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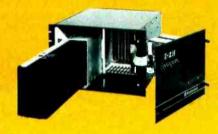
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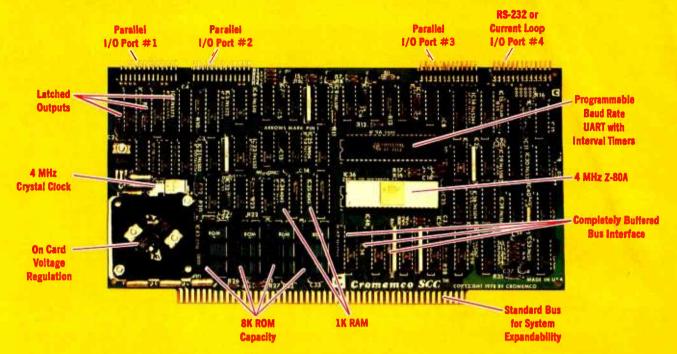
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#### **Foreground**

 $17\,$  ease into 16-bit computing: Get 16-bit performance from an 8-BIT COMPUTER by Steve Ciarcia

Steve tells you how the Intel 8088 is well-suited for building a minimum-configuration 16-bit computer.

34 ELECTRON BEHAVIOR IN A CHEMICAL BOND by Michael Liebl Learn how to use a computer to explore the inner processes of a molecule by finding solutions to the Schrödinger

74 SOLVING PROBLEMS INVOLVING VARIABLE TERRAIN, PART 2: SPECIAL CASES, INCLUDING HEXAGONAL GRIDS by Scott T Jones

After developing a general algorithm last month, Scott now explores several modifications that may be applied to typical conflict-simulation problems.

126 A POWER-LINE PROTECTION CIRCUIT by Neil Schneider and Bror Erickson For hobby applications where an isolation transformer is too big and expensive, this relay-based circuit can provide some protection from power-line wiring errors.

 ${f 130}$  LANDING MODULE SIMULATION WITH RANDOM SURFACE by S  $_{\it I}$  Houng This game uses the Motorola MEK6800 D2 kit. It can be interfaced to display the landing approach on an oscilloscope.

 $142\,$  the dirt-cheap bootstrap, more notes on bringing up a MICROCOMPUTER by Albert S Woodhull An inexpensive way to add front-panel functions to a minimal microcomputer system.

 $156\,$  HYDROCARBON MOLECULE CONSTRUCTOR, by Randall S Matthews The program presented here uses the high-resolution graphics ability of the Apple II to give a visual representation of molecular bonding.

**232** SUPER TIC by J Roehrig

This is a three-dimensional, 4-by-4-by-4, tic-tac-toe game that can play against a human opponent. The program has ten levels of expertise, is written in BASIC, and can be modified to run in two dimensions.

#### **Background**

60 HEWLETT-PACKARD'S NEW PERSONAL COMPUTER, THE HP-85 by Christopher P Morgan

A first look at a personal computer from a company esteemed for its calculators and minicomputers.

84 TRS-80 PERFORMANCE, EVALUATION BY PROGRAM TIMING by James R Lewis James provides us with a direct comparison of the TRS-80 computer with an IBM System/370.

114 ELECTRONIC PLANIMETRY by Peter A Santi, John Fryhofer and Gregory Hansen

These authors describe a situation in which a specialized tool was replaced by a general-purpose minicomputer.

 $194\,$  OPERATION CODES FOR 8080, 8085, AND Z80 PROCESSORS by D Martin Harrell

The need to convert an assembler mnemonic to the hexadecimal object code often occurs when programming the 8080 microprocessor family. Here is a helpful summary of related information.

**230** TO ERR IS HUMAN by Roger A McGregor

Techniques to enable your computer to detect and correct typographical errors in assembly-language programs.

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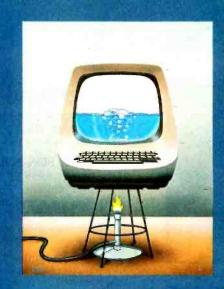
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#### ON THE COVER

This month's cover theme is "Computers in the Laboratory." Personal computers can be employed as a tool of analysis and control in scientific applications. We celebrate this theme with a fantasy suggestive of one area of scientific application: an advanced colorgraphics-oriented personal computer is shown over a Bunsen burner on a beaker stand. On the terminal is a high-resolution image of some liquid boiling. This computer, without floppy-disk drives, certainly suggests a future direction: built-in, permanent mass storage with sufficient capacity to eliminate any need for removable media. We might even conjecture that a pattern is shown here being "boiled" into a bubble memory.

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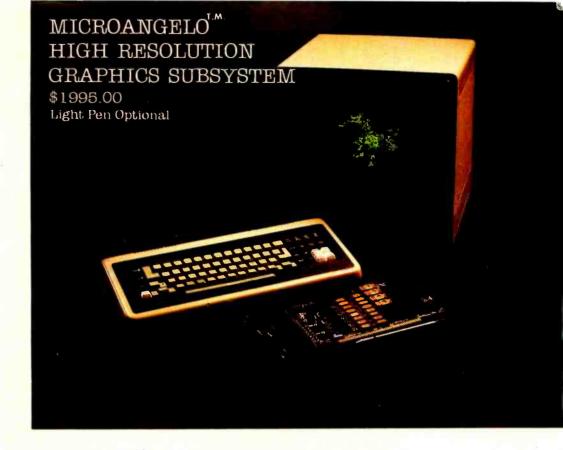
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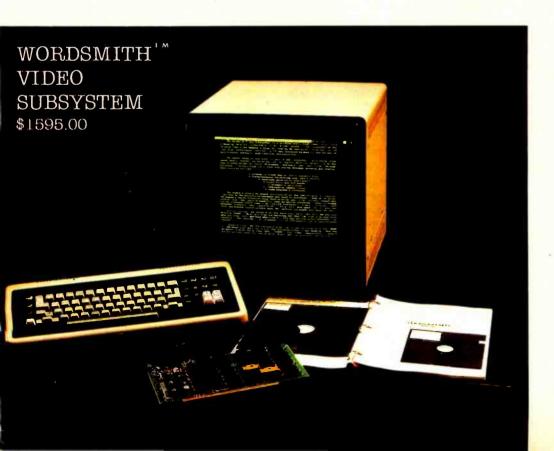
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### Editorial

## Hunting the Computerized Eclipse

#### by Carl Helmers

As noted last month, the subject of this editorial is completing some technical details of a project that has consumed all my spare time during the closing months of 1979. This project is the practical execution of what was really a pipe dream last March when the July 1979 editorial ("Computers and Eclipses") was written. The July editorial was inspired by my travels the previous February to see my first total solar eclipse from a roadside near Roundup, Montana. During that event, which took place in cold wintry weather, all my pictures were taken manually using the telephoto lens on my Nikon F2A camera. I knew there had to be a better way of controlling my camera during an eclipse event, and set about concocting a suitable first approximation of a computer-control method.

As a result of writing about the problem, I received a letter from and eventually met one of our readers, Norm Whyte, of Monte Rio, California. In the course of the ensuing correspondence and telephone calls, we developed a degree of friendship based on mutual interests in matters scientific and technological. The result was that since there were a couple of berths left in the travel plans for Norm's eclipse trip to Kenya during February 1980, I was able to become more serious about making a real version of the fantasy sketch outlined in last July's editorial.

With the decision to go made, the next decision was how to implement the system. The number one step, of course, was to order a motor drive and a magazine back for the Nikon camera. I quickly came to the conclusion that if I were going to travel all the way to Kenya to watch 4 minutes of celestial follies, more than thirty-six exposures would be appropriate. The Peterborough Camera Shop did their job, so by September I had the motor drive, and I had the magazine-back and bulk-loading accessories by mid-October. The camera system and methods of developing a 250-frame roll in a small batch tank were debugged at the camera store in November, through the efforts of its owner Wayne Esty and lab technician Skip DeLiquori.

At about this time, I began testing my refined concept of electrical control for the motor-drive/shutter mechanism. It took about 15 minutes to verify what I wanted to know: applying an ohmmeter and a miniature Phillips screwdriver to the detachable control head of the motor drive, I was able to determine the proper wiring of the four-wire MC-1 remote-control cable I had purchased. In the normal use of a Nikon motor drive, this cable serves as the electrical equivalent of a mechanical cable release.

In my application, I simply cut off and set aside the extension socket for the control head. In its place I wired an electronic simulation of the control head. This electronic simulation is the circuit of figure 1 (see page 10), which acts like the push-button switch of the motor drive head. One silicon diode is required in the logic which distinguishes between single shot and continuous firing of the motor drive.

The relatively machine-independent, Pascal language interface to the machine-dependent absolute addresses of the annunciator output ANO is provided through a variant record technique. This technique works in UCSD Pascal implementations such as Apple Pascal, but may not work in all implementations since it definitely "bends" the formal definition of the language.



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Photo 1: The Camera. The camera equipment has slightly expanded since originally conceived. The method of interfacing has also been greatly simplified. The camera now has a 250-exposure magazine back, which will be loaded with ASA 64 Kodak Ektachrome slide film. It turns out that the Nikon MD-2 motor drive allows direct computer control of camera operation, through a single bit interface (see figure 1). When the shutter speed control is in the "bulb" position, this single bit out of the computer controls exposure time and motor drive action.

A transition from 0 to 1 opens the camera shutter after flipping the reflex mirror out of the way; a transition from 1 to 0 closes the shutter and causes the motor drive to advance the film to the next frame. The optically isolated two-transistor interface is wired to the four conductors in the Nikon MC-1 remote shutter extension cable. Readers should refer back to the July 1979 BYTE editorial for a much more elaborate and probably unworkable mechanical kludge suggestion.

All one needs to do is reference the appropriate address. One address, if referenced, sets the ANO output line; the second address, if referenced, resets the ANO line. I could have used the Apple-dependent, machine-language routine called TTLOUT, but decided instead to use the variant record escape of setting a pointer to an integer address value. The test program of listing 4 was used to verify the operation of the circuit in figure 1.

At the stage of this editoral's writing during December 1979, I had created a Pascal program shown in listing 1 (with execution shown in listings 2 and 3 photographed from my terminal). This program represents the most difficult part of the model, allocating the detail exposure times for all the shots of the eclipse.

The advantages of using this high-level language become obvious whenever such an elaborate program is even contemplated. I started out with a first version of the program that defined the application-specific data types of "seconds," "milliseconds," "absolute-time," "exposures," and "an-exposure-detail." The records "absolute-time" and "an-exposure-detail" give examples of how Pascal may be used to create conceptually oriented data types for specific purposes.

In this real-time simulation, I chose to use the millisecond as the basic unit of time, with actual time values on the order of seconds expressed as a two-part record with an integer value 0 thru 999 of milliseconds and an integer value of 0 thru 32,767 of seconds. I chose to express time in this manner as a part of my original intention to use a small, single-board computer programmed in

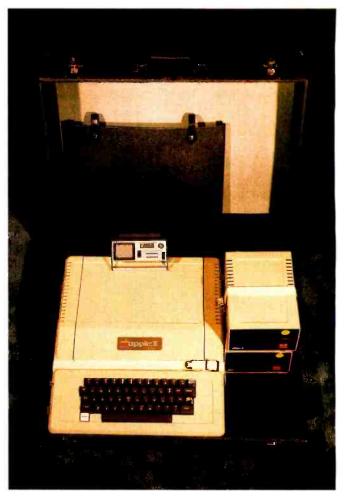


Photo 2: Field computer equipment. My original plan was to take a small, single board computer for use in the field. However, as the winter solstice of 1979 was fast approaching, it became obvious that it would be far easier to simply take along the Apple II Pascal machine which has the complete simulation of the event written in a high-level form. Thus, I went hunting at a local computer store, where I came upon a truly elegant Apple II traveling case. (Contact Bob McGuffie, Computerland of Nashua, New Hampshire, if you want one. I paid \$108 for this product.) The case will accept two floppy-disk drives, the Apple, and the Sanyo miniature television which will be used as my field display. (At the eclipse field site, we will have 110 V AC power provided by a small gasoline generator.)

assembly language. Such an expression of the data would have made it easy to translate the high-level language simulation into a hand-crafted small program.

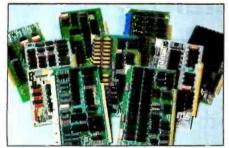
(After time started growing short and I had not yet received the small computer I had intended to use, I started asking skeptical questions like: "Why should I flagellate myself with a macroassembly language expression of a perfectly good program written in Pascal?" After all, this "big machine" with its new suitcase is certainly portable and has the single-bit output needed.)

The variables needed by the program are declared with long, explanatory names immediately following the TYPE declarations. Thus, whenever I need a variable which is intended to be an "absolute-time" value, I declare it using the application-specific type of that name.

Text continued on page 12

# At Intersystems, "dump" is an instruction. Not a way of life.

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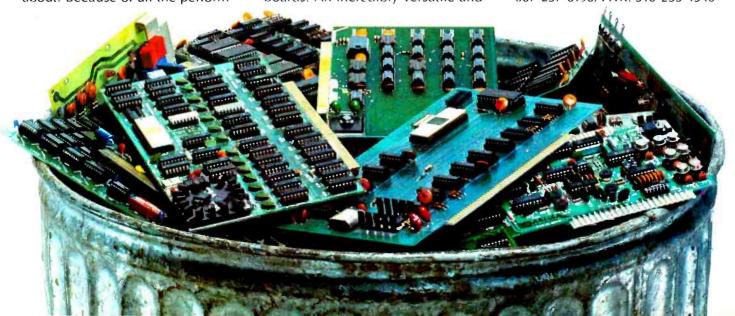


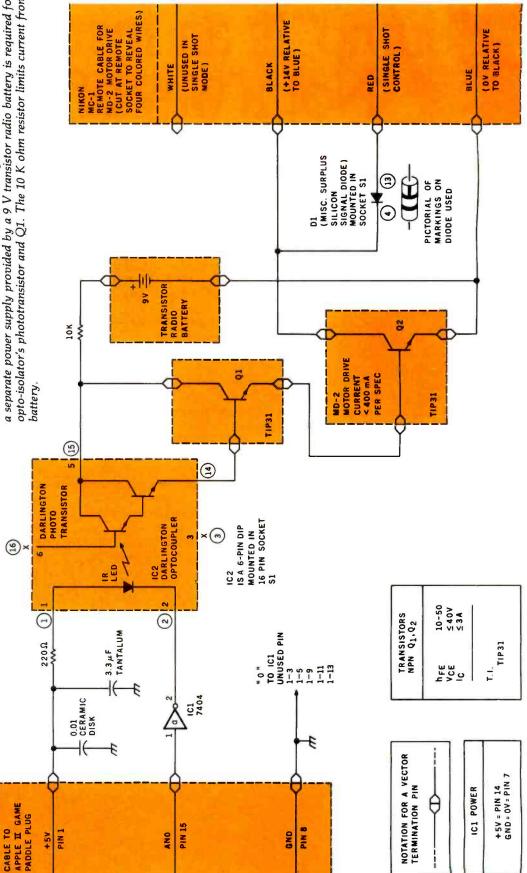
Figure 1: The schematic of the Apple II/Nikon interface. The two transistors (Q1 and Q2) and diode D1 simulate a switch and a diode found inside the original Nikon MD-2 motor drive shutter-control head. The colors noted at the right in this figure correspond to the colors found in the four-wire cable of the Nikon MC-1 remote shutter extension cable. An opto-isolator with Darlington phototransistor was required in order to isolate the Apple II from the noisy transients of the motor drive.

The Apple 11 from the 1059 translens of the motor with after much frustration (and Before this final optically isolated version was devised after much frustration (and productive suggestions from Steve Ciarcia and Chris Bancroft), three different versions were tried in which switching transients propagated back to the Apple II via a common ground. The first unsuccessful version simply had a 7404 gate driving a reed relay. Then a 75450 peripheral driver was tried because the surplus relay proved to require a higher voltage (12 V) than the 5 V available from TTL. The peripheral driver made the relay

flip state. But at random times when operating the motor drive, the ANO output bit would refuse to stay in the state defined by my program. So, I then tried eliminating the relay entirely and using both output transistors of the 75450 in parallel.

The random state changes remained. The lack of a 100 MHz storage scope prevented me from seeing what had to be there: short (order of magnitude: nanoseconds) high voltage, inductive transients occurring during the time when the LS Schottky TTL latch in the Apple was having its state redefined by the program. After a trip to a Radio Shack store to buy two transistors and two packages of random assorted opto-isolators, the present circuit resulted.

The opto-isolator darlington phototransistor and transistor Q1 provide drive to an output transistor Q2. If all of the transistor collectors are wired to a common supply provided by the "black" lead of the MC-1 cable, then the circuit will latch into the "shutter open" state with transistor Q2 conducting between emitter and collector. Thus a separate power supply provided by a 9 V transistor radio battery is required for the opto-isolator's phototransistor and Q1. The 10 K ohm resistor limits current from the



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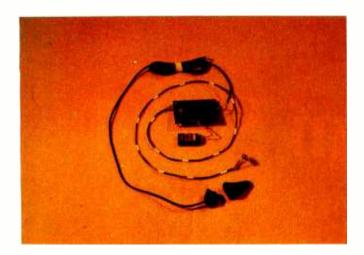


Photo 3: The Apple II/Nikon interface. The interface of figure 1 was wired on a framework of "P" pattern Vector perforated board. Vector terminal pins were used to provide anchorage for the Apple II cable (left edge), the cable from the Nikon MC-1 shutter extension (right edge), the connector for a 9 V transistor radio battery (bottom edge), and mountings for the two NPN transistors. Wiring was done using number 20 guage copper wire for most connections; wire-wrap connections were used for one or two signal buses.

Text continued from page 8:

The model I am using for exposure control is a tabledriven one, with two tables of the data type "anexposure-detail." The table "ten-shot-grouping" is initialized (in procedure "initialize," naturally) with a set of ten exposures bracketing a range from 2 milliseconds to about 4 seconds. The second table "transient-shots" is used to specify the exposures that will be taken during the transient diamond ring events at the beginning and the end of the eclipse.

The exposure control details are provided by two numbers in my model: the number of milliseconds devoted to the open camera shutter state, and the number of milliseconds of waiting time which will be used to separate the shot from the next shot. This waiting time is initialized to an "overhead-duration" figure set by a Pascal constant of that name. The present value of "overhead-duration" is set at 200 milliseconds, corresponding to the motor drive's maximum speed of 5 frames per second. This initial value of the time required for each frame is used for the first pass through the procedure "sum-up-eclipse" in order to calculate the minimum time needed for all the exposures in the total phase.

The procedure "normalize-timing" is the main portion of the simulation program as it stands in listing 1. After some initialization dialog in listing 2, the procedure "alloc-exposures" is used to assign an equal number of exposures to each diamond ring sequence (second contact and third contact) given the number of exposures during totality and the total number of exposures available in the bulk film cassette.

Then the procedure "preliminary-allocation" is used to total up the time requirements of the diamond ring exposures, totality exposures, and an arbitrary amount of slack time entered to allow a hand-coordinated cuing of the third contact diamond ring sequence. The margin

Text continued on page 102

Listing 1: A Pascal eclipse interval-allocation program. This listing contains the first cut at a Pascal camera-control program for the 1980 solar eclipse. The program's name is "eclipsemonitor-simulation" in order to emphasize that the entire process is a conceptual simulation of an actual detailed sequence of events. At this stage in the design, most of the model details have been selected in order to produce a detailed time line specified by tables. The input parameters to the program are the number of exposures, the number of exposures during totality, the time expected for totality at the site of observation, and the time to be reserved at the end of totality for manual cuing of the second diamond ring/Baily's beads (so-called third contact) exposure sequence. Listings 2 and 3 were made photographically from the terminal during a run of the program. The program as shown here has the time allocation portion completed, with the details of the actual time line simulation represented by dummy procedures, which were written in late December 1979.

```
NOTES ABOUT THE
                                                                     DESIGN PROCESS
        Step 1: High Level Description - begun November 22, 1979
This is a first cut at a program to simulate the eclipse photography process, and define some of the necessary global data of the problem.

COMPLETED 11/24/79
         Step 2: Fill in allocation details -
              Achieve a complete allocation of the eclipse camera con-
trol function as evidenced by calculation of a detailed time
line for the eclipse event siven various conditions:
                             Given:
                                         = number of totality exposures
                                          = number of diamond rins exposures
= totality time
                             rorems: d2 d3 derived from table of diamond ring frames A derived from table of totality frames z = (d2 + d3)/2 p = d2 / 2 a = t - r - -
                                   x = (a - A) / n
                        PROCEDURES Detailed Here Are...
                            normalize
                                           COMPLETED 12/16/79
         Step 3: Fill in the simulated details...
              P3: Fill in the simulated details...
Create a prosham which uses the results of step 3 to
so through a detailed time line of the experiment on paper
(or terminal screen). Each event (shutter transition
open-->close or close-->open will be marked by a report of
its nature and time of execution relative to <start> signal
                       PROCEDURES Detailed Here Are...
                             await_cue
diamond_ring_burst
totality
        Step 4: Adapt to real time control -
Put in audmentations of the software to actually demon
strate operation with the Nikon F2A camera via a relaw
pludded into the Apple II Game Paddle Socket
THIS IS THE FINAL FORM OF THE PROGRAM TO BE USED IN THE
              FIELD CONTROLLING THE EXPERIMENT...

Necessary step: determining a method of measuring time intervals from the CPU clock which is consistent with UCSD
               Pascal. Possibly use assembly language subroutine.
PROGRAM eclipse_monitor_simulation;
             overhead_duration = 200 (milliseconds)
              units : seconds;
thousandths : milliseconds
                    END:
                                  = INTEGER:
                        duration
                         duration : milliseconds; wait_after : milliseconds
              string_pointer = tSTRING;
        VAR
                                               : STR ING[ 128 ];
              crash_ahead
```

Listing 1 continued on page 96

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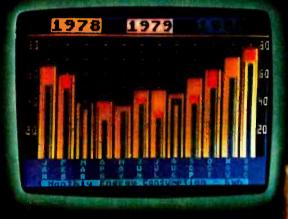
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### Letters

#### Needed: Software and/or Computers in Rhodesia

In the Faculty of Engineering at the University of Rhodesia, we have a critical shortage of computing facilities, and we do not have the foreign currency or the monies to purchase even simple systems like the Apple II or Cromemco. We are therefore obliged to build our own microcomputer systems. Unfortunately, we do not have the necessary expertise at the University or in the country to write the necessary BASIC interpreters, assemblers, and editors to make our systems useful or suitable for teaching purposes. I would appreciate it if one of your readers could put me on to someone who could possible supply the BASIC interpreter and/or compiler; assembler, with loader if required; and a text editor for the Intel 8080 or 8085 microprocessors.

I have been through BYTE magazine, but no one seems to offer the above software in the form which we could adapt for our own homebrew computers, and, therefore, we would appreciate it if one of your readers could advise us of anyone who may be able to sell or donate such software to enable us to offer a more effective computer teaching facility.

W B Green Projects Engineer POB M P 167 Mount Pleasant Salisbury RHODESIA

#### The Bare Necessities

I enjoyed the article "Budget Building on a Bare Board" by Dan S Parker (October 1979 BYTE, page 206). As he points out, there are large savings in building up only the parts of a circuit board that are needed. For instance, I have built only one serial input/output (I/O) port (for my Teletype) from the two serial and four parallel ports available on the SSM IO-4 circuit board. I have also applied this technique to a Z80 processor board, an 8 K-byte memory board, an erasable programmable-read-only memory board, and a cassette interface board.

Mr Parker's article did not go on to

describe what you can do using these partially built-up boards. I am using the Integrand Research mainframe box, the SSM Monitor VI.0 (in the erasable programmable-read-only memory), and Palo Alto Tiny BASIC (Extended), which I typed into my system from the May 1976 and February 1977 issues of Dr Dobb's Journal of Computer Calisthenics and Orthodontia. This BASIC interpreter fits in only 2 K bytes of memory and is amazingly powerful.

I am writing a program to store a mailing list of 1000 names and addresses in main memory. The program should be able to add, delete, alphabetize, sort by ZIP code, and compress the list to free space from deleted entries. Just how far can one go without a floppy disk drive?

Readers of BYTE can obtain copies of the software I have written from me for either a small copying charge or in exchange for other software. I use the Intel hexadecimal checksum format on either paper tape or Kansas City cassette tape.

I have found that the Jade Serial/ Parallel/Cassette I/O board is not software-compatible with the SSM monitor, but it can be made so through a process that involves cutting conductor etches on the board. You must reverse the port address bits 0 and 7, invert the transmitter-buffer-empty signal, invert the read-data-available signal and move to bit 7, and cut the control bits for the universal asynchronous receiver/ transmitter (UART) from the data bus. Following this, you rewire these in the desired format.

Ralph Johnston 35 Groveland St Newton MA 02166

#### Biological Rhythms and Biased Data

Regarding the editorial "... Pseudoscience Done ..." (November 1979 BYTE, page 6): I totally agree with Carl Helmers' comments on the "science of biorhythms." At many times I have also been curious about the apparent cyclical nature of my physical and mental processes — such as, a few occasional nights of especially weird dreams; or several days of running slower and more painfully than usual (I run for exercise); days of great mental energy filled with

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great plans, etc. . . . But each time I think about "taking data" on these phenomena, I realize the strong possibility that such data would be biased by my expecting that cycles do exist. We know how powerful our subconcious minds are. I feel my subconcious mind is easily capable of keeping track of days and thus creating (or at least influencing) the very cyclical data I am searching for.

If this is the case, perhaps the data gathering would only be valid for someone who had never heard of biorhythms. Or, maybe the human-behavior guys can figure a way around the bias.

Anyway, thanks for a good magazine.

Sid G Knox 4621 South G St Oxnard CA 93030

Correspondence Regarding "Curve Fitting with Your Microcomputer"

"Curve Fitting with Your Microcomputer" (October 1979 BYTE, page 150) has resulted in interesting mail correspondence, some of which has enough general value to merit discussion in BYTE.

Several readers have requested information on reference books which relate to least-squares curve fitting in more than one dimension. I have yet to find a book which has a good, balanced discussion on this subject. Perhaps a reader has. One useful book is Applied Regression Analysis, by Norman Draper and Harry Smith (John Wiley and Sons, 1966). Another more detailed and complicated discussion appears in Computational Geometry for Design and Manufacture, by I D Faux and M J Pratt (John Wiley and Sons, 1979).

Dr Titus (of Tychon) has informed me of a convolution technique for least-squares smoothing of equally spaced data. The mechanics of the method are very similar to those involved in non-recursive digital filters, and reminiscent of Akima's approximation to the cubic spline fit. The reference Dr Titus supplied was "Smoothing and Differentiation of Data by Simplified Least-Squares Procedures," by A Savitsky and M J E Golay (Analytical Chemistry, volume 36, number 8, July 1964).

As a final note, it has been noted that program line 800 in listing 1 has an error in it. The correct statement is S = S/(I-3), instead of S = S/(I-1). This does not affect the curve fit or relative comparisons, but influences the printed value of the standard deviation by several percent.

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On top of that, Pascal is easy to understand, elegant and able to handle advanced applications. It allows one programmer to pick up where another left off with minimal chance of foul up.

the time required for equivalent BASIC

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### Ciarcia's Circuit Cellar

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### Ease into 16-Bit Computing: Get 16-Bit Performance from an 8-Bit Computer

Steve Ciarcia POB 582 Glastonbury CT 06033

Stopping for coffee at the local doughnut shop has become a morning ritual. I am quite capable of making coffee at home, but I am not what you would call a "morning person." Even though I have culinary talents that include the preparation of eggs Benedict and strawberry crepes, it had better be evening when you request them around our house.

This morning started out like any other. I pulled my car into the doughnut shop's parking lot only after carefully examining all the potential hazards. I carefully avoided the broken glass, the beat-up 1962 Chevy and the large black van with a "Tax the Rich!" bumper sticker.

After entering the shop, I sat down and spread my reading material, the latest issue of BYTE, on the counter. As my coffee and bran muffin were delivered, I could not help but overhear the conversation of two other people at the counter.

"Dave, have you been reading any of the magazines lately? It looks like everyone is going 16-bit crazy."

"I've read a lot of descriptive articles, but I suppose it'll take a while before we see any real hardware."

"Actually, I'm a little hesitant to just jump on the bandwagon. My 8085 works just fine."

"I know what you mean, Ed. The Z80 system I built from scratch is still cranking along. I'd like to do something with the 16-bit chips, but I sure don't want to throw out my 8-bit system."

"What about building a small system to experiment with? Didn't I see an article a few months ago on a single-board 8086?"

"Yeah, I remember. It was in BYTE. Wasn't it written by that guy who lives around here someplace, in his cellar or something?"

Upon hearing that last statement, I nearly choked on my muffin. I thought it would be prudent to remain anonymous until I learned whether or not they enjoyed the article. I carefully closed the magazine and placed it face down on the counter.

One way to ease yourself into the world of 16-bit computers is with the Intel 8088. This microprocessor is an 8086 on the inside with an 8-bit data bus on the outside.

"Maybe, but anyway, the article wasn't too bad," said Ed. I'm sure they didn't hear the sign of relief from across the counter. Then he continued, "But it just seemed like a

larger computer than I have time to build. It's obviously oriented toward guys who don't have any other development system. I'd prefer a minimal hardware configuration to start with. If I want large programs, I'll run a macroassembler on my 8085 system, write the object code into an EPROM, and then plug it into the test board."

"Eliminating all the keys and displays will help, but how small a computer can we end up with and still be 16-bit? You'll need 16-bit address and data buses, and what's 1 K words of memory—four chips? All the EPROMs I know are 8-bit output. That means at least two of them."

"Wait a minute," said Ed. "I didn't say I had all the answers. The minimal configuration may be twenty chips, but isn't this closer to something we could afford to experiment with?"

This was the perfect opportunity to express my point of view concerning the things that I write and consult about. "Excuse me," I said. "I couldn't help but overhear your conversation. Had you considered using an 80887"

The two young men looked up at me, paused, and harmonized, "An 80 what?"

"I know a little about microprocessors. Have you considered using an Intel 8088?" "Is it 16-bit?" asked Dave.

"Well, yes and no," I replied. "It uses an 8-bit data bus, but, internally it's an 8086. Essentially it's an 8-bit chip that's completely 8086-software-compatible."

Should they listen to this doughnut and coffee philosopher? "That sounds tremendous, but won't it still require quite a few chips to make an operational computer?"

I sensed that this was a good time for my exit. Staying any longer would involve my designing a computer for them on the back of a napkin. Ordinarily I probably would have stayed, but I had just completed a similar task in my latest article, so I decided to let them wait a few more weeks. I rose to leave, carefully rolling up the copy of BYTE, cover page inside, and stopped behind them on my way out. 'My recollection is that while four chips is a possibility, a five-chip computer is quite a reality. I've even seen how a BASIC interpreter could be written to run on it. In case you're interested, the next issue of BYTE has an article all about it."

I excused myself to attend an

important meeting. As I opened the door I heard, "Thanks, I'll look forward to reading it." They watched me intently as I drove out. I could only speculate on their final conversation.

#### The 16-Bit Generation

The exciting items in microcomputing these days are the 16-bit microprocessors made by companies such as Intel (the 8086), Zilog (the Z8000) and Motorola (the M68000). All of these devices, although they differ in internal architectures, commonly claim to have compressed the power of a minicomputer within a single chip of silicon. Most notably are the 16-bit data bus and increased addressing space. A 20-bit address can directly address a megabyte of memory.

There seems to be little doubt in the minds of microcomputer-system designers that the 16-bit processors are the wave of the future. Already some major manufacturers are designing the new processors into intelligent terminals, word-processing systems, and other equipment. The day when this revolution within a

revolution will affect the personal and small-business computer market-place is not too far away.

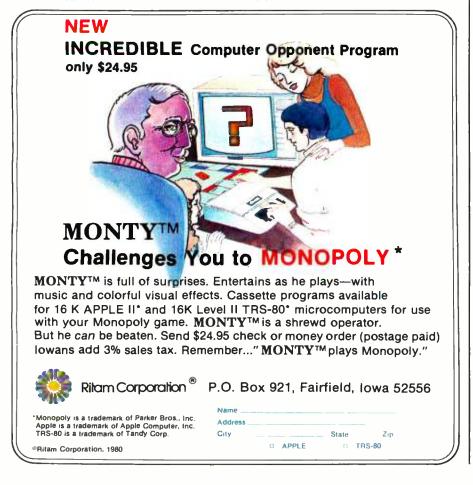
But if it is obvious that the 16-bit machines will be the trend of future product technology, it is equally obvious that it is relatively difficult for the designer to make a leap from the 8-bit world of the 8080, Z80, 6800 and 6502 to the emerging 16-bit world. The 16-bit instruction sets are more complex. The 8086, for instance, has a repertoire of some 133 instructions, as compared to seventyeight for the 8080. Simply because of the larger range of memory that can be addressed and because of address segmentation, addressing of memory is more advanced. Also, the register set is more complicated, and the types of operands with which the processor can work are more extensive.

As complex as the 8086 or any other 16-bit microprocessor is from a software viewpoint, it is in the design of hardware circuits to work with the 16-bit processors where the real complexities arise. Peripheral interfaces and existing hardware systems are generally based on an 8-bit data bus. When your whole design is built to make efficient use of an 8-bit data bus, converting to a 16-bit architecture is not a simple matter of replacing the processor. This incompatibility dictates substantial design changes to take advantage of the new 16-bit microprocessor.

#### A Gradual Approach to 16-Bit Computing

There is an alternative to converting abruptly to 16-bit architecture. Look at photo 1 and observe the Intel 8088 microprocessor. This device uses an 8-bit data bus, so all of your present hardware system components will work with it from the standpoint of getting information between the processor and the peripheral-support devices or memory, but the 8088 features a common internal architecture and complete software compatibility with the 16-bit 8086 processor.

As a result, the 8088 provides an excellent way for designers, engineers, hobbyists, and students to ease into the world of 16-bit computing. Its 8-bit-compatible bus structure makes it the logical choice for upgrading 6800, 6502, Z80 and 8080 designs to 16-bit capability without



## I've finally found a personal It's not surprising that professionals computer I respect. get excited about the Compucolor II. It's a totally-integrated 8080A system Compucolor II. with full color graphics display, built-in 51K mini-disk drive, and the best cost performance

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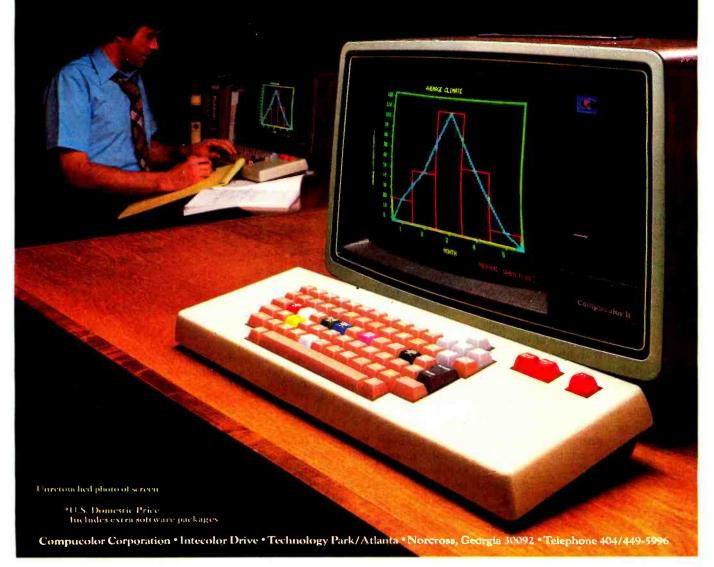
compatibility and random access file capabilities.

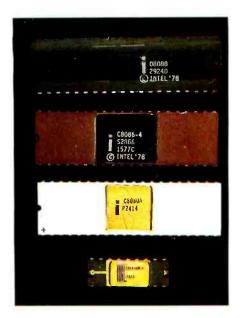
Our 8 foreground and background colors will boost your comprehension, while introducing you to an exciting new dimension in BASIC programming. The vector graphics have 16,484 individually-accessible plot blocks. And the 13" diagonal measure screen gives you 32 lines of 64 ASCII characters. You also have the flexibility that comes with 16K Extended Disk BASIC ROM.

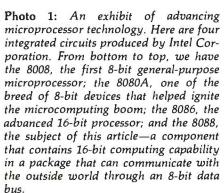
Compucolor II offers a number of other options and accessories, like a second disk drive and expanded keyboard, as well as expandability to 32K of user RAM. Of course we also have a whole library of low-cost Sof-Disk™ programs, including an assembler and text editor.

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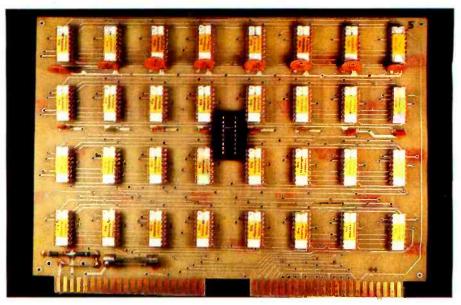
alteration of existing 8-bit hardware.

The 8088 can be used in projects such as a low-cost system that employs multiplexed peripherals such as the 8155, 8755A and 8185. Or, fully expanded, it forms a system that allows a full megabyte of address space and compatibility with the 8086 family of coprocessors and multiprocessors.

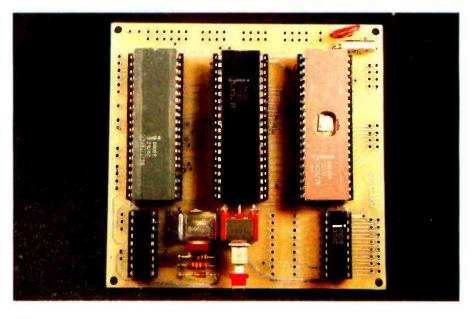
This two-part article is designed to give you a glimpse of the 8088. This month in Part 1, I shall attempt to familiarize you with the instruction set of the 8088 and the hardware of a microcomputer that is made from an 8088 and only four other integrated circuits. The power of this five-chip circuit will be emphasized by illustrating, among other examples, how it can be configured to support a multi-user Tiny BASIC.

#### Architecture of the 8088

Anyone comparing the internal architectures of the 8088 and the 8086 processors will realize that they are



**Photo 2:** An exhibit of advancing memory technology. The single black integrated circuit at the center can replace the entire board of components. The center component is the Intel 8185 1 K-byte static programmable memory. The board is a 1 K-byte memory board from a Scelbi 8B microcomputer system, which used the 8008 microprocessor (circa 1975).



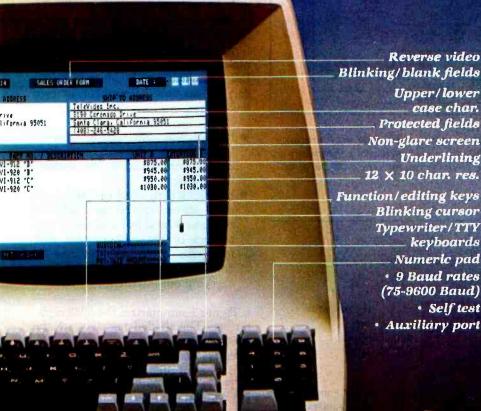
**Photo 3:** Using the 8088 and other components of kindred technology, it is possible to build a functional microcomputer system with only five integrated circuits. Part 2 of this article (in the April 1980 BYTE) will present more detailed information about this system.

identical. Even though I have previously discussed the 8086, a brief explanation of this architecture is necessary since the capabilities of our five-chip computer depend directly upon it. However, if you wish to read a more detailed description, you should refer to a previous Circuit

Cellar article, "The Intel 8086" (November 1979 BYTE, page 14).

A diagram of the internal structure of the 8088 is shown in figure 1. The 8088 contains two logical "units", the bus-interface unit (BIU) and the execution unit (EU), and a 4-byte instruction queue.

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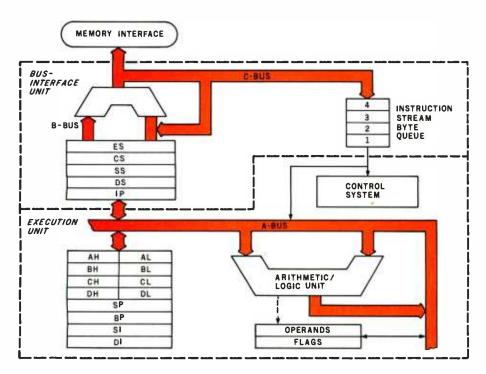
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**Figure 1:** Diagram showing internal operational principles of the 8088 microprocessor. The 8088 (and the 8086) use a pipelined architecture that increases performance by overlapping instruction execution with memory-fetch operations. The 8088 can directly execute any 8086 software.

#### 8088 REGISTER MODEL: (8080 REGISTERS SHADED)

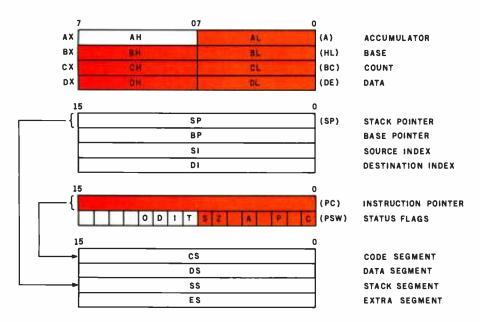


Figure 2: The 8088 contains fourteen 16-bit registers. The shaded registers are those common to the 8088 and the 8080.

The execution unit is where the actual processing of data takes place inside the 8088. It is here that the familiar arithmetic logic unit (ALU) is located, along with the registers used to manipulate data, store intermediate results, and keep track of the stack. The execution unit accepts instructions that have been fetched by the bus-interface unit, processes the instructions, and returns operand addresses to the bus-interface unit. The EU also receives memory operands through the bus-interface unit, processes the operands, and then passes them back to the bus-interface unit for storage in memory.

The role of the bus-interface unit is to maximize bus-bandwidth utilization, (that is, to speed things up by making sure that the bus is used to its full capacity). The bus-interface unit carries out this assignment in two basic ways:

- by fetching instructions before they are needed by the execution unit, storing them in the instruction queue
- by taking care of all operand fetch and store operations, address relocation, and bus control (These actions of the bus-interface unit leave the execution unit free to concentrate on processing data and carrying out instructions.)

Figure 2 summarizes the 8088 register set. The shaded registers are the 8080 register subset, that is, the registers that are common to the 8088 and its 8-bit predecessors.

The general registers, also called the HL group because they can be subdivided into High and Low bytes, include the accumulator (AX), base (BX), count (CX) and data (DX) registers. The AX register may be addressed as a 16-bit register, AX, or the high-order byte can be addressed as the register AH and the low-order byte as AL. The same holds true of the other three general registers (BX, CX, and DX).

Another group of registers is the pointer and index (or P and I) group. This set contains the stack pointer (SP), base pointer (BP), source index (SI), and destination index (DI)



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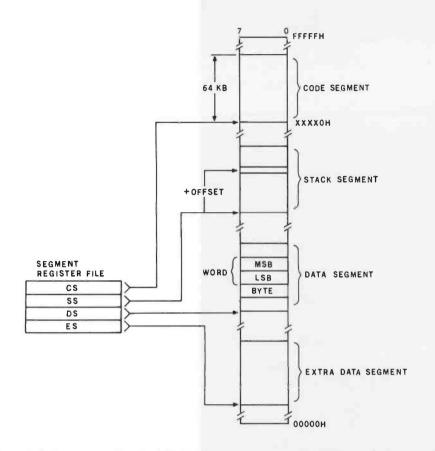
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**Figure 3:** Memory organization. The 8088 uses a memory-segmentation technique to address up to 1,048,576 bytes (1 M byte) of memory. The user can use attributes of the memory-addressing system to dynamically relocate a program anywhere within the entire address space.

registers. Generally speaking, these registers hold offset addresses used for addressing within a segment of memory. They can also participate, along with the general register group, in arithmetic and logical operations of the 8088.

The 8088 uses memory segmentation to address this large memory space efficiently. At any one time, the 8088 can deal with memory as a set of four 64 K-byte segments. The total memory is organized as a linear array of 1,048,576 bytes, addressed as hexadecimal 00000 to hexadecimal FFFFF. The 8088 creates a 20-bit address by combining a 16-bit offset and a segment boundary value stored in one of the segment registers. Figure 3 demonstrates how this works.

Each of the 16-bit-segment registers, the code segment (CS) register, the stack segment (SS) register, the data segment (DS) register, and the extra data segment (ES) register, contains a value that is added to a 16-bit

offset address, forming a 20-bit address. The memory is thus divided into a maximum of four 64 K-byte segments that are active at any single time. The code segment of memory is where instructions are stored, the stack segment of memory is where the pushdown stack is located, the data segment is where data to be operated on is found in memory, and the extra segment is an additional 64 K-byte data area.

When fetching an instruction from memory, the location accessed is given by a 20-bit address that is the sum of two numbers. The first number is the value of the 16-bit instruction pointer. The second number is a 20-bit value that is the 16-bit code-segment register with four low-order zero bits appended. This forms the 20-bit address required to specify any location in the megabyte-sized address space.

In the case of a memory-reference operation for a transfer of data, the

absolute memory address referenced by a given memory-access instruction is calculated by adding the given 16-bit address to the base address. The base address is given by the contents of the data-segment or extrasegment register and is followed by four low-order zero bits.

In the case of a stack operation, the memory location referenced is similarly offset from the value contained in the stack-segment register.

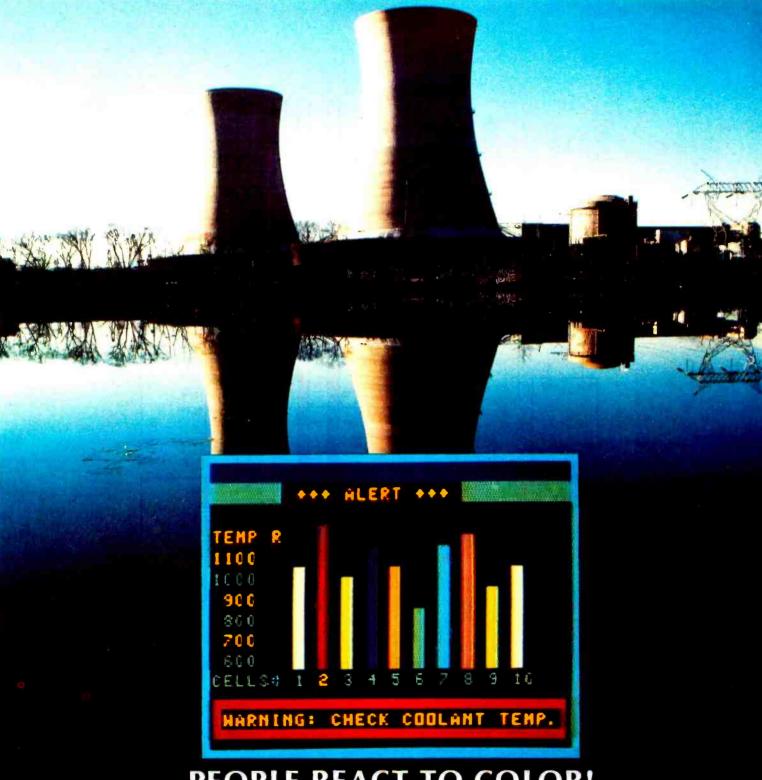
The 8088 has both relative and absolute branch instructions. When all branch instructions within a given segment of memory are specified in relation to the instruction pointer and the program segment does not modify the value of the code-segment register, the program segment can be relocated dynamically anywhere within the megabyte address space. A program is relocated in the 8088 simply by moving the code, updating the value of the code-segment register, and resuming execution.

**Small System Applications** 

The 8088 can be used in a broad range of applications, from systems requiring use of a minimum number of components to systems requiring maximum performance. The component-count-sensitive applications include point-of-sale terminals and simple controllers, which require that system cost be kept low, but need substantial processing power. A big reason for this design flexibility is the ability of the 8088 to operate in a minimum-hardware mode.

The minimum-mode, multiplexed configuration, as shown in figure 4, is an effective way of building a powerful system around the 8088, while using the smallest number of parts. The processor is connected in the minimum mode by wiring its Mn/Mx pin in the high-logic state (at V<sub>cc</sub> potential). The multiplexed bus is directly compatible with the Intel 8085A-family peripheral components (8155, 8355, 8755A, and the new 8185).

A four-chip system can be designed using the following components: an 8088 microprocessor; an 8284 clock generator; an 8155 memory, input/output (I/O), and timer device; and an 8755A EPROM and I/O device. A fifth component, the 8185, is a simple



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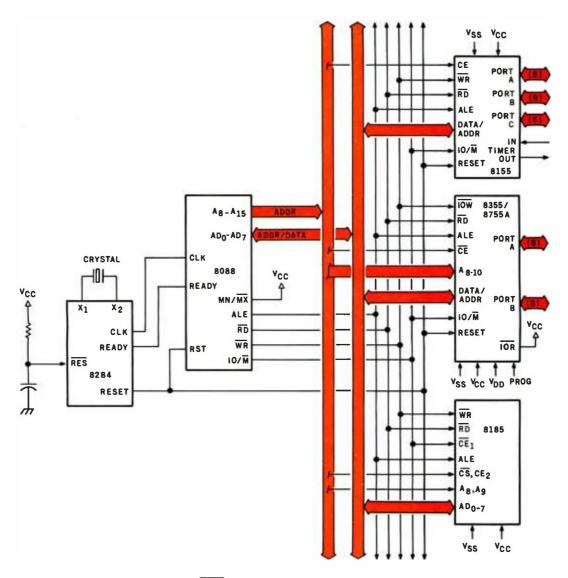


Figure 4: When used in the minimum mode  $(MN/\overline{MX})$  line held high), the 8088 interfaces directly with the multiplexed address and data components in the 8085A-support family to form a functional microcomputer system using only five integrated circuits. Detailed information concerning this circuit will be given in Part 2.

addition to the system and provides an extra 1 K bytes of user memory.

In the minimum-mode configuration, the 8088 provides all necessary bus-control signals, including RD, WR, IO/M and ALE. It further provides HOLD and HLDA (hold-acknowledge) signals to allow direct-memory-access (DMA) data transfer, INT and INTA to interface the 8259A interrupt controller, and DEN and DT/R to control transceivers on the data bus.

The power of the 8088 can be extended in large-system applications by wiring it into the maximum-mode configuration. However, a discussion

of maximum-mode features is beyond the scope of this article.

#### The 8088 Instruction Set

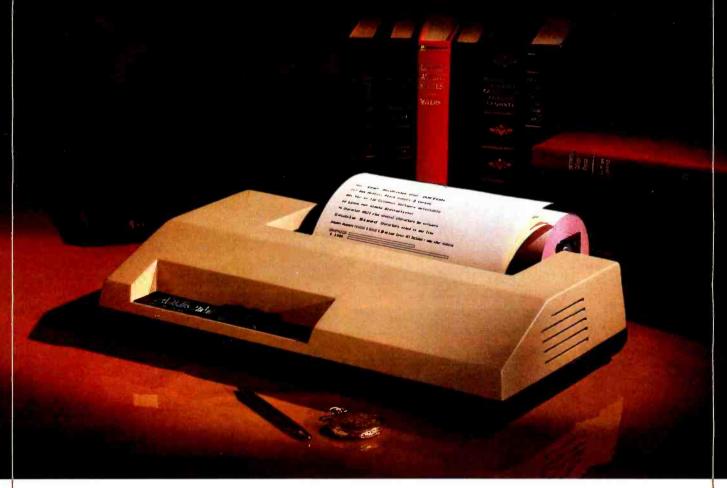
A complete discussion of the 8088's instruction set is also beyond the scope of this article. Rather than attempt it, I shall concentrate on some specific features of the 8088 instruction set that facilitate the specific application discussed next month in Part 2 of this article. These features include extended arithmetic instructions, direct use of ASCII-encoded data, multiprocessing features, string-manipulation instructions, and table-translating aids. The

8088 instruction set includes singleinstruction multiplication and division instructions, along with five different types of addition and seven types of subtraction operations.

These multiply and divide instructions greatly facilitate "number crunching." This numerical ability saves much time in such applications as data sampling, signal processing, and scientific calculation. Not only are fewer machine instructions needed to perform a given task, with corresponding savings in memory usage and execution time, but the versatility of the instructions and the

Text continued on page 30

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Listing 1: An example of the efficiency of the 8088 and 8086 instruction set. This short routine accepts input of five values from an input port, and then calculates and sends a running-average value to an output port. Compare this listing with listing 2.

	XOR MOV	BX, BX CX, 5	;CLR BX ; Set loop counter
Average	INC IN ADD MOV DIV	BL AL, Port # BH, AL AL, BH BL	;Increment data counter ;Input data ;Update running total ;Divide running total by ;data counter.
	OUT	Port #, AL.	;Output running average.
	LOOP	Äverage	;Return unless fifth pass ;is completed.
	HLT		

Listing 2: A routine that performs the same task as the routine given in listing 1. This code, however, was written for the older 8080 processor. As you can see, it is longer and more tedious to write.

	MVI MVI	H,00 E,00	;Clear H register ;Clear E register
Average	INR	E	;Increment data counter
	MOV IN ADD	C, H A, Port # H	;Input data ;Add data to running total
Divide	XRA MOV MOV MVI	A B, A L, A C, 80	;Clear accumulator ;Clear B register ;Clear L register ;Initialize bit counter
Loop	MOV RAL MOV MOV RAL MOV	A, C C, A A, B B, A	;Shift B and C as ;a 16-bit unit— ;one bit left
	CMP JC	E Next E	;Compare data ;counter (divisor) with ;dividend; if divisor is larger, ;bypass subtract.
	MOV MOV ORA MOV	B, A A, D L L, A	;Divisor is smaller; subtract. ;Set current bit of: ;L to 1
Next	MOV RRC	A, D	;Shift D right and check carry
	INC	Loop	;If no carry, return for next bit.
	MOV OUT	A, L Output #	;Outport running average
	MVI CMP JNZ	A, 05 E Average	;Return unless fifth pass is ;completed.
	HLT		

Text continued from page 26

ability of the 8088 to deal with several types of data remove the usual necessity of handling messy conversions from one type of data representation to another and back again.

Two program listings demonstrate the saving of effort. Listing 1 gives the 8088 code for the skeleton of a subroutine that accepts data from a specified input port and calculates a running average of the values entered. The same subroutine section coded for the older 8080 microprocessor is shown in listing 2.

#### Direct Use of ASCII and Decimal Data

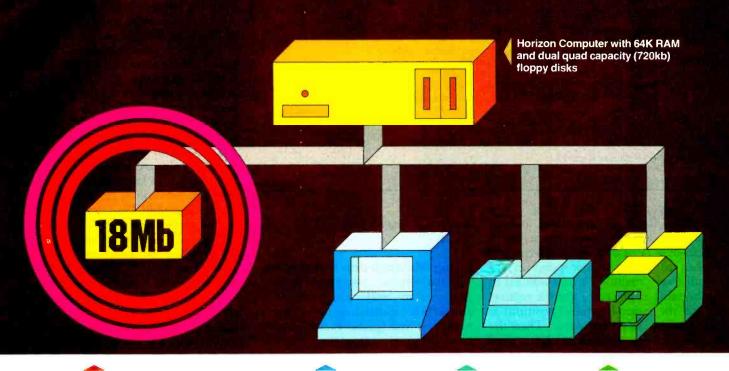
The direct use of unpacked binarycoded decimal (BCD) or ASCIIencoded data in a microcomputer has a number of obvious advantages. Since many I/O devices present data to the processor in American Standard Code for Information Interchange (ASCII) format and expect responses in the same format, microcomputer-system designers have for years faced the necessity of putting their input and output through a translation process (usually involving a table look-up operation) before processing the input or responding with output.

With the 8088's instruction set, such manipulation is no longer necessary. All four mathematical instruction types (add, subtract, multiply, and divide) provide for ASCII adjustment of the accumulator contents by a single instruction. This feature is obviously of great use in everyday microprocessor applications. Equally interesting (and useful) are the two instructions that adjust the results of addition and subtraction to packed decimal form.

Table-Translating Aid

Despite the availability of single instructions to convert accumulator contents from one type of data representation to another, it may still be necessary from time to time to translate data by means of the traditional look-up table. This might, for example, be necessary if the data is being received or transmitted in EBCDIC (Extended Binary-Coded-Decimal Interchange Code) rather than in ASCII form.

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**Listing 3:** A segment of 8088 code that translates characters from Extended Binary-Coded-Decimal Interchange Code (EBCDIC) to American Standard Code for Information Interchange (ASCII) form. The 8088 instructions for manipulating and translating strings of characters are put to good use.

NEXT:	MOV MOV MOV CLD JCXZ LODS XLAT STOS CMP LOOPNE	SI, FFFE BX, 0100 DI, ASCBUF CX, 528 EMPTY EBOBUF TABLE ASCBUF AL, EOT NEXT	; Source index register contains start of EBCDIC Buffer; B register points to translate table; Destination index points to ASCII buffer; C register contains length of buffer; Skip if input buffer empty; Get next EBCDIC character; Translate to ASCII; Transfer ASCII character to buffer; Test for EOT character; Continue if no EOT received (CX decrements first)

EMPTY: (Program continues)

The XLAT (ie: translate) instruction allows the user to define a 256-byte table of correspondence and then to reference any point in the table very easily. The base address of the table is placed in the BX register and the index (ie: table position) is stored in the accumulator. Then the single instruction code XLAT is used to refer to the proper point in the table, pick out the translation, and store the result in the accumulator.

This is useful particularly when data that has been entered from a port comes into the accumulator for disposition or transfer. If you are dealing with a stream of incoming characters in EBCDIC format, for example, the translation proceeds thusly. You begin by storing the beginning memory address of your 256-byte translation table in the BX register. If you set up the table so that the base address of the table corresponds to an incoming EBCDIC value of 00, the next address to an incoming value of 01, etc, all you must do is simply accept a byte of data and execute the XLAT instruction.

This simple procedure lets us obtain the correct translation of that byte into the proper format for handling by the 8088 or some other processor. A MOV instruction will then store the result of translation until it is needed; the translation process can then be repeated with the next incoming byte. Setting up the necessary instruction sequence requires one instruction: a MOV to the BX register of the base address of the table. The loop for handling the translation requires only three basic instructions:

the input instruction, XLAT, and MOV.

#### String-Manipulation Instructions

Since typical computer applications often deal with strings of characters consisting of letters, numbers, and special symbols, easy-to-use string-manipulation instructions are a welcome enhancement to 8-bit processors. The 8088 addresses this need by providing five powerful primitive string operators that may be preceded by a single-byte repetition prefix.

For a byte-for-byte or word-for-word comparison of two data strings (as you might use in verifying the accuracy of data loaded into memory from a mass-storage device, for example), the 8088 offers the CMPS instruction. This also allows termination of a program segment upon occurrence of a predetermined equality or inequality condition, as well as automatic incrementing or decrementing.

You can scan through a string of data for an occurrence or for an absence of occurrence of a specific string or character by using the SCAS instruction. This operation subtracts the byte or word operand in memory (or elsewhere) from the accumulator and changes the logic state of the flags; it does not, however, return a result. Again, decrementing or incrementing is automatic.

The STOS instruction allows you to fill a string of arbitrary length with a single value (eg: a string of zeros or nulls for a floppy disk initialization routine), once more with automatic

incrementing or decrementing of a predetermined count.

Putting Some Things Together

Let's take a quick look at a small but powerful example that employs both the string manipulation and the XLAT instructions to solve a very practical problem.

You are designing an input routine that must translate a buffer filled with EBCDIC characters into ASCII form. continuing the transfer until one of several possible EBCDIC characters is received. The transferred ASCII string should be terminated with an EOT (end-of-transmission, hexadecimal value 04) character. Assume that the buffer starts at hexadecimal memory location FFFE, the table to translate the EBCDIC form to ASCII begins at hexadecimal location 0100 and the CX register is to contain a value giving the length of the buffer containing EBCDIC characters. The buffer may, of course, be empty.

The small 8088 program segment shown in listing 3 accomplishes this task in a small number of instructions and handles a great deal of overhead work with little effort or concern on the part of the system designer and programmer.

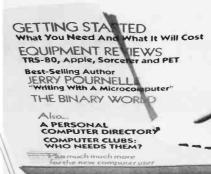
By now you should have an understanding of the power of the 8088 microprocessor. Even in a minimal-mode, five-component circuit, our little computer will have the following attributes:

- 5 MHz 8088 8-bit processor (completely 8086 software-compatible)
- 1280 bytes of static user memory
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- 38 parallel I/O lines
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Next month, in Part 2, we will deal with some key features of the 8088 which make it particularly suited to multiprocessing situations. We will investigate the operating system of a multi-user, Tiny BASIC language system on our minimal-configuration computer.

These figures are provided through the courtesy of Intel Corporation.

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## Electron Behavior in a Chemical Bond

Michael Liebl, OSB Mount Michael High School Elkhorn NB 68022

Years spent subconsciously gathering and sifting data in our daily lives gives each of us a common sense intuition for the laws of nature. But our intuitive understanding of how nature works often fails when we explore worlds beyond the realm of common experience. In the submicroscopic world of atoms and molecules, matter exhibits unexpected behavior attributable to its dual nature as particle and wave. Scientists interpret this world with the aid of quantum mechanics, a discipline that more often than not involves long and complicated mathematical operations.

The computer, by virtue of the ease and speed with which it handles such operations, has become an invaluable tool in the quantum-mechanical study of atoms and molecules. This article describes a program written in BASIC which allows anyone with an elementary understanding of quantum mechanics to investigate the behavior of an electron in the bond formed between two atoms in a diatomic molecule.

#### **Electronic Potential Well**

A chemical bond is the result of attractive, electric interaction between the atoms' electrons which are negatively charged and the nuclei which are positively charged. Opposite charges attract; like charges repel. In the vicinity of the nucleus of an atom, an electron feels an attractive force. The environment in which the electron is subject to this force is

described as a potential. A rectangular potential well, as shown in figure 1, is an approximate model of the relation between an electron and its nucleus. The depth of this rectangular well determines the extent to which the electron is confined to the region about the nucleus. If the well is deep, it is difficult for the electron to cross the boundaries of the high walls. If, on the other hand, the well is shallow, then it is relatively easy for the electron to escape the nucleus.

A molecular bond can form when two atoms exchange or share an electron. For example, table salt is composed of two elements, sodium, an alkali metal, and chlorine, a halogen. Sodium, like all alkalis, can arrive at a stable electronic configuration by giving away one of its electrons to form a positively charged sodium ion. This element has a shallow

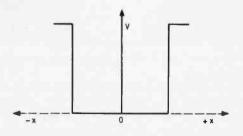


Figure 1: Rectangular potential well model that approximates the relation of an electron to the nucleus of an atom. The depth of the well indicates the extent to which the electron is confined to the region about the nucleus.

