual Conference of the Society for Computer Medicine, San Diego Hilton, San Diego CA. This conference has been planned for physicians, attorneys, administrators, computer professionals, comptrollers, engineers, nurses, and anyone interested in the use of computers for patient

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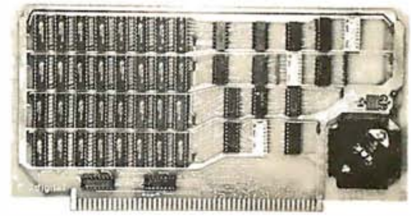

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care. Sessions on medical subjects, technical subjects, and contributed papers on new research in computer medicine will be offered. For information, contact Society for Computer Medicine, 1901 N Ft Myer Dr, Suite 602, Arlington VA 22209, (703) 525-0098.

September 25-28

Mid-Atlantic Personal and Business Computer Show, Philadelphia Civic Center, Philadelphia PA. General admission for adults is $5. The show is being produced by National Computer Shows, POB 678, Brookline Village MA 02147, (617) 524-0000.

September 26-27

Classroom Applications of Computers in Grades K Through 12, Independence High School, San Jose CA. A visit to "Silicon Valley," tutorials, workshops, and exhibits, will highlight this conference. The emphasis will be to inform teachers about the possible uses of computers in all areas of education. Contact Computer-Using Educators, c/o W Don McKell, Independence High School, 1776 Educational Park Dr, San Jose CA 95133.

September 27-28

New Jersey Personal Computer Show and Flea Market —80, Holiday Inn (North) Convention Center, Newark NJ. This show will feature an indoor commercial exhibit and sales area, an outdoor flea market with room for 100 sellers, and forums for all popular hobby computing systems. This show is primarily for hobbyists and small-business owners. The admission price is $4 in advance and $5 at the door. Contact NJPCS, Kengore Corp, 9 James Ave, Kendall Park NJ 08824, (201) 297-6918 after 7 PM.

September 30-October 4

The 8th International Conference on Computational Linguistics, Tokyo, Japan. This conference will provide a forum for a variety of computational linguistics topics including theories, methods, and problems of computational linguistics; models of natural language processing; applications of natural language processing; hardware and software supports for language data processing; and more. For information, contact Professor David G Hays, Twin Willows, 5048 Lakeshore Rd, Hamburg NY 14075. ■

BYTE's Bugs

Hiding Your Lamp Under a Bread Tin

The article by L B Golter "Build a Low-Cost EPROM Eraser" was published in the April 1980 BYTE on pages 234 thru 238. The article contained plans for building an EPROM-erasing device from a set of parts that included two bread-baking tins and an ultraviolet lamp tube.

Unfortunately, the author did not discover that he used the wrong type of ultraviolet lamp (an F6T5/BLB unit); erasable programmable read-only-memory (EPROM) parts placed in the unit will achieve only incomplete erasure. The lamp that should have been used, a General Electric G8T5, will not fit in the bread-tin case devised by Mr. Golter.

A different lamp, the General Electric G4T4/1, will fit, after some modification of the mounting. The G4T4/1 is a U-shaped lamp tube of a low-pressure mercury-vapor type and requires 4 W of power. Because of the lower power, EPROM parts may require longer periods of exposure to achieve complete erasure. Both the G8T5 and the G4T4/1 are widely marketed as "germicidal" lamps.

We apologize for the problems caused to our readers by this situation.

More Ripple Than We Thought

A faulty figure caption appeared in John Thomas' article "Calculating Filter Capacitor Values for Computer Power Supplies" (April 1980 BYTE, pages 118 thru 122).

The caption of figure 4 on page 120 contained the clause "...an almost constant DC voltage with a small fluctuation (ripple) is presented to the voltage regulator stage of the power supply." Anyone looking at the published figure can see that the ripple voltage is indeed *not* small, and can in fact be quite large. The published figure 4 matches the conditions for the design example wherein the ripple voltage (6.8 V) is larger than the output voltage.

We apologize for any confusion this may have caused.

Filter Capacitor Values

I wish to comment on the article by John Thomas, entitled "Calculating Filter Capacitor Values for Computer Power Supplies" (April 1980 BYTE, page 118). Although I have not actually used the formula given on page 118 for computing C_{min}, I did notice something that may be of value to your readers. It should be pointed out that in order for the formula to result in a value representing farads, it is necessary to express the quantity

$$\arcsin \frac{V_{min}}{V_{max}}$$

in terms of radians. A simple formula that may be used to convert degrees to radians is

$$\text{radians} = \frac{2\pi\,(x)}{360} \quad \text{where}$$

$$x = \arcsin \frac{V_{min}}{V_{max}}$$

expressed as degrees. ■

Gene A Chaves

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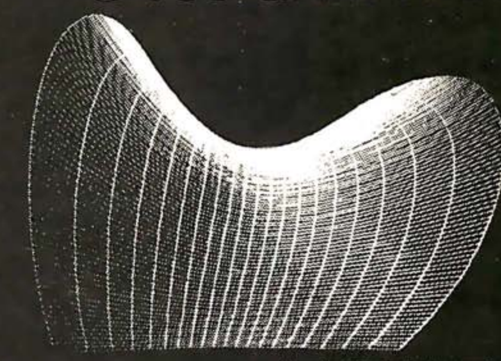

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Ask BYTE

Conducted by Steve Ciarcia

The Very Busy Box

Dear Steve,

Thank you for writing that great article in January's BYTE about the BSR X-10 controller. I am interested in designing an interface for the Heath H-8 computer, but would like to avoid using analog circuitry, wherever possible, by deriving the timing from a single clock signal. Obviously, not many of the frequencies called for in your article are going to be met exactly. Could you give me some idea of the tolerances involved?

John R Souvestre

In that article, I was careful to quote only the manufacturer's specifications, the time intervals 1.2 ms and 4.0 ms, and the frequency 40 kHz. Experimentation using an oscilloscope and a frequency counter has demonstrated a fairly large tolerance in these settings. I have been successful with settings in the ranges of 1.1 ms to 1.7 ms, 3.5 ms to 4.5 ms, and 39,500 Hz to 40,800 Hz, respectively. The amount is dependent upon the particular command controller.

If you really want bare bones, use an NE555 timer as a 40 kHz oscillator and gate its output with software timing.

Steve

Dear Steve,

I have been considering methods to control most of the appliances in my house through my computer, and your January article has given me the means. I have started collecting parts, but I ran into a problem: I cannot find the address of Massa Products, supplier of the ultrasonic transducer.

Mike McLennan

Unfortunately, Massa Products has a minimum-order policy, so it may not be cost-effective to use their transducer unless you need other parts too. You can use a Panasonic EFROSB40K2, available from Panasonic's distributors, or as part number MM1002 from: The MicroMint, 917 Midway, Woodmere NY, 11598, (516) 374-6793; cost: $6.

Steve

Dear Steve,

Your recent article about computer control of appliances prompted me to purchase a BSR X-10 system. I have devised a simple remote audio-volume control which uses a lamp-dimmer module, acting on a photoresistive cell. By inserting the cell in line between the preamp and power amp of my stereo system, the volume is controlled through an isolating optical link.

Jim Smirniotopoulous

That's one idea I never considered. My experience using AC-powered lights to control a photocell has always required filtering out the 60 Hz power-line noise. One easy solution is to build an averaging circuit from a bridge-rectifier, thus driving the lamp with DC.

Steve

16-Bit Systems

Dear Steve,

I was fascinated by your series of articles in BYTE ("Ease into 16-Bit Computing" March 1980 BYTE, page 40), and I am impressed by the added computing power available through the new 16-bit microprocessors, but I am interested in building a complete system, not just a computer. This practically requires that the processor board be S-100 compatible. How long will it be until these specifications are met, and will it be worth the wait? Which one will have the edge in performance under personal computing conditions?

Lynne Poderson

I have written articles about the Intel 8086 and 8088 processors, and generally like what I hear regarding the Motorola 68000. I try to refrain from making too many claims for hardware that I have not personally checked out. There are 8086 S-100 boards presently available, but it will be a while before any 68000 or Zilog Z8000 units are available. Industrial users are acquiring most of the parts, so prices are currently high. My opinion is that these third-generation microprocessors will all perform in the same league when used in personal computers. The true measure of efficiency will be a function of well-written operating systems and high-level language implementations.

Steve

Dear Steve,

Last spring I acquired an 8086 "University Kit" from Intel, with the intention of breadboarding a system. Several tinkerers dissuaded me, saying that the high frequencies involved would not be suitable to my intended medium. I decided to shelve the idea until a reasonably priced S-100 processor board became available. The boards that are presently available are all in the $500 range. Would I be better off buying an 8088 and building your five-chip system described in the March and April Circuit Cellars, or are cheaper boards going to be available soon?

Tom Boerjan

I disagree with the person that told you not to prototype an 8086 system because of the high frequencies involved. The frequencies are no higher than those used in the 8080. The key, of course, is good layout and proper construction techniques. You can still try an 8088, but a bird in the hand...

The 8088 is still new and University Kits did not exist when I wrote the article. An S-100 board for either processor will be expensive. Only time and increased chip production will lower the cost.

For a printed-circuit board for the 8088 system described in my article, write to John Bell Engineering, POB 338, Redwood City CA 94064. They should be able to provide the necessary components. For application notes on the 8088 processor, write directly to Intel Corporation at 3065 Bowers Ave, Santa Clara CA 95051.

Steve■

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:

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MICRO8: Using BASIC to Learn Assembly Language

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Piedmont Virginia Community College
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In this article we present a program in BASIC which simulates a very simple digital computer and the assembly language which runs on it. The program is called MICRO8. MICRO8 was developed as a teaching tool to give students some idea of computer architecture and how to write in assembly language. The emphasis is on programming procedures and information flow, without the complexities of number-system conversions and fixed-point arithmetic. All input and output data is in floating-point decimal format, and op codes are in two-digit decimal form, so that the user need not struggle with binary, octal, or hexadecimal number systems. The next step, using an actual microprocessor assembly language, is therefore made easier. [*This tutorial approach is in many ways very similar to that taken by Donald Knuth in his MIX language found in the epic series* The Art of Computer Programming . . . .**ed**]

Many useful problems can be solved with MICRO8, including sum of infinite series to a specified convergence, area under curves, square roots, and others. It is quite a challenge for our students to accomplish these solutions with MICRO8, which has only 14 op codes. These students have previously solved these problems in BASIC; nonetheless, working with MICRO8 gives them a good understanding of the details of using an assembly language.

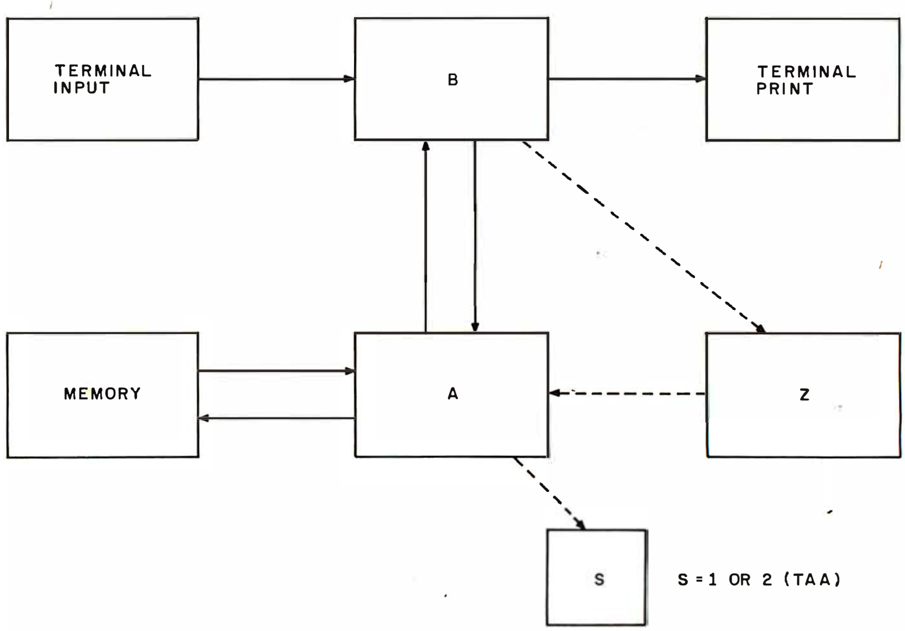

Figure 1: *MICRO8 architecture. When the system is started, all registers and memory locations are cleared automatically. Arithmetic operations leave their results in register A. The exchange command (EXE) leaves the first value of B in Z. The maximum size of registers A and B is 1×10^{20}. The running time limit is five minutes, after which a dump command is performed. The limit on the number of machine cycles is 20,000.*

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MICRO8 operates as a stored-program computer, as outlined in the block diagram of figure 1; four registers (A, B, S, Z) and memory (up to 200 numbers, or "words") are provided. Input and output are via a terminal.

MICRO8 includes 14 "machine" instructions (op codes), as shown in table 1. These allow the user to perform arithmetic as well as transfers, tests, and jumps. Note that some op codes require two bytes. For instance, ADD, op code 17, requires a second byte to specify the memory address of the number to be added to register A. A dump routine is also provided to aid in debugging, and several error messages are automatically printed in case of illegal op codes, division by zero, excessive running time, etc.

As indicated in figure 1, operator input and output is done only through register B (with instructions INP and PRB). A and B can interchange data (EXE). Memory reading, storage, and arithmetic operations are performed only in conjunction with register A. Registers S and Z are not user-accessible. Z is used with the EXE operation, and S is a flag set by the test TAA.

A programming sheet, shown in figure 2, is useful in organizing programs and provides good documentation practice. The program shown in figure 2 illustrates the use of MICRO8 to calculate the value of $R^2 + X^2$.

Memory locations 1 thru 10 are reserved for a "scratch pad," convenient for constants and various intermediate calculations in a problem. In this case, locations 1 and 3 are specified for input numbers R and X, and location 2 will contain the value R^2 when calculated by the program.

This program requires 17 steps (sequence of operations). The step-by-step "description" column aids in explaining what is intended, and the "result" column describes what has happened at various points in the program. The last command is dump (DMP), which is optional, but which is recommended to provide a permanent record of the program *as run* (not *as intended*, which may be

Operation	Mnemonic	Op Code	Explanation
input data	INP	11	Terminal input to register B.
output	PRB	12	Output contents of register B to terminal.
clear	CLE xx	13 xx	Clear register or memory as specified by xx: 14: clear A; 15: clear B; 16: clear memory.
add	ADD xx	17 xx	Add contents of memory location xx to register A.
subtract	SUB xx	18 xx	Subtract contents of memory location xx to register A.
multiply	MUL xx	19 xx	Multiply contents of register A by contents of memory location xx.
divide	DVD xx	20 xx	Divide contents of register A by contents of memory location xx.
exchange	EXE	25	Swap contents of registers A and B.
store	MAM xx	22 xx	Move contents of A to memory location xx.
test	TAA xx	24 xx	Test if absolute value of register A is less than contents of memory location xx. (Sets S = 1 if true; S = 2 if false.)
jump absolute	JMA xx	28 xx	Jump to address xx.
jump-if	JMI xx	30 xx	Jump to address xx if S = 1.
halt	HLT	26	Stop processing.
dump	DMP	27	Print contents of all registers and memory, then stop.

Table 1: *MICRO8 instruction set. This simplified language is used to help students learn assembly-language techniques.*

PROGRAMMING SHEET

Memory Allocation
("Scratch Pad"): M(1) = 168 (R) M (6) = ______
(2) = R^2 (7) = ______
(3) = 12 (X) (8) = ______
(4) = ______ (9) = ______
(5) = ______ (10) = ______

PROGRAM: Description	Mnemonic	Op Code	Memory Location	Result
Bring Value of R to A	ADD	17	11	
		1	12	R in Accum.
Multiply Accum. by R	MUL	19	13	
		1	14	R^2 in Accum.
Store R^2 in Memory	MAM	22	15	
		2	16	R^2 in Memory M(2)
Clear Accumulator	CLE	13	17	
		14	18	
Bring Value of X to A	ADD	17	19	
		3	20	X in Accum.
Multiply Accum. by X	MUL	19	21	
		3	22	X^2 in Accum.
Add R^2 to Accum.	ADD	17	23	
		2	24	$R^2 + X^2$ in Accum.
Move Accum. Value to B	EXE	25	25	$R^2 + X^2$ in B
Print contents of B	PRB	12	26	Prints B on terminal
Dump routine	DMP	27	27	

Figure 2: *Programming sheet for the solution of $R^2 + X^2$. These programming sheets promote good documentation techniques.*

Listing 1: *Program input for calculation of R^2+X^2. These program lines are added to listing 5.*

```
1400  REM: NEXT LINE, NUMBER OF PROGRAM STEPS
1410  DATA 17
1420  REM: FOLLOWING LINES = PROGRAM
1430  DATA 17, 1, 19, 1, 22, 2, 13, 14, 17, 3, 19, 3, 17, 2, 25, 12, 27
1450  LET M[1] = 168
1460  LET M[3] = 12
```

Listing 2: *Sample run of listing 1. The DMP command causes a complete printout of all registers and memory used.*

```
RUN
MICRO8

B REGISTER = 28368     MACHINE CYCLES = 9     LAST ADDR = 26
DUMP ROUTINE
A = 0    B = 28368    Z = 0    LAST OPCODE = 27    LAST ADDR = 27
S = 0    MACHINE CYCLES = 10    RUN TIME = 0    MINUTES

MEMORY CONTENTS:
168   28224   12    0    0    0    0    0    0    0   17
1     19      1    22    2   13   14   17    3   19    3   17
2     25     12    27
DONE
```

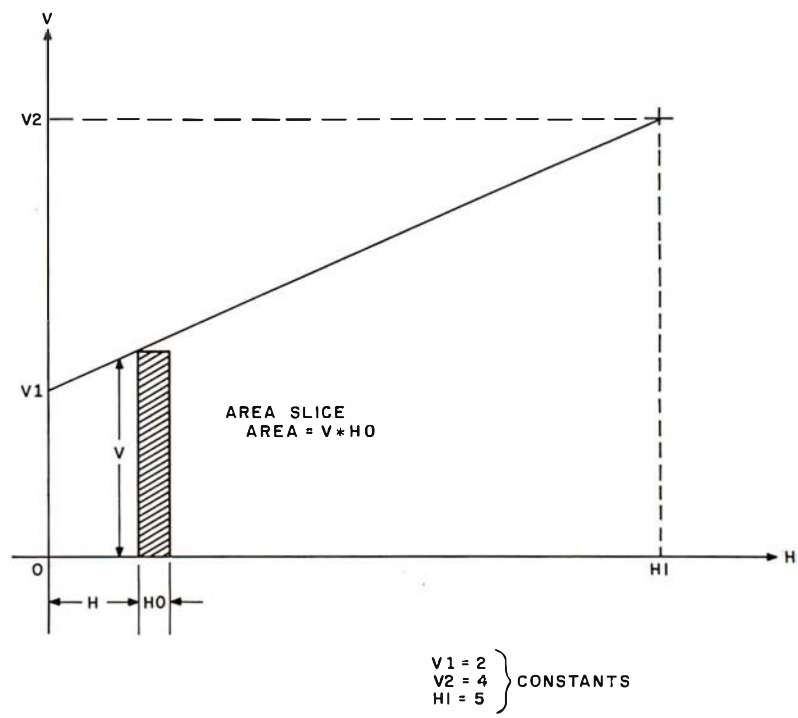

Figure 3: *Problem setup for area under the curve problem.*

another matter!). DMP provides a printout of the entire memory contents along with the contents of all registers.