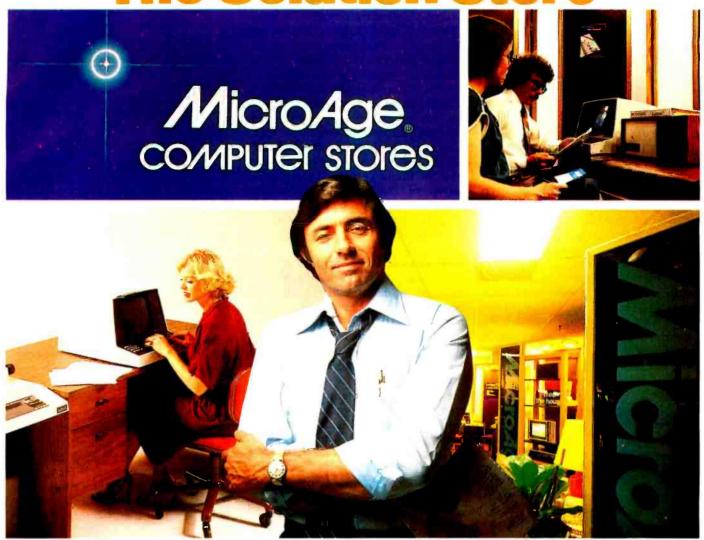
potential well. Chlorine, like all halogens, can arrive at a stable electronic configuration by accepting an extra electron to form a negatively charged chloride ion. Chlorine has a deep potential well.

A bond can form between a sodium atom and a chlorine atom, and between any alkali and any halogen, when the former donates an electron to the latter. The result is a molecule, the positively charged sodium ion bound to the negatively charged chloride ion. We will use the potential well model to study different elements and the bonds that they make.

No two elements are exactly alike either in their ability to receive or in their ability to donate an electron. Thus the behavior of the electron in a chemical bond depends upon certain properties of the two elements involved. To determine the depth of the rectangular potential well for a given element, we will refer to two characteristic properties of the elements: ionization potential and electron affinity.

lonization potential is a measure of the amount of energy required to remove an electron from a neutral atom of some element X:  $X \rightarrow X^+ + e^-$ . For alkalis this number is small, for halogens large. Electron affinity is a measure of the amount of energy released when a neutral atom acquires an extra electron:  $X + e^- \rightarrow X^-$ . For alkalis this number is 0, for halogens the number is large. (For values of ionization potentials and

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Composite Potential Model

When two atoms form a diatomic molecule, each of the atoms brings its potential well to the bond. The electron exchanged or shared by the two atoms can be pictured as being confined to a composite rectangular well that consists of the two potential wells placed side by side, as shown in figure 2. Unless the two atoms are of the same element, one side of the composite well will be deeper than the other. The difference in height between the two levels of the well is the essential feature of the bond which determines how much time the electron spends in the vicinity of one atom's nucleus as compared to the other.

Because the difference in height is the crucial factor, the lower level of the potential well can always be assigned as the origin on the potential axis of a Cartesian coordinate system. The upper level of the well is located at the point that represents the difference between the averages of the ionization energies and electron affinities of the two elements. Finally, it is also convenient to assume that the walls of the potential well at the endpoints of the bond are infinitely high. Given this assumption, it is impossible for the electron to escape the confines of the molecule. This potential model of the bond in a diatomic molecule simplifies the equations that describe the behavior of the electron in the bond.

Schrödinger Wave Equation

In 1926, Erwin Schrödinger formulated a differential equation to describe the behavior of a submicroscopic particle such as an electron. This equation incorporates both the particle and wave nature of the electron. Fundamentally, Schrödinger's equation is a restatement of the basic energy relation; the kinetic energy,  $p^2/2m$  (derived from momentum and mass), plus the potential energy, V, yields the total energy, E,

of any particle:

$$p^2/2m + V = E$$

Schrödinger's equation takes the form:

$$\frac{-\hbar^2}{2m}\frac{d^2\psi}{dx^2}+V\psi=E\psi$$

for a single-dimension model.

In the equation, h is read as "h-bar," and stands for a value equal to Planck's constant divided by  $2\pi$ . Planck's constant, h, is an empirically determined value equal to 6.6256 X 10-34 Joule-seconds. The mass of the particle is shown as m. The Greek psi  $(\psi)$  is the notation for the wave function. In Schrödinger's formulation, the energy equation has been multiplied by a wave function,  $\psi$ , to account for the wave-like behavior of submicroscopic particles, and the square of the momentum has been replaced by the differential operator,  $-h^2 d^2/dx^2$ .

When the Schrödinger equation is solved for a particular set of circumstances, called boundary conditions, it yields as a solution the form of  $\psi$ , the wave equation.  $\psi^2$  gives the relative probability, for the conditions assumed, of finding the particle it describes at some point in space. It is known as the probability distribution function.

In our model, the depth of the rectangular potential well is a measure of the magnitude of the potential energy, V, which acts on the electron and affects its location. In a split-level well the deeper side exerts a greater force on the electron. Therefore we

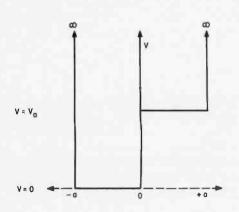
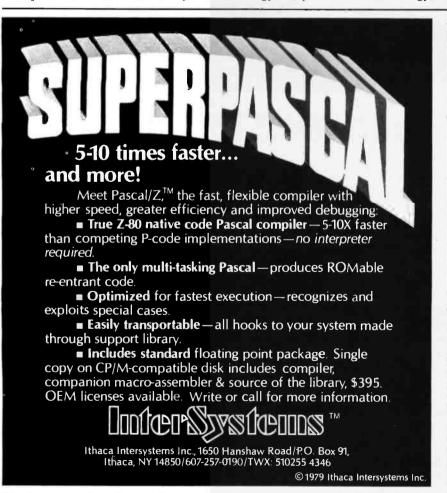


Figure 2: When a diatomic molecule is formed, the relationship between the two atoms may be considered as a combination of two potential wells.



- m mass of an electron; 9.109 × 10<sup>-31</sup> kilograms
- q charge on an electron; 1.602 × 10<sup>-19</sup>
- Planck's constant divided by 2π;
   0.658 × 10<sup>-15</sup> electron-volt-seconds momentum of the electron
- p momentum of the electron a length of chemical bond V<sub>0</sub> potential difference between elements
- total energy of the electron coefficient of the wave equation,  $\psi_L$ ,
- for the left side of the potential well coefficient of the wave equation,  $\psi_R$ ,, for the right side of the potential well when  $E > V_0$
- C,D coefficients of the wave equation,  $\psi_{R,u}$ , for the right side of the potential well when  $E < V_0$

**Table** 1: Symbols and constants that are used throughout this article.

would expect the probability distribution function,  $\psi^2$ , to be skewed toward the deeper side of the well.

Two-Part Equation Solution

For the potential well pictured in figure 2, the Schrödinger equation is solved in two parts, corresponding to the lower or left side and to the upper or right side of the well. The potential in the left side of the well is equal to zero. The potential in the right side of the well is equal to the difference between the potentials of the two elements,  $V_0$ .

The wave-equation solution,  $\psi$ , must meet four requirements:

- At the left boundary of the well, the potential wall is infinitely high. There is no possibility for the electron to pass beyond this point. Therefore at x = -a, the value of the function  $\psi_L$  must be zero.
- Similarly, the wall at the right boundary is infinitely high. There is no possibility for the electron to pass beyond this point. Consequently at x = +a,  $\psi_R$  must also be equal to zero.
- We are studying a single electron.
   Although we attack the solution in two parts that correspond to the two sides of the potential well, a

Text continued on page 44

Listing 1: BASIC program that solves the Schrödinger equation to simulate the behavior of an electron in a diatomic chemical bond. The program finds  $\alpha a$ ,  $\beta a$ , and  $\gamma a$  in terms of  $V_0$ .

The correspondence of variables in the program to terms in the equations is as follows: A1 stands for  $\alpha a$ ; B1 stands for  $\beta a$ ; G1 stands for  $\gamma a$ ; V0 stands for  $V_0$ .

20 REM WRITTEN BY MICHAEL LIEBL
30 REM CALCULATION OF N AND VO
40 REM PROGRAM LINES 10-1000
50 PRINT: PRINT: PRINT
60 DIM S\$(10),R(10),IP(10),EA(10)
70 PRINT TAB(20);"-PROFILE OF A CHEMICAL BOND-"
30 PRINT
90 PRINT" THE ELECTRON DENSITY IN THE CHEMICAL BOND OF A DIATOMIC MOLECULE"
100 PRINT"DEPENDS UPON THE POTENTIAL DIFFERENCE (VO) BETWEEN THE TWO ELEMENTS"

TO REM PROFILE OF A CHEMICAL BOND IN A DIATOMIC MOLECULE

- 110 PRINT"WHICH ARE BOUND TOGETHER AND UPON THE LENGTH OF THE BOND (A). TH 120 PRINT"AVERAGE OF THE IONIZATION ENERGY AND THE ELECTRON AFFINITY OF AN"
- 130 PRINT"ELEMENT OFFERS A MEASURE OF THE POTENTIAL OF THE ELEMENT."
- 140 PRINT
- 150 PRINT" THIS PROGRAM CALCULATES A PROFILE OF A CHEMICAL BOND BASED"
- 140 PRINT"UPON THIS INFORMATION. FROM THE LIST OF ELEMENTS BELOW, SELECT TWO"
- 170 PRINT"WHICH WILL MAKE UP THE MOLECULE. ENTER THE SYMBOLS FOR THESE"
- 180 PRINT"ELEMENTS AT THE REQUEST OF THE PROGRAM."
- 190 PRINT : PRINT
- 195 F=0
- 200 PRINT TAB(10)"HYDROGEN H"
- 210 FRINT TAB(10)"LITHIUM Li"; TAB(40)"FLOURINE F"
- 220 PRINT TAB(10)"SODIUM Na"; TAB(40)"CHLORINE C1"
- 230 PRINT TAB(10)"POTASSIUM K"; TAB(40)"BROMINE Br"
- 240 PRINT TAB(10)"RUBIDIUM Rb"; TAB(40)"IODINE I"
- 250 PRINT TAB(10)"CESIUM Cs"
- 260 PRINT
- 270 PRINT
- 280 INPUT"ENTER ELEMENT NUMBER ONE "; A\$
- 290 FOR I=1 TO 10
- 300 READ S#(1),R(1), IP(1),EA(1)
- 310 IF S\$(I) COA\$ THEN NEXT I
- 320 IF IKD11 THEN 350
- 330 GOSUB 800
- 340 GOTO 280
- 350 RESTORE
- 360 INPUT"ENTER ELEMENT NUMBER TWO "; A\$
- 370 FOR J=1 TO 10
- 380 READ S\$(J),R(J),IP(J),EA(J)
- 390 IF S\$(J)<>A\$ THEN NEXT J
- 400 IF JC>11 THEN 430

Listing 1 continued on page 38

```
Listing 1 continued:
410 GOSUB 800
420 GOTO 360
430 RESTORE
440 PRINT : PRINT : PRINT
450 M=9.109E-31
460 Q9=1.602E-19
470 H=0.658E-15
480 A=(R(I)+R(J))*1E-10
490 V1≈(IP(I)+EA(I))/2
500 V2=(IP(J)+EA(J))/2
510 V0=V2-V1
520 IF VO<0 THEN VO≕-VO
530 N=SQR(2*M*V0/Q9)*A/H
540 N2=N^2
550 PRINT"VO = ";
560 PRINT USING"##.###"; VO
570 PRINT" N = ";
580 PRINT USING"##.####";N
590 PRINT : PRINT : PRINT
400 INPUT"WHEN READY TO CONTINUE TYPE A CARRIAGE RETURN. "; A$
610 GOTO 1010
800 REM SYMBOL ENTRY ERROR
TMIRG 018
820 PRINT"THE CHEMICAL SYMBOL ENTERED DOES NOT MATCH ANY IN THE FILE.
                                                                          CHECK"
830 PRINT"THE LIST AND TRY AGAIN."
840 PRINT
850 RESTORE
860 RETURN
900 REM DATA FILE
910 DATA H, 1.54, 13.595, 0.80
920 DATA Li, 0.68, 5.39, 0
930 DATA Na, 0.97, 5.138, 0
940 DATA K. 1.33, 4.339, 0
950 DATA Rb, 1.47, 4.176, 0
960 DATA Cs, 1.67, 3.893, 0
970 DATA F, 1.33, 17.418, 3.448
980 DATA CI, 1.81, 13.01, 3.613
990 DATA Br, 1.96, 11.84, 3.363
1000 DATA I, 2,20, 10.454, 3.063
1010 REM CALCULATION OF A1 AND B1 OR G1, LINES 1010-1780
1020 PRINT
1030 PRINT"GRAPHICAL SOLUTION OF"
1040 PRINT"TRANSCENDENTAL EQUATION"
1050 PRINT
1060 PRINT TAB(6); "-30"; TAB(36); "0"; TAB(64); "+30"
1070 FOR A=1 TO 60
1080 PRINT TAB(A+6); "--";
1090 NEXT A
1100 PRINT
1110 PRINT " -A1-"; TAB(36); "!"
1120 FOR A1=.1 TO 3.2 STEP .1
1130 PRINT USING " #.##";A1;
1140 PRINT"--1";
1150 A2=A1^2
1160 GOSUB 1530
1170 IF INT(Y1)=INT(Y2) THEN GOTO 1290
1180 IF Y2<Y1 THEN GOTO 1240
1190 IF ABS(Y1)<=30 THEN PRINT TAB(36+Y1);"+";
1200 IF ABS(Y2)<=30 THEN PRINT FAB(36+Y2); "*" ELSE GOTO 1220
1210 GOTO 1300
1220 PRINT""
1230 GOTO 1300
1240 IF ABS(Y2)<=30 THEN PRINT TAB(36+Y2); "*";
1250 IF ABS(Y1)<=30 THEN PRINT TAB(36+Y1);"+" ELSE GOTO 1270
1260 6010 1300
```

Listing 1 continued on page 40

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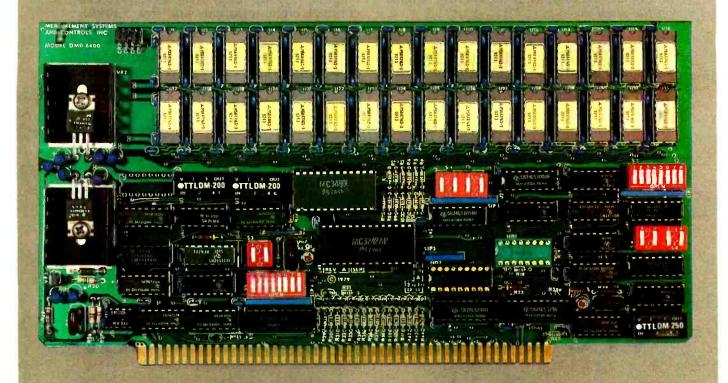
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```
Listing 1 continued:
1270 PRINT""
1280 GOTO 1300
1290 PRINT TAB(36+Y1);"x"
1300 NEXT A1
1310 FOR A=1 TO 60
1320 FRINT TAB(6+A); "-";
1330 NEXT A
1340 FOR A=1 TO 3
1350 PRINT
1360 NEXT
1370 PRINT"AT WHAT VALUE OF A1 DO THE LINES SEEM TO INTERSECT?"
1380 PRINT"AL=
1390 INPUT A1
1400 IF N=0 THEN A1=1.57079
1410 G9=1000
1420 A1=A1+.0004
1430 A2=A1^2
1440 GOSUB 1530
1450 IF SKG9 THEN G9=8 ELSE GOTO 1480
1460 IF A1=3.1416 THEN PRINT"DID NOT FIND POINT OF INTERSECTION"
1470 GOTO 1420
1480 PRINT
1490 PRINT"THE POINT OF INTERSECTION IS: "
1500 PRINT"A1= ";
1510 PRINT USING "##.###"; (A1-.0004)
1520 GOTO 1670
1530 REM SUBROUTINE FOR TRANSCENDENTAL EQUATION
1540 IF NOA1 THEN GOTO 1560 ELSE GOTO 1610
1550 REM PAIR OF EQUATIONS FOR NOA1
1560 Q1=SQR(N2-A2)
1570 Y1=Q1*SIN(A1)/(A1*COS(A1))
1580 Y2=-(EXP(Q1)-EXP(-Q1))/(EXP(Q1)+EXP(-Q1))
1590 S=(Y1-Y2)^2
1600 RETURN
1610 REM PAIR OF EQUATIONS FOR NOA1
1620 Q2=SQR(A2-N2)
1630 Y1=Q2*SIN(A1)/(A1*COS(A1))
1640 Y2=-SIN(Q2)/COS(Q2)
1650 S=(Y1-Y2)^2
1660 RETURN
1670 REM END SEARCH
1680 A2=A1^2
1690 IF NOA1 THEN 02=N2-A2 ELSE B2=A2-N2
1:700 G1=SQR(G2)
1710 B1=SQR(B2)
1720 IF NCAL THEN GOTO 1760
1730 PRINT"G1= ";
1740 PRINT USING "##.###";61
1750 GOTO 1780
                11 5
1760 PRINT"B1=
1770 PRINT USING "##.###"; B1
1780 PRINT
2000 REM CALCULATION OF PSI
2010 PRINT"-CALCULATION OF PSI-"
2020 PRINT
2030 REM CHOICE OF OUTPUT
2040 PRIN)"DO YOU WANT QUIPUT AS TABLE OF VALUES (1) OR IN GRAPHICAL FORM (2)?"
2050 PRINT"ENTER A 1 OR 2"
2060 INPUT Z9
2070 IF Z9=1 THEN GOTO 2090
2080 IF Z9≈2 THEN GOTO 2310 ELSE GOTO 2050
2090 REM TABLE OF VALUES
2100 PRINT TAB(9); "TABLE OF VALUES" 2110 PRINT TAB(8); "-----
2120 PRINT
```

Listing 1 continued on page 43



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\*CP/M 2.0 is a registered trademark of Digital Research, and CBASIC II is a trademark of Software Systems. Listing 1 continued: 2130 PRINT TAB(4); "A"; TAB(17); "PSI"; TAB(26); "(PSI)^2" 2140 FOR P=-16 TO O 2150 GOSUB 2610 2160 GOSUB 2830 2170 NEXT P 2180 FOR P=1 TO 16 2190 GOSUB 2680 2200 GOSUB 2830 2210 NEXT P 2220 PRINT 2230 IF F=1 THEN 3000 2240 PRINT"WOULD YOU LIKE TO SEE THE GRAPHICAL FORM?" 2250 PRINT"ENTER A YES OR NO" 2260 F=1 2270 INPUT A\$ 2280 JF A\$="YES" THEN GOTO 2310 2290 IF A\$="NO" THEN 3000 2300 6010 2250 2310 REM GRAPHICAL FORM 2320 PRINT 2330 PRINT TAB(9); "GRAPHICAL FORM" 2340 PRINT TAB(8);"--2350 PRINT 2360 PRINT TAB(10);"(PSI)^2" 2370 PRINT 2380 FOR A=1 TO 50 2390 PRINT TAB(12+A);"\_"; 2400 NEXT A 2410 PRINT 2420 FOR P=-16 TO 0 2430 GOSUB 2610 2440 GOSUB 2900 2450 NEXT P 2460 FOR P=1 TO 16 2470 GOSUB 2680 2480 GOSUB 2900 2490 NEXT P 2500 IF F=1 THEN 3000 2510 PRINT 2520 PRINT"WOULD YOU LIKE TO SEE THE TABLE OF VALUES?" 2530 PRINT"ENTER A YES OR NO" 2540 F=1 2550 INPUT A\$ 2560 JF A\$="YES" THEN GOTO 2090 2570 IF A\$="NO" THEN 3000 2580 GOTO 2530 2590 PRINT 2600 GOTO 3000 2610 REM SUBROUTINE FOR PSI FROM -16 TO 0 2620 W=P/16 2630 X=W#A 2640 A9=1 2650 P1=A9\*SIN(A1\*(X+A)/A) 2660 P2=P1^2 2670 RETURN 2680 REM SUBROUTINE FOR PSI FROM 0 TO 16 2690 W=P/16 2700 X=W#A 2710 IF NOA1 THEN GOTO 2720 ELSE GOTO 2790 2720 D=A9\*SIN(A1) 2730 C = -D\*(EXP(G1) + EXP(-G1))/(EXP(G1) - EXP(-G1))2740 E5=EXP(G1\*X/A) 2750 E6=EXP(-G1\*X/A) 2760 P1=C\*(E5-E6)/2+D\*(E5+E6)/2 2770 P2=P1^2 Listing 1 continued on page 44

Listing 1 continued: 2780 GOTO 2820 2790 B=A9\*SIN(A1)/SIN(B1) 2800 P1=B\*SIN(B1\*(A-X)/A) 2810 P2=P1^2 2820 RETURN 2830 REM SUBROUTINE FOR TABLE OF VALUES 2840 PRINT USING "##.###"; W; 2850 PRINT TAB(14); 2860 PRINT USING " #.###";P1; 2870 PRINT TAB(26); 2880 PRINT USING " #.###";P2 2890 RETURN 2900 REM SUBROUTINE FOR GRAPHICAL FORM 2910 P9=INT(50\*P2) 2920 PRINT TAB(5); 2930 PRINT USING"##.###";W; 2940 PRINT "1"; 2950 FOR F9=0 TO P9 2960 IF F9+13<>13 THEN PRINT TAB(F9+13);"="; 2970 NEXT F9 2980 PRINT 2990 RETURN 3000 REM CONTINUE OR FINISH 3010 PRINT : PRINT 3020 PRINT"WOULD YOU LIKE TO STUDY ANOTHER PAIR OF ELEMENTS?" 3030 PRINT"ENTER A YES OR NO" 3040 INPUT A\$ 3050 IF A\$="YES" THEN 190 3060 IF A\$<>"NO" THEN 3030

Text continued from page 37:

3070 END

single function,  $\psi$ , must describe a single particle. Thus at the junction of the two sides of the well, the solution for the left side must take on the same value as the solution for the right side:

$$\psi_L = \psi_R$$
 at  $x = 0$ 

 In addition, the solutions for the left and the right sides must fit together smoothly at the junction of the two sides.

Mathematically, this fourth requirement is met if the first derivatives of the solutions for the left and the right sides of the well take on the same value at the junction:

$$\frac{d\psi_L}{dx} = \frac{d\psi_R}{dx}$$

at x = 0.

There is a further complication in the solution for the right side of the potential well. Two cases must be distinguished. The total energy of the electron, E, may be greater than the potential difference between the elements,  $V_0$ , or E may be less than  $V_0$ . According to classical theory, if E were less than  $V_0$ , the electron would never be able to pass into the region of the bond that is represented by the upper level of the potential well. But such is not the case in quantum mechanics.

Because of the wave-like nature exhibited by submicroscopic particles, it is possible for an electron to enter an area where its total energy is less than the potential of that area. If E > $V_0$ ,  $\psi_R$  is a sine function designated  $\psi_R$ , similar in form to the solution for the left side of the potential well. But if  $E < V_0$ , then  $\psi_R$  is a linear combination of hyperbolic functions designated  $\psi_{R,ii}$ . The Schrödinger equation and these boundary conditions lead to the equations listed in table 2. The program in listing 1 portrays electron behavior in a chemical bond based on these equations.

Algorithm for Simulation

To simulate the behavior of the

electron in a chemical bond, the program executes the following steps:

- determine the potential difference, V<sub>0</sub>, between the two elements that make up the molecule
- 2. determine the bond length, a
- 3. determine the parameter, n, which is a function of  $V_0$  and a
- 4. determine  $\alpha a$  (where  $\alpha$  is equal to the momentum of the particle divided by  $\hbar$  when the particle is in the left, low side of the well) by solving the appropriate transcendental equation depending upon whether  $E > V_0$  or  $E < V_0$
- 5. determine  $\beta a$  or  $\gamma a$  (where  $\beta$  and  $\gamma$  correspond to  $\alpha$ , but for the right, high side of the well) depending upon whether  $E > V_0$  or  $E < V_0$
- 6. determine the coefficients B or C and D in terms of A depending upon whether  $E > V_0$  or  $E < V_0$
- 7. evaluate  $\psi_L$  and, depending upon whether  $E > V_0$  or  $E < V_0$ , evaluate either  $\psi_{R,i}$  or  $\psi_{R,ii}$
- 8. list the values of  $\psi$  and  $\psi^2$  in tabular form or display  $\psi^2$  in graphical form



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Table 2: Equations and definitions for solving Schrödinger's equation. The author is indebted to Lars Melander for the potential-well model described in this article and the equations listed in this table. For a complete description of the problem and its solution see Melander's article "Rectangular Box Model of the Polar Bond" in the Journal of Chemical Education, October 1972, pages 686 thru 688. Melander's article was the inspiration for the program of listing 1.

$$A \frac{d^2 \psi}{dx^2} = \frac{-2mE\psi}{dx^2} = -\alpha^2 \psi ; \psi_L = A \sin(\alpha(x+a))$$

The Schrödinger equation and its solution for the left side of the potential well. The solution can be verified by differentiating  $\psi_L$  twice.

**B** i) 
$$\frac{d^2\psi}{dx^2} = \frac{-2m(E - V_0)\psi}{\pi^2} = -\beta^2\psi$$
;  $\psi_{R,t} = B \sin(\beta(a - x))$  for  $E > V_0$   
ii)  $\frac{d^2\psi}{dx^2} = \frac{2m(V_0 - E)\psi}{\pi^2} = \gamma^2\psi$ ;  $\psi_{R,tt} = C \sinh(\gamma x) + D \cosh(\gamma x)$  for  $E < V_0$ 

The Schrödinger equations and their solutions for the right side of the potential well. There are two possible solutions depending upon whether E is greater than or less than  $V_0$ . The solutions can be verified by differentiating  $\psi_R$  twice.

$$\mathbf{C} \, n^2 = \frac{2mV_0a^2}{4n^2}$$

Definition of n, a parameter which is a function of  $V_0$  and a. It is introduced for reasons of convenience.

**D** i) 
$$\beta^2 a^2 = \alpha^2 a^2 - n^2$$
 for  $E > V_0$   
ii)  $\gamma^2 a^2 = n^2 - \alpha^2 a^2$  for  $E < V_0$ 

Identities that can be verified by combining the appropriate definitions from A, B and C.

$$E i) \sqrt{\frac{\alpha^2 a^2 - n^2}{\alpha a}} \tan(\alpha a) = -\tan(\sqrt{\alpha^2 a^2 - n^2}) \text{ for } E > V_0$$

$$ii) \sqrt{\frac{n^2 - \alpha^2 a^2}{\alpha a}} \tan(\alpha a) = -\tanh(\sqrt{n^2 - \alpha^2 a^2}) \text{ for } E < V_0$$

Pair of transcendental equations that derive from the boundary conditions. They determine the value of  $\alpha a$  given n. The equation used depends upon whether E is greater than or less than  $V_0$ .

F i) 
$$B = A \sin(\alpha a)/\sin(\beta a)$$
 for  $E > V_0$   
ii)  $C = -D/\tanh(\gamma a)$  for  $E < V_0$   
 $D = A \sin(\alpha a)$ 

Equations which define the coefficients of the solutions for the right side of the potential well in terms of the coefficient (amplitude), A, of the solution for the left side of the potential well. These equations also derive from the boundary conditions.

A small data file is created. The file contains a list of elements capable of forming a diatomic molecule by exchanging or sharing a single electron with another element. The file contains the following information: the chemical symbol of the element, its ionic radius, ionization potential, and electron affinity. [Note: The ionic radius of an element depends upon whether the molecule is a single unit, as in the gas phase, or whether it belongs to a larger group as in the crystalline or solid phase. The crystalline ionic radii used in this program may be found in the Handbook of Chemistry and Physics, Chemical Rubber Company, 18901 Cranwood Parkway, Cleveland OH 44128.]

The program lists the elements by

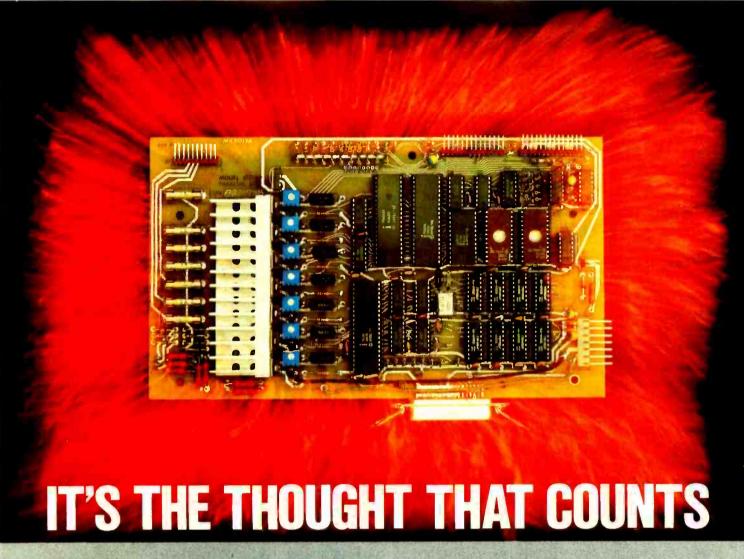
name and symbol after a short introduction. The operator enters the symbols for the two elements to be involved in the bond. The program determines potential energy,  $V_0$ , and the bond length, a, then solves for and prints out the parameter, n. Then the product of the momentum and the bond length,  $\alpha a$ , must be determined. If the diatomic molecule is in a state of lowest energy, the ground state, then  $\alpha a$  must lie in the interval between 0 and  $\pi$ .

Theoretically, the best method of solving the appropriate transcendental equation for  $\alpha a$  would be to evaluate each side of the equation separately for all values of  $\alpha a$  between 0 and  $\pi$ , and find the point at which the two sides of the equation

are equivalent. It is possible for a computer to find the correct value of  $\alpha a$  by stepping  $\alpha a$  from 0 to  $\pi$  in very small increments. In practice, this is far too time-consuming, especially on a small computer.

100

The program of listing 1 determines the value of  $\alpha a$  in two stages. In the first stage,  $\alpha a$  is increased from 0 to  $\pi$  by steps of 0.1. A graph of each side of the transcendental equation is plotted on the same axis. The point where the two lines generated by the two halves of the equation intersect gives a rough approximation to the proper value of  $\alpha a$ . The operator then enters the value of  $\alpha a$  immediately before the point of intersection. The program begins with this value of  $\alpha a$  and increments it in steps of 0.0004. When



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MICROTEK, Inc. 9514 Chesapeake Drive San Diego, CA 92123 Tel. (714) 278-0633 the difference between the two sides of the transcendental equation (squared so that negative numbers are inconsequential) is a minimum, the program prints out the value of  $\alpha a$ . Depending upon the relative size of  $\alpha a$  and n, the program then evaluates and prints out either  $\beta a$  or  $\gamma a$ .

Next the coefficients of the equations for the right side of the potential well are determined in terms of A, the amplitude of the wave equation for the left side of the potential well. The value of the coefficient A could be determined by normalization, making the probability that the electron is at some point between -a and +a equal to 1. In this program, the wave equation is left unnormalized.

The equations defining the relationship among these coefficients are

the result of application of the boundary conditions. Finally, numerical values of  $\psi$  and  $\psi^2$  can be determined. The program evaluates  $\psi$  for each side of the potential well at fractional intervals along the bond length according to the appropriate equation. The data is available to the operator either in tabular or in graphical form. As might be expected, the graphical form gives a better impression of how the electron behaves in the bond.

#### Characteristics of the Program

The program of listing 1 was written in AlphaBASIC to run on an AlphaMicro Systems AM-100 computer. The hyperbolic trigonometric functions,  $\sinh(x)$  and  $\cosh(x)$ , do not appear in AlphaBASIC. But these functions can be defined in terms of

the natural exponential function, which appears in most versions of BASIC:

$$\sinh(x) = \frac{e^x - e^{-x}}{2}$$

$$\cosh(x) = \frac{e^x + e^{-x}}{2}$$

In these equations, e is the base of the Napierian natural logarithm and has a value of approximately 2.71828. Otherwise there are no unusual statements or functions in the program. The processing of mathematical variables is carried out in floating-point notation with elevendigit accuracy.

The formatted output rounds off all results at the third decimal place.

Text continued on page 56

Listing 2: A sample execution of the program of listing 1.

RUM CHMBNO

#### -PROFILE OF A CHEMICAL BOND-

THE ELECTRON DENSITY IN THE CHEMICAL BOND OF A DIATOMIC MOLECULE DEPENDS UPON THE POTENTIAL DIFFERENCE (VO) BETWEEN THE TWO ELEMENTS WHICH ARE BOUND TOGETHER AND UPON THE LENGTH OF THE BOND (A). THE AVERAGE OF THE IONIZATION ENERGY AND THE ELECTRON AFFINITY OF AN ELEMENT OFFERS A MEASURE OF THE POTENTIAL OF THE ELEMENT.

THIS PROGRAM CALCULATES A PROFILE OF A CHEMICAL BOND BASED UPON THIS INFORMATION. FROM THE LIST OF ELEMENTS BELOW, SELECT TWO WHICH WILL MAKE UP THE MOLECULE. ENTER THE SYMBOLS FOR THESE ELEMENTS AT THE REQUEST OF THE PROGRAM.

HYDROGEN H F LITHIUM Li FLOURINE CI CHLORINE MUIDOS Ma POTASSIUM -K BROMINE Er. RUBIDIUM Rы IODINE CESTUM 135

ENTER ELEMENT NUMBER ONE - Na ENTER ELEMENT NUMBER TWO - CI

VO = 5.743N = 3.414

WHEN READY TO CONTINUE TYPE A CARRIAGE RETURN.

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Order Codes:

Micro Dept R. Proper J. 39 32 1525 Lart 3 do 32 1278

-A1- 0.10-1 0.20-1 0.30-1 0.30-1 0.40-1 0.50-1 0.50-1 0.50-1 0.70-1 0.80-1 0.70-1 0.80-1 0.90-1 1.10-1 1.20-1 1.30-1 1.40-1 1.50-1 1.50-1 1.50-1 1.70-1 1.80-1 1.90	-30	Q	+30
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1.60-1	1.40-1	* +	
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2.10-} 2.20-1 2.30-  2.30-  2.40-1 2.50-  2.50-  2.60-1 2.70-  2.30-  2.90-  3.00-1 3.10-			
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2.70-1			
2.80-1		×	
2.90-1 × 3.00-1 × 3.10-1 ×			
3.00-1 × 3.10-1 ×			
3.10-1 ×			
3.20-1 *+			
	3,20-1	<b>¾</b> +	

AT WHAT VALUE OF A1 DO THE LINES SEEM TO INTERSECT? A1 = ? 2.3

THE POINT OF INTERSECTION IS:

A1 = 2.378

G1 = 2.449

-CALCULATION OF PSI -

DO YOU WANT OUTPUT AS TABLE OF VALUES (1) OR IN GRAPHICAL FORM (2)? ENTER A 1 OR 2 ? 1

#### TABLE OF VALUES

A	PS1	(PSI)^2
-1.000	0.000	0.000
-0.938	0.148	0.022
-0.875	0.293	0.086
-0.813	0.431	0.186
-0.750	0.560	0.314
-0.688	0.677	0.458
-0.625	0.778	0.606
-0.563	0.863	0.744
-0.500	0.928	0.861

Listing 2 continued on page 52

# Now... You, the small systems user can enjoy the advantages of HI-performance low cost computer graphics



-0.438	0.973	0.947
-0.375	0.996	0.993
-0.313	0.998	0.996
-0.250	0.977	0.955
-0.188	0.935	0.875
-0.125	0.872	0.761
-0.063	0.790	0.625
0.000	0.691	0.477
0.063	0.591	0.350
0.125	0.506	0.256
0.188	0.432	0.186
0.250	0.368	0.135
0.313	0.313	0.098
0.375	0.265	0.070
0.438	0.223	0.050
0.500	0.187	0.035
0.563	0.155	0.024
0.625	0.127	0.016
0.688	0.101	0.010
0.750	0.078	0.006
0.813	0.057	0.003
0.875	0.037	0.001
0.938	0.018	0.000
1.000	0.000	0.000

WOULD YOU LIKE TO SEE THE GRAPHICAL FORM? ENTER A YES OR NO ? YES

#### GRAPHICAL FORM

(PSI)^2

```
-1.0001
-0.9381 =
-0.8751
   7277
  -0.8131
-0.7501
  -0.6881
-0.6251
   -0.5631
   -0.5001
   -0.4381
   -0.3751
   -0.3131
   -0.2501
   -0.1881
   memendentmentetttentromannernderentra
-0.1251
   -0.0631
   0.0001
   0.0631
   0.1251
   0.1881
   0.2501
   ======
0.3131
   ----
0.3751
   ---
0.4381
0.5001
0.5631
0.6251
0.6881
0.7501
0.8131
0.8751
0.9381
```

1.0001

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#### Listing 2 continued:

WOULD YOU LIKE TO STUDY ANOTHER PAIR OF ELEMENTS? ENTER A YES OR NO ? YES

> HYDROGEN -FLOURINE LITHIUM Li CISODIUM Na CHLORINE POTASSIUM -K BROMINE Br RUBIDIUM -Rb IODINE. CESTUM 0.5

ENTER ELEMENT NUMBER ONE - A ENTER ELEMENT NUMBER TWO - I

VO = 0.439N = 1.270

WHEN READY TO CONTINUE TYPE A CARRIAGE RETURN.

GRAPHICAL SOLUTION OF TRANSCENDENTAL EQUATION

-30	0	4:30
-01-	<u> </u>	
0.10-1	* +	
0.20-1	* +	
0.30-1	* +	
0.40-1	* +	
0.50-1	₩ •/•	
0.60-1	* +	
0.70-1	<b>*</b> 4F	
0.80-1	* +	
0.90-1	* +	
1.00-1	* +	
1.10-1	* 1	
1.20-1	*+	
1.30-1	*+	
1.40-1	* 4	
1.50-1	* *	
1.40-1	+· ×	
1.70-1	+ *	
1.80-1	×	
1.90-1	* +	
2.00-1	<b>.</b>	
2.10-1	*	
2.20-1	<b>+</b> ★	
2.30-1	<b>∤</b> • ★	
2.40-1	4 *	
2.50-1	k *	
2.60-1	4 *	
2.70-1		
2.80-1	<b>+</b> *	
2.90-1	+ *	
3.00-1	+*	
3.10-1	+*	
3.20-1	×	



Suddenly, S-100 microcomputer systems can easily handle 100 million bytes. Because Morrow Designs™ now offers the first 26 megabyte hard disk memory for S-100 systems—the DISCUS M26™ Hard Disk System.

It has 26 megabytes of useable memory (29 megabytes

unformatted). And it's expandable to 104 megabytes.

The DISCUS M26™ system is delivered complete a 26 megabyte hard disk drive, controller, cables and operating system—for just \$4995. Up to three additional drives can be added, \$4495 apiece.

The DISCUS M26™ system features the Shugart SA4008 Winchester-type sealed media hard disk drive, in a handsome metal cabinet

with fan and power supply.

The single-board S-100 controller incorporates intelligence to supervise all data transfers, communicating with the CPU via three I/O ports (command, status, and data). The controller has the ability to generate interrupts at the completion of each command to increase system throughput. There is a 512 byte sector buffer on-board. And each sector can be individually write-protected for data base security.

The operating system furnished with DISCUS M26™ systems is the widely accepted CP/M\* 2.0.

See the biggest, most cost-efficient memory ever introduced for S-100 systems, now at your local computer shop. If unavailable locally, write Morrow Designs,™ 5221 Central Avenue, Richmond, CA 94804. Or call (415) 524-2101, weekdays 10-5 Pacific Time.

\*CP/M is a trademark of Digital Research.



Thinker Toys

AT WHAT VALUE OF A1 DO THE LINES SEEM TO INTERSECT? A1 = ? 1.70

THE POINT OF INTERSECTION IS:

A1 = 1.791 B1 = 1.264

-CALCULATION OF PSI-

DO YOU WANT OUTPUT AS TABLE OF VALUES (1) OR IN GRAPHICAL FORM (2)? ENTER A 1 OR 2 ? 1

#### TABLE OF VALUES

A	PS1	(PSI)^2
-1.000	0.000	0.000
-0.938	0.112	0.012
-0.875	0.222	0.049
-0.813	0.330	0.109
-0.750	0.433	0.188
-0.688	0.531	0.282
-0.625	0.622	0.387
-0.563	0.706	0.498
-0.500	0.781	0.610
-0.438	0.846	0.715
-0.375	0.900	0.310
-0.313	0.943	0.889
-0.250	0.974	0.949
-0.188	0.993	0.987
-0.125	1.000	1.000
-0.063	0.994	0.988
0.000	0.976	0.952
0.063	0.948	0.899
0.125	0.915	0.837
0.188	0.876	0.767
0.250	0.831	0.691
0.313	0.782	0.611
0.375	0.727	0.529
0.438	0.668	0.446
0.500	0.605	0.366
0.563	0.538	0.289
0.625	0.467	0.218
0.688	0.394	0.155
0.750	0.313	0.101
0.813	0.240	0.058
0.875	0.161	0.026
0.938	0.081	0.007
1.000	0.000	0.000

WOULD YOU LIKE TO SEE THE GRAPHICAL FORM? ENTER A YES OR NO ? YES

Text continued from page 48:

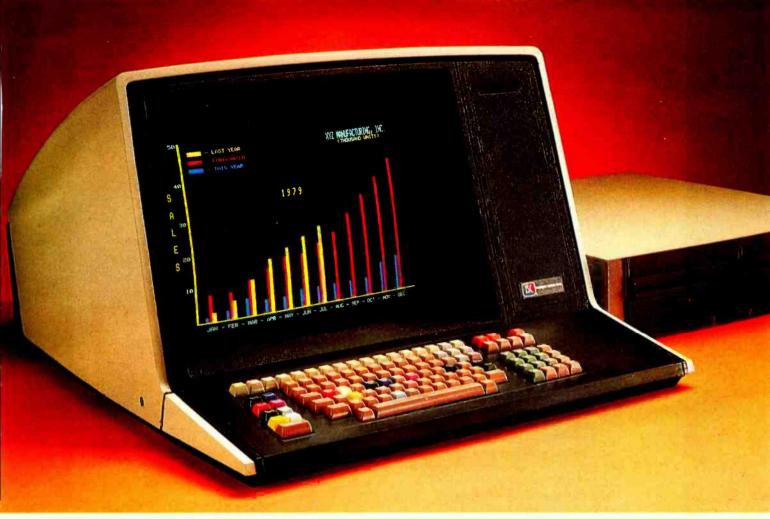
The format (PRINT USING) statements are somewhat rare and may have to be modified according to the particular version of BASIC with which you happen to be working. The program requires no special graphics systems. All graphic features are generated by using terminal keyboard symbols (such as the asterisk).

#### Uses of the Program

The program can be easily adapted for further study of chemical bonds in diatomic molecules. You can study the electron distribution for different bond lengths at a constant potential difference. Alternately, you could study the electron distribution for varying potential differences at a constant bond length.

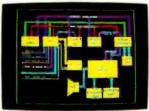
It is also possible to estimate the ionic character of the bond. If the potential difference between two elements was infinitely large, the electron would be confined indefinitely to the lower side of the potential well. The most probable electron location in a symmetrical well would be at the center of the well, in this case at x = -0.5a. Since one nucleus would

Listing 2 continued on page 58



#### Color communicates better. That's the obvious benefit of ISC's new CP/M<sup>o</sup>2 compatible desktop computer.









What isn't as obvious is the benefit of the CP/M2 operating system. CP/M2 allows Intecolor® 8963 users to choose from an abundance of software. The wide variety of business programs available in CP/M greatly reduces the need for speciallyprepared software.

Simply load the CP/M2 operating system disk to run any CP/M program (without modification), whether it's in BASIC, COBOL. FORTRAN IV, or any other programming language. Add the superb readability and improved comprehension of color graphics and you've got unparalleled desktop performance.

The Intecolor 8963 is complete with 19" display, 32K of user RAM, 591K dual 8" floppy disk drive, CP/M2 operating system and a color version of Microsoft® Business BASIC. At just \$6395,\* it's perfect for the small business.

See the new 8963 at selected computer dealers. Or ask your ISC sales representative for a demonstration and find out how color—and CP/M2—can work to your advantage.

\*U.S. domestic price

Unretouched photo of screen

CP/M is a registered trademark of Digital Research Corp.

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Intelligent Systems Corp. Intecolor Drive - Technology Park/Atlanta - Norcross, GA 30092 - Telephone 404/449-5961 - TWX 810-766-1581

```
-1.0001
-0.9381
-0.8751
-0.8131
                      .
-0.7501
-0.6881
                      -0.6251
                      -0.5631
                      ----
-0.5001
                      THE PERSON NAMED IN COLUMN TWO IS NOT THE OWN DOTS NAMED AND ADDRESS OF THE OWN DATE OF THE OW
-0.4381
-0.3751
                      -0.3131
-0.2501
                      -0.1881
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                      0.1251
                      _______
                      0.1881
  0.2501
                      0.3131
                      0.3751
                      0.4381
                      0.5001
                      0.5631
                      0.6251
                      0.6881
                      -----
   0.7501
   0.8131
                      -
   0.8751
   0.9381
   1.0001
```

WOULD YOU LIKE TO STUDY ANOTHER PAIR OF ELEMENTS? ENTER A YES OR NO ? NO

have exclusive possession of the electron, such a bond would be 100% ionic.

If there was no potential difference between the two elements, the most probable location in the symmetrical well would again be the center of the well, but this time at x = 0. The bond has 0% ionic character.

All real molecular bonds lie between these two extremes. estimate the ionic character of a bond, search for the fractional value of the bond length at which the probability distribution curve has maximum amplitude. Multiply this number by two, make it positive, and convert it to a percentage form. The result is a model estimate of the ionic character of the bond.

This program represents a mere peek at the quantum mechanical world of atoms and molecules. Much has been discovered and much remains to be discovered. The computer facilitates investigation of this world. Moreover, the computer can be a spur to our imagination beckoning us to new vistas in the microscopic world and beyond.

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is a collection of the best articles from past issues of BYTE magazine plus new material collected specifically for the series, on subjects such as multiprogramming, stacks, interrupts optimation, and real time processing.

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#### Hewlett-Packard's New Personal Computer The HP-85

Christopher P Morgan Editor-in-Chief

Photos by Ed Crabtree

A question often heard in personal computer circles is, "When is Hewlett-Packard going to bring out a personal computer?" The question has been answered, and the new HP-85 computer is quite a system.

Hewlett-Packard (HP) has long been a respected manufacturer of minicomputers, desktop calculators, and handheld calculators; the high quality of their electronic test equipment is well known to the engineering community. Hewlett-Packard also has the reputation for being a careful, conservative company, and the HP-85 is, not surprisingly, a logical outgrowth of their desktop and handheld calculators.

We recently had the opportunity to audition the HP-85. Our preliminary findings are listed below.

#### System Features

The basic HP-85, shown in photo

1, costs \$3250 and consists of a microcomputer with a custom 8-bit processor and several other custom integrated circuits, data cartridge drive for DC-100 tape cartridges, a highresolution video display with a 5-inch screen (measured diagonally) with resolution of 256 by 192 dots (individually addressable) for graphics, 16 lines by 32 characters of text, keyboard, and thermal printer. The unit comes with 16 K bytes of program-

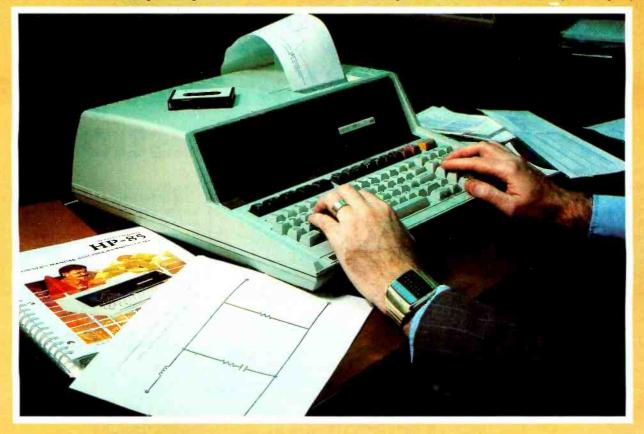
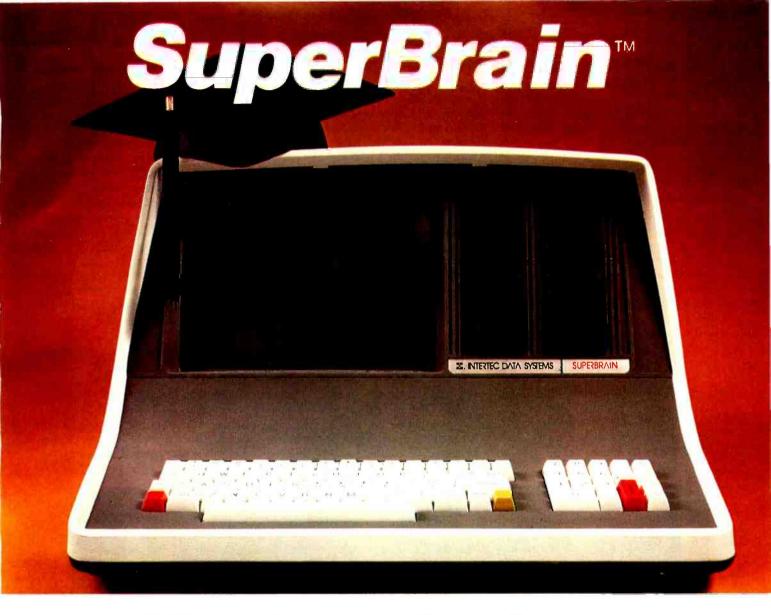


Photo 1: Hewlett-Packard's new entry into the personal computer market: the HP-85. The \$3250 unit features a 5-inch video display, data cartridge drive, keyboard with user-programmable keys, and thermal printer. The HP-85 also offers interesting graphics capabilities. Every point on the 256 by 192 dot array can be individually addressed by the programmer. The built-in thermal printer can make a copy of any graphic design on the screen or any alphanumeric data. Sophisticated features included in this unit are a hardware and software self-test key; four levels of security protection for files on data cartridges; plug-in memory expansion to the basic package of 16 K bytes of programmable memory and 32 K bytes of read-only memory; ANSI standard Enhanced BASIC with the ability to chain programs together; and line editing.



#### The Honor Graduate

There's been a lot of talk lately about intelligent terminals with small systems capability. And, it's always the same. The systems which make the grade in performance usually flunk the test in price. At least that was the case until the SuperBrain graduated with the highest PPR (Price/Performance Ratio) in the history of the industry.

For less than \$3,000\*, SuperBrain users get exceptional performance for just a fraction of what they'd expect to pay. Standard features include: two dual-density mini-floppies with 320K bytes of disk storage, up to 64K of RAM to handle even the most sophisticated programs, a CP/M Disk Operating System with a high-powered text editor, as-

sembler and debugger. And, with SuperBrain's S-100 bus adapter, you can even add a 10 megabyte disk!

More than an intelligent terminal, the SuperBrain outperforms many other systems costing three to five times as much. Endowed with a hefty amount of available software (BASIC, FORTRAN, COBOL), the SuperBrain is ready to take on your toughest assignment. You name it! General Ledger, Accounts Receivable, Payroll, Inventory or Word Processing . . . the SuperBrain handles all of them with ease.

Your operators will praise the SuperBrain's good looks. A full ASCII keyboard with a numeric keypad and function keys. A non-glare, dynamically focused, twelve inch screen. All in an attractive desktop unit weighing less than a standard

office typewriter. Sophisticated users will acclaim SuperBrain's twin Z-80 processors which transfer data to the screen at 38 kilobaud! Interfacing a printer or modem is no problem using SuperBrain's RS-232C communications port. But best of all, you won't need a PhD in computer repair to maintain the SuperBrain. Its single board design makes servicing a snap!

So don't be fooled by all the freshman students in the small systems business. Insist on this year's honor graduate . . . the SuperBrain.



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<sup>\*</sup>Quantity one. Dealer inquiries invited.

mable memory (14,500 of which are available to the user) expandable to 32 K bytes, and 32 K bytes of read-only memory. The latter contains the operating system and the Enhanced BASIC package.

#### Data Cartridges

One of the main differences between the HP-85 and most other small systems on the market is its use of data cartridges for reading and writing programs and data. This is not surprising, since the company expects to sell the unit in large quantities to professionals, and the data cartridge is one of the most reliable forms of mass storage available today. The cartridge-drive slot is located on the front of the machine (see photo 1).

Each cartridge can hold 780 program records consisting of 192 K bytes each, or 850 data records of 210 K bytes. There can be a maximum of forty-two named files per cartridge.

Cartridge rewind time is 29

seconds; search speed is 152 cm (60 inches) per second; data transfer speed is 25.4 cm (10 inches) per second; and tape length is 43 meters (141 feet). With the data cartridge system the user can create data files, input arrays into the computer with a single program statement, store an "autostart" program that is automatically loaded and executed at power-on, and secure programs from unauthorized access.

#### Keyboard

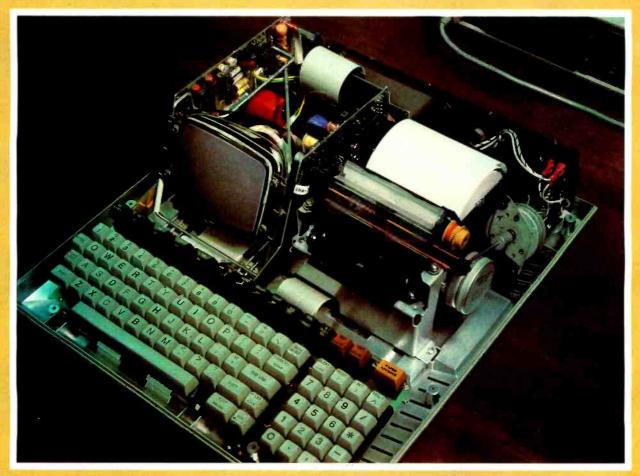
The keyboard is divided by function: the typewriter keyboard for entering alphanumeric data, the numeric pad for entering numeric information, and eight user-definable keys. (These keys are located directly under the video screen. Labels for the keys can be entered by the user and will appear at the bottom of the screen). Display, editing, and system-control keys permit the user to control the video display. The keyboard is hinged and can be easily swung out

of the way after the cover is removed to service the processor board (see photo 3).

#### Video Display

One of the HP-85's strong points is its graphics and alphanumeric display capability. Sixteen lines of text can be displayed at a time on the screen, but a buffer holds up to sixty-four lines, so the user can back up and see a part of a listing that has scrolled off the screen— a decided convenience in writing or debugging programs. If you come to the end of the sixty-four-line section in the buffer, the display wraps around to the beginning again. Characters are formed in a 5 by 7 dot matrix.

In the graphics mode, the display consists of a 256 (wide) by 192 (high) dot field, giving a total of 49,152 individual dots available for high-resolution plotting. The HP-85 also stores the last alphanumeric display and the last graphics display in separate buffers so the user can switch more freely



**Photo 2:** Inside the HP-85, showing the 5-inch video display cathode-ray tube, thermal printer, and data cartridge drive. The processor board is located under the keyboard (see photo 4). Note the set of user-definable keys at upper left of the keyboard. Labels for these keys are displayed at the bottom of the video screen.



## It's off and running. And delivering as promised.

#### What is MicroNET?

It is the personal computing service of CompuServe, Incorporated. CompuServe is a nationwide commercial time sharing computer network with large-scale mainframes. MicroNET allows the personal computer user access to CompuServe's large computers, software and disc storage during off-peak hours (from 6 PM to 5 AM weekdays, all day on Saturdays, Sundays and most holidays).

#### What do I get?

You can use our powerful processors with X-Basic, Fortran, Pascal, Macro-10, AID or APL. You get 128K bytes of storage free (just access it at least once a month). Software includes games—including networking multi-player games—personal, business and educational programs.

In addition, there is the MicroNET National Bulletin Board for community affairs,

for sale and wanted notices and the MicroNET Electronic Mail System for personal messages to other MicroNET users. You can even sell software via MicroNET.

> NEW! MicroQUOTE, a security information system for corporate stocks and public debt. NEW! MicroNET Soft-

ware Exchange with dozens of new programs available for downloading to your personal computer at a specified charge.

NEW! Executive programs for TRS-80, Apple II and CP/M systems (so your machine and ours can talk to each other error-free). You can switch between terminal and local mode while on line.

#### What do I have to have to use MicroNET?

The standard 300 baud modem. MicroNET has local phone

service in most major cities (see below) and a reduced phone charge in over a hundred others.

#### What is the cost?

We've saved the best for last. There is a one-time hook-up charge of only \$9.00! Operating time—billed in minutes to your VISA or MasterCharge card—is only \$5.00 an hour.

#### Want more information?

Good. Write to us at the address below. We'll send you a full packet of information about MicroNET.

#### **CompuServe**

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MicroNET is available via local phone calls in the following cities: Akron, Atlanta, Boston, Canton, Chicago, Cincinnati, Cleveland, Columbus, Dallas, Dayton, Denver, Detroit, Houston, Indianapolis, Los Angeles, Louisville, Memphis, West Caldwell (NJ), New York, Philadelphia, Pittsburgh, San Francisco, Stamford (CT), St. Louis, Toledo, Tucson and Washington, D.C.

Access to the MicroNET service is available in 153 other cities for an additional charge of \$4.00 per hour.



"... but the really impressive stuff is in the back room."

from one mode to the other without losing data.

Readers familiar with the company's desktop calculators will be immediately at home with the HP-85's graphics-handling routines. There are sixteen graphics commands for setting up graphs, locating the origin, and scaling and labeling the axes quickly.

Anything that appears on the screen can be printed on the thermal printer by simply pressing the GRAPH and COPY keys in that order. You may also enter commands from the keyboard while in graphics mode. Inverse video is also available, as well as a BPLOT routine for user-defined graphics.

The alphanumeric characters are on the small side compared to the average personal computer display because of the screen size. However, they are quite readable— not unlike the IBM 5100 display. Screen editing is convenient. There are five cursor-

control keys, plus keys for clearing the screen, a line, or a single character. The ability to edit within a program line is a great time saver.

#### Security

The HP-85 offers unprecedented versatility when it comes to securing data and programs. The SECURE command is used to prevent specific program files from being listed, edited, or stored; to prevent any file's name from appearing in the directory listing; and to protect the user from writing over a file. The UNSECURE command removes security on secured programs or data files. The file name to be secured must already appear in the directory (ie: it must already exist on tape).

The file name may be any string of characters except the null string. The system takes the first two characters of the string and stores them as the security code. There are four levels of security.

At level 0, the program may not be listed or edited. Level 1 further prevents the program from being duplicated. At level 2, the program may also not be overwritten. Level 3 removes the name of the file from the catalog and replaces it with blank.

#### Printer

The thermal printer operates in both alphanumeric and graphics modes. In the alphanumeric mode, it can print the full 128-character ASCII character set, which includes uppercase and lowercase letters, numerals, and special symbols. The full character set can be underlined. Printer speed is 2 lines per second.

#### **Enhanced BASIC**

The HP-85's Enhanced BASIC interpreter meets and exceeds the most recent ANSI standard. Its features include: 12-digit accuracy and exponents up to ±499 for calculations; extremely versatile



**Photo 3:** Internal view of the HP-85, showing the processor board under the hinged keyboard. The 8-bit processor is a custom Hewlett-Packard design, as are most of the integrated circuits in the computer.

# TER OUTS

\*HEE

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string-handling capability (a string in HP-85 Enhanced BASIC can theoretically be up to 32 K bytes long) compatible with string handling on other HP computers; 42 predefined functions: formatted output: the ability to chain BASIC programs together; multistatement lines; a programmable sound generator that can play single-voice lines of melody through the built-in speaker or make audible beeps at predetermined times during the execution of a program; and calculator capability. For debugging, the user can single-step through BASIC programs, branch ON ERROR, or have the program provide a default value with DEFAULT ON to enable a program to continue executing. In particular, the formatted-output capability is useful for generating headings, columns, and spaces for program output.

#### Self-Test

A unique feature of the HP-85 is the built-in self-test routine. When the TEST key is pressed, the computer runs through an electronic check of all internal components— a feature common to many Hewlett-Packard electronic instruments. If everything checks out correctly, a particular set of characters is displayed on the screen. (The graphics display will be cleared, but programs and variables in memory will remain intact.) If the system is not operating correctly, the system displays "Error 23 SELF TEST."

Input/Output

Photo 4 shows the back of the HP-85 and the four input/output (I/O) ports. Additional memory can be added via the ports. The company will be introducing a variety of peripherals for the unit, including dual 5-inch floppy-disk drives, external printers, plotters, and so on. An extra 16 K bytes of memory costs \$395.

#### Software

Software currently available on data cartridges for the HP-85 includes BASIC training, general statistics, mathematics, electrical engineering, finance, linear programming, and regression analysis. Each package costs \$95. More packages are under

development. BASIC program developed for Hewlett-Packard's desktop computers can be adapted for use on the HP-85, as can most programs written in ANSI BASIC. The unit also comes with a well-written, 350-page owner's manual and a standard application software package. Hewlett-Packard is quoting immediate delivery on the HP-85.

#### **Evaluation**

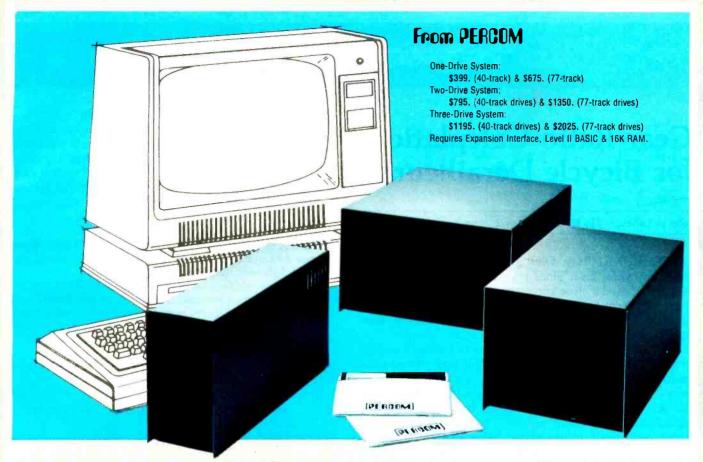
We were impressed with the performance of the HP-85 computer. The graphics alone make this an attractive, albeit not inexpensive, alternate to existing small systems on the market. And many of its features are unique. Although Hewlett-Packard is pinning its hopes on heavy sales to the professional marketplace, it is our guess that many personal computer experimenters and hackers will want this machine.

In future issues of BYTE we will evaluate the HP-85 in greater depth.

For further information about the HP-85, contact: Inquiries Manager, Hewlett-Packard Co, 1507 Page Mill Rd, Palo Alto CA 94303.



Photo 4: Rear view, showing the four I/O ports and their removable covers.



#### Low Cost Add-On Storage for Your TRS-80\*. In the Size You Want.

When you're ready for add-on disk storage, we're ready for you. Ready with six mini-disk storage systems — 102K bytes to 591K bytes of additional on-line storage for your TRS-80\*.

- Choose either 40-track TFD-100™ drives or 77-track TFD-200™ drives.
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- Systems include Percom PATCH PAK #1™, on disk, at no extra charge. PATCH PAK #1™ de-glitches and upgrades TRSDOS\* for 40- and 77-track operation.
- TFD-100™ drives accommodate "flippy disks." Store 205K bytes per mini-disk.
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- Enclosures are finished in system-compatible "Tandy-silver" enamel.

Whether you need a single, 40-track TFD- $100^{\text{TM}}$  add-on or a three-drive add-on with 77-track TFD- $200^{\text{TM}}$ s, you get more data storage for less money from Percom.

Our TFD-100™ drive, for example, lets you store 102.4K bytes of data on one side of a disk — compared to 80K bytes on a TRS-80\* mini-disk drive and 102.4K bytes on the other side, too. Something you can't do with a TRS-80\* drive. That's almost 205K bytes per

And the TFD-200™ drives provide 197K bytes of on-line storage per drive 197K, 394K and 591K bytes for one-,

two and three-drive systems.
PATCH PAK #1™, our upgrade program for your TRSDOS\*, not only extends TRSDOS\* to accommodate 40and 77-track drives, it enhances TRSDOS\* in other ways as well. PATCH PAK #1™ is supplied with each drive system at no additional charge.

The reason you get more for less from Percom is simple. Peripherals are not a sideline at Percom. Selling disk systems and other peripherals is our main business - the reason you get more engineering, more reliability and more back up support for less money.

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#### **Programming Ovickies**

380

NEXT

END

## Gear-Ratio Calculation for Bicycle Derailleurs

John A Lehman, 716 Hutchins, Apt 2, Ann Arbor MI 48103

KERCHUNK! "Hey, what gear is next on this thing?" asked my wife, Lisa. Since my old, reliable three-speed bicycle suffered a close encounter of the worst kind with a car impatient to turn right on a red light, we had both decided to buy used ten-speed bikes. Unfortunately, that meant having to worry about seven more "speeds."

"Why don't you use your computer to figure out what order to do things in?" she asked. This was a good suggestion, especially since one of our neighbors had been wanting me to figure out whether it would be worthwhile for him to change from a five-speed to a ten-speed shift mechanism. The result is this Programming Quickie which describes a program that helps answer these and other questions.

The most popular gear shift mechanism on bicycles these days is the *derailleur*. This mechanism uses one, two, or three front gear sprockets (ie: chain wheels) and either five or six rear gear sprockets. This means that one can have a five-, six-, ten-, twelve-, fifteen-, or eighteen-speed shift mechanism. The derailleur device moves the chain between the different gear sprockets, as shown in figure 1 on page 70. This means that, unlike two- and three-speed bikes, the shift mechanism cannot go directly from low to high gear. Rather, there are as many separate sequences of gear combinations as there are front chain wheels; the rider has to combine these different sequences into one overall shift pattern.

To make things more complicated, there are fairly wide variations in the number of gear teeth on the front and rear sprockets. Differently configured gear-tooth combinations are used for different riding conditions. For example, racers who ride mostly on level ground have a narrower gear-ratio range than bike tourists who have to manage both long, level stretches and steep hills. It would be nice to be able to tell what difference it would make riding up that long hill if you changed to a given front and rear sprocket combination.

The program given in listing 1 addresses both of these problems. It will analyze any combination of between five and eighteen speeds; it will produce a shift chart to indicate the order in which to use different combinations of front and rear gear sprockets and a chart of gear range so that comparisons can be made between different combinations of sprockets with variations in the number of gear teeth.

The unit of measure used here for gear range is the traditional one of wheel size. This is the size of the front wheel that would be necessary to produce the same drive ratio on one of the old high-wheel (ie: penny-farthing) bikes of the nineteenth century. The program is written in TDL 12 K BASIC, but should run unaltered on any computer that uses Microsoft or a similar BASIC system such as the TRS-80, PET, Apple II, or Ohio Scientific. Happy cycling, and wear a helmet!

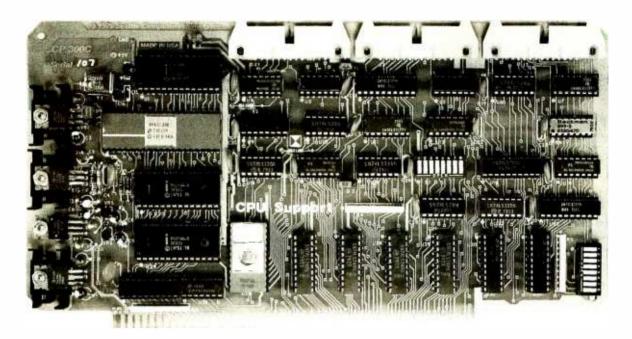
**Listing 1:** A program written in TDL 12 K BASIC that calculates the gear ratios available from combinations of front and rear gear sprockets with varying numbers of teeth.

Special language features are as follows. A PRINT USING statement provides formatted output. A simple PRINT will work, but will be slightly less neat. If your BASIC does not have the EXCHANGE statement used in lines 310 thru 314, you can substitute a simple swap routine such as:

T1 = P(J+1,1) : P(J+1,1) = P(J,1) : P(J,1) = T1 to perform the exchange. A question mark is an abbreviation for PRINT.