To run this program in MICRO8, the desired sequence of op codes (the program) is typed in, beginning with line 1430 as DATA. The number of program steps is then typed in as DATA on line 1410. Next, any "scratch-pad" values are typed in as LET statements, beginning on line 1450. The complete MICRO8 program input then appears as shown in listing 1.

Next, type RUN. MICRO8 will store the entire program in memory, beginning at location M(11); it will then proceed to execute the instructions beginning at location 11, one step at a time.

The resulting run appears in listing 2; the particular numbers used for R and X were 168 and 12, respectively.

Text continued on page 248

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PROGRAMMING SHEET

Memory Allocation
("Scratch Pad"): M(1) = 2 (V1) M (6) = 0 (Area)
(2) = 4 (V2) (7) =
(3) = 5 (H1) (8) =
(4) = 0 (H) (9) =
(5) = 0.01 (H0) (10) =

PROGRAM: Description	Mnemonic	Op Code	Memory Location	Result
Bring V2 to Accum.	ADD	17	11	
		2	12	
Subtract V1	SUB	18	13	
		1	14	V2 − V1 in Accum.
Divide by H1	DIV	20	15	
		3	16	$\frac{V2 - V1}{H1}$
Multiply by H	MUL	19	17	
		4	18	
Add V1	ADD	17	19	
		1	20	$V = \frac{(V2 - V1)}{H1} \times H + V1$
Multiply by H0	MUL	19	21	
		5	22	V × H0 in Accum.
Add previous Area	ADD	17	23	
		6	24	Updated Area
	MAM	22	25	
Store Area in Memory (6)		6	26	Store updated Area
Clear Accum.	CLE	13	27	
		14	28	
Bring H to Accum.	ADD	17	29	
		4	30	
Add H0 to Accum.	ADD	17	31	
		5	32	New Value for H
Store New Value of H	MAM	22	33	
		4	34	H updated, in M(4)
Clear Accum.	CLE	13	35	
		14	36	
Bring H1 to Accum.	ADD	17	37	
		3	38	
Test if H1 < H	TAA	24	39	If yes, sets S = 1
		4	40	
Jump if S = 1	JMI	30	41	Jump to 47 if S = 1
		47	42	
Clear Accum.	CLE	13	43	
		14	44	
Jump to Memory (11)	JMA	28	45	
		11	46	Jump to 11
Clear Accum.	CLE	13	47	
		14	48	
	ADD	17	49	
Bring updated Area to A.		6	50	Area in Accum.
	EXE	25	51	Area in B
Print	PRB	12	52	Print out
	DMP	27	53	Dump routine

Figure 4: *Programming sheet for the solution of area under curve problem presented in figure 3.*

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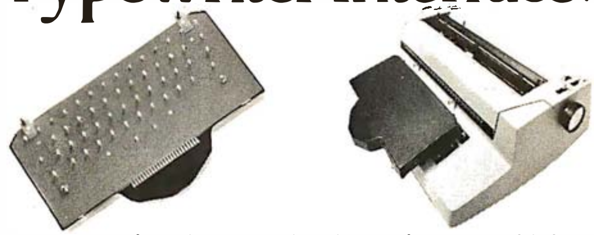

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Listing 3: *Program input for calculation of area under a curve.*

```
1400 REM: NEXT LINE, NUMBER OF PROGRAM STEPS
1410 DATA 43
1420 REM: FOLLOWING LINES = PROGRAM
1430 DATA 17, 2, 18, 1, 20, 3, 19, 4, 17, 1, 19, 5, 17, 6, 22, 6
1440 DATA 13, 14, 17, 4, 17, 5, 22, 4, 13, 14, 17, 3, 24, 4
1450 DATA 30, 47, 13, 14, 28, 11, 13, 14, 17, 6, 25, 12, 27
1460 LET M[1] = 2
1461 LET M[2] = 4
1462 LET M[3] = 5
1463 LET M[4] = 0
1464 LET M[5] = .01
1465 LET M[6] = 0
```

Listing 4: *Sample run of listing 3.*

```
RUN
MICRO8

B REGISTER = 14.99     MACHINE CYCLES = 9002     LAST ADDR = 52
DUMP ROUTINE
A = 0     B = 14.99     Z = 0     LAST OPCODE = 27     LAST ADDR = 53
S = 1     MACHINE CYCLES = 9003     RUN TIME = 4     MINUTES

MEMORY CONTENTS:
2    4    5    5.00007   .01        14.99        0    0    0
0    17   2    18    1   20    3    19     4     17   1    19
5    17   6    22    6   13    14   17     4     17   5    22
4    13   14   17    3   24    4    30     47    13   14   28
11   13   14   17    6   25    12   27
DONE
```

Listing 5: *BASIC listing for the MICRO8 computer.*

```
10   REM: "MICRO8", SIMULATION OF AN ASSEMBLY LANGUAGE, IN BASIC
20   REM: VERSION "B" JULY 27, 1978 R.T. PICKETT
30   REM: TYPE IN PROGRAM AS DATA BEGINNING ON LINE 1430
40   REM: TYPE IN NUMBER OF PROGRAM STEPS AS DATA ON LINE 1410
50   REM: ALL REGISTERS AND MEMORY LOCATIONS ARE AUTOMATICALLY
60   REM: CLEARED AT START; ARITHMETIC OPERATIONS LEAVE RESULT IN
70   REM: REGISTER A; EXCHANGE (EXE) LEAVES FIRST VALUE
80   REM: OF B IN Z REGISTER; MAXIMUM SIZE OF A & B IS 10120; RUNNING
90   REM: TIME LIMIT IS 5 MINUTES; LIMIT ON NUMBER OF MACHINE CYCLES
100  REM: IS 20000, THEN DUMPS AUTOMATICALLY.
110  GOTO 1330
120  LET A=B=S=T=Z=0
130  DIM M[200]
140  REM: L = MEMORY LOCATION
150  LET L = 11
160  LET T0 = TIM(0)
170  GOTO 220
180  LET L=L+1
190  REM: NEXT LINE IS FIVE MINUTE RUNNING TIME LIMIT
200  IF TIM(0)-T0>5 THEN 1250
210  REM: NEXT LINE, FETCH OPCODE "C" FROM MEMORY
220  LET C=M[L]
230  REM: T = MACHINE CYCLE COUNTER
240  LET T=T+1
250  IF T > 20000 THEN 1290
260  REM: BEGIN DECODER
270  IF C< 10 THEN 1230
280  IF C=11 THEN 500
290  IF C=12 THEN 530
300  IF C=13 THEN 550
310  IF C=14 THEN 180
320  IF C=15 THEN 180
330  IF C=16 THEN 180
340  IF C=17 THEN 660
350  IF C=18 THEN 690
360  IF C=19 THEN 720
370  IF C=20 THEN 760
```

Listing 5 continued on page 246

Listing 5 continued:

```
380   IF C=21 THEN 180
390   IF C=22 THEN 810
400   IF C=23 THEN 180
410   IF C=24 THEN 840
420   IF C=25 THEN 900
430   IF C=26 THEN 940
440   IF C=27 THEN 1000
450   IF C=28 THEN 960
460   IF C=29 THEN 180
470   IF C=30 THEN 1100
480   GOTO 1230
490   REM: BEGIN OPERATIONS SPECIFIED BY OPCODES
500   INPUT B
510   IF ABS(B)>1.E+20 THEN 1310
520   GOTO 180
530   PRINT "B REGISTER ="; B; "MACHINE CYCLES =";T; "LAST ADDR ="; L;LIN(1)
540   GOTO 180
550   LET L=L+1
560   IF M[L]=14 THEN 600
570   IF M[L]=15 THEN 620
580   IF M[L]=16 THEN 640
590   GOTO 1210
600   LET A=0
610   GOTO 180
620   LET B=0
630   GOTO 180
640   MAT M=ZER
650   GOTO 180
660   LET L=L+1
670   LET A=A+M[M[L]]
680   GOTO 180
690   LET L=L+1
700   LET A=A-M[M[L]]
710   GOTO 180
720   LET L=L+1
730   LET A=A*M[M[L]]
740   IF ABS(A) >1.E+20 THEN 1310
750   GOTO 180
760   LET L=L+1
770   IF M[M[L]]=0 THEN 1270
780   LET A=A/M[M[L]]
790   IF ABS(A)>1.E+20 THEN 1310
800   GOTO 180
810   LET L=L+1
820   LET M[M[L]]=A
830   GOTO 180
840   LET L=L+1
850   IF ABS(A)<M[M[L]] THEN 880
860   LET S=2
870   GOTO 180
880   LET S=1
890   GOTO 180
900   LET Z=B
910   LET B=A
920   LET A=Z
930   GOTO 180
940   PRINT "HALT"
950   STOP
960   LET L=L+1
970   LET L=M[L]
980   GOTO 200
990   REM: DUMP ROUTINE PRINTS OUT MEMORY BEGINNING AT LOCATION 1
1000  PRINT "DUMP ROUTINE";LIN(1)
1010  PRINT "A=";A;"B=";B;"Z=";Z;"LAST OPCODE =";C;"LAST ADDR=";L
1020  PRINT
1030  PRINT "S=";S;"MACHINE CYCLES =";T;"RUN TIME=";TIM(0)-T0;
1040  PRINT "MINUTES";LIN(1)
1050  PRINT "MEMORY CONTENTS:"
1060  FOR D=1 TO N+10
1070  PRINT M[D];
1080  NEXT D
1090  STOP
1100  IF S=1 THEN 1130
1110  IF S=2 THEN 1160
1120  GOTO 1190
```

Listing 5 continued on page 248

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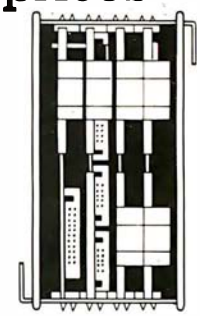

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Listing 5 continued:

```
1130    LET L=L+1
1140    LET L=M[L]
1150    GOTO 200
1160    LET L=L+2
1170    GOTO 200
1180    REM: BEGIN DIAGNOSTIC MESSAGES
1190    PRINT "INVALID S =";S;"ADDR=";L;
1200    STOP
1210    PRINT "ILLEGAL DEVICE CODE UNDER CLEAR;LAST ADDR=";L
1220    GOTO 180
1230    PRINT "INVALID OP CODE; LAST MEM ADDR =";L
1240    STOP
1250    PRINT "FIVE MINUTE RUN TIME EXCEEDED"
1260    GOTO 1000
1270    PRINT "DIVIDE BY ZERO, MEM ADDR=";L
1280    STOP
1290    PRINT "EXCESSIVE NO. MACH. CYCLES; AUTO DUMP"
1300    GOTO 1000
1310    PRINT "OVERFLOW; LAST ADDR =";L
1320    GOTO 1000
1330    REM: BEGIN MEMORY LOADING(BEGINS LOADING AT LOCATION 11)
1340    READ N
1350    MAT M=ZER
1360    FOR K=11 TO N+10
1370    READ A
1380    LET M[K]=A
1390    NEXT K
1400    REM: NEXT LINE, NUMBER OF PROGRAM STEPS
1410    DATA 17
1420    REM: FOLLOWING LINES = PROGRAM
1430    DATA 17, 1, 19, 1, 22, 2, 13, 14, 17, 3, 19, 3, 17, 2, 25, 12, 27
1450    LET M[1]=168
1460    LET M[3]=12
1470    GOTO 120
1480    END
```

Text continued from page 240:

The answer is 28368 which is the value of the B register printed out. Note also the DUMP routine: it prints out all register contents and memory contents sequentially, 1 thru 27 for this program.

An even better example for illustrating the capability of MICRO8 is the calculation of the area under a curve. The curve for this example is a straight line, as shown in figure 3.

The whole area can be calculated (approximately) by adding up the areas of many small rectangles, V×H0, from H = 0 to H = H1; the height of each rectangle is V, which is given by the following relation:

$$V = \frac{V2 - V1}{H1} \times H + V1$$

The procedure is to start at the left side of the curve (at H = 0), calculate the area slice (V × H0), and save that value. Then move the slice over slightly (increment size H0), calculate the next height, V, and a new area slice (V × H0), and add that to the previously calculated slice. Continue to add H0 to H, calculating and adding area slices until the right-hand boundary, H1, is reached. The sum of the area slices is then equal to the total area (approximately). The smaller the increment, H0, the more accurate the area calculation will be (and the longer the computer running time). The programming sheet in figure 4 shows the 43 steps required.

The MICRO8 program input for this problem is shown in listing 3 and the results in listing 4. Of course, the known area here is 15.00; the MICRO8 calculation gives 14.9 for H0 = 0.1, and 14.99 for an increment of 0.01. Note that this smaller increment gives a running time of 4 minutes, during which 9003 machine cycles occur (here, one "machine cycle" means one op-code procedure).

As shown in listing 5, MICRO8 has been used by three groups of students so far and has generated much interest. In all respects, it has simplified the teaching of programming techniques, *before* getting involved with the instruction set of the 8080 microprocessor.

We are currently developing an executive program to enable the user to single-step through a MICRO8 program, to alter contents of any memory location while single-stepping, and to provide a dump at any time for debugging purposes. ■

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The Model 460 64 K-byte programmable memory board is a high-speed, low-power memory system that supports 8080 and Z80 microprocessors and operates at 4 MHz with no wait states. The Model 640 provides parity capability and 64 K bytes of memory organized into four blocks, each of which is individually deselectable for memory mapping. It is available from Industrial Micro Systems, 628 Eckhoff St, Orange CA 92668, (714) 978-6966. The suggested retail price for the model 460 is $1050.

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Circle 454 on inquiry card.

Percom Introduces Color Display for TRS-80 and Other Computers

The Electric Crayon is a computer-operated color graphics generator and controller. The system includes an operating system, EGOS, and has a provision for 1 K bytes of programmable memory, and an erasable programmable read-only memory (EPROM) for extending EGOS and a second dual-bidirectional 3-bit port for peripherals. Up to eight colors may be generated, depending on which of ten modes has been selected. In the highest density mode, the display resolution is 256 by 192 pixels. The Electric Crayon, a manual, an assembly-language listing of EGOS, and listings of other BASIC programs sell for $249.95 from Percom Data Co, 211 N Kirby, Garland TX 75042.

Circle 455 on inquiry card.

End the TRS-80 Loading Problem

The Data Dubber is a device for TRS-80 users who want easy loading from cassettes. With too low a volume during the loading of a program from cassette, the TRS-80 misses data bits. Too high a volume causes an overload. The Data Dubber expands the upper and lower volume limits so that setting the volume is less critical. It connects between the cassette and the TRS-80 to filter the incoming data. The unit ignores noise, volume variations, static and distortion, and takes the incoming data and reproduces or regenerates the original data pulses. By connecting the device between two recorders, tapes can be copied. The Data Dubber also allows monitoring of tapes to listen for dropouts or gaps. It costs $39.95 by mail and $49.95 at dealers. Contact The Peripheral People, POB 524, Mercer Island WA 98040.

Circle 456 on inquiry card.

CMOS Circuit Soothes Infants with Prebirth Sounds

A unique product is available to help eliminate the "3-AM-walk-the-baby-blues." A 29 cm (11.5 inch) teddy bear reproduces the intrauterine sounds recorded inside an expectant mother's womb. The sounds are the pulse beat and blood going through the major arteries. It can make crying babies quiet in about five to ten seconds, and asleep in thirty to sixty seconds. The complementary metal-oxide semicondutor (CMOS) integrated circuit that contains the sound, a linear power amplifier, resistors, capacitors, and a volume control are mounted on a printed-circuit board and are housed with a speaker and 9 V battery within the teddy bear. Volume is controlled from the front. The sounds were recorded by placing a specially designed eight millimeter microphone inside a pregnant mother's womb, directly next to the unborn infant's ear just prior to the mother's entering labor. The sounds were then transferred to records and tapes. These prebirth sounds are usually effective with infants up to the age of three months. The "Rock-a-Bye Bear" is priced at $39.95. For information about the circuit, contact Motorola, POB 20912, Phoenix AZ 85036. Contact Rock-A-Bye-Baby Inc, POB 24160, Fort Lauderdale FL 33307, for information about the teddy bear.

Circle 457 on inquiry card.

What's New?

MISCELLANEOUS

Multi-User, 20-Megabyte Hard-Disk Options Highlight This 6809-Based System

Smoke Signal Broadcasting, 31336 Via Colinas, Westlake Village CA 91361, (213) 899-9340, has introduced its 6809-based series of Chieftain Business Systems featuring multi-user and 20-megabyte hard disk options. The system is configured around SSB's Chieftain computer with 64 K bytes of programmable memory and the DCB-4 disk controller capable of handling four 8-inch floppy disks, each storing 1 megabyte of data. The hard disk provides 10 megabytes of fixed and 10 megabytes of removable storage and can be accessed by up to four users. Up to sixteen 64 K-byte blocks of memory can be addressed and 1 megabyte of memory can be accessed in 4 K-byte blocks. The system also includes a video display terminal and either a high-speed line printer or letter-quality daisy-wheel printer. A wide range of programs are available for business applications, including word processing. The Chieftain series of systems supports COBOL, FORTRAN, and UCSD Pascal. Prices range from $5000 to $8400, depending on disk storage and printer. The hard disk and multi-user options are $8500.

Circle 459 on inquiry card.

Programmer Module for Intel 2732A Erasable Programmable Read-Only Memory (EPROM)

A generic module that enables all Series 90 programmable read-only memory (PROM) programmers to program Intel's 2732A HMOS EPROM has been developed. The PM9074 module will also accommodate other HMOS EPROMs and higher-density PROMs as they are developed. When plugged into a Pro-Log Series 90 PROM programmer master-control unit, the module provides the control lines and timing necessary to list, program, duplicate, and verify these devices. The PM9074 features cold sockets that allow installation and removal of PROMs without applying supply voltage to the sockets; high/low voltage verification to permit reading of PROMs with the supply voltage adjusted to its high and low limits; and parametric testing, which adjusts the PROM output to its high and low limits during reading. The PM9074 adapts to the correct bit structure and memory size of each PROM. It is priced at $550 from Pro-Log, 2411 Garden Rd, Monterey CA 93940, (408) 372-4593.

Circle 461 on inquiry card.

Data Transceiver for ASCII/Baudot/Morse Code

The UDT-170 connects directly between an ASCII or Baudot (5-level) teletypewriter or video terminal and the station transceiver in an amateur radio station. The unit combines the power of two microprocessors as a radioteletypewriter (RTTY) terminal unit and Morse code converter. It has the capability of taking keyboard commands from a Teletype, computer, or video terminal. The UDT-170 can handle 60 to 100 words per minute Baudot and 110 to 1200 bits per second (bps) ASCII. The device can display 64 to 80 characters per line and automatically buffer up to 32 characters. The unit will operate at any frequency-shift keying (FSK) shift from less than 100 Hz to over 1000 Hz. The price for the UDT-170 is $479. Information is available from Xitex Corporation, 9861 Chartwell Dr, Dallas TX 75243, (214) 349-2490.

Circle 458 on inquiry card.

Flying Head for Removable Hard Disks

A new read/write head from Trans Datacorp, 1717 Old Country Rd, Belmont CA 94002, has a small core of hot-pressed manganese zinc ferrite, inserted in an extremely hard ceramic slider, achieving higher recording densities while virtually eliminating Winchester's extreme sensitivity to particle contamination and surface scratching. This design allows the head to be loaded and unloaded, enabling drive designers to provide very high-density removable pack and removable cartridge drives. Because of this design, drive motor size can be reduced, lubrication overcoat can be eliminated on the disk, and cleanliness requirements can be reduced. The flying head is designed specifically for individual systems and applications. Trans Datacorp also reconditions disk heads.