```
10
         'PROGRAM TO CALCULATE 10 SPEED OR 15 SPEED
         GEAR RATIOS
20
         DIM W(16),P(16,3)
         INPUT "NUMBER OF FRONT GEARS";F1
40
         INPUT "NUMBER OF GEARS ON REAR
         FREEWHEEL";R1
         IF F1 = 0 THEN F1 = 2
50
         IF R1 = 0 THEN R1 = 5
60
70
         N = R1 + F1
         INPUT "REAR WHEEL DIAMETER";W1
80
         IF F1 = 3 THEN 120
100
         F$(1) = "INNER ":F$(2) = "OUTER"
         GO TO 130
110
         F$(1) = "INNER ":F$(2) = "MIDDLE ":F$(3) = "OUTER"
120
         FOR I = 1 TO F1
130
140
         PRINT "NUMBER OF TEETH ON ";F$(I); "GEAR";
150
         INPUT T(I)
160
         NEXT I
         FOR I = 1 TO R1
170
         PRINT "NUMBER OF TEETH ON "; I;" REAR GEAR";
180
         INPUT S(I)
190
200
         NEXT I
         FOR I = 1 TO F1
210
220
         FOR J=1 TO R1
         X = (I - 1) R1 + J
225
230
         W(X) = T(I)/S(J)_*W1
         P(X,1) = X:P(X,2) = I:P(X,3) = J
235
240
         NEXT J
250
         NEXT I
260
         FOR I = 1 TO N:P(I,1) = I:NEXT I
         'START SORT
270
280
         FOR I = 1 TO N
290
         FOR J = 1 TO N - 1
300
         IF W(P(J,1)) < W(P(J+1,1)) THEN 320
310
         EXCHANGE P(J,1),P(J+1,1)
312
         EXCHANGE P(J,2), P(J+1,2)
314
         EXCHANGE P(J,3), P(J + 1,3)
320
         NEXT J
         NEXT I
330
         7.7.7
340
350
         ?"WHEEL";TAB(10);"FRONT";TAB(20);"REAR"
         FOR I = 1 TO N
360
         PRINT USING "###.##"; W(P(I,1));
370
375
         PRINT TAB(10); F$(P(I,2)); TAB(20); P(I,3)
```

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#### Notes on Gear Ratios

Contrary to popular belief, on most ten-speed bicycles the first five gear ratios are not all produced using the small front sprocket, with the top five gear ratios correspondingly produced using the large front sprocket. The actual case is more complicated, as can be seen from listing 2.

On many bikes, the setup is as follows. The first and

Listing 2: Sample execution of the program of listing 1. The gear ratios are measured in terms of the equivalent size of the front wheel of a high-wheel (ie: penny-farthing) bicycle needed to produce the same final drive ratio.

RUN
NUMBER OF FRONT GEARS? 2
NUMBER OF GEARS ON REAR FREEWHEEL? 5
REAR WHEEL DIAMETER? 27
NUMBER OF TEETH ON INNER GEAR? 44
NUMBER OF TEETH ON OUTER GEAR? 52
NUMBER OF TEETH ON 1 REAR GEAR? 14
NUMBER OF TEETH ON 2 REAR GEAR? 16
NUMBER OF TEETH ON 3 REAR GEAR? 18
NUMBER OF TEETH ON 4 REAR GEAR? 20
NUMBER OF TEETH ON 5 REAR GEAR? 22

WHEEL	FRONT	REAR
54.00	INNER	5
59.40	INNER	4
63.82	OUTER	5
66.00	INNER	3
70.20	OUTER	4
74.25	INNER	2
78.00	OUTER	3
84.86	INNER	1
87.75	OUTER	2
100 29	OUTER	1

READY:

lowest gear ratio is produced using the small front sprocket and the largest rear sprocket. The second gear ratio is produced using the small front sprocket and the next-to-largest rear sprocket.

Now for the anomaly. The third gear ratio is produced using the large front sprocket and the largest rear sprocket. The fourth gear ratio is obtained using the small front sprocket and the third-largest rear sprocket. For the fifth gear ratio, we move the chain back onto the large front sprocket and onto the second-largest rear sprocket.

At this point, we may become perplexed. Is there not one pattern in the sprocket use that we can remember? Well, there is some regularity. Using the small front sprocket and all the rear sprockets in order from largest to smallest, we obtain gear numbers 1, 2, 4, 6, and 8. Using the large front sprocket and all the rear sprockets in order from largest to smallest, we obtain gear numbers 3, 5, 7, 9, and 10. So really, only the very top and bottom gears fall out of the easily remembered even/odd sequence.

Now you may object, "How am I supposed to follow such a complex shifting sequence while I am dodging traffic, pot holes, and vicious dogs?" Well, you don't have to follow the sequence strictly.

Most bike riders, in fact, rarely use gears three and eight. These are the extreme combinations of large front sprocket with largest rear sprocket, and of small front sprocket with smallest rear sprocket. Since the chain has to bend rather sharply when it is set up in these combinations, mechanical stress and wear are increased.

In my own riding around hilly Peterborough, New Hampshire, I typically leave the chain on the large front sprocket and shift up and down through the range made available by moving the chain to the various rear sprockets. I move the chain to the small front sprocket when I need the bottom two gears, such as when I ride up the steep hill that leads to my home. . . . RSS

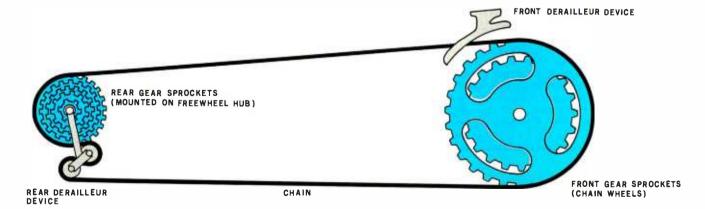
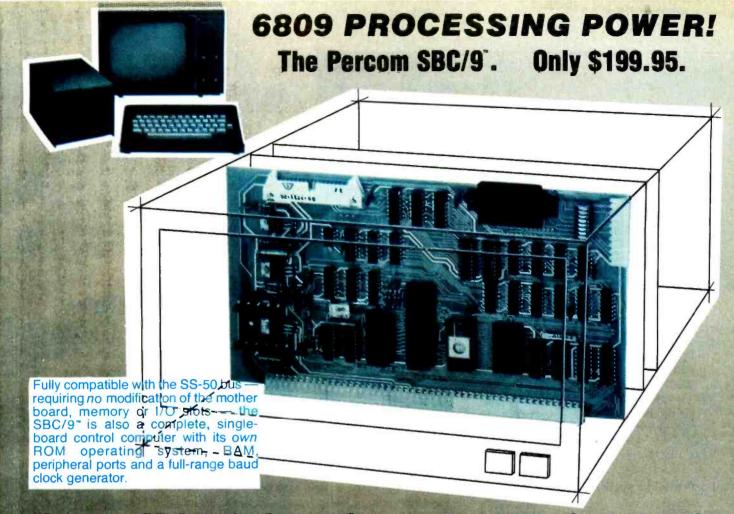


Figure 1: Diagram of the drive mechanism of a ten-speed, derailleur-equipped bicycle. The pedal cranks (not shown) are attached to the front gear sprockets (ie: chain wheels) through the crank axle. The front derailleur device can shift the chain between the large front sprocket and the small front sprocket.

The rear gear sprockets are attached to the rear axle by means of a freewheel hub that allows the rider to stop pedaling while the bicycle remains in motion. The rear derailleur device can shift the chain between any of the five rear gear sprockets. Different front and rear sprocket combinations produce the ten gear ratios.



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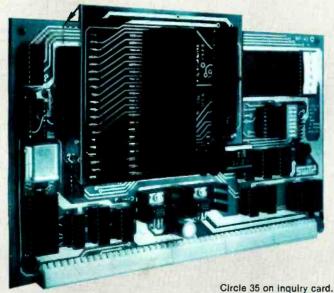
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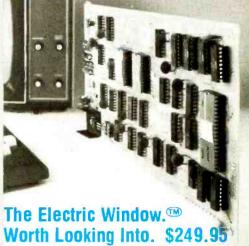
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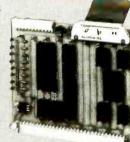
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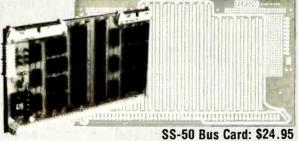
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# Solving Problems Involving Variable Terrain

# Part 2: Special Cases, Including Hexagonal Grids

Scott T Jones 271 NW 28th St Boca Raton FL 33431

In part 1 some general terrain problems were defined. These were problems that could be expressed in terms of movement on a map, with terrain defined as any map feature affecting movement. By superimposing a rectangular grid and coordinate system on these maps, we were then able to represent the terrain with a set of boolean arrays or terrain masks. Movement, distance, and the concept of movement cost for different types of terrain were also defined. A scatter function was then defined to generate scatter maps representing all possible movement within the limits imposed by the terrain.

Finally, we demonstrated the use of these scatter maps to solve such problems as the feasibility of road construction within cost restraints and the determination of an optimal path between two points on a map, across variable terrain.

Part 2 is concerned with the application of these techniques to the problems encountered in conflict simulations.

#### Conflict Simulations and the Hexagonal Grid

The most common type of conflict simulation is the war game. In a war game, playing pieces that represent military units are moved on a terrain map to simulate a battle. The map has been overlaid with a grid; each unit has an inherent movement factor; and each type of terrain has a movement cost. The ideas presented in this article were developed when I was trying to solve the problems of writing programs to play conflict simulations.

The most common grid used today is the hexagonal grid. Instead of an array of squares, the map is divided into hexagons or "hexes" to form a honeycomb pattern. Each hexagon has six adjacent hexagons. We can easily define the distance between a hexagon and any adjacent hexagon to be equal to 1 without worrying about the am-

biguous, diagonally adjacent squares that we encountered with rectangular grids. The problem is in defining a coordinate system and a distance function or metric.

Most games use an offset coordinate system. The hexagonal grid is treated as a rectangular grid in which every even-numbered column is offset by one-half the size of the squares. (See figure 9.) The trouble with this system is that there is no uniform relationship between these coordinates and a metric. Note the relationships of the coordinates of those hexagons adjacent to (2,2) as opposed to (3,2). Separate metrics must be used for the even and odd values of the first coordinate. Clearly, another system is required.

The solution is the *slant* coordinate system (X,Y) where the second coordinate is constant along a slanting, diagonal line from upper right to lower left, or viceversa. (See figure 10.) The relationships of the coordinates are now consistent throughout the array.

By defining a third, dependent coordinate Z to be X-Y+C, where C is any integer constant, our slant metric (ie: distance function) is simply the maximum of the absolute values of the differences of the three coordinates. That is, for (a,b,c) and (d,e,f), the distance is defined as:

$$\max(|a-d|,|b-e|,|c-f|)$$

The Z coordinate is constant along the other slanting line from upper left to lower right. It will be left for the reader to prove both of these statements by working examples with figure 10.

Using these slant coordinates, we can now assign any hexagon to a square in a standard, rectangular scatter



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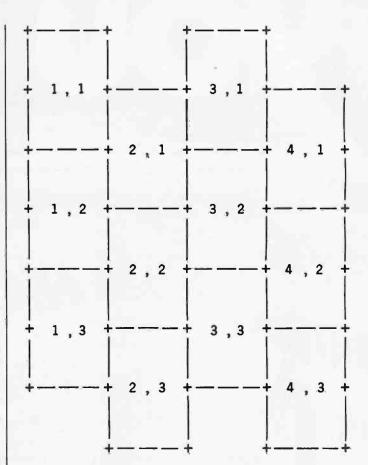


Figure 9: When working with a hexagonal grid, a set of coordinates different from those used for a square grid must be developed. One such coordinate system, shown here, is the offset coordinate system. This system produces difficulties when the distance between two coordinates must be determined. (Numbering of figures is continued from Part 1.)

mapping. Each hexagon (X,Y) is assigned to the square or element in row X and column Y of the two-dimensional matrix. The hexagonal scatter function HSC will assign to each element in array B the value:

$$B(I,J) = HSC(A(I,J)) = A(I,J) OR A(I-1,J-1) OR A(I-1,J) OR A(I,J-1) OR A(I,J+1) OR A(I+1,J+1)$$

Figure 11 demonstrates the scatter mappings that are generated from the same initial position used with the square and city scatter functions in a previous example. (See part 1, figure 4.)

If we are working with a map that already has offset coordinates printed on it, in a case where we would prefer to use slant coordinates, the following relations allow an easy transformation from one system to the other:

$$X(slant) = X(offset)$$

and

$$Y(slant) = Y(offset) + INT(X/2)$$

where INT is the greatest-integer function.

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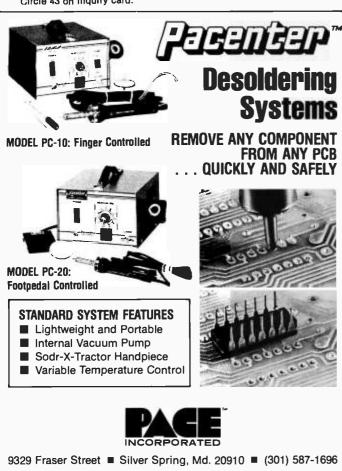
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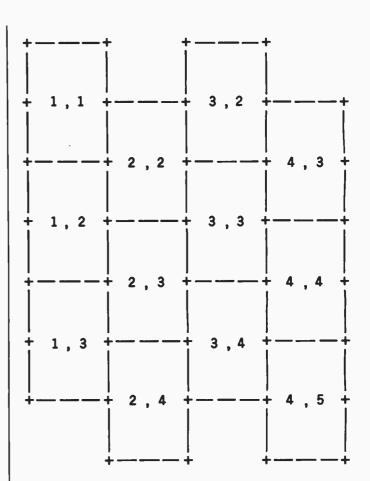


Figure 10: A coordinate system that solves the distance problems found in the offset coordinate system is the slant coordinate system. In this system, one of the coordinates is constant along a diagonal (ie: slanted) axis.

Specific Game Applications

It should now be obvious how to determine movement in a game environment when fixed terrain is the only constraint. However, in many war games, the concept of a zone of control introduces a new type of terrain. The unit may enter this zone at the normal movement cost but may not leave until the opposing unit that *imposed* the zone of control is removed, usually by combat of some form.

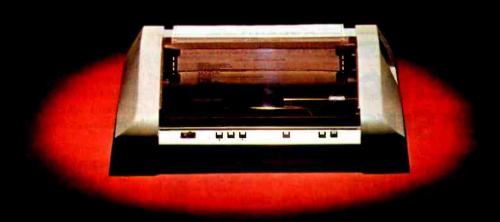
A unit's zone of control is usually defined as all positions (ie: squares or hexagons) that are adjacent to the unit's own position. In other words, a unit's zone of control is simply the first scatter mapping of its position. Thus, when moving with the constraints of zones of control, a new terrain map Z must be defined where Z(I,J) is 0 if (I,J) is 1 in the first scatter mapping of any opposing unit, and Z(I,J) = 1, otherwise.

This terrain map is then used to mask out starting positions that will be used on the next scatter. This gives us the relation:

	OR (T1 AND OR (T2 AND		
•			
•			
•	OR (Tk AND	XSC(Z. AND	(Mn-k)

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00000	0 1 1 0 0	1 1 1 1 0
00100	0 1 1 1 0	1 1 1 1 1
00000	00110	0 1 1 1 1
00000	00000	0 0 1 1 1
a. A	b. HSC(A)	c. HSC(HSC(A))

Figure 11: An example of the hexagonal scatter-function mappings that develop from a central starting point, assuming that the movement cost of all terrain is equal.

This relation now shows how we can "premask" our scatter mappings to include the effects of zones of control or other types of no-exit terrain found on our terrain map

while we postmask to include the effects of movement costs.

This relation is the basis for our movement algorithm in most conflict simulations. With it, we can easily determine not only if a unit can reach a position, but also if the unit is inhibited by opposing units or if it is surrounded. By operating with sets of these scatter mappings, we can even coordinate the moves of a group of units. Scatter mappings can be weighted by the relative combat strengths of the corresponding units so that sums of these weighted mappings represent the total strength that can be applied to any position on the map.

The metrics (ie: distance functions) work well as range functions for game features that are unaffected by ter-

> rain, such as determining the range to a target in the simulation of naval battles. Line-of-sight rules that govern the use of projectile weapons in land-battle simulations pose new problems which we will not attempt to resolve at this time.

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In a game environment, concessions are often made to the scale of the terrain map. This means that prohibited terrain, like rivers, or ideal terrain, such as roads, must be represented in a nonstandard way. In situations where you are not fixed by the terrain map provided with the game, you may either increase the scale so that terrain types can be easily isolated, or reduce the scale so that single locations contain many types of terrain, but the effects are dominated by only one type.

With a fixed scale, however, our algorithm must be modified. For example, when we have roads that lower the movement cost for units following the road, we must first adjust our cost scale so that this cheaper, road-movement cost is our unit cost.

Next we must define a set of directional terrain masks which function like the zone-of-control masks to premask invalid starting positions for the direction being considered. In the mask for a given direction, the locations contain values of 1 if movement is allowed from the current position in that given direction. Otherwise, the locations contain 0.

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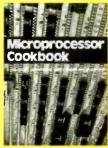
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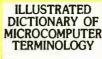
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Prohibited terrain, such as a river that occupies only the edges of a position and can be crossed only via a bridge, poses yet another problem. A bridge is an example of directional terrain that does not affect the movement cost. To include the effects of bridges, you must define a set of directional terrain premasks to be used in conjunction with all other terrain masks. To represent the effects of directional terrain that adds a constant factor to the movement costs, yet another set of premasks must be defined.

The most effective way to use these directional terrain masks is by modification of the basic scatter function. Consider a game situation where we have clear terrain (one movement factor), rough terrain (two movement factors), roads (one-half movement factor in the direction that the road travels), and bridges over rivers (restricted movement that does not alter movement cost). Let us also use the city metric.

First, we must scale all of our movement costs to reflect the lower cost for the ideal terrain. Thus, we have roads



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(1), clear (2) and rough (4). Note that bridges are unaffected. Let T2 and T4 be the terrain masks for clear and rough terrain as described in part 1 of this article. Let Id be the terrain mask for the ideal terrain in the d direction and let Pd be the terrain mask for the prohibitive terrain (eg: rivers without bridges) in the d direction, where d=1, 2, 3, 4. Both Id and Pd will be 1 only if movement is allowed from that location in direction d for each position on the map. Note that Id(I,I) = Id(I,I) AND Pd(I,I) for all I and I.

Let us now define our modified scatter functions CSC' and CSC" as follows:

```
CSC'(A(I,J)) = A(I,J) OR (I1(I,J+1) AND A(I,J+1))

OR (I2(I,J-1) AND A(I,J-1))

OR (I3(I+1,J) AND A(I+1,J))

OR (I4(I-1,J) AND A(I-1,J))
```

Similarly:

$$CSC''(A(I,J)) = (I,J) OR (P1(I,J+1) AND A(I,J+1))$$
  
 $OR (P2(I,J-1) AND A(I,J-1))$   
 $OR (P3(I+1,J) AND A(I+1,J))$   
 $OR (P4(I-1,J) AND A(I-1,J))$ 

Finally, by replacing CSC in the mapping relation developed in part 1 with CSC' and CSC" we get:

$$Mn=Mn-1$$
 OR CSC'( $Mn-1$ )  
OR (T2 AND CSC''( $Mn-2$ ))  
OR (T4 AND CSC''( $Mn-4$ ))

#### Summary

We have seen that many problems involving variable terrain may be solved through the use of scatter mappings, scatter sums, premasking, and postmasking. Fixed, prohibited, and ideal terrain, as well as no-exit conditions, have been discussed in reference to our general algorithm of successive scatter mappings. Three different scatter functions and distance-function metrics have been demonstrated for use with two different grids. Two different coordinate systems have also been presented for hexagonal-grid problems.

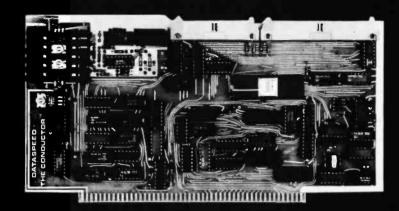
Since you will most likely want to code it in your favorite language, I have not tried to write this algorithm as a program. I will, however, make a few suggestions. Perform logical functions on groups of elements simultaneously. The rows and columns of the arrays used in the island problem lend themselves nicely to implementation as 8-bit bytes of data. By using a little judicious shifting of these bytes, entire arrays can be scattered with only a few operations.

Do not be afraid to waste a few bits of storage or perform a few unnecessary logical operations to gain a more general representation of your map. It is easier to employ a buffer of unused elements around your arrays than to check for array subscripts that are out of range. Notice how the water terrain provided just such a buffer in the island problem.

In conclusion, this graphical approach to terrain problems provides a viable solution for a wide range of applications, not the least of which is conflict simulation.

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# TRS-80 Performance

# **Evaluation by Program Timing**

James R Lewis 4051 Mountain Dr San Bernardino CA 92407

I have been asked to evaluate the performance characteristics of numerous hardware and software computer products in my capacity as a systems programmer. In late 1978 I acquired a Radio Shack TRS-80 personal computer system with Level I BASIC and 4 K bytes of memory. I did not consider a performance evaluation; after all, this was my own toy. I did not have to respond to any requests for performance improvements or evaluations. Only my personal satisfaction was important.

As it turned out, I was satisfied, but my friends and colleagues were not. They were continually asking,

Listing 1: Prime-number generator written in Level I BASIC for the TRS-80. No attempt was made here to optimize the speed of execution.

```
PRINT " LIST OF PRIME NUMBERS"
40
      PRINT
50
      PRINT 1;2;3;
55
      C = 0
70
      M = 3
      M = M + 2
      FOR K = 3 TO M/2 STEP K - 1
90
100
      IF INT(M/K)*K - M = 0 THEN 190
110
      NEXT K
121
      PRINT M;
122
      C = C + 1
190
      IF M < 10000 THEN 80
      PRINT "C = ";C
195
200
```

Listing 2: Level I BASIC version of the prime-number generator in which abbreviations were used and explanatory material omitted to increase speed. Such practices are termed "optimization."

80	F.M = 5TO10000S.2
90	F.K = 3TOM/2S.2
100	IFI.(M/K)*K = MT.N.M
110	N.K
120	P.M;
190	N.M

"How fast does your toy run?" or "What new tricks have you taught it now?" It seemed that a comprehensive performance testing and evaluation plan was called for. I decided to compare my TRS-80 personal computer with one of the IBM computers (a System/370-148) at work. Since I was also in the process of converting from Level I to Level II BASIC and acquiring more hardware, I wanted to see if I could verify the performance improvements claimed by Radio Shack.

#### Test Problem

The test problem to be solved was one familiar to computer science students: calculation of primenumber integers from 5 to 10,000. This problem was chosen for several reasons. First, it is a problem that many computer programmers can relate to; second, it uses two program loops; and third, it requires calculations more complex than simple addition. The number of microseconds or nanoseconds required to perform a single function like addition does not adequately describe the performance characteristics of an individual computer, nor does comparison of timing determine the difference between two machines. What is needed is a comparison of a group of instructions or the use of a program representative of those which will be used extensively on that computer as the comparison base. The problem used here performs loops, does moderately complex arithmetic calculations, and performs some input/output (I/O) operations.

### Test Problem and the TRS-80 Level I

Listing 1 gives the BASIC statements from my first coding of

the test problem. Note that each keyword of the program was completely entered and spelled out in full, without regard to the abbreviations allowed in Level I. This code took 8 hours and 12 minutes to run to completion (see table 1 for a complete comparison of the results). By simply using the keyword abbreviations (ie: F. instead of FOR and N. instead of NEXT, shown in listing 2), the run time was cut to 7 hours and 12 minutes. The extra N.M (NEXT M) statement was used to speed up the loops, but at the completion of the problem run, a FOR-NEXT error results. This is okay because the problem has been completed.

Listing 3: Level II BASIC version of test program. Keywords must be spelled out in Level II, but the use of integer variables makes it faster than the optimized Level I program. Level II BASIC is also an interpretive system.

10	DEFINTM,K
80	FORM = 5TO10000STEP2
90	FORK = 3TOM/2STEP2
100	IFINT(M/K)*M = MTHENNEXTM
110	NEXTK
120	PRINTM;
190	NEXTM

The first performance conclusion has been reached; abbreviated syntax cut an 8-hour program by 1 hour. This gave me a 12% improvement in throughput, the magic measure of system performance. Now the problem solution can be accelerated with faster software. For \$99 you can go back to fully spelled out keywords and still gain speed. [Although Level II BASIC requires that keywords be entered in the fully spelled out form, and displays them in that way, the keywords are stored in memory in the

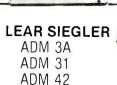
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#### Test Problem and Level II BASIC

I sent back my TRS-80 Level I 4 K computer. A short time later it came back with Level II BASIC and an expanded 16 K bytes user memory. The original test problem now ran in 6 hours and 31 minutes. This improvement was approximately 9%; there was an \$11 investment for each percent of performance gained.

Test	Listing	hours	Run Time minutes	seconds	Description
1 2 3 4 5 6	1 2 3 4 4 5	8 7 6	12 12 31 21 22	13 27 10 55 50 19	TRS-80 Level I Nonoptimized BASIC TRS-80 Level I Optimized BASIC TRS-80 Level II BASIC Z80 Assembler Language Z80 Assembler Language under TRSDOS Disk Operating System PL/I for IBM 370-148 using Optimizing Compiler 370-148 Assembly Language IBM 370-148 Assembly Language
					IDIVI DI DE 140 Addenibily Language

Table 1: Summary of tests in our performance evaluation. In each case the program found integer prime numbers from 5 to 10,000.

Test Problem and Z80 Assembly Language

Several years ago I became proficient in Datapoint 2200 assembly language, which is very similar to Z80 assembly language. I thought that several hours of coding and testing would be required to implement the test problem in Z80 assembly instructions. After several days of relearning the microinstruction format and developing the conversion and division subroutines, I finally ran my assembly test. To my surprise, it now ran in just under 22 minutes, an improvement of over 6 hours. Note that in the assemblylanguage program multiplication was not required, because all that is needed for prime number detection is division and determination of the remainder. The quotient proved useful in controlling the inner loop.

My next expansion of the system added a floppy-disk drive and more memory to a 32 K bytes total. There was an apparent five-second reduction in run time when the prime number output conversion was eliminated. However, I observed no noticeable performance change when the program ran in either the first 16 K bytes of memory or in the second 16 K bytes. Now that I had a disk and the TRSDOS disk operating system, I thought of the real-time CLOCK function now activated and wondered about its effect on performance.

#### Test Problem and the TRSDOS Disk Operating System

I relocated my assembly-language program to hexadecimal location

Text continued on page 92

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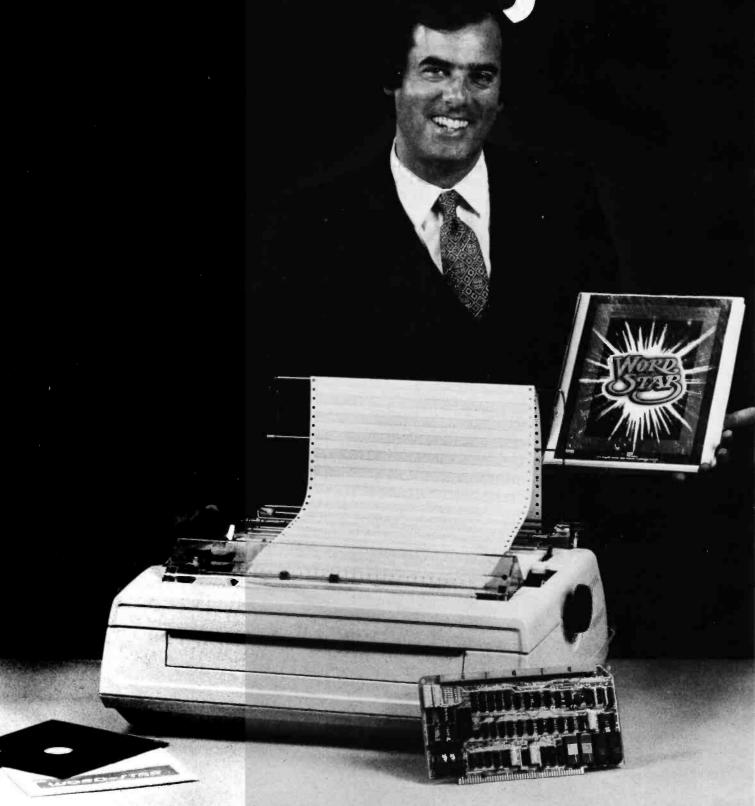
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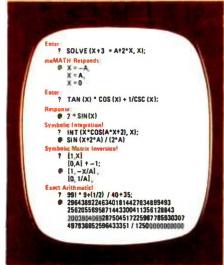
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**Listing 4:** Prime-number generator coded in Z80 assembler for the TRS-80. The Radio Shack Editor and Assembler package was used. The efficiency of assembler coding is clearly shown in the greatly reduced execution time. No interpretation is required; we are speaking in the "native language" of the machine.

ure speakin	8 111 1116	number language of the h	machine.
START	ORG LD INC LD LD SUB LD SBC IR LD LD	7000H HL,(NUM) HL HL (NUM),HL A,10000<8<-8 L A,10000<-8 A,H C,DONE DE,1 (NUM2),DE	GET NUMBER  BUMP NUMBER  BY TWO TO INSURE ODD VALUE  SAVE FOR NEXT TIME  LSB OF 10000  DOUBLE PRECISION COMPARE  MSB OF 10000  CHECK HIGH BYTE  END OF RUN  START VALUE  SAVE IT
DLOOP	LD INC INC LD LD CALL LD OR IR DEC LD OR IR NUMBER LD LD CALL LD CALL LD CALL LD INC LD IR	DE,(NUM2) DE DE (NUM2),DE BC,(NUM) HL,0 DIV16 A,H L Z,START BC A,B C NZ,DLOOP R IS PRIME HL,(NUM) IX,WORK DCONV HL,WORK DSPLY HL,(COUNT) HL (COUNT),HL START	:DIVISOR :BUMP IT :TWICE TO KEEP ODD :SAVE FOR NEXT TIME :TARGET :CLEAR HIGH HALF OF DIVIDEND :PERFORM 16 BIT DIVIDE :CHECK REMAINDER :IF ZERO WAS DIVISABLE :AND NOT PRIME :CHECK FOR ONE :AS THIS MEANS WE :HAVE GONE HALFWAY :NO, LOOP :DISPLAY THIS NUMBER :WORK AREA :CONVERT TO ASCII :AREA FOR DISPLAY :TO SCREEN :COUNT PRIME NUMBERS :BY ONE
; DONE	LD LD CALL LD CALL JR	HL,(COUNT) IX,WORK DCONV HL,TOTAL DSPLY \$	;DISPLAY TOTAL COUNT ;CONVERT TO ASCII ;DISPLAY STRING ;LOOP
TOTAL WORK NUM NUM2 COUNT ; DCHAR DSPLY	DEFM DEFM DEFW DEFW DEFW EQU LD CP RET CALL INC IR	'TOTAL = ' '12345 ' 3 1 0 0 DISPLAY STRING TO SO 33H A,(HL) 3 Z DCHAR HL DSPLY	;LEVEL II CHAR DISPLAY ;GET CHARACTER ;END OF STRING? ;YES, DONE :LET LEVEL II MANAGE SCREEN ;BUMP MEMORY POINTER
DCONV DCONV1	LD LD LD LD INC LD INC		T AREA POINTED TO BY IX ;TRIGGER AND ASCII CHARACTER ;COUNT OF CONVERSION ;CONVERSION TABLE ;LSB OF FACTOR ;MSB OF FACTOR
DCONV2	SUB SBC	A HL,DE	;CLEAR C FLAG AND DIGIT COUNTER ;16 BIT SUBTRACT

Listing 4 continued on page 92

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```
Listing 4 continued:
                   C,DCONV3
                                        :UNDERFLOW
           IR
           INC
                                        :BUMP DIGIT
                   Ā
           JR
                   DCONV2
                                        CONTINUE BUILDUP
                   HL,DE
DCONV3
           ADD
                                        :COMPENSATE FOR UNDERFLOW
           OR
                                        ;NON-ZERO DIGIT?
                   Z.DCONV4
                                        :NO. ZERO. DO NOT RESET TRIGGER
           JR
                                        ; ASCII TRIGGER
           LD
                   C,'0'
                                        ;TURN INTO ASCII (OR BLANK)
DCONV4
           OR
                   C
                   (IX),A
                                        STORE DIGIT
           LD
           INC
                   ΙX
                   DCONV1
           DJNZ
                                        :COUNT DOWN
                                        ;MUST SHOW A ZERO DIGIT
           LD
                   A,(IX-1)
                                        :IF ZERO
           OR
                   '0'
           LD
                   (IX-1),A
           RET
                   CONVERSION TABLE
CTBL.
           DEFW
                   10000
           DEFW
                   1000
           DEFW
                   100
           DEFW
                   10
           DEFW
; 16 BIT DIVISION
      DIVIDEND = HLBC
       DIVISOR = DE
     OUOTIENT = BC
    REMAINDER = HL
DIV16
        LD
                A,16
                                      ;16 BIT DIVISION
DIV161
        SLA
                C
                                      :MOVE C REG
        RL
                R
                                      ;NOW B WITH CARRY
        ADC
                                      BUMP REMAINDER
                HL.HL
                                      ;16 BIT SUBTRACT WITH CARRY
        SBC
                HL,DE
        IR
                NC,DIV162
                                      ;UNDERFLOW
                                      ;ADJUST
        ADD
                HL.DE
                DIV163
                                      SKIP SETTING QUOTIENT BIT
        IR
DIV162
        INC
                                      ;BUMP QUOTIENT
                C
DIV163
        DEC
                                      :DECREMENT LOOP COUNTER
        IR
                NZ,DIV161
                                      :LOOP TIL DONE
        RET
        END
                START
```

Listing 5: Test program coded in the PL/I language for the IBM System/370-148. An optimizing compiler was used to run this version. Compilation is more efficient than interpretation in reducing execution time. This program also finds prime numbers.

```
PRIME: PROC OPTIONS(MAIN) REORDER:
         DECLARE (C, D, M) FIXED BINARY(31) INIT(0);
         DO M = 3 \text{ to } 10000 \text{ BY } 2;
                  DO D = 3 \text{ TO M/2 BY 2};
                           IF MOD(M, D) = 0 THEN GOTO NOT_PRIME;
                  C = C + 1;
                  PUT LIST(M):
NOT_PRIME:
         END:
         PUT SKIP DATA(C);
END PRIME;
```

#### Text continued:

7000 and constructed a disk operating system command (CMD) file. When run under the disk operating system, the test problem execution time was extended by 55 seconds. I attributed this delay to the 25 ms interrupt from the expansion interface and the processing required to service the interrupt and update the clock. This amounted to about 4 to 5% overhead. Using the disk operating system BASIC, the T command to turn off the interrupt will speed up the execution of programs not requiring clock functions. Listing 4 represents the Z80 assembly-language version of the prime number finding program.

Circle 56 on inquiry card.



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Checker King

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Listing 6: Test program coded in assembler language for the IBM 370. Writing in the native language of this very fast machine, we obtain the shortest time for finding prime numbers from 5 to 10,000.

	LA	R2,5	STARTING VALUE FOR TEST
	SR	R10,R10	COUNT OF PRIME NUMBERS
	LA	R6,2	LOOP INCREMENT - INNER LOOP LOOP INCREMENT - OUTER LOOP
	LR LH	R8,R6 R9, = H'10000'	UPPER LIMIT FOR OUTER LOOP
OLOOP		R3,3	STARTING VALUE FOR TESTING NUMBER
OLOOP	LR	R7,R2	COMPUTE INNER LOOP LIMIT
	SRL	R7,1	DIVIDE BY TWO
ILOOP	SR		ZERO EVEN DIVIDEND PAIR
	LR	R5,R2	LOAD ODD DIVIDEND VALUE
	DR	R4,R3	R3 IS DIVISOR
	LTR	R4,R4	CHECK REMAINDER
	BZ	NEXTO	ZERO IS NOT PRIME
	BXLE		
	CVD		CONVERT PRIME NUMBER TO DECIMAL
	UNPK		
	OI		
	PUT		OUTPUT PRIME NUMBER
	LA	R10,1(,R10)	INCREMENT PRIME NUMBER COUNT
NEXTO	BXLE		
	CVD		CONVERT COUNT TO DECIMAL
	UNPK	DATA(7), WORK + 4(4)	AND TO EBCDIC
	OI	DATA + 6, X'F0'	
	PUT	SYSPRINT, DATA	OUPUT COUNT

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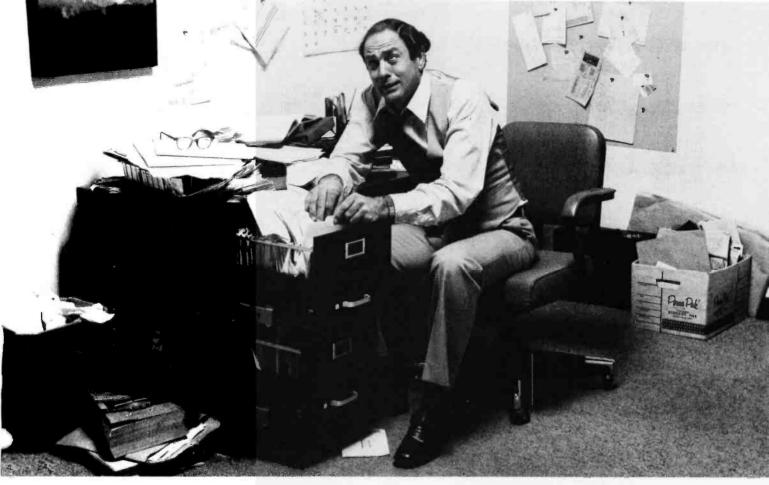
### Test Problem and the Large System

At the completion of the TRS-80 testing phase, I coded two versions of the test problem to be run on the IBM 370-148. Listings 5 and 6 show PL/I language and 370 assembler language codings of the prime-number generator. The execution times showed little difference. The PL/I version (compiled, rather than interpreted) ran in 1 minute and 19 seconds of processor time. The test run in assembler language used 56 seconds of processor time.

The best comparison between the two machine's capabilities is arranged by counting the number of instructions needed to perform division; twelve for the TRS-80 (ten of which are looped sixteen times) and one for the 370. Performance difference is also indicated by the average execution time of 1108 us for the Z80 division subroutine versus 30.7 µs for the DR (divide register into register) instruction of the 370-148. This is a time ratio of 36 to 1. If you compare a less complex function, such as 16-bit storage-to-register load, the TRS-80 performs closer to the 370 capability; the Z80 LD HL,(n) instruction takes 16 cycles or 9.008  $\mu$ s, and the 370 load halfword takes 1.958 μs. The 16-bit load operation compares as a 4.6 performance ratio. Thus, it is shown that a single instruction comparison does not always represent the required work performance ratio.

#### Conclusions

The test program I chose can be run with the same results on both the TRS-80 and the IBM 370-148. There is a difference in system throughput and cost. An analysis of the TRS-80 performance indicates that the advertised improvements of Level I keyword abbreviations and Level II BASIC are present. The analysis of the TRS-80 BASIC versus Z80 assembler language shows a significant improvement in assembler language, if you care to code the program that way or if you need the speed. I now have an answer for my friends at work when they ask about the speed differences between my personal computer system and the impersonal IBM 370-148. ■



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#### Editorial Listing 1 continued from page 12:

```
: INTEGER;
: (second:third);
    which_rins
                                       absolute_time;
    3,0,0
    ring_time : absolute_time;
second_contact_ring : absolute_time;
                                  : absolute_time;
    third_contact_rins
                                   : absolute_time;
: absolute_time;
: absolute_time;
    time_totality
    mardin_time
   current_time
half_time
auarter_time
                                    : absolute_time;
                                   : absolute_time;
: absolute_time;
: absolute_time;
: absolute_time;
: absolute_time;
     slack_in_totality
     total duration
    maximum
total_eclipse
rind_frames
                                 : exposures;
                                 : exposures;
     current shot
    ten_shot_grouping : PACKED ARRAY[0..9] OF an_exposure_detail; transient_shots : PACKED ARRAY[0..1] OF an_exposure_detail;
PROCEDURE new_page;
         stuff : STRING[24];
          clear_screen : CHAR;
    RECTN
           stuff := "
        stuff != 'clear_screen := CHR(24);
WRITELN(clear_screen, stuff);
WRITELN(' ');
WRITELN(' ');
          WRITELN( S )
PROCEDURE set_parameter(VAR time : absolute_time);
          a_string : STRING[128];
i : INTEGER;
period : BOOLEAN;
          decimal_count : INTEGER;
factor, result : INTEGER;
          PROCEDURE add_a_disit(position : INTEGER);
              disit : INTEGER;
BEGIN
                   an
digit := (ORD(a_stringCposition])-ORD('0'));
IF period THEN
                        period THEN
BEGIN
                            decimal_count := decimal_count + 1;
IF decimal_count < 4 THEN
BEGIN
```

```
time.thousandths := time.thousandths
+ ((1000 # disit) DIV factor);
factor := 10 # factor
                   END
              ELSE (before period)
  time.units := (time.units * factor) + disit
         FND:
BEGIN (set_parameter)
    :IN (set_manager)
PAGE(OUTPUT);
time.units := 0;
time.thousandths := 0;
WHILE ((time.units=0) AND (time.thousandths=0)) DO
BEGIN
               factor := 10;
decimal_count :=
period := FALSE;
WRITELN(s);
               READLN(a_string);
FOR i := 1 TO LENGTH(a_string) DO
BEGIN
                        add_a_disit(i)!
                                 period := TRUE
              END CHHILE)
     END (set_parameter);
PROCEDURE initialize;
           : INTEGER:
     := 1;
:= 4;
:= 16;
:= 64;
:= 120;
:= 256;
:= 512;
:= 1024;
         ten_shot_sroupins[7].duration
ten_shot_sroupins[8].duration
ten_shot_sroupins[9].duration
FOR i := 0 TO 9 DO
                                                               := 2048;
               ten_shot_grouping[i].wait_after := overhead_duration;
         transient_shots[0].duration transient_shots[1].duration FOR i := 0 TO 1 DO
```

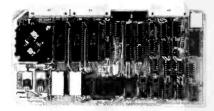
Listing 1 continued on page 98

### SPECIALIZING IN

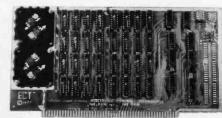
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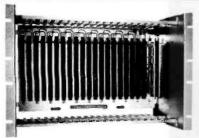
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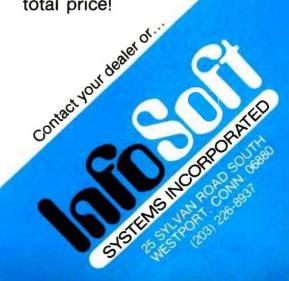
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	Signature	
Name		
Address		
City	State	Zip
I have a		
Please advise wh	en Minimodel will be availab	ole.

```
Listing 1 continued:
                transient_shots[i].wait_after := overhead_duration;
              := 'Freliminary data initialization';
          new_pase;
WRITELN(
             ""totality" is defined as time from second to third contacts');
:= ' Enter number of exposures';
          det_parameter(dummy);
          maximum := dummy.units;
s := 'Enter number of exposures during totality';
                     set_parameter(dummy);
total_eclipse := dummy.units
               END
           Unit

(total_eclipse > 0)

AND

(total_eclipse < maximum);

s := ' Enter time of totality in "seconds.thousandths"';

set_parameter(time_totality);
    s:= ' Enter slack time margin (in seconds)';
get_parameter(slack_in_totality);
crash_ahead := TRUE
END (initialize);
PROCEDURE error_abort;
     BEGIN
          IN
maximum != 250;
total_eclipse != 200;
rins_frames != 25;
MRITELM('Unrecoverable error in data');
crash_ahead != FALSE
FROCEDURE subtract_time(a,b : absolute_time; VAR c : absolute_time);
          c.thousandths := a.thousandths - b.thousandths;
           sidma t= 0;
IF c.thousandths < 0 THEN
                     c.thousandths := c.thousandths + 1000;
                ENT
    C.units
END;
                        t= a.units - b.units + sisma
PROCEDÜRE divide_time(
                                      VAR a : absolute_time;
b : absolute_time;
n : INTEGER
                                    n
     ( a <-- b DIV n ∮
VAR
           Pra : INTEGERC163;
     BEGIN
         GIN

a.thousandths := 0;
a.units := 0;
a := b.units;
a := a * 1000;
a := a + b.thousandths;
a := a DIV 1000;
F = a DIV 1000;
FF p < 32768 THEN
a.units := TRUNC(p);
F := a - (1000 * F);
F = a 2768 THEN
a.thousandths := TRUNC(p)
b;
     END;
PROCEDURE add_time(a,b : absolute_time; VAR c : absolute_time);
     BEGIN

sigma := a.thousandths + b.thousandths;
c.thousandths := sigma MOD 1000;
c.units := a.units + b.units + (sigma DIV 1000)
PROCEDURE print_time(a : absolute_time);
          =1000 - = 100 : STRINGE 1 1:
    BEGIN
          IF a.thousandths < 100 THEN z1000 := '0' ELSE z1000 := 'IF a.thousandths < 10 THEN z100 := '0' ELSE z100 := '';
WRITELN(s,a.units,'.',z1000,z100,a.thousandths)
FROCEDURE normalize_timins;
                                   : INTEGER;
    PROCEDURE sum_up_ring(ring: INTEGER; VAR ring_total : absolute_time);
               index.i : INTEGER;
this_rins : absolute_time;
               ring_total.units := 0;
ring_total.thousandths := 0;
FOR i := 1 TO ring_frames DO
REGIN
                          IN
this_ring.units := 0;
this_ring.thousandths := transient_shots[ring].wait_after;
add_time(this_ring.ring_total,ring_total);
this_ring.thousandths := transient_shots[ring].duration;
this_ring.thousandths := transient_shots[ring].duration;
                    this_ring.thousandths (= transient_shots[
add_time(this_ring,ring,ring_total)ring_total)
END
    PROCEDURE sum_ur_eclipse(VAR eclipse_total : absolute_time);
```

this\_shot : absolute\_time; index.i.J : INTEGER; BEGIN

eclipse\_total.units := 0; eclipse\_total.thousandths := 0; FOR i := 1 TO total\_eclipse DO BEGIN

Listing 1 continued on page 100

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- EXPLICIT REPRESENTATION OF ONE-TO-ONE, ONE-TO-MANY, MANY-TO-ONE AND MANY-TO-MANY SETS
- RECORO TYPES MAY OWN OTHER OCCURRENCES OF THE SAME RECORD TYPE
- A SINGLE SET MAY HAVE MULTIPLE OWNER AND MEMBER RECORD TYPES

#### FEATURES COMMON TO HDBS and MDBS

STRAIGHT FORWARD USE OF ISAM-LIKE STRUCTURES

SORTED, FIFO, LIFO, NEXT AND PRIOR SET ORDERING PROVIDED

COMMANDS TO ADD, DELETE, UPDATE, SEARCH AND TRAVERSE THE DATA BASE

NAMES OF DATA ITEMS, RECORDS, SETS AND FILES ARE WHOLLY USER DEFINABLE

RECORDS CAN BE MAINTAINED IN A NUMBER OF SORTED ORDERS

ROUTINES ARE CALLABLE FROM BASIC, PASCAL, FORTRAN, COBOL OR MACHINE LANGUAGE

WRITTEN IN MACHINE LANGUAGE FOR MAXIMAL EXECUTION EFFICIENCY AND MINIMAL MEMORY USAGE

SUPPORTS DATA BASE SPREAD OVER SEVERAL DISK DRIVES (MAX. 8) DISKS MAY BE MINI OR FULL SIZED FLOPPIES OR HARD DISKS

- Also -

UP TO 254 RECORD-TYPES MAY BE DEFINED IN THE DATA BASE EACH RECORD-TYPE MAY CONTAIN UP TO 255 ITEM-TYPES EACH ITEM-TYPE MAY BE UP TO 9,999 BYTES IN LENGTH

#### REQUIREMENTS

- Z-80 APPROXIMATELY 16K MEMORY -
- 8080 APPROXIMATELY 20K MEMORY-
- IN ADDITION TO THE OPERATING SYSTEM, HOST LANGUAGE, USER'S PROGRAM AND SOME BUFFER AREA
- 6502 APPROXIMATELY 26K MEMORY

#### NEW DYNAMIC RESTRUCTURING SYSTEM

#### MDBS-DRS FEATURES

ALLOWS ITEM, RECORD AND/OR SET TYPES TO BE ADDED TO DR DELETED FROM AN EXISTING MDBS DATA BASE. THIS ALLOWS THE USER TO RE-DESIGN A DATA BASE AFTER IT IS ALREADY ON-LINE.

THIS FEATURE CAN ONLY BE ADDED TO THE MOBS SYSTEM.

#### **RUNS UNDER**

- CP/M\* WITH MICROSOFT BASIC, COBOL AND FORTRAN
- NORTHSTAR DOS WITH NORTHSTAR BASIC
- TRSDOS\* AND DISK BASIC
- NEWDOS AND DISK BASIC
- APPLE" DOS AND APPLE" SOFT BASIC
- MACHINE LANGUAGE CALLABLE FORMS
- OTHER FORMS IN DEVELOPMENT

#### HDBS and MDBS PACKAGES INCLUDE

DDL DATA DEFINITION LANGUAGE ANALYZER/EDITOR, The user specifies data structures to be used in a Concise Data Definition Language (DDL). The Data Definition Language Analyzer/Editor allows the user to interactively create and edit DDL Specifications and to initialize the data base for use based on these specifications.

260 PAGE USERS MANUAL with extensive documentation of the Data Base Management System.

DMS DATA MANAGEMENT ROUTINES. These are the routines callable from the host language (BASIC, PASCAL, etc.) which perform the data base operations of finding, adding, and deleting records; fetching and storing data items; and traversing the (possibly complex) data structure.

#### SAMPLE APPLICATION PROGRAM AND DOL FILES

#### RELOCATOR TO RE-ORG ALL ROUTINES

SYSTEM SPECIFIC MANUAL to show how to bring up our software on your computer

MANUAL ONLY	\$ 5
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UPGRADE TO MDBS	\$550
MANUAL ONLY	\$ 35
HDBS Z80 VERSION 8080 and 6502 VERSIONS	\$250 \$325



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#### MICRO DATA BASE SYSTEMS, INC

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```
Listing 1 continued:
                                        this_shot.units := 0;
index := (i-1) MOD 10;
this_shot.thousandths := ten_shot_grouping[index].wait_after;
add_time(this_shot.eclipse_total.eclipse_total);
this_shot.thousandths := ten_shot_grouping[index].duration;
add_time(this_shot.eclipse_total.eclipse_total)
          ENTI:
PROCEDURE preliminary_allocation;
           BEGIN

s := 'Allocation of Eclipse Times...';
                                                                                              Total time for eclipse = ';
                    print_time(time_totality);
                    which_rind := second;
sum_up_rind(ORD(which_rind),second_contact_rind);
                     s := 'Time required for second contact transient =
print_time(second_contact_rins);
                   which_ring := third;
                    sum_up_ring( ORD( which_ring), third_contact_ring);
                     s := 'Time required for third contact transient = print_time(third_contact_rins);
                     add_time(second_contact_rins,third_contact_rins,rins_time);
s= 'Total time devoted to diamond rins sequences= ';
>rinL_time(rins_time);
                     divide_time(quarter_time,second_contact_rins,2);
s != ' Anticipation time for first diamond rins
rrint_time(quarter_time);
                     sum_up_eclipse(tot_time);
                                                                                                       Time devoted to totality = *;
                     print_time(tot_time);
                    s := ' Slack time margin at end of totality = ';
print_time(slack_in_totality);
                     divide_time(half_time;rind_time;2);
s := 'Extra slack due to diamond rind overlaps
print_time(half_time);
                    add_time(tot_time;slack_in_totality;total_duration);
add_time(total.duration;half_time;total_duration);
s := 'fotal time committed before mardin alloc. = ';
print_time(total_duration);
          WRITELN(
subtract_time(time_totality,total_duration,marsin_time);
s != ' Difference is time marsin for allocation = ';
print_time(marsin_time)
END (preliminary_allocation);
 PROCEDURE mardin_dispersal;
                    narsin_per_frame : absolute_time;
i : INTEGER;
                     divide_time(marsin_per_frame,marsin_time,total_eclipse);
FOR 1 := 0 TO 9 DO
          FUR 1 := 0 TO 9 50

ten_shot_sroupinsfil.wait_after :=
ten_shot_sroupinsfil.wait_after +
(1000 * marsin_per_frame.units) +
marsin_per_frame.thousandths;
s := ' Marsin_per_tablity frame = ';
print_time(marsin_per_frame)
END (marsin_dispersal);
PROCEDURE final_allocation;
                     sum_up_eclipse(tot_time);
s := ' Adjusted time devoted to total phase
print_time(tot_time);
                     add_time(tot_time;slack_in_totality;total_duration);
add_time(total_duration;half_time;total_duration);
s := ' Adjusted total time committed
print_time(total_duration);
          subtract_time(time_totality,total_duration,marsin_time);
s:= ' Marsin time after allocation to totality = ';
print_time(marsin_time)
END (final_allocation);
 PROCEDURE alloc_exposures;
                  TINDEFINE STATEMENT OF THE PRINCIPLE OF 
                     WRITELN('Press return to continue');
READLN(s)
          END (alloc_exposures);
BEGIN (normalize_timing)
          alloc_exposures;
          preliminary_allocation;
```

CP/M FLDPPY DISKETTE OPERATING SYSTEM CP/M FLOPPY DISKETTE OPERATING STORMS

PRICLAGES SUPPLIED ON DISKETTE CONTROL WITH B000 asstembler, text editor, 8080 debugger and various unitienes plus Mid documentation CP/M avsitable configured for most popular computer/disk systems including North Star Single, Double or Quad density, Alfar 87 disks, Helios II, Exidy Sorcerer, Vector M. Heath H717 or H891, TRS-801, COM 3172 and ICOM Micro Disk plus many other configurations available of this shelf. 

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  TEX Text for a ref to create paginated, page-numbered and justited copy from source text files, directable to drak or printer
  \$70/\$15

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- FORTRAN-30 ANSI 86 (except for COMPLEX) plus many extensions, includes relocatable object compiler, linking loader, library with manager. Also microtest MACRO-80 (see below) \$400/825
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- ence List utilities included

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  stightly modihab of a Intel ASM86. Compatibility data
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- MICRO FOCUS

  STANDARD CIS COBOL ANSI '74 COBOL stand(a) ard compiler fully validated by U.S. Navy lesis to
  ANSI level 1 Supports many leatures to level 2 cluding dynamic loading of COBOL modules and a
  full ISAM file facility. Also, program segmentation,
  niteractive debug and powerful interactive extensions
  to support profected and unprofected CRT screen
  formatting from COBOL programs used with
  the terminal #850/830
- FORMS 2 CRT screen editor. Output is COBQL data descriptions for copying into CIS COBQL programs. Automatically creates a query and update program of indexed files using CRT protected and unprotected acreen formats No programming experience needed. Output program directly compiled by CIS COBQL (standard)
- HOBS Hierarchical Data Base System CODASYL oriented with Files, SETs, RECORDs and ITEMs which are all user delined ADD, GelEFE UPDATE SEARCH, and TRAVERISE commands supported, SET ordering is sorted, FIFO, LIFO, next or prior. One to many sci relationship supported Read/Write protection at the FILE level Supports FILEs which extend over multiple floppy or hard disk devices.

over multiple (loppy or nard orax devices.
MDBS — Micro Data Stase System. Full network data
base with all features of HDBS plus multi-level Read/
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Explicit (epsesprilation of one to one, one to many,
many to many, and many to one SET relationships.
wathout SETs. HDBS files are fully compatible.

Willin SETS PLYS integrate from Compatible
MDBS-DRS - MDBS with Dynamic Restricturing System option which allows affering MDBS data bases
when new IFEAS. RECORDs or SETs are needed
without changing existing data.
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MDBS-240 version
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280 version requires 20K RAM, 8080 version requires 24K RAM (Memory requirements are additional to PPM and \$50 piculation programs.)

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- FORTRAN-80 or COBOL-83, etc.

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  To ticensed users of Microsoft BASIC-80 (MBASIC-80)
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    editional control of the standard of the s
- version of WORU-STAR ... MAYSTOW, J WORD-MASTER Text Editor In one mode has super-iset of CP/M's ED commands including global search, ing and replacing, forwards and backwards in life in wideo mode, provides full screen editor for users with serial addressable-cursor terminal \$125/\$25
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- PASCAL/M Compiler generales P code from ex-tended language, implementation of standard PAS-CAL Supports overlay structure through additional procedure calls and the SEGMENT procedure type. The added variable type STRING, Unityped historic memory image I/O, Requires 56K CP/Med 182 500/20
- memory image I/U, requires sor. CP/M ... 3-suryasu

  PASCALZ 280 native code PASCAL compiler. Prodiuces optimized, ROMable re-entrant code. All Interfacing to CP/M is through the support Ilbaray. The package includes compiler, companion macro-assembler and source for the library. Requires 56K and 280 CPU. Version 2 Includes all of Jensen/Wirth except variant records. Includes all of Jensen/Wirth except variant records.
  - records \$275/\$25
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- expected 3/80 3395/825 PASCAL/MT Subset of standard PASCAL Generates ROMable 8080 machine code. Symbolic debugger included Supports interrupt procedures. CP/M life I/O and assembly language miertace. Real variables can be BCD, software floating point, or AMD 9511 hardware tildating point, version 3 includes Sets, Enumeration and Record data types. Manual & explains BASIC to PASCAL conversion. Source for the run time package requires MAC [See under Digital Research). Requires 34.

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- CPU
  280 DEVELOPMENT PACKAGE Consists of: (1) disk, file line editor, with global inter and intra-line facilities; (2) 280 eriocating assembler, Ziogy/Mostet me-monics, conditional assembly and cross reference table capabilities; (3) linking loader producing absolute Intel liex disk tile.

- \*CP/M is a trademark of Digital Research.
  \*280 is a trademark of Zilop, Inc.
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  \*Electric Pencil is a trademark of Mchael Shrayer Soft-
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- †CP/M for Heath, TRS-80 Model I and PolyMorphic 8813 are modified and must use specially compiled versions of system and applications software.
- † fRecommended system configuration consists of 48K CP/M, 2 full size disk drives, 24 x 80 CRT and 132 column strates.
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- Extended Disk or Extended ROMable

  Extended Disk or Extended ROMable

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  Package of powerful general purpose fest macro
  Processor and SMAL structured language compiler.
  SMAL is an assembler language with IF-THEN-ELSE.

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- CPM/374X Has full range of functions to create or re-name an IBM 3741 volume, display directory information and edit the data set contents. Provides full file transfor faculities between 3741 volume data sets and CP/M files \$195/\$10.
- and CP/M files

  SaleL UTILITY DISK Consists of: (1) CRUNCH-14

  Compacing utility to reduce the size and increase
  the speed of programs in Microsoft BASIC and TRS80 BASIC, (2) DPFUN Double precision subroutines
  for computing mietern transcendental functions including squate roof, natural (o), (log base 10, sin, arc
  sin, hyperbolic air, hyperbolic arc sin, etc. Furnished
  in source on diskette and documentation \$30x35
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  THE STRING BIT FORTRAN character string handling. Routines to find, fill, pack, move, separate, concatenate and compare character strings. This package completely eliminates the problems associated with character string handling in FORTRAN. Supplied with source
- Supplied with source . 445/815

  18 TAM Utility to link one computer to another also be equipped with 8 \$TAM. Allows file transfers at full data speed (no confession to hex), with CRC block control check, for very risks are detection and automatic retry. We see if it great? Full wildcard expansions to send CDM etc. 900 board with with . 300 baud with phone conjecture. Both ends need one. Standard and/eversides an talk to one another. Compatible TRSDOS version also available \$158/85

#### \* \* \* \* \* \* **\*** SUNDRIES & NOTIONS

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#### Listing 1 continued:

```
mardin_dispersal;
        final_allocation
    END (normalize_timing);
PROCEDURE await_cue;
     BEGIN (awail_start)
   END (await_start);
PROCEDURE diamond_rins_burst;
BEGIN (diamond_rins_burst)
   END (diamond_ring_burst);
PROCEDURE totality;
REGIN (totality);
END (totality);
PROCEDURE summarize;

REGIN (summarize)

WRITELN('Press return to end prodram');
    END (summarize);
BEGIN (eclipse_monitor_simulation)
     initialize
    normalize_timing;
    await_cue;
diamond_rins_burst;
totality;
    await_cuei
    diamond_rins_burst;
END. (eclipse_monitor_simulation)
```

Listing 2: Preliminary allocation steps. The first stage of the execution of the program is this listing of an interactive sequence to determine the independent variables of the simulation.