Circle 460 on inquiry card.

BOSS Bus Catalog

Micro Link Corporation, 624 S Range Line Rd, Carmel, IN 46032, has made available a catalog describing its BOSS (BUS Oriented System Support) line of microprocessor system-support cards. The cards are designed for the STD BUS and measure 11.5 by 16.8 cm (4.5 by 6.5 inches) with standard 56-pin connectors. Features, applications, operating procedures, and data are detailed in the catalog.

Circle 462 on inquiry card.

What's New?

PERIPHERALS

The 737 Printer from Centronics

The model 737 dot-matrix printer features right-margin justification, proportional spacing, forward and reverse paper motion, and three-way paper handling. It prints 7-by-8 dot-matrix characters at 10 and 16.5 characters per inch for standard data processing tasks, and generates n-by-9 dot-matrix characters in the proportional character spacing used for data and text processing. The printer incorporates an adjustable nine-wire, free-flight printhead. Under manual or software control, the operator can roll the paper forward or backward in half-line steps to print subscripts and superscripts for equations, footnotes, and other text printing tasks. The 737 accepts letterhead 80-column fanfold pinfeed paper. Under host computer control it will justify righthand margins. It also generates expanded print for headlines and column subheadings. The 737 printer is priced at $995, from Centronics Data Computer Corporation, Hudson NH 03051, (603) 883-0111.

Circle 464 on inquiry card.

VAMP's New Color Receiver/Monitor

Automatic fine tuning, automatic gain control, slotted mask, and a black matrix are some of the features of this color receiver/monitor from VAMP Inc, 1617 El Centro Ave, Suite 19, Los Angeles CA 90028, (213) 466-5533. In the monitor mode the set will accept standard composite video. Looping inputs are provided so that multiple sets can be linked. An audio input is also provided. The resolution is 300 lines horizontal and 350 lines vertical. The 13-inch model (VM-1300) is $449 and the 19-inch model (VM-1900) is $575.

Circle 463 on inquiry card.

The ACI Pascal Terminal

Associated Computer Industries Inc's ACI Pascal Terminal is a 12-inch, 24-line by 80-character video terminal for use with the UCSD Pascal operating system. It incorporates a separate ETX key along with standard UCSD Pascal X,Y cursor addressing. The terminal provides the standard uppercase and lowercase 96-character ASCII (American Standard Code for Information Interchange) set. Cursor display is switch selectable for steady or blinking underline or block. It accommodates several international-language character displays by internal switch changes. The terminal also incorporates provisions to display thirty-two control characters. The price for the Pascal Terminal is $1095 from Associated Computer Industries Inc, 17751 Sky Park E, Suite G, Irvine CA 92714, (714) 557-0560.

Circle 465 on inquiry card.

KB-2100 Word-Processing Keyboard

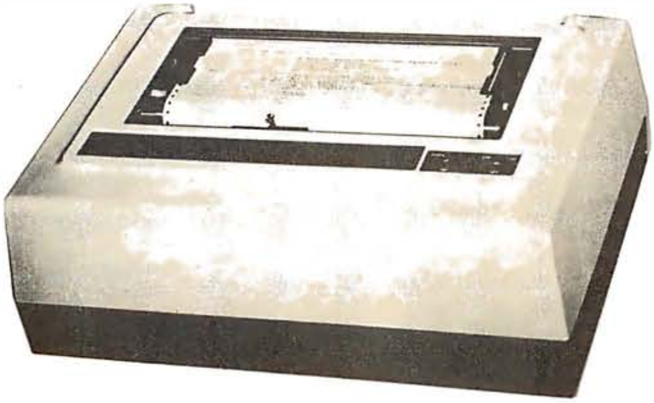
Algorithmics has announced the KB-2100 extended English keyboard for its line of word-processing and office information systems. The detachable keyboard features 113 keys arranged in five key clusters. Mechanical keyboard features are designed to provide the operator with tactile feedback that closely matches the familiar feel of typewriter keyboards. Extra-large sculptured keys are used for the traditional special actions such as carriage return, shift, and tab. The shift-lock key contains a light to indicate uppercase mode. The keys have a capacitive action, insuring reliability through the elimination of mechanical switch contacts. To allow for fast typists, the keyboard has n-key rollover.

Used in the ALGO-2100 word-processing system, the keypads produce brackets, greater-than and less-than symbols, and 20 symbols for technical, mathematical, or foreign characters. The key clusters across the top of the keyboard permit block-move, word-delete, forward-search, and other word-processing functions. Cursor keys automatically repeat when held down, and any other key can be made to automatically repeat by depressing the repeat key. The keyboard is standard on ALGO-2100 systems and is offered to other computer and office equipment manufacturers for incorporation into their products. It is priced at $450 from Algorithmics Inc, 177 Worcester Rd, Wellesley MA 02181, (617) 237-7226.

Circle 466 on inquiry card.

What's New?

PERIPHERALS



Color Matrix Printer

Integrex has announced a color serial-matrix printer. The microprocessor-controlled bidirectional Model 454C prints 250 characters per second (cps) with a single printhead on a 9-by-9 matrix. Maximum line length is 155 characters. The standard character font is ECMA-42; custom fonts are available. The 454C is designed for color video display dumping. Graphics areas may be color mixed for mimic diagrams and other applications. Vertical shifting of the three-color striped ribbon ensures maximum throughput. The printhead is momentarily retracted during color shifts. Serial and parallel interfaces are available, including IEEE-488. For prices and more details, contact Integrex Limited, Portwood Industrial Estate, Church Gresley, Burton on Trent, Staffordshire, DE11 9PT England, telephone Burton on Trent (0283) 215432 or Telex 377106.

Circle 468 on inquiry card.

300 bps Modem from Ireland

The CCITT V21 single-card modem is made by Bootstrap Limited of Dublin, Ireland. The modem has full-duplex operation at up to 300 bits per second (bps) over the public switched telephone network or over two-wire leased lines. It can be switched for use in call-originate mode with terminals or in automatic-answer mode at a central site. The modem is available in tabletop, 38 cm (19 inch) rack mounting, or single-card versions. The tabletop model measures 24 by 29 by 6 cm (9.5 by 11.5 by 2.4 inches). The 38 cm card cage can hold sixteen modem cards. The single card is suited for building into terminals and other equipment. The modem accepts serial asynchronous data via the CCITT V24 (RS-232) interface through a 25-pin female D-type socket. It will operate with a minimum of three connections. Telephone Bootstrap Limited at 01-887892 or write the company at 9 Georges Ave, Blackrock, County Dublin, Republic of Ireland.

Circle 467 on inquiry card.

Low-Cost ASCII Keyboards from RCA

The VP-601 with a 58-key typewriter format at $65 and the VP-611 with the typewriter format plus a 16-key numeric keypad for fast data entry at $80 have been announced by RCA. Both boards feature fully encoded 128-character ASCII (American Standard Code for Information Interchange) sets and flexible-membrane key switches. The keyboard surface, which is impervious to liquids or dust, combines with complementary metal-oxide semiconductor (CMOS) circuitry to make the units suitable for use in hostile environments. The keyboards operate on a 5 VDC supply, and the buffered 7-bit ASCII output is transistor-transistor logic (TTL) compatible. The user may select either the full 128-character uppercase and lowercase alphanumerics or 102-character uppercase only. Two-key rollover circuitry, even-parity, buffered key-down, and handshake signals are also featured. For further information, contact RCA COSMAC VIP Marketing, New Holland Ave, Lancaster PA 17604.

Circle 469 on inquiry card.

A Modem Inside a Telephone

A switched-network, 300 bits-per-second (bps) full-duplex Bell 103/113-compatible modem, housed inside a standard telephone set, is now being produced by Racal-Vadic. Users merely plug the VA103 ModemPhone, with its direct-connect originate/answer modem, into a standard telephone-company voice jack or programmable data jack. The device comes with an 8-foot cable and plug, plus a 25-pin connector to accept the RS-232 connection from a terminal. The ModemPhone uses a standard ITT rotary-dial or Touch Tone telephone with all modem circuitry mounted inside the case. An additional circuit board provides the originate/answer option. Many useful features are provided by the automatic originate/answer option, including loss-of-carrier line disconnect, forcing of the data-set-ready and data-terminal-ready conditions, and operator mode control. All models have local copy and 20 mA current-loop options. The VA103 is priced at $250 and the automatic originate/answer models are $330 each. Contact Racal-Vadic, 222 Caspian Dr, Sunnyvale CA 94086, (408) 744-0810.

Circle 470 on inquiry card.

What's New?

SYSTEMS

Compact LSI 11/23 Computer System

A computer contained in a compact cabinet is the latest device from Chrislin Industries Inc, 31352 Via Colinas #102, Westlake Village CA 91361, (213) 991-2254. The CI-103 consists of a Digital Equipment Corporation VT100 video terminal, LSI 11/2 or LSI 11/23 microprocessor, and 64 K bytes of programmable memory. The unit has a detached keyboard, and Digital Equipment's line of PDP-11 software is available. The DEC RX02 1-megabyte floppy-disk system or a 10-megabyte cartridge-disk system is offered as an option. The computer with the LSI 11/2 and 64 K bytes is $4500. With the LSI 11/23 and 256 K bytes of programmable memory, the cost is $9600. The optional RX02 floppy-disk system sells for $3045 and the 10-megabyte cartridge-disk system is priced at $6100.

Circle 471 on inquiry card.

Multi-User Computer System for $4700

IBC has introduced a multi-user, multitasking, small-business computer. The System 40 comes with the FAMOS operating system and a BASIC compiler. The computer includes 64 K bytes of programmable memory, two dual-sided, double-density 8-inch floppy-disk drives, six serial RS-232 ports, vectored interrupt, and a real-time clock. By using a compiled BASIC with re-entrant code, multiple users can share the same memory when running the same program. Memory is allocated dynamically, and fixed or hard memory partitions are not required. The single-board computer can handle 128 K bytes of memory. The System 40 can accommodate five video terminals, a printer, and a second set of floppy-disk drives, for a total of 4 megabytes. The System 40 and 64 K bytes of memory, 2-megabyte disk storage, six serial ports, cabinet, and operating system with BASIC, is priced at $4700. The 128 K-byte memory expansion is $700. The floppy disk upgrade to four drives is $1750. The price for a 20-megabyte Winchester drive is under $4000. Contact Integrated Business Computers, 22010 S Wilmington Ave, Suite 306, Carson CA 90745, (213) 518-4245.

Circle 473 on inquiry card.

Data General Offers Nova and MicroNova Computer Systems

Data General has announced microNova and Nova 4/C packaged computer systems based on the company's Winchester disk drives. Users can choose a packaged system with a 12.5-megabyte or a 25-megabyte Winchester-type nonremovable disk, with an integral 1.26-megabyte floppy disk. One package is a complete microNova MP/100 system with 64 K bytes of programmable memory, a 12.5-megabyte Winchester-type disk with integral 1.26-megabyte floppy disk, plus a Dasher terminal and cabinet for $12,350. The price of the Nova 4/C in the same configuration is $13,750. Address inquiries to Data General, Rt 9, Westboro MA 01581, (617) 336-8911.

Circle 472 on inquiry card.

AlphaMicro Offers Small-Business Computer Systems

The AlphaMicro series 1011, 1031, and 1051 computers are multitasking, multi-user, and multiprocessor time-sharing computers. They are designed for programming in BASIC and other high-level languages. All three systems include a 16-bit processor, with two serial and one parallel input/output (I/O) port. They also feature 64 K bytes of user memory, which can be expanded up to 1 megabyte, in 64 K-byte increments. All programmable memory contains full error correction logic. Some of the other features include floating-point hardware, a real-time clock, eight levels of direct memory access (DMA), and multilevel vectored interrupt lines.

The AM 1011 includes dual floppy-disk drives (2.4 megabytes).

The AM 1031 has a 10-megabyte hard-disk drive with a 5-megabyte removable cartridge.

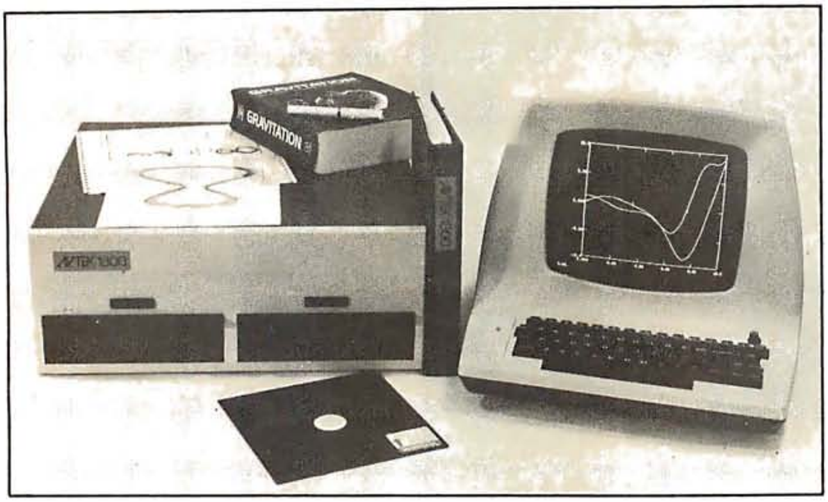
The AM 1051 system includes a 90-megabyte hard-disk drive with a 15-megabyte removable cartridge.

All operations are fully supported by the AlphaMicro Operating System (AMOS). The standard software package consists of a macroassembler; AlphaMicro versions of BASIC, LISP, and Pascal; word-processing software; and utility programs. Prices for the systems depend upon additional hardware and software features. Contact your local computer stores and dealers for information.

Circle 474 on inquiry card.

What's New?

SYSTEMS



Microcomputer for Scientific Use

The Avtek 1800 Graphics and Scientific System is designed for scientific use. Standard hardware features include a 256-by-512 graphics terminal, 64 K bytes of memory, dual 8-inch floppy-disk drives, and floating-point processor. The software includes a screen-oriented editor, a word-processing package with features for creating scientific papers, a communications package, and both subroutine and stand-alone packages for graphics and scientific applications. Programs may be written in FORTRAN or assembly language, with other languages available. A printer, an X,Y plotter, and double-density drives are also available. The computer with a terminal and software is priced at $9995. Contact Avtek, 301 Side Cut Rd, West Redding CT 06896, (203) 938-3202.

Circle 475 on inquiry card.

Z8000-Based Multi-User System

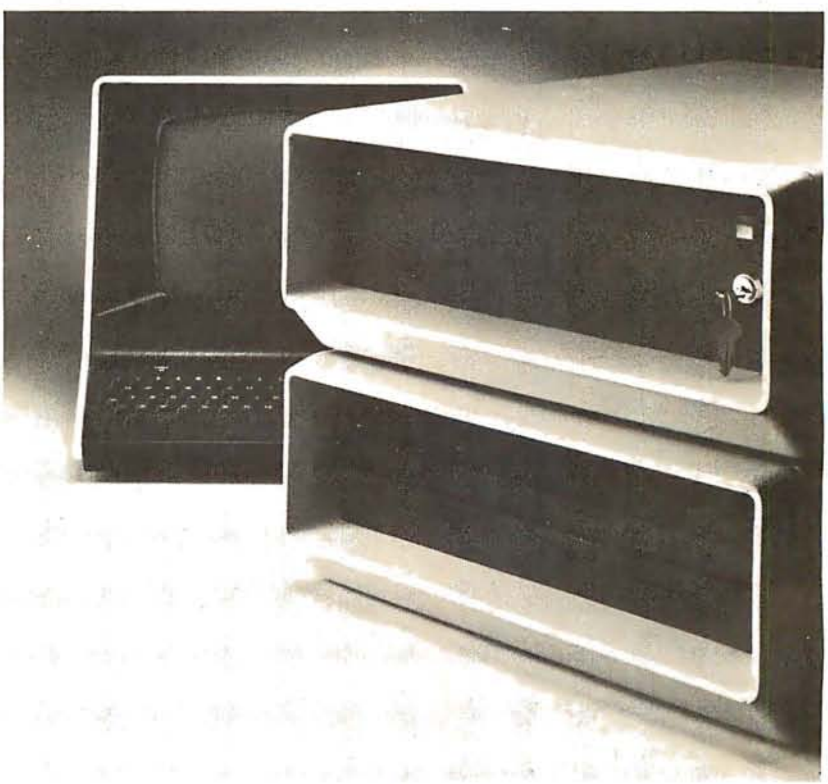
Taurus Research Inc has announced a multi-user, multitasking computer system based on the Zilog Z8000 16-bit microprocessor. The Taurus T8000 series supports up to forty-eight users, and has a hard-disk capacity of up to 640 megabytes using Winchester-type disks.

The T8000/2 comes with two double-sided, double-density floppy-disk drives and two serial ports. The T8000/40 comes with 8 serial I/O ports, a 40-megabyte hard disk, and a single, double-density double-sided floppy-disk drive for backup. The Taurus Operating System (TOS) performs print spooling to multiple printers, security with multiple priority levels, user time accounting, and system status of all jobs running on the system. Included with TOS is an assembler, text editor, utilities, a sort function, and ISAM file handling. Business software is available for the series. Additional 10-, 20-, 40-, and 160-megabyte hard-disk drives are also available. The T8000/2 is priced at $12,500 and the T8000/40 is $19,000. For detailed information, contact Taurus Research Inc, 2880 S Main St-220, Salt Lake City UT 84115, (801) 485-1552.

Circle 476 on inquiry card.

Fast 8-Bit Microcomputer Aimed at Small-Business Applications

Artec Electronics Inc, 605 Old County Rd, San Carlos CA 94070, has introduced the Centurion system, which is approximately six times faster than comparable systems. The Centurion is built around Intel's 8085A-2 microprocessor. The latter has a processing speed of 5 MHz, but system speed is faster than that because of a floating-point-mathematics integrated circuit that handles all calculations. The system features 16 K bytes of programmable read-only memory (PROM), 64 K bytes of programmable memory, a floppy-disk controller, and the CP/M operating system. The Centurion I has two single-sided, double-density, 8-inch floppy-disk drives and is compatible with printers having RS-232 interfaces. The single quantity price of the Centurion I with a Hazeltine 1500 video terminal is $10,825. Other models are available for $9500 and $8025. Additional twin 8-inch floppy-disk drives capable of storing one megabyte and a power supply are priced at $2500.



Circle 477 on inquiry card.

What's New?

SOFTWARE

Turbocharger Enhances CP/M Systems

Info 2000 Corporation's Turbocharger software enables CP/M 2.0 users to accomplish disk input/output (I/O) three to five times faster than standard CP/M in most applications, and to store 30 percent more data on each disk. The package can be used with most 8080 or Z80 systems with floppy-disk and/or hard-disk storage. The speed of the Turbocharger is achieved by multilevel buffering of disk input/output, using an LRU (least-recently-used) buffer-assignment algorithm. The use of larger physical sector sizes, the elimination of the reserved system tracks required by standard CP/M, and the storing of the operating system as a relocatable module in an ordinary disk file allow more data to be stored on each disk. The Turbocharger package includes CP/M version 2.0, the source code for sample BIOS and bootstrap programmable read-only memory (PROM), and documentation. It is priced at $300 from Info 2000 Corp, 20620 S Leapwood Ave, Carson CA 90746, (213) 532-1702.

Circle 478 on inquiry card.

Some Common BASIC Programs for Heath Computers

The JE Brancheau Engineering Co, POB 67, Trenton MI 48183, is offering Heath cassette system owners the 76 programs presented in the book *Some Common BASIC Programs* by Lon Poole and Mary Borchers of Osborne/McGraw-Hill. This collection includes business, finance, math, statistics, plotting, and other general interest applications programs. Most programs will run with any version of Heath BASIC; only four require Extended BASIC. The price is $15 for the cassette tape.

Circle 479 on inquiry card.

A CP/M Inventory-Control System for Businesses

Structured Systems Group has announced an inventory-control software package for small to medium businesses. The program can support up to 32,767 inventory item records. The program provides quick access to file records by item number. It creates a hard-copy record of stock additions, stock depletions, or both. The system also generates such reports as item list, stock activity report, and a reorder report. The system incorporates a full-screen formatting utility. The Inventory Control System requires CBASIC2 and will run on most CP/M systems with dual floppy-disk drives and 48 K bytes of programmable memory.

For details, contact Structured Systems Group, 5204 Claremont Ave, Oakland CA 94618, (415) 547-1567.

Circle 480 on inquiry card.

Z80 Softcard for the Apple II

Microsoft Consumer Products has developed a Z80 card, the Softcard, that plugs into the Apple II and allows the Apple to run software written for Z80-based computers. The Softcard package includes the CP/M operating system and Microsoft disk BASIC. The Softcard allows either the Apple's 6502 processor or the Z80 processor to run a program. It is compatible with existing Apple software and peripherals. CP/M software written for Z80 computers can run on the Apple with minimal alteration. The Z80 Softcard will run on all configurations of the Apple at a clock rate of 2 MHz. The version 5.0 Microsoft BASIC that comes with the package includes PRINT USING for formatted output; long variable names; random disk input/output (I/O) with variable-length records; WHILE/WEND conditional statement; 16-bit precision; and AUTO and RENUM for numbering and renumbering lines. Graphics capabilities are expanded with the statements LINE, PUT and GET. The Z80 Softcard with CP/M and Microsoft BASIC will run on the Apple II with 48 K bytes of programmable memory and a single disk drive. The package includes the card, CP/M and BASIC on floppy disk and documentation. The suggested retail price is $349. For the name of the nearest dealer, contact Microsoft Consumer Products, 10800 NE 8th, Suite 507, Bellevue WA 98004, (206) 454-1315.

Circle 482 on inquiry card.

Medical Office Business System

A Medical Office Business System (MOBS) is now available for 6800/6809 computer systems. MOBS will maintain patient account records; prepare billing statements, insurance forms, and routine correspondence; and present reports for the management and control of a medical office for one or many doctors. Reports are obtained at the close of the business day, summarizing daily activity and account status. Other reports list appointments for the next day or any specified day, still other lists report on distribution of credits among doctors and accounts receivable. The system includes a text editor and text processor which can be used as a word processor independently of the business application software. MOBS is designed to run on a 40 K-byte 6800/6809 computer with a minimum of one dual 5-inch disk system. SSB DOS and Computerware Random BASIC are required. MOBS is priced at $1000. Contact Computerware, 1512 Encinitas Blvd, POB 668, Encinitas CA 92024, (714) 436-3512.

Circle 481 on inquiry card.

Enhanced COBOL Packages from MCBA

MCBA (Mini-Computer Business Applications Inc) has announced the completion and availability of enhanced versions of its accounting packages in CS (Commercial Systems) COBOL for Data General CS/30, CS/40, and CS/60s. Included are MCBA's accounts receivable with sales analysis, order entry/invoicing, accounts payable, payroll, and general ledger. Data General's ICOS (Interactive COBOL Operating System) is required to run MCBA's CS COBOL packages. Source code and documentation are provided. The single microprocessor license is $1500 for the accounting packages and $2500 for the Client Write-Up Package. Contact MCBA, 117 S Brand Blvd, Glendale CA 91204, (213) 247-9050.

Circle 483 on inquiry card.

LISP/80

LISP/80 is a LISP interpreter which runs on an 8080 or an equivalent microprocessor. LISP/80 runs under CP/M versions 1.4 and 2.0. It includes MAPCAR, MAPLIST, PROG, TRACE, and UNTRACE functions; string data types and subatomic pattern matching functions; garbage collection and list storage format; and it has editing commands for console input. Input may be loaded from a disk file; and definitions, properties, and values may be saved on a disk file in editable form. LISP/80 is supplied on an 8-inch, single-density, soft-sectored floppy disk. It comes with a manual for $75 from T W Yonkman, 4182 Caminito Islay, San Diego CA 92122.

Circle 484 on inquiry card.

What's New?

SOFTWARE

AlphaMicro Introduces a Word-Processing System

This word-processing system consists of two components: a screen editor (AlphaVUE) and a text formatter (TXTFMT). AlphaVUE is a high-speed, two-dimensional editor capable of editing large files by displaying a single page at a time. It includes local and global search and replace commands. TXTFMT is used in conjunction with AlphaVUE to produce formatted documents, which can then be written to an output file.

The word processor features automatic page numbering, table of contents, index production, backup file protection, and left and right justification.

The system hardware requirements are an AlphaMicro AM 100 computer system and a video display with direct cursor addressing and erase-to-end-of-line capability. The word-processing software is available as a standard feature of all AlphaMicro computer systems. For details, contact Alpha-Micro, 17881 Sky Park N, Irvine CA 92714, (714) 957-1404.

Circle 485 on inquiry card.

6809 Diagnostics and Disk Repair

This memory-diagnostic and disk-repair package is for the Motorola MC6809 microprocessor. The utility programs in the package are designed to run under the 6809 FLEX operating system. Included in the memory diagnostics portion of the package are 0s and 1s test, random pattern test, walking bit tests, dynamic programmable-memory dropout test, and convergence test. All memory tests are position independent. Among the diagnostic utilities are three that report unreadable sectors and structural inconsistencies among the files on the disk. Other utilities remove bad or intermittent sectors from the free chain. The manual includes descriptions of the diagnostics, some information on types of errors, and troubleshooting guides. The price is $75 on 5- or 8-inch floppy disks. Contact Technical Systems Consultants Inc, POB 2570, West Lafayette IN 47906, (317) 463-2502.

Circle 486 on inquiry card.

TRS-80 Model II CP/M

Lifeboat Associates, 2248 Broadway, New York NY 10024, is offering CP/M 2.0 for the TRS-80 Model II. The package makes it possible to run existing CP/M programs for business accounting, word processing, scientific, and special application programming. The system has nearly 500 K bytes of storage per disk with double-density formatting, but will read and write standard single-density disks. The serial ports and parallel printer port are easily configured for use with the CP/M system. The printer port has complete format- and page-control implemented in software for the standard Radio Shack printer. The CP/M 2.0 system with documentation is $170.

Circle 487 on inquiry card.

North Star BASIC Utility Set

N*BUS is a North Star BASIC utility set featuring an editor; BPAK, a program pack utility; BPRT, a program formatted list and cross-reference utility; RE, a file rename utility; and a manual for $69. The editor encompasses commands including global locate and change, line insert and append, copy, move, erase columns, delete, print and line scrolling, and more. N*BUS is delivered with a BASIC program that personalizes the machine code of the editor to any version of North Star BASIC version 4 or later. For details, contact SZ Software Systems, 1269 Rubio Vista Rd, Altadena CA 91001.

Circle 488 on inquiry card.

Z8000 Floating-Point Package

This package provides a set of floating-point support subroutines for Z8002 microcomputers. Using a 32-bit binary floating-point format, these subroutines provide fast arithmetic operations, integer-float and float-integer conversions, float-ASCII string representation, ASCII string-float conversions, and give between six and seven digits of precision. These subroutines run in 200 to 400 microseconds on a Z8002 with a 3.9 MHz clock. Each subroutine is reentrant and interruptible. The package requires 1.4 K bytes of memory and may use up to 50 bytes of stack memory. Some of the subroutines included in the package are FADD, FSUB, FMUL, FDIV, and FTOA (float-to-ASCII string).

The package costs $99.95 and is available from Hemenway Associates Inc, 101 Tremont St, Suite 208, Boston MA 02108.

Circle 489 on inquiry card.

TRS-80 SERIAL I/O

• Can input into basic • Can use LLIST and LPRINT to output, or output continuously • RS-232 compatible • Can be used with or without the expansion bus • On board switch selectable baud rates of 110, 150, 300, 600, 1200, 2400, parity or no parity odd or even, 5 to 8 data bits, and 1 or 2 stop bits. O.T.R. line • Requires +5, -12 VDC • Board only $19.95 Part No. 8010, with parts $59.95 Part No. 801 0A, assembled $79.95 Part No. 8010 C. No connectors provided, see below.

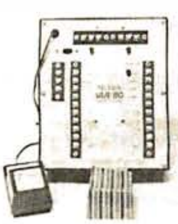
EIA/RS-232 connector Part No. 0825P $6.00. with 9', 8 conductor cable $10.95 Part No 0825P9

3' ribbon cable with attached connectors to fit TRS-80 and our serial board $19.95 Part No 3CA840

COMPUCRUISE

$129.95; with cruise control $169.95

THE TELESIS VAR-80 INTERFACE UNIT



For the TRS-80 with Level II Basic • Provides 8 outputs • Provides 8 inputs • 2 ft. of interconnecting cable w/connector • Plugs directly into TRS-80 • Power supply provided • Assembled and tested. Part No. VAR80, Introductory price $109.95.

GAME PADDLES & SOUND

Includes: 2 game paddles, interface, software, speaker, power supply, full documentation including: schematics, theory of operation, and user guide; plus 2 games on cassette (Pong and Starship War). $79.95 Complete Part No. 7922C

DIGICOM DATA PRODUCTS INC. Series 312 Acoustic Coupler

300 BAUD Originate, Part No. AC3122, $219.95. 300 BAUD Answer, Part No. AC3122, $219.95. 300 BAUD Answer/Originate, Part No. AC3123, $229.95.

LIGHT-PEN For Your TRS-80

Your TRS-80 Light-Pen is a carefully engineered instrument and with the proper care will give satisfactory use and many years of service. Part No. TRS80LP $24.95.

SYSTEM EXPANSION from LNW Research

• Serial RS232C/20 mA I/O • Floppy controller • 32K bytes memory • Parallel printer port • Dual cassette port • Real-time clock • Screen printer bus • Onboard power supply • Software compatible • Solder mask, silk screen. PC board and user manual, Part No. LNW80, $69.95.

DISKETTES

Box of 10, 5" $29.95, 8" $39.95.
Plastic box, holds 10 diskettes, 5" - $4.50, 8" - $6.50.

16K RAMS

For the Apple, TRS-80 or Pet $8 each Part No. 4116/2117.

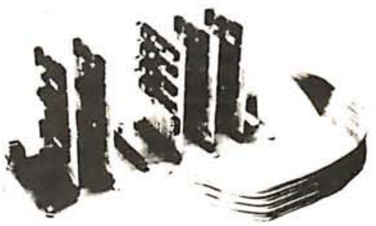
LEEDEX MONITOR

12" Black and White • 12 MHz Bandwidth • Handsome Plastic Case • $139.00

S-100 INTERFACE

AN S-100 bus Adapter—Motherboard for the TRS-80. Kit, Part No. HUH81DLXK, $295.95. Assembeled, Part No. HUH81DLXA, $375.95.

NOW! A FULL SUPPORT SYSTEM FOR TRS-80



• 32K of RAM • EPROM firmware • Disk control • Data acquisition • Parallel I/O • Serial I/O • Plug into GPA's Motherboard. GPA's quality design includes • 6-44 pin edge connectors • +5V, -5V, +12V, -12V external power supply required • Active termination. The Motherboard, Part No. GPA80, is only $149.95.

TAKE ADVANTAGE OF GPA-EXPANSION CARDS FOR THE GPA80

Memory cards: Now with Fortran compilers available for your TRS-80, additional expansion memory is a must! Card with sockets only, Part No. GPA801, $119.95. Card with 16K of 4116 Dynamic Ram, Part No. GPA802, $224.95. Card with 32K of 4116 Dynamic Ram, Part No. GPA803, $329.95. All cards come equipped with sockets to accomodate 32K of Ram.
EPROM firmware card. Put those valuable subroutines in firmware. Don't waste time loading and unloading tapes and disks. For 2708 or 2716 EPROMS, Part No. GPA806, $79.95.
Serial I/O card. Here's what you've been asking for, a full serial terminal interface, with RS-232C or 20 mA. Current loop. Input/output capabilities. Part No. GPA807, $79.95.
Parallel I/O Card. Control functions in the outside world, monitor and store real time events. Two parallel output ports. Dip switches select ports (0-254). Part No. GPA808, $79.95.

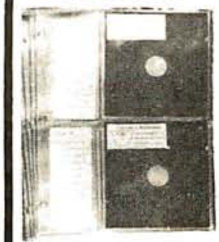
FLOPPY DISK STORAGE BINDER

Three-ring binder comes with ten transparent plastic sleeves which accommodate either twenty, five-inch or ten, eight-inch floppy disks. Binder & 10 holders $14.95 Part No. 8800; Extra holders 95¢ each. Part No. 800.

DIGITAL CASSETTE

5 min. each side. Box of 10 $9.95. Part No. C-5.

DISK JACKET™



Holds two 5-1/4 inch diskettes and will fit any standard three ring binder. $9.95/10 Pack.

TRENDCOM PRINTER

• 40 characters per second • 4-7/16 inch wide thermal paper • Graphics (TRENDCOM 100): 480 sevendot print postions per line. TRENDCOM 100, Part No. TRC0100, $495.95. TRENDCOM 200, Part No. TRC0200, $375.95. **Interface** for TRS-80, Part No. T80A $45.95. For Apple II, Part No. TRCAII, $75.95. For PET, NO. TRCP2, $79.95. For Scoccerer, TRCSR1 $45.95.

SARGON: A Computer Chess Program

Features the complete program that won the 1978 West Coast Computer Faire Tournament. Part No. 00603 — TRS-80 Level II; Part No. 00604 — Apple II (24K). $19.95

SOUND EFFECTS AND MUSIC FOR YOUR COMPUTER

SOUNDWARE is a complete system. It includes a speaker/amplifier unit with volume control, earphone jack, and connectors. It boasts excellent tone quality yet is small and convenient to use. Add batteries, plug it in, and play. One year warranty. SOUNDWARE package (includes INTRO to SOUNDWARE programs) PET (8K), Part No. 20003, $29.95. TRS-80 Level II (16K), Part No. 20002, $29.95. Compucolor II (8K), Part No. 20001, $39.95. INTRO to SOUNDWARE programs only PET and TRS-80, Part No. 20005, $14.95. Compucolor II Part No. 20006, $19.95.

To Order: Mention part no. description, and price. In USA shipping paid by us for orders accompanied by check or money order. We accept C.O.D. orders in the U.S. only, or a VISA or Master Charge no., expiration date, signature, phone no., shipping charges will be added. CA residents add 6.5% for tax. Outside USA add 10% for air mail postage and handling. Payment must be in U.S. dollars. Dealer inquiries invited. 24 hour order line (408) 448-0800

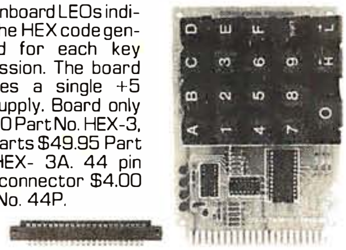
Send for FREE Catalog . . . a big self-addressed envelope with 41¢ postage gets it fastest!

ELECTRONIC SYSTEMS Dept. B P. O. Box 21638, San Jose, CA USA 95151

Circle 219 on inquiry card.

HEX ENCODED KEYBOARD

Four onboard LEDs indicate the HEX code generated for each key depression. The board requires a single +5 volt supply. Board only $15.00 Part No. HEX-3, with parts $49.95 Part No. HEX- 3A. 44 pin edge connector $4.00 Part No. 44P.



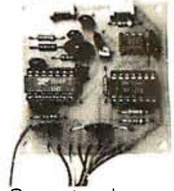
ASCII TO CORRESPONDENCE CODE CONVERTER

This bidirectional board is a direct replacement for the board inside the Trendata 1000 terminal. The on board connector provides RS-232 serial in and out. Sold only as an assembled and tested unit for $249.95. Part No. TA 1000C

T.V. INTERFACE

● Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple ● Power required is 12 volts AC C.T., or +5 volts DC ● Board only $7.60 part No. 107, with parts $13.50 Part No. 107A

TAPE INTERFACE



● Converts a low cost tape recorder to a digital recorder ● Works up to 1200 baud ● Digital in and out are TTL-serial ● Output of board connects to mic. in of recorder ● Earphone of recorder connects to input on board ● No coils ● Requires +5 volts, low power drain ● Board only $7.60 Part No. 111, with parts $29.95 Part No. 111A

T.V. TYPEWRITER

● Stand alone TVT ● 32 char/line, 16 lines, modifications for 64 char/line included ● Parallel ASCII (TTL) input ● Video output ● 1K on board memory ● Output for computer controlled curser ● Auto scroll ● Non-destructive curser ● Curser inputs: up, down, left, right, home, EOL, EOS ● Scroll up, down ● Requires +5 volts at 1.5 amps, and -12 volts at 30 mA ● All 7400, TTL chips ● Char. gen. 2513 ● Upper case only ● Board only $39.00 Part No. 106, with parts $145.00 Part No. 106A

UART & BAUD RATE GENERATOR

● Converts serial to parallel and parallel to serial ● Low cost on board baud rate generator ● Baud rates: 110, 150, 300, 600, 1200, and 2400 ● Low power drain +5 volts and -12 volts required ● TTL compatible ● All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity. ● All connections go to a 44 pin gold plated edge connector ● Board only $12.00 Part No. 101, with parts $35.00 Part No. 101A, 44 pin edge connector $4.00 Part No. 44P

ASCII KEYBOARD

53 Keys popular ASR-33 format • Rugged G-10 P.C. Board • Tri-mode MOS encoding • Two-Key Rollover • MOS/DTL/TTL Compatible • Upper Case lockout • Data and Strobe inversion option • Three User Definable Keys • Low contact bounce • Selectable Parity • Custom Keycaps • George Risk Model 753. Requires +5, -12 volts. $59.95 Kit.

ASCII KEYBOARD

TTL & DTL compatible • Full 67 key array • Full 128 character ASCII output • Positive logic with outputs resting low • Data Strobe • Five user-definable spare keys • Standard 22 pin dual card edge connector • Requires +5VDC, 325 mA. Assembled & Tested. Cherry Pro Part No. P70-05AB. $119.95.

SOROC IQ 120

Upper/lower case display • Numeric keypad & cursor keys • Protected fields, ½ intensity display • RS 232 interface & aux. port. IQ120—$799.95 • IQ140 Detachable keyboard—$1199.95

MODEM

● Type 103 ● Full or half duplex ● Works up to 300 baud ● Originate or Answer ● Serial TTL input and output ● connect 8 Ω speaker and crystal mic. directly to board ● Requires +5 volts ● Board only $7.60 Part No. 109, with parts $29.95 Part No. 109A.

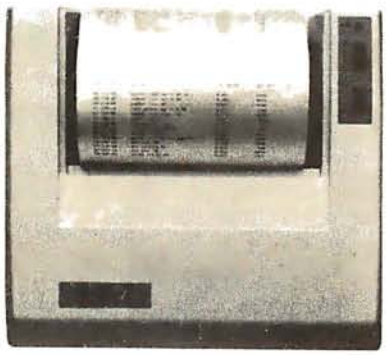
44 BUS MOTHER BOARD

Has provisions for ten 44 pin (.156) connectors, spaced 3/4 of an inch apart. Pin 20 is connected to X, and 22 is connected to Z for power and ground. All the other pins are connected in parallel. This board also has provisions for bypass capacitors. Board cost $15.00 Part No. 102. Connectors $3.00 each Part No. 44WP.