```
Preliminary data initialization
"totality" is defined as time from second to third contacts
Enter number of exposures
258
Enter number of exposures during totality
208
Enter time of totality in "seconds thousandths"
248
Enter slack time margin (in seconds)
6

Exposures map:
First diamond ring = 25
Totality = 208
Second diamond ring = 25
TOTAL = 258

Press return to continue
```

#### Editorial text continued from page 12:

time is calculated as the difference between all the time commitments and the total time available during totality. (Half the time required for the diamond ring effects is assumed to take place during actual totality, so that the transient effects will be bracketed in time.) The margin time must be equally divided among the individual shots during totality. The procedure "margin-dispersal" is used to divide the margin by the number of totality exposures, then add this amount to the "wait-after" field of each of the ten unique totality exposure specifications in the array "ten-shot-grouping."

Finally, the procedure "final-allocation" reports on the actual allocation achieved by recalculating the margin time. This second margin time calculation reflects the allocation's effect. In photo 3, the value of 0.17 seconds is well within the limits of human hand/eye coordination by yours truly. (Hand/eye coordination will be used to

Listing 3: Final computation. Using a brute force technique of adding up various time intervals, the program arrives at this calculated model of the parameters. It first sums up the required time budget for all the events that must happen. The difference between this value and the time of totality is a margin value. This value is then evenly allocated to the timing of exposures during the main part of the eclipse. In the example, I have assumed 250 exposures total, 200 of which occur in the main portion of a 240.0 second eclipse event with a 6.0 second margin for manual timing at the end of the main sequence of totality.

```
Allocation of Eclipse Times...
                       Total time for eclipse = 240.800
                                                                   5.100
5.800
10.900
2.550
Time required for second contact transient =
Time required for third contact transient =
Total time devoted to diamond ring sequences=
Anticipation time for first diamond ring =
                           Time devoted to totality = 282.988
Slock time margin at end of totality
Extra slock due to diamond ring overlaps
Total time committed before margin alloc.
                                                                   6,800
5,458
                                                               = 214.430
    Bifference is time margin for allocation =
Margin per totality frame = 0.127
Adjusted time devoted to total phase =
                                                                    25.578
                                                                = 228.386
                                                                = 239.838
     Adjusted total time committed
     Margin time after allocation to totality =
                                                                     0.170
 Press return to end program
```

observe the digital wristwatch set to Universal Coordinated Time and pick the precise time to start the real-time sequence of the program by hitting any key on the Apple keyboard. Later in the eclipse, the second diamond ring event (third contact) will be initiated by a similar procedure while watching the eclipsed sun.)

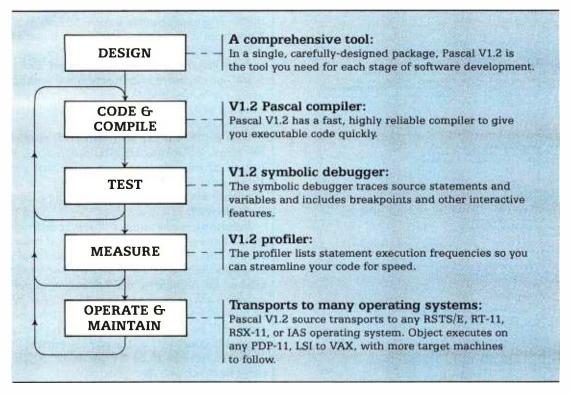
As it stands in listing 1, the program still must be filled out with the actual details of procedures "await-cue," "diamond-ring-burst," "totality," and "summarize." These are all relatively straightforward procedures, which will execute the real-time process of the eclipse observation. Other details to be verified include the actual model of the bulb-release exposure event (ie: what fixed overhead time is associated with the mirror flip/shutter opening action of the mechanism), calibration of a Pascal "do nothing" timing loop running with the Apple II's crystal clock so that the entire program executes all exposures within the time set by the model, and so forth. I will have more details on this in a forthcoming editorial, as I complete the model and finish verifying the system concept.

The most important concept here is the very real machine-independent viability of a high-level language, such as Pascal, in designing and then communicating the idea of a program. The functional simulation stage of my eclipse control program is now complete in concept and awaits some final details to be added over the next week or so. When it is done, going from the functional simulation to the actual eclipse control program I bring with me to Africa will be achieved by the simple act of reconfiguring the textual displays for a more limited 40-column output display and making multiple, redundant copies of the software on floppy disks for my travels.

# The Pascal Software Tool

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Listing 4: A camera interface test program. This Pascal test program exercises the camera shutter control interface of figure 1 by alternating the state of Apple II Game I/O annunciator output ANO.

```
ubkan lest.interrace;

tihis program, unitten Necember 25, 1979 is designed to test out
the interrace to the Mikon MN-2 motor drive by alternately
setting the state of output transistor Q2 in response to carriade
return characters. A galay count set by a null FQR statement
is used to allow repeated actuation with a minimum time between
output state changes. A variant record technique is used in the
fascal sortware of the procedure "ref.memory" in order to set and
rese, the output bit at absolute addresses COS8 and COS9 hexadecimal.
 CUNST
          oren_shutter_address = -16295 (sets ANO output to "1");
close_shutter_address = -16296 (resets ANO output to "0");
          J.K. : INTEGER
          s : CHAR:
PROLEDURE ref_memory(address: INIEGER);

( Ihis procedure uses the variant record technique to reference an address passed to it as a 16 bit sidned INIEGER. The Apple-II hardware will set or reset the annunciator outputs of the Game I/O connector if the uppropriate addresses are simply referenced by a prodram.
                     PLC = 1CHAR;
                           mory_access = (pointer:number)
                   memory_access = (pointer number)

this is a dummy statement required by the suntax of

Pascal variant records such as "memory" below. The
variant record "trick" is not the most elegant way
to reference an absolute hardware address, since it
requires an implementation-dependent assumption about
variant records, ie: that a 16 bit sisted two's complement
INTEGER type maps but for bit into the 16 bit positive
integer value of an address stored in a Pascal pointer
data type.

);
                            RECORD
                                      CASE memory_access OF
pointer : (a_pointer : ptr);
number : (a_number : INTEGER)
           VAR
                     anybyle : memory;
anychar : CHAR;
          ENF (Let_wewora):
suachar := suapare:= sojufer;
suachar := suapare:= sojufer;
suachar := suapare:= sojufer;
             PROCEDURE end_exposure;
                     MRITELN('Motor drive now fires... and shutter cocks');
    ref.memory(close_shutter_address)
END (end_exposure);
              PROCEDURE start exensure:
                       WRITELN('Shutter opens with a "click"');
  ref_memors(open_shutter_address)
END (start_exposure);
              PROCEDURE change_resterations;
                       REGIN

WRITELN('Enter integer time delay count');

WRITELN(' (old count was = ',reiterations,')');

REABLAN(reiterations);

IF reiterations ' I THEN reiterations := 1;

IF reiterations ' 2500 THEN reiterations := 2500

ENII (change_reiterations);
                      reiterations := 1000
                            1.06
                                        READLN( 5);
                                                ELSE IF s = 'N' THEN change_reiterations
ELSE IF s = 'E' THEN i != 1000;
                             ELSE I
end_exposure
END
```

#### Bar Codes and Home Brewing . . . **Progress Reports**

As of early December 1979, we received some exciting word about the state of manufacturing of barcode-reader wands. This word comes from John Sien of Hewlett-Packard's Optoelectronics Division in Palo Alto, California. Hewlett-Packard has just completed the formal announcement of a truly inexpensive optical bar-code reader, which will be available from stocking distributors of their component lines, possibly by the time you are reading this issue of BYTE.

The bar-code reader interfaces to transistor-transistor logic (TTL) or complementary metal-oxide semiconductor (CMOS) logic with three wires: signal, ground and power. It enables an individual with a personal computer to read Universal Product Codes (as on grocery items) or PAPERBYTES bar codes, or a host of other possible machine-readable printed formats. This reader costs a mere \$99.50 in single quantities from a distributor and much lower in manufacturing quantities.

John reports that there is a great deal of interest from one or more microwave-oven manufacturers in using bar codes and this reader to transfer individual cooking programs from food-packets or recipe books into the oven's control circuitry.

This product is the same bar-code reader used with the Hewlett-Packard HP-41C calculator for the distribution of miscellaneous user-submitted programs. In short, now that the single enabling piece of hardware is widely available in an inexpensive form, bar codes have arrived.

Returning to the subject of my homebrew 6809 project, I have put off further work until return from the eclipse trip early this month. In a personal analogy to concepts held dear by many of our readers, I have pushed the homebrew 6809 down on my internal procedure stack, in order to execute a higher priority procedure that has a definite, celestial time deadline. The stack will be popped up upon return from my trip, so the next installment of the 6809 homebrew project can occur no sooner than the issues of BYTE published early next summer.

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# BYTE News . . .

FRANCE TO INTRODUCE HOME TERMINALS: The French Postal and Telecommunications agency is undertaking a project to put a computer terminal in every home. According to a report that appeared in *Business Week* magazine, the government agency intends to give all telephone customers a free two-way video display terminal, in lieu of printed directories. A similar machine that can send and receive a full page of text in two minutes will also be offered for under \$500. Over 1000 terminals will be installed early next year. Each terminal is expected to cost the agency less than \$100.

IBM MOVES TO ASCII: Until now you either did it the ASCII way or the IBM way. In other words, all IBM communication was done in Extended Binary-Coded-Decimal Interchange Code (EBCDIC), while all other computer manufacturers used the American Standard Code for Information Interchange (ASCII). Anyone who has tried to interface an IBM terminal to a non-IBM system has encountered the problem.

Now IBM has introduced their first product that uses ASCII, the model 3101 video terminal. Depending on options, prices range from \$1300 to \$1520. These units can be ordered over the telephone, and IBM installation is not required, as is the case with all other IBM products. The unit, largely made in Japan, qualifies for discounts up to 20%—a new departure for IBM.

IBM has apparently been forced to compete with other computer component makers on their level. This may be the forerunner of a new IBM marketing philosophy for small-computer systems.

Rumor has it that IBM will become more aggressive in the small-computer market with enhancements to its 5110 tabletop computers. Look for IBM to increase the number of "retail stores" for small-business computer systems to 200 by the end of 1980. Most of these stores will be in branch offices of the General Systems Division.

TANDY. APPLE AND ATARI ASK FCC FOR DELAY: Atari asked the Federal Communications Commission (FCC) to delay the effective date of the waiver of rules for Texas Instruments (as previously reported in the January 1980 BYTE News) until a rulemaking proceeding on television-interface devices is completed. Atari cited allegedly illegal action by the FCC in granting the waiver and noted the potential increased radio and television interference. After two weeks consideration, the FCC rejected Atari's request.

Tandy Corporation and Apple Computer Company asked the FCC to delay the deadline for compliance with the FCC's new radio frequency interference (RFI) standard, which is due to go into effect on July 1, 1980. Both firms have claimed that this is too short a time to change manufacturing processes and order the necessary components.

LATEST RUMORS: Designers of Radio Shack's successor to the TRS-80 Model I have changed their minds and will employ Microsoft for writing the BASIC interpreter and operating system. Motorola also made a bid to do this software development; however, Microsoft ended up with the contract. Radio Shack had been planning to call the unit the "TRS-90," but the firm is now leaning toward "TRS-80/COLOR." . . . It is rumored that Sony and Texas Instruments have reached an agreement whereby Sony will sell Texas Instruments' personal-computer systems in the United States under the Sony name, with a Sony Trinitron color video monitor, instead of the Zenith monitor Texas Instruments is currently using. . . . Microtype Corporation will soon introduce a \$250 electronic typewriter with RS-232 input/output (I/O). It will use a daisy-wheel-like printing method, and it will print 15 characters per second. Look for it by the end of 1980. . . .

RANDOM NEWS BITS: Burroughs has introduced a 6 megabyte floppy-disk drive. It holds two disks on a common spindle and uses four data-transfer heads on a common assembly. Cost is only \$1950 in original equipment manufacturers quantities. . . .GR Electronics Ltd of Santa Monica, California, has introduced a pocket ASCII terminal in a case the size of a standard pocket calculator. It has forty keys and transmits the 128 ASCII character codes. It has an light-emitting diode display and stores thirty received characters. It has an RS-232C interface (110 or 300 bits per second), requires 5 V at 400 mA for power, and sells for \$395....Hewlett-Packard (HP) has introduced its personal-computer system. The system costs \$3250 and is being manufactured at HP's Corvallis, Oregon, calculator division. See page 60 in this issue for a report....Godbout Electronics, Oakland Airport, California, plans to introduce an S-100 processor circuit card that contains both 8088 and 8085 microprocessors on the same card. The 8088 is a 16-bit processor with 8-bit I/O (it executes 8086 ob-

# MICROSOFT. NOBODY DOES IT BETTER.

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NEW XMACRO-86 For the development of 8086 programs, our new XMACRO-86 cross assembler has just been released. It supports the same features as our MACRO-80 assembler. Develop 8086 programs now on your current CP/M, ISIS-II, or TEKDOS system. \$300.

NEW Micro-SEED DBMS Ifyou are developing applications software inhouse or bundling hardware and software for resale, a database manager could be the software tool you've been looking for. Micro-SEED is the first CODASYL compatible database management system to run with CP/M; and Microsoft's FORTRAN-80 has been implemented as the host language. When an application becomes limited by traditional floppy disk file handling, but remains overpowered by the cost and maintenance of a minicomputer, the solution is Micro-SEED. \$900.

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-			-	-		
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	BASIC COMPILER	•	•		•	
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	COBOL-80 COMPILER	•	•		•	
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ject code). A user can run the standard CP/M operating system on the 8085 to handle all I/O devices, and use the 8088 to run software such as a multi-user BASIC system. The processor card will drive 24 address lines (16 megabytes of memory space), and has a direct-memory-access (DMA) peripheral controller. . . . Heath Company has decided to resume production of the H8 8080-based microcomputer system. Surprisingly, the sales of the H8 have increased, despite the introduction of the Heath/Zenith H89 integrated Z80-based system. Apparently, with its plug-in bus construction, the H8 is more to the liking of hobbyists who prefer to configure their own systems. Also, Zenith is now producing the assembled Heath H19 video terminals on one of its television set production lines. . . . Mattel Electronics and General Instrument are about to start testing a television attachment that can receive a variety of video games sent over cable television. . . . McGraw-Hill, The New York Times, Times-Mirror, and Time Magazine are considering setting up systems which would allow personal-computer users to access their data bases.

HIGH-DENSITY 5-INCH DISK DRIVES: Micropolis Corporation and several other floppy-disk drive makers have announced 5-inch floppy-disk drives with a density of 96 tracks per inch (tpi). Fortyeight tracks per inch has been standard, while some firms have sold 77 tpi drives.

The Micropolis disk system will read older 48 tpi disks by skipping every other track under software control. The new drives will range in capacity from 436 K to 1064 K unformatted bytes and will cost between \$450 to \$570 each.

PERSONAL COMPUTER SYSTEM DELIVERIES DELAYED: Texas Instruments (TI), Mattel Electronics, and Atari have all experienced delayed deliveries of their personal computer systems in the past few months. Delays were due to a shortage of parts, which restricted production of these new systems. Atari did not start shipping units until October 1979, and TI did not start until November. Quantities were severely limited during the Christmas season. Mattel did not even start shipping until after Christmas. In all cases, the companies claimed that "silicon shortages" caused the delays. TI and Atari had promised to start deliveries in August. This problem is common throughout the computer industry, due to an unexpectedly high demand for integrated circuits.

DATA-STORAGE ADVANCES PREDICTED: A San Jose, California, market research firm has released an interesting report on the future of microcomputer storage systems. Creative Strategies International predicts that during the next two years we will see the introduction of new, low-cost 5-inch and 8-inch Winchester-technology disks, new sizes (4-inch and 6-inch) of Winchester drives, "backend" processors (disk controller and data base manager), and on-line archives in both video-disk and cartridge-tape form.

Low-cost, 5-inch floppy-disk drives and digital cassettes are expected from Japan. They will be mass-produced for intelligent-typewriter and home-computer applications. Prices of floppy-disk and Winchester disk drives are expected to drop to less than one-third of current prices.

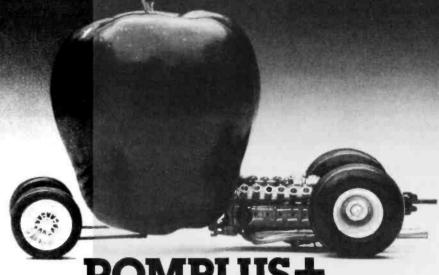
The new small Winchester disk drives, or micro-Winchesters, will have storage capacities starting at 1 megabytes and removable disk modules about the size of an 8-track audio tape cartridge. The back-end processors will be available by the mid-1980s. They will combine Winchester-diskcontroller and data-base-management functions in large-scale integrated circuits, with fast parallel architecture, content-addressed memory, charge-coupled memory systems or bubble memory. On the other hand, 8-inch floppy disks should reach the 5 megabyte capacity by the mid-1980s.

BUBBLE MEMORY STATUS REPORT: Bubble memory has developed considerably during the past year. Device size has jumped from 64 K bit, serial shift-register architectures to 1 megabit major/minor-loop, block-replicate architecture. Four megabit devices, organized as 4- and 8-bit words, are expected next year. Access times have dropped from hundreds of milliseconds; under 10 milliseconds is expected by the end of 1980. Five companies, Fujitsu, Intel, Plessey, Rockwell and Texas Instruments, are now competing for a share of the developing bubble memory business. Three more companies, Hitachi, Motorola, and Siemens, are expected to enter the market this year.

SPEECH-SYNTHESIS TECHNOLOGY IMPROVING: A year and a half ago when Texas Instruments introduced its Speak & Spell toy with voice output, the experts were amazed at is voice quality and low cost. Now single-board synthesizers, which can be easily interfaced to computers, are available from Texas Instruments, the Votrax Division of Federal Screw Works in Troy, Michigan, and Telesensory Systems Inc (TSI) of Palo Alto, California (TSI specializes in products for aiding the blind). Even IBM has added voice output to a typewriter. Further, Texas Instruments has now made available a low-cost voice synthesizer chip set for use by game and appliance manufacturers.

The Texas Instrument synthesizer stores words in its memory and thus is limited to 180 standard words, plus up to 180 words stored in external read-only memory. On the other hand, the Votrax unit is programmed with 62 phonemes (sound units) and can form an unlimited number of words.

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- Software support provided on disk includes demonstration programs and two Editors that allow you to define your own characters or keyboard macros.

## SOPHISTICATED FIRMWARE.

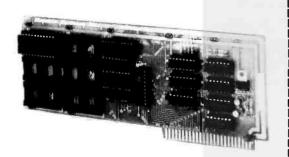
In addition to the Keyboard Filter ROM, ROMPLUS+ offers five sockets for ROM or EPROM, plus "scratch-pad" RAM. And, sophisticated firmware on ROMPLUS+ allows one, two, or more of its chips to be used simultaneously for programs longer than 2K.

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Many software programs really ought to be utilized as firmware. ROMPLUS+ makes that an actuality for the Apple by providing six additional ROM sockets.

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Name _					
Address					
City			State	Zip	
Dhono					

<sup>\*</sup>Trademark of Apple Computer Inc.

The voice quality of present units is acceptable but still leaves much to be desired. Most listeners agree that the Texas Instruments' unit produces better quality voices. There is no doubt that next year we will see a larger number of devices and appliances with voice output on the market, some possibly with voice input.

ANALOG MEMORY DEVELOPED: Sanyo Electric Company of Tokyo, Japan, recently reported at a Institute of Electrical and Electronics Engineers conference that it has developed a nonvolatile analog memory. The memory permits the direct storage of analog signals, eliminating the current technique of digitizing the analog signal and storing it in binary form. Analog memory could greatly simplify the circuitry used in voice and music synthesizer equipment, as well as in such applications as television tuning.

TANDY TO ENTER DISK DRIVE BUSINESS: Tandy Corporation has agreed to form a joint floppydisk manufacturing venture with Datapoint Corporation. Final approval is still pending from the boards of directors of both companies. Tandy currently buys floppy-disk drives for its Radio Shack computers from Shugart Associates, Control Data, and Tandon Magnetics. Datapoint makes their own units under a license from Shugart. Last year, Tandy attempted to purchase Perkins Elmer's Orbis floppy-disk operation for \$2.2 million, but was outbid (\$2.5 million) by Siemens.

DUAL-SIDED FLOPPY-DISK AVAILABILITY IMPROVES: In 1977, floppy-disk manufacturers started showing prototypes of their dual-sided floppy-disk drives. Shipments started in early 1979, but the firms soon ran into production problems. The double-sided drives caused excessive wear on disks and had other reliability problems. Manufacturers now have apparently learned how to manufacture these drives reliably and are finally getting into quantity production.

Last year a total of nearly 250,000 8-inch drives and 500,000 5-inch drives were made. It is expected that well over 1 million 5-inch drives will be made this year, and that nearly 30% will be double-sided.

RADIO SHACK TAKES ACTION TO PROTECT TRS-80 TRADEMARK: At the opening of a recent microcomputer show in Boston, federal court injunctions were served to three exhibitors, ordering them to immediately stop selling or distributing anything with the characters "TRS-80" written on it, and to hand over all such items and literature to Tandy-Radio Shack for disposal. Further, Radio Shack demanded \$10,000 for damage done to Radio Shack by each of the three companies.

Radio Shack claimed the companies were using the TRS-80 trademark illegally and in such a manner that people would think they were buying Radio Shack products. Further, Radio Shack claimed that business was being stolen from them, and that should the products prove defective, Radio Shack's reputation would be damaged.

The exhibitors had no prior warning of the injunction. Two of the exhibitors immediately appealed the injunction, pointing out that Radio Shack was clearly credited as the trademark owner in all advertising; the injunction was rescinded. The third exhibitor, who failed to take immediate legal action, was prevented from selling his regular merchandise at the show; instead he substituted a line of goods contained in packages not bearing the legend "TRS-80."

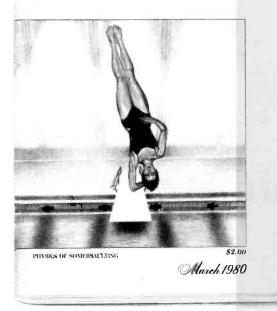
16-BIT MICROPROCESSOR STATUS REPORT: Intel has been producing its 8086 16-bit processor in volume since the spring of 1979. The 8086 has been successful but it is generally considered to be a less powerful device than either the Zilog Z8000 or Motorola 68000. While Zilog has been providing samples of the Z8000 for over six months, the firm is only now beginning volume production. Reportedly the samples did not execute all instructions correctly. Motorola has been sampling the 68000 for several months, and production quantities are expected soon. Recipients of sample devices from Motorola have reported that some instructions do not execute correctly and that the device will not operate at maximum rated speed. The companies are aware of these problems, and actual production units are expected to operate properly.

Other problems slowing the adoption of the Zilog and Motorola processors are lack of availability of peripheral devices (such as the Zilog memory-management integrated circuit), lack of software, and the fact that second-source suppliers are still far from production.

MAIL NOTE: I receive a lot of mail each month, as a result of this column. If you write to me and wish a response, enclose a self-addressed, stamped envelope.

Amateur Computer Group of New Jersey (ACG-NJ) 1776 Raritan Rd Scotch Plains NI 07076

# SCIENTIFIC AMERICAN



We are accustomed to seeing divers and gymnasts begin to twist and somersault long after they have left the springboard or the floor. Indeed, in order to win gold medals divers need to perform such complex feats in midair as the forward two-and-a-half somersault with two twists. But, you may ask, doesn't this violate the law of conservation of angular momentum? It postulates: In the absence of torques, or rotational forces, the angular momentum of a body is conserved. In the March SCIENTIFIC AMERICAN you will see how this paradox is resolved. You may be relieved to learn that divers and gymnasts (and free-falling cats, too) perform their midair rotations without violating any laws of physics. Moreover, the underlying

# Do divers and gymnasts violate the law?

physics is the same for the astronauts in space who need to control their body orientation in a weightless environment.

In the same issue you will find that impaired communication among cells can be a cause of a variety of diseases, as widely different from

each other as cholera, diabetes and manic-depressive psychosis. In each there occurs a form of failure of fit between signal-bearing molecules from one cell and the receptor molecules in the outer or internal membranes of the target cell.

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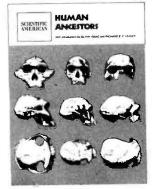
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GS

# **Electronic Planimetry**

Peter A Santi John Fryhofer Gregory Hansen Medical Research East University of Minnesota 2630 University Ave SE Minneapolis MN 55414

A planimeter is an instrument (formerly mechanical) for measuring the area of a two-dimensional figure by tracing its perimeter. Area measurements obtained from planimeters are useful for a variety of applications, such as cartography, geology, metallurgy and biology. Our biomedical application requires area and length measurements of irregularly shaped two-dimensional figures. To this end an electronic planimeter has been designed consisting of a Summagraphcs Bit Pad and a Terak microcomputer programmed in UCSD Pascal (Version I.5).

In practice, a user specifies a scale factor and then traces the boundary line of a figure using either a stylus or a single-button cursor. To improve the accuracy of the area measurement, the program detects closure (ie: when the end of the tracing meets the beginning) and displays the calculations. You can trace additional figures with the same scale by using only the stylus or cursor switch. Using this electronic planimeter, area and perimeter length measurements are more accurate and can be obtained faster than with a mechanical planimeter.

## The Terak Microcomputer

The Terak 8510 (see photo 1) is a

completely self-contained, 16-bit microcomputer using a Digital Equipment Corporaiton (DEC) LSI-11 with the hardware floating-point option. The Terak contains 56 K bytes of memory, a single 8-inch floppy disk drive, 128-character ASCII keyboard, 12-inch video monitor with a 320-by-240 graphics dot matrix, a 24-line-by-80-character display, and an RS-232C and 20 mA serial interface. The cabinet also houses an additional serial or 16-bit parallel interface card. The Terak is supported by the DEC RT-11 operating system and UCSD Pascal.

The Terak is well suited for UCSD Pascal, which can be purchased for a reasonable price. The Terak is a conservative, but well-designed system which performs with a high degree of reliability. It serves as a generalpurpose laboratory computer and in this application as a host computer for the Summagraphics Bit Pad digitizer.

## The Summagraphics Bit Pad

The Bit Pad includes a digitizing surface or data tablet, control unit, power supply, and writing stylus or a single-button cursor. The control unit consists of an 8-bit microcomputer (Intel 8035), a control program in erasable, programmable read-only

memory, and binary counters. The control unit generates X and Y coordinate points of the location of the stylus or cursor as it travels across the tablet surface. These coordinate points are generated as serial or parallel data and can be used by a host computer for a variety of applications.

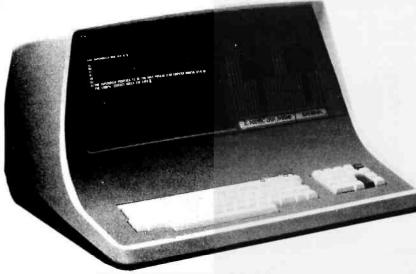
#### Theory of Operation

The Bit Pad operates on a magnetic principle. Current is pulsed along a send wire that lies perpendicular to a mesh of magnetostrictive wires lying beneath the writing surface of the tablet. The current pulse changes the dimensions of the magnetrostrictive material and a strain wave simultaneously propagates down all the wires in one direction. This propagated strain wave is sensed by a receive coil in the stylus or cursor. The control unit times the delay

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RT-11 and LSI-11 are registered trademarks of Digital Equipment Corporation.

Bit Pad is a registered trademark of Summagraphics Corporation.



\*Superbrain is a registered trademark of Intertec Data Systems.

# System Specifications

CPU Microprocessors

Word Size
Execution Time
Machine Instructions
Interrupt Mode
Floppy Disk
Storage Capacity

orage Capacity

Data Transler Rate Average Access Time Media

Disk Rotation Internal Memory Dynamic RAM Static RAM

ROM Storage

T
Display Size
Display Format
Character Font
Line Drawing Characters
Display Presentation
Bandwidth
Cursor
mythications

Cursor
Communications
Screen Data Transfer
Auxiliary Interface
Parallel Interface
S-100 Bus Transparent Mode

Transparent Mode
Parity
Transmission Mode
Addressable Cursor
System Utilities
Disk Operating System
DOS Software
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FORTRAN
COBOL
BASIC
ON CORREST OF BACKARDS

Application Packages

Keyboard
Alphanumeric Character
Special Features
Numeric Pad
Special Functions Keys
Cursor Control
Internal Construction
Chalmetry

Cabinetry Component Layout

Mounting

Environment Weight Physical Dimensions

Environment Power Requirements

Twin 280A's with 4MHZ Clock Frequency. One 280A (the host processor) performs all processor and screen related functions. The second 280A is "down-loaded" by the host to execute disk I/O. When not processing disk data, the second 280 may be programmed by the host for other processor related functions.

8 bits

1.0 microseconds register to register
158

All interrupts are vectored.

285K total bytes formatted on two double density drives. Optional external 10-300 megabyte hard disk storage is available using optional S-100 bus adaptor 250K bits/second 250 milliseconds. 35 milliseconds track-to-track

5 4 inch mini-disk 300 RPM

64K bytes dynamic RAM.
256 bytes of static RAM is provided in addition to the main processor RAM. This memory is used for program and/or data storage for the auxiliary processor.
1K bytes standard. Allows ROM "bootstrapping" of system at power-on. ROM storage is 2708 compatible and may be reprogrammed by the user for custom applications.

12-inch, dynamically focused. P4-phosphor
25 lines x 80 characters per line.
8 x 8 character matrix on a 8 x 12 character field.
Eleven special graphics symbols used for form generation.
Light characters on a dark background. Reversible through keyboard/program selection.
20 MHZ. Reversed image (block cursor)

Memory-mapped at 38 kilobaud Serial transmission of data at rates up to 9600 bps, Universal RS-232 asynchronous. Synchronous interface optional. Radio Shack TRS-80 compatible.

Radio Shack TRS-80 compatible.

Printed circuit edge connector provided for connection of optional S-100 bus adaptor, 
Enables display of all incoming and outgoing control codes.

Choice of even. odd. marking, or spacing.

Half or Full Duplex. One or two stop bits.

Direct positioning by either discrete or absolute addressing.

An 8080 disk assembler, debugger, text editor and file handling utilities.

ANSI standard. Relocatable, random and sequential disk access.
ANSI standard. Relocatable, sequential, relative and indexed disk access.
Sequential and random disk access. Full string manipulation, interpreter.
Extensive software development tools are available including software for the following applications. Payroll, Accounts Receivable, Accounts Payable, Inventory Control, General Ledger and World Processing.

Generates all 128 upper and lower case ASCII characters. N-Key Rollover. Automatic repeat (at 15 CPS), Keyboard lock/unlock. O-9, decimal point, comma, minus and lour user-programmable function keys. Up to 64 user-defined two-key function sequences. Up, down, forward, backward, and home.

Structural foam
Two board modular design. All processor related functions and hardware are on a single printed circuit board. All video and power related circuits on a separate single board. These two boards are interconnected via a single 22-pin ribbon cable.
CRT and two circuit boards mounted to base. CRT in a rigid steel frame. Disk Drive assembly mounted into upper cover for ease of servicing.

Approximately 45 pounds 14  $^{\circ}$ / $^{\circ}$ (H) x 21  $^{\circ}$ / $^{\circ}$ (W) x 23  $^{\circ}$ / $^{\circ}$ (D) Operating: 0° to 50° C Storage: 0° to 85° C: 10 to 95% rel. humidity - non condensing: 115 VAC: 60 Hz. 1 AMP (optional 230VAC/S0Hz model available)

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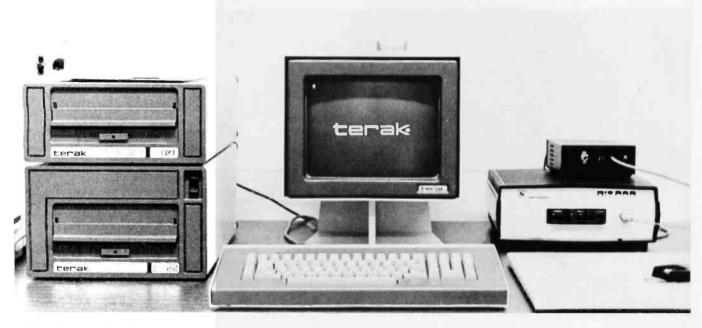
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Microcomputer Systems Division



**Photo 1:** The Terak microcomputer with dual floppy-disk drive, video display, and keyboard. The Summagraphics Bit Pad consists of the digitizing tablet and the microcomputer control unit.

required for the strain wave to reach the receive coil, and this delay is used to calculate X and Y coordinate data.

Digitizing Tablet

The data tablet is a low-profile, plastic pad that has an active surface area of approximately 784 square centimeters. The X,Y origin is located in the lower left corner of the tablet and is not relocatable. The active surface area can be visualized as a square matrix of 2795 by 2795 points with a resolution of 0.1 mm. The Bit Pad can also be configured for English unit measurements.

#### Microcomputer Control Unit

The control unit contains six frontpanel, push-button switches (see photo 1). One is a reset switch, three switches control the digitizing rate, and two switches control the operating mode. These switches may be overridden by software from the host processor, thus allowing complete host control.

The three rate switches select 64, 32, 16, 8, 4, 2, or 1 coordinate pairs to be generated per second. The two mode switches select point, switch-stream, or stream operating mode.

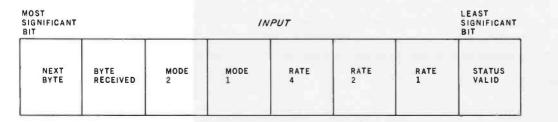
A coordinate pair is generated for each depression of the Z-axis switch in the stylus or cursor in the point mode. In the switch-stream mode, coordinate pairs are generated continuously as long as the Z-axis switch remains depressed. Coordinate points are generated continuously in the stream mode. It should be noted that no points are generated unless the stylus or cursor is within 4 mm of the active surface area of the tablet.

The control unit also contains an 8-bit input and output (I/O) port, an interrupt line, a single-bit reset line, and optionally a TTL or RS-232C serial line. The input port (also referred to as the command byte, figure 1) allows for control of both the operating mode and transmission rate of

the Bit Pad by a host processor. Three bits are allocated for the transmission rate, two bits for the operating mode and three bits serve as hand-shaking signals between the host processor and the Bit Pad.

The three handshaking bits are: status valid, which is used by the host computer to signal a change in mode or rate; byte received, which indicates that a byte of data has been read by the host; and next byte, which is used by the host to request the next byte of data from the Bit Pad. An additional single-bit line (in strobe) enables the host to reset the Bit Pad's control unit.

A host processor can receive data from the Bit Pad by polling or handshaking, or the Bit Pad interface can be driven by interrupts. The output port of the Bit Pad provides coordinate points to the host processor in a sequence of five data bytes (see figure 2). A 1 in the most significant bit of the first byte signals the host



CLEAR OR RESET

Figure 1: The bit format of the input or command byte for the Bit Pad. In addition, a single line is used by the host computer to reset or clear the Bit Pad's electronic circuitry.

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	MOST SIGNIFICANT BIT			OUTP	UT			LEAST SIGNIFICANT BIT
BYTE 1	FIRST BYTE	BYTE AVAILABLE	F3	F2	F1	FO	0	0
BYTE 2	FIRST BYTE	BYTE AVAILABLE	Х5	Х4	хз	Х2	X1	хо
BYTE 3	FIRST BYTE	BYTE AVAILABLE	X11	X10	Х 9	Х8	Х7	X6
BYTE 4	FIRST BYTE	BYTE AVAILABLE	Y5	Y4	Y3	Y2	Y1	YO
BYTE 5	FIRST BYTE	BYTE AVAILABLE	Y11	Y10	<b>Y9</b>	Y8	Y7	Y6

Figure 2: Five bytes of data are transmitted from the Bit Pad's output port for each coordinate pair of points generated. The first byte contains information concerning depression of the Z-axis switch. The next four bytes contain a 12-bit representation of the X and Y coordinates. Each byte also contains two control bits, which are used for handshaking purposes.

that the current byte is the first of the five-byte sequence. The next bit (byte available) when set to 1 indicates that a byte of data is available, and the bit labeled F0 corresponds to the status of the Z-axis switch.

An optional four-button cursor may also be used. The four buttons correspond to bits F0 thru F3 in byte 1. The next four bytes in the sequence contain a 12-bit representation of the X and Y coordinates. This data can also be transmitted in serial format with parity and stop bits, at data transmission rates from 37.5 bps to 28,000 bps.

The control unit does not contain a pilot light; however, it does contain two diagnostic routines that can be used to check its circuits and interface connections to the host processor. The control unit requires power sup-

plies of +5 V and +12 V, and -12 V or, with optional regulators, +8 V, +16 V, and -16 V.

#### Pascal Program: PLANIMETER

This program, which appears in listing 1, receives coordinates points five bytes at a time from the Bit Pad. The line length and area of a closed two-dimensional figure are calculated by integrating the figure with trapezoids. By using Pascal and the Terak, it is possible to receive and process approximately thirty coordinate points per second.

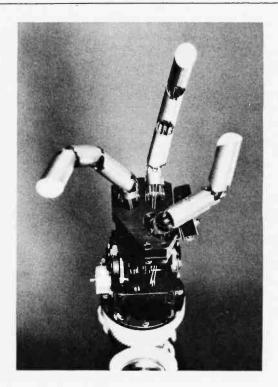
User-defined data types are used to interface the Bit Pad to the Terak minicomputer. LOWBYTE is the image of the output from the Bit Pad. It contains three fields: the data (D), READY (byte available) and the FIRST-byte bits. DEVICE is a data-

type that represents the I/O buffers on the Terak's port which are connected to the Bit Pad.

At the beginning of the main program, the pointer BITPAD is set to the integer value -160 (which is the address of the port) using a variant record type. The pointer BITPAD.P points to the port, and BITPAD.P1 contains the Terak I/O buffers for the parallel port.

Each input byte is read as LOOKB := BITPAD.P¹.INBUF in the procedure NEXTBYTE using handshaking. The sequence begins by waiting for the next byte to be ready (LOOKB.READY is true). The Terak signals the Bit Pad that it has read the data by sending the command byte OUTRECEIVED. The program increments the counter (BYT), waits for the Bit Pad to clear and then signals

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```
PROGRAM PLANTMETER O
(* Written by:
                    John Erybofer
    and modified by Gres Hansen.
    This program reads parallel data from a digitizing tablet and calculates
     the area and perimeter of a closed figure traced on it
CONST
   PORTADOR = -160;
   OUTRECEIVED = 95 (* 01011111 *);
OUTREXT = 159(* 10011111 *);
   OUTNEXT = ...
TYPE
   (* Output from BIT PAD *)
LOWBYTE = PACKED RECORD
              D: 0..63;
READY: BOOLEAN;
FIRST: BOOLEAN
           ENTE
  (* this is what the device looks like *)
   DEVICE = PACKED RECORD
CSR : PACKED ARRAY [0..15] OF BOOLEAN;
                  OUTBUF
                            : INTEGER;
: LOWRYTE;
                              INTEGER;
                  INBUF
             ENT:
   RITPAD : RECORD (* Loads the device address as an integer and points to it *)
                 CASE BOOLEAN OF
                     FALSE : (P : †DEVICE);
TRUE : (I : INTEGER)
            END
   CALCDELTA, CLOSEDELTA, BYT, F : INTEGER;
   LOOKE: LOWBYTE;
   RESPONS: CHAR;
                  (* Start new figure *)
   DIDPRINT:
                  (* Already printed for button up *)
      BOOLEANS
   FIRSTX, FIRSTY, LASTX, LASTY, X, Y,
   AREA, LEN, CUMAREA, CUMLEN, MAGR: REAL;
K: PACKED ARRAY [0..1] OF CHAR; (* Dumma acras; K[0] holds command *;
   PTR : INTERACTIVE;
PROCEDURE NEXTRYTE:
VAR W: LOWBYTE;
BEGIN
                  (* Reads next bute from BIT PAD *)
   REPEAT
      IF NOT UNITBUSY(2) THEN UNITREAD (2-KEO]-1--1)+ (* Look for command *)
   LOOKE := BITPAD.Pt.INBUF
UNTIL LOOKE.READY OR (K[0] = 'Q'); (* Good data *)
   BITEAD.Pt.DUTBUF := OUTRECEIVED;
   IF LOOKB.FIRST THEN BYT := 0;
   BYT := BYT + 1;
       W := BITPAD.Pt.INBUF
   UNTIL NOT W.READY; (* BIT PAD reset *)
   BITPAD.Pt.DUTBUF := OUTNEXT; (* BIT PAD sends next byte *)
END (* NEXTRYTE *);
PROCEDURE BEBUGO;
                  (* used for debussins only *)
REGIN
   WRITE(LOOKE,D);
   IF LOOKB. READY THEN WRITE( '
                                    READY');
    IF LOOKE.FIRST THEN WRITE( '
   WRITELN;
PROCEDURE PRINT;
                        (* Frint results *)
   50 mm
                               / Lensth :', HAGR*CUMLEN:9:6, " mm", CHR(10))4
END: (* PRINT *)
PROCEDURE NEWFIGURE;
                 (* initialize *)
BEGIN
   START := FALSE;
   FIRSTX:= X;
FIRSTY:= Y;
   LASTX := X;
LASTY := Y;
P := 0;
   CUMAREA := 0;
CUMLEN := 0;
WRITE ('*BOWN', CHR(7));
```

Listing 1: Pascal program that uses input from the Summagraphics Bit Pad and determines the area perimeter of a traced figure.

the Bit Pad with OUTNEXT that the next byte is ready to be received.

The first loop in the main program waits for the depression of the cursor Z-axis switch ("button down" in the listing). The loop also synchronizes the program with the five data bytes from the Bit Pad. Only the first byte of the five-byte sequence contains a 1 in bit 7 (FIRST is TRUE), and a 1 in bit 2 ( D = 4 ) when the switch is depressed. Bit 6 is set to 1 (READY is TRUE ) by the Bit Pad when the byte is available. When the switch is released the results are displayed using the procedure PRINT.

The second loop is executed for each point when the switch is depressed and coordinates are being received. Bits 0 thru 5 (D) of input bytes 2 and 3 contain the 12-bit X coordinate and D in bytes 4 and 5 contain the Y coordinate. After each byte is fetched, the CASE-statement code transfers the data into the integers X and Y by adding up the values. When the final byte is taken, it may then start a new figure if the switch was just pushed, calculate the next point, and/or detect closure and print the results.

The procedure CALC is called after each X,Y coordinate input that is located at a distance at least CALCDELTA away from the last point. X and Y are the integer coordinates in units of the Bit Pad's increments, which are 0.1 mm from the tablet's origin (lower left corner). The maximum value possible for X and Y is 2795. The length is calculated with the formula for the distance (d) between two points:

$$(d) = \sqrt{(X1-X0)^2 + (Y1-Y0)^2}$$

where X1 and Y1 are the current coordinates and X0 and Y0 are the last coordinates. Since many points are processed, the length of an irregular line is calculated from a number of short straight lines that yield a good approximation of the true line length.

Listing 1 continued on page 122

# DATA PROCESSING SYST ONE STEP BEY

If you thought the TRS-80™ microcomputer was just a toy, think again. These **TBS-80** software systems will turn that INFORMATION SYSTEM by Dale Kubler is simply the best in-memory, data base manager on the market. It allows you to create files with up to ten fields per record, up to 40 characters per field and 200 characters total per record. Data from the keyboard is entered directly onto a screen display of one entire file. Once entered, you can sort or search your entire data base by any Category and have the information desired displayed on the any category and have the information desired displayed on the screen. INFORMATION SYSTEM provides a thorough editing mode allowing changes by line without rewriting an entire file. This program allows you to program your own printouts to almost any form you desire for line or serial printers. Screen prints from anywhere in the program are also available INFORMATION SYSTEM creates either disk or cassette files depending upon the version you use. From mail lists to recipes, this program is the the version you use. From man note to recipes, this program, ideal small system information manager. The price for this program, 32K up disk is \$34.50. For systems 16K up tape it's \$24.50. DATA MANAGER by Dale Kubler starts out where INFORMA-TION SYSTEM leaves off. Requiring 32K and one disk, it accepts up to too year defined fields with up to forty characters per field and to ten user-defined fields with up to forty characters per field and 255 characters per record. As with all TBS software, data entry and editing is professional and simple to use. What makes this and editing is professional and simple to use, what makes this program stand apart from "in-mem" data managers is that it uses up to four disks on line as memory, or as much as 320K of memory of as much as 320K of memory. storage. Because disk sorts take more time than in-mem sorts, DATA MANAGER enables the user to create and maintain up to 5 "key" sort files for quick access of data. A utility program is provided to calculate the number of records possible since the amount of records you can maintain is dependent on a number of variables. This program also supports the upper lower case modification, and printouts can be programmed to almost any format and sent to line or serial printer. Background printing is provided enabling the computer to search and print at the same time. If you already have INFOR-MATION SYSTEM, DATA MANAGER will accept those files. A necessity for organized people, this program sells for \$49.50.

BUSINESS MAIL SYSTEM by Dale Kubler is designed for large-scale business users. Requiring 32K, two disks and printer, this program will store up to 150,000 names in a single pread out over multiple disks. file spread out over multiple disks. Each data disk holds 500 names. After data entry, BMS automatically sorts the data by zip code and alphabetical order within the zip code. The program tells you when and which data disk to insert, expanding your files automatically until you've reached 300 disks. Data is input directly onto formatted screen display with the option to use Company Name/ Attention instead of Last Name/First Name. Three numeric and Attention instead of Last Name/First Name. Three numeric and one alpha code fields are provided to help you use the search and printout mode. **BUSINESS MAIL SYSTEM** allows you to

MTRS-80 is a trademark of the Tandy Corporation.



program the number and spacing of your labels. With more features than can be described here, this high-powered program sells for \$125.00. TEXT MERGE is the program that puts it all together. If you have the ELECTRIC PENCIL from Michael Shrayer, 32K and one disk drive, then this program is a must. It will merge your data base from any of the above programs with an Electric Pencil file. vase from any of the above programs with an electric Feroir me.

For example, when you write a letter that is going to several hundred and a second control of the second contro dred people, you can "code" it by entering a field name from the above programs in place of the actual information. Then, when TEXT MERGE is run, it will print out your Pencil file and substitute the "Code" with the actual data. In other words, you can print out 1,000 personalized letters without stopping the computer. This program will also enable you to selectively search out only the records from your data base that you wish to use. Also included is the ability to set left, right, top and bottom margins, set page numbers anywhere on the page, and print out right justified if you numbers anywhere on the page, and print out right justined if you so choose. **TEXT MERGE** will turn your computer into a powerful TBS has other incredible software for Tandy's microcomputer. Intent on making it a powerful tool, we have large scale business accounting systems, general accounting systems, system utilities and the Library 100. We have the only System utilities and the Library 100. We have the only DISK HEAD CLEANER (for APPLE too!) and GRAN MASTER TBS is YOUR COMPANY, and we build systems, not