RS-232/20mA INTERFACE

This board has two passive, opto-isolated circuits. One converts RS-232 to 20mA, the other converts 20mA to RS-232. All connections go to a 10 pin edge connector. Requires +12 and -12 volts. Board only $9.95, part no. 7901, with parts $14.95 Part No. 7901A.

COMPRINT PRINTER



Printing Characteristics: 225 characters/second (170 lines/minute) throughput ● 9 horizontal x 12 vertical matrix ● 96 ASCII character set with upper and true lower case ● 80 characters/line ● 5.8 lines/inch
Buffer Memory: standard 256 bytes; ● optional; 2,048 bytes (buffer memory option designated as Model 912-2K), add $149.95.
Paper Requirements: electrosensitive type (aluminum coated) ● 8-1/2 inch width ● 3.7 inch max. (300 ft.) roll diameter.
Model 912-S Interfacing: serial interface RS232 and 20 mA current loop ● BAUD rates 110, 150, 300, 600, 1200, 2400 and 4800 are strap selectable.
Model 912-P Interfacing: parallel interface, IEEE-488 and 8 bit parallel (strobe/ acknowledge). Model 912-S, Part No. CPIA, 32118, $579.95. Model 912-P, Part No. CPIA, 32117, $559.95.

RS-32/TTL INTERFACE

● Converts TTL to RS-232, and converts RS-232 to TTL ● Two separate circuits ● Requires -12 and +12 volts ● All connections go to a 10 pin edge connector, kit $9.95 Part No. 232A 10 Pin edge connector $3.00 part No. 10P.

COMPUCOLOR II

With reg. keyboard MOD3 8K $1595.95 MOD4 16K $1695.95 MOD 5 32K $1995.95 Now includes $250 more, worth of software and accessories with 101 key option add $134.95 with 117 key option add $179.95

DC POWER SUPPLY

● Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. ● Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps. ● Board only $12.50 Part No. 6085, with parts excluding transformers $42.50 Part No. 6085A

To Order: Mention part no. description, and price. In USA shipping paid by us for orders accompanied by check or money order. We accept C.O.D. orders in the U.S. only, or a VISA or Master Charge no., expiration date, signature, phone no., shipping charges will be added. CA residents add 6.5% for tax. Outside USA add 10% for air mail postage and handling. Payment must be in U.S. dollars. Dealer inquiries invited. 24 hour order line (408) 448-0800

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apple II Or APPLE II PLUS

16K $975.95, Extra 16K E.S. RAM installed $74.95, extra 32K E.S. RAM installed $148.95.

APPLE II HOBBY/ PROTOTYPING CARD

Part No. 7907 $14.95

REAL TIME 100,000 DAY CLOCK

MT. HARDWARE Double the utility of your S-100 bus computer with a real-time clock that keeps time in 100μS increments for over 273 years. Program events for the entire period with real time interrupts...without derailing the system. Maintain a log of computer usage, time and date transaction printouts, call up lists...virtually any activity where time is a factor. On-board battery backup. MHPX004—$249.95

SUPER MODEM

Orignate, RS-232 and 20 mA compatable, Full duplex, and half duplex, direct connect or acoustic coupled, on board power supply, carrier detect light, DB25 plug, 300 BAUD, Type 103 compatable frequencies, Bare board Part No. 2000, $19,95, Kit Part No. 2000A, $99.95.

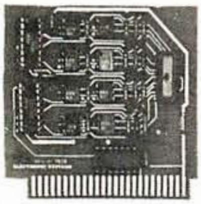
16K EPROM

Uses 2708 EPROMS, memory speed selection provided, addressable anywhere in 65K of memory, can be shadowed in 4K increments. Board only $24.95 part no. 7902, with parts less EPROMs $49.95 part no. 7902A.

PET COMPUTER

With 16K & monitor - $ 795. Dual Disk Drive - $10 95

OPTO-ISOLATED PARALLEL INPUT BOARD FOR APPLE II



There are 8 inputs that can be driven from TTL logic or any 5 volt source. The circuit board can be plugged into any of the 8 sockets of your Apple II. It has a 16 pin socket for standard dip ribbon cable connection. Board only $15.00. Part No. 120, with parts $69.95. Part No. 120A.

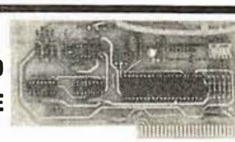
VIDEO TERMINAL

16 lines, 64 columns • Upper and lower case • 5x7 dot matrix • Serial RS-232 in and out with TTL parallel keyboard input • On board baud rate generator 75, 110, 150, 300, 600, & 1200 jumper selectable • Memory 1024 characters (7-21L02) • Video processor chip SFF96364 by Neculonic • Control characters (CR, LF, →, ←, ↑, ↓, non destructive cursor, CS, home, CL • White characters on black background or vice-versa • With the addition of a keyboard, video monitor or TV set with TV interface (part no. 107A) and power supply this is a complete stand alone terminal • also S-100 compatible • requires +16, & −16 VDC at 100mA, and 8VDC at 1A. Part No. 1000A $199.95 kit.

PARALLEL TRIAC OUTPUT BOARD FOR APPLE II

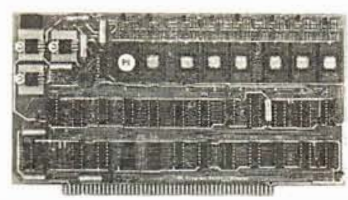
This board has 8 triacs capable of switching 110 volt 6 amp loads (660 watts per channel) or a total of 5280 watts. Board only $15.00 Part No. 210, with parts $119.95 Part No. 210A.

APPLE II SERIAL I/O INTERFACE



Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain. RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some selectrics. • Also watches OTR • Board only $15.00 Part No. 2, with parts $42.00 Part No. 2A, assembled $62.00 Part No. 2C

8K EPROM PICEON



- Programs 2708's address relocation of each 4K of memory to any 4K boundary • Power on jump and reset jump option for "turnkey" systems and computers without a front panel
- Program saver software in 1 2708 EPROM $25. Bare board $35 including custom coil, board with parts but no EPROMS $139, with 4 EPROMS $179, with 8 EPROMS $219.

WAMECO PRODUCTS

With ELECTRONIC SYSTEMS parts

FDC-1 FLOPPY CONTROLLER BOARD will drive shugart, pertek, remex 5" & 8" drives up to 8 drives, on board PROM with power boot up, will operate with CPM (not included). PCBD $42.95

FPB-1 Front Panel. (Finally) IMSAI size hex displays. Byte or instruction single step. PCBD $42.95

MEM-1A 8Kx8 fully buffered, S-100, uses 2102 type RAMS. PCBD .... $24.95, $168 Kit

QMB-12 MOTHER BOARD, 13 slot, terminated, S-100 board only .... $34.95 / $89.95 Kit

CPU-1 8080A Processor board S-100 with 8 level vector interrupt PCBD .. $25.95 / $89.95 Kit

RTC-1 Realtime clock board. Two independent interrupts. Software programmable. PCBD .... $25.95, $60.95 Kit

EPM-1 1702A 4K EPROM card PCBD .... $25.95 / $49.95 with parts less EPROMS

EPM-2 2708/2716 16K/32K EPROM card PCBD .... $24.95 / $49.95 with parts less EPROMS

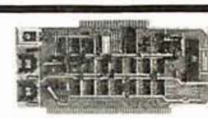
QMB-9 MOTHER BOARD. Short Version of QMB-12. 9 Slots PCBD .... $30.95 / $67.95 Kit

MEM-2 16Kx8 Fully Buffered 2114 Board PCBD .... $25.95, $269.95 Kit

D.C. HAYES MICROMODEM

Fully S-100 bus compatible including 16-bit machines and 4 MHz processors. • Two software selectable Baud rates—300 Baud and a jumper selectable speed from 45 to 300 Baud. (110 standard). Supports originate and answer modes. • Direct-connect Microcoupler. This FCC-registered device provides direct access into your local telephone system, with none of the losses or distortions associated with acoustic couplers and without a telephone company supplied data access arrangement. • Auto-Answer/Auto-Call. The MICROMODEM 100 can automatically answer the phone and receive input; it can also dial a number automatically. • Automatic Reset and Disconnect. • Software compatible with the D.C. Hayes Associates 80-103A Data Communications Adapter. Micromodem-DCHA32625—$379.95

TIDMA



Tape Interface Direct Memory Access • Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate • S-100 bus compatible • Board only $35.00 Part No. 112, with parts $110.00 Part No. 112A.

SYSTEM MONITOR

8080, 8085, or Z-80 System monitor for use with the TIDMA board. There is no need for the front panel. Complete with documentation $12.95.

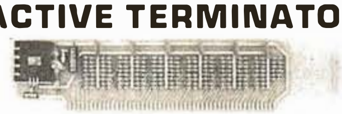
RS-232/TTY INTERFACE

This board has two active circuits, one converts RS-232 to 20 mA, the other converts 20 mA to RS-232. Requires +12 and −12 volts. $9.95 Part No. 600A Kit.

SERIAL I/O

Four Serial I/O RS-232 ports. S-100 Bus, Software or jumper selectable baud rate (110, 300, 600, 1200, 2400, 4800, 9600, 19.2K), on board Xtal baud rate generator, Addressing, switch selectable, Parity or no parity (odd or even) switch selectable, 1 or 2 stop bits, 5 to 8 bits/character. Board only $29.95, Part No. 7908. With parts (kit) $199.95, Part No. 7908A.

S-100 BUS ACTIVE TERMINATOR



Board only $14.95 Part No. 900, with parts $24.95 Part No. 900A

To Order: Mention part no. description, and price. In USA shipping paid by us for orders accompanied by check or money order. We accept C.O.D. orders in the U.S. only, or a VISA or Master Charge no., expiration date, signature, phone no., shipping charges will be added. CA residents add 6.5% for tax. Outside USA add 10% for air mail postage and handling. Payment must be in U.S. dollars. Dealer inquiries invited. 24 hour order line (408) 448-0800

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Circle 220 on inquiry card.

PRIORITY ONE ELECTRONICS

CENTRONICS 730 Dot Matrix Printer

SAVE $100.00

WOW

PRICE $695.00

WOW

STANDARD FEATURES: • 50 Characters/second • Characters/line • 10 characters/inch • 3 way paper handling system • 7 x 7 dot matrix • 96 character ASCII • microprocessor electronics • unidirection print at 50 ips • high speed return approximately 10 ips • 21 lpm with 80 columns printed • 58 lpm with 20 columns printed • 80 character buffer • 6 lpi vertical • Centronics Colors and logo

FORMS HANDLING: Roll Paper 8.5 in x 5.0 dia with 1 in core maximum dimension 3.5 in wide with 38 in core minimum dimension Fan Gold 9.0 in /22.9 cm wide pin to pin 9.5 in /24.1cm wide overall Up to 3 ply paper with 2 carbons (total thickness not to exceed .012 inches) Cut Sheet Maximum width 8.5 inches

RIBBON SYSTEM: Continuous ribbon 9/16" (14mm) wide 20 yards (18.3 meters) long Mobius Loop allows printing on upper and lower portion on alternate passes

OPERATOR CONTROLS: Power on/off Reset Switch allows disabling of printer without dropping AC

DATA INPUT: 7 or 8 bit ASCII parallel TTL levels with strobe Acknowledge pulse indicates that data was received

PHYSICAL DIMENSIONS: Weight less than 10 lbs 5 kg Width 14.5 inches/37 cm Depth 11.0 inches/28cm Height 4.89 inches/13cm Dimensions exclusive of roll paper holder

SHIPPING WEIGHT 14 lbs

CEN-730-1 (Parallel Int.)............ LIST PRICE: $795.00

TRS-80/APPLE MEMORY EXPANSION KITS

4116's RAMS

from Leading Manufacturers

(16Kx1 200/250ns)

100% GUARANTEED

1,000's SETS SOLD

8 for $50.00

ADD $3.00 FOR PROGRAMMING JUMPERS FOR TRS-80 KEYBOARD

4116's 100 pcs & UP $5.20 each

1000 pcs & UP $4.45 each

STARS & STRIPES SPECIAL

LIST PRICE **199.00**

OUR CORNER THE MARKET PRICE **$139.00**

FEATURE FITS GTE HANDSETS!

STAR MODEM

The STAR modem from Livermore represents a significant breakthrough in the development of acoustic modems. The small, lightweight case houses a high-performance modem that competes with the highest quality standard-sized couplers available. Yet, because of its cost effective design, the STAR has become the price/performance leader in the industry.

CIRCUITRY

The switchable, four-section bandpass filter provides the user with excellent out-of-band rejection to assure accurate processing of the received carrier, even at signal levels of less than −47 dBm. Further, the proven soft limiter and phase lock loop discriminator yields data that is essentially jitter free.

The oscillator is built using highly stable, state-variable circuitry that delivers a nearly harmonic free, phase coherent sine wave to the telephone network, assuring compatibility with all other 103 type modems. Because of the pureness of the sine wave, the STAR modem exceeds even the stringent harmonic requirements of all CCITT countries.

CARRIER DETECT

To assure accurate teleprocessing connections, the carrier detect circuitry prevents the modem from attempting to operate when excessive noise would produce errors or cause marginal operation. The circuitry also has a special amplitude sensor that prevents chatter when the received signal fades.

EXCLUSIVE ACOUSTIC CHAMBERS

The exclusive triple seal of Livermore's new flat mounted cups locks the handset into the acoustic chamber yielding superior acoustic isolation and mechanical cushioning. Designed to adapt to most common handsets used throughout the world, the STAR offers the utmost in flexibility and transmission reliability.

SELF TEST

The self test feature on the STAR allows the user to verify total operation of the acoustic modem by using the terminal in the full duplex mode. No need for remote assistance in diagnosing terminal or modem problems.

Utilizing the experience gained from building high quality couplers for over twelve years, Livermore has designed a coupler superior to any in its class for cost efficiency in industrial, commercial, business or home situations. You can see why we call it the STAR*

SPECIFICATIONS

Data Rate. 0 to 300 baud.

Compatibility. Bell 103 and 113; CCITT

Transmit Frequencies.* Originate − 1070 Hz/Space, 1270 Hz/Mark. Answer − 2025 Hz/Space, 2225 Hz/Mark

Receive Frequencies.* Originate − 2025 Hz/Space, 2225 Hz/Mark; Answer 1070 Hz/Space, 1270 Hz/Mark.

Frequency Stability. ± 0.3 percent

Receiver Sensitivity. −50 dBm ON, −53 dBm OFF

Transmit Level. −15 dBm.

Modulation. Frequency shift keyed (FSK)

Carrier Detect Delay. 1.2 seconds ON; 120 msec OFF

EIA Terminal Interface. Compatible with RS 232 specifications

Teletype Interface. 20 milliampere current loop.

Optional Interfaces. IEEE 488; TTL; TTY 43.

*International (CCITT) frequencies available.

Switches. Originate/Off/Answer; Full Duplex/Test/Half Duplex.

Indicators. Transmit Data, Receive Data, Carrier Ready, Test

Environmental. Ambient operating temperature 5° C. to 50° C. Relative humidity 10 to 90 percent (non-condensing).

Power. Suppled by 24 VAC/150 MA UL/CSA listed wall-mount transformer. Input 115 VAC, 2.5 watts. (A 220 VAC, 50 Hz adaptor is available upon request.)

Dimensions. 10"x 4"x 2"

Weight. 1.75 lbs (2.2 lbs. shipping weight including AC adaptor.)

Warranty. Two years on parts and labor, excluding the AC adaptor which carries th manufacturer's warranty

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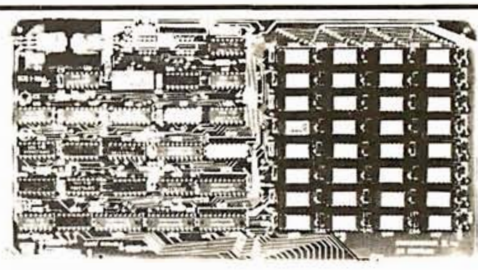

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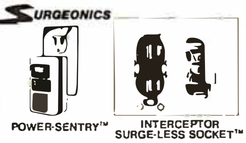

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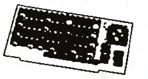

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21L02 250ns	1.59	1.55	1.15
2111	3.75	3.65	3.55
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14	19	36	59
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18	24	59	84
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24	38	85	1.20
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FND501	500	Red	Comm Cathode (+1)	99
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FND507(510)	500	Red	Comm Anode	99
FND508	500	Red	Comm Anode (+1)	99
FND530	500	Green	Comm Cathode	149
FND550	500	Orange	Comm Cathode	149
FND803(800)	800	Red	Comm Cathode	175
FND807(810)	800	Red	Comm Anode	175
HP5062-7340	600	Red	4 x 7 Hexidecimal	2095
HP5082-7300	600	Red	4 x 7 Sgl Digit RHD	1895
HP5082-7731	300	Red	Comm Anode	75
TIL305	-	Red	Array 5 x 7	795
TIL308	270	Red	Numerical Display	1095
TIL309	270	Red	Numerical Display	995
TIL311	270	Red	4 x 7 Hexidecimal	1095
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MAN10A	270	Red	Alpha Numeric	895
XAN3061	300	Red	Comm Anode Right DP	125
XAN3062	300	Red	Comm Anode Left DP	125
XAN3063	300	Red	Overflow CA left DP	125
XAN3064	300	Red	Comm Cathode Right DP	125
XAN3051	300	Green	Comm Anode Right DP	199
XAN3052	300	Green	Comm Anode Left DP	199
XAN3053	300	Green	Overflow CA Left DP	199
XAN3054	300	Green	Comm Cathode Right DP	199
XAN3081	300	Yellow	Comm Anode Right DP	210
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ICM 7209 Clock Generator	6.95
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LM 1850N Ground Fault IC	3/1.00
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LM 2917N Freq. to Volt Conv.	2/1.99
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AY-5-3507 40MHz DVM	9.95
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27S08 32 x 8 Prom (IM 5600)	2.95
G115M 6 channel Mosfet	1.49
ULN 2003A 7 channel Driver	99
10146 1K x 1 ECL Ram	995
MCM 14505 64 bit Static Ram	695

7520/25	50	LM 377	1.25
1488/1489	2/1.99	LM 387	1.25
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540-01	Soft Sectored 40 Tracks	3695
540-10	10 Hole Hard 40 Tracks	3695
540-16	16 Hole Hard 40 Tracks	3695
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550-01	Soft Sectored SA 450 MPI 52	4695
550-10	10 Hole Hard BASF WANGCO	4695
550-16	16 Hole Hard Micro²	4695
• 77 TRACKS, SINGLE-SIDED, DOUBLE DENSITY 5¼		
577-01	Soft Sectored TRS80 etc	4695
577-10	10 Hole Hard NS Apple etc	4695
577-16	16 Hole Hard Micropolis	4695
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6800 .... $11.95
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8035 .... $24.00
8035-8 ...... $24.00
8080A ...... $ 6.59
8085 .... $15.95
TMS9900JI . $39.95

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2716 (450ns) $34.95
2716 (5v) ... $34.95
2732 (5v) ... $95.00
2758 (5v) ... $34.95

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21L02 (4 MHz) ... $ 1.50
2114L (2 MHz) ... $ 5.75
2114L (4 MHz) ... $ 5.95
4116 .... $ 8.95
4127 (70ns) ...... $ 39.95
4164 (64K x 1) $175.00
5257 (2 MHz) ..... $ 6.75
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8214 .... $ 4.65
8216 .... $ 2.95
8224 .... $ 3.25
8224-4 .. $10.95
8226 .... $ 3.85
8228 .... $ 4.95
8238 .... $ 4.95
8243 .... $ 8.00
8250 .... $14.95
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8253 .... $13.95
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8259 .... $17.95
8275 .... $49.95
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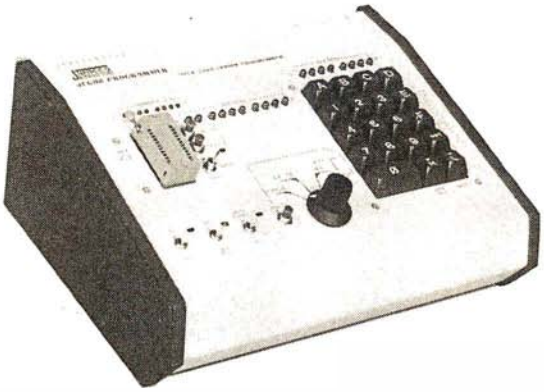
Jameco ELECTRONICS KITS

JE608 PROGRAMMER

2704/2708 EPROM PROGRAMMER



- 3 separate Display Registers: 8 LED's for Hex Key entries, 10 LED's (2^0-2^9) for Address Register and 8 LED's for Data Memory Register. The Data Memory Register displays the content of the EPROM.
- Development of microprocessor systems by means of a ribbon cable from the programmer panel test socket to the EPROM socket on the microprocessor board.
- Rapid checking verification of programmed data changes.
- User may move data from a master to RAM's or write into RAM's with keyboard entries.
- Allows manual stepping manipulation (up and down) at any address location.
- Stand-alone EPROM Programmer consisting of: A 19-key Hexadecimal Keyboard assembly, Programmer Board assembly with 4 power supplies and a LED/Test Socket Panel Board assembly. The Test Socket is zero force insertion type. Power requirements: 115VAC, 60Hz, 6W.
- Compact desk-top enclosure: Color-coordinated designer's case with light tan panels and end pieces in molded mocha brown. Size: 3¼"H x 11"W x 8¾"D. Weight: 5 lbs.

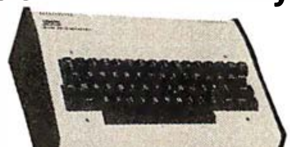
The JE608 EPROM Programmer is a completely self-contained unit which is independent of computer control and requires no additional systems for its operations. The EPROM can be programmed from the Hexadecimal Keyboard or from a pre-programmed EPROM. The JE608 Programmer can emulate a programmed EPROM by the use of its internal RAM circuits. This will allow the user to test or pretest a program, for a system, prior to programming a chip. Any changes in the program can be entered directly into the memory circuits with the Hexadecimal Keyboard so that rewriting the entire program will not be necessary. The JE608 Programmer contains a Programmer/Board with 25 IC's and including power supplies of: –5V, +5V, +12V and +26V. The Hexadecimal Keyboard and LED/ Test Socket Panel board are separate assemblies within the system.

GENERAL APPLICATIONS:

- TO PROGRAM EPROMS 2704 and 2708.
- DEVELOPMENTAL SYSTEM FOR MICRO-COMPUTER CIRCUITS
- TO READ THE CONTENTS OF A PRE-PROGRAMMED EPROM.
- TO COMPARE EPROM(S) FOR CONTENT DIFFERENCES
- TO EMULATE A PROGRAMMED EPROM
- TO STORE PROGRAM IN RAMS FOR ALTERATIONS

JE608 Kit $399.95
Assembled and tested . . $499.95

JE610 ASCII Encoded Keyboard Kit



The **JE610 ASCII Keyboard Kit** can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and –12V @ 10mA for operation. Features: 60 keys generate the full 128 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector.

JE610 ASCII Encoded Keyboard Kit only . . $79.95

Desk-Top Enclosure for JE610 ASCII Encoded Keyboard Kit

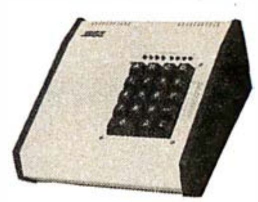
Compact desk-top enclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3½"H x 14½"W x 8¾"D.

DTE-AK $49.95

SPECIAL: JE610/DTE-AK PURCHASED TOGETHER (Value $129.90) $124.95

JE600 Hexadecimal Encoder Kit

FULL 8-BIT
LATCHED OUTPUT
19-KEY KEYBOARD



The **JE600 Encoder Keyboard Kit** provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation.

JE600 Hexadecimal Board Kit only $59.95

Desk-Top Enclosure for JE600 Hexadecimal Keyboard Kit

Compact desk-top enclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3½"H x 8¼"W x 8¾"D.

DTE-HK $44.95

SPECIAL: JE600/DTE-HK PURCHASED TOGETHER (Value $104.90) $99.95

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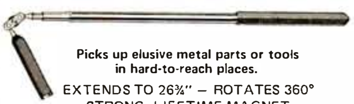

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Input Impedance: 300,000 Ohms.
Thresholds: "Lo" 30%Vcc – "Hi" 70%Vcc
Maximum Speed: 300 nsec., 1.5MHz
Input Protection: ±50VDC continuous 117VAC for 15 sec.
Power: 30mA @5V – 40mA @ 15V – 25V max. reverse voltage protected; 36" cable with color coded clips included.
Operating Temp.: 0-50°C.
Dimensions: 5.8L x 1.0W x 0.7D in. (147 x 25 x 18mm)
Weight: 30 oz. (85 gm)

LPK-1 .... $21.95/Kit

Proto Clips

14-PIN CLIP	PC-14	$ 4.50
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24-PIN CLIP	PC-24	$10.00
40-PIN CLIP	PC-40	$16.00

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* Four .630"ht. and two .300"ht. common anode displays
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* 12 or 24 hour operation
* Includes all components, case and wall transformer
* Size: 6¾ x 3⅛ x 1¾

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* Uses MM5314 clock chip
* Switches for hours, minutes and hold modes
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* Simulated walnut case
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* 12 or 24 hr. operation
* Incl. all components, case & wall transformer
* Size: 6¾" x 3-1/8" x 1¾"

JE701

6-Digit Clock Kit $19.95

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Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

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ADAPTER BOARD
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DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

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2650	MPU		19.95
6502	CPU		11.95
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P8085	CPU		19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide		49.95
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MM503H	Dual 50 Bit Dynamic		.50
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M-CDP1802	User Manual		7.50
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2516	Character Generator		10.95
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	*Requires single +5V power supply		
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2716 T.I.	16K**	EPROM	29.95
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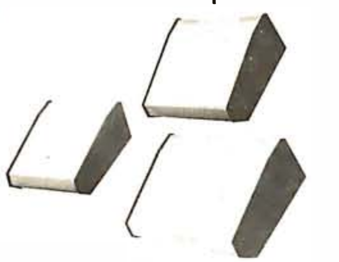

* High strength epoxy molded end pieces in mocha brown finish.
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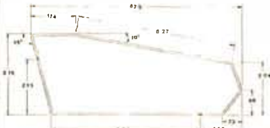

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Transmit Level	−15 dbm nominal. Adjustable from −6 dbm to −20 dbm.
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

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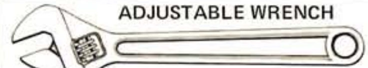

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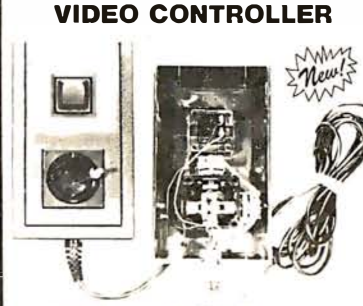

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SWITCHABLE 2 or 4 MHz

THE QT Z+80 REV 1

Z-80A CPU with Serial I/O Port
This CPU can accommodate a 2708, 2716, or 2732 EPROM in SHADOW mode, allowing you to use a full 64K of RAM. The MWRITE signal is generated automatically if you use the board without a front panel. There's also an independent on-board USART to control the RS232 serial port at baud rates from 110 to 9600.

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CPU-Z+80AT (A&T) $189.00
CPU-Z+80BB (BARE BOARD) .... $ 33.00

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QTMO 525 10	Hard 10 Sector	$ 8.95	$29.95
QTMO 525 18	Hard 16 Sector	$ 8.95	$29.95
QTFO32 1000	Hard Sector	$11.95	$34.95
QTFO34 1000	Soft Sector	$11.95	$34.95

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100 pcs .... $ 5.00 ea.
1,000 pcs .... $ 4.50 ea.

16 X 64 VIDEO BD

BY ITHACA AUDIO
ASSEMBLED & TESTED

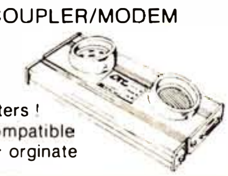
- Full upper/lower case ASCII character set, numbers, symbols and Greek letters
- 7 x 9 Dot matrix in 8 x 10 field
- Selectable display modes, normal & reverse video, blinking characters
- Memory addressable to any 1K page
- Software driver simulates TTY, provides full cursor control, scrolling & paging

A&T PRICE ONLY $139.95

NOVATION CAT

ACOUSTIC COUPLER/MODEM

$156.00



Let your computer talk to other computers!
Bell Systems 103 compatible
300 baud, answer or orginate

EPROMS

1702A .... $ 4.95
2708 .... $ 6.75
2516 .... $22.00
2716 (TI)(5V-12V) $20.00
2716 (5 VOLT) $22.00
2758 .... $27.00
2532 .... $75.00
2732 .... $75.00

TRS-80 DISK DRIVE (CABLES INCLUDED)

TRS-80 I (5¼") $395.00
TRS-80 II (8") $1095.00
APPLE II $1550.00

DISK DRIVE SYSTEMS

S-100

MS-800-1 (Drive with case, cables & power supply) $1095.00
MS-800-2 (2 Drives with case, cables & power supply) $1595.00

5¼" DISK DRIVES

MPI B-51 .... $295.00
SHUGART SA400 .... $295.00

8" DISK DRIVES

SHUGART 8" 801R $450.00
REMEX RFD 4000 .... $635.00

TEXTOOL

ZIP* DIP II SOCKETS

16 PIN ZIP* DIP II .... $ 5.50
24 PIN ZIP* DIP II .... $ 7.50
40 PIN ZIP* DIP II $10.25
*ZERO INSERTION PRESSURE

MATCHLESS PRINTER

FEATURES:

- 132/80 Columns, 63 LPM, Bi-Directional, Nominal Thruput
- 100% Heavy Duty Cycle - High Reliability. 100 Million Character Print Head Life
- Sprocket Feed; Variable Forms Width. 4.5" - 9.5"
- Double Width Characters
- 9 x 7 Dot Matrix Character Font
- 12-Channel Electronic Vertical Format Unit

SALE PRICE WITH CABLE

FOR **TRS-80 I** $795.00
FOR **TRS-80 II** $795.00
FOR **APPLE** **$849.00
FOR **S-100** (parallel interface) $795.00
**Includes parallel interface with documentation.
Add freight $20.00

PAPER TIGER

- 132/80 Columns; 6 or 8 lines per inch
- 1.75"-9.5" Adjustable Tractor and Friction Feed
- Parallel and Serial Interface
- 98 Character ASCII Set
- 8 Software Selectable Character Sizes
- 110, 300, 600 or 1200 Baud

QT PRICES

PT-132 .... $ 950.00
PT-132G (Graphics & 2K Buffer) $1050.00

STATIC RAM BOARDS

SR-8K BARE BD (Ithaca Audio) **21L02** .... $ 19.00
SR-16K BARE BD (Problem Solvers) **2114** . $ 19.00
SR-16K A&T (Cal. Comp Sys) **2114L 4MHz** $269.95
SR-32K KIT (Uses 2114L) **4MHz** $475.00
SR-32K A&T (Uses 2114L) **4MHz** $500.00

PARTS

MICROPROCESSORS

Z80 (2 MHz) $10.95
Z80A (4 MHz) ... $12.95
6502 .... $11.25
6800 .... $12.50
8802 .... $19.50
8035 .... $20.00
8080A .... $ 3.95
8085A $20.00
8088-4 .... $80.00
8748-8 .... $70.00

BOBOA SUPPORT

8212 .... $ 3.50
8214 .... $ 4.50
8216 .... $ 2.95
8224 .... $ 4.00
8228 .... $ 8.00
8238 .... $ 6.00
8243 .... $ 5.00
8251 .... $ 7.00
8253 .... $19.00
8253-5 .... $27.00
8255 .... $ 8.25
8257 .... $17.95
8257-5 .... $19.00
8259 .... $19.95
8275 .... $69.95
8279 .... $17.50
8279-5 .... $18.00
8295 .... $16.50

KEYBOARD CHIPS

AY5-2378 88 ...... $13.75
AY5-3600 90 ...... $13.75

BAUD RATE GENERATORS

MC14411 .... $11.00
1.8432 XTAL ...... $ 4.95
BR1941L $14.00

DISC CONTROLLER

1771B01 .... $24.95
1791B01 .... $39.95

USRT

S2350 .... $10.95

MISCELLANEOUS OTHER COMPONENTS

N8T20 .... $ 3.25
N8T28 .... $ 2.50
N8T97 .... $ 2.00
N8T98 .... $ 2.00
1488 .... $ 1.25
1489 .... $ 1.25
D3205 .... $ 3.00
D3242 .... $10.15
D3245 .... $ 5.60
P3404 .... $ 8.75
TMS5501 .... $19.00
DM8131 .... $ 3.00

CRT CONTROLLER

MC6845P $18.00

STATIC RAMS

21L02 (450 ns)
.... 64/ea./$1.20 ea.
..........100 ea./$1.10 ea.
2114L (450 ns) $5.25 ea.
..........100 ea./$4.50 ea.
2114L (300 ns) $5.50 ea.
..........100 ea./$4.75 ea.

UARTS

TR1602B .... $ 3.75

CHARACTER GENERATORS

2513 (Upper case) $10.95
2513 (Lower case) $10.95
2513 Upper (5 v) $ 9.75
2513 Lower (5 v) $10.95

Circle 242 on inquiry card.

EXPANDORAM I

EXPANDABLE TO 64K USING 4116 RAMS

Interfaces with most popular S-100 boards
Bank selectable: PHANTOM provision
Draws only 5 watts fully populated
Designed to work with Z-80, 8080, and 8085 systems
No wait states required
16K boundaries & protect via dip switches
Kits come with sockets for full 64K
Invisible refresh

MEM-16K (16K KIT)	$199.00
MEM-16AT (16K A&T)	$269.00
MEM-32K (32K KIT)	$260.00
MEM-32AT (32K A&T)	$329.00
MEM-48K (48K KIT)	$315.00
MEM-48AT (48K A&T)	$379.00
MEM-64K (64K KIT)	$370.00
MEM-64AT (64K A&T)	$439.00

EXPANDORAM II

THE RANDOM ACCESS MEMORY

S-100 Bus Compatible
Up to 4Mhz Operation
Expandable Memory from 16K to 256K
Dip Switch Selectable Boundaries
Uses 16K (4116) or 64K (4164) Memory Devices
Page Mode Operation Allows up to 8 Memory Boards on Bus
Operates with Z80 CPU's
Phantom Output Disable
Invisible Refresh (Synchronized with Wait States)

MEMII-16K (KIT)	$250.00
MEMII-16AT (A&T)	$300.00
MEMII-32K (KIT)	$325.00
MEMII-32AT (A&T)	$375.00
MEMII-48K (KIT)	$395.00
MEMII-48AT (A&T)	$475.00
MEMII-64K (KIT)	$475.00
MEMII-64AT (A&T)	$539.00

QT LOW PRICES!

Z-80 STARTER KIT

COMPLETE Z-80 MICROCOMPUTER

On-board keyboard, display, EPROM programmer, and cassette interface
On-board S-100 interface
Wire-wrap area and room for 2 S-100 connectors
Two 8-bit parallel I/O ports, 4-channel CTC, 5 programmable breakpoints
Examine and change memory, I/O ports, or register

Z-80K (KIT)	$310.00
Z-80AT (A&T)	$369.95

SD SYSTEMS

VERSAFLOPPY I

SINGLE DENSITY DISK DRIVE CONTROLLER

S-100 Bus Compatible
IBM 3740 Compatible Soft-Sectored Format
Operates with both Standard (8") and Mini (5¼") Drive
Provides Control for Single or Double-Sided Operation
Controls up to Four Drives Simultaneously
Operates with SDOS or CP/M Disk Operation System
Operates with Z80, 8080, and 8085 Central Processing Units
Utilizes FD 1771B-1 Controller Device
Control and Diagnostic Software Available in PROM
Interrupt Operation Optional

VF-IK (KIT)	$235.00
VF-IAT (A&T)	$295.00

VERSAFLOPPY II

DOUBLE DENSITY DISK CONTROLLER

Single or double density floppy disk controller
985600 bytes on 8" double sided diskettes
259840 bytes on double sided 5¼" diskettes
S-100 bus (IEEE) standard compatible
IBM 3740 format in single density
8" and 5¼" drives controlled simultaneously
Operates with Z-80, 8080, and 8085 CPU's
Controls up to 4 drives
Vectored interrupt operation optional

VF-2K (KIT)	$335.95
VF-2AT (A&T)	$385.95

SBC-100/200

OR 4 MHz SINGLE BOARD COMPUTER

S-100 bus compatible Z-80 CPU
1K of on-board RAM
4 EPROM sockets accomodates 2708, 2716, or 2732
One parallel and one serial I/O port
4-channel counter timer chip (Z-80 CTC)
Software programmable serial baud rates

SBC-100K (2 MHz KIT)	$280.00
SBC-100AT (2 MHz A&T)	$340.00
SBC-200K (4 MHz KIT)	$299.00
SBC-200AT (4 MHz A&T)	$359.00

VDB-8024

VIDEO DISPLAY BOARD

WITH ON-BOARD Z80 MICROPROCESSOR

S-100 Bus Compatible
Full 80 Characters by 24 Lines Display
Characters Displayed by High Resolution 7 x 10 Matrix
Composite or TTL Video Output
Keyboard Power and Interface
Forward and Reverse Scrolling Capability
Blinking, Underlining, Field Reverse, Field Protect and Combinations
Full Cursor Control
96 Upper and Lower Case Characters
32 Special Character Set
128 Additional User Programmable Characters (Optional)
On-Board Z80 Microprocessor
2K Bytes Independent On-Board RAM Memory
Glitch-Free Display

VDB-K (KIT)	$365.00
VDB-AT (A&T)	$440.00

PROM-100

PROGRAMMING BOARD FOR PROM DEVELOPMENT

S-100 Bus Compatible
Programs the Following EPROMs:
2708, Intel 2758, 2716, 2732 and Texas Instruments 2516
Dip Switch Selection of EPROM type
25 VDC Programming Pulse Generated On Board
Maximum Programming Time: 16,384 Bits in 100 Seconds
Power Requirement: +8VDC at 300 ma; +16 VDC at 100 ma; -16VDC at 60 ma
TTL Compatible
Software Provides for Reading of Object File from SDOS, CP/M or PROM and Programming into EPROM
Program Verification
Verification of Erasure
Zero Insertion Force Socket