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```
Listing 1 continued:
END; (*NEWFIGURE*)
PROCEDURE CALC:
BEGIN
                      (* Caculate incremental area and length *)
   P:= P + 1;
    AREA:= (X - LASTX) * (Y + LASTY) / 2 / 100;
    LEN: = SQRT(SQR(LASTX-X) + SQR(LASTY-Y)) / 10;
    CUMAREA:= CUMAREA + AREA;
CUMLEN:= CUMLEN + LEN;
IF KC0] = 'A' THEN (* Pri
                    THEN (* Print each point *)
           PRINT;
    LASTX:= X; (* Save this point *)
    LASTY:= Y
ENDS (* CALC *)
PROCEDURE CLOSURE;
                   (* back at first point: finish *)
    CUMAREA:= CUMAREA + (FIRSTX - LASTX)*(FIRSTY + LASTY) / 2 / 100;
CUMLEN:= CUMLEN + SQRT(SQR(LASTX-FIRSTX) + SQR(LASTY-FIRSTY)) / 10;
    WRITELN ('*CLOSURE', CHR(7) );
    PRINT;
    DIDPRINT:= TRUE;
    START := TRUE;
ENTIS
BEGIN
         ( * MAIN *)
 REWRITE(PTR, 'REMOTE: ');
 BITPAD.I := PORTADDR;
 RITPAD.P1.OUTBUF := OUTNEXT;
WRITELN(' LENGTH AND AREA MEASUREMENTS');
 WRITEIN.
 WRITELN('Please leave all the switches out. The program sets the BIT PAD to');
 WRITELN( '
             stream mode and full speed. ' );
 WRITELN('Type a ''G'' at any time to change magnification or quit,');
 WRITELNO
           ''A'' to see all the points displayed ( with speed degradation ),');
 WRITELNO!
 WRITELN(' and press a space to turn off the modes.');
 REPEAT
    KE01 := ' ';
    WRITELN:
    WRITE('CALCDELTA: ');
    READLN( CALCDELTA );
    WRITE( 'CLOSEBELTA: ');
    READLN( CLOSEDELTA );
    WRITE ('MAGNIFICATION FACTOR? ');
    READLN (MAGR);
    WRITELN ('READY, FACTOR = ', MAGR :9:7);
    START := TRUE;
DIDPRINT := TRUE;
    MHILE KEOJ <> 'Q' DO
                             (* Loop for each point *)
        BEGIN
           REFEAT
                                 (* Wait for button down *)
               NEYTHYTE:
               IF (BYT = 1) AND (LOOKB.D <> 4) AND NOT DIDPRINT THEN
                                               (* If first point and button up *)
                      WRITELN('*UF', CHR(7));
                      PRINTE
                      DIDPRINT:= TRUE;
                      START := TRUE
           END (* If first point and button up *) UNTIL (BYT = 1) AND (LOOKB.D = 4) OR (KCO3 = 'Q');
           (* Rutton is down *)
WHILE (BYT < 5) AND (KEO] <> 'Q') NO
BEGIN (* Get whole point *)
                  NEXTBYTE;
                   DIDPRINT:= FALSE;
                  CASE BYT OF
2: X := LOOKB.D;
                      3: X := X + 64*LOOKB.D;
                      4: Y := LOOKR.D;
                      5: BEGIN
                            Y := Y + 64*LOOKB.D;
IF START THEN
                                NEWFIGURE
                            ELSE IF (ARS(X - LASTX) > CALCDELTA) OR
(ARS(Y - LASTY) > CALCDELTA) THEN
                            CALC; (* Only take points for enough away *)
IF (ABS(X-FIRSTX) < CLOSEDELTA) AND
(ABS(Y-FIRSTY) < CLOSEDELTA) AND (P > MINDTS) THEN
                                CLOSURE; (* Back at first point +/- DELTA *)
                  END( * 5: *)
END; ( * CASE *)
               END;
                        (* Get whole point *)
                          ( * Next point *)
    WRITE ( 'ANOTHER MEASUREMENT? ' );
    READ( RESPONS );
 UNTIL RESPONS = 'N';
 END.
```

### Area Calculation

Area is calculated by integration, by dividing the figure being traced into trapezoids. The trapezoids are calculated with the X axis as the base and up to the present and last points as the top. This formula is calculated for each new point:

Area = 
$$[(X1 - X0) \times (Y1 + Y0)]/2$$
.

When the current point is within a distance equal to CLOSEDELTA of the *first* point, closure is detected. This is done in order to achieve the lowest possible error by ending the figure where it started (ie: within 0.3 mm of the beginning of the trace). When closure is detected, final calculations are made to close the figure. The results are printed, and START is set so it will clear the variables the next time around for a new figure.

CALCDELTA is used to correct for oscillation of the coordinates due to the analog-to-digital (A/D) conversion, which results in inaccurately measured line lengths. If CALCDELTA is too small, then oscillation between points causes many coordinates to be inappropriately summed resulting in an overestimation of the true length of the traced figure. If CALCDELTA is too large, not enough points will be fitted, resulting in a less accurate approximation. Good results have been obtained with CALCDELTA = 3 (that is, 0.3 mm).

#### Conclusion

This electronic planimeter has been used for thousands of measurements in a laboratory environment. It is faster to use and more accurate than a mechanical planimeter. The relative error between twenty repeated areatracings of several different figures was consistently less than 0.5%. This electronic planimeter is less expensive and more flexible than commercially available dedicated-microprocessor systems that are specifically designed for planimetry, such as the Leitz Image Analysis System and the Zeiss MOP-3. A microcomputer or minicomputer user whose application involves length and area calculations of irregularly shaped figures will find this system useful and relatively inexpensive to construct.



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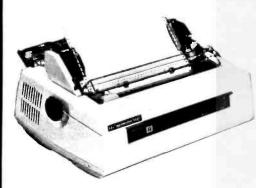
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# A Power-Line Protection Circuit

Neil A Schneider Bror E Erickson 9434 Ironwood Des Plaines IL 60016

Several years ago while he was working with color organ circuits, a friend of mine connected a color organ to an All American Five radio receiver. For those of you who are too young to remember, the All American Five was a popular five-tube radio design containing no power transformer. To my friend's surprise, and fortunately not to his harm, the connection of his color

organ to this radio resulted in foothigh flames as the audio output transformer burned.

The radio receiver had a "hot" internal chassis which was isolated from the outside world by its plastic case. The power cord was not polarized to connect the chassis to the low side of the AC power line. As my friend made his connection, he placed the 117 VAC power line current across the 8 ohm impedance audio-output secondary winding of the transformer, and across the speaker. This resulted in flames and a destroyed radio receiver.

Home computer enthusiasts of

ROUND

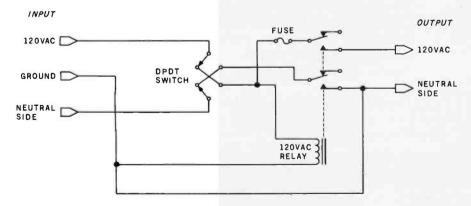
NEUTRAL
SIDE

120VAC
RELAY

100K

Editor's Note: For industrial applications we recommend use of an isolation transformer for circuit protection.

**Figure 1:** A simple circuit that offers some protection by using a relay to reverse connections to the power line. However, no protection is provided if the earth-ground line is defeated.



**Figure 2:** A better circuit that uses a double-pole, double-throw switch to present reversible power to the relay. If an attempt is made to defeat the earth ground, the power is cut off.

today face the same problem. While my friend's error only resulted in the loss of a radio (about \$15), the connection of computer circuits to transformerless hot-chassis television sets can result in the loss of hundreds of dollars in digital circuits.

The obvious solution is to use three-wire power cords on all equipment to insure that the television chassis is at *earth ground*. This solution works fine as long as no wiring errors have been made in the AC power socket. If you transport your computer to a friend's house, you are again betting the hundreds of dollars, and maybe your life, on the accuracy of *his* electrical system.

The circuit shown in figure 1 is a better solution. This circuit is less expensive than an isolation transformer, and it can even incorporate a power-line fault indicator. The circuit simply detects ground-fault conditions. The 117 VAC relay connects between the cold-side power and earth-ground lines.

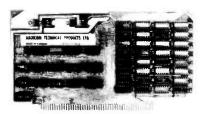
If a wiring error has been made, and the cold terminal is hot with respect to earth ground, the relay closes to reverse the power connection to the television. A neon lamp wired across the relay will provide a line-fault indication. CAUTION! No protection is provided with this circuit if the earth-ground line is defeated.

All that is required to provide full power-line protection is the addition of a double-pole, double-throw on/off switch as shown in figure 2. This switch is used to present reversible power to the relay. When the AC line is switched to the proper connection, the relay activates, and applies power to the load. If any attempt is made to defeat the earth ground, the circuit will not function, and the load will not receive power.

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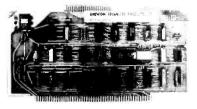
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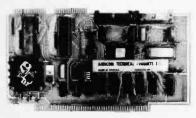
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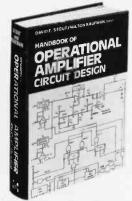
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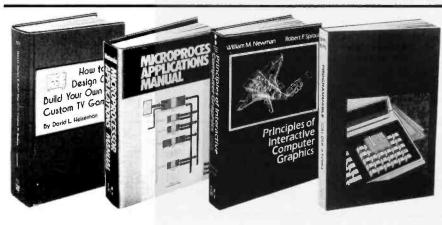
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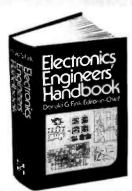
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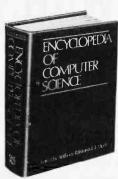
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# Landing Module Simulation with Random Surface

S J Houng E 36 Salmon St Spokane WA 99218

This article describes a program that simulates the landing of a jet-propelled craft on a random surface. The surface is generated by a random-number generator. As seen in photo 1, the craft can be steered vertically or horizontally by the firing of the main jet, the side jets, or

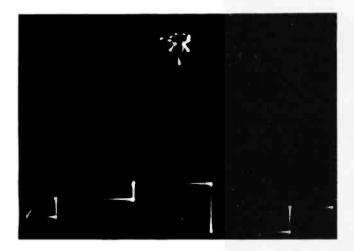


Photo 1: Landing module hovering over the five-segment random surface as it cautiously approaches its landing site.

both of them. During the dynamic simulation, the craft will move vertically along the central vertical line of the oscilloscope. The horizontal movement of the random surface causes the craft to appear to move in the opposite direction.

The sequence of the simulation is as follows:

- The dynamic equations of the craft are solved by Euler's method. The solutions are velocity and displacement.
- The craft is displayed according to the vertical

displacement, and the jets are made visible when they are fired.

- The random surface is displayed relative to the horizontal displacement of the craft. There are 256 segments of random surface which form a continuous terrain. Only five surface segments are shown on the oscilloscope at one time.
- When the craft has touched down on the surface. the vertical and horizontal velocity are compared with the crash velocity. If the craft exceeds the crash velocity, it will disappear from the screen. If it lands safely, it will remain on the surface waiting for lift-

The needed hardware is: a Motorola MEK6800 D2 Kit, two 8-bit digital-to-analog (D/A) converters, and an oscilloscope with DC inputs, as shown in figure 1. The capacitors at the output of the digital-to-analog converter are used to obtain a straight line display between two points. The keyboard will be used to enter the following commands:

G — Go to start the simulation

M - Main jet firing

R — Right jet firing

P — Left jet firing

After the program has been entered, the microprocessor will be directed to execute the program beginning at hexadecimal address 00F1 (listing 1). The oscilloscope will display a stationary craft and a random surface. Closure of the G key will start the dynamic simulation. Now you may control the firing of jet engines by pressing the M, R, or P keys. The objective of the control is to land safely. If the craft crashes, it will disappear from the screen. By pressing the G key, a new craft for you to command will appear on the screen. A star will be

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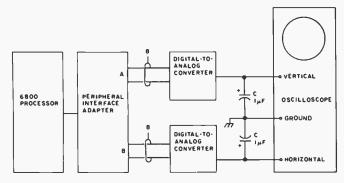


Figure 1: A block diagram illustrating the interface connections used to monitor the landing simulation on an oscilloscope.

seen above the craft whenever you make a safe landing. The craft will stay on the surface until you lift it from the surface by pressing the G and M keys simultaneously. The degree of control skill required depends on the speed of the simulation. You may change the speed by increasing or decreasing the time delay at hexadecimal address 01BB.

The graphic resolution is 256 by 256 points on the screen for an 8-bit microprocessor. The contour of the craft and jets is defined by coordinate points, and lines between points. Each point needs 2 bytes of storage. The first byte defines the horizontal coordinate, and the second byte defines the vertical coordinate. If the value of the first byte is 0, this will signal the end of display. The coordinate points for the top section of the craft begin at hexadecimal address 01F1. This is followed by the left jet, left side, main jet, right side, right jet, and a 5-point star.

The movement of the craft on the screen is obtained by the translation of points. This is accomplished by adding to or subtracting from the first byte with the amount of horizontal displacement, and the second byte with the amount of vertical displacement. The motion is such that the shape, size, and orientation are not changed. The display program DSPLY begins at hexadecimal address 01A3. You can see here that only the second byte is translated to simulate the vertical motion of the craft. The random surface is displayed by the subroutine SURF (hexadecimal address 01C0), that simulates the horizontal motion for the craft.

The subroutine RAND (hexadecimal address 0056) can generate a string of 256 random numbers before repeating the numbers. A number is picked as the seed for producing a string of random numbers. Beginning with the seed, the random-surface generator SRFGEN (hexadecimal address 0062) always produces the same string of numbers. The length of the string is determined by the total horizontal displacement of the craft. Only the last five numbers are used to represent the height of five surface segments. The third surface segment is located directly below the craft.

The length of the horizontal display is hexadecimal FF, and each surface segment has a width of hexadecimal 40. The subroutine BXING (hexadecimal address 0085) will

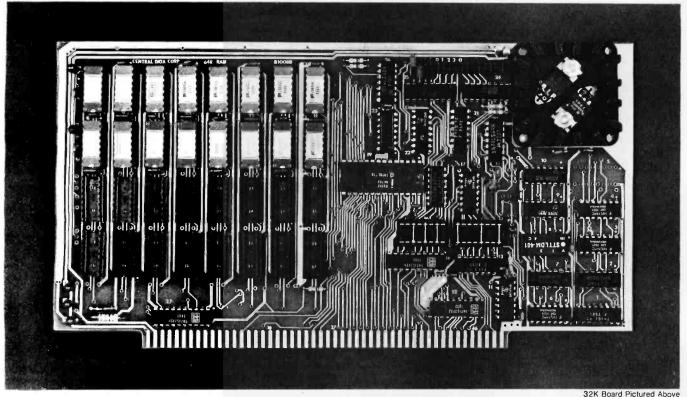
add or subtract a random number from the string whenever the horizontal displacement of the craft is increased or decreased by an amount of hexadecimal 40. This will create a continuous horizontal movement for the craft which appears to be flying over an unknown terrain. The last random number of the string is saved as the seed for the next simulation. Therefore, none of the landing simulations will be the same.

An 8-bit microprocessor represents a numerical range of decimal 0 to 255, or hexadecimal 0 to FF. It seems that Text continued on page 139

Listing 1: M6800 assembler listing of the program that controls all movement of the landing module. The speed adjustment can be made by modifying the contents of hexadecimal location 01BB. The subroutine SURF, starting at hexadecimal location 01CO, displays the random surface which simulates the horizontal motion of the craft. The coordinate points for the top section of the craft are stored at hexadecimal location 01F1.

00001					NAM		LM	SIMULATION
00002		800	)4	PIA	EQU		\$8004	2.
00003		800	)6	PIB	ΕΩυ		\$8003	3.
00004		800		CRA	EQU		\$8005	4.
00005		800		CRB	EQU		\$8007	5.
00006		802		SCHREG			\$8022	6.
00007		802		DISREG			\$8020	7.
00008	0000			1.101120	ORG		0	8.
00009	0000	80		X1	FCB		\$80	9.
00010	0001	00		X2	FCB		0	10.
00011	0002	00		Ŷ1	FCB		ŏ	11.
00012	0003	00		Y2	FCB		ŏ	12.
00013	0004	00		RND	FCB		Ö	13.
00014	0005	00		RNDO	FCB		ŏ	14.
00015	0006	F6		GO	FCB		\$F6	15.
00016	0007	OA		G1	FCB	•	\$A	16.
00017	8000	05		JL.	FCB		\$5	17.
00018	0009	FB		JR	FCB		\$FB	18.
00010	000A	00		FLAG1	FCB		0	19.
00020	000B	00		FLAG2	FCB		ŏ	20.
00021	000C	00		FLAG3	FCB		Ö	21.
00021	0000	00		TEMP	FCB		0	22.
00022	000E	00		ODOM	FCB		Ö	23.
00023	000F	00		FLAG4	FCB		\$00	24.
00024	0010	000	١٨	GETSRF	FDB		\$00	25.
00025	0012	00	,,,	SUR	FCB		0	26.
00028	0012	000	١٨	SUK	FDB		0	27.
00027	0015	00	,,,	<b>B</b> 5	FCB		0	28.
00028	0015	96	02	SYS	LDA	Α	Y1	29.
00030	0018	D6	03	313	LDA	R	Y2	30.
00030	0018	8D	31		BSR	D	-	31.
00031	001C	97	02		STA	Α	EULER Y1	32.
00032	001E	96	03		LDA		Y2	33.
00033	0020	116	0A		LDA	A R	_	34.
			_			Б	FLAG1	
00035	0022	27 116	06		BEQ	۳.	NEXT	35.
00034	0024		07 25		LDA	B	G1	36.
00037	0026	20	04		BSR		EULER	37. 38.
00038		D6	06	MEVE		T.	STORE	
00039	002A	8D		NEXT	LDA BSR	B	GO	39.
00040	002E	97	1F 03	STORE			EULER Y2	40.
00041	0030	96	00	SIUKE	LDA	A		41.
00042	0030	116					X1	
00043	0032	80	01 17		LDA BSR	F	X2 EULER	43. 44.
00045	0034	97	00		STA	Α		
		96					X1	45.
00046	0038		01		LDA	A	X2	46.
00047	003A	D6	OB		LDA	B	FLAG2	47.
00048	0030	26	01		BNE		FIRE	48.
00049	003E	39	Λ0	CIOC	RTS	r.		45.
00050	003F	D6	08	FIRE	LDA	B	JL TLACE	50.
00051	0041	71	000B		TST		FLAG2	51.

Listing 1 continued on page 134



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

Circle 81 on inquiry card.

Deselect around PROMs. Our boards have the important deselect feature which lets you overlap any fixed memory in your system with no interference.

Our features make the board easily used and expanded. You address our boards on 16K boundaries with mini-jumps (small shorting plugs that slide over wirewrap pins) near the top of the board for easy access. If you want to expand your board after you have purchased it, all that you need to do is add memory. We can supply you with expansion packages (\$150-2MHz, \$160-4MHz) which include eight RAMs that you can depend on as well as two mini-jumps for addressing. And of course, our board never generates wait states.

Low power consumption keeps your computer running cool and reliable. The total power consumption of our 16K board is typically less than 4 watts (+8V @ 300ma, +16V @ 150ma and

-16V @ 20ma). Boards with additional memory typically increase power consumption only 1 watt per 16K!

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

Call or write us today. That will guarantee a fast response with more information on the board. Or make an order - you'll probably have the board in two weeks! If you're interested, also ask for a catalog on our Z8000 16-bit processor board designed for the MULTIBUS. All of these products are available to your local dealer.

Central Data Corporation, 713 Edgebrook Drive, PO Box 2530, Station A, Champaign, IL 61820. (217) 359-8010

## **Central Data**

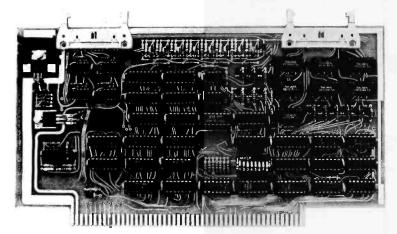


Listing	1 cont	inue	d:					
00052	0044	2E	02		BGT		LFIRE	52.
00053	0046	116	09		LIA	H	JR	53.
00054	0048	81	03	LFIRE	BSR		EULER	54.
00055	004A	97	01		STA	A	X2	55.
00056	004C	39			RTS			56.
00057	0041	CE	0002	EULER	LIX		#\$2	57.
00058	0050	57		EO	ASR	B		58.
00059	0051	09			DEX			59.
00060	0052	26	FC		BNE		E0	60.
00061	0054	18			ABA			61.
00062	0055	39	0.4	DANE	RTS		DME	62.
00063	0056	D6	04	RAND	LDA	B	RND	64.
00064	0058	17			TBA	<b>T</b> .		65.
00065	0059 005A	58 58			ASL	B		66.
00067	005B	1B			ABA	ь		67.
88000	005C	58			ASL	В		68.
00069	0050	18			ABA	-		69.
00070	005E	4C			INC	Α		70.
00071	005F	97	04		STA	A	RND	71.
00072	0061	39			RTS			72.
00073	0062	D6	0E	SREGEN	LDA	B	ODOM	73.
00074	0064	117	OL		STA	B	TEMP	74.
00075	0066	D6	05		LDA	B	RNDO	75.
00076	0068	17	04		STA	B	RND	76.
00077	006A	80	EA	NXT	BSR		RAND	77. 78.
00078	006C	7A 26	000D		DEC		TEMF NXT	79.
00080	0071	CE	0010		LDX		#GETSRF	80.
00081	0074	C6	05		LDA	B	#\$5	81.
00082	0076	17	OD		STA	B	TEMP	82.
00083	0078	80	DC	NXTS	BSR		RAND	83.
00084	007A	44			LSR	Α		84.
00085	007B	44			LSR	A		85.
00086	007C	A7	00		STA	A	0 • X	86.
00087	007E	08	0005		INX		TEVE:	87.
00088	007F 0082	7A 26	000D		DEC		TEMP	88. 89.
00090	0084	39	F -4		RTS		NXTS	90.
00071	0085	7F	000F	BXING	CLR		FLAG4	91.
00092	0088	96	00	LAZITO	LDA	A	X1	92.
00093	00BA	84	3F		ANI	A	#\$3F	93.
00094	008C	81	30		CMF	A	#\$30	94.
00095	008E	2A	09		BPL		XING	95.
00096	0090	81	10		CMF	A	#\$10	96.
00097	0092	28	05		BMI		XING	97.
00098	0094	84	20		ANI	A	#\$20	98. 99.
20100	0096	97 39	15		STA	A	P5	100.
00101	0079	84	20	XING	ANI	A	#\$20	101.
00102	009B	16	2.0	X1110	TAB	П	****	102.
00103	009C	90	15		SUR	A	R5	103.
00104	009E	27	OF		BEQ		TUO	104.
00105	00A0		05		BMI		PLUS	105.
00106	00A2	7A	000E		DEC		ODOM	106.
00107	00A5	20	03	D. 110	BRA		SAVE	107.
00108	00A7	7C	000E	F'LUS	INC		OLIOW	108.
00109	OOAE	7C	000F	SAVE	INC	B	FLAG4 B5	109.
00111	OOAF	39	13	OUT	RTS	E.	<b>P</b> O	111.
00112	OOBO	80	D3	TERR	ESR		EXING	112.
00113	00B2	116	OF		LDA	B	FLAG4	113.
00114	00H4	27	02		REQ		SUSPLY	114.
00115	9400	81	AA		FSR		SREGEN	115.
00116	OOBB	FI	01C0	SIISFLY	JSR		SURF	116.
00117	OOFF	39		EEV	RTS			117.
00118	OORC	4F 97	OA	KEY	CLR	A	EL AG1	118.
00119	OOBF	97	OF		STA	A	FLAG1 FLAG2	119.
00121	00C1	86	20		LIA	A	#\$20	121.
00122	0003	81	25		BSR		TKEY	122.
00123	00C5	2B	03		BMI		L	123.
00124	00C7	7C	000A		INC		FLAG1	124.
00125	OOCA	86	10	L	LDA	Α	#\$10	125.
00126	0000	81	10		BSR		TKEY	126.
00127 00128	00I0	2F 7C	03 000F		BMI INC		R ELAG2	127. 128.
00128	0010	86	AO	R	LDA	Α	FLAG2 #\$AO	129.
00130	0015	80	13	100	BSK		TKEY	130.
00131	00117	28	03		<b>EMI</b>		EXT	131.
00132	00119	7A	000F		DEC		FLAG2	132.
					I ie	tima	1 continued	OM W00

Listing 1 continued on page 136

# IDS Announces S-100 Energy Management Module

The 100-EMM Energy Management Module provides temperature measurement at four separate locations indoors or out; monitors eight (8) doors, windows, or fire sensors; controls six external devices via relay or optoislator; and provides an intrusion alarm with battery backup (alarm operates even during primary power outages). Put the 100-EMM to use in your home or business and claim a 30% tax credit for the cost of your S-100 computer system including the 100-EMM. (Purchasing the 100-EMM can actually save you several times its cost in tax credits. Full instructions for filing are included in the 100-EMM manual.)



BUY THIS S-100 BOARD AND GET UP TO A 30% TAX CREDIT BASED ON THE COST OF YOUR COMPUTER SYSTEM!

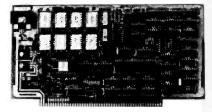
100-EMM Energy Management Module Assembled and Tested \$395.00 Kit \$345.00

Options for 100-EMM:

CP-52 Cable Panel - Terminates two 26-conductor flat cables in 26 screwlugs. Use it for convenient interconnection of the 100-EMM to the "outside world". \$45.00

CABL-26-STD 26-Conductor Flat Ribbon Cable - Four feet in length with connectors for 100-EMM and CP-52 above. \$35.00 Other lengths available on special order. Add \$1.00 per foot.

**OTHER PRODUCTS FROM IDS.** The most complete source of S-100 compatible modules for process control, data acquisition, energy management, and data communications.



**88-MODEM S-100 ORIGINATE/ANSWER MODEM WITH AUTO-DIALER.** Software selectable baudrate provides any baudrate from 66-600 baud. Provides 1.5 stop bits when operated in 5-bit code mode. Auto-answer programs available for CROMEMCO CDOS, CP/M, North Star Horizon and MDS, and Alpha Micro.

Assembled and Tested \$395.00 Kit \$245.00

**Dulles International Airport** 

Telephone (703)661-8442

Washington, DC 20041

#### 88-UFC UNIVERSAL FREQUENCY COUNTER

Four software selected inputs. Measure frequency from O-650 MHz and period from .luS to 1 Second. Extensive software included.

Assembled and Tested \$299.00 Kit \$199.00 Temperature-Compensated Crystal Oscillator option \$145.00

## 88-SAI SYNCHRONOUS/ASYNCHRONOUS INTERFACE

The most versatile serial interface on the market. Computer access/control of all data and handshake lines and provision for masked interrupts, inversion of any input or output signal, and onboard baudrate generation for 110, 134.5, 150, 300, 600, 1200, 2400, 4800, 9600, and many other baud rates. Many more features.

Assembled and Tested \$299.00 Kit \$199.00

INTERNATIONAL DATA SYSTEMS, INC.

88-SPM TIME OF DAY CLOCK with battery backup. Set the clock with three out instructions: no delays! Programs included in North Star BASIC, CBASIC, and 8080 assembly language.

Assembled and Tested with crystal option \$199.00 Kit less crystal option \$99.00 Crystal Option Kit \$25.00

## 88-RCB RELAY CONTROL BOARD

16 Relays on one board. Control appliances, production equipment, or even musical instruments (See BYTE Magazine Sept 1977 page 12)

Assembled and Tested \$299.00 Kit \$199.00

Mailing Address: Shipping Address: Post Office Box 17269 400 West Service Re

400 West Service Road, Suite 130 Dulles International Airport Washington, DC 20041 USA

TELEX 901112 IDS CTLY



### NOW BETTER THAN EVER

- Control Program for Microcomputers.
- Includes Editor, Assembler, Debugger, Utilities.
- Supports Floppy Disks and Hard Disks.
   For 8080, 8085, Z-80, MDS.
- \$150-Diskette and Documentation
- \$25-Documentation only

# MP/M™

### **NEW INDUSTRY STANDARD**

- Multi-terminal access.
- Multi-programming.
- CP/M-compatible.
- Real-time features.
- \$300-Diskette and Manual
- \$25-Manual only

# DIGITAL RESEARCH

## **OPTIONAL SOFTWARE PACKAGES**

## MAC™ MACRO ASSEMBLER:

- Compatible with new Intel macro standard.
- Complete guide to macro applications.
- \$90-Diskette and Manual.

### SID™ SYMBOLIC DEBUGGER:

- Symbolic memory reference.
- Built-in assembler/diassembler.
- \$75-Diskette and Manual.

### TEXT FORMATTER:

- Powerful text formatting capabilities
- Text prepared using CP/M Editor.
- \$75-Diskette and Manual.

## **DESPOOL**TM

- Background print utility.
- Use with CP/M
- \$50-Diskette and Manual.

# **NDIGITAL RESEARCH**

P.O. Box 579 • Pacific Grove, California 93950 (408) 649-3896

Listing	1	continued:	
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Listing	1 conti	nuec	ž:					
00133	OODC	39		EXT	RTS			133.
00134	0000	7F	000C	GO	CLR		FLAG3	134.
00135	00E0	86	E0		LDA	Α	#\$E0	135.
00136	00E2	81	06		BSR	• •	TKEY	136.
00137	00E4	28	03		BMI		0	137.
00138	00E6	7C	0000		INC		FLAG3	138.
			0000	0			F L.HUS	
00139	00E9	39		0	RTS			139.
00140	00EA	87	8022	TKEY	STA	Α	SCNREG	140.
00141	OOED	フロ	8020		TST		DISREG	141.
00142	00F0	39			RTS			142.
00143	00F1	7F	8005	REGIN	CLR		CRA	143.
00144	00F4	7F	8007		CLR		CRB	144.
00145	00F7	86	FF		LDA	Α	#\$FF	145.
00146	00F9	B7	8004		STA	A	FIA	146.
00147	OOFC	B7	8006		STA	A	FIB	147.
00148	OOFF	86	25		LDA	A		148.
							#\$25	
00149	0101	B7	8005		STA	Α	CRA	149.
00150	0104	B7	8007		STA	A	CRB	150.
00151	0107	4F		INIL	CLR	Α		151.
00152	0108	97	03		STA	Α	Y2	152.
00153	010A	86	0A		LDA	Α	#\$A	153.
00154	010C	97	01		STA	Α	X2	154.
00155	010E	86	60		LDA	Α	#\$60	155.
00156	0110	97	02		STA	Α	Y1	156.
00157	0112	86	20		LIIA	A	#\$20	157.
00158	0114	97	0E		STA	A	ODOM	158.
00159	0116	96	04		LDA	A	RND	159.
00160	0118	97	05		STA	Α	RNDO	160.
00161	011A	81	5C	START	BSR		LANDER	161.
00162	011C	BD	0010		JSŔ		TERR	162.
00163	011F	81)	вc		BSR		GO	163.
00164	0121	106	OC.		LDA	B	FLAG3	164.
00165	0123	27	F5		BEQ		START	165.
00166	0125	81	95	MOTION	BSR		KEY	166.
00167	0127	BI	0016		JSR		SYS	167.
00168	012A	80	4C		BSR		LANDER	168.
00169	0120	80	4A					
		81			BSR		LANDER	169.
00170	012E		48		BSR		LANDER	170.
00171	0130	BD	0080		JSR		TERR	171.
00172	0133	96	02		LDA	Α	Y1	172.
00173	0135	81	80		ADD	Α	<b>#</b> \$80	173.
00174	0137	90	12		SUB	Α	SUR	174.
00175	0139	22	EA		BHI		MOTION	175.
00176	013B	81	FB		CMP	Α	#\$FB	176.
00177	0130	28	10		BMI		CRASH	177.
00178	013F	96	01	LAND	LDA	Α	X2	178.
00179	0141	81	08		CMF	A	#\$8	179.
00180	0143	2A	0A		BPL	••	CRASH	180.
00181	0145	81	F8					
			06		CMP	Α	#\$F8	181.
00182	0147	28			BMI		CRASH	182.
00183	0149	96	03		LIA	Α	Y2	183.
00184	014B	81	FO		CMP	Α	#\$F0	184.
00185	0141	2A	OB		BF'L		SAFE	185.
00186	014F	ΒĐ	0080	CRASH	JSR		TERR	186.
00187	0152		89		BSR		GO	187.
00188	0154	D6	0C		LIIA	F	FLAG3	188.
00189	0156	2E	AF		EGT		INIT	189.
00190	0158	20	F5		BRA		CRASH	190.
00191	015A	C6	04	SAFE	LDA	B	#\$4	191.
00192	015C	117	03		STA	В	Y2	192.
00193	015E	5F	00		CLR	В	12	193.
00174		D7	01				V2	
	015F				STA	B	X2	194.
00195	0161	D7	0A		STA	B	FLAG1	195.
00196	0163	117	OB		STA	B	FLAG2	196.
00197	0165	CE	A04E	SF	LDX		‡S	197.
00198	0168	80	39		BSR		DSPLY	1984
00199	016A	80	OC.		BSR		LANDER	199.
00200	016C	BD	0010		JSR		TERR	200.
00201	016F	BD	OODE		JSR		GO	201.
00202	0172	116	OC		LDA	B	FLAG3	202.
00203	0174	2E	AF		BGT		MOTION	203.
00204	0176	20	ED		BRA		SF	204.
00205	0178	ČE.	01F1	LANDER	LDX			
00203	0178			FURNER			#TOP	205.
		80	26		BSR	r.	DSPLY	206.
00207	017[	146	OF OF		LDA	B	FLAG2	207.
00208	017F	2F	05		BLE		RUET	208.
00209	0181	CE	01FA		LDX		#LJ	209.
00210	0184	81	10		BSR		DSPLY	210.
00211	0186	CE		RJET	LDX		#LS	211.
00212	0189	80	18		BSR		DSFLY	212.
00213	018F	D6	0A		LDA	B	FLAG1	213.
							1 continued	

Listing 1 continued on page 138

# TIMEafterTIME



# BATTERY SUPPORTED CALENDAR CLOCKS

# **PDP-11\***

TCU-100 • \$495

- Provides month, day, hour, minute and second.
- Can interrupt on date/time, or periodic intervals.

TCU-150 • \$460

- Provides year, month, day, hour, minute and second.
- Automatic leap year.
- Patches for RSX-11M, RT-11 FB/SJ VO2, VO3 and UNIX.

# LSI-11/2\*

TCU-50D • \$325

- Provides month, day, hour, minute and second.
- Dual size board.
- Patches for RT-11 SJ/FB VO2, VO3B.

# Lockheed SUE

TCU-200 • \$550

- Provides year, month, day, hour, minute, second and milli-second.
- Interval interrupts between 1/1024 seconds and 64 seconds.

# Computer Automation (Naked Mini)

TCU-310 • \$385

 Provides year, month, day, hour, minute and second.

\*Trademark of Digital Equipment Corporation

# Multi-Bus\*\*

TCU-410 • \$325

- Provides year, month, day, hour, minute and second.
- SBC/BLC compatible.

# **HP 2100**

TCU-2100 • \$395

- Correct time restored after power failure.
- Compatible with the HP TBG card.

# Serial Clock (RS 232 or 20 mA)

SLC-1 • \$640

- Connects between any terminal and host computer.
- Provides date, time and more!

All Digital Pathways TCUs have on board NICAD batteries to maintain time and date during power down. Timing is provided by a crystal controlled oscillator. Prices are U.S. domestic single piece. Quantity discounts available.

For more information on these products, contact: Digital Pathways Inc. 4151 Middlefield Road Palo Alto, CA 94306 Phone: (415) 493-5544



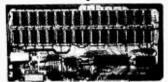
\*\*Trademark of Intel Corporation

\*\*\*Trademark of Computer Automation Incorporated

# **DIGITAL PATHWAYS**

Circle 85 on inquiry card.





# INTRODUCING

the ultrabyte memory board

**99**.95

complete kit with 16K memory

Netronics consistently offers innovative products at unbeatable prices. And here we go again - with JAWS, the ultrabyte 64K S100 memory board.

#### ONE CHIP DOES IT ALL

JAWS solves the problems of dynamic RAM with a state-of-the-art chip from Intel that does it all. Intel's single chip 64K dynamic RAM controller eliminates high-current logic parts . . . delay lines . . . massive heat sinks . . . unreliable trick circuits.

#### **REMARKABLE FEATURES OF JAWS**

Look what JAWS offers you: Hidden refresh . . . fast performance . . . low power consumption . . . latched data outputs . . . 200 NS 4116 RAMs . . . on-board crystal . . . 8K bank selectable . . . fully socketed . . . solder mask on both sides of board . . . designed for 8080, 8085, and Z80 bus signals . . . works in Explorer, Sol. Horizon, as well as all other well-designed \$100

GIVE YOUR COMPUTER A BIG BYTE OF MEMORY POWER WITH JAWS — SAVE UP TO 450 ON INTRODUCTORY LIMITED-OFFER SPECIAL PRICES!

UNDECIDED? TRY A MARCO 18K JAWS IN YOUR COMPUTER ON OUR 10-DAY MONEY- BACK OFFER ISPECIFY YOUR COMPUTER).

CONTRIBUTALULA CREDIT CAND BUYERS OUT BUS COMMETTICUT CALL

# CALL TOLL FREE 800-243-7428 From Connecticar Or For Assistance, (203) 354-8376 NETRONICS RESEARCH & B NETRONICS DEVELOPMENTLTD

333 Litchfield Road, New Milford, CT 06776

Please send the items checked below:

- ☐ JAWS 16K RAM kit, No. 6416, \$199.95.\*
  ☐ JAWS 16K RAM fully assembled, tested, burned in, No. 6416W, \$229.95.\*
- ☐ JAWS 32K RAM kit, No. 6432, (reg. price \$329.95), SPECIAL PRICE \$299.95.\*
- ☐ JAWS 32K RAM fully essembled, tested, burned in, No. 6432W, (reg. price \$369.95), SPECIAL PRICE **\$339.95.**\*
- JAWS 48K RAM kit, No. 6448, (reg. price \$459.95),
- SPECIAL PRICE #399.95.\*

  JAWS 48K fully essembled, tested, burned in, No. 6448W, (reg. price \$509.95), SPECIAL PRICE
- ☐ JAWS 64K RAM kit, No. 6464, (reg. price \$589.95), SPECIAL PRICE #499.95.\*
- JAWS 84K RAM fully essembled, tested, burned in, No. 6464W, (reg. price \$649.95), SPECIAL PRICE 8559.95.\*
- Expansion kit, JAWS 16K RAM module, to expand any of the above in 16K blocks up to 64K, No. 16EXP, \$129.95.\*

\*All prices plus \$2 postage and handling. Connecticut

Total enclosed: S_	sales tax.
Personal Check	Money order or Cashiers Check
□ VISA	MASTER CHARGE (Bank No)
Acct. No	Exp. Date
Signature	
Print Name	
Address	
	Zio
Send me more i	

Listing	1 cont	ınuea:									
00214	018D	27 0	)5		REQ		NOJET	214.			
00215	018F	CE A	AE04		LDX		#MJ	215.			
00216	0192	8D 0	)F		BSR		DSFLY	216.			
00217	0194	CE A	1030	NOJET	LDX		#RS	217.			
00218	0197	8D 0	)A		BSR		DSPLY	218.			
	0199				LIIA	B	FLAG2	219.			
	019B				BGE		NORJ	220.			
	0190				LDX		#RJ	221.			
	01A0				BSR		DSPLY	222.			
	01A2			NORJ	RTS			223.			
	01A3		00	DSFLY	L.DA	Α	0 - X	224.			
	01A5				BEQ		END	225.			
	01A7				STA	A	PIA	226.			
	0144				LDA		1 • X	227.			
	01AC				ADD		Y1	228.			
	01AE				ADD		#\$70	229.			
	01B0				STA		PIB	230.			
	01 B3				INX			231.			
00232	01B4	08			INX			232.			
	01B5		03		BSR		TDELAY	233.			
	01B7				BRA		DSFLY	234.			
	01B9			ENI	RTS			235.			
00236	01BA	C6 8	30	TUELAY	LDA	В	#\$80	236.			
	01BC			DELAY	DEC			237.			
00238	OIBD	26 F	T)		BNE		DELAY	238.			
	01BF				RTS			239.			
			0010	SURF	LDX		#GETSRF	240			
	0103				CLR	Α		241.			
	01C4		00		LDA		0 • X	242.			
	0106				STA		FIA	243.			
	0109				STA		FIB	244.			
	0100				BSR	_	TDELAY	245.			
	01CE				LDA	Α	X1	246.			
	0100				COM	A		247.			
	01D1		3F		AND		#\$3F	248.			
				NEXTS			FIA	249.			
	0106				BSR		TUELAY	250.			
	0108				INX			251.			
	01119		00		LDA	B	0,X	252.			
	OIDB				STA		PIB	253.			
	01DE				BSR	_	TDEL.AY	254.			
	01E0				CF'X		#GETSRF+4		55.		
	01E3				BEQ		LAST	256.			
	01E5				ADD	Α	#\$40	257.			
	01E7				BRA	••	NEXTS	258.			
	01E9			LAST	LDA	Α	#\$FF	259.			
	01EB				STA		FIA	260.			
	01EE				BSR		TDELAY	261.			
00262	01F0	39			RTS			262.			
00263	01F1	8820	)	TOP	FDB		\$8820,\$84	424,\$	7024,\$7820	263.	
	01F3	8424	4								
	01F5	7024	1								
		7820									
00264	01F9	00			FCB		\$00	264.			
00265	01FA	701E	Ξ	LJ	FDB		\$701E	265.			
	01FC				FCB		\$00	266.			
	A031				ORG		\$A031	267.			
00268	A031	7810		LS	FDB				7810,\$7C18	268.	
	A033	7018	3								
	A035	7810	)								
	A037	7C18	3								
00269	A039	00			FCB		\$00	269.			
00270	A03A	8000	)	MJ	FDB		\$8000	270.			
00271	A03C	00			FCB		\$00	271.			
00272	A03D	8418	3	RS	FDB		\$8418,\$88	310,\$8	8418,\$881C,\$8	3820	272.
	A03F	8810	)								
	A041	8418	3								
ı	A043	8810	;								
	A045	8820	)								
00273	A047	00			FCB		\$00	273.			
00274	A048			RJ	FDB		\$901E,\$88	31C	274.		
		8810	:								
	A04C				FCB		\$00	275.			
00276	A04[			S	FDB		\$8540,\$80	50,\$7	7B40,\$884A	276.	
		8050									
		7B40									
0000		884A					47044		0.77		
002//	A055				FDB		\$784A,\$85	40	277.		
00279	A057	8540	,		CCD		0	270			
00278		VV			FCB		0	278. 279.			
()(),,,,					FIAT.			4/70			

Text continued from page 132:

we do not have much room to move around, but the landing simulation is very realistic. In numerical calculation the 2's complement arithmetic is used. The 2's complement number has a range of decimal —128 to +127, or hexadecimal 80 to 7F. Since the number can be positive or negative, the summation will only be sufficient to perform addition and subtraction. The shift instructions ASL and ASR can be used to perform multiplication or division by 2 respectively. By repeating the use of shift operation, it is possible to multiply or divide a number by 2, 4, 8, and so on.

The dynamic equations for the landing craft are given by the following four first-order ordinary differential equations:

$$\frac{dX_1}{dt} = X_2$$

$$\frac{dX_2}{dt} = \pm SJET$$

$$\frac{dY_1}{dt} = Y_2$$

$$\frac{dY_2}{dt} = -g + JET$$

where:

X<sub>1</sub> = horizontal displacement

X<sub>2</sub> = horizontal velocity

SJET = side jet thrust; negative for the right-hand side jet, positive for the left-hand side jet, and 0 when neither are firing

Y<sub>1</sub> = vertical displacement

 $Y_2$  = vertical velocity

g = gravity

JET = main jet thrust; 0 when it is not firing

t = time

According to the Euler's method (see reference on "Applied Numerical Methods"), an equation of the form:

$$\frac{dZ}{dt} = f(t, Z)$$

can be replaced by the following equivalent numerical routine:

$$Z_{n+1} = Z_n + hf(t_n, Z_n)$$
  
 $t_{n+1} = t_n + h$   
 $n = 0,1,2,...$ 

where the quantity  $Z_{n+1}$ , at the time  $t_{n+1}$ , can be calculated by adding the previously calculated value  $Z_n$ , and the product of the time increment h and the function  $f(t_n, Z_n)$ . Starting from the given initial value  $Z_n$  at  $t_n$ , the solution for  $Z_n$  at  $t_n$  can be obtained by repeating the calculation from the Euler's routine. This concept has been carried out in the program SYS (address 0016). An assumption is made that the time increment h is equal to 1/4 second.

A total of 553 bytes of memory is needed for the program. If you have more memory space available, you may want to add more constraints to your simulation. The limited fuel capacity can be added to the program. The fuel gauge, velocity, altitude, displacement, and elapsed time can also be displayed on the screen. The trace between craft and surface can be blanked by the beam-intensity modulation. The control line on the peripheral interface adapter (PIA), such as CA2 or CB2, can be used for the blanking control.

The microprocessor can be a useful tool in the classroom for the dynamic simulation. An automobile traveling on a random surface can be an interesting subject for studying the suspension system. Even a simple mass, spring, and dashpot system would prove to be an interesting simulation to observe on the osccillosope.

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# The Dirt-Cheap Bootstrap

### More Notes on Bringing Up a Microcomputer

Albert S Woodhull RFD 2, Enfield Rd Amherst MA 01002

How do you take the very first steps into learning about microprocessors? An article by Sol Libes ("Notes on Bringing up a Microcomputer," January 1978 BYTE, page 162) described a procedure for the initial testing of a homebrew microcomputer which uses simple procedures to determine whether or not address and control signals are functioning properly. The procedures described are effective, but in order to use them you need a way to load some programs into memory.

If you are building a kit or following a complete microcomputer design, then the details of input and output interfacing will be provided for — a bootstrap program will either be available in read-only memory or can be easily entered from a front panel. But suppose you are just feeling your way along, as I did. I had obtained an 8080A chip set through Intel's University Program, but I had no intention of building a real computer. I had full access to an Altair and an IMSAI at the college where I teach; I wanted only to learn a little about how the hardware worked. I certainly did not want to spend either

the money or the time to imitate the Altair's front panel. The following is a description of how I solved this problem in an economical way.

To set the stage: I had the 8080A microprocessor interfaced with the 8224 clock generator/driver device and 1 K bytes of programmable memory. I had thirty-two lightemitting diodes (LEDs), driven by simple emitter-follower transistor buffers, which indicated the state of the bidirectional data bus, the address bus, and the decoded status signals. Three problems seemed important:

- I needed to be able to single-step the processor so that the lightemitting diodes would show more than a meaningless blur.
- I needed a way to transfer data from the outside world to memory.
- I needed some kind of keyboard or switch panel for entering data.

#### Single-Stepping

The 8080A is a dynamic device. This means that you can't slow it down to human speed by slowing its clock signal. The 8080A can, however, be made to enter a wait state in which it essentially does nothing at high speed. While in the wait state, the processor uses the clock signal to keep its internal registers refreshed, but does not change its state.

To single-step through a program to make the computer perform each operation only at my command, I needed to be able to hold the processor in a wait state. The processor would stay in this wait state until I asked it to take a step; it would then immediately return to the wait state. As shown in the schematic diagram of figure 1, it was very easy to do this with only a single flip-flop.

The output of the flip-flop (half of a 7474 dual D edge-triggered type) was connected to the RDYIN line on the 8224 clock generator and driver. This line initiates a wait state when it is pulled low. Three inputs of the 7474 were used. The D (data) line was connected to ground. The clock input on the 7474 was driven by the SYNC output of the 8080A. Finally, a simple pulse generator drove the SET input to the flip-flop.

The operation of this circuit resembles that of a person whose reflexive response to the sound of an

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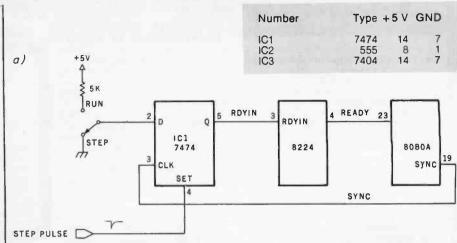


Figure 1a: A single-step mode can be implemented on an 8080A processor by using a flip-flop and the 8080A SYNC signal to clock a low-logic level through to the READY line. This puts the 8080A into a wait state. A very brief pulse to the SET input of the flip-flop ends the wait state until the next SYNC signal.

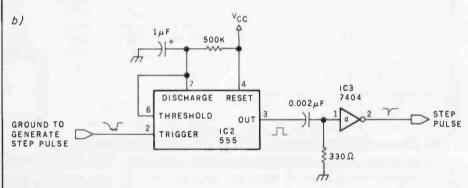


Figure 1b: The very narrow STEP pulse can be generated by a half-monostable circuit, a resistor-capacitor network at the input to a 7400 inverter. The manual switch contact must be debounced by a monostable circuit with a 0.1 to 1 second pulse width, for which a 555 timer is well-suited.

alarm clock is to roll over and turn it off. Normally the processor is in the wait state. A pulse to the SET input of the flip-flop ends the WAIT state, allowing the computer to complete execution of the process that is in suspension. At the very beginning of the processor's next cycle, it will send out a SYNC signal which will again clock the flip-flop output low, and reinitiate the processor wait state.

#### Getting the Data In

There are two ways an 8080A can access the outside world. IN or OUT instructions generate status signals which can be decoded, along with an 8-bit address, to activate input buffers or output latches. Alternatively, a memory address that is not actually used by memory devices can be decoded, along with read-frommemory or write-to-memory status signals. This can be used to activate a

memory-mapped buffer or latch. If a limited amount of memory and a small number of I/O (input/output) ports are to be addressed, the decoding can be ambiguous—some of the address lines may be ignored.

For bootstrapping purposes I took this to the limit: I arranged a switch to allow all memory-read signals to activate an input buffer, regardless of the state of the address lines. The principle is illustrated in the schematic diagram of figure 2. In the LOAD position of the switch, the real memory is never read, but memorywrite signals are still capable of performing their normal function. When the processor begins an instruction cycle, it reads a byte from "memory" which is interpreted as an instruction. It makes no difference to the processor if the byte actually originates on the front panel.

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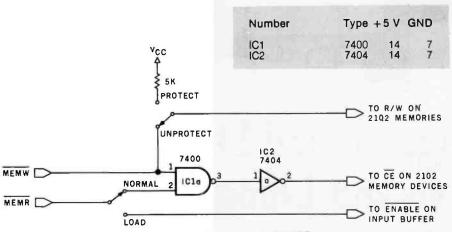


Figure 2: The LOAD/NORMAL switch routes the MEMR signal to an input buffer instead of to the memory, thus enabling the operator to control the processor by entering instruction codes from the outside. Also shown is another switch which can protect memory from inadvertent writing during debugging.

to move a byte of data from the front panel to the real memory by first setting up the code for a move immediate data to memory instruction (MVI M) on the panel, allowing the processor to execute a single step, and then setting up the value to be loaded on the panel. A second single step will read the data from the panel input,

and a third step will then write that data into a memory location.

The particular memory location must be specified somehow, so several additional bytes of instructions must have been *previously* entered. A few simple additions to the hardware already described make it necessary to do this only once, even if

many bytes are to be loaded into memory. A look at the computer to human interface should come first, however.

Cheap Keyboard Substitute

Figure 3 illustrates the ultimate in low-budget input devices. I took a scrap of copper-clad circuit board, scored it with a hacksaw into two rows of ten copper-bearing squares each, and soldered a length of wire to each square. Eight pairs of wires went to the inputs of simple latch circuits made by cross-connecting 7400 NAND gates; the other four pads on the circuit board were available for other controls. Light-emitting diodes (LEDs) indicated the state of each of the eight bits. A probe made from a defunct ball-point pen could be used to momentarily ground any of the pads.

In this way I could set up any desired combination on the latches; their outputs were in turn connected to the input port of the computer. One of the extra pads was connected to the single-step pulse generator mentioned earlier, via a debouncing circuit, and another was connected to the processor RESET line.

#### A Few Extras

Some additions to the elementary circuits described above were incorporated into the final version. The first of these is a trick I call "double addressing." An input port is physically just a buffer; there is no reason why a single physical port cannot have multiple logical identities.

I set up some logic gates to decode the input status signal and an address, along with an additional gate, to allow either the result of this decoding or a memory-read signal from the LOAD switch to activate the input buffer. The LOAD mode is used to load a simple bootstrap program. The bootstrap routine specifies a starting address for the program to be loaded, gets the data from the input port, moves it to memory, increments the pointer to memory, and then loops back to get another byte from the input. Once this bootstrap program has been loaded, the MEMR signal is switched back to the real programmable memory, but an IN instruction can still read the input port.

Text continued on page 148



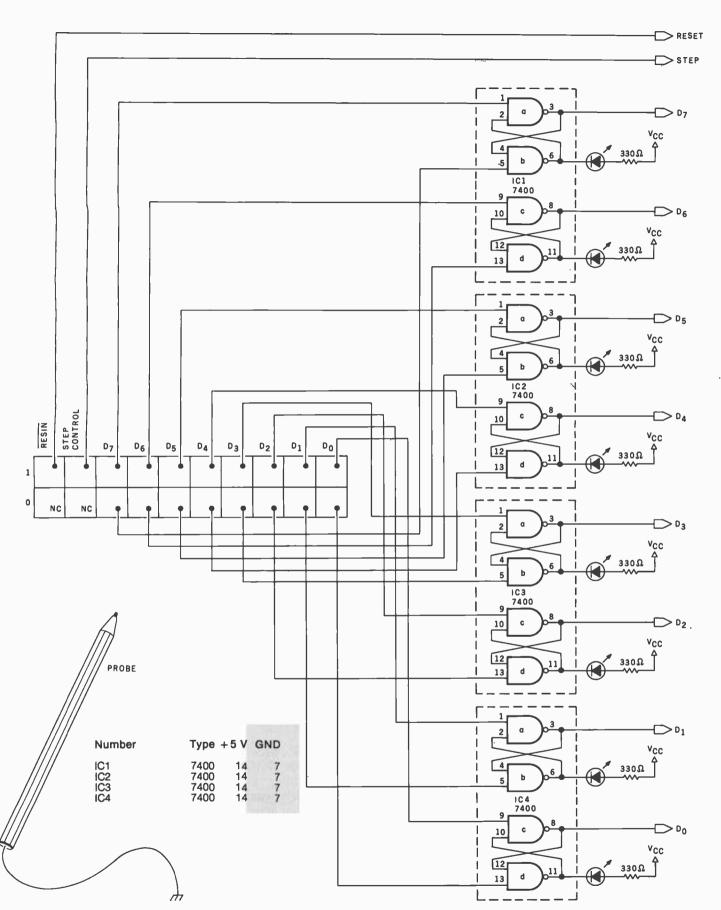


Figure 3: A small scrap of printed circuit board, an old ball-point pen, and some latch flip-flop circuits make a very inexpensive input device. With a little practice, an 8-bit number can be set up as easily and quickly as on a row of toggle switches. The surface of the printed circuit board has been scored to create isolated areas of copper for sensing purposes.

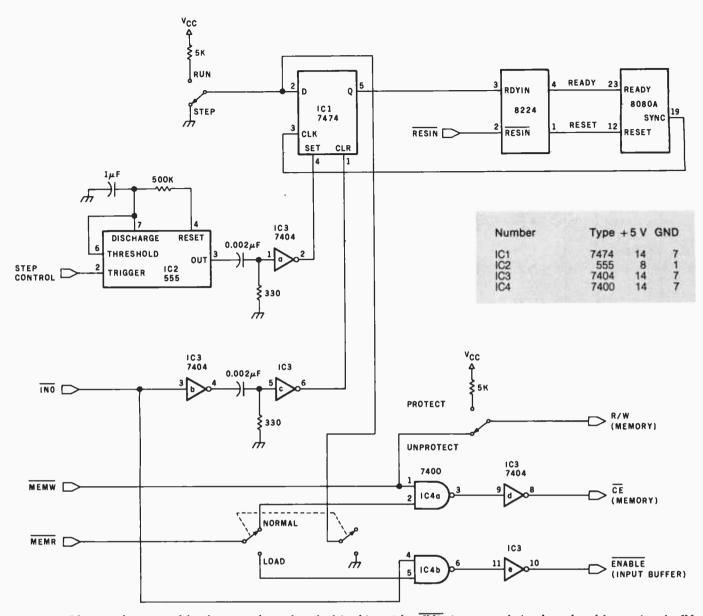


Figure 4: The complete control hardware package described in this article. INO is a control signal produced by getting the IN status signal from the 8080A and the address bus. Its orthodox function is to enable the input buffer; in this circuit the input buffer may also be enabled by a MEMR signal when the LOAD/NORMAL switch is in the LOAD position. INO also causes the 7474 single-step flip-flop to be cleared, thus forcing the processor into a wait state so that a human operator can set up the desired data on the input latch. Note the additional section of the LOAD/NORMAL switch which forces single-step operation in the LOAD mode, when full machine speed would be useless.

#### Text continued:

In the apparatus described so far, it would be necessary to single-step through the bootstrap program loop because at full machine speed the very first byte of data entered would be rapidly written into every possible memory location. Most monitor programs for handling such inputs have some provision for ensuring that they read each keystroke on a terminal only once. This is usually done by using a second input port as a control port which signals when new data is available. The hardware and software required for this would have

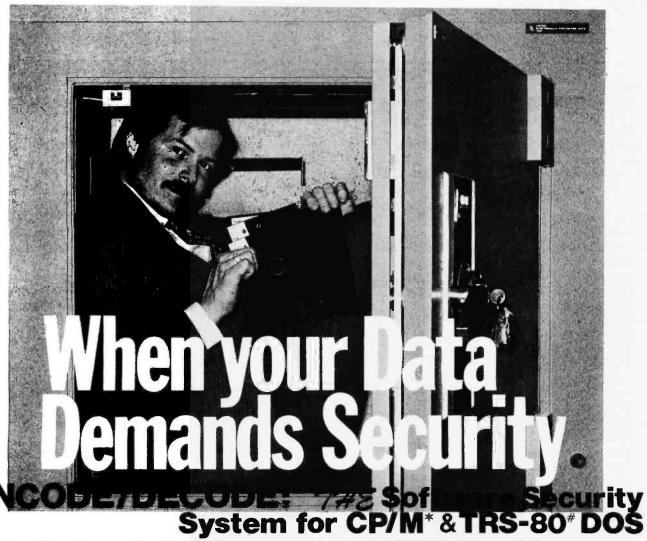
been inconveniently complicated for my early breadboard system.

A second unconventional trick avoided the problem. I made wait states programmable by adding a second pulse generator which was driven by the same decoder that activated the input buffer. The output of this pulse generator was fed to the RESET input on the single-step flipflop. Instead of directly grounding the D input on the flip-flop, I put in a RUN/STEP switch which selects either a logic 1 or a logic 0 level for this input.

When the 0 level is selected, opera-

tion in the single-step mode proceeds as previously described. When the 1 level is selected, the processor runs at full speed *until* the program calls for data to be input. As the input port is selected, a wait state is initiated. At human speed, the required data can be set up on the input latches. A touch on the STEP pad then causes execution to resume. Figure 4 shows the circuit that incorporates all of these features, and example 1 in the text box describes in detail the procedure for loading the bootstrap program.

Text continued on page 152



Let's face it, there is information which just isn't meant for everyone who uses or has access to your computer. Consider payroll or tax records. Until now, the only way to secure these and other valued or privileged records meant either "pulling the plug" or locking the discettes in a safe. Who wants to run to the safe each time an update needs to be made? At last a simple, effective and convenient method of data security is available—ENCODE/DECODE.

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#### Example 1 Cold Start Bootstrap

The following sequence of operations is used with the hardware system described in the text to load a program when power is supplied to the computer:

- 1. Set LOAD/NORMAL switch to LOAD.
- 2. Momentarily ground the RESIN line. This clears the program counter and ensures that the processor will interpret the first byte it reads as an instruction.
- 3. Set up the input latch with the binary data 00100001. This is hexadecimal 21, the op code for a load-immediate data into the HL register pair (LXI H) instruction. When ready, ground the STEP line.
- 4. The processor will now expect a second and third byte for the LXI H instruction. These bytes will be loaded into the L and H registers and will act as a pointer to a particular memory address. To start at address 0000, set up all zeros on the input and STEP twice.

5. Set up the op code for the load immediate data into a memory location pointed to by the HL pair (MVI M) instruction, hexadecimal 36, then STEP by

grounding the line.

6. The processor will now expect a byte of data. Set up hexadecimal DB on the latches. This is the code for the IN (receive input) instruction. Then STEP twice, once for the processor to read the data, and once for it to write the data into the memory.

7. Now set up hexadecimal 23 and STEP. This is the op code for the INX H instruction. This operation increments the address stored in the L and H registers and prepares the processor to write a byte to the next address in memory.

Only the last three operations of this sequence must be repeated to load additional bytes of data into the memory. Furthermore, only six more repetitions of steps 5, 6, and

7 are needed to complete the loading of the program given as

listing 1.

After you enter this program, reset the program counter by grounding the RESIN line. Switch the LOAD/NORMAL control to NORMAL. The single-step mode can be used to verify that the program has been loaded properly, and then the full-speed run mode can be entered. Loading additional data into memory requires only that you set up the data on the input device and ground the STEP line. With an almost imperceptible flicker of the light-emitting diodes (LEDs), the data is read from the input and written into the memory. The processor again waits for another byte.

#### Example 2 Examination of a Memory Location

To examine a particular location follow this procedure:

- 1. Set the LOAD/NORMAL switch to LOAD.
- 2. Momentarily ground the RESIN
- 3. Enter hexadecimal C3, the code for a JMP, then STEP.
- 4. Enter the low byte of the desired address, then STEP.
- 5. Enter the high byte of the desired address, then STEP.
- 6. Setting the LOAD/NORMAL switch back to NORMAL will put the data at the desired location on the data bus, thus displaying it on the data LEDs.

After examining a location, a STEP will start execution from that location. You can then conduct another examine operation to show a new location, or the examine-next procedure of example 3 can show the next location.

#### Example 3 The Examine-Next Function

To look at a program or data in memory without executing it, first examine the first byte in the desired memory segment, then do the following:

- 1. Set the LOAD/NORMAL switch to LOAD. Do not ground RESIN.
- 2. Set up all zeros on the input latch. This is the code for a no operation (NOP) instruction.
- 3. STEP, then switch to NOR-MAL. The next byte in memory will be displayed on the data LEDs.

This procedure can be repeated as desired. Note, however, that strange things can happen if you start execution while examining a byte which is the second or third byte of a multibyte instruction. This error of starting in the wrong place is also possible with most conventional front panels.

#### Example 4 Temporary Patches

When a program contains loops that are repeated many times, single-step debugging can be simplified by substituting instructions. For example, a subroutine that generates eight cycles of 2400 Hz audio to record a logic 1 bit on magnetic tape is shown in listing 2.

To verify that this program worked properly, you would not want to single-step through the inner loop 416 times! You might step through it once, but the next time you came to the INZ instruction, you could use the LOAD function to make the processor see three successive NOPs. Alternately, you might change the cycle counting and timing bytes at locations 0102 and 0104 to the value 01. Since the LOAD substitution does not actually alter memory contents, this procedure can also be used for a program stored in read-only memory. There is no need to go back and undo patches after tracing the program. In these respects the LOAD function of this simple control system is more versatile than most conventional front panels. If a permanent patch is needed, you can use the LXI H and MVI M instructions.



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Listing 1: Program instructions which are loaded into the 8080 memory by manual means, and are then used to load further memory locations more quickly.

Hexadecimal Data Loaded	Instruction Mnemonic	Explanation
DB	IN	Input
00		Input port address (hardware dependent)
77	MOV M,A INX H	Copy data from accumulator to memory
23		Increment HL, the memory pointer
C3	JMP	Jump
00		Jump address, low byte
00		Jump address, high byte

Listing 2: A routine for the 8080 which can record a logic 1 bit on a cassette tape by generating eight cycles of a 2400 Hz audio signal.

Address	Label	Mnemonic	Explanation
0100	MARK	XRA A	Set accumulator to zero
0101		MVI B	Set up a counter
0102		10	to count 16 half cycles
0103	HALFCY	MVI C	And another counter
0104		1 A	to time 26 loops
0105		OUT	Then output to
0106		00	port 0
0107	TIMELOOP	DCR C	Countdown the timer
0108		JNZ TIMELOOP	And stay in the loop
0109		07	until counter is zero
010A		01	
010B		CMA	Complement the accumulator
010C		DCR B	Countdown half cycles
010D		JNZ HALFCY	And send more until
010E		0	cycle counter is zero
010F		01	
0110		RET	Then return to main program

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Text continued:

Additional Applications

The LOAD mode permits direct control of the computer at any time. Most of the functions of the front panel on an IMSAI or Altair can be simulated by causing the processor to execute instructions loaded directly from the crude printed-circuit-pad "front panel." For example, executing a IMP instruction is equivalent to the examine function of the usual front panel. Examine next is implemented by single-stepping a no-operation (NOP) instruction. A program can also be temporarily patched during single-step debugging to break out of a loop, or to try an alternative instruction. Examples 2, 3, and 4 in the text box explain these functions in more detail.

**Evolution of the System** 

While developing the circuits I have described, I became hooked on microprocessors. What started out as a breadboard project is now a computer, but I have spent less money along the way than is ordinarily paid for a system of less capability.

To encourage others who might wish to follow a route similar to mine, I want to emphasize that all of the effort and material that went into my first experiments were useful in the larger system that grew from it. The single input port that served my printed circuit board input device was later shared by an ASCII keyboard and a cassette recorder.

The addition of a single output port made possible the use of software timing in a routine to generate audio tones for recording programs on tape. Another bit of the same output port can drive a printer in serial mode; again, software timing can be used.

The first 256-byte block of readonly memory that I added was adequate to hold all of the programs that I needed to read cassette tapes. During the few weeks it took me to develop those programs, not wishing to lose the programs by removing power from the programmable memory, I connected an old car battery to the memory to keep it alive.

I have now reached the point of connecting commercial S-100 cards to my system. Because I have built it and know the function of every wire, it is easy to make minor modifications when a control signal is needed for interfacing a new device.

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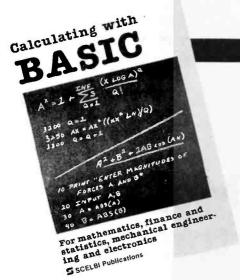
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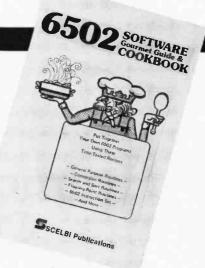
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# Hydrocarbon Molecule Constructor

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To an organic chemist learning to program a newly acquired microcomputer (in my case, the 16 K byte Apple II), the challenge of "teaching" chemical principles to the computer naturally arises. For example: can the Apple II learn the rudiments of structural organic chemistry, and use that knowledge to assemble and draw simple molecules? This subject is usually covered early in the first semester of sophomore organic chemistry. I decided to write a BASIC program that would accept a hydrocarbon molecular formula as input, and then randomly construct a molecule fitting that formula and draw its structure using high-resolution graphics as output.

#### Initialization

First, the program must be initialized and the input accepted and analyzed. The user will enter a molecular formula in the form C,H (where C is the number of carbon atoms and H is the number of hydrogen atoms in the molecule).

Clearly, the program must accept only values of C and H that are positive, and less than the maximum numbers allowed by the dimension statement (line 100). However, the dictates of organic chemistry force further restrictions.

In a neutral, ground-state, hydrocarbon molecule, every carbon atom must have exactly four bonds (ie: connections to other atoms), and every hydrogen atom must

Figure 1: In the hydrocarbon 3-methyl-1-butene, each carbon atom has four connections. This is true of any hydrocarbon molecule.

have exactly one bond. In 3-methyl-1-butene, as shown in figure 1, notice that each carbon has four connections.

Carbon atom number 2 (C-2) has one bond to C-3, one bond to a hydrogen (H), and two bonds to C-1. Similarly, each H has only one bond. This *valence* restriction means that, for a given number of carbons C, the maximum number of hydrogens is  $2 \times C + 2$ . A little thought will verify that conclusion.

Consider the propane structure, as shown in figure 2, with a formula  $C_3H_8$  (8=2×3+2). No more hydrogens can be added, since each carbon already has its maximum number of connected atoms. Note that if we make a double bond (C-1 to C-2) to form 1-propene, two hydrogens must be removed. This observation leads to a second restriction: the total number of hydrogens in a hydrocarbon must always be even. A good exercise is to try to draw a counter-example, remembering the valence restrictions.

#### **Connection Table**

Having accepted and screened the input, our program must now put together carbon and hydrogen atoms to form a molecular structure that fits the formula input. This process involves the construction of a connection table. To illustrate this concept, consider again the molecule in figure 1. How can the information in that structure be numerically represented? One convenient

**Figure 2:** Examples of propane and propene. For any given hydrocarbon with C carbon atoms, the maximum number of possible hydrogen atoms, H, is  $2 \times C + 2$ .

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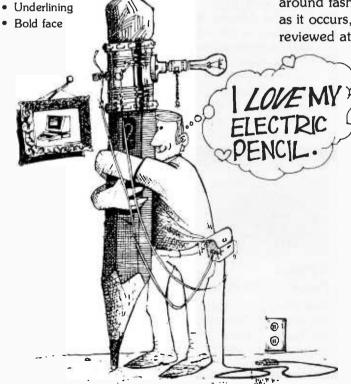
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		BOND	NUMBER		
	. 1	2	3	4	
CI	2	2	0	0	
C2 C3 C4	1	1	0	3	
C3	4	5	2	0	
C4	3	0	0	0	
C5	3	0	0	0	

Figure 3: A possible method of representing a connection table. This connection table represents every bond for every carbon atom. The information is stored by the computer in the form shown in figure 4.

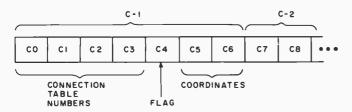


Figure 4: The connection table is stored in array C.

		(	a)				(1	5)	
CI	2	4	0	0	CI	4	4	0	0
C2	1	3	0	0	C2	3	3	0	0
С3	2	4	0	0	C3	2	2	0	0
C4	1	3	0	0	C4	-1	T	0	0
		н	н				н	н	
		- 1	- 1				- 1	- 1	
	H	- cı -	- C2-	-н		н	-C1	Ç2-	-н
							Ш	11	
	Н	- C4 -	- C3 -	- H		Н	-C4	C3-	-н
		н	н				н	н	

Figure 5: Using the random method of generating connection tables may result in some difficulties. Two connection tables for  $C_4H_8$  are shown. One possible and acceptable connection table is figure 5a. Figure 5b is an unacceptable connection table since it results in two separate molecules.

method is shown in figure 3.

This connection table indicates every bond for every carbon atom. For example, in column 2 of row C3 is a 5, indicating that the second bond of C-3 connects to carbon atom number 5 (C-5). An entry of 0 in the table means connection to a hydrogen. Thus, the number of 0s in the table necessarily equals the number of hydrogens in the molecule. Reading across row C2, we find that carbon C-2 is connected twice to C-1, constituting a double bond, once to C-3, and once to a hydrogen.

In the computer, the information contained in the connection table is stored in array C, as indicated in figure 4. The information for C-1 is stored in array elements C(0) thru C(6); the information for C-2 is stored in elements C(7) thru C(13); etc. In every such block of seven elements, the first four elements contain the four numbers from the connection table for that carbon atom. Thus, using the connection table in figure 3 as an example, we have: C(0)=2, C(1)=2, C(2)=0, C(3)=0, C(7)=1, C(8)=1, C(9)=0, C(10)=3, etc. The use of the other elements in the array is explained later.

My first programming impulse was to construct the connection table entirely at random. Unfortunately, this method proved inadequate for several reasons. First, it was very slow. After each attempt at constructing the table, the program would check if the generated numbers were consistent with the input molecular formula. If they were not, as was often the case, the program recycled to try again. This process was very inefficient.

The second problem was that the connection tables generated often did satisfy the formula, but led to disconnected structures. For example, suppose the formula  $C_4H_8$  (4,8) is input. Figure 5 shows two connection tables, along with their corresponding structures, that fit this formula. Clearly, the output in figure 5b is unacceptable because it is two separate structures, even though its connection table still conforms to the input.

How may these problems be solved? The answer lies in the new algorithm illustrated in figure 6, which again uses the hypothetical input C₄H₃. This method begins by connecting C-1 to C-2. A random integer between 0 and 3 is then selected, and C-3 is bound to the carbon atom with



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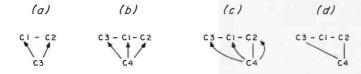


Figure 6: A more efficient method for connecting the carbon atoms is to first connect C-1 to C-2. A random number between 0 and 3 is then selected and C-3 is bound to that carbon atom (6a,6b). C-4 is then randomly connected to one carbon atom in the range C-1 thru C-3. After all carbon atoms have been connected thus, the table is cleaned up by another routine. Two different carbon atoms are chosen randomly and a bond is formed between them if their valence restrictions allow. (Remember there may be only four bonds to a carbon atom.) In the example the final connection is between C-4 and C-3. All of the available bonds will be filled with hydrogen atoms in the final molecule.

that number as shown in figures 6a and 6b. An integer between 0 and 4 is randomly chosen, and C-4 is connected to that atom as shown in figures 6b and 6c.

After all of the carbons have been thusly connected, another routine is used to finish the table, wherein more connections are randomly made as follows. Two different carbons in the existing structure are randomly chosen, and, if the valence restriction allows, a bond is made between them.

In our example, the final connection is made between C-4 and C-3. (See figures 6c and 6d.) After connecting all the carbons, the number of such additional bonds that must be made can be calculated beforehand from the molecular formula according to the equation:

$$EU = ((2 \times C + 2)-H)/2$$

where EU represents the number of additional bonds to be formed, and C and H are the formula input numbers. The origin of this equation is not within the scope of this article, but the enterprising reader might be able to derive it. EU stands for elements of unsaturation. In the example above, EU=1 (for C<sub>4</sub>H<sub>8</sub>), so only one additional bond had to be made to complete the connection table. (See figures 6c and 6d.)

**Assigning Coordinates** 

Having assembled the molecule, coordinates for each carbon must now be assigned before drawing the structure. For the final drawing to be as clear as possible, the assignments need to satisfy at least two requirements. First, no two carbons should have the same coordinates; and second, carbons that are bound to each other should be plotted next to each other whenever possible.

The following algorithm was devised to assign coordinates according to the two criteria. Carbon C-1 is given the coordinates 120,75 in the Apple's 270 by 160 highresolution graphics display. Next, all of the carbons connected to C-1 that do not already have coordinates are assigned coordinates next to C-1. These coordinates are stored in the sixth and seventh elements of the requisite block in array C as shown in figure 4. After its neighbors have been given coordinates, the flag element in C-1's block of array C is set to 1. (Again, see figure 4.) If it has already received its coordinates, the same procedure is then followed for C-2 and continued until all of the carbons have been used. This method does not always give the best or even an adequate representation, but it does offer the advantages of simplicity and speed. Also, the confusing drawings that sometimes result are in most cases easily improved.

Drawing the Structure

With all the necessary information now contained in array C, the final structure may be drawn. This straightforward process uses Apple's machine-language, high-resolution graphics subroutines (stored in hexadecimal locations C00 thru FFF prior to running the program), as well as the several vector tables given in the text box, allowing the atomic symbols to be easily drawn by the shape subroutine. These vector tables must be stored in hexadecimal locations 1000 thru 1129, and are protected by a LOMEM setting that is automatically performed by the BASIC program (line 5).

Text continued on page 166

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**Listing 1:** An Apple II integer-BASIC program for generating hydrocarbon representations using the available high-resolution graphic routines. The high-resolution routines use the graphics tables in listing 2.

5 PAKE 204,4400 MOD 256: POKE 205,4400/256: POKE 74,4400 MOD 256: POKE 75, 4400/256 10 GOTO 100 30 POKE 802,Y: POKE 800,X MOD 256 35 POKE 801, X/256: RETURN 40 POKE 804, X MOD 256; POKE 805, X/256; RETURN 100 DIM C(110) 110 TEXT : CALL -936: VIAB 5: TAB 8: PRINT "APPLE-CHEM II" 120 YTAB 10: PRINT "THIS PROGRAM WILL DRAW A MOLECULE": PRINT "FOR A GIVEN M OLECULAR FORMULA. " 130 VTAB 15: PRINT "ENTER A MOLECULAR FORMULA": PRINT "IN THE FORM 10,H1 , W HERE" 140 PRINT "101 = THE NUMBER OR CARBON ATOMS": PRINT "IN THE MOLECULE, ETC." 150 INPUT NO. NH 152 NF=0 157 NF=1: CALL -936: VTAB 22: PRINT "C-"; NC; ", H-"; NH: GOTO 180 160 IF NC>1 AND NC<16 AND NH>-1 AND NH<=2\*NC+2 AND (NH/2=NH-NH/2) THEN 180 170 PRINT : PRINT "IMPROPER DATA!": PRINT "C MUST BE >= 2 AND < 16": PRINT "H MUST BE EVEN, >= 0 AND <= 2\*C+2": GOTO 150 180 EU=((2\*NC+2)-NH)/2 190 FOR I=0 TO NC\*7:C(I)=0: NEXT I 200 C(0)=2:C(7)=1: IF NC=2 THEN 300 210 FOR I=3 TO NO 220 X= RND (I-1)+1230 IF C((X-1)\*7+1)#0 THEN 250 240 C((I-1)\*7)=X:C((X-1)\*7+1)=I: GOTO 290 250 IF C((X-1)\*7+2)#0 THEN 270 260 C((I-1)\*7)=X:C((X-1)\*7+2)=I: GOTO 290 270 IF C((X-1)\*7+3)#0 THEN 290 280 C((I-1)\*7)=X:C((X-1)\*7+3)=I 290 NEXT I 300 IF EU=0 THEN 410 310 FOR K=1 TO EU 320 X= RND (NC)+1:Y= RND (NC)+1: IF X=Y THEN 320 330 FOR I=1 TO 3: IF C((X-1)\*7+1)#0 THEN 350 340 X1=I: GOTO 360 350 NEXT I: GOTO 320 360 FOR I=1 TO 3: IF C((Y-1)\*7+I)#0 THEN 380 370 Y1=I: GOTO 390 380 NEXT I: GOTO 320 390 C((X-1)\*7+X1)=Y:C((Y-1)\*7+Y1)=X400 NEXT K 410 FOR I=4 TO (NC-1)\*7+4 STEP 7: FOR J=0 TO 2 420 C(I+J)=0: NEXT J: NEXT I 430 GOSUB 1000: GOSUB 2000 435 CALL -936: VTAB 22 437 IF NF#1 THEN 440:NC=-100: GOTO 155 440 PRINT "HIT 'D' TO DRAW THIS DIFFERENTLY" 450 PRINT "HIT 'I' FOR A NEW ISOMER (SAME FORMULA)" 460 PRINT "HIT 'F' FOR A NEW MOLECULAR FORMULA" 470 KEY= PEEK (-16384): IF KEY<128 THEN 470 480 POKE -16368,0 490 IF KEY=196 THEN 410; IF KEY=201 THEN 190; IF KEY=198 THEN 110 500 END

```
1000 C(5)=120:C(6)=75
1010 FOR K=1 TO NO: IF C((K-1)*7+4)=0 AND C((K-1)*7+5)#0 THEN 1030
1020 NEXT K: GOTO 1090
1030 FOR I=0 TO 3:J=(K-1)*7+I: IF C(J)=0 THEN 1080
1040 IF C((C(J)-1)*7+5)#0 THEN 1080
1050 GOSUB 1500
1060 FLAG=0: GOSUB 1600: IF FLAG=1 THEN 1050
1070 C((C(J)-1)*7+5)=TX(C((C(J)-1)*7+6)=TY
1080 NEXT I:C((K-1)*7+4)=1: GOTO 1010
1090 RETURN
1500 TX=C((K-1)*7+5):TY=C((K-1)*7+6)
1510 A1=( RND (3)*30)-30:A2=( RND (3)*30)-30
1520 TX=TX+A1:TY=TY+A2
1530 IF TX<4 OR TX>264 OR TY<4 OR TY>152 THEN 1500
1540 RETURN
1600 FOR II=1 TO NO
1610 IF C((II-1)*7+5)=TX AND C((II-1)*7+6)=TY THEN 1630
1620 NEXT II: GOTO 1640
1630 FLAG=1
1640 RETURN
2000 CALL 3072: POKE 812,255: POKE 806,1: POKE 807,0
2010 S=3805:L=3786:P=3780: POKE 28,255
2020 FOR I=1 TO NO: FOR J=0 TO 3: IF C((I-1)*7+J)=0 THEN 2160
2030 FLAG=0: IF C((I-1)*7+J)<I THEN 2160
2040 FOR K=0 TO 3: IF K=J THEN 2060
2050 IF C((I-1)*7+K)=C((I-1)*7+J) THEN FLAG=FLAG+1
2060 NEXT K:T=C((I-1)*7+J)
2070 X1=0((I-1)*7+5);Y1=0((I-1)*7+6);X=X1;Y=Y1
2080 GOSUB 30: CALL P
2090 X2=C((T-1)*7+5);Y2=C((T-1)*7+6);X=X2;Y=Y2
2100 GOSUB 30: CALL L: IF FLAGK1 THEN 2160
2110 X=X1+6;Y=Y1+3; G0SUB 30; CALL P
2120 X=X2+6:Y=Y2+3: GOSUB 30: CALL t.
2130 IF FLAG#2 THEN 2160
2140 X=X1-3:Y=Y1-6: GOSUB 30:
                              CALL P
2150 X=X2-3:Y=Y2-6: GOSUB 30: CALL L
2160 NEXT J: NEXT I
2170 FOR I=1 TO NC:X1=C((I-1)*7+5):Y1=C((I-1)*7+6)
2180 POKE 812,0:X=X1:Y=Y1+2: GOSUB 30: CALL P
2190 POKE 804,4199 MOD 256: POKE 805,4199/256: CALL 5: POKE 812,255
2220 X=X1:Y=Y1: GOSUB 30: CALL P:FLAG=0
2230 FOR J=0 TO 3
2240 IF C((I-1)*7+J)=0 THEN FLAG=FLAG+1
2250 NEXT J
2260 IF FLAG#0 THEN 2280
2270 X=4096: GOSUB 40: GOTO 2330
2280 IF FLAG#1 THEN 2300
2290 X=4107: GOSUB 40: GOTO 2330
2300 IF FLAG#2 THEN 2320
2310 X=4130: GOSUB 40: GOTO 2330
2320 X=4166: GOSUB 40
2330 CALL S: NEXT I: RETURN
```

Listing 2: The program in listing 1 uses a high-resolution shape (or vector) table which is shown here. It stores shapes for the chemical symbols. The operation of the shape table is defined in the Apple II Programmer's Manual and in the documentation for the high-resolution routines. These vector tables are used to draw the different parts of molecules on the video screen.

1000-	22	64	2D	15	96	F2	3F	07	1028-	17	17	36	28	2D	D5	DB	C3
1008-	20	04	00	24	2D	2D	24	34	1030-	18	08	18	24	24	24	DF	33
1010-	36	36	FE	1B	24	24	24	D7	1038-	36	36	3E	D8	1E	3F	07	20
1018-	E3	3F	17	36	36	0E	2D	05	1040-	24	64	2D	15	06	00	2E	2D
1020-	20	00	2D	2D	4D	62	AD	F6	1048-	AD	09	0C	AD	36	3F	2D	36

#### Listing 2 continued:

, a communem																	
1050-	1E	3F	EO	D8	24	24	24	DF	10C0-	2D	3E	3F	3F	3F	3F	3F	3F
1058-	33	36	36	3E	D8	1E	3F	07	10C8-	3F	3F	3F	3F	37	2D	2D	2D
1060-	20	24	64	2D	15	06	00	24	10D0-	2D							
1068-	24	24	24	3C	3F	3F	3F	3F	10D8-	3F							
1070-	3F	2D	10E0-	3F	3F	3F	37	2D	2D	2D	2D						
1078-	2D	2D	2D	2D	3E	3F	3F	3F	10E8-	2D	3E						
1080-	3F	37	10F0-	3F													
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10A8-	2D	2D	3E	3F	3F	3F	3F	3F	1118-	2D	2D	2D	2D	2D	3E	3F	3F
10B0-	3F	3F	3F	3F	3F	37	2D	2D	1120-	3F							
10B8-	2D	1128-	07	00													

Table 1.

Program Lines	Function
5	Set LOMEM:4400
30-40	Subroutines used for drawings.
100-170	Accept and analyze input.
180-400	Construct connection table.
435-500	Special features.
1000-1640	Subroutine to assign coordinates.
2000-2330	Subroutines to draw molecule.

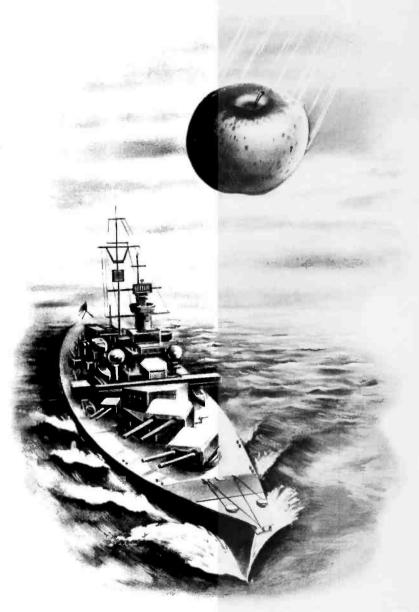
#### Program Notes

Since remark statements were deleted from the final program to increase execution speed, the explanations provided in table 1, should prove useful when reading the program. Table 2 provides a list of all machine language accesses in the Apple II used in this program. These explanations should help implement the chemistry program on a different computer.

Table 2.

Command	Occurrence	Effect
POKEs to 204, 205, 74, 75	line 5	Set LOMEM:4400. This protects the vector table in the Apple's memory from being
POKEs to 802, 801, 800	lines 30, 35	written over. These locations hold the coordinates for the next point to be plotted.
POKEs to 804, 805	line 40	These locations hold the address of the part of the vector table containing the shape about to be drawn.
CALL 3072	line 2000	Initializes high-resolution graphics mode.
POKE 812, 255 POKE 806, 1	lines 2000, 2190 line 2000	Set color to white. Set scaling factor to 1. (full size)
POKE 807, 0	line 2000	Set rotation factor to 0.  (right side up)
CALL P	lines 2080, 2110, 2140, 2180. 2220	Causes point to be plotted at coordinates set in SUB 30.
CALL L	lines 2100, 2120, 2150	Causes line to be drawn from last point plotted to coordinates set in SUB 30.
POKE 812, 0 CALL S	line 2180 lines 2190, 2330	Set color to black. Cause shape to be drawn starting at last point plotted (line 2180). Shape is determined by which section of vector table is poked into locations 804 and 805 as shown below:
	table location	figure drawn
	4199 4096 4107 4130 4166	blank space C CH CH <sub>2</sub> CH <sub>3</sub>

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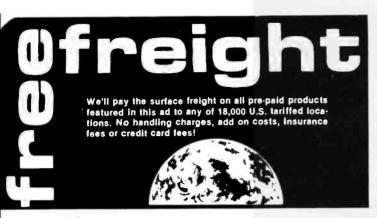
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Text continued from page 160:

#### Program Description and Instructions

To run the program, load the high-resolution graphics subroutines, the vector tables, and the BASIC program (remembering to set HIMEM;8192) and type RUN. You will be asked to input a molecular formula. To test the program, type 4,8. In a few seconds, an isomer of butene should appear. At the bottom of the screen, you will note several special features. Pressing the D key will draw a new picture of the same compound; in other words, the same connection table is used, but different coordinates are assigned. This command is very useful, particularly for complicated structures, when the initial drawing is too confusing to understand. You may continue to press the D key until a satisfactory drawing results. Pressing the I key isomerizes the structure (ie: a different compound with the same molecular formula is drawn). Thus, you could investigate some of the many isomers of tetrahedrane (C<sub>4</sub>H<sub>4</sub>). Pressing the F key simply recycles the program to allow new input. Pressing any other key ends the run.

One other very interesting special feature is demonstrated by entering the "formula" -100,0. This input is a signal for the program to begin drawing structures from randomly chosen molecular formulae. It will continue to draw new compounds until interrupted by control-C. This feature makes a fascinating demonstration display for the Apple II.

#### **Concluding Comments**

Finally in possession of a running program, you may well inquire: what good is it? Certainly, for a practicing organic chemist, the program has little practical value. However, by exposing several of my chemist friends to the program, I have found that they do enjoy playing with it, especially the isomerization feature. It is fun!

For those who are interested in practical applications of microcomputing, I stress that this program has valuable use in chemical education. For beginning organic students, it provides an enjoyable introduction to numerous seminal concepts of structural chemistry (eg: to the ideas of structural isomerism and valence requirements). Moreover, it could be used to test comprehension of nomenclature, particularly for more advanced students. For instance, I have enjoyed entering formulae and challenging others to assign International Union of Pure and Applied Chemistry (IUPAC) names to the resulting structures.

In closing, I must point out that the program described here is only a beginning. Several potential improvements immediately spring to mind. One is the possibility of the Apple drawing three-dimensional representations. Also, anyone with much chemical background will quickly realize that many structures generated by the program are rather unlikely, if not practically impossible. For instance, the Apple does not hesitate to draw cyclopropadiene, an impossibly strained ring. It might be possible to teach the Apple such concepts as ring strain and Bredt's rule; however, I am not sure if that would be desirable. Much of the program's charm derives from its naive approach to molecular assemblage, yielding delightfully unexpected structures. And who knows? Recent experience in organic synthesis has demonstrated that improbable structures are not always impossible.



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# **Book Reviews**

What Computers Can't Do

Hubert L Dreyfus Harper and Row New York 1972 hardcover, 259 pages \$10.95

Brain, Mind and Computers

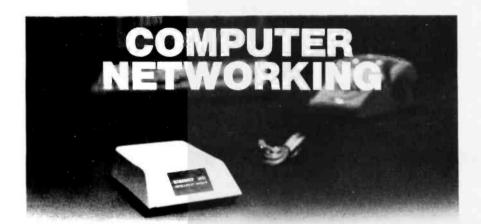
Stanley L Jaki Gateway Editions softcover, 267 pages \$4.95

What Computers Can't Do and Brain. Mind and Computers are two widely available critiques of artificial intelligence. Their authors bring somewhat different credentials to the task. Hubert Drevfus is a philosopher who has worked in artificial intelligence research for well over a decade, and Dr Jaki is a theologian concerned with the philosophy of science.

What Computers Can't Do is a follow-up on a RAND Corporation paper which Dreyfus did in the mid-1960s. The question he raises is why, after the rapid advances in artificial intelligence research during the 1950s, was there such a slowdown in results during the 1960s and early 1970s? Many of the results which were forecast for the period 1969 thru 1979 never occurred (such as general-purpose language translation, innovative work in mathematics by computers, etc). Drevfus believes that there are a number of mistaken assumptions underlying the hopes in artificial intelligence research: assumptions about how we think and about the nature of the world. His conclusion is that more attention must be paid to the ways in which humans think about things and how these differ from the ways in which computers work. He argues that the result of this is a classification of tasks into different groups, some of which are definitely fair game for machines, some of which pose serious problems, and some of which are not likely to yield human-type performance to computers as they are presently designed.

Overall, this book is very interesting reading, and contains well-thought-out discussions of many of the issues in artificial intelligence research.

Brain, Mind and Computers was originally published ten years ago and has since been reissued. It is ostensibly a discussion of artificial intelligence research; it is in fact a refutation of physicalism, which the author maintains is synonymous with determinism. While discussing artificial intelligence at length, Dr Jaki never defines what he means by it: he seems to mean a machine which will be fully equivalent to the human mind in all respects. Given this implicit definition, the task of arguing against the possibility is simplified.



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#### Merging with external data files

You may access any external data file, with either fixed length or sequential records. The MAGIC WAND converts the record into variables that you define and can use like any other variable. Of course, you may use the data for automatic form letter generation. But you can also use it for report generation.

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Brain, Mind and Computers is an excellent guide to the history of physicalism in scientific thought. The computer is taken as a metaphor for "machine," and artificial intelligence is taken in its strongest sense- a sense that is almost unknown in the current artificial intelligence research literature.

John A Lehman 716 Hutchins #2 Ann Arbor MI 48103

#### **Z80 Software Gourmet** Guide and Cookbook

Nat Wadsworth Scelbi Publications, 1979 softcover, 322 pages \$14.95

The Z80 Software Gourmet Guide and Cookbook is one in a series of such books which Scelbi has published; previous "cookbooks" have appeared for the 8080 and the 6800

processors. The primary theme behind these books is to explain how to perform common assembly-language programming tasks for the various microprocessors, and to provide tested routines for these tasks which can be included as part of larger programs.

The Z80 volume covers the Z80 instruction set. utility operations (such as multibyte arithmetic), stack operations, input/output (I/O) processing, charactercode conversion, searching

and sorting, decimal arithmetic, and floating point arithmetic. These topics were also covered in the 8080 volume. Additional chapters in the Z80 book include one that presents a simple space-capture game, and one entitled "Creative Programming Concepts,' which discusses data structures. Appendices include the Z80 instruction set. character code and numberbase tables, and hexadecimal. object code dumps for the major programs in the book.

The first question that comes to mind is, "How does this book differ from the 8080 volume?" Obviously, the sections on the instruction set are changed. Besides having many more instructions to explain, the Z80 book uses Zilog mnemonics. Unfortunately, much of the rest of the book contains the old 8080 code with new mnemonics. Even the discussion of interrupts in the I/O section treats only mode 0 (8080-compatible), which is probably the least useful for anyone not trying to write 8080-executable code.

Another example of the lack of changes: absolutejump instructions are used throughout the book where almost any Z80 programmer would use relative jumps. The major changes in the book then seem to be the discussion of the instruction set, the two new chapters. and the fact that the floating point routines appear to be shorter. If you have the 8080 volume, do not purchase this volume.

If you do not have the 8080 volume, then that is another story. Whether you want to convert American Standard Code for Information Interchange (ASCII) to Baudot code (or Selectric correspondence code), parse an input string, change number representations, fill memory, write timing loops, or whatever, you will probably find just the subroutine you are looking for. I have been taking subroutines out of the 8080 version of this book for two years now, and have yet to



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have one not work.

In conclusion, if you already have the 8080 Software Gourmet Guide and Cookbook, just buy Scelbi's Z80 Instruction Handbook; the two together will give you almost everything in this volume, and you will save the cost of a floppy disk or two. If you do not have the 8080 volume, then the Z80 Software Gourmet Guide and Cookbook could be a good addition to your

assembler reference library.

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#### **BASEX**

Paul Warme BYTE Books Peterborough NH, 1979 softcover, 97 pages \$8

BASEX is an interactive Compiler written for the 8080 family of computers. The book is complete with bar code, source listing and machine code listing.

Many language systems for microprocessors are written as interactive interpreters which do not convert the sentence-like statements of the language into machine code, but simply perform the command in each line of source program as the line is scanned. In short, the language system interprets statements and performs tasks via interpretative runtime routines. In contrast, a compiler does not immediately execute statements in source code, but translates the source code into object code which can be directly executed by the machine.

There are advantages to both approaches in implementing a computer language, and I simply will refer the reader to the almost never-ending discourse in any of the computer journals for the facts. and opinions. My bias is towards use of compilers.

When you purchase BASEX, you receive a wellwritten document describing an interesting approach to compiler construction. First, you get a complete assembler source listing of all the run-time routines that add, subtract, multiply, and divide; and that perform memory block-move, memory read, memory write, memory compare, accumulator OR operations: plus routines that perform input and output. You also get a listing of the BASEX compiler and a relocating loader, both written in BASEX. What you do not get is floating point math, error messages, error recovery operations, and mass storage operations.

I bought BASEX to see if it could be used in a business environment. It simply is not sophisticated enough for business use, but it is ideal for text editors, disk operating systems, and other applications where high speed, simple math, and well-defined static applications prevail. If serious use of BASEX is contemplated, the following should be developed:

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Packed with games, graphics, and practical applications, this
eagerly awaited guide leads you step by step to maximum use
and enjoyment of your new TRS-80.

336 pp. April 1980 \$8.95 paper

"The book is OUTSTANDING....the best thing to happen to LEVEL II owners."—TRS-80 Monthly Newsmagazine

#### STRUCTURED COBOL

Ruth Ashley

This new guide to the computer language most widely used in business emphasizes structured programming to help make programs easier to understand and check...and less costly to debug. Covers the structure of COBOL, use of unit record files, control logic, tape and disk files, sequential files, random access files, and many other programming techniques.

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management for line insert and delete.

Linking BASEX to CP/M

BASEX may be run as a command (COM) file under CP/M. First, enter the entire BASEX compiler into your computer. If you do not have a bar-code reader, prepare yourself for a threehour exercise in data entry. Next, move the code residing at hexadecimal locations 0000 thru 0103 to hexadecimal locations 2000 thru 2103. Then place a JMP instruction at location 0100 which causes a branch to hexadecimal location 2105 (object code C3 05 21). At memory location 2105 assemble the following:

LXI LXI	H,2000H D,0H A.M
STAX	D
INX A,D	D
CPI	01H MOVIT
MOV	A,E
JNZ	03H MOVIT
JMP	OH
	LXI MOV STAX INX A,D CPI JNZ MOV CPI JNZ

Follow the instructions in the BASEX book for changing I/O addresses in BASEX. Now save BASEX with CP/M as "BASEX.COM". Now type BASEX. You should be able to start using BASEX, unless you made an error somewhere.

I would be interested in hearing other readers' experiences with the BASEX compiler.

Wayne F Miller 905 Fairmont Jefferson City MO 65101

# BYTE's Bits

Wozniac Receives 1979 ACM Grace Murray Hopper Award

Stephen Wozniac, Vice President of Research and Development for the Apple: Computer Co, Cupertino, California, received the Association for Computing Machinery (ACM) Grace Murray Hopper Award for "his many contributions to the rapidly growing field of personal computing and, in particular, to the hardware and software for the Apple Computer." The award acknowledges his work on programmable pocket calculators which he accomplished while employed by Hewlett-Packard. The annual award is given in recognition of achievements in the computer field made before attaining the age of 30. The \$1000 award is donated by Sperry Univac, a longtime employer of Dr Hopper.

#### Real-Time BASIC Available Free

If you are doing process control applications in real time, you should investigate Lawrence Livermore Laboratory's (LLL) version of BASIC. It was developed with public funds, hence copies are available for just the duplication fee. Contact Harry Edwards, National Software Center, 9700 S Cass Ave, Bldg 221, Argonne IL 60439.

LLL BASIC was designed to run on an 8080-based system. The interpreter can execute BASIC source code contained in a read-only memory. A companion compiler can produce faster and more efficient object code. LLL BASIC has machine control statements and works with the Advanced Micro Devices AMD9511 mathematicalfunction integrated circuit for faster execution time.

# 64KB RAM MEMORIES

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CI-6800 64K x 8



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CI-1103 — 16KB to 64KB on a single dual height board. On board hidden refresh. Plugs directly into LSI 11/2, H11 or LSI 11/23. Addressable in 2K word increments up to 256 K Bytes. 8K x 16 \$390.00. 32K x 16 \$750.00.

CI-6800 — 16KB to 64KB on a single board. On board hidden refresh. Plugs directly into EXORciser I and compatible with Rockwell's System 65. Addressable in 4K increments up to 64K. 16K x 8 \$390.00. 64K x 8 \$750.00.

CI-8080 — 16KB to 64KB on a single board. Plugs directly into MDS 800 and SBC 80/10. Addressable in 4K increments up to 64K, 16 KB \$390,00. 64K \$750.00.

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# Clubs and Newsletters

International Computer Chess Association

The International Computer Chess Association was established at the Second World Computer Chess Championship in Toronto in 1977. It currently has about 200 members, and publishes

the ICCA Newsletter three or four times per year. The cost of membership for a single year is \$10 in US funds. Contact Professor Ben Mittman, Vogelback Computer Center, Northwestern University, Evanston IL 60201.

#### Lincoln Micro-Computer Club

This club has changed its name from the Lincoln Computer Club to the present name. They meet on the first Wednesday of each month at 7 PM at the State Federal Savings and Loan on

40th St and South St in Lincoln, Nebraska. The club is open to users and owners of all types of microcomputers. Yearly subscription fees are \$5. Contact Hubert Paulson Jr. 1209 Garber Ave. Lincoln NE 68521.

#### Micro

This club is open to users and owners of microcomputers. The members meet at 9:30 AM on the second Saturday of each month at the NWTI in Green Bay, Wisconsin. Contact Stuart Mong, 1824 Glenview Ave, Green Bay WI 54303.

Change in Meeting Place for Chicago Area Computer Hobbyist's Exchange (CACHE)

The CACHE group meets at the same time but now at the DeVry Technical Institute, 3300 N Campbell, Chicago IL. This is one block west of Western Ave.

New Information on the AIM-65 Newsletter

For information on AIM-65, contact Target, c/o Don Clem, RR 2, Spencerville OH 45887. Inquiries should include a selfaddressed, stamped envelope and all orders must be prepaid. Sample copies are \$1 each; a bi-monthly, one year subscription is \$5 in the US and Canada and \$12 (airmail) elsewhere.

#### CP/M Users Group

The Washington CP/M Users Group generally meets on the third Wednesday of each month at members' homes. Most members own S-100 disk systems with a variety of microprocessors, disks, terminals, printers, and boards. CP/M is the format of software exchange and the subject of frequent meetings. Annual dues are \$6, primarily to cover postage. Contact Winston Riley III, 7315 Wisconsin Ave, Washington DC 20014.

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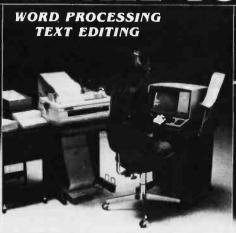
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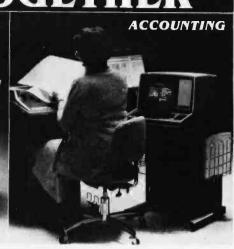
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### Wyoming Valley Computer Club

The TRS-80 users club in Pennsylvania is seeking new members. The Wyoming Valley Computer Club meets on the second Tuesday of every month at 7:30 PM at the Artco Electronics building in Kingston, Pennsylvania. There is a monthly newsletter for all members. For more information, contact Art Prutzman, Artco Electronics, 302 Wyoming Ave, Kingston PA 18704.

### Apple Educators' Newsletter

This publication is devoted to educators and researchers using the Apple II system and other compatible systems. Articles concerning educational programs, grants for microcomputers and education, exchanges of ideas using computers in education, and general items are featured. Contact Apple Educators' Newsletter, 9525 Lucerne, Ventura CA 93003.

### Apple Users Group in Arlington TX

The Fort Worth Apple Users Group (FWAUG) has been created to help users, owners and beginners understand and fully utilize their Apple II systems. The group meets on the third Sunday of each month at 3 PM at the CompuShop Store, 6353 Camp Bowie, Fort Worth TX. The group has a software program exchange and a library for members. The FWAUG

Newsletter is an eight-page monthly publication, sent to all members. Dues are \$9 per year. For more information, contact FWAUG, c/o Lee Meador, 1401 Hillcrest Dr. Arlington TX 76010.

### OSI Superboard Club

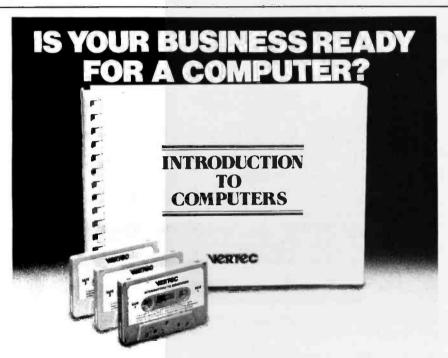
This newsletter contains programs, ideas, technical data, hints and suggestions on the use of Ohio Scientific Challenger IP and Superboards. The newsletter will be published every two months. Send a selfaddressed business envelope and \$1 for further information to Superboard Club. POB 55, Agincourt, Ontario MIS 3B4 CANADA.

### Dental Computer Newsletter

The DCN is a group of dentists, physicians and office management people that have interests in computers. DCN offers members a monthly newsletter, software exchange, advice and experience, and access to members in specific areas. Annual membership dues are \$12 per year. Back issues of the Dental Computer Newsletter are \$1 each and \$10 per year. Membership and equipment listings are \$5. Commercial software lists and DCN software exchange lists are free with a \$0.28 stamped, selfaddressed envelope. Contact Dental Computer Newsletter, E J Neiburger, editor, 1000 North Ave, Waukegan IL 60085.

### Computer Law Journal

Each issue of the Computer/Law Journal is devoted to a single topic of computer law, and contains feature articles by experts in the field, a comprehensive bibliography on the featured topic, case digests of all significant court and administrative agency decisions on the topic, and other reference materials. Topics have included patent protection of computer software and computer-assisted legal research. Future issues will



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When connected to a computer, the computer must echo the
character received. This data is received by the VID which
processes the information converting to data to video suitable

character received. This data is received by the VID which processes the information, converting to data to video suitable to be displayed on a TV set (using an RF modulator) or on a video monitor. The VID generates the cursor, horizontal and vertical sync pulses and performs the housekeeping relative to which character and where it is to be displayed on the screen.

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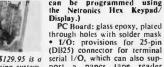
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System Monitor (Terminal Version): 2k bytes of deluxe system monitor to many monitor (Terminal Version): 2k bytes of deluxe system monitor (Terminal Version): 2k bytes of deluxe system monitor to many monitor (Terminal Version): 2k bytes of deluxe system monitor to many monitor (Terminal Version): 2k bytes of deluxe system monitor tape dump with labeling ... examine/change contents of memory automatic baud rarealle output for high speed printer... serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Version): Tape load with labeling ... examiner change all register dump with labeling ... examiner change contents of memory ... insert data ... warm start ... examine and change all register dump with labeling ... examiner/change contents of memory ... insert data ... warm start ... examine and change all registers dump with labeling ... examiner/change contents of memory ... insert data ... warm start ... examine and change all registers ... and t

tape dump with labeling ... examine/change contents of memory ... insert data ... warm start ... examine and change all Netronics

By Netronics

isters...single step with register display at each break point go to execution address. Level "A" in the Hex Version makes a perfect controller for industrial applications and can be programmed using the Netronics Hex Keypad/Display.



Hex Keypad/Display

Hex Keypad/Display Specifications

Calculator type keypad with 24 Calculator type keypad with 24 system defined and 16 user defined keys. 6 digit calculator type display which displays full address plus data as well as register and status information.

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Explorer/85 with L el "C" card cage.

Level "C" Specifications Level "C" Specifications
Level "C" expands Explorer's
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Level "C" includes a sheet metal superstructure, a 5-card gold plated S-100 extension PC board which plugs into the mother-board. Just add required number of S-100 connectors

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Level "D" provides 4k or RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 8000 to EFFF in 4k blocks.

Level "E" Specifications

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for soon to be available RAM IC's (allowing for up to 12k of onboard RAM).

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### Scampus

Articles on bus structures, software, conversion circuits and other aspects of microcomputers are covered in this monthly newsletter. The material comes from members of the group, so ideas and items are constantly needed and welcomed. There are no membership fees. A large supply of self-addressed, stamped envelopes are the only requirements. Write to Scampus, POB 132, Knob Noster MO 65336.

### Another Apple II Club

The Adam and Eve Apple II Users Group meets at the Madison Public Library in Madison, Wisconsin on the second Tuesday of each month at 7 PM. The group wants to exchange newsletters and software with other groups and receive advice on software. Adam and Eve is a subscriber of The Source, an information network. The dues are \$1 per meeting or \$3 per year for the Adam & Eve Newletter. For more information, write to Adam and Eve, Apple II Users Group, 11 S Hancock St, Madison WI 53703.

# BYTE's Bugs

Reversi Bug Makes Computer End Game Too Quickly

Several readers have pointed out a problem in the program published in "Programming Strategies in the Game of Reversi, November 1979 BYTE, page 66. In the program given in listing 1, the published code behaves in the following manner. Either after you have twice forced the computer into a position where it has no legal moves, it concedes the game and resigns; or after the computer has forced you into a moveless position twice, it declares itself to have won the game. Thanks to Darrell Pittman, Jack Guinnip, Delmer Hinrichs, Willy Verwoerd, and Betty Vogel for spotting the error.

Mr Guinnip deserves special praise, not only for spotting the error so quickly, but for doing it while working through the program with pencil and paper. He does not have access to a computer, as an inmate of the Sheridan Correctional Center in Illinois.

A simple patch suggested by Mr Pittman was published in the February 1980 BYTE on page 168, but readers may instead wish to make the somewhat more complete correction suggested by Mr Hinrichs. This includes a change to line 1382 and insertion of two other lines:

1382IF B(K) = THEN 1396 1396LET T3 = 0 1398RETURN

To improve the quality of play, Ms Vogel suggests that line 4200 be deleted, and that line 5310 be changed to read:

5310LET E(79) = 5

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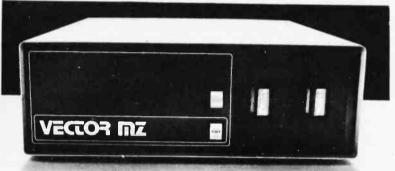
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# Product Reviews

# Lucidata P-6800 Pascal

Phil Hughes, POB 2847, Olympia WA 98507

If you own a Southwest Technical Products Corporation (SwTPC) compatible system that runs Technical Systems Consultants' FLEX 2.0 or mini-FLEX operating system, you too can use Pascal. P-6800 Pascal is a substantial subset of full Pascal, and is designed for a SwTPC with FLEX or mini-FLEX.

I mailed my order for P-6800 Pascal, and thirteen days later the manual and disk arrived. I would consider this excellent delivery if Lucidata were in Kansas, but they are in the Netherlands! Even if it had not worked, I think I would have been amazed.

Two major items missing from this Pascal subset are the REAL and RECORD data types. Also missing are some of the capabilities of other directives. For example, the TYPE directive only supports enumerated types.

Looking at the capabilities in a more positive light, files, procedures, functions, recursion, and multidimensioned arrays are supported. The branching constructs IF . . THEN . . ELSE and CASE . . OF as well as the looping constructs REPEAT . . UNTIL and WHILE . . DO are also supported. Data types that are supported are BOOLEAN, CHAR, ALFA (six-character string), IN-TEGER, and BYTE as well as scalars which can be made members of sets.

The standard input/output (I/O) procedures (RESET, REWRITE, READLN, WRITELN, READ, WRITE) are defined, as are the standard ordinal and predicate functions ORD, CHR, SUCC, PRED, ODD, EOF and EOLN. Additionally, the procedures HALT and POKE are defined as are the functions PEEK and USER.

The compiler generates pseudocode (p-code) that is in-

terpreted by the run-time system. The run-time system simulates the Pascal P-machine. For those unfamiliar with Pascal, this is a standard approach. The P-machine is a theoretical, stack-oriented machine designed specifically for execution of Pascal. This makes it possible to transport the compiler to another machine by writing a p-code interpreter for the new machine.

The Lucidata run-time system allows automatic paging of the p-code file. In other words, if all of the p-code for your program does not fit in available memory, the runtime system reads it in pieces from a disk as required. Because of this feature, it is possible to run the compiler in 12 K bytes (plus 4 K or 8 K for mini-FLEX or FLEX).

The manual describes this particular subset of Pascal in detail, then discusses the run-time system. This includes a description of how to use files. The memory requirements are discussed next. This includes how to estimate memory required for p-code, stack, and file buffers, and for the run-time system. The estimation of disk storage requirements is also discussed. The final chapters cover fine tuning of your programs and the run-time system. The customizing of the run-time system includes interfacing your program to assembly language subroutines and support of non-FLEX-compatible peripheral devices.

Five appendices are included. The first is the syntax diagrams for P-6800 Pascal. Next is a list of compiler error messages. Then there is a list of run-time error messages. The fourth appendix consists of sample programs that demonstrate most of the system capabilities. These sample programs are also on the system disk so you can play with them. The last appendix is a bibliography of further reading on Pascal.

What you receive is a P-6800 Pascal compiler and run-time package, a good manual, sample programs, and excellent delivery. If you are running FLEX 2.0 or mini-FLEX, the Pascal system can be installed in a few minutes. The P-6800 package costs \$150.00 from Lucidata, Oosteinde 223, 2271 EG Voorburg, Netherlands. Their telephone number in the Netherlands is 70-862387. ■

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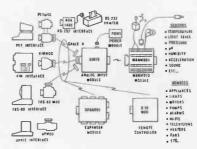
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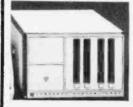
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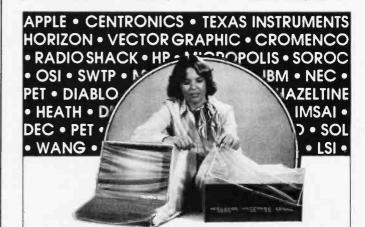
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# Technical Forum

# The Direct Impact of the Computer

Richard S Shuford, Editor

Some years ago, I was doing volunteer work for a nonprofit organization. Late one evening we were preparing an important newsletter for mailing the next day. We had used a computer at Lenoir-Rhyne College, where I was a student, to prepare our adhesive address labels. We had pasted on all the labels when we found that our rubber stamp that said "ADDRESS CORRECTION REQUESTED" had been lost.

Groaning over our misfortune, we were just about to begin the time-consuming task of writing this message on every envelope by hand, when I had the following thought: the computer printed the address labels for us; why can't it print this simple message?

I began to consider how the job could be handled using the computer facilities available. Adhesive labels were too expensive to print the message on and then affix to the envelopes. But wait, perhaps we do not have to use the labels. Could the computer printer print directly on the envelopes?

A time-honored principle is that if there is a simple test to be made, make it. So I gathered up several newsletter envelopes and hastened to the college's academic com-

puter center to try it.

The particular printing peripheral I had in mind was a Centronics Model 101A, high-speed, serial character impact printer, which we loosely called a "line printer." This Centronics machine prints dot-matrix characters by driving a column of print pins into an inked ribbon held before the paper as the print head moves horizontally. (Many other printers also work in this manner.) The Centronics printer has a paper-thickness adjustment, which soon became important.

The Centronics printer was attached to a minicomputer timesharing system. I logged into the system, and quickly wrote a BASIC program. After a brief period of experimentation, I saved my program, logged out, and dashed back to the other late-night envelope-stuffers to report success.

I led a disbelieving troop of workers carrying stacks of envelopes back to the computer room to see how I was going to save them a lot of work by letting the machine do some. My demonstration worked like this.

I logged in and called up the BASIC program I had written for my experiment. This program is shown in listing 1. I typed "RUN" on my terminal, and with one hand held a newsletter envelope carefully inside the print position of the Centronics printer, just behind the ribbon. As the others crowded around to see what I was doing, I hit the carriage return key on the terminal with my free hand. The print head buzzed and moved across the envelope. I held up the letter, and all could see that "ADDRESS CORRECTION REQUESTED" was plainly

printed on it in dot-matrix characters.

Well, we set up an assembly line to insert envelopes into the printer and then to stack them. We found that using the computer printer actually was faster than using the rubber stamp, but I do not recommend buying a computer if you can get by using a rubber stamp under normal conditions. The computer did allow us to get our mailing out on time. (Later on, of course, it was not so much fun to pay \$0.25 for every corrected address that came back, but we got our mailing list updated).

If you want to try to use this rubber-stamp simulator, observe these points. The print head can move very fast, and you can hurt yourself if you are not careful as you hold the paper inside the printer. You have to be sure to hold the paper in the right place. With the Centronics, the right place is approximately 5 cm (2 inches) to the right of the print head's rest position, behind the ink ribbon. Timing is not critical with this program. Note that the program requires that you press the return key before it will print anything. There is no rush to insert the paper into the printer, since you just hit the key when you are ready.

Finally, note that the paper-thickness adjustment is fairly critical for printing on an envelope that has a newsletter in it. Adjust carefully, so that the print head neither shreds the envelope, nor fails to print, nor jams and becomes damaged.

The moral of this story is not that rubber stamps are obsolete. Rather this: a general-purpose computer system is exactly that—general purpose. If you buy a computer to assist you in keeping up with your tax records or the like, that is fine. But don't forget that the program determines the function of the computer. The next time you have a problem, whether simple or complex, perhaps the computer can help you with it.

Listing 1: A BASIC program that uses a computer equipped with an impact printer to simulate a rubber stamp in printing a simple message many times.

Line 10 determines what message is printed. Lines 20, 30, and 40 print the message on the terminal for verification. Line 50 is used to give the human operator time to put the paper inside the printer in the correct position. The computer will not output the message to the printer until the operator presses the return key in response to the INPUT statement in line 50. Variable B\$ is merely a dummy variable.

The LPRINT statement in this version of BASIC causes output to the line printer. The TAB(10) function causes 10 spaces to be printed before the message. Line 70 causes the program to loop indefinitely. Execution must be terminated by some means provided by the system. Such a means could be typing control-C, pressing a Break key, or hitting a Reset switch.

- 5 REM RUBBER STAMP SIMULATOR
- 6 REM USE WITH COMPUTER IMPACT PRINTER
- 10 A\$ = "ADDRESS CORRECTION REQUESTED"
- 20 PRINT "HIT 'RETURN' KEY TO PRINT"
- 30 PRINT A\$
- 40 PRINT "WITH PRINTER."
- 50 INPUT B\$
- 60 LPRINT TAB(10); A\$
- 70 GOTO 50
- 99 END

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# Technical Forum

# Cutting the Gregorian Knot

Myron Pulier MD, 101 Cedar Ln, Teaneck NJ 07666

Program development is more an artistic process of playful reshaping than it is an analytic process of systematic logic. This proved true in a search for an efficient way of handling dates in computer programs.

Using dates in Julian day-number form simplifies manipulation of date information. For example, if the Julian date of the calendar date January 1 is 1, then February 2 would be 33 and December 31 would be 365, or 366 on leap year. Clearly it is easier to store a single number than to wrestle with a number triplet like 9/8/79. Furthermore, the Julian concept makes finding the number of days between two dates a trivial process.

Calculation of the Julian date is complicated because Roman legislators altered Julius Caesar's orderly scheme by making the months uneven in length. This inspired Richard Grafton's famous table lookup. In the year 1570 he wrote "Thirty days hath November, April, June, and September," etc. While there's no longer much danger of copyright infringement, Grafton's method wastes memory space, rest his soul.

According to Grafton the months with thirty days are the eleventh, fourth, sixth and ninth, which seems difficult to convert into a formula. If only Grafton and his politician forebears had given the second month thirty days as well! We would then be close to the familiar sequence 2,4,6,8,10, which can be calculated by the formula  $B = 2 \times A$ . If we plot the numbers 2, 4, 6, 9, 11 as the first, second, third, fourth, and fifth numbers of a set (as shown in figure 1), all we need is a formula that threads a line slightly above the desired values for B. We can then throw away the fractional parts by truncating the resulting B value to an integer. In other words, we want a formula of the form:

$$B = INT (C1 \times A + C2)$$
 (1)

The determination of suitable values for the constants C1 and C2 may not be immediately obvious. An empirical method for finding C1 and C2 is trial-and-error substitution using the following BASIC program:

110 INPUT C1, C2 FOR A = 0 TO 13120 130 LET B = C1 \* A + C2140 PRINT A, INT (B), B 150 NEXT A 160 **GOTO 110** 

I suggest you enter the above program on your own computer and try values for C1 and C2.

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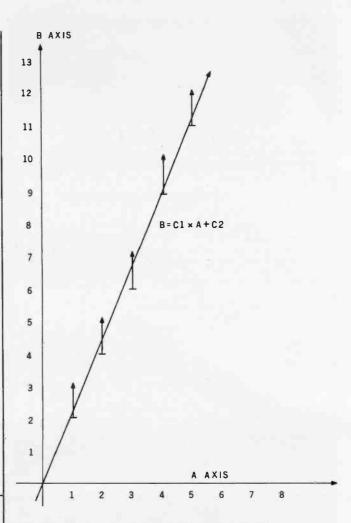


Figure 1: Fitting the numbers 2, 4, 6, 9, 11 to the straight-line equation  $B = C1 \times A + C2$ . Given the sequence 2, 4, 6, 9, 11, we can represent this in two dimensions by letting the horizontal axis represent the order of the number in the sequence (first, second, etc), and the vertical axis, the value of the number (2, 4, etc). Thus, the fourth number in the sequence, 9, gives the point (4,9) to be plotted. These numbers are almost, but not quite, on a straight line. But if we stipulate that the line can go through the unit line segments extending above each point, then the integer values can be obtained by truncating the values obtained with the INT function in BASIC.

Playing around with this program shows that C1 can range between 2 and 2.5 if C2 is suitably chosen between -0.5 and 1. For example, setting C1 to 2.25 and C2 to 0 gives the desired sequence of 2,4,6,9,11,... for INT(B).

Now we can turn our attention to the irregularities in the Gregorian calendar. First, let us temporarily give February thirty days (remember that month 2, February, is included in the above sequence). Next, calculate the Julian values of the last days of each month in this altered year. The numbers are 31, 61, 92, 122, 153, 183, 214, 245, 275, 306, 336, 367. (The extra two days in February give us a 367-day year). Can we find a formula that threads its way along the last days of each month?

We have 367 days divided among 12 months. That comes to a new month about every 30.58 days. If we use 30.58 for C1 in the program we wrote, we find that the output comes close to the sequence we want. A few minutes of tinkering with C2 shows that 0.5 works nicely. The expression M-1 gives us the last day of the

preceding month. Substituting the values for C1 and C2, and using (M-1) in place of A in equation (1) produces the equation:

$$B = INT (30.58 \times M - 30.08)$$
 (2)

A quick check with our BASIC program shows that we can get away with three bytes less with the following equation:

$$B = INT (30.57 \times M - 30)$$
 (3)

If we compensate for leap years and for the 28-day February, we have the following BASIC subroutine for computing the Julian date, Z, given the month, M, day, D, and year, Y.

210 
$$Z = INT (30.57 * M - 30) + D$$
  
220 IF M < 3 THEN RETURN  
230 IF INT (Y / 4) \* 4 = Y  
THEN  $Z = Z - 1 : RETURN$   
240  $Z = Z - 2 : RETURN$ 

Using the constant values we found for equation (3), line 210 calculates the Julian date of the end of the month preceding month M. Adding the day of the month to this produces a first estimate of the Julian date of the given calendar date. Line 220 says that if it is before March, we are done. Otherwise, in line 230 we adjust for a 29-day February if it is leap year (until now we were crediting February with 30 days), or for 28 days if it is not leap year. Let us forget about leap centuries for now.

We can improve on this system. We have been defining the Julian date, Z, as the number of days since the previous December 31. To include information about the year, we can define a new type of Julian date, J, as the number of days elapsed since December 31 of some base year, say 1972. To calculate J, we first find Z, then add the days in each year between the present year and 1972. Years have an average of 365.25 days. If we try 365.25 for C1 and 0 for C2 in our original BASIC program tool, we get the Julian dates of the last day of each year. Taking December 31, 1972 as our base and the year, Y, in the form "yy" rather than "19yy" we modify equation (3) to:

$$B = INT (30.57 \times M - 30) + INT (365.25 \times (Y - 1 - 72))$$
 (4)

This may be rearranged to:

$$B = INT (30.57 \times M) + INT (365.25 \times Y - 26693.25)$$
 (5)

bringing us to the new BASIC subroutine:

The above will return negative values for dates before December 31, 1972.

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Listing 1: BASIC routines for converting between the Julian date and the calendar (month, day, year) date and for determining the day of the week from the Julian date. In Processor Technology BASIC, the multiple-line user-defined functions (ending with FNEND) are permitted; also, J\$(A,B) is the substring of the unsubscripted string variable "J\$", from Ath to Bth character.

```
710 REM
720 REM.
               DATE HANDLING PACKAGE
730 REM
760 REM.
          CALENDAR TO JULIAN CONVERSION
770 REM
780 REM.Given day, D, month, M and year, Y
790 REM. returns the number of days elapsed
800 REM.since December 31, 1900.
810 REM-----
820 DEF FNJ(D,M,Y)
830 LET X=INT(30.57*H)+INT(365.25*Y-395.25)+D
840 IF M<3 THEN RETURN X
850 IF INT(Y/4) + 4=Y THEN RETURN X-1
860 RETURN X-2
870 FNEND
880 REM
890 REM-----
900 REM.
          JULIAN TO CALENDAR CONVERSION
910 REM
920 REM.Given D, number of days elapsed since
930 REM. December 31, 1900, returns day, D,
940 REM.month, M, and year, Y.
950 REM-----
960 LET Y=INT(J/365.26)+1
970 LET D=J+INT(395.25-365.25*Y)
980 LET D1=2: IF INT(Y/4)+4=Y THEN LET D1=1
990 IF D>91-D1 THEN LET D=D+D1
1000 LET H=INT(D/30.57),D=D-INT(30.57*M): RETURN
1010 REH.
1020 REM-----
1030 REM.
              JULIAN COMPACTION
1040 REH
1050 REM.Given julian, J, returns 2-byte
1060 REM.representation of J
1070 REM-----
1080 DEF FNJ$(J)
1090 LET J1=INT(J/256): RETURN CHR(J1)+CHR(J-J1*256)
1100 FNEND
1110 REM
1120 REM-----
1130 REM.
               JULIAN EXPANSION
1140 REM
1150 REM.Given J$, a 2-byte representation of a
1160 REM.julian, returns decimal value of julian
1170 DEF FNJ1(J$)=256*ASC(J$(1,1))+ASC(J$(2,2))
1180 REM
1190 REM-----
1200 REM.
            DAY OF WEEK CALCULATION
1210 REH
1220 REM.Returns day of week (Sunday = 1) given
1230 REM. the julian, J
1240 REH-----
1250 DEF FNW(J)
1260 LET W=(J+1)/7: RETURN INT((W-INT(W))*7+1.1)
1270 FNEND
```

Now that we have a way of abbreviating the calendar date into a Julian date, we need a program for reversing the conversion. This is done by extracting the year, correcting for a 28- or 29-day February, then extracting the month to leave the day of the month as the remainder:

Line 420 computes the day of the year, Z. Then D1 is set to 1 if the year is a leap year, or 2 otherwise. Z is adjusted for the proper February length in line 440, if the day is after February. The month is extracted in line 460, leaving D, the day of the month. Unfortunately, the program above is wrong for New Year's Day after a leap year because the value for Y lags a bit. This can be managed by setting the divisor in line 410 to 365.26. The resulting inaccuracy will not cause trouble for thousands of years.

You will see that selecting 1900 rather than 1972 as the base year will save two bytes each in lines 310 and 420 and one in line 410. [Note: Astronomers calculate Julian day numbers using the date January 1, 4713 BC as a base: all historical dates become positive numbers. . . . RSS

If your version of BASIC handles character strings, it can compact each non-negative Julian date into two bytes of storage, which could speed input and output of dates by a factor of four. The following routine in Processor Technology BASIC essentially converts the decimal value of the Julian date to a base-256 number:

where CHR (J1) is the character with the ASCII code J1. Converting the string J\$ back to a decimal value is done as follows:

610 
$$J = 256 * ASC (J$ (1, 1)) + ASC (J$ (2, 2))$$

where J\$ ( n , n ) is the n-th character in J\$ and where ASC(C\$) is the decimal value of the ASCII code for C\$. The two bytes in J\$ can cover a span of 256x256/365.25 = 179 years.

The day of the week is readily calculated from the modulo 7 value of the Julian date. We can now reshape our programs into a compact and efficient package for handling dates between 1901 and 2080.

As for leap centuries, Pope Gregory luckily decreed the year 2000 a leap year, although 1900 was not. Century years not evenly divisible by 400 are not leap years. Therefore, the routines in listing 1 will be wrong for dates before March 1, 1900, but are useful for most practical applications.

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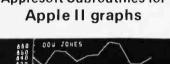
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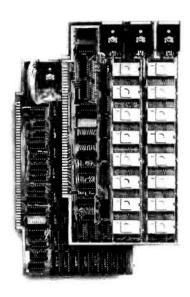
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# **Operation Codes** of the 8080, 8085, and Z80 Processors

D Martin Harrell 313 Hollyberry Rd Severna Park MD 21146

Manual conversion between assembly language mnemonics and hexadecimal object code can be tedious particularly if much code is involved. However, the task does not have to be overwhelming. A conversion table helps immensely and is also a good training aid for novice programmers. It presents the entire instruction set in compact form, revealing useful patterns, and also inconsistencies.

### 8080 and 8085 Operation Codes

Operation codes for the Intel 8080 and 8085 microprocessors are shown in table 1. The only difference between the instruction sets for this pair is that the 8085 has two additional instructions: the read-interrupt-mask instruction (mnemonic RIM, hexadecimal code 20), and the set-interrupt-mask instruction (mnemonic SIM, hexadecimal code 30). They allow the user to control interrupts and a serial I/O (input/output) line, thus making them useful additions.

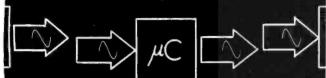
The position of an 8080/8085 operation code in the table does not give a reliable clue about the implied addressing mode. Table 1 is generally organized according to the operands involved. Residing in the middle eight columns of the table (columns 4 thru B) for example, are the instructions for single-byte move, arithmetic, and logical operations. (Length attributes in this article refer to data, rather than instruction length, unless otherwise noted.) Regardless of the column, progression through the eight possible choices for the source (second) operand is always in the same sequence as the user moves down a column: registers B thru L; followed by memory reference; and finally, register A, the accumulator. Then, because each column has sixteen entries, the sequence repeats. If the arithmetic and logical instruction groups do not seem to conform to this rule, note that the first operand (always register A) is implied rather than stated explicitly.

This same sequence is used for advancing through choices for the destination (first) operand. In this case, however, progression is column to column from left to right, with each successive column containing two of the eight possible operands. The double-byte instructions also conform to this first-operand type of arrangement. Most of these appear in the first four columns of the table; however, the stack commands to PUSH and POP double-byte data are located at the far right in the top section.

An apparent inconsistency appears in the middle of the table. Hexadecimal code 76 is the instruction to halt the processor (HLT). Expected there instead is MOV M,M, the op code meaning "move the content of the memory location whose address is in the H and L register pair into that

Text continued on page 197

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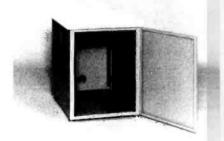
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_	1	2	3	47	5	9	2	8	6	Ą	ΩQ	O	Q	E	Ste
-		ROM	S 100	MOV B,B	MOV D,B	MOV H,B	MOV M,B	ADD 3	SUB B	ANA B	ORA B	RNZ	FINC	RPO	RP
	LXI D	LXI H	LXI SP	MOV B,C	MOV D,C	MOV H,C	MOV M,C	ADD C	SUB C	ANA C	ORA C	POP B	POP D	FOP H	POP PSW
	STAX D	SHLD	STA	MOV B,D	MOV D, D	MOV H,D	MOV M.D	ADD D	SUB D	ANA D	ORA D	JNZ	JNC	JPO	JP
1	DIX D	H XNI	TNX SP	MOV B,E	MOV D,E	MOV H,E	MOV M.E	ADD E	SUB E	ANA E	ORA E	JMP	TUO	XXHT	Id
	DAR D	DNR H	INR M	MOV B,H	MOV D,H	н.н чом	H.M VOM	А ДД Н	SUB H	ANA H	ORA H	CNZ	CNC	CPO	CD CD
	DCR D	DCR H	DCR M	MOV B,L	MOV D,L	MOV H,L	MOV M.L	ADD L	SUB L	ANA L	ORA L	PUSH B	PUSH D	PUSH H	WS4 HSV4
	MVI D	MVI H	M I M	MOV B,M	MOV D,M	MON H,M	HLT	ADD M	SUB M	ANA M	ORA M	ADI	Ins	ANI	ORI
	RAL	DAA	STC	MOV B,A	MOV D,A	MOV H,A	MOV M,A	A DD A	SUB A	ANA A	ORA A	RST 0	RST 16	RST 32	RST 48
				MOV C,B	MOV E,B	MOV L,B	MOV A,B	ADC B	SBB B	XRA B	CMP B	RZ	RC	RPE	FW
	DAD D	DAD H	DAD SP	MOV C,C	MOV E,C	MOV L,C	MOV A,C	ADC C	SBB C	XBA C	CMP C	RET		PCHL	SPHL
	LDAX D	LHLD	LDA	MOV C,D	MOV E,D	MOV L,D	MOV A,D	ADC D	SBB D	XRA D	CAMP D	32	JC	JPE	МС
	DCX D	рсх н	DCX SP	MOV C,E	MOV E, E	MOV L,E	MOV A, E	ADC E	SBB E	XRA E	CMP E		ă	XCHG	EI
	DAR E	DAR L	DVR A	MOV C,H	MOV E,H	MOV L,H	MOV A,H	ADC H	SBB H	XRA H	н амо	ZD	99	CPE	CM
	DCR E	DCR L	DCR A	MOV C, L	MOV E, L	MOV L,L	MOV A,L	ADC L	SBB L	XRA L	CMP L	CALL			
	MVI E	MVI L	MVI A	MOV C,M	MOV E,M	MOV L,M	Mov A,M	ADC M	SBB M	XRA M	CMP M	ACI	SBI	XRI	CPI
	RAR	CMA	CMC	MOV C,A	MOV E,A	MOV L,A	MOV A,A	A DC A	SBB A	XRA A	CMP A	RST 8	RST 24	BST 40	RST 46

Second Nybble

**Table 1:** Mnemonics of the operation codes of the 8080 and 8085 microprocessors arranged conveniently for conversion to the hexadecimal object code. This task is aided by the organizational consistency of the instruction set. The two instructions (RIM and SIM) found only in the 8085 are indicated by shading.

Text continued from page 194:

same memory location." The expected instruction is effectively just a slow equivalent of the no operation (NOP) located at hexadecimal 00. Hence, its replacement by the halt command improves, rather than degrades the power of the instruction set. Still, I wonder why an otherwise empty spot in the table was not chosen — as was done for the two additional 8085 instructions.

The right quarter of the table mainly contains program branching and data exchange instructions. Excluding the previously mentioned stack commands, none of these have explicit operands so the previously discussed organization is impossible. The miscellaneous nature of these instructions also tends to prevent predictable order.

Nonetheless, the op codes in this area have a consistent structural style. Most are arranged in complementary order, with mutually exclusive conditions placed in the same column, separated by eight rows. The group of return instructions is typical. The unconditional return from subroutine command is hexadecimal C9. Starting immediately above it and proceeding to the right, four of the eight conditional return instructions are found. The other four (the complements) are eight rows higher.

The order in which these conditions appear is uniform from group to group. To determine that this is so, compare similar elements of the call, jump, and return groups. The unconditional jump (JMP) instruction is a curious exception. Its expected code is CB, but it actually appears eight rows higher in the table. Such exceptions are few enough not to be bothersome.

**Z80 Operation Codes** 

The Z80 is an enhanced version of the 8080. It runs faster, has twice as many general purpose registers, and has a much larger instruction set. Included as a subset in this instruction is the entire repertoire of the 8080. (This compatibility exists at the machine language level, but not the assembly language level; standard mnemonics and assembly language formats for the two processors differ considerably.) Thus, in hexadecimal object form, almost any program written for the 8080 will produce identical results when executed by a

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Z80. Because of the Z80's generally higher speed, software timing loops are an exception to this upward compatibility feature. [Editor's note: There is also a slight difference in the operation of the parity flag . . . . RSS]

The similarities of the two instruction sets can be seen by comparing corresponding positions of table 1 and table 2. Table 2 is the basic conversion table for the Z80. For every valid 8080 instruction in table 1, its correspondent in table 2 produces logically equivalent results. The differences between the two instruction sets stem from the twelve positions unused by the 8080. These, which are clearly indicated in table 2, are used to greatly expand the Z80's capabil-

The Zilog Corp used the seven unfilled positions on the left side of table 1 and the uppermost one on the right side to give the Z80 processor the ability to perform relative branching and to exchange the contents of its two sets of registers. However, the use of hexadecimal codes 20 and 30 for two of the jump relative instructions means that the Z80 is not as compatible with the 8085 as it is with the 8080.

The real expansion of the Z80's instruction set over that of the 8080 is the result of the interesting use of the four other empty spaces in table 1. In essence, the Z80 uses them as pointers to four additional 16 by 16 tables, thus increasing the number of possible op codes by 1532. (The Z80 does not use most of these, but flexibility for future expansion is certainly there.) Had this innovative use of the unimplemented codes not been done. the Z80 would have been limited to 256 different op codes, which is only twelve more than the 8080.

There is a penalty for this flexibility: all instructions in these expansion sets must be multibyte. The first byte identifies the appropriate expansion instruction set, after which, the second byte identifies the operation to be performed. Sometimes there is an additional third or fourth byte to provide data or addressing information.

### Shift, Rotate, and Bit Manipulation Instructions

Consider these pointer instructions one at a time. All of the instructions which begin with hexadecimal CB are contained in table 3. All of the direct-

	First Nybble															
	0	1	2	3	47	5	9	2	80	6	¥	ted	0	D	卸	íz.
0	NOP	DING .	JR 825, e	JR MC.	E,E di	LD D,B	LD H,B	a'(1H) dI	ADD A,B	SUB B	AND B	OR B	RET NZ	RET NC	RET PO	RET P
1	LD BC, nn	LD DE, nn	LD KL,nn	LD SP, nn	LD B,C	np p,c	л, н ш	р (нг),с	ADD A,C	SUB C	AND C	OR C	POP BC	POP DE	POP HL	POP AF
2	I.D (BC),A	LD (DE),A	IH' (nn) al	A, (nn) dl	LD B,D	מים מז	п, н ш	מ' (אר) מז	ADD A, D	SUB D	AND D	OR D	JP NZ,nn	JP NC,nn	JP PO,nn	JP P, nn
3	INC BC	INC DE	INC HE	INC SP	LD B,E	ED D.E	LD H,E	а, (лн) сл	ADD A,E	SUB E	AND E	OR E	JP nn	OUT (n),A	EX (SP),HL	Iq
4	INC B	INC D	H DAT	INC (HL)	LD B,H	н, а ал	н'н сп	н' (т) ст	н'и ппи	SUB H	H QNY	OR H	CALL NZ, nn	CALL NC, nn	CALL PO, nn	CALL P, nn
5	DEC B	DEC D	н жа	DEC (HL)	T'E CT	LD D,L	т,н ст	LD (HL),L	ADD A,L	SUB L	AND L	OR L	PUSH BC	PUSH DE	PUSH HI	PUSH AF
9	LD B,n	ID D,n	LD H,n	ro (HL),n	LD B, (HL)	LD D, (HL)	гр н, (нг.)	HALT	ADD A, (HL.)	SUB (HL)	AND (HL)	OR (HL)	ADD A,n	SUB n	AND n	OR n
7	RLCA	RLA ·	DAA	SCF	LD B,A	A,d d.	A,H Q1	LD (HL),A	A, A ddA	SUB A	AND A	OR A	RST 00H	RST 10H	RST 20H	RST 30H
8	-010	78	JB 2.0	JR C.e	נים מו	LD E, B	ED L,B	LD A, B	ADC A,B	SBC A,B	XOR B	CP B	RET Z	RET C	RET PE	RET M
6	ADD HL, BC	ADD HL, DE	אר'זא מסץ	ADD HL,SP	נים מיז	o'a di	p'T dT	LD A,C	ADC A,C	SBC A, C	XOR C	CP C	RET	Ħ	JP (HL)	LD SP, HL
4	LD A, (BC)	LD A, (DE)	LD HL, (nn)	LD A, (nn)	נים מים	u.a a.ı	מ"ז מיז	LD A, D	ADC A,D	SBC A,D	XOR D	CP D	JP Z,nn	JP C,nn	JP PE,nn	JP M,nn
В	DEC BC	DEC DE	DEC HL	DEC SP	LD C,E	a'a on	ID L,E	LD A, E	ADC A,E	SBC A,E	XOR E	GP E	See Tatle 3	DN A, (n)	EX DE, HL	EI
O	DAC C	INC E	T DATE	INC A	LD C,H	LD E,H	H'T CT	LD A, H	ADC A, H	SBC A,H	хов н	CP H	CALL Z,nn	CALL C, nn	CALL PE, nn	CALL M,nn
А	ානය ය	DEC E	DEC L	DEC A	ID C,L	T'Z CT	T'T OT	LD A, L	ADC A,L	SBC A,L	XOR L	CP L	CALL nn	Sac Table 4	See	Patie 6
回	LD C,n	LD E,n	LD L,n	LD A,n	пр с, (нг)	LD E, (HL)	LD L, (HL)	LD A, (HL)	ADC A, (HL)	SBC A, (HL)	XOR (HL)	CP (HL)	ADC A,n	SBC A,n	XOR n	CP n
(se <sub>4</sub>	RRCA	RRA	CPL	CCF	LD C,A	LD E,A	LD L,A	LD A,A	ADC A,A	SBC A,A	XOR A	CP A	RST 08H	RST 18H	RST 28H	RST 38H

second Mybble

operation codes of the Z80 microprocessor arranged for conversion to hexadecimal object code. Correin notation. Enhancements I and table 2 generally perform the identical function, despite differences indicated by shading. Mnemonics used here are those specified by Zilog. Table 2: Mnemonics of the sponding positions of table the 8080 instruction set are

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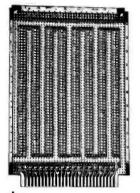


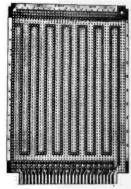
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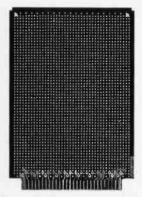
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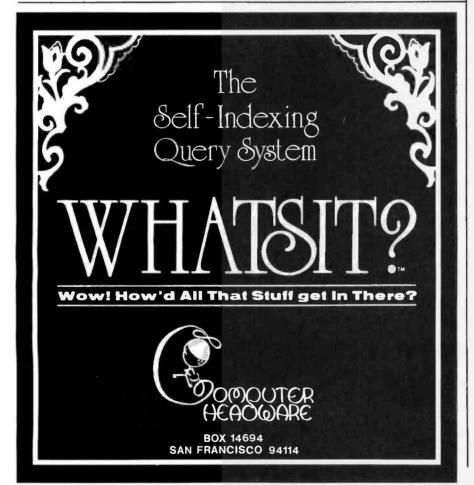


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mode instructions to shift or rotate (in either direction) any byte in memory or in any of the eight active registers are located here. Table 3 also contains the direct-mode instructions to set, reset, or test any bit in any of these bytes. All of these operations have a length of two bytes. Interestingly, there are more valid instruction combinations derived from the ten basic instructions in this table than there are in the entire 8080 set.

Two features of table 3 are notable. The first is the absence of a "shift left logical" counterpart to the SRL command group. The shift left logical counterpart is not there because it is not needed; the "arithmetic shift left" instructions in column 2 (hexadecimal) accomplish this function. The use of the same general organizational rules indicated earlier for the 8080 is the more important of the two properties of this table. Such uniformity is a good aid in locating instructions in this table.

### Indexed Instructions

Instructions beginning with hexadecimal DD are in one of two indexed classes of instructions. These use the IX and IY registers respectively in forming a data address. Those related to the former are depicted in table 4 and its associated table 5.

The analogy between tables 2 and 4 and between tables 3 and 5 is striking. The organizational patterns are identical - even to the point of using the same expansion technique. They should be identical. Each of these indexed instructions was formed by replacing the (HL) operand of an equivalent register-indirect instruction with the indexed notation (IX+d). Thus, every operation that can be performed in the registerindirect mode by the 8080 or Z80 can also be performed in the indexed mode by the Z80.

The resulting positional equivalence between the two sets of tables is most helpful in determining the required hexadecimal code for the indexed instructions. An easy way to do this without having to refer to tables 4 or 5 is to first select from table 2 or 3 (as appropriate) the hexadecimal code for the register-indirect form of the desired operation. Then place a DD prefix in front of this code if the operation was found in table 2, or a DDCB prefix, if found in table 3.

Text continued on page 207

	First Nybble															
	0	1	2	3	77	5	9	2	80	6	٧	В	O	Q	Œ	(St.
0	RLC B	RL B	SIA B		BIT 0,B	BIT 2,B	BIT 4, B	BIT 6,B	RES 0,B	RES 2, B	RES 4,B	RES 6, B	SET 0,B	SET 2,B	SET 4,B	SET 6,B
Ţ-I	RLC C	RL C	SIA C		BIT 0,C	BIT 2,C	BIT 4,C	BIT 6,C	RES 0,C	RES 2,C	RES 4,C	RES 6,C	SET 0,C	SET 2,C	SET 4,C	SET 6,C
2	RLC D	RL D	SIA D		BIT 0,D	BIT 2,D	BIT 4, D	віт 6, р	RES O,D	RES 2,D	RES 4, D	RES 6,D	SET 0,D	SET 2,D	SET 4,D	SET 6,D
3	RLC E	RL E	SIA E		BIT O,E	BIT 2, E	BIT 4, E	BIT 6,E	RES O, E	RES 2,E	RES 4, E	RES 6, E	SET 0,E	SET 2,E	SET 4, E	SET 6, E
t.	RLC H	RL H	SIA H		BIT 0,H	BIT 2,H	BIT 4,H	віт 6,н	RES O, H	RES 2, H	RES 4,H	н 6, н	SET 0,H	SET 2,H	SET 4,H	ВЕТ 6, Н
2	RUC L	RL L	SIA L		BIT 0,L	BIT 2,L	BIT 4,L	BIT 6,L	RES O, L	RES 2,L	RES 4,L	RES 6, L	SET 0,L	SET 2,L	SET 4,L	SET 6,1
9	RLC (HL)	RL (HL)	SIA (HL)		BIT O, (HL)	BIT 2, (HL)	BIT 4, (HL)	BIT 6, (HL)	RES 0, (HL)	RES 2, (HL)	RES 4, (HL)	RES 6, (HL)	SET 0, (HL)	SET 2, (HL)	SET 4, (HL)	SET 6, (HL)
2	RLC A	RL A	SIA A		BIT 0,A	BIT 2,A	BIT 4,A	BIT 6,A	RES O, A	RES 2,A	RES 4, A	RES 6,A	SET 0,A	SET 2,A	SET 4,A	SET 6,A
œ	RRC B	RR B	SRA B	SRL B	BIT 1,B	BIT 3,B	BIT 5,B	BIT 7,B	RES 1,B	RES 3, B	RES 5,B	RES 7, B	SET 1,B	SET 3,B	SET 5,B	SET 7,B
6	RRC C	RR C	SRA C	SRL C	BIT 1,C	BIT 3,C	BIT 5,C	BIT 7,C	RES 1,C	RES 3, C	RES 5,C	RES 7,C	SET 1,C	SET 3,C	SET 5,C	SET 7,C
٧	RRC D	RR D	SRA D	SRL D	BIT 1,D	віт 3,р	BIT 5,D	BIT 7,D	RES 1,D	RES 3, D	RES 5,D	RES 7, D	SET 1,D	SET 3,D	SET 5,D	SET 7,D
щ	RRC E	RR E	SRA E	SRL E	BIT 1.E	BIT 3,E	BIT 5,E	BIT 7,E	RES 1,E	RES 3, E	RES 5,E	RES 7, E	SET 1,E	SET 3,E	SET 5,E	SET 7,E
U	RRC H	н н	SRA H	SRL H	BIT 1,H	віт 3,н	BIT 5,H	BIT 7,H	RES 1, H	RES 3,H	RES 5,H	RES 7,H	SET 1,H	SET 3,H	SET 5, H	SET 7,H
О	RRC L	RR L	SRA L	SRL L	BIT 1,L	BIT 3,L	BIT 5,L	BIT 7,L	RES 1, L	RES 3,L	RES 5,L	RES 7,L	SET 1,L	SET 3,L	SET 5,L	SET 7,L
(a)	RRC (HL)	RR (HL)	SRA (HL)	SRL (HL)	BIT 1,(HL)	BIT 3, (HL)	BIT 5. (HL)	BIT 7, (HL)	RES 1, (HL)	RES 3, (HL)	RES 5, (HL)	RES 7, (HL)	SET 1, (HL)	SET 3, (HL)	SET 5, (HL)	SET 7, (HL)
Cu,	RRC A	RR A	SRA A	SRL A	BIT 1,A	BIT 3,A	BIT 5,A	BIT 7,A	RES 1,A	RES 3,A	RES 5,A	RES 7,A	SET 1,A	SET 3,A	SET 5,A	SET 7,A

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**Table 3:** Enhancement operation codes of the Z80 invoked by the hexadecimal CB instruction prefix. These CB class operations give bit manipulation, data shifting, and enhanced rotation capability to the Z80.

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(M)										LD SP, IX						
3		POP IX		EX (SP),IX		PUSH IX				JP (IX) IL						
		POJ		S) X3		PUS				J.P.						
Q		- 6									*					
ט												See Table 5				
Ø							OR (IX+d)								CP (IX+d)	
A							AND (IX+d)								XOR (IX+d)	
6							SUB (IX+d)								ADC A,(IX+d) SBC A,(IX+d)	
8							ADD A, (IX+d) SUB (IX+d)								ADC A, (IX+d)	
7	ID (IX+d),B	D, (D+XI) dl	LD (IX+d),D	LD (IX+d),E	H, (b+XI) dl	T'(p+XI) dI		A, (b+XI) dı							LD A, (IX+d)	
9							LD H, (IX+d)									
5															LD E, (IX+d) LD L, (IX+d)	
17							LD (IX+d),n LD B,(IX+d) LD D,(IX+d)								LD C, (IX+d)	
3					INC (IX+d)	DEC (IX+d)	u'(p+xI) dI			ADD IX,SP						
23		LD IX,nn	LD (nn), LX	INC IX	-1					ADD IX, IX	LD IX, (nn)	DEC IX				
Ţ.										ADD IX, DE						
0										ADD IX, BC						
	0	+	2	6	- <del>-</del>	5	9	2	8	6	4	æ	O	Ω	(3)	(z,

provide indexed-mode instructions equivalent to the

These

Table 4: Operations of the Z80 invoked by the instruction prefix DD.

ndirect-mode instructions and employ the IX register

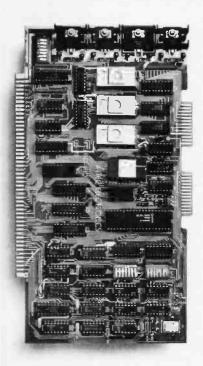
First Nybble

	٥	-	2	3	4	5	9	2	æ	6	٧	æ	D)	А	ы	[s.
0			Ŧ				RLC (IX+d)								RRC (IX+d)	
1							RL (IX+d)								RR (LX+d)	
2							SIA (IX+d)								SRA (IX+d)	
3															SRL (IX+d)	
4							BIT 0, (IX+d)								SRL (IX+d) BIT 1,(IX+d) BIT 3,(IX+d) BIT 5,(IX+d) BIT 7,(IX+d) RES 1,(IX+d)	
5							BIT 0,(IX+d) BIT 2,(IX+d) BIT 4,(IX+d) BIT 6,(IX+d) RES 0,(IX+d)								BIT 3, (IX+d)	
9							BIT 4, (IX+d)								BIT 5, (IX+d)	
2							BIT 6, (IX+d)								BIT 7, (IX+d)	
89							RES O, (IX+d)								RES 1, (LX+d)	
6							RES 2, (IX+d)								RES 3, (LX+d)	
A							RES 2,(IX+d) RES 4,(IX+d) RES 6,(IX+d) SET 0,(IX+d) SET 2,(IX+d) SET 4,(IX+d) SET 6,(IX+d)								RES 3,(IX+d) RES 5,(IX+d) RES 7,(IX+d) SET 1,(IX+d) SET 3,(IX+d) SET 5,(IX+d) SET 7,(IX+d)	
В							RES 6, (IX+d)								RES 7, (IX+d)	
O							SET 0, (IX+d)								SET 1, (IX+d)	
Ω							SET 2, (IX+d)								SET 3, (IX+d)	
Œ							SET 4, (IX+d)								SET 5, (IX+d)	
(E,							SET 6, (IX+d								SET 7, (IX+d	

Second Nybble

Table 5: These DDCB-class operation codes are an indexed equivalent of the indirect-mode operation codes of the Z80 shown in table 3.

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- Addressable cursor
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	77	5	9	2	8	6	٧	щ	O	D	ខា	(in <sub>q</sub>
				LD (IY+d),B								
				LD (IY+d),C							POP IY	
				ID (IY+d),D								
				LD (IY+d),E							EX (SP), IY	
INC (IX+d)	()			H, (b+YI) dl								
DEC (IY+d)	0			T'(D+KI) OT							PUSH IY	
D (IY+d),	LD (IY+d),n LD B, (IY+d) LD D, (IY+d)	LD D, (IY+d)	LD H, (IY+d)		ADD A, (IY+d)	SUB (IY+d)	AND (IY+d)	OR (IY+d)				
				In (IY+d),A								
ADD IY,SP											JP (IY)	ID SP, IY
									See Table 7			
	LD C, (IY+d)	LD E, (IY+d)	LD L, (IT+d)	LD A, (IY+d)	ADC A, (IY+d)	SBC A, (IY+d)	XOR (IY+d)	CP (IY+d)				

These operation codes begin with the FD prefix.

 Table 6: Indexed instructions employing the IY register. Note the similarity with table 4.

Çe,							ET 6, (IY+d)								ET 7, (IY+d)		
E							SET 4, (IY+d) S								SET 5, (IY+d) S		
Q							SET 2, (IY+d)								3,(IY+d)		
υ							SET 0, (IY+d)								SET 1, (IY+d)		
æ							RES 6, (IY+d)								RES 7, (IY+d)		
¥							RES 4, (IY+d)								RES 5, (IY+d)		
6							RES 2, (IY+d)								RES 3, (IY+d)		
8							RES O, (IY+d)								RES 1,(IY+d)		
7							BIT 6, (IY+d)								BIT 7, (IY+d)		
9							BIT 4, (IY+d)								BIT 5, (IY+d)		
5							BIT 2, (IY+d)								BIT 3, (IY+d)		
4							BIT 0, (IY+d)								BIT 1, (IY+d)		
0															SRL (IY+d)		
2							SLA (IY+d)								SRA (IY+d)		
1							RL (IY+d)								RR (IY+d)		
0							RLC (IY+d)								RRC (IY+d)		
	1 2 3 4 5 6 7 8 9 A B C D E	1 2 3 4 5 6 7 8 9 A B C D E	1 2 3 4 5 6 7 8 9 A B C D E	1 2 3 4 5 6 7 8 9 A B C D E	1 2 3 4 5 6 7 8 9 A B C D E	1 2 3 4 5 6 7 8 9 A B C D E	1 2 3 4 5 6 7 8 9 A B C D E	1	1         2         3         4         5         6         7         8           RL (1Y+d)         SLA (1Y+d)         BIT 2, (1Y+d)         BIT 2, (1Y+d)         BIT 6, (1Y+d) <td< td=""><td>  1   2   3   4   5   6   7   8    </td><td>  1   2   3   4   5   6   7   8    </td><td>1 2 3 4 5 6 7 8  RL (1Y+d) SLA (1Y+d) BIT 0, (1Y+d) BIT 4, (1Y+d) BIT 6, (1Y+d) RES 0, (1Y+d)</td><td>  1   2   3   4   5   6   7   8    </td><td>  1   2   3   4   5   6   7   8    </td><td>  1   2   3   4   5   6   7   8    </td><td>  1   2   3   4   5   6   7   8    </td><td>  1   2   3   4   5   6   7   8    </td></td<>	1   2   3   4   5   6   7   8	1   2   3   4   5   6   7   8	1 2 3 4 5 6 7 8  RL (1Y+d) SLA (1Y+d) BIT 0, (1Y+d) BIT 4, (1Y+d) BIT 6, (1Y+d) RES 0, (1Y+d)	1   2   3   4   5   6   7   8	1   2   3   4   5   6   7   8	1   2   3   4   5   6   7   8	1   2   3   4   5   6   7   8	1   2   3   4   5   6   7   8

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Table 7: Indexed instructions of the FDCB class, again employing the IY register. Note the similarity with table

5



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| D RETI   
   | 0  | B LD BG, (nn) LD DE, (nn) LD SP, (nn) OUTD OTDR  
  | A ADC HL, BC ADC HL, HL ADC HL, SP DD DD DDR   
   
   | 9 OUT (C), C OUT (C), E OUT (C), A CPDR  | 8 IN C, (C) IN E, (C) IN L, (C) IN A, (C) IN A, (C)  
   | 7 LD I,A LD A,I RRD  | 6 В В В В В В В В В В В В В В В В В В В  
  | 5 RETN   
   | th NEC  | 3 LD (nn),BC LD (nn), DE LD (nn),SP OUTI OTIR  | 2 SBC HL, BC SBC HL, DE SBC HL, HL SBC HL, SP INI INIR   | 0 1 2 3 4 5 6 7 8 9 A B C D B  |  |   | LDDR OTTR DNDR CPDR DNDR OTDR | CPI CPI DNI OUTI LDD CPD CPD CPD CPD CPD CPD CPD CPD CPD C | ω | SBC HL,SP LD (nn),SP Di A,(C) OUT (C),A ADC HL,SP LD SP,(nn) | BRD BRD DN L, (C) OUT (C), H SEC HL, HL RRD DN L, (C) OUT (C), L ADC HL, HL | DN D, (C) OUT (C), D SBC HL, DE LD (nn), DE  DN 1 
LD A, I  DN E, (C) OUT (C), E  ADC HL, DE  LD DE, (nn) | H B, (C) OUT (C), B SBC HL, BC LD (nn), BC NEC NEC NEC DH O LD I, A LD C, (C) OUT (C), C ADC HL, BC LD BC, (nn) RETI | 2 | 0 |
|---
---|--
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--|--
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---|--|---|--|--
--|--|---|-------------------------------|--|---|--|---|---|--|---|---|
| B IN 2   
   | D  |  
  | LD BC, (m) LD DE, (m) LD SP, (m) QUTD CUTD AETI  
   
   | ADC HL, BC         ADC HL, DE         ADC HL, SP         DD HL, SP         DD GUTD           LD BC, (nn)         LD DE, (nn)         LD SP, (nn)         LD SP, (nn)         OUTD  | OUT (C), C         OUT (C), E         OUT (C), E         OUT (C), A         OPD         OPD           ADC HL, BC         ADC HL, HL         ADC HL, FL         ADC HL, FL         ADC HL, FL         DND           LD BC, (mn)         LD BC, (mn)         LD SP, (mn)         LD SP, (mn)         OUTD  
   | Dir C, (C)   Dir L, (C)   | ID 1.A         ID 6.1         IRD         IRD         ID 6.0         IRD         IDD         IDD <t< td=""><td>  DA O   DA O  </td><td>  No DH 1   NO D</td><td>  NBC   NBC</td><td>  NEC   LD (nn), DE   LD (nn), DE   LD (nn), SP   LD (nn),</td><td>  December   December</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>PM 2</td><td></td><td></td><td></td></t<> | DA O      | No DH 1   NO D  | NBC    | NEC   LD (nn), DE   LD (nn), DE   LD (nn), SP   LD (nn), | December   December  |  |   |                               |  |   |  |   | PM 2  |  |   |   |
|  
   | RETI   | NI NETI  
  | LD BG, (m) LD DE, (m) LD SP, (m) OUTD OUTD AT THE TI ND 2  
   
   | ADC HL, BC         ADC HL, DE         ADC HL, DE         ADC HL, SP         DD HL, SP  | ADC         HL, BC         ADC         HL, SP         DDD         DDD           HETI         HETI <td< td=""><td>  Dir C, (C)   Dir L, (C)   Dir L, (C)   Dir A, (C)   Dir</td><td>  LD I.A   LD A.I   RRD   RRD   LD A. CO   LD C</td><td>ID I,A         ID A,I         RRD         TA, (c)         ID A,I         RRD         TA, (c)         ID B, (d)         ID B, (d)</td><td>  HETN   HETN  </td><td>  NBC</td><td>  ID (nn), BC   ID (nn), DE   ID (nn), SP   ID (nn), SP  </td><td>  Dia B, (c)   Dia</td><td></td><td>+</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<> | Dir C, (C)   Dir L, (C)   Dir L, (C)   Dir A, (C)   Dir | LD I.A   LD A.I   RRD   RRD   LD A. CO   LD C  
   | ID I,A         ID A,I         RRD         TA, (c)         ID A,I         RRD         TA, (c)         ID B, (d)   | HETN     | NBC  | ID (nn), BC   ID (nn), DE   ID (nn), SP    | Dia B, (c)   Dia |  | + |                               |  |   |  |   |   |  |   |   |
| Modern Land         SBC HL, BC         SBC HL, BC         SBC HL, SP         SBC HL, SP         Mod TL, SP         LD (nn), SP <t< td=""><td>  SBC HL, BC   SBC HL, BC   SBC HL, SP   SBC</td><td>MEC         LD (nn), BC         SBC HL, BC         SBC HL, BC         SBC HL, SP         LD (nn), SP         LD (nn), SP         LD (nn), SP         DN L         LD (nn), SP         DN L         DN L         LD (nn), SP         DN L         DN L<!--</td--><td>MECHL, BC         SBC HL, BC         SBC HL, BC         SBC HL, SP         DA (nn), BC         LD (nn), SP         LD (nn), SP         DA (nn), SP         <t< td=""><td>  SBC HL, BC   SBC HL, DC   SBC HL, DC   SBC HL, DC   SBC HL, SP   SBC HL, SB</td><td>SEC HL, BC         SEC HL, DC         SEC HL, SP         DEC HL,</td><td>SBC HL, BC         SBC HL, DE         SBC HL, SP         ID (m), SP         ID (m),</td><td>SDC HL, BC         SBC HL, BC         SBC HL, BC         SBC HL, BC         SBC HL, SP         IND (nn), BC           NBC         NBC         NBC         LD (nn), SP         LD (nn), SP         CUT1           NBC         NBC         NBC         NBC         NBC         NBC</td><td>SBC HL, BC SBC HL, DE SBC HL, HL SBC HL, SP ID (nn), S</td><td>SBC HL, BC SBC HL, HL SBC HL, SP ID (nn), BC ID (nn), BC ID (nn), DB ID (nn), SP ID (nn),</td><td>SBC HL, BC SBC HL, HL SBC HL, HL SBC HL, SP INI</td><td></td><td>IN B, (C) IN H, (C) IN H, (C)</td><td></td><td></td><td>CPIR</td><td>CPI</td><td></td><td></td><td>N, (C) TUO</td><td>OUT (C),D</td><td>our (c),B</td><td></td><td></td></t<></td></td></t<> | SBC HL, BC   SBC HL, BC   SBC HL, SP   SBC | MEC         LD (nn), BC         SBC HL, BC         SBC HL, BC         SBC HL, SP         LD (nn), SP         LD (nn), SP         LD (nn), SP         DN L         LD (nn), SP         DN L         DN L         LD (nn), SP         DN L         DN L </td <td>MECHL, BC         SBC HL, BC         SBC HL, BC         SBC HL, SP         DA (nn), BC         LD (nn), SP         LD (nn), SP         DA (nn), SP         <t< td=""><td>  SBC HL, BC   SBC HL, DC   SBC HL, DC   SBC HL, DC   SBC HL, SP   SBC HL, SB</td><td>SEC HL, BC         SEC HL, DC         SEC HL, SP         DEC HL,</td><td>SBC HL, BC         SBC HL, DE         SBC HL, SP         ID (m), SP         ID (m),</td><td>SDC HL, BC         SBC HL, BC         SBC HL, BC         SBC HL, BC         SBC HL, SP         IND (nn), BC           NBC         NBC         NBC         LD (nn), SP         LD (nn), SP         CUT1           NBC         NBC         NBC         NBC         NBC         NBC</td><td>SBC HL, BC SBC HL, DE SBC HL, HL SBC HL, SP ID (nn), S</td><td>SBC HL, BC SBC HL, HL SBC HL, SP ID (nn), BC ID (nn), BC ID (nn), DB ID (nn), SP ID (nn),</td><td>SBC HL, BC SBC HL, HL SBC HL, HL SBC HL, SP INI</td><td></td><td>IN B, (C) IN H, (C) IN H, (C)</td><td></td><td></td><td>CPIR</td><td>CPI</td><td></td><td></td><td>N, (C) TUO</td><td>OUT (C),D</td><td>our (c),B</td><td></td><td></td></t<></td> | MECHL, BC         SBC HL, BC         SBC HL, BC         SBC HL, SP         DA (nn), BC         LD (nn), SP         LD (nn), SP         DA (nn), SP <t< td=""><td>  SBC HL, BC   SBC HL, DC   SBC HL, DC   SBC HL, DC   SBC HL, SP   SBC HL, SB</td><td>SEC HL, BC         SEC HL, DC         SEC HL, SP         DEC HL,</td><td>SBC HL, BC         SBC HL, DE         SBC HL, SP         ID (m), SP         ID (m),</td><td>SDC HL, BC         SBC HL, BC         SBC HL, BC         SBC HL, BC         SBC HL, SP         IND (nn), BC           NBC         NBC         NBC         LD (nn), SP         LD (nn), SP         CUT1           NBC         NBC         NBC         NBC         NBC         NBC</td><td>SBC HL, BC SBC HL, DE SBC HL, HL SBC HL, SP ID (nn), S</td><td>SBC HL, BC SBC HL, HL SBC HL, SP ID (nn), BC ID (nn), BC ID (nn), DB ID (nn), SP ID (nn),</td><td>SBC HL, BC SBC HL, HL SBC HL, HL SBC HL, SP INI</td><td></td><td>IN B, (C) IN H, (C) IN H, (C)</td><td></td><td></td><td>CPIR</td><td>CPI</td><td></td><td></td><td>N, (C) TUO</td><td>OUT (C),D</td><td>our (c),B</td><td></td><td></td></t<>   | SBC HL, BC   SBC HL, DC   SBC HL, DC   SBC HL, DC   SBC HL, SP   SBC HL, SB | SEC HL, BC         SEC HL, DC         SEC HL, SP         DEC HL,  | SBC HL, BC         SBC HL, DE         SBC HL, SP         ID (m),  | SDC HL, BC         SBC HL, BC         SBC HL, BC         SBC HL, BC         SBC HL, SP         IND (nn), BC           NBC         NBC         NBC         LD (nn), SP         LD (nn), SP         CUT1           NBC         NBC         NBC         NBC         NBC         NBC  | SBC HL, BC SBC HL, DE SBC HL, HL SBC HL, SP ID (nn), S | SBC HL, BC SBC HL, HL SBC HL, SP ID (nn), BC ID (nn), BC ID (nn), DB ID (nn), SP ID (nn), | SBC HL, BC SBC HL, HL SBC HL, HL SBC HL, SP INI  |  | IN B, (C) IN H, (C) IN H, (C)  |  |   | CPIR                          | CPI  |   |  | N, (C) TUO  | OUT (C),D   | our (c),B  |   |   |
| COT         COT         COT         COT         COT         CPI         CPI           COT         SBC HL, BC         SBC HL, SP         DN I   
  | Corr (c), b   OuT (c), c   Ou | COT         OUT (c), B         OUT (c), D         OUT (c), H         SBC HL, BC         SBC HL, BC         SBC HL, BL         SBC HL, SBC         SBC HL,  
   | COT         COT <td>COT         COT         COT         COT         COT         CPI         CPI           COT         SBC HL, BC         SBC HL, DC         SBC HL, DC         SBC HL, SP         BDT         BD</td> <td>OUT (C), B         OUT (C), D         OUT (C), H         DAI         DAI<td>OUT (C), B         OUT (C), D         OUT (C), H         OUT (C), H         OUT (C), H         CPI           SEC HL, BC         SEC HL, DC         SEC HL, DC         SEC HL, SP         LD (nn), SP         NTI         NTI</td><td>OUT (C), B         OUT (C), D         OUT (C), H         ED         OUT (C), H         CPI         CPI           SBC HL, BC         SBC HL, BC         SBC HL, HL         SBC HL, SP         ID (nn), SP         ID (nn)</td><td>OUT (C), B         OUT (C), D         OUT (C), H         OUT (C), H         OUT (C), H         CPI           SBC HL, BC         SBC HL, DE         SBC HL, HL         SBC HL, SP         ID (INI), SP</td><td>OUT (C), B         OUT (C), D         OUT (C), H         OUT (C)         OUT (C)</td><td>OUT (C), B OUT (C), H OUT (C), H GP SEC HL, HZ SEC HL, SP EN HL, S</td><td><math>\operatorname{OUT}(C),B</math> <math>\operatorname{OUT}(C),D</math> <math>\operatorname{OUT}(C),H</math> <math>\operatorname{CPI}</math></td><td></td><td></td><td></td><td>LDIR</td><td>IOI</td><td></td><td></td><td>IN H, (C)</td><td>D, (C)</td><td>DN B, (C)</td><td></td><td></td></td> | COT         COT         COT         COT         COT         CPI         CPI           COT         SBC HL, BC         SBC HL, DC         SBC HL, DC         SBC HL, SP         BDT         BD   | OUT (C), B         OUT (C), D         OUT (C), H         DAI         DAI <td>OUT (C), B         OUT (C), D         OUT (C), H         OUT (C), H         OUT (C), H         CPI           SEC HL, BC         SEC HL, DC         SEC HL, DC         SEC HL, SP         LD (nn), SP         NTI         NTI</td> <td>OUT (C), B         OUT (C), D         OUT (C), H         ED         OUT (C), H         CPI         CPI           SBC HL, BC         SBC HL, BC         SBC HL, HL         SBC HL, SP         ID (nn), SP         ID (nn)</td> <td>OUT (C), B         OUT (C), D         OUT (C), H         OUT (C), H         OUT (C), H         CPI           SBC HL, BC         SBC HL, DE         SBC HL, HL         SBC HL, SP         ID (INI), SP</td> <td>OUT (C), B         OUT (C), D         OUT (C), H         OUT (C)         OUT (C)</td> <td>OUT (C), B OUT (C), H OUT (C), H GP SEC HL, HZ SEC HL, SP EN HL, S</td> <td><math>\operatorname{OUT}(C),B</math> <math>\operatorname{OUT}(C),D</math> <math>\operatorname{OUT}(C),H</math> <math>\operatorname{CPI}</math></td> <td></td> <td></td> <td></td> <td>LDIR</td> <td>IOI</td> <td></td> <td></td> <td>IN H, (C)</td> <td>D, (C)</td> <td>DN B, (C)</td> <td></td> <td></td>   
  | OUT (C), B         OUT (C), D         OUT (C), H         OUT (C), H         OUT (C), H         CPI           SEC HL, BC         SEC HL, DC         SEC HL, DC         SEC HL, SP         LD (nn), SP         NTI   | OUT (C), B         OUT (C), D         OUT (C), H         ED         OUT (C), H         CPI         CPI           SBC HL, BC         SBC HL, BC         SBC HL, HL         SBC HL, SP         ID (nn), SP         ID (nn)  
   | OUT (C), B         OUT (C), D         OUT (C), H         OUT (C), H         OUT (C), H         CPI           SBC HL, BC         SBC HL, DE         SBC HL, HL         SBC HL, SP         ID (INI), SP   | OUT (C), B         OUT (C), D         OUT (C), H         OUT (C)   | OUT (C), B OUT (C), H OUT (C), H GP SEC HL, HZ SEC HL, SP EN HL, S | $\operatorname{OUT}(C),B$ $\operatorname{OUT}(C),D$ $\operatorname{OUT}(C),H$ $\operatorname{CPI}$   |  
   |  |   | LDIR                          | IOI  |   |  | IN H, (C)   | D, (C)  | DN B, (C)  |   |   |

 Table 8: The class of miscellaneous instructions invoked by the ED prefix.

Text continued from page 200:

Finally, place after this code group a displacement suffix, d.

The Z80 also has a second index register, which is designated the IY register. Op codes which use it for addressing are contained in tables 6 and 7. It takes only a quick glance to notice the strong similarity between tables 4 and 6 and between tables 5 and 7. As might be expected, virtually everything said previously about the IX class of op codes also refers to the IY class. The sole exception to this statement is that the IY-type instructions begin with hexadecimal code FD. instead of DD.

### Miscellaneous Additions

All fifty-six instructions in the last of the four expansion sets begin with hexadecimal code ED. They are listed in table 8. Though they are quite heterogeneous, they add considerably to the power of the Z80. Among these, for example, are instructions that enhance the 16-bit arithmetic capability, set interrupt modes, permit complementing the accumulator, and allow a register-indirect type of I/O to be performed. There are instructions also, which allow counting or block processing to be done during loading, comparison, and I/O operations. Even if the other three expansion sets were omitted, the instructions in this set would be highly useful additions to the basic 8080 complement.

With such a hodgepodge of function, it is rather surprising that any order at all can be made of these ED class instructions. Nonetheless, consistency with the other tables is maintained. It is evident from the arithmetic and the leftmost I/O instructions that arrangement by order of first and second operands is used whenever possible. Separation of complementary functions by eight rows in a column is also followed.

There are 696 valid op codes in the seven Z80 tables. Without organizational consistency, conversion of these instructions from mnemonic to hexadecimal form would be extremely difficult and probably ridden with error. Fortunately, these codes are very well arranged, following the pattern established for the 8080. It takes a little practice to become adept at making these transformations, but with the aid of these tables it can be accomplished successfully.

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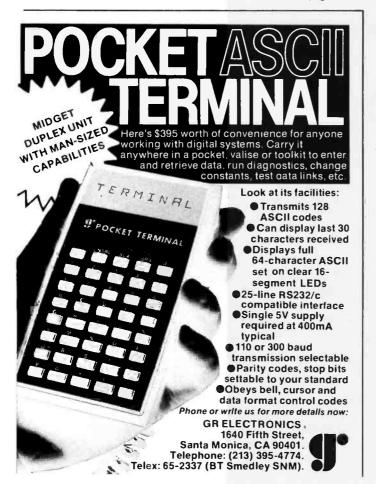
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Text continued on page 210



Listing 1: Keystrokes for the periodic-table program. The TI-59 should be configured for 319 program steps and 79 data registers, and the program will require two magnetic cards for storage. When running the program, the user can recover from an error condition by pressing CLR and beginning again.

$\begin{array}{c} 0.1234567890112345678901233456789012334567890123345678901233456789012334\\ 0.00000000000000000000000000000000000$
76 LB. TF38F125 P78 P7 104T8L R13 G000148 R13 G05068L68L R13L5TV8L R13L6836371255VF38636148 P7 104T8L R13 G6 G0004448 R G6 G05068267 G6 R G6 R G7 R G7 R G7 R G7 R G7 R G7
075 0778 0778 0779 082 0834 0845 0856 0889 0990 0993 0995 0996 0996 0997 0998 0997 0998 1001 1003 1004 1007 1009 1101 1112 1113 1114 1115 1116 1127 1128 1129 1129 1129 1139 1139 1141 1142 1143 1144 1145 1146 1147 1148 1149 1149 1149
T O E 0 2 1 0 6 VE 0 2 5 2 6 1 5 7 0 1 1 0 2 7 0 2 1 0 6 VE 0 2 7 0 2 1 0 6 VE 0 2 7 0 2 1 0 6 VE 0 2 7 0 2 1 0 6 VE 0 2 7 0 2 1 0 6 VE 0 2 7 0 2 1 0 6 VE 0 2 7 0 2 1 0 6 VE 0 2 7 0 2 1 0 6 VE 0 2 7 0 2 1 0 6 VE 0 2 7 0 2 1 0 6 VE 0 1 2 7 0 2 7 0 2 1 0 1 0 1 2 0 1 2 0 1 2 0 1 2 0 1 1 1 1
150 151 152 153 154 155 157 158 160 161 163 164 165 167 167 167 177 177 177 177 177 177 177
0722800 × L4 M M ST S V V F 20 22 V F 11 N L O 2 V V Q 18 C 7 C 28 C 28

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237 43 RCL 256 00 00 275 43 RCL 238 07 07 257 92 92 276 08 08 239 75 - 258 87 IFF 277 32 X;T 240 01 1 259 03 03 278 61 GTD 241 95 = 260 02 02 279 00 00 242 55 ÷ 261 75 75 280 09 09 243 02 2 262 43 RCL	226 22 IN 227 87 IF 228 01 0 229 00 0 230 92 9 231 22 IN 232 86 ST 233 02 0 234 71 SE 235 75 7 237 43 R0 238 07 0 239 75 7 237 43 R0 239 75 7 240 01 1 241 95 8 242 55 8	F- 246 00 1 247 95 0 248 42 2 249 01 2 250 59 F 251 32 2 252 43 2 253 01 2 254 22 2 256 00 7 258 87 2 259 02 2 260 02 2 261 75	IFF 277 03 278 02 279 75 280	32 X‡T 61 GTO 00 00
--	---	---	---------------------------------------	---------------------------

(a)	A'	B'	C'	D'	E'
	Α	В	С	D	Е

4	4)		<b>&gt;</b>
Aton	nic Weights		
Load Atomic Number	Load Atomic Weight		Initialize
N (Occurrence of an Atom)	Atomic Number	Sum of Weights	Run

Figure 1: Placement and definition of user-defined keys. Given the placement of the user-defined keys in figure 1a, the program tape in figure 1b shows the meaning of each key. For example, user-defined key A is used when entering the value for N. See tables 1 and 2, which describe the usage of these keys.

Table 1: Loading and changing atomic weight information. The first routine allows the user to enter the atomic weight for all elements, starting with element 1 and continuing through element 106. The second routine allows the user to make changes to a group of consecutive elements. Since two atomic weights are stored in a single register, both weights for an odd-even pair must be entered even if only one of the two is to be changed. Pressing the R/S button causes the calculator to request the next odd-even pair of atomic weights. The E' key, used to end this loop, can be pressed only when the atomic number showing in the display is odd.

Steps	Procedure	Press	Display
1.	To load atomic weight Initialize.	E,	does not change
2. 3.	Enter 1. Enter atomic weight for atomic number 1.	A' B'	1 2
4.	Enter atomic weight for atomic number 2.	R/S	3
		Ŧ	
	•		
	÷		:
	Enter atomic weight for atomic number 106.	R/S	107
5.	Initialize.	E'	does not
6.	Load data into banks 2, 3, and 4. (Refer to owner's manual for TI Programmable 58/59.) (The program is now complete. The load subroutines will not be needed unless a change of data is required at a later date.)		change
7.	To change atomic weight data Initialize.	E′	does not change
8. 9. 10.	Enter n, where n = 1, 3, 5, 103, 105. Enter atomic weight for n. Enter atomic weight for n + 1. (n + 1 is even)	A' B' R/S	n n+1 n+2
	•		
i i	•		
11.	If the number displayed is odd, press E' to exit the "change atomic weight data" routine.	È'	does not change
12.	To recall atomic number for the next atomic weight to be entered. (Step 12 is performed when the operator initializes with n, an even integer, thereby initiating an error condition.)	CLR, B'	Atomic number
13.	Repeat steps 9, 10, and 11 to continue.		

Text continued from page 208:

I realized that a programmable calculator could easily be used to store and retrieve data contained in the periodic chart; once this is done, the user can manipulate periodic-chart data with a small chance of error. Using the Texas Instruments TI-59, I developed the program shown in listing 1.

This program, documented in tables 1 and 2, contains two types of routines, the first for loading atomic weights, and the second for retrieving them. I decided to

Table 2: Retrieval of data from the program. The first routine finds an element's atomic weight, given its atomic number. The second routine calculates the molecular weight of a molecule given a set of quantity/atomic-number pairs that describe the molecule. The quantities marked with asterisks (\*) denote numbers that will be printed when a PC-100A or PC-100C printer is attached.

Steps	Procedure	Press	Display
1	To find atomic weight Initialize.	E'	does not
2.	(When program is initialized, the display is preserved.) Enter atomic number.	B,E	value of atomic weight*
3.	Repeat step 2 for new atomic number.		
4.	To find molecular weight Initialize.	E'	does not
5.	Enter atomic number.	В	does not
6.	Enter how many of that particular element.	A,E	change A x atomic weight*
7. 8.	Repeat steps 5 and 6 for each element. Calculate total weight (sum weight.)	С	total weight of mole- cule*
9.	(Note: label C is a subtotal.) To find weight of a new formula, go to step 4.		
10. 11.	Recall last A entry (when desired) Recall last B entry (when desired) (Steps 10 and 11 are merely for convenience and do not interfere with program flow.)	CLR, A CLR, B	Last A Last B

**Table 3:** Table showing usage of registers 00 thru 79 in the periodic-table program, listing 1. The atomic weights must be in the form of XXX.XXX; leading and trailing zeros will be automatically inserted.

Register Number	Use
00 thru 09 10 thru 19	Used. These registers are left open to allow the operator to store additional data during program use without altering internal program executions.
20 thru 72 73 thru 79	Used to store atomic weights. Not used.

sacrifice speed of execution for ease of operation and protection of loaded data.

This program will enable you to:

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- Calculate molecular weights.
- Calculate any combination of atomic weights.
- Load atomic weights either sequentially or randomly.
- Print values using the PC-100A or PC-100C printers.

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# **Programming Ovickies**

# KIM-1 Multiplication and Division

James C Couchman, General Dynamics Corp, Fort Worth Division, POB 748, Fort Worth TX 76101

When I bought a MOS Technology KIM-1 microcomputer to use in a specific control function, it arrived with a set of comprehensive instruction, programming, and hardware books. As soon as I connected a 5 V power supply, I was able to interact with the machine through the hexadecimal keyboard and light-emitting diode (LED) display. It was a bit more difficult to get our Teletype to work with the KIM-1, but with a slight adjustment to the teleprinter timing, the problem was cured.

The KIM-1 is still a real bargain, with features including the 6502 microprocessor, 2 K bytes of read-only memory (containing the Keyboard Input Monitor from which the name is derived), an interval timer, fifteen input and output lines, 1 K bytes of programmable memory (with address logic for 16 K bytes), and probably some features I have not yet discovered.

Since the KIM-1 is programmed in machine language using a set of fifty-six instructions, I believe that the best way to learn to program it is to not just read about it, but do it. One should just start writing code, and, in time, the power of the basic instruction set will really be understood and appreciated.

Once the user is familiar with the capabilities of the KIM-1, he begins to wish that it could do more. One tool that provides more capability is a set of software routines that perform sixteen-bit multiplication and division on the 6502 processor. After I searched for a suitable set of routines, I concluded that I would have to write my own.

To prevent you from having to "reinvent the wheel," I am presenting these routines here. In developing these routines, I enlisted the invaluable assistance of my associates G R Arnett and J R Williamson. These routines should work without much difficulty on other 6502-based computers.

### Sixteen-Bit Routines

These routines can multiply and divide two 16-bit signed quantities together and produce a signed 16-bit result. The routines are written as relocatable subroutines.

In multiplication, the high-order byte of the first multiplicand is loaded into hexadecimal location 0000, and the low-order byte into location 0001. The high-

order byte of the second multiplicand is put into location 0006, and the low-order byte into location 0007.

In division, the high-order byte of the divisor is loaded into hexadecimal location 0000; the low-order byte into location 0001. The high-order byte of the dividend is placed into location 0006, and the low-order byte is loaded into location 0007. If the value of the divisor is zero, the division routine will return control to the calling program.

For both the multiplication and the division routines, the answer is returned in hexadecimal locations 0002 (high-order) and 0003 (low-order byte). It should not be very hard to change this if need be.

An example of a simple calling routine is shown in listing 1. The calling sequence is essentially the same for both multiplication and for division; only the value contained in the two bytes that follow the jump-to-subroutine (JSR) instruction must be changed.

Listing 1a: Calling sequence for 16-bit multiply subroutine.

Address	Code
0007 0008 0009 000 A 000 B 000 C 000 D	20 (JSR) 00 01 (multiply) A9 (LDA) 00 F0 FC
000C	FO

Listing 1b: Calling sequence for 16-bit divide subroutine.

Address	Code
0007	20 (JSR)
0008	30 00 (divide)
000A	A9 (LDA)
000B	00
000C	<b>F</b> 0
000D	FC

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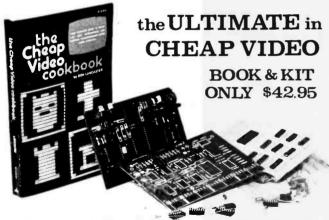
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The assembler mnemonics and hexadecimal code for the multiplication subroutine are given in listing 2. The division subroutine is given in similar form in listing 3. The multiplication subroutine is shown in hexadecimal memory-dump form in listing 4; the division code in that form in listing 5.

My collegues and I hope that these programs will help other KIM-1 users. We know that having had them prepared for us would have saved us much time.

Listing 2: Relocatable subroutine to perform multiplication of 16-bit quantities on the 6502 microprocessor as used in the MOS Technology KIM-1. Both assembler mnemonics and hexadecimal code are given. Entry point is hexadecimal location

Address	Mnemonic	Hexadecimal Code
0100	CLC	18
0101	CLD	D8
0102	LDA #0	A9 00
0104	TAX	AA oc. oo
0105 0107	STA 0002 STA 0003	85 02 85 03
0107	LDA 0000	A5 00
010B	BNE	D0 11
010D	LDA 0001	A5 01
010F	BEQ	FO OC
0111	CMP #1	C9 01
0113	BNE	D0 1D
0115	LDA 0006	A5 06
0117	STA 0002 LDA 0007	85 02 A5 07
0119 011B	STA 0007	85 03
011D	RTS	60
011E	BPL	10 12
0120	INX	E8
0121	LDA 0001	A5 01
0123	CLC	18
0124	EOR FF	49 FF
0126	ADC #1	69 01
0128	STA 0001	85 01 A5 00
012Ā 012C	LDA 0000 EOR FF	49 FF
012E	ADC #0	69 00
0130	STA 0000	85 00
0132	LDA 0006	A5 06
0134	BNE	D0 26
0136	LDA 0007	A5 07
0138	BEQ "	F0 18
013A	CMP #1 BNE	C9 01 D0 32
013C 013E	DEX	CA
013E	BNE	D0 12
0141	LDA 0001	Ā5 01
0143	CLC	18
0144	EOR FF	49 FF
0146	ADC #1	69 01
0148	STA 0003	85 03 A5 00
014Å 014C	CDA 0000 EOR FF	49 FF
014E	ADC #0	69 00
0150	STA 0002	85 02
0152	RTS	60
0153	LDA 0001	A5 01
0155	STA 0003	85 03
0157	LDA 0000	A5 00
0159 015B	STA 0002 RTS	85 02 60
015C	BPL	10 12
015E	INX	E8
015F	LDA 0007	A5 07

#### Listing 2 continued:

01A7 EOR FF 49 FF 01A9 CLC 18 01AA ADC #1 69 01 01AC STA 0003 85 03 01AE LDA 0002 A5 02 01B0 ADC #0 69 00 01B2 STA 0002 85 02 01B4 RTS 60		0161         CLC         18           0162         EOR FF         49 FF           0164         ADC #1         69 01           0166         STA 0007         85 07           0168         LDA 0006         A5 06           016A         EOR FF         49 FF           016C         ADC #0         69 00           016E         STA 0006         85 06           0170         LDA 0000         A5 00           0172         STA 0004         85 04           0174         LDA 0001         A5 01
--	--	---

Listing 3: Relocatable subroutine to perform division of 16-bit quantities on the 6502 microprocessor of the KIM-1, with assembler mnemonics. Entry point is hexadecimal location 0030.

Address	Mnemonic	Hexadecimal Code
0030	CLC	18
0031	CLD	D8
0032	LDA #0	A9 00
0034	TAX	AA
0035	STA 02	85 02
0037	STA 03	85 03
0039	LDA 00	A5 00
003B	BNE	D0 05
003D	LDA 01	A5 01
003F	BNE	D0 15
0041	RTS	60
0042	BPL	10 12
0044	INX	E8
0045	LDA 01	A5 01
0047	CLC	18
0048	EOR FF	49 FF
004A	ADC #1	69 01
004C	STA 01	85 01
004E	LDA 00	A5 00
0050	EOR FF	49 FF
	Listin	ig 3 continued on page 2.

Listing 3 continued on page 216

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0052 0054 0056 0058 005A 005C 005E 0060 0062 0063 0065 0067 0068 006A 006C 006E 0070 0072 0074 0076 0077	ADC #0 STA 00 LDA 06 BNE LDA 07 BEQ CMP #1 BNE DEX BNE LDA 01 CLC EOR FF ADC #1 STA 03 LDA 00 EOR FF ADC #0 STA 02 RTS LDA 01 STA 03 LDA 00 STA 02	69 00 85 00 A5 06 D0 26 A5 07 F0 18 C9 01 D0 32 CA D0 12 A5 01 18 49 FF 69 01 85 03 A5 00 49 FF 69 00 85 02 60 A5 01 85 03 A5 00 85 02
007F 0080 0082 0083 0085 0086 0088 008A 008C 008E 0090 0092 0094 0096 0097 0099 009B 009D	RTS BPL INX LDA 07 CLC EOR FF ADC #1 STA 07 LDA 06 EOR FF ADC #0 STA 06 LDA 03 CLC ADC #1 STA 03 LDA 02 ADC #0 STA 02	60 10 12 E8 A5 07 18 49 FF 69 01 85 07 A5 06 49 FF 69 00 85 06 A5 03 18 69 01 85 03 A5 02 69 00 85 02
00A1 00A2 00A4 00A6 00A8 00AA 00AC	SEC LDA 01 SBC 07 STA 01 LDA 00 SBC 06 STA 00 LDA 00	38 A5 01 E5 07 85 01 A5 00 E5 06 85 00 A5 00

00B4	LDA 01	A5 01
00B6	BNE	D0 DC
00B8	BEQ	FO OD
OOBA	SEC	38
00BB	LDA 03	A5 03
00BD	SBC #1	E9 01
OOBF	STA 03	85 03
00C1	LDA 02	Ā5 02
00C3	SBC #0	E9 00
00C5	STA 02	85 02
00C7	DEX	CA
00C8	BNE	D0 15
00CA	LDA 02	A5 02
00CC	EOR FF	49 FF
OOCE	STA 02	85 02
00D0	LDA 03	A5 03
00D2	EOR FF	49 FF
00D4	CLC	18
00D5	ADC #1	69 01
00D7	STA 03	85 03
00D9	LDA 02	A5 02
00DB	ADC #0	69 00
00DD	STA 02	85 02
OODF	RTS	60

Listing 4: Multiplication subroutine in hexadecimal memorydump form.

```
; 18010018D8A900AA85028503A500D011A501F00CC901D01DA50685097A
; 18011802A5078503601012E8A50118A9FF69018501A50049FF6900081D
; 180130850DA506D026A507F018C901D032CAD012A5011849FF6901081D
; 1801488503A500A9FF6900850260A5018503A5008502601012E8A5088F
; 180160071849FF69018507A50649FF69008506A5008502601012E8A5088F
; 180178A5031865018503A5026500850238A507E9018507A506E90007C0
; 1801908506C900D0E2A507C900D0CCAD015A50249FF8502A503490BE6
; 1801A8FF1869018503A5026900850260E9008D0600C900D0BAC070962
; 000000800008
```

Listing 5: Division subroutine in hexadecimal memory-dump form.

```
; 18003018D8A900AA8502E503A500D005A501D015601012E8A5011808C7
; 18004849FF69018501A50049FF69008500A506D026A507F018C9010992
; 180060D032CAD012A5011849FF69018503A50049FF6900850260A50A0Q
; 180078018503A5008502601012E8A5071849FF69018507A50649FF08A4
18009069008506A5031869018503A5026990850238A501E50785010735
; 1800A8A500E5068500A5003008D0E0A501D0DCF00D38A503E901850B00
; 1800C003A502E9908502CAD015A50249FF8502A50349FF186901850A0E
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## The purpose of computation is insight not numbers

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March

James Martin Seminar James Martin will discuss the design and management of distribution processing and networks.

For details of his March appearances write Technology Transfer Institute, POB 49765, Los Angeles CA 90049, (213) 476-9747.

March

Short Courses on Microcomputers, George Washington University, Washington DC. Contact the Director of Continuing Engineering Education, George Washington University, Washington DC 20052 or call (202) 676-6106 or (800) 424-9773.

March

Workshops for TRS-80 Interfacing, 8080-8085 and Z80 Design and Digital Electronics for Instrumentation and Automation, Virginia Polytechnic Institute and State University, Blacksburg VA 24061. For additional information on times and dates, contact Dr Linda Leffel, CEC, Virginia Tech, Blacksburg VA 24061 or call (703) 961-5241.

March 1

Exploring Small Computers, Albion College, Albion MI. This fair will feature exhibits and seminars on microcomputers and their applications in business, education, and the home. Contact D W Kammer, Dept of Physics, Albion College, Albion MI 49224.

March 3-5

Office Automation Conference, Georgia World Congress Center, Atlanta GA. A combination conference and exhibition of office computer systems has been developed to help management understand the growing technology of business computer systems. For more information, contact H A Bruno and Associates Inc, 78 E 56th St, New York NY 10022.

March 4 and 5

8th Annual Midwest Digital Equipment Exhibit and Seminar, Thunderbird Motel, Minneapolis MN. Manufacturers of computer terminals, data communication equipment, peripherals, data acquisition systems and digital test instruments will display their products. Seminars will be held both days. For further information, contact John Bastys Countryman Associates Co, 1821 University Ave, St Paul MN 55104.

March 6-8

Microprocessor Peripherals Workshop, Montgomery AL. This hands-on workshop includes 27 hours of instruction, with a takehome option and one microcomputer station for every two participants. Contact Paul A Willis, POB 29, Arlington VA 22210.

March 10-12
1980 National Office Exhibition and Conference,
Automotive Building,

In order to gain optimum coverage of your organization's computer conferences, seminars, workshops, courses, etc, notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, 70 Main St, Peterborough NH 03458. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.

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March 11-13
SEMICON/Europa, Zurich,
Switzerland.

This show and symposium is the initial step in the organization of a European forum for the exchange of information on the latest semiconductor technology. Included in the topics of presentation are semiconductor materials, device production, and technology; future trends; photovoltaic conversion of solar energy; and standardization of testing and materials. Contact the Semiconductor Equipment and Materials Institute Inc. 625 Ellis St. Suite 212, Mountain View CA 94043.

March 14-16

West Coast Computer Faire, Civic Auditorium and Brooks Hall, San Francisco CA. An expected 15,000 attendees, over 340 exhibits, and more than 100 conference speakers will highlight this year's program. Exhibitor and speaker information may be requested from the Computer Faire, 333 Swett Rd, Woodside CA 94062.

March 15

Annual PACS Computer Games Festival, LaSalle College Ballroom, 20th and Olney, Philadelphia PA. This event is sponsored by the Philadelphia Area Computer Society and the LaSalle College Physics Dept. The Festival hours are from 10 AM to 6 PM. For further information, contact Stephen A Longo, Physics Dept, LaSalle College,

Philadelphia PA 19141, or call (215) 951-1255.

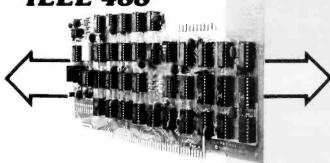
March 17-20
Interface '80, Miami Beach
Convention Center, Miami
Beach FL. This conference
and exposition is devoted to
data communications,
distributed data processing
(DDP), and networking.
Approximately 1000 exhibitors are expected, and
attendance is anticipated to
exceed 12,000. For information, contact Interface '80,
160 Speen St, Framingham
MA 01701.

March 17-21 Applied Time Series Analysis, University of California at Los Angeles CA. This course is designed for engineers, scientists, programmers, economists and other users of digital time series who require modern methods of data analysis using the fast Fourier transform (FFT), digital filtering, power spectral densities and correlation functions. The lectures cover topics relating to the Fourier transform, sampling linear systems, convolution, covariance, digital filtering, power and cross-spectral density functions, and introductions to new methods in spectral analysis and rotating machinery analysis. For more information, contact UCLA Extension, 10995 Le Conte Ave, Los Angeles CA 90024.

March 18-20 **Electrical Power Problems:** The Mathematical Challenge, Seattle WA. This conference is sponsored by the Society for Industrial and Applied Mathematics (SIAM). The program is designed to bring together experts from power engineering and applied mathematics fields to focus on electrical power problems and the applied mathematics techniques relevant to their solution. Contact SIAM, 33 S 17th St, Philadelphia PA 19103.

March 20 Electronic Road Shows, Castaways Restaurant, Bur-

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bank CA. This traveling exhibition of components, materials, and instruments is being produced by the Electronic Representatives Association (ERA). Over eighty ERA member firms will participate, and product's from over 700 electronic companies will be displayed. For more information, contact the Southern California ERA office, 20969 Ventura Blvd, Suite 9, Woodland Hills CA 91364

March 24-26

Data Entry Management and Supervision Seminar, Cherry Hill NJ. This course deals with the practical aspects of data entry, and the problems encountered that are common to supervisors and managers. Concepts, techniques, motivation, training, and productivity will be covered. The fee is \$415 for subscribers of MIC publications and \$445 for nonsubscribers. For more information, contact MIC, 140 Barclay Ctr, Cherry Hill NJ

Fourth European Conference on Electrotechnics, Stuttgart. This conference will review recent developments, trends, and applications in the field of microelectronics. Microprocessors, computer communication, industrial electronics, applications of microelectronics in the automobile and in medicine. and other topics will be covered. The conference language will be English. Contact Professor Dr W E. Proebster, IBM Deutschland GmbH. Postfach 80 08 80.

March 24-28

March 26-28 Viewdata '80, Wembley Conference Centre, London England. Viewdata '80 is an international exhibition and conference on video-based systems and microcomputer industries. The British Post Office is presenting the Prestel Show, which is about electronic mail ser-

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March 30

Greater Baltimore Hamboree and Computerfest, Maryland State Fairgrounds, Timonium MD. Personal, dealer, and small business computer displays and exhibits will be featured. Space is available outside the fairgrounds for tailgate sales and swaps. For more information, contact Joseph Lochte Ir. 2136 Pine Valley Dr. Timonium MD 21093.

March-June

Computer and Office Systems Expo and Conference. This is an exposition for marketers of office systems equipment. The show and conference will focus on the local problems and opportunities of each region. The exposition and conference will be held in major cities around the nation. Contact The Conference Co. 60 Austin St. Newton MA 02160, or phone (617) 964-4550.

#### **APRIL 1980**

April 1-2

Southeast Printed Circuits and Microelectronics Exposition, Sheraton-Twin Towers Convention Center, Orlando FL. This show is a specialized event devoted entirely to the packaging, production and testing of printed circuits, multilayers, semiconductor devices, and hybrids. The conferences are aimed at electronics specialists. Contact ISCM, 222 W Adams St. Chicago IL 60606.

April 9-11

The Practical APL Conference, Washington DC. This conference is addressed to business executives and systems designers. For more information, contact Joan Gurgold, STSC, 7 Holland Ave, White Plains NY 10603.

April 9-11

International Conference on Acoustics, Speech and

Signal Processing, Fairmont Hotel. Denver CO. The IEEE Acoustics, Speech and Signal Processing Society is sponsoring this conference devoted to experimental and theoretical aspects of signal processing, speech, and acoustics. For more information, contact IEEE, 1100 14th St. Denver CO 80202.

April 10

Electronic Road Shows, Anaheim Convention Center, Anaheim CA. See March 20th for details

April 11-12

10th Annual Virginia Computer Users Conference. This conference is sponsored by the Virginia Tech Association for Computing Machinery (ACM) student chapter. The topics of discussion will be programming languages and system and personnel management. For more information, contact VCUC10, 562 McBryde Hall, VPI&SU, Blacksburg VA 24061.

April 13-16 A Gateway to the Use of Computers in Education, Chase Park Plaza Hotel, St Louis MO. The purpose of this convention is to provide a forum for the exchange of information and ideas between individuals, to inform educators of developments in computer technology, and to expose participants to innovations in computing which can be utilized in the

Educators are encouraged to exhibit and make presentations of instructional microprocessor materials during the convention. Contact the Association for **Educational Data Systems** (AEDS), POB 951, Rolla MO 65401.

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April 14-18 High-Speed Computer Organization, 6266 Boelter Hall, UCLA Extension, Los Angeles CA. This course is for computer designers, system architects, project leaders and managers. The course provides an understanding of the principles of high-speed com-



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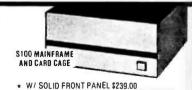
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For more information, contact the UCLA Extension at POB 24901, Dept K, UCLA Extension, Los Angeles CA 90024.

April 21-25

National Micrographics Association 29th Annual Conference and Exposition, Sheraton Center Hotel and Coliseum, New York NY. The theme for the show is "Focus on Productivity in Office Management.' Highlighting the conference and exposition will be presentations and talks concerning the use in offices for computer systems and related items.

For more information. contact the Conference Dept, National Micrographics Association, 8719 Colesville Rd, Silver Spring MD 20910.

April 23-25

International DP Training Conference, Hyatt Regency, Chicago IL. The theme for this event will be "The 1980s: The Information Decade." The conference is a symposium for data processing experts and corporate training executives. For information, contact

Deltak Inc, 1220 Kensington Rd. Oak Brook IL 60521.

April 27-30

17th Numerical Control Society Annual Meeting and Technical Conference, Hartford Civic Center, Hartford CT. This convention will offer technical sessions covering such areas as computer-aided design engineering, business management, tool design and graphics; computeraided assembly, facilities planning, inventory control, and management information systems; numerical control in various areas; data base structure and management; and other educational programs. There is also a large exhibition being presented.

For more information. contact Numerical Control Society, 1800 Pickwick, Glenview IL 60025.

April 28-30

Managing Technical Programs and Projects, White Plains NY. For more information, contact the Institute for Advanced Professional Studies, One Gateway Ctr, Newton MA 02158.

April 30-May 2

Computerized Office Equipment Expo, O'Hare Exposition Center, Rosemont IL. The latest developments in

computers, word processors, copiers/duplicators, telephone systems, and other business equipment will be featured. The seminars will cover guidelines on buying computer systems, telephone and copier systems; the use of word processors, and more. Contact Industrial and Scientific Conference Management Inc, 222 W Adams St, Chicago IL 60606

#### **MAY 1980**

May

**IEEE Computer Society** Conferences and Meetings. For a list of events, contact the Executive Secretary, Harry Hayman, POB 639, Silver Spring MD 20901, or phone (301) 439-7007.

May 5-11

Engineering, Science, and Public Policy, 16th Annual Meeting, Baltimore Convention Center, Baltimore MD. Companies from around the world and the US will be exhibiting. The conference is being sponsored by the AIAA. Contact Lawrence Craner, Director of Technical Displays, AIAA. 1290 Avenue of the Americas, New York NY 10019, or the Conference General Chairman, Laurence Adams at Martin Marietta

Aerospace.

May 6-8 Micro/Expo 80, Centre International de Paris, Paris France. This is one of the leading shows in Europe for microcomputer users and manufacturers. Exhibits of new equipment, presentations, games, educational materials, and more will be featured. For more information, contact Sybex Inc. 2020 Milvia St. Berkelev CA 94704.

May 6-8

The 7th International Symposium on Computer Architecture, La Baule, France. This symposium will consist of discussions and readings in the following areas: distributed architectures, special-purpose architectures, hardware description languages, fault-tolerant architectures, high-speed computers, control schema, evaluation of architecture performance, and more.

Contact, Daniel E Atkins, Dept of Electrical and Computer Engineering, University of Michigan, Ann Arbor

MI 48109.

May 6-10

8th Annual Canadian Association for Information Science, Toronto, Canada. Technology, commodity, and rights are the themes of this conference. Topics will

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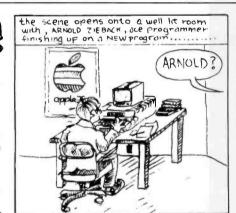
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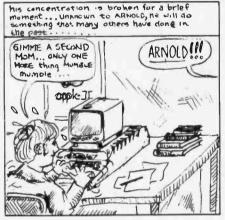
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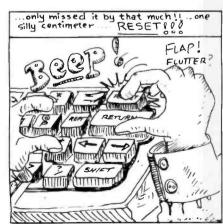
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cover information in the marketplace, information transfer and policy issues, right to access, new information technologies and applications, and other subjects. For more information, contact the Program Chairman, 8th Annual CAIS Conference, Technical Information Centre, Bell Northern Software Research, 12th floor, 522 University Ave, Toronto Ontario M5G 1W7 CANADA.

May 13-15

Electro/80 Show and Convention, Hynes Auditorium and Boston Sheraton, Boston MA. This show consists of presentations and exhibitions by manufacturers in the computer industry. Contact Electronic Conventions Inc, 99 N Sepulveda Blvd, El Segundo CA 90245.

May 13-16

9th Annual Conference of MUMPS Users Group, Islandia Hyatt House, San Diego CA. The meeting will bring together scientific, medical, and business professionals to discuss current research and application development. Areas of participation are paper presentations, workshops and tutorials, and vendor exhibits. Contact Dr Jack Bowie, MUG 80 Program Chairman, The MITRE Corp, Mail Stop 641, 1820 Dolley Madison Blvd, McLean VA 22102.

May 14-16

Carnahan Conference on Crime Countermeasures, Carnahan House, Lexington KY. This conference is devoted to the application of engineering and science to law enforcement, security, and crime prevention. Emphasis will be on effective research and development in computer security.

Contact the Office of Continuing Education, College of Engineering, University of Kentucky, Lexington KY 40506.

May 15 Electronic Road Shows, Griswold's Restaurant, Pomona CA. See March 20th for details.

May 19-22

1980 National Computer Conference, Anaheim Convention Center, Anaheim CA. The conference program will include more than 120 sessions covering computing careers and education, office automation, and auditing in the area of management; computers in earth resource management, human services, and word processing in the field of applications; programming languages, design techniques and methodology, and voice simulation and recognition in software; earth resources, education, women and minorities in the computing discipline in the area of social implications; microcomputers and minicomputers, computer architecture, and new concepts in memories in the area of hardware.

For information, contact American Federation of Information Processing Societies Inc, 1815 N Lynn St, Arlington VA 22209.

May 21-22

2nd Clemson Small Computer Conference, Clemson University, Clemson SC. This conference will discuss applications in engineering, science, manufacturing, small business data processing, and education. Contact William J Barnett, Electrical and Computer Engineering Dept, Riggs Hall, Clemson University, Clemson SC 29631.

May 24-25

Amateur Radio and Computer Hobbyists 2nd Annual Convention, Cervantes Convention Center, St Louis MO. Speakers, presentations, equipment displays, and a flea market will be featured. For more information, contact the Gateway Amateur Radio Assocation Inc, POB 68, Marissa IL 62257.

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## To Err Is Human

GIGO (garbage in, garbage out) is an expression heard so often by programmers that it is accepted as truth and even offered as an excuse for poorly written programs. It is a truism that ought to be examined, especially in the area of human prepared input that is typed.

If the instructions in figure 1a are entered instead of the correct instructions of figure 1b, the great majority of microprocessor assemblers will be unable to locate any of the program symbols. This inability compels the user to go through the tedious process of calling an edit program, making corrections, calling the assembler, and trying once more to assemble the source code, hoping that no new errors have been introduced. This procedure can be very time consuming; it is always frustrating. An examination of how the errors are detected in a normal assembler

Label	Operation	Operand
1 LOOP 2 3 4 5 COPY	CPY JSR CMP BEQ EUQ	SPAEC PRJNT STRE LOOPS LOOP

Figure 1a: A section of code which illustrates several common typing errors often made during entry of an assembly program. These particular errors can be detected and corrected by a simple algorithm which determines if the operand is "close enough" to what it is supposed to be. If the operand has two transposed letters, one character wrong, or one character too many or too few, it is automatically changed to the correct form listed in the symbol table.

Label	Operation	Operand
1 LOOP 2 3 4 5 COPY	CPY JSR CMP BEQ EQU	SPACE PRINT STORE LOOP LOOP

Figure 1b: The code from figure 1a after error detection and correction.

Roger A McGregor 6933 S Allison Way Littleton CO 80123

or compiler may shed light on how an automated correction can be attempted.

Normally, after a symbol has been segregated from the source text, it is passed to a symbol table lookup routine as a search argument. The function of the lookup routine is to find an entry in the symbol table whose symbol matches the search argument, and to either return that entry (a hit) or set some indicator to inform the calling routine of an unsuccessful search (a no-hit). Both hits and no hits are valid returns, depending on the pass being made on the source code.

The first pass causes two types of lookup calls; definition and reference. For a definition lookup, a symbol has been extracted from the label field. That symbol and its attributes are to be entered into the symbol table if and only if the symbol is not already present in the symbol table. However, if the symbol is already present, it is multiply defined and in error. For a reference lookup, a symbol found in the operand field is needed for a compile time computation (line 5 of figure 1b). For this lookup, the symbol must be present in the symbol table or an error condition exists.

During any other pass, a no-hit constitutes an error. It is at this point that error correction may be attempted in the form of an alternate (associated) symbol lookup.

If the lookup routine can find another symbol in the symbol table that is "close enough" to the search argument, then the entry's symbol is associated with the argument symbol and may be returned as a hit. When an alternate symbol is substituted in this fashion, the programmer must be given a warning as the substitution may not be correct. By checking the object code generated, the programmer can verify the substitution.

What constitutes "close enough" before a symbol table entry can be substituted for the search argument?

#### About the Author

Roger McGregor works as a systems programmer on a large IBM system. He has written or worked on many operating systems, assemblers, compilers, and interpreters, and has successfully used the techniques presented here in an assembler.

"Close enough" is defined as two characters transposed (line 1, figure 1a), one character wrong (line 2, figure 1a), one missing character (line 3, figure 1a), or an extra character (line 4, figure 1a).

Given the above criteria, only certain symbols in the symbol table need be reexamined. Those symbols are the ones possessing an equal number of characters. or one more or one less character than the search argument. An exception occurs when the search argument consists of only a single character: if this happens, error correction should be terminated and a no-hit returned. Those symbols with an equal number of characters should be compared for transposed characters or one wrong character in the string. Those symbols with one more or one less character than the search argument should be checked for a single character difference. If any symbol in the symbol table passes one of the above tests, an association has occurred and the associated entry should be returned as a hit.

Generally, making a single pass through the symbol table and returning the first entry passing a check is sufficient. However, if the keyboard layout is more conducive to wrong characters due to upper and lower case shifting than to the other common errors of transposition, addition, or deletion, then a first pass through the symbol table checking only equal character count symbols for wrong characters could prove to be more accurate. Alternate strategies do however increase memory usage and execution time. The execution time is well spent if a proper association prevents the edit and reassemble process already described. Memory usage is another matter. The less memory used by the correction routine, the better.

Besides alleviating reassembly problems, the error correction process tends to encourage better documented programs. Due to the nature of the checks made for the association, longer symbols have a better chance of being correctly associated. They are also usually more meaningful.

The above correction process is by no means limited to just the symbol table of an assembler and compiler. It can be applied to any dictionary type lookup including op codes, text processors, and console commands.

The only obvious limitation would occur when symbols intentionally differ by a transposition or length. In order to overcome this objection, we simply require an explicit declaration statement and correct spelling in such statements with the extended error correction applied to uses of a name.

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```
40 FORA=1T076\READ$0,W(0,A),W(1,A),W(2,A),W(3,A)\NEXT\FORA=1T064
50 REAI#0,N(0,A),N(1,A),N(2,A),N(3,A),N(4,A),N(5,A),N(6,A)\NEXT
60 CLOSE#0\INPUT'0 TO 9 : 0 I PLAY BEST AND 9 WORST ? ",Z\Z=1+(Z/10)
100 FDRA=1T064\B=A*4\C$(B-3,B)=" "\C=INT(A/10)\D=A-(C*10)
110 C$(B-1,B-1)=C1$(C+1,C+1)\C$(B,B)=C1$(D+1,D+1)\NEXT
120!"HERE IS MY BOAR!"\!""\GOSUB1000\!""\!"ENTER MOVES BY",
130!" NUMBER AND YOUR'RE X"
140 !""\INPUT"YOUR MOVE ? ",X\IFX<10RX>64THEN140\IFS(X)<>OT
160 Q=0\FORA=1T076STEPZ\C=T(A)\IFC<0THEN200\IFC=15THENEXIT400
170 IFC<>OTHEN180\B=1\GOSUB500\GOTD200
180 IFC>4THEN190\B=P(C-1)\GOSUB500\GOTD200
190 C=INT(C/5)+2\B=P(C)\G0SUB500
200 NEXT\FDRA=1TD64\IFV(A)<QTHEN210\Q=V(A)\X=A
210 V(A)=0\NEXT\IFQ=0ANDZ=1THEN1600\IFQ<>0THEN220
215 FORA=1TD64\IFS(A)=0THENEXIT217\NEXT\G0T01600
217 S(A)=1\X=A
220 S(X)=1\A=X*4\C$(A-3,A)="0000"\P=5\G0$UB900
230 | "I WENT", X\! " \GOSUB1000\GOT0140
400 1 THE COMPUTER WINS WITH BOXES', W(0,A), W(1,A), W(2,A), W(3,A) \GOTO2000
500 FORF=OTO3\G=W(F,A)\IFS(G)=OTHENV(G)=V(G)+B\NEXT\RETURN
900 FORA=0T06\C=N(A,X)\IFC=OTHEN950\IFT(C)<OTHEN950
910 T(C)=T(C)+P\IFT(C)<4THEN950\IFT(C)=4THENEXIT1700
920 D=INT(T(C)/5)\IFD*5<>T(C)THENT(C)=-1
950 NEXT\RETURN
 1000 FORA=0T03\FORB=2T00STEP-2\FORC=0T03\FORD=1T04
 1010 E=(((C#16)+D+(A*4))*4)-B\!C$(E-1,E)\TiPI<4THEN!" = 1020 NEXT\IFC<3THEN!" *,\NEXT\!"\NEXT\IFA=3THEN1040
 1030 FORE=1T03\!
                                                       " , \NEXT\! " ===
 1040 NEXT\RETURN
1500 | ""\!*IT'S A DRAW"\GOTO2000
1700 | ""\F=C\GOSUB1000\!""\C=F\!"YOU WON", W(0,C), W(1,C), W(2,C), W(3,C)
2000 INPUT"CARRIAGE RETURN ENDS, ANYTHING ELSE FLAYS AGAIN ? ",Z$
2005 IFZ$=""THENEND\FORA=1T076\T(A)=0\NEXT\FORA=1T064\S(A)=0\V(A)=0\NEXT
 2010 GOT0100
 READY
```

Listing 1: Super TIC, a three-dimensional tic-tactoe computer game written in North Star BASIC. (All other programs in this article are also written in North Star BASIC.)

## Super TIC

J Roehrig **POB 74** Middle Village NY 11379

Listing 2: Modifications to listing 1 to change the three-dimensional version into two-dimensional 4 by 4 tic-tac-toe.

> 140 !""\INPUT"YOUR MOVE ? ";X\IFX<10RX>16THEN140\IFS(X)<>0THEN140 160 Q=0\FORA=1T010STEPZ\C=T(A)\IFC<0THEN200\IFC=15THENEXIT400 1000 FORA=0T03\FORB=2T00STEP-2\FORC=0T00\FORD=1T04 1030 | "==============

#### Super Micro-Tic

This article describes Super TIC, a program that plays three-dimensional (4 by 4 by 4) tic-tac-toe. It was written specifically for microprocessors and has the following features:

 It is fast, despite the fact that it checks every possible move. The response time is 13 seconds per move (worst case) using an IMSA1 8080 computer with North Star BASIC, and it averages less than six seconds per move.

- It gives a graphic display of the game (designed for a 24 line by 80 character terminal) without requiring a graphics board.
- It plays at ten different levels of skill without requiring modification of the program.
- One program line can be modified to change the program's strategy so that it plays defensively or aggressively.
- The modification of four lines (see listing 2) allows the game to be played in a two-dimensional 4 by 4 format.

Listing 3 shows a sample run of the 4 by 4 by 4 version. The computer asks for the level of play desired and gives a display of the game board. The player enters a move selection (a number from 1 to 64 corresponding to the desired box) and the computer answers with its move. Next, the

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	(Bytes)	(Sec)		(Bytes)	(Sec)
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SORT	32K	49	SORT	680K	2569
SORT	85K	173	SORT and	85K SORT +	1757
SORT	170K	445	MERGE	1275K Merge	

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entire game board is reprinted with the player's boxes represented by Xs and the computer's boxes by Os.

For those readers not familiar with threedimensional tic-tac-toe, table 1 shows all of the 76 possible winning combinations. The

Table 1: The 76 possible ways to win in 4 by 4 by 4 three-dimensional tic-tactoe. The columns labelled M1, M2, M3 and M4 given an integer identification of a particular cube in the three-dimensional 4 by 4 by 4 matrix.

	_	_			_					-
COMB	H1	M2	нз	M4		COMB	H1	M2	нз	M4
====	===:	===	===	=====	22		===:	===	====	===
		_	_			_	_		_	_
1	9	10	11	4		2	13	14	7 15	16
5	1	5	9	12 13		6	2	6	10	14
7		_	-				4	8	12	_
9	3	7	11	15 16		10	4	7	10	16
11	17	18	19	20		12	21	22	23	24
13	25	26	27					30	31	32
15		_	-	28		14	29			
	17	21	25	29		16	18	22	26	30
17	19	23	27	31		18	20	24	28	32
19	17	22	27	32		20	20	23	26	29
21	33	34	35	36		22	37	38	39	40
23	41	42	43	44		24	45	46	47	48
25	33	37	41	45		26	34	38	42	46
27	35	39	43	47		28	36	40	44	48
29	33	38	43	48		30	36	39	42	45
31	49	50	51	52		32	53	54	55	56
33 35	57 49	58 53	59 57	60		34	61	62	63	64
				61		36	50	54	58	62
37	51	55	59	63		38	52	56	60	64
39	49	54 17	59 33	64		40	52	55 18	58 34	61 50
41		19	35	49			2	20		
45	3	21	37	51		44	4	22	36	52
47	5	23	39	53 55		46 48	6	24	40	54
							8			
49	9	25	41	57		50	10	26	42	58
51	11	27	43	59		52	12	28	44	60
53	13	29	45	61		54	14	30	46	62
55	15	31	47	63		56	16	32	48	64
57	1	22	43	64		58	5	22	39	56
59	9	26	43	60		60	13	26	39	52
61	2	22	42	62		62	14	26	38	50
63	3	23	43	63		64	15	27	39	51
65	4	23	42	61		66	8	23	38	53
67	12	27	42	57		68	16	27	38	49
69	1	21	41	61		70	1	18	35	52
71	4	19	34	49		72	4	24	44	64
73	13	25	37	49		74	13	30	47	64
75	16	31	46	61		76	16	28	40	52

Listing 3: Sample printout of the beginning of Super TIC.

O TO 9 : O I PLAY BEST AND 9 WORST 7 O HERE IS MY BOARD

	=:		=		==			122				220					-		m			200		=		222	
01	=	02	=	03	=	04	17	=	18	:==	19	::::	20	33	****	34	****	35	222	36	49	$\equiv$	50		51	72	52
===	====	===	==:	====	===	===	72.7	===:	===	==:	===:	===:	= == ==	==:	=======================================	= == == :	E: 220 :	===:	w == =	- III	==:	==:	====	===	===	==:	===
	=		=		nine.			=		100		100			m		****		940-4 1900-1			2001 0001		200		(1-2K) 1000	
05	=	06	===	07	===	08	21	-	22	resis.	23	=	24	37	:=	38	=	39	=	40	53	222	54	100	55	200	56
====		===	==:		===	===	==:	==:	===	===		==:	===		===	===:	==:	===:	1: 000 0	===		==:		===	= == == :	T III 1	22 22 22 22 22 22
	=		=		=			200		128		225			===		200					=		matri matri		34 mm Tunin	
09	=	10	***	11	=	12	25	==	26	=	27	=	28	41	=	42	=	43	=	44	57	=	58	222	59	=	60
=====	122	===	==:	====	===	===	==:		===	===	===:	= == =	===	101 100 11	===	===	====	===:	==:	122	=======================================	321		=======================================			===
	=		=		=			-		1000		100			101		==		=					=		-	
13	=	14	=	15	=	16	29	=	30	=	31	=	32	45	=	46	=	47	=	48	61	****	62	-	63	***	64
ENT	EF	M S	OVE	ES I	RY	NUME	ER (	INA	Y	DUF	R'RE	Ξ >	<														
YOU	IR.	MO	VΕ	?	1																						
		Ty.			7																						

YOUR MOVE ? 1 I WENT 64			
XX == = =		= = =	- 12 x
XX = 02 = 03 = 04	17 = 18 = 19 = 20	33 = 34 = 35 = 36	49 = 50 = 51 = 52
	============		
= = =	= = =	Sens And And And	= = =
05 = 06 = 07 = 08	21 = 22 = 23 = 24	37 = 38 = 39 = 40	53 = 54 = 55 = 56
*************			
= = =	100 100		
00 40 44 40		= = =	III III III
09 = 10 = 11 = 12	25 = 26 = 27 = 28	41 = 42 = 43 = 44	57 = 58 = 59 = 60
09 = 10 = 11 = 12 =============================	25 = 26 = 27 = 28		
09 = 10 = 11 = 12			57 = 58 = 59 = 60
************		41 = 42 = 43 = 44	57 = 58 = 59 = 60

first player to occupy 4 squares (or, more properly, "cubes") in a straight line wins. Note that there are ten ways to win on each of the four boards (four horizontal, four vertical and two diagonal) and 36 ways to win by occupying one adjoining square on each of the separate boards.

For comparison of strategies, the tic-tactoe program, written by R K Louden ("TTT3D" in *Programming the IBM 1130* and 1800, Prentice-Hall, 1967), keeps totalling values for the 76 winning combinations after each move, tests for only three or four critical situations and always examines the 64 squares for vacant positions. The use of this technique would take a few minutes for each move using a microcomputer, and the program is considerably longer.

The key to writing a program efficient enough to operate on a microcomputer is to limit the number of operations performed. Instead of constantly totalling winning combinations after each move, a running total is maintained in Super TIC. The importance of winning combination totals is simple. A 0 is assigned to blank squares, a 1 to squares with Xs and a 5 to squares with Os. A winning combination totalling 0 represents a line that either player can still win with; a combination value less than 5 and greater than 0 is a combination in which only X can win; a combination total evenly divisible by 5 represents a possible O win; and all other values are blocked (no one can win) combinations. This same totalling method shows how many Xs or Os occupy the four squares of the winning combinations.

In order to make Super TIC execute quickly, only the 76 winning combinations are checked to determine the computer's

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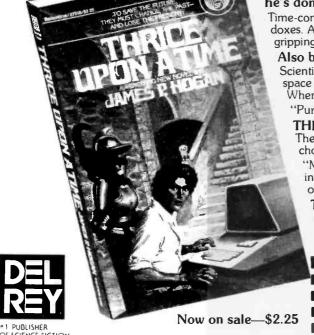
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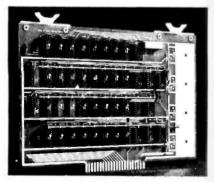
Combination	Variable	Value (Defensive Version)	Value (Aggressive Version)		
All Blanks		1	1		
One X	P(0)	22	7		
Two Xs	P(1)	147	22		
Three Xs	P(2)	1030	147		
One O	P(3)	2	2		
Two Os	P(4)	3	3		
All Others		0	0		

NOTE: The computer is O and the values described are used to determine the computer's move. A value for three Os is not needed, since the computer will select that as its winning move without additional evaluation.

Table 2: Values assigned to squares under consideration. Each time a combination of four squares is checked by the program, these values are assigned to blank squares depending upon the nearest neighbors forming the best partial pattern combination listed.

Table 3: Winning combinations for each square. The 64 squares of the board are listed under NUM, to the right of which are the winning combination numbers involved with each square (see table 1). After each combination is examined, the value shown in table 2 is assigned to any blank square in the combination. These values are accumulated as each combination is evaluated. The square with the highest value becomes the computer's next move.

	MUN		02		C4		<b>C</b> 6					02					-	
8.3	===:	EE:							2222		tees	====	==:		====		==	
	.1	1	5	9	41	57	69	70		2	1	6	42	61	0	0	0	
	3	1	7	43	63	0	0	0		4	1	8	10	44	65	71	72	
	5	2	5	45	58	0	0	0		6	2	6	9	46	0	0	0	
	7	2	7	10	47	0	0	0		8	2	8	48	66	0	0	0	
	9	3	5	49	59	0	0	0		10	3	6	10	50	0	0	0	
	11	3	7	9	51	0	0	0		12	3	8	52	67	0	0	0	
	13	4	5	10	53	60	73	74		14	4	6	54	62	0	0	0	
	15	4	7	55	64	0	0	0		16	4	8	9	56	68	75	76	
	17	11	15	19	41	0	0	0		18	11	16	42	70	0	0	0	
	19	11	17	43	71	0	0	0		20	11	18	20	44	0	0	0	
	21	12	15	45	69	0	0	0		22	12	16	19	46	57	58	61	
	23	12	17	20	47	63	65	66		24	12	18	48	72	0	0	0	
	25	13	15	49	73	0	()	0		26	13	16	20	50	59	60	62	
	27	13	17	19	51	64	67	68		28	13	18	52	76	0	0	0	
	29	14	15	20	53	0	0	0		30	14	16	54	74	0	0	0	
	31	14	17	55	75	0	0	0		32	14	18	19	56	0	0	0	
	33	21	25	29	41	0	0	0		34	21	26	42	71	0	0	0	
	35	21	27	43	70	0	0	0		36	21	28	30	44	0	0	0	
	37	22	25	45	73	0	0	0		38	22	26	29	46	62	66	68	
	39	22	27	30	47	58	60	64		40	22	28	48	76	0	0	0	
	41	23	25	49	69	0	0	0		42	23	26	30	50	61	65	67	
	43	23	27	29	51	57	59	63		44	23	28	52	72	0	0	0	
	45	24	25	30	53	0	0	0		46	24	26	54	75	0	0	0	
	47	24	27	55	74	0	0	0		48	24	28	29	56	0	0	0	
	49	31	35	39	41	68	71	73		50	31	36	42	62	0	0	0	
	51	31	37	43	64	0	0	0		52	31	38	40	44	60	70	76	
	53	32	35	45	66	0	0	0		54	32	36	39	46	0	0	0	
	55	32	37	40	47	0	0	0		56	32	38	48	58	0	0	0	
	57	33	35	49	67	0	0	0		58	33	36	40	50	0	0	0	
	59	33	37	39	51	0	0	0		60	33	38	52	59	0	0	0	
	61	34	35	40	53	65	69	75		62	34	36	54	61	0	0	0	
	63	34	37	55	63	0	0	0		64	34	38	39	56	57	72	74	



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move. Furthermore, once the combination is considered blocked (at least one X and at least one O in the four boxes making up the possible winning combination) a negative value is assigned and the combination is never checked again.

This leaves us with the problem of selecting a move. Each time a combination is checked, a value is assigned to the group of four squares making up the combination. These values are shown in table 2 for two possible versions of Super TIC, and are contained on line 20 of the program.

The next difficulty is determining which winning combinations are associated with each square. These values are calculated ahead of time using a short program and are read into the program as data. Table 3 shows the 64 game squares and which of the winning combinations use which particular squares (the winning combination numbers refer back to the combinations detailed in table 1). After each combination is examined, the value shown in table 2 is assigned to any blank square in the combination. These values are accumulated as each combination is evaluated. The square with the highest value becomes the computer's move.

In order to test the program as well as the different strategies, the program shown in listing 4 can be used to pit the computer against itself. The defensive game always plays itself to a draw. Note that line 35 in listing 4 adds a new variable Y(4) that gives a different strategy to be used for the player moving first when the computer plays against itself. To my surprise, the defensive version can be beaten.

As mentioned earlier, the game plays at ten different levels. Level 0 checks all 76 combinations, while level 9 checks only 40 combinations. Table 4 shows which levels check how many combinations and which specific combinations.

Listing 4: Program to enable the computer to play against itself in the game of Super TIC.

```
10 DIMC$(256)+S(64)+W(3+76)+I(76)+N(6+64)+P(4)+V(64)
15 DIMM(1,36)
20 C1$=*0123456789*\P(0)=22\P(1)=147\P(2)=1030\F(3)=2\P(4)=3
30 OFEN#0, "A16"\LTNE130
35 DIMY(4)\Y(0)= 2\Y(1)=147\Y(2)=1030\Y(3)=2\Y(4)=3
40 FORA=1TD76\READ#0,W(0,A),W(1,A),W(2,A),W(3,A)\NEXT\FORA=1TO64
50 REATHO, N(0,A), N(1,A), N(2,A), N(3,A), N(4,A), N(5,A), N(6,A) \NEXT
60 CLOSE#0\Z=1
90 N(0,30)=14
100 FORA=1TO64\R=A*4\C$(B-3,B)=*
                                     *\C=INT(A/10)\D=A~(C*10)
110 C$(B-1,B-1)=C1$(C+1,C+1)\C$(B,B)=C1$(D+1,D+1)\NEXT
114 FOR [9:=1T064\X=[9\C9=1
    1 " NI GAME STARTED WITH" , T9
115
141 GOT0150
145 6010660
150 S(X)=1\A=X*4\C$(A-3,A)=°XXXX°\P=1\GOSUR900
155 M(0,C9)=X
160 Q=0\FORA=1T076STEPZ\C=T(A)\IFC<0THEN200\IFC=15THENEXIT400
170 IFC<>OTHEN180\B=1\GOSUB500\GOTO200
180 IFC>4THEN190\B⇒P(C-1)\GOSUB500\GOTO200
190 C=INT(C/5)+2\B=P(C)\GOSUB500
200 NEXT\FORA=1T064\IFV(A)<QTHEN210\Q=V(A)\X=A
210 V(A)=0\NEXT\IFQ=0THEN1900
220 S(X)=1\A=X*4\C$(A-3,A)="0000"\P=5\G0SUB900
230 M(1,C9)=X\C9=C9+1\G0T0145
400 ! THE COMPUTER WINS WITH BOXES , W(O,A), W(1,A), W(2,A), W(3,A) \GDTD2000
500 FORF=OTO3\G=W(F,A)\IFS(G)=OTHENV(G)=V(G)+B\NEXT\RETURN
660 Q=O\FORA=1T076STEPZ\C=T(A)\IFC<OTHEN700\IFC=3THENEXIT400
670 IFC<>OTHEN680\B=1\GOSUB500\GOTO700
680 IFC<5THEN690\B=INT(C/5)\B=Y(B-1)\GOSUB500\GOTO700
690 B=Y(C+2)\GDSUB500
700 NEXT\FORA=1TO64\IFU(A)<@THEN710\Q=U(A)\X=A
710 V(A)=0\NEXT\IFQ=0THEN1900
720 GUTU150
900 FORA=OTO6\C=N(A,X)\IFC=OTHEN950\IFT(C)<OTHEN950
910 T(C)=T(C)+F\1FT(C)<4THEN950\1FT(C)=4THENEXIT1700
920 D=INT(T(C)/5)\IFD*5<>T(C)THENT(C)=-1
950 NEXT\RETURN
1000 RETURN
1700 !**\F=C\GDSUB1000\!**\C=F\!*YOU WDN*,W(0,C),W(1,C),W(2,C),W(3,C)
1700 ! " \F=C\GDSUB1000\
1900 | " \! "IT'S A DRAW"
2000 Z$= " "
2005 IFZs=""THENEND\FORA=1T076\T(A)=0\NEXT\FORA=1T064\S(A)=0\V(A)=0\NEXT
2020 '*PLAYER 1*\FDRA=1T036\IFM(0,A)=OTHENEXIT2030\!X3I,M(0,A),\NEXT
2030 !**\!*PLAYER 2*\FDRA=1T036\IFM(1,A)=0THENEXIT2035\!X3I,M(1,A),\NEXT
2035 ! " \FORA=1T036\M(1,A)=0\M(0,A)=0\NEXT
2040 NEXTT9\END
READY
RUN
GAME STARTED WITH 1
THE COMPUTER WINS WITH BOXES 1 2 3 4
PLAYER 1
  1 61 52 49 25 47 60 16 4 42 38 22 19 36 26 2
PLAYER 2
```

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Dave DeLauter

PS\_See you the next time you're in the Midwest\_Say hi to Jamet & James Paul.

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Listing 5: Sample printout of two-dimensional version of Super TIC (see listing 2).

```
O TO 9 : O I PLAY BEST AND 9 WORST ? 5
HERE IS MY BOARD
01 = 02 = 03 = 04
= 06 = 07 = 08
      200
09 = 10 = 11 = 12
______
13 = 14 = 15 = 16
ENTER MOVES BY NUMBER AND YOUR'RE X
YOUR MOVE ? 9
I WENT 5
01 = 02 = 03 = 04
00 = 06 = 07 = 08
-------------
XX =
XX = 10 = 11 = 12
13 = 14 = 15 = 16
```

```
COMB 0 1 2 3 4 5 6 7 8 9
                                COMB 0 1 2 3 4 5 6 7 8 9
         x x x x x x x x x
                                                      XXX
                                                           XXXXX
                                             x x
               X X
   7 X X X 9 X X X
                                        X X X X X
                                                         X
            Х
                 Х
                   X.
                      X
                                    8
                                                  X
               X
                                   10
     X
            Х
                                             X
                                                      X
                                  Х
                        X
                                                      X
                 Х
                   X
  15 X X X
17 X X X
19 X X X
            X
X
X
              X
X X
                                                    х
                                                           X
                                                      X
                   Х
                        X
              X X
                      Х
                        X
                                                    X
                   х
  21 X
                                     X
                                                      XXX
                 X
                      X
                                   24
                                             Х
  25 X
27 X
            X
                                   26
                                                    X
                                                  X
                                   28
                                             X
                                                    Х
                                               X
                                   30
                                                X X
                   X
                      X X
X X
  31 X
        Х
               Х
                 X
                                   32
            x x
  33 X
35 X
          X
                                   34
        Х
                 X
                                   36
                                      X X
X X
X X
X X
  37 X
39 X
                                           X X
                                                         X
X X
X X
                                   38
                                               X
                        Х
                                                       X
  40
                                             Х
                                                    X
                   X
                      X
                                   42
                                           X
                                                X
                                                    X
                    X X
                                   46
                                           X
                                             X
                                                  Х
                                                      XXX
                                      X
                   X
                                   48
                                                 X
                                                    X
                    Х
                        X
                                   50
           X
X
X
                 X
                      X X
X X
                                             x x
                    X
X
                                   55 X X X 57 X X X
                                                         XXX
  59 X
61 X
            XXX
        X
          X
                   X
X
X
               X X
  63 X X
65 X X
            X
                      X
X X
                                   64
66
                                      X X
                                             X
                          X
                                           Х
                                                X
                                                  Х
               X X
  × × × × × × × × × × × × ×
                                   68 X X X
70 X X X
72 X X
74 X X X
76 X
                                             X X X
                          X
                                                    X
                                                       X
                          XXX
                                             x x
                                                  XXXX
                      ×
FOR LEVEL 0
               :1.000% OR 76/76 OF THE COMBINATIONS ARE CHECKED
FOR LEVEL
             1
                  .908% OR 69/76 OF
                                       THE
                                            COMBINATIONS ARE
                                                                CHECKED
             2
                             63/76 OF
FOR LEVEL
                   .829% OR
                                       THE
                                            COMBINATIONS
                                                           ARE
                                                                CHECKED
                             58/76 OF
54/76 OF
FOR LEVEL
                   .763% OR
                                        THE
                                            COMBINATIONS
                                                           ARE
                                                                CHECKED
FOR LEVEL
                         OR:
                                            COMBINATIONS
                   .711%
                                        THE
                                                           ARE
                                                                CHECKED
FOR LEVEL
                   .671%
                         OR:
                             51/76
                                    OF
                                       THE
                                            COMPINATIONS
                                                           ARE
                                                                CHECKED
                   .618% OR 47/76 OF .592% OR 45/76 OF
FOR LEVEL
             6
                                       THE COMPINATIONS
                                                           ARE
                                                                CHECKED
FOR LEVEL
                                       THE COMBINATIONS
                                                           ARE.
                                                                CHECKED
                   .553%
                             42/76
FOR LEVEL
             8
                         0R
                                    OF
                                            COMBINATIONS
                                                           ARE
                                       THE
FOR LEVEL
                   .526% OR
                             40/76 OF THE COMBINATIONS
                                                           ARE CHECKED
```

Table 4: Winning combinations checked by each level of expertise in Super TIC. Level 0 is the most proficient level, level 9 the least. An X in the column for a given combination indicates that the given combination is to be checked.

Listing 6: Modifications to listing 1 to avoid the need for a disk data file.

```
30 LINEBO
40 FORA=1T076\READW(0,A),W(1,A),W(2,A),W(3,A)\FORB=0T03\C=W(B,A)
50 FORD=OTO6\IFN(D+C)=OTHENEXIT52\NEXT
52 N(D+C)=A\NEXT\NEXT
3000 DATA 1, 2, 3, 4, 5, 6, 7, 8, 9,10,11,12,13,14,15,16, 1, 5, 9,13
3010 DATA 2, 6,10,14, 3, 7,11,15, 4, 8,12,16, 1, 6,11,16, 4, 7,10,13
3020 DATA17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,17,21,25,29
3030 DATA18:22:26:30:19:23:27:31:20:24:28:32:17:22:27:32:20:23:26:29
3040 DATA33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,33,37,41,45
3050 DATA34,38,42,46,35,39,43,47,36,40,44,48,33,38,43,48,36,39,42,45
3060 DATA49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,49,53,57,61
3070 DATA50,54,58,62,51,55,59,63,52,56,60,64,49,54,59,64,52,55,58,61
3080 DATA 1,17,33,49, 2,18,34,50, 3,19,35,51, 4,20,36,52, 5,21,37,53
3090 DATA 6,22,38,54, 7,23,39,55, 8,24,40,56, 9,25,41,57,10,26,42,58
3100 DATA11,27,43,59,12,28,44,60,13,29,45,61,14,30,46,62,15,31,47,63
3110 DATA16,32,48,64, 1,22,43,64, 5,22,39,56, 9,26,43,60,13,26,39,52
3120 DATA 2,22,42,62,14,26,38,50, 3,23,43,63,15,27,39,51, 4,23,42,61
3130 DATA 8:23:38:53:12:27:42:57:16:27:38:49: 1:21:41:61: 1:18:35:52
3140 DATA 4,19,34,49, 4,24,44,64,13,25,37,49,13,30,47,64,16,31,46,61
3150 DATA16,28,40,52
READY
```

A sample run of the 4 by 4 version is given in listing 5. Here level 5 was used and, according to table 4, combination 3 is not checked. Therefore, combination 3 was an easy winner.

The data read into Super TIC was taken from a disk file using conventions of North Star BASIC. In order to modify this, merely take out the open file statement (line 30) and add data statements. The file designation in the line 40 and line 50 read statements should also be removed. Listing 6 shows how this can be accomplished.

Super TIC, as presented, is almost unbeatable (I believe that it is impossible to write an unbeatable version as long as the player always goes first and the computer second). You could probably play for days and never do better than a draw. However, armed with the computer generated winning combination in listing 4, you can beat the computer easily by remembering 16 exact moves.

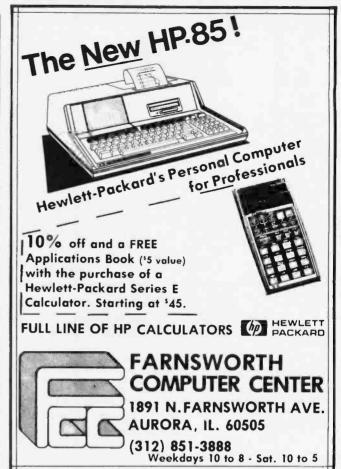
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The system has been designed to be upwardly compatible with the now unavailable Proc Tech Music System, so users of that system may run their programs with the new interpreter. The new interpreter has been dubbed Music Language #1 or ML/1 for short. The programs written for the old Music System will be greatly improved with the new system as the tones produced are much finer and more controllable.

ONLY \$79.95

The software includes a line oriented text editor, a high level music language compiler, a file management system and the advanced music syntheizer.

Ordering information: The price of the system on diskette or cassette with complete documentation and with the hardware kit and ten songs is \$79.95 (cables not included). Those interested in obtaining a system should order from California Software, Box 275, El Cerrito, CA 94530. Dealer inquiries are invited. Specify CP/M, Northstar or Cuter.

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## Programming Ovickies

## The Towers of Hanoi Solution Using BASIC Recursion

Stanley Switzer, 1019 W 27th St, Lawrence KS 66044

The Towers of Hanoi is an intriguing puzzle of the Orient. The puzzle requires three vertical rods and a given number of disks with holes in the center to be placed on the rods. Initially, all of the disks are placed on the leftmost rod, arranged by size with the largest disk on the bottom (see figure 1). The objective is to move all of the disks to the rightmost rod. There are, however, a few restrictions. Only one disk may be moved at a time, and no disk may be placed over a disk smaller than itself. The solution to this puzzle may seem difficult at first, but with the help of a recursive program, it is simple.

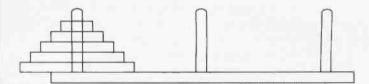


Figure 1: Initial configuration for the Towers of Hanoi problem. The objective is to move all the disks one at a time from the left rod to the right rod without ever placing a larger disk on top of a smaller disk. Intermediate moves can be made to the center rod, of course.

A recursive program is one that is defined in terms of itself. It is utilized when a problem can be broken into several parts, and when one of those parts is a similar problem of lesser magnitude. A common example is a definition of factorials:

$$0! = 1$$
  
 $n! = n(n-1)!$ 

Here is a recursive program for factorials written in pseudocode:

In this case an iterative definition is more practical for computational purposes, but this does illustrate the concept of recursion.

When broken into its basic parts, the solution to the Towers of Hanoi problem is as follows:

• When one disk is to be moved, the solution is ob-

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vious — move the disk from the source to the destination rod.

• When n+1 disks are to be moved:

REM Declare the stack arrays.

010

- 1) Move n disks from the source rod to the intermediate rod;
  - 2) Move one disk from the source rod to the destination rod; and
  - Move n disks from the intermediate rod to the destination rod.

**Listing 1:** Recursive solution to the Towers of Hanoi problem in BASIC.

```
020
       DIM S$(15), D$(15), I$(15)
030
          PRINT
          PRINT "Number of disks";
040
050
          INPUT P
          REM If P is too large or too small, STOP.
060
          IF (P>15) THEN 170
070
          IF (P<1) THEN 170
080
          REM Move P disks from Left to Right.
LET S$(P) = "L"
LET D$(P) = "R"
090
100
110
          LET I$(P) = "C"
120
130
          REM Move those disks!
          GOSUB 180
140
150
          REM Since that was so much fun let us do it again.
160
       GOTO 30
170
       STOP
          REM This is the recursive HANOI procedure.
180
190
          REM If P = 1, move one disk from source to destination.
          IF (P> 1) THEN 230
PRINT "Move a disk from ";S$(P);" to ";D$(P);"."
200
210
220
230
              REM Else, move P-1 disks from Source to Intermediate.
240
250
                  LET S$(P) = S$(P + 1)
260
                  LET D\$(P) = I\$(P + 1)
                 LET I$(P) = D$(P + 1)
GOSUB 180
270
280
              REM Move one disk from Source to Destination. PRINT "Move a disk from ";S$(P + 1);" to ";D$(P + 1);"."
290
300
              REM Move P-1 disks from Intermediate to Destination.
310
                 LET S$(P) = I$(P + 1)
LET D$(P) = D$(P + 1)
320
330
340
                 LET I$(P) = S$(P + 1)
              GOSUB 180
LET P = P + 1
350
360
370
          RETURN
380
      END
Number of disks?4
Move a disk from L to C
Move a disk from L to R.
Move a disk from C to R.
Move a disk from L to C.
Move a disk from R to L
Move a disk from R to C
Move a disk from L to C.
Move a disk from L to R.
Move a disk from C to R. Move a disk from C to L.
Move a disk from R to L
Move a disk from C to R.
Move a disk from L to C.
Move a disk from L to R.
Move a disk from C to R.
Number of disks?2
Move a disk from L to C.
Move a disk from L to R.
Move a disk from C to R.
Number of disks?1
Move a disk from L to R.
Number of disks?0
```

The fact that this algorithm is correct can be proven via the principle of mathematical induction. Since a solution is defined in the case of having to move one disk and since, given a solution for n disks, a solution can be found for n+1 disks. That is, given a solution for one disk, we have a solution for two disks; given a solution for two disks, we have a solution for three disks, and so on. The proof that this algorithm produces the fewest possible moves is left to the reader.

Now that our algorithm is defined, we can implement the program. In many BASICs, recursion is allowed in function calls. In my BASIC, however, it is not. It turns out that recursion is supported in all BASICs for subroutine calls. The only limiting factor is the depth of subroutine nesting allowed. In my case, this limit was fifteen levels. The only major problem was the method of parameter passing. Each invocation of the HANOI program has different source, intermediate, and destination rods. In order to keep these straight, the names of these rods [L (left), R (right), C (center)] must be kept on separate stacks [S\$ (source), D\$ (destination), I\$ (intermediate)]. The variable P tells the program the number of disks to move, as well as the offset into the arrays to find the current names of the rods.

Recursion, when applied effectively, is one of the most powerful tools a programmer has. Many computer languages support recursion more fully than BASIC. Among these are Pascal, LISP, and APL. These languages allow recursive functions and local variables (local variables have separate storage locations for each invocation of the function). I hope that this Programming Quickie will prompt you to try some recursive programs. If you have access to any of the above languages, I suggest that you use them. If not, BASIC will still work.

## The Correct Order of Operations Can Shorten Code

Pointer Decrementing on the 6502

Philip K Hooper, 5 Elm St, Northfield VT 05663

Several instances of 6502 code I have come across decrement a 16-bit pointer as follows:

DEC POINTL

LDA POINTI CMP \$FF BNE 02 decrement low byte of the pointer.
move result to accumulator.
test for page crossing.
if not FF, no page crossing
—decrementing complete.

ready

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DEC POINTH

DEC POINTH

otherwise, decrement high byte of pointer to cross page.

The following code produces the same result, but requires two fewer bytes of code and executes 2 µs faster:

LDA POINTL bring low byte of pointer into ac-

cumulator.

**BNE 02** if not zero, no page crossing, so

branch ahead, skipping high byte. otherwise, decrement high byte of

pointer.

DEC POINTL and decrement low byte of

pointer.

Although this might seem a minor improvement, it amounts to 20% (for a pointer on page 0), and sometimes several similar small savings substantially shrink software storage space stress.

#### Sets

#### **Tutoring in BASIC**

Linda M Schreiber, 29143 Carlton, Inkster MI 48141

Listing 1: Altair Extended BASIC listing for helping children learn about sets.

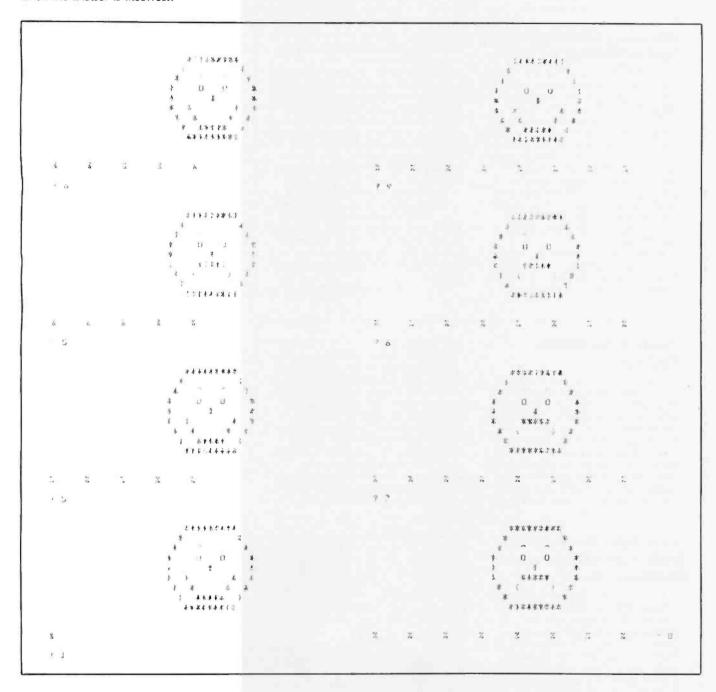
```
180 PRINT L9
190 NEXT P
195 IF W=3 THEN PRINT = "N:GOTO 120
200 PRINT:PRINT:IMPUT G$ 'ENTER NUMBER OF CHARACTERS
210 IF VAL(G$)<>n THEN F$= "FROWN" 'CHECK ANSWER
 215 FRINT: PRINT
220 PRINTTAB(23) *********
 230 PRINTTAB(22) **
240 PRINTTAB(21) **
250 PRINTTAB(20) **
 370 GOTO 160
380 PRINT:PRINT:PRINT:PRINT'BYE'
390 END
```

The program Sets (shown in listing 1) reinforces the recognition of numbers and their set values for a preschool child. Except for a message at the beginning of the program, no reading is required. All interaction be-

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Listing 2: Sample run of program Sets. The computer outputs a smiling face when the child's answer is correct and a frowning face when the answer is incorrect.



tween the computer and the child is accomplished by the use of graphics.

The terminal prints out a set of 1 to 9 characters for the child to count (see listing 2 for sample run). The child enters the number from the keyboard. If the number entered is incorrect, a frown will appear on the terminal. When the correct number is entered, the terminal will show a smile. The child is allowed three attempts to answer each set correctly. The answer will be printed after the third attempt.

In line 200, a string variable is used for input, so that a

child who mistakenly enters a letter or symbol will not become frustrated with error messages. All incorrect inputs are treated in the same manner.

The T variable in line 140 counts the number of sets the child will be shown. In this version the program will end after 5 sets. The variable can be easily increased (lines 195 and 320) for a child with a longer attention span. Similarly, the 9 in line 130 can be changed to a greater value for the child who has mastered sets from 1 to 9.

Sets is written in Altair (Microsoft) Extended BASIC and uses just over 1 K bytes of memory.

## What's New?

#### SOFTWARE

## Z80-Based Disk Operating System Written in PL/M

A Z80-based operating system which allows up to four simultaneous users and hard disk-drive control has been released by Altos Computer Systems. AMEX (Altos Mutli-User Executive) is written in PL/M and is compatible with CP/M versions 1.4 and 2.0. AMEX can manage up to four user-memory areas of up to 48 K bytes each. It utilizes a priority ordered interrupt-driven dispatching algorithm. Priority is given to input/output (I/O) bound tasks, while microprocessor compute-bound tasks tend to migrate to the bottom of the priority line.

Access to on-line storage on floppy or hard disk is handled for multiple users by AMEX, using direct memory address (DMA) hardware. AMEX features a dispatcher and a spooler that allocate and free various peripheral devices as requested by user programs or commands. The system is designed to carry on multitasking operations within an individual user's 48 K memory block. AMEX includes a screen-oriented text editor, an 8080 assembler, built-in utilities, file management commands and a transient command handler which allows the user to define new disk-oriented commands separate from those implemented by CP/M.

AMEX requires an Altos ACS8000 series computer and 64 K bytes for one user, 112 K bytes for two users, and 208 K bytes for four users. It is priced at \$250 and comes on a single floppy disk. Contact Altos Computer Systems, 2338-A Walsh Ave, Santa Clara CA 95050

Circle 400 on inquiry card.

## Apple II Animation Package

The A2-3D1 is a package of easy to use assembly language programs for three-dimensional and two-dimensional animation on the Apple II. The program allows users to view two- or three-dimensional scenes created in the standard XYZ coordinate system, zoom between wide angle and telephoto fields of view, select a location in space, and a direction of view. One feature allows users to generate an output array of line

start and end points instead of plotting on the Apple screen. Other features include zero page restore which leaves all zero page variables intact after subroutine exit, page control for selective page erase, display, and draw for ping-ponging between screens for smooth animation. The load and go manual guides beginners through an orientation session with the A2-3D1 program. The technical manual is for advanced applications and describes the transformer algorithm in detail. The program requires 16 K bytes of pro-

#### Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgement the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first in first out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company perfor-

grammable memory for the three-dimensional and two-dimensional transformer, small scenes, and small control programs. Larger scenes, control programs and the DEVELOP program require 24 K bytes of programmable memory. The program costs \$45 on cassette and \$55 on floppy disk. For more information, contact Sublogic, POB 5, Savoy IL 61874.

Circle 401 on inquiry card.

#### Intel Adds Pascal-80 to 8080/8085 Microprocessor Software Development

Intel Corp has developed Pascal-80 to support 8080 and 8085 microprocessor software development on Intellec microcomputer development systems. Similar to its PL/M, BASIC, and FORTRAN programs, the Pascal-80 package is available on floppy disk and runs under the ISIS-II operating systems on Intellec Series II and MDS-800 models. This Pascal-80 offers extensions that make the language suitable for commercial and industrial applications. The extensions include three new data types-the string type, untyped files, and interactive files-plus twenty-eight predeclared procedures and functions. Pascal-80 provides a Trace facility allowing a user to monitor program execution, and a set of compile and runtime error diagnostics. Users create Pascal source programs using the Pascal-80 software and standard Intel microcomputers. The Pascal-80 software



package includes a floppy disk containing a compiler, a pseudocode interpreter and demonstration programs, a Pascal-80 user's manual and the Pascal User Manual and Report, second edi-

tion, by Jensen and Wirth. The software package is priced at \$975 and is available from Intel Corp, 3065 Bowers Ave, Santa Clara CA 95051.

Circle 402 on inquiry card.

## What's New?

#### SOFTWARE

#### Bell and Howell Introduces Software for Education

These software packages from Bell and Howell allow instructors to create courseware for students. No prior programming knowledge is needed by either instructor or students. Some of the features of the Generalized Instructional Systems (GENIS) include the authoring system which allows teachers to create curriculum material, obtain grade reports, control class enrollment, and more. A system that allows student interaction with the computer is included. The programs understand misspelled words: present lessons in words, animation, graphics, and color; grade student performance; generate drills, practice, and simulation programs; and other administrative projects. The GENIS program is price at \$300. Write to Bell and Howell Audio-Visual Products Division, 7100 N McCormick Rd, Chicago IL 60645.

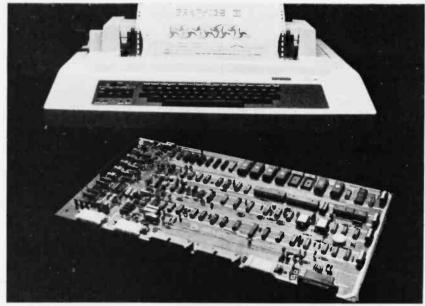
Circle 403 on inquiry card.

#### Information Storage and Retrieval (ISAR) for TRS-DOS

ISAR is a data base management system designed for users of TRS-DOS random file structures. The system utilizes the limited TRS-80 chaining techniques that keep as much of the program in memory as necessary to perform any given function.

The basic ISAR system consists of six modules which allow users to create new files, define all elements within each file, and manipulate each file. Each file or portion of a file can be sorted using BASIC Shell-Metzer sort. The package includes source listing, documentation, potential recovery techniques in the event of a system failure and suggested personal applications. ISAR comes on cassette for \$13.95 or diskette for \$16.95. For further information, contact The Alternate Source, 1806 Ada St, Lansing MI 48910.

Circle 405 on inquiry card.



#### DECwriter Graphics Available for Timeshare Computers

Graphics II is a modification to the DECwriter II printer for conversion to a plotter. Graphics II features APL character set, forms control, horizontal and vertical tabs, answerback, bidirectional line feed, four character sets

with four different styles—characters can be printed in four directions. The average speed is 40 characters per second (cps). One inch per second for plotting and communication up to 12 bits per second (bps) is possible. The price is \$850, and Graphics II is available from Selanar Corp, 2403 DeLaCruz Blyd. Santa Clara CA 95050.

Circle 404 on inquiry card.

## Space Shuttle Landing Simulator

This program is modeled after the NASA Shuttle Mission Simulator in Houston. It is a real flight simulator (except for roll motion) with a visual display of the sky and ground. High resolution graphics show the cockpit view using animation, projective geometry, and graphics to depict the runway, sky, ground, and distant mountains and clouds. The paddles control the pitch control and speed brakes. Speed, altitude, sink and climb rate, distance from the threshold, speed brake

setting, glide slope, and angle of attack are displayed. Warnings and messages are also displayed.

Functional features include angle of attack control, full stall capability, eject and eject warning, landing gear, speed brakes, and wheel brakes on rollout. Runway stripes on roll out give a visual indication of motion.

The program is available from Harvey's Space Ship Repair, POB 3478, University Park, Las Cruces NM 88003, for \$15 on cassette. A floppy disk version is also available.

Circle 406 on inquiry card.

#### Multitasking Disk Operating System for 8080, 8085, and Z80 Systems

EFAMOS is a disk-operating system for 8080, 8085, and Z80 systems that supports multitasking and multiusers with memory mapping. Up to 3 M bytes of memory can be available to users through 32 K byte memory banks. EFAMOS is compatible with all software

developed under MVT-BASIC. It provides full system support to each memory bank, including assembler BASIC run-time, system utilities, BASIC, utilities and word processing. BASIC support includes chaining with parameter passing and machine language calls with over ten ISAM functions. Word processing activities with several concurrent users can be completely supported in one memory bank, while program development and data processing functions are supported in other

memory banks. Batch monitors can reside in any bank of memory and can process job files submitted from any other bank. One design feature of EFAMOS precludes terminal lockup during any input/output operation, which prevents the loss of characters in a busy multiuser environment. For licensing and terms, contact MVT Microcomputer Systems Inc, 9241 Reseda Blvd, Suite 203, Northridge CA 91324.

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## What's New?

#### SOFTWARE

#### Pascal for the 8080 and 7.80 Processors

Built upon Whitesmiths' C compiler and libraries, the Pascal Development System provides a software environment for Pascal programming on PDP-11, LSI-11, 8080 and Z80 computers. The compilers and all support utilities run under IDRIS, UNIX, RT-11, RSX-11M, RSTS, or IAS on the PDP-11 and LSI-11, and under CP/M or CDOS on the 8080 and Z80, producing code that runs faster than Pascal interpreters. Included as part of the package are an A-Natural assembler, an 8080 linking loader, a librarian, and other utilities. Users also receive the Whitesmiths' Portable Pascal and C library and manual. Supporting these portable libraries are an operating system-specific interface library, a machine library, and 64-bit floating point arithmetic. The 8080/Z80 and PDP-11 Pascal Development Systems, are available from Lifeboat Associates, 2248 Broadway, NY NY 10024, for \$750 per single microprocessor license.

Circle 408 on inquiry card.

#### Graham-Dorian Introduces a Software Medical **Package**

This package was written and tested by medical professionals. It handles billing insurance forms, treatment records, charge and payment entry, patient statements, Medicare submittals, collection accounting and dunning, patient processing, patient listing, aged accounts receivables, transaction reporting, and more

The package can be ordered on eightinch floppy disks and includes a manual and hard copy source listing. The price for the program is \$1000 and is available from Graham-Dorian Software Systems Inc, 211 N Broadway, Wichita KS 67202

Circle 409 on inquiry card.

#### Machine Language Disk File Sorting Program for Apple II



Datacope, POB 55053, Hillcrest Sta. Little Rock AR 72205, has released an enhanced version of their sorting program that is compatible with either the Apple II or the Apple II Plus computer systems. The new version of the

#### CP/M Compatible Operating System for TRS-80 Level II Computers

A fully CP/M compatible operating system for the TRS-80 II computer has been developed. The operating system works with CBASIC and all other CP/M programs, requiring no changes to the operating codes. The system sells for \$249.95 from MPU, POB 808, San Carlos CA 94070.

Circle 411 on inquiry card.

#### More Programs for Apple II Systems

Apple Barrel Bushel #1 is a collection of twenty-five programs including Mortgage Loan, Days Between Dates, Calendar, Savings, Checkbook, Addition, Subtraction, Metric Conversion, Luna C, Apple LeMans, Alien, and more. The package is available on cassette tape for \$24.95 or on floppy disk for \$29.95. Contact CDS Corp, 550 N Main St, Logan UT 84321.

Circle 412 on inquiry card.

#### Language Translator Program

This program translates from English to any foreign language, from any language back to English, or from one foreign language to another. Simple commands bring in the correct vocabulary or words. The program checks the entire sentence for the proper verb conjugation and word contractions. New words may be added at any time and saved as part of the vocabulary. One mode lets the translator receive

data in one language from a reader, and then sends the translation to a printer. Display formatting commands show vocabulary words alphabetically or in categories. Spelling errors are caught and corrected.

The Language Translator from Practical Programming Corp, POB 3069, N Brunswick NJ 08902, is available on CP/M or North Star floppy disk with one extended language for \$30. Additional languages are \$10 each.

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Datacope Single Disk Sort performs user-specified direct commands upon completion of the sorts, for easy use in turn-key systems. The program employs one disk drive, and sorts a single file of fixed-length records on a single floppy disk. A file may fill the entire disk because the program uses no workspace on the disk. Blocks of consecutive records may be sorted without disturbing the remainder of the file. Files may contain records with 5000 characters and may be sorted by ten key fields simultaneously, with each key field in either ascending or descending alphabetical or numerical order. The program features other necessary functions. The package includes a manual and a floppy disk with the sort programs, a test file, and test file access programs in Applesoft II for \$49.95.

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#### A Forth Software Development Tool

The XL5 is an interactive programming system with compiler, interpreter, assembler, disk operating system, and a library of procedures. It is written in XL5 and is based on the recommendations of the 1977 Forth Standards Committee. A host-executable code kernel, a source code kernel, and a system generation program (SYSGEN) are provided. SYSGEN regenerates the kernel from the source or generates read-only memory (ROM) modules. An XL5 development system requires less than 32 K bytes of memory. The \$100 package includes source code and a reference manual. XL5 is available with a CP/M boot loader for the 8080 and the Z80. For information, contact XL Computer Products, 321 E Kirkwood Ave, Bloomington IN 47401.

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#### 1979 Federal Tax Programs for Microcomputers

Aardvark Software Inc. POB 26505. Milwaukee WI 53213, is marketing a software program which will calculate an individual's federal tax liability. The program displays the tax information as it would appear on an IRS form. It also calculates the tax liability using the tax tables, tax rate schedules, income averaging, maximum tax on earned income, and alternative minimum tax choosing the most favorable method. A manual is included to organize the tax information for input. Three programs are available at \$22, \$35, and \$50.

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### **PUBLICATIONS**

#### Guidebook for the TRS-80 Level II Microcomputer

Learning Level II, written by Dr David A Lien, is a step-by-step guide to help users of the Level II TRS-80. It contains a section updating the Level I manual to Level II. Readers are guided through the fundamentals and special characteristics of Level II BASIC, beginning with setting up the system. The book explains how to properly use the Editor to change and correct BASIC programs. Another section is devoted to the conversion of Level I programs to Level II. The book also explains dual cassette operation, using the expansion interface box with the real-time clock, printers and other peripheral devices. It is available from Computer Books Division, Compusoft Inc. 8643 Navajo Rd, San Diego CA 92119, for \$15.95, plus \$1.45 for postage and handling. Circle 416 on inquiry card.

#### 1980 Computer Catalog

Sara Tech Electronics Inc, POB 692, Venice FL 33595, is offering their sixteen-page 1980 computer catalog featuring more than 1000 products. All major brands of computers and equipment are carried. Write for a free copy.

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### Catalog Features Articles on Classroom Computing

Creative Publications is publishing a color newsletter/catalog of computer materials for the classroom. The publication features an article on the television documentary "Don't Bother Me, I'm Learning," which discusses computers in education. All products in the catalog are described with the educational user in mind. The catalog is available from Creative Publications, POB 10328, Palo Alto CA 94303.

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### Documentation Standards for Computer Systems

Norman L Enger's Documentation Standards for Computer Systems, Second Edition, is a reference manual that shows how to document a computer application to utilize the full potential of the computer resources. The book includes revised and expanded material that describes the evolution of a system through the stages of initiation, analysis, design, development, implementation, and operation. The sec-

TRS-80 Software Source

This catalog contains over 5000 software listings that are available from 380 suppliers. The publication lists business, education, games, home, math, and utility software with a section of addresses of the suppliers. A one-year subscription is \$15 and a single issue is \$6. Contact Computermart, POB 1664, Lake Havasu AZ 86403.

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#### Computer Book Catalog Released by Sams

The Howard W Sams and Co Inc has released a catalog featuring a large selection of computer and computer related titles. It is organized for quick reference into five areas—basics, programming, computer technology, reference, and computer related. This free catalog details books that are directed to a wide range of people and interests, from the home hobbyist to the technically oriented professional.

For a catalog, contact the Advertising Director, Howard W Sams and Co Inc, 4300 W 62 St, POB 558, Indianapolis IN 46206.

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#### New Renaissance!

New Renaissance! is a bimonthly magazine for lighting and laser artists and technicians who desire to share their works, events, goals, and discoveries with others in the field. It features performance news and reviews; projects, plans and schematics; new techniques and products; interviews; books and other data sources, and more. A one-year subscription is \$25 and is available from New Renaissance!, 5267 11th Ave NE, Seattle WA 98105.

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tion on 'Techniques and Tools for Analysis" facilitates the analyst's work. This book aids in determining the amount of documentation needed for specific types of projects. Procedures can be established to employ documentation standards adopted by the organization. Dr Enger's book is useful to computer professionals, students and novices in the computer industry. It is available by mail for \$25 from The Technology Press Inc, POB 125N, Fairfax Station VA 22039

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#### Magazine on Robotics



Robotics Age magazine contains readable articles of high technical content that present the latest results of research in robotics and artificial intelligence. The contents include welldocumented electromechanical circuit designs, microcomputer interfaces, and programming techniques suitable for economical applications to small systems. Abstracts of research papers are also featured. New products items describe new commercially available kits and robotics related products. The quarterly publication is available at \$8.50 for one year from Robotics Age, POB 801, La Canada CA 91011.

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### Publication of Sorting Subroutines

Creative Computer Consultants Inc, POB 2111, 1 Quarry Ln, Norwalk CT 06851, has published volume 4 of Sortmaster in the Standard Software Library. Sortmaster contains listings of five BASIC subroutines designed to sort numeric data in memory. The subroutines have been designed to be integrated into the user's main line program. Numeric fields are sorted by designating that field as the sorting key. This makes it possible to sort records of any length and also permits multiple sorting keys. By adjustment of certain variables, all of the routines can handle alphanumeric data as well. Sortmaster includes an introduction to basic sorting concepts as an aid to beginners. The programs work with the TRS-80, PET, and Apple II. The book costs \$8.95.

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### **PERIPHERALS**

#### Eight-Inch Winchester Disk Up to 20 M Bytes



The Series 7000 hard disk drives have unformatted capacities of 4 megabytes in the single disk version, 12 megabytes in the double-density version and 20

megabytes in the three-disk unit. Data transfer rates are 5.5 million bits per second (bps). The Series 7000 employs the Winchester technique, using an ironless rotary actuator to position the heads in response to prerecorded