PROM-100K (KIT)	$175.95
PROM-100AT (A&T)	$235.00

PLACE ORDERS TOLL FREE
1-800-421-5150
Continental U.S. only
Except California

S-100 BARE BOARDS

CB1A 8080 CPU	$30.95
VB1B Memory Mapped Video Interface	$26.95
VB2 I/O Mapped Video Interface	$29.95
I02 Parallel I/O Interface	$34.00
I04 2P + 2S I/O Interface	$26.95
SB1 Music Synthesizer	$39.95
OB1 Vector Jump & Prototyping Board	$29.95
MB6B 8K Static RAM	$25.95
MB7 Low Power 16K Static RAM	$26.95
MB8 4K 1702 EPROM Board	$29.95
MB8A 16K 2708 EPROM Board	$34.95
T1 Terminator	$26.00
MT1 15 Slot Motherboard	$45.00
XB1 Extender Board	$13.50

S-100 KITS & ASSEMBLED BOARDS

IO4 2P + 2S I/O Interface	
Kit	$129.95
Assembled & Tested	$199.95
PB1 2708/2716 EPROM Programmer	
Kit with Textool sockets	$124.95
Assembled & Tested with Textool sockets	$174.95
VB1B Memory Mapped Video Interface	
Kit	$125.00
Assembled & Tested	$180.00

SSM PRODUCTS

VB2 I/O Mapped Video Interface	
Kit	$150.00
Assembled & Tested	$195.00
VB3 80 Character Video Interface	
80x24 Display, 2 MHz	
Kit	$299.95
Assembled & Tested	$389.95
80x24 Display, 4 MHz	
Kit	$324.95
Assembled & Tested	$410.00
Upgrade Kit for 80x24 Display	
2 MHz	$ 69.00
4 MHz	$ 89.00
IO2 Parallel I/O Interface	
Kit	$ 59.00
Assembled & Tested	$ 89.00
CB1A 8080 CPU	
Kit	$129.95
Assembled & Tested	$189.95
SB1 Music Synthesizer (4)	
Kit	$199.00
Assembled & Tested	$279.00
OB1 Vector Jump & Prototyping Board	
Kit	$ 55.00
Assembled & Tested	$ 85.00

MB6B 8K Static RAM	
450 ns RAM	
Kit	$129.95
Assembled & Tested	$149.95
250 ns RAM	
Kit	$159.95
Assembled & Tested	$224.95
MB7 Low Power 16K Static RAM	
Kit	$269.96
Assembled & Tested	$375.00
CB2 Z-80 CPU	
Kit	$185.95
Assembled & Tested	$250.00
MB3 4K 1702 EPROM Board	
Kit - without EPROMs	$ 65.00
Assembled & Tested	$125.00
MB8A 16K 2708 EPROM Board	
Kit - without EPROMS	$ 85.00
Assembled & Tested	$139.00
T1 Active Terminator	
Kit	$ 34.00
Assembled & Tested	$ 64.00
MT1 15 Slot Motherboard	
Kit (with Connectors)	$129.95
Assembled & Tested	$149.95
XB1 Extender Board	
Kit (with Connector)	$ 19.95
Assembled & Tested	$ 29.95

QT COMPUTER SYSTEMS INC.
QUICK & TIMELY
15335 South Hawthorne Boulevard
Lawndale, California 90260
(213) 970-0952

PLACE ORDERS TOLL FREE
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(CONTINENTAL U.S. ONLY)
(EXCEPT CALIFORNIA)

TERMS OF SALE: Cash, checks, money orders, credit cards accepted. Also C.O.D. orders under $100.00. Minimum order $10.00. California residents add 6% sales tax. Minimum shipping and handling charge $2.50.
Prices subject to change without notice.
International sales in American dollars only.

VISA | master charge

Circle 242 on inquiry card.

Keyboard Special 1 !!

CHERRY "PRO" Keyboard $119.00
Streamlined Custom Enclosure 34.95
BOTH only $134.95

Keyboard Special 2 !!

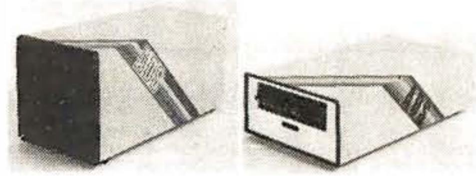
Keytronics 1660 .... $149.00
Hard Plastic enclosure 49.00
BOTH only $152.00

June Bonanza!!

4116 dynamic RAM, 16K
Set of 8, 16K, for Apple, TRS-80, Exidy, Heath & more. 200 Ns., prime parts, at the unheard of $49/8.
Large discounts available for quantity & dealers (500 & up). Offer limited while supply lasts, as these will vanish quickly!!!

Disk Subsystem

Matchmaker Technology
TURNKEY DISK SUBSYSTEMS



APPLE ...... Single density disk controller. Expanded Apple DOS
TRS-80 .... Single or double density. Expansion interface necessary. Space for 48K dynamic RAM on controller card RS232 port
SORCERER .. Full RS-232 Interface. One S-100 slot for memory expansion. Single or double density

All above units come as follows: Complete, assembled and tested, with two 8" floppy disk drives (Apple available in one drive model). Includes all cabling, connectors and documentation in a stunning color coordinated cabinet with power supply. Ready to go, plug in and run!!!

* * *

When ordering specify single or double sided drives

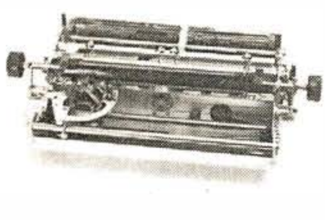
* * *

Software available for above disk add-ons

* * *

TRS-80 & Sorcerer operate on all CP/M compatible software

Daisy Wheel Printers



Qume Sprint 3\45

PRINTER (factory warr.)	$1499.
POWER SUPPLY (Borschert) (Shown mounted on rear of printer)	349.
COMBINATION SPECIAL	1699.
Cases available	200.
S-100 interface card	149.
SPRINT 5/45 RO, RS-232 Complete, assembled, in case, plug-in & print, hence, no muss & no fuss	$2699.
NEC Spinwriter	$2899.

Data Display Monitors

Please call us for particulars

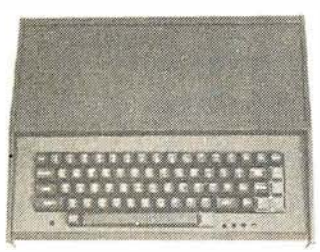
Electrolabs
POB 6721, Stanford, CA 94305
415-321-5601 800-227-8266
Telex: 345567 (Electrolab Pla)
Visa MC Am. Exp.

Software

CP/M 1.4	$ 99
CP/M 2.0	149
OS-1 (incl. 1st yr. update) ..	249
Spellbinder (Exc. secretiarial type word-processor)	350

Peripheral Sale!!

Hiplot Plotter	$875.
Hipad Digitizer	715.
Televideo 912C	760.
Televideo 920C	860.
IDS 440 Paper tiger	899.
SD Expandoram II (A&T, 64K)	560.
Imsai 65K dynamic RAM III	399.
DC Hayes Micromodem 100 ..	399.
Super switcher power for hard disk & more	349.
CII HB 10 MBY	3300.
SA 4008	2799.
C-Basic	99.
Fortran Compiler	100.
C Compiler	600.
Basic compiler	350.



ESAT 200B

BI-LINGUAL 80x24
Communicating Terminal
Scrolling, full cursor, bell, 8x8 matrix, 110-19,200 baud, Dual Front Applications. Arabic & Hebrew, Multilingual Data Entry Forms Drawing, Music, & Switchyards.
Alone .... $279.
with Cherry Pro keyboard & custom metal case .... $399.

NEW "UNIX-like" Operating System for Z-80

OS-1

OS-1 is truly a breakthrough in the micro world! OS-1 is NOT a "control program for micros" but is, instead a large, professional operating system designed to lower the cost and improve the quality of programming efforts. OS-1 provides a "friendly" human interface for both system programmers and users. Finally, with OS-1, the capability of a Z-80 system is vastly expanded.

OS-1 appears exactly like UNIX to the user, and includes virtual i/o, "set tty" and "login" commands, a shell, a hierarchical "tree" type file structure with 16Mby file size and an unlimited no. of files and devices. OS-1 allows the extremely useful "pipes" and "filters" to be implemented. OS-1 also provides for up to 1024 users and 64 groups and security for users, groups, files and devices. OS-1 occupies 12Kby and comes with a 4Kby "enhanced" cp/m adapter which runs ALL cp/m and most CDOS programs. Source code is supplied with adapter.

OS-1 (Including Debugger, "UNIX-type" editor, Linker-Loader & 1 Yr. update) **$249**

"C" Compiler (Whitesmiths') **$600**

Microsoft Compiler Interface (Interfaces MS Fortran & Cobal compilers directly to OS-1. This allows compiler output to "Command" OS-1 Routines. The Electrolabs' Software Group considers this interface indispensable. Contains over 100 separate routines) **$49**

Manuals:
(price applies to OS-1 purchase)

Introduction to OS-1 (60pg)	**$15**
OS-1 Users' Guide (150pg)	**$35**
Sys-Gen Manual for OS-1 (40pg)	**$10**
SET ------	**$45**

Circle 243 on inquiry card.

page

DEAL #1

Hobby Wire Wrap Starter Package

BW2630	WW Tool	$19.95
BT30	#30 Bit..........	3.95
BC1	Batteries & Charger	14.95
*Kit #1	Wire Kit...........	9.95
	Regular Price	$48.80

$39.95

*Kit #1 Contains 900 pcs. of precut wire in asst. sizes.

Choose from Red, Blue, White, Black, Green, Orange, Violet, Yellow, or assortment.

DEAL #2

Industrial Wire Wrap Starter Package

BW928BF	WW Tool	$52.95
BT30I	#30 Bit & Sleeve..	29.50
BC1	Batteries & Charger	14.95
*Kit #3	Wire Kit...........	32.95
	Regular Price ...	$130.35

$119.95

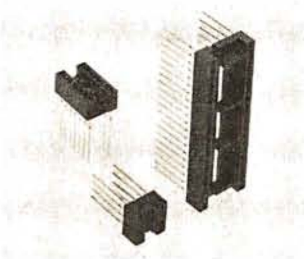
*Kit #2 Contains 4000 pcs. of precut wire in asst. sizes.

Choose from Red, Blue, White, Black, Green, Orange, Violet, Yellow or assortment.

★ ★ BIG DEAL ★ ★

RN IC Sockets by the Tube

RN HIGH RELIABILITY eliminates trouble. "Sidewipe" contacts make 100% greater surface contact with the wide, flat sides of your IC leads for positive electrical connection.



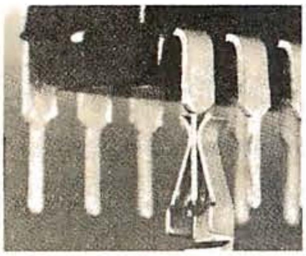
WIRE WRAP SOCKETS

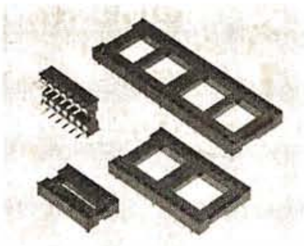
3-level Gold Closed Entry Design

*Sockets sold at these prices by the tube only.

Size	Quantity/Tube	Price ea.*	Price/Tube
08 pin	52	.39	**$20.28**
14	30	.46	**$13.80**
16	26	.50	**$13.00**
18	23	.68	**$15.64**
20	21	.85	**$17.85**
22	18	.42	**$16.56**
24	17	.94	**$15.95**
28	15	1.23	**$18.45**
40	10	1.60	**$16.00**

Above prices include gold up to $800/oz.





SOLDER TAIL

Low Profile Tin Closed Entry Design

*Sockets sold at these prices by the tube only.

1¢/pin (over 5 tubes)

3/4¢/pin (over 100 tubes)

See tube quantities above.

ORDERING INFORMATION

- Orders under $25 include $2 handling
- All prepaid orders shipped UPS Ppd.
- Visa, MC & COD's charged shipping
- All prices good through cover date
- Most orders shipped next day.

Limited to products Page Ditigal stocks. All discounts are off of list price. Call or write for list prices.

10% off on all OK hobby products!
10% off on all Bishop Graphics products!
5% off on all Vector products!

page 135 E. Chestnut Street 5A, Monrovia, California 91016 Phone (213) 357-5005

Circle 244 on inquiry card.

California Digital

Post Office Box 3097 B • Torrance, California 90503

NEW
from
INTEGRAL DATA
460
Paper Tiger

**** All the features of the 440 and more ****

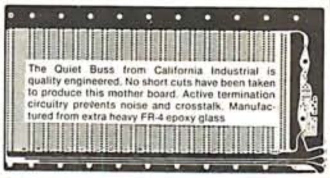
The 460 uses a dot matrix character formation technique in which the placement of the dots overlap both horizontally and vertically to achieve a correspondence-quality printing.
The printer's nine-wire print head uses staggered needle rows to create the vertically overlapping dots. The head is driven bi-directionally under microprocessor control by a stepper motor driven mechanism with logic-seeking look ahead capability.
Standard "Two-K Byte" buffer allows the printer to accept the entire content of a 1,920-character CRT screen. Weight 27 lbs.

suggested list price $1,295. Calif. Digital price **$1,076**

S-100 Mother Board

Quiet Buss

$29.95
8803-18
18 slot
IMSAI



The Quiet Buss from California Industrial is quality engineered. No short cuts have been taken to produce this mother board. Active termination circuitry prevents noise and crosstalk. Manufactured from extra heavy FR-4 epoxy glass

TELETYPE® MODEL 43

4320 KEYBOARD

TTL ...... AAA	$ 950	
RS232 .... AAK	1050	
Friction ... AAE	1100	plus shipping
103 Modem AAB	1575	

WESTERN UNION ENCLOSURE

These enclosures were manufactured for Western Union by Universal Technology. The exact purpose of the product is still a myster but the enclosure is ideally suited for an S-100 motherboard with shielded power supply.
Removable hood and plexiglas front make this enclosure an attractive home for any hobby product.
New surplus in factory boxes supplied with three 22/44 edge connectors; DB25S communications connector; six foot grounded power cord and more. Inside dimensions: 19"x 10 1/2" x 6 7/8". Shipping weight 8 lbs.

$24.95

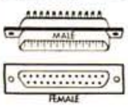
FREE

PLASTIC LIBRARY CASE with purchase of each box of .... Memorex mini-diskettes. $5 value.

$24.95 BOX of 10
DISKETTES

DB25

	each	10+
male	$2.50	1.95
female	3.25	3.05
hood-2p	1.25	.98
Centronic	6.95	



Edge Connectors

GOLD
100 PIN
IMSAI/ALTAIR

Imsai solder .125x.250	$2.95	3/$ 7.50
Imsai w/w .125centers	$4.95	3/$13.00
Altair soldertail .140row	$5.95	3/$15.00
SPECIALS		
22/44 Kim eyelet .156"	$1.95	3/$5.00
25/50 solder tab .156"	$1.09	3/$2.00
36/72 wide post w/w.156	$1.95	3/ $5.00

BCD Thumbwheel Switch 1.95

Ten Position
Mfg. by Digiswitch
1 7/8"high 1/2" wide

COMPUTERS

Apple II standard 16K	$988
Apple Plus 16K	988
Atari 400	450
Atari 800	850
Texas Instruments 99/4	895.
Northstar Quad 32k Horizon	2995
Vector MZ	
Compucolor II Model 3	1395
Rockwell Aim 65 (1K)	375

CRT TERMINALS

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ADDS Regent 60	1495
Hazeltine 1420	850
Hazeltine 1500	995

MONITORS

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SD 64K Expandoram Memory	

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DATA INPUT TERMINAL

This Keystation terminal was recently acquired from the CMC division of the Pertec Corporation. The unit was originally designed for inputing data directly onto magnetic tape.

The system is comprised of a premium cast aluminum and fiberglass enclosure, along with a Honeywell / Microswitch hall effect keyboard. Thirty display lamps advise the operator of the systems status. Four inch loud speaker acknowledges acceptance of data and alerts the operator of pending problems.

But most of all this "USED" terminal, with a little imagination, can be engineered to make the perfect home for an S-100 computer and video display; or with slight modification will accept the Rockwell AIM-65 micro/computer.

Five volt regulated power supply is available for an additional $20. (see June Byte) All units are in excellent condition. Original acquisition over $700. 22 lbs.

direct connect MODEM
Universal Data 103

Connects directly to the new modular phone jack. Fully powered from your existing telephone line. No need to locate external AC power. Crystal control prevents frequency drift. Direct connect feature eliminates loss of information due to carbon compression that is associated with acoustic modems. Runs circles around those other "Domesticated" modems.

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Through years of research the ADDS Corporation has evolved a low maintenance, extremely durable CRT terminal capable of withstanding an abusive 24 hour duty cycle. The Regent 25 features Intel 8085 microprocessor controlled circuitry along with the Cherry Switch long-life capacitance keyboard.

18 key cursor and numeric pad doubles to allow for user definable special functions. True descending lower case characters along with a fully addressable cursor makes the Regent 25 the ideal word processing terminal.

High-resolution screen is capable of displaying 96 upper and lower case ASCII characters and 32 control codes. This terminal is switch selectable to display six European languages.

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your choice

	10	50
$.98	$.88	.81

SPDT Miniature Toggles

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7107 jbt	ON-OFF(mnt.ON)
7108 CK	ON-(moment ON)
7103 CK	ON OFF ON
Rotary	3P-4-Pos.
Rotary	3P-6-Pos.
Push B (N.O.)	$.39ea. 4/$1

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	10	25	100	1K
$1.29 ea.	$1.19	1.09	.97	.83

specify 4 7 or 8 pos.

SPST

$139.50

PORTABLE DATA ENTRY SYSTEM

These used data terminals were originally designed for chain store inventory control and order entry systems. The operator enters the inventory control number, merchandise on hand and the unit price. After all pertinent data has been entered into the recorder, the main warehouse is telephoned, the handset is placed in the acoustic coupler and all the recorded information is transmitted back to the master computer. With a little imagination and one of these portable entry systems, you should be able to exchange programs and computer information with associates across the country. All units were removed from service in working condition. Original cost $2,500. Each system comes complete with:

- Portable Cassette Drive Unit
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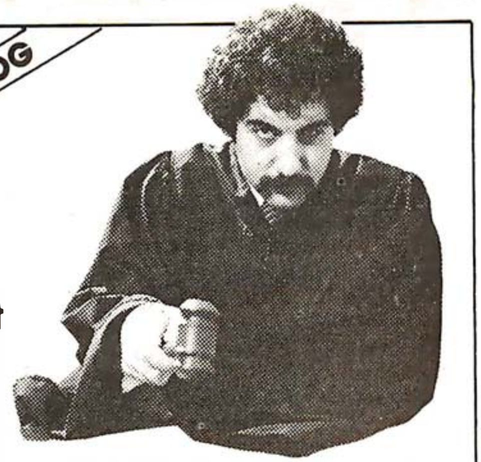

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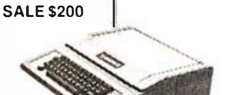

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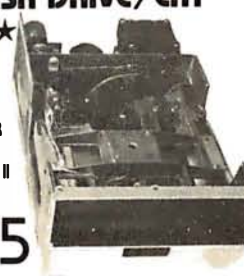

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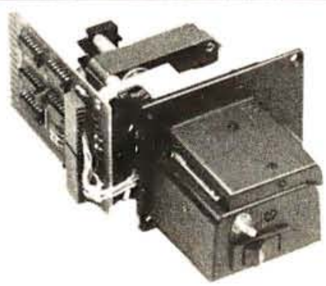

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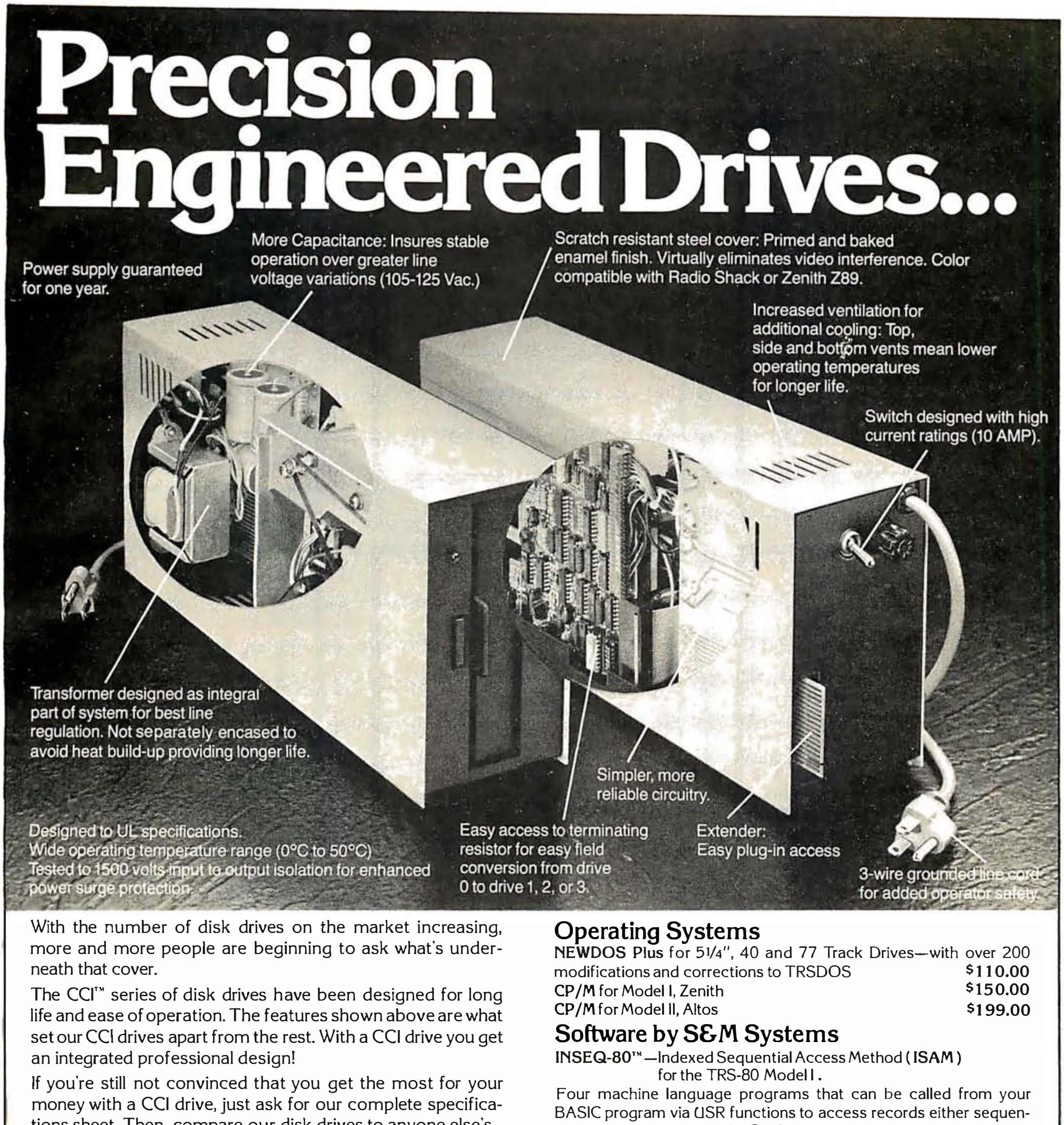

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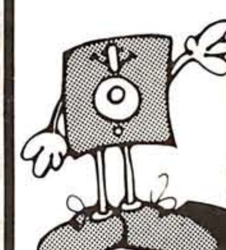

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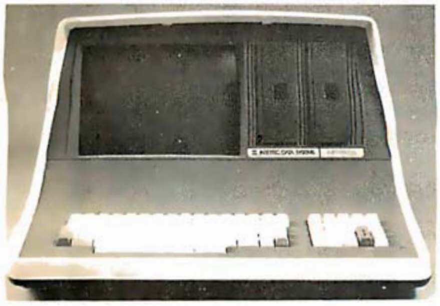

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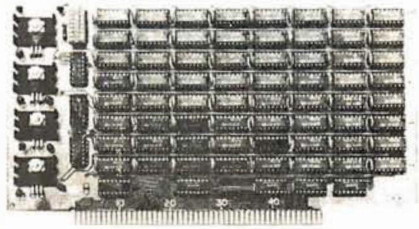

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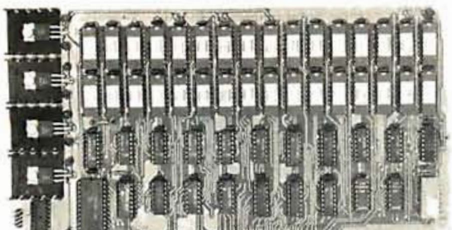

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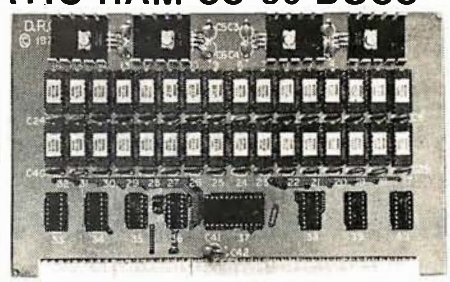

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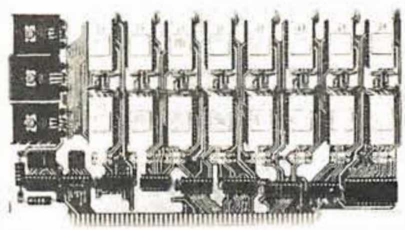

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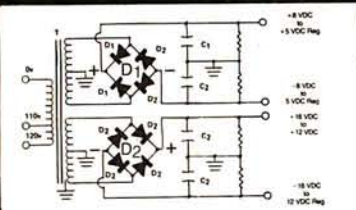

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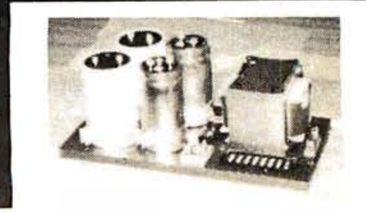

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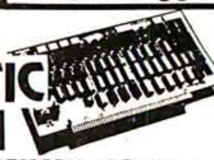

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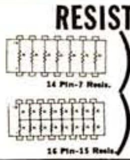

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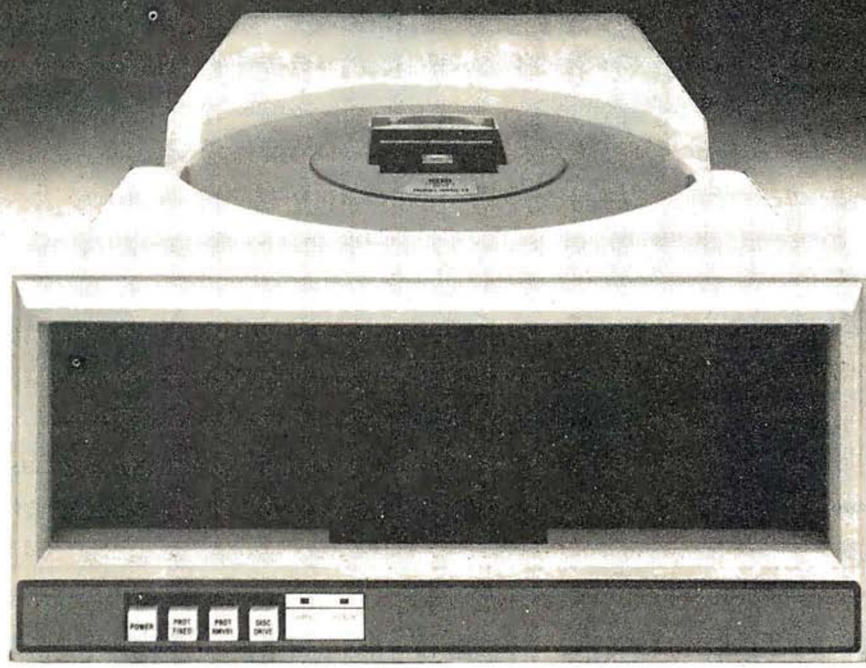

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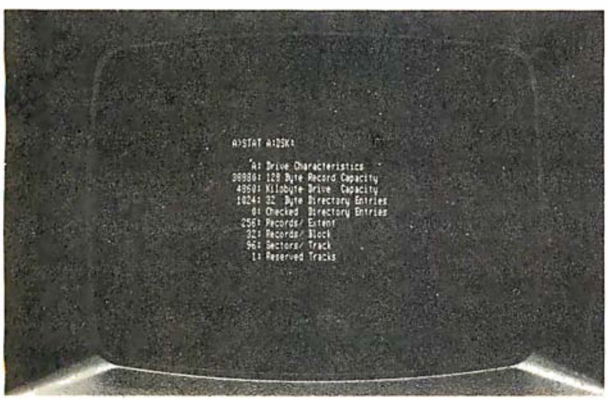

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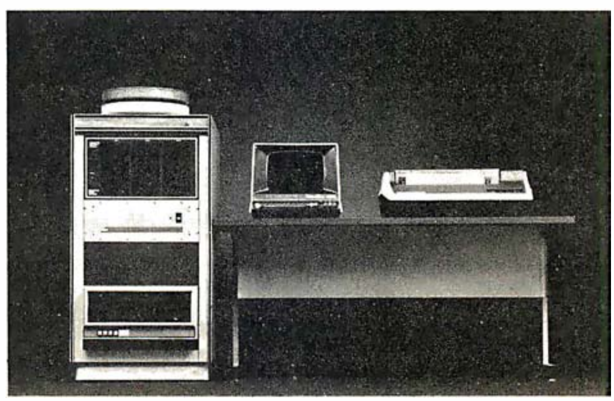

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15885	25/50 W/W	.200	4.85	4.35	3.90
16115	36/72 S/E	.140	6.50	5.85	5.20
16120	36/72 S/T	.140	6.55	5.90	5.25
16125	36/72 W/W	.200	6.75	6.10	5.40
16145	36/72 S/T	.200	6.50	5.85	5.20
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DB 25S	Female	3.60ea.	3.40ea.	3.20ea.
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DC 37S	Famala	6.00ea.	5.75ea.	5.50ea.
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DD 50P	Mala	5.50ea.	5.10ea.	4.75ea.
DD 50S	Female	9.40ea.	8.60ea.	8.00ea.
DD 51216-1	1 pc. Grey Hood	2.40ea.	2.20ea.	2. 00ea.
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Easily adaptable on most 1802 systems. *Requires* 12K RAM minimum for Basic and user programs. Cassette version in stock now. ROM versions coming soon with exchange privilege allowing some credit for cassette version. New improved version with improved speed and accuracy now avail. Source list for I/O now incl.

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Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded with additional memory, Full Basic, ASCII Keyboards, video character generation, etc.**

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The Super Elf includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during** and **after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker ampifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step.** Large, on board displays provide output and optional **high and low address.** There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for **all** IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game. Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and R&D.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95.** Expansion Cabinet with room for 4 S-100 boards **$41.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested. **Questdata**, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year. Issues 1-12 bound $16.50.

Tiny Basic Cassette **$10.00,** on ROM **$38.00,** original Elf kit board **$14.95. 1802 software;** Moews Video Graphics **$3.50.** Games and Music **$3.00,** Chip 8 Interpreter **$5.50.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface.** Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf.** The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed.** EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake.** They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $15.25 for easy connection between the **Super Elf** and the **Super Expansion Board.**

Power Supply Kit for the complete system (see Multi-volt Power Supply below).

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7422N	.39
7430N	.20
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7445N	.74
7447N	.58
7448N	.77
7450N	.20
7474N	.35
7475N	.49
7485N	.88
7489N	1.85
7490N	.43
7492N	.43
7493N	.43
7495N	.69
74100N	1.20
74107N	.35
74121N	.34
74123N	.59
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74145N	.77
74150N	1.20
74151N	.69
74154N	2.00
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74174N	.96
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74LS05N	.40
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LM340K-8	1.35
LM340K-12	1.35
LM340K-15	1.35
LM340K-24	1.35
LM340T-5	1.25
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CD4049	.45
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CD4051	1.13
CD4060	1.42
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DL747/750	CA/CC	.600	1.95
DL750	CC	.600	1.95
FND359	CC	.357	.70
FND500/507	CC/CA	.500	1.35
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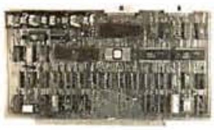

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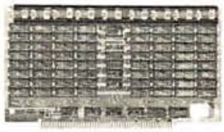

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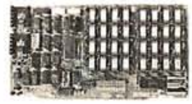

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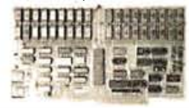

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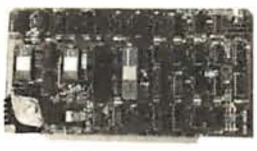

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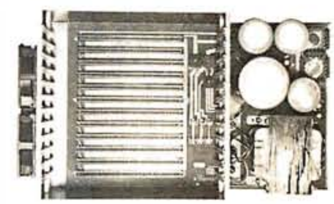

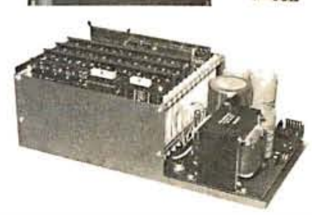

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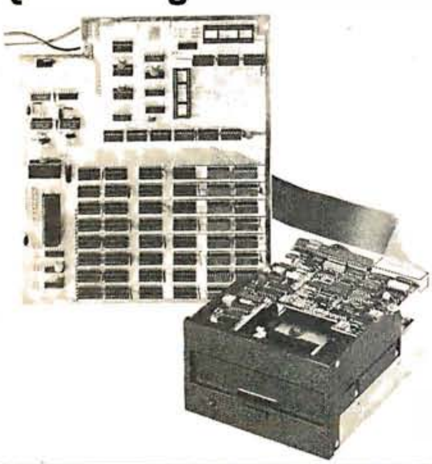

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WANTED: A used Shugart SA-400 or SA-800 disk drive. Or a Commodore single- or dual-disk drive for my PET. I also want a used printer that will handle all of the PET graphics. Scott Summer, 27 Leicester Way, Pawtucket RI 02860, (401) 728-4678.

FOR SALE: Xitan mainframe (8 slots), factory-assembled S-100 unit with power supply; Xitan video display board, also factory assembled. Both work fine. Also have GRI keyboard kit (assembled), Z80 processor kit (assembled), and Xitan SMB-1 kit (assembled), one which does not work. Xitan Alpha-1 software on cassette and full documentation are included. Total cost over $1000. Best offer takes. M W Williams, 111 Kempsey Ct, Slidell LA 70458, (504) 643-1995.

FOR SALE: Intel D8086-4 16-bit microprocessor and October 1979 *Family User's Manual* for $50. I decided to try the 68000 instead. Unit never used/in original foam. R Rowe, c/o A H P, POB 1032, Ridgecrest CA 93555.

FOR SALE: Complete set of *Kilobaud Microcomputing* magazine thru December 1979 (issues 1 thru 36), in excellent condition. $120. Arthur Granville, 5515 Crane Rd, Ypsilanti MI 48197, (313) 434-1586.

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FOR SALE: GE Terminet 300 printer. Prints at 30 cps. RS-232 interface. Reliable letter quality, 9-inch tractor feed. $500. M W Basch, POB 344, Harvard MA 01451.

FOR TRADE: Intel SKD 8086 with extra memory for 8 K Challenger IP. Allan Musser, 6514 El Nido #4, Isla Vista CA 93017, (805) 685-4202.

WANTED: Plastic card edge guides for IMSAI 8080 mother board cage. Three IMSAI Cable As with matching plugs and one Cable M for an MIO board. Len Tower, POB 29 MIT Branch, Cambridge MA 02139, (617) 253-1541.

FOR SALE: 165 cps printer, uses regular paper, same as the Paper Tiger, almost new; $499. S-100 bus video display board, 16 by 64 characters; $100. Speech Technology voice generator; $300. Stan Levine, 1802 Melville St, Ocean NJ 07712, (201) 531-8305.

FOR SALE: Datatype Corp DFR-100 optical page reader with maintenance/operation manuals; best offer. Anyone interested in a Digital Computer Controls Inc D-116 minicomputer, Remex optical tape reader, Remex tape punch, spare boards for interfacing Mohrtext (Omnitext Inc) 1200 editing proofing terminal? Ken Cazakoff, RR #2, Nelson British Columbia, CANADA V1L 5P5.

FOR SALE: OSI Challenger C2-4P with 8 K read-only memory BASIC, 8 K programmable memory, graphics, and polled keyboard. $500 or best offer. Also, OSI minifloppy owners, are any newsletters or clubs in existence? Al Casper, 3632 CTH, I, Saukville WI 53080, (414) 675-6946.

FOR SALE: SYM BASIC read-only memories (BAS-1) for $65. Send check and SASE. Ken Henrich, 14 Meadow Pl, Northport NY 11768, (516) 754-1677.

WANTED: TRS-80 Level II system or comparable system with business operating software. Also needed: Heathkit electronics courses and microcomputer course with training units or comparable home-study course material. Also interested in print-quality printer with interface. Mike McColligan, 7341 West Chester Pike, Upper Darby PA 19082, (215) 352-8110.

FOR SALE: 6802 system with 4 K programmable memory and BASIC in read-only memory. Keyboard and video with modulator and cassette interface, $250. 16 K Econoram IV S-100, $150. Visible Memory (graphics for KIM) and Music Card with all software, $175 and $25 respectively. System above with homemade expansion and power supply, $600. (SwTPC power supply free, all parts included.) Also, sell separately or swap for Apple stuff. Mark Siebert, 2599 Caulfield, San Diego CA 92154, (714) 423-0609.

FOR SALE: 8 K PET computer with BETSI S-100 interface, joystick, and many tapes, including Microchess. $600 or best offer. Mark Poeschl, 1065 Witte B, Madison WI 53706.

BOMB
BYTE's Ongoing Monitor Box

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Ciarcia's First Place BOMBs Defused

Steve Ciarcia's April article "Ease Into 16-Bit Computing" did not place first in the BOMB; thus, his four-month streak was ended with a second place finish. Hal Chamberlin's "Advanced Real-Time Music Synthesis Techniques" was rated best by BYTE readers who responded to the April BOMB. Hal will receive a $100 bonus for his work, and Steve will be awarded $50. Congratulations to both authors for their efforts.■

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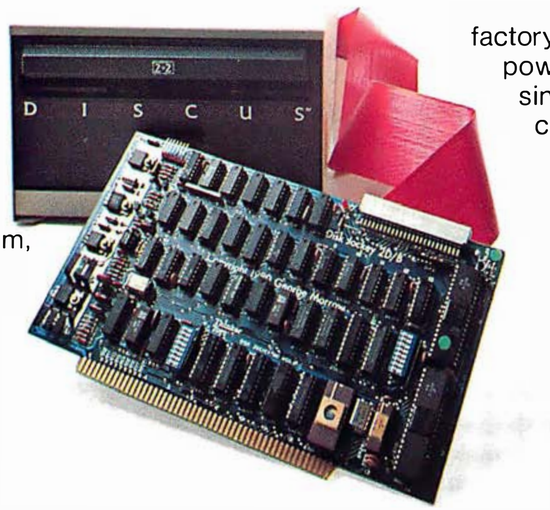

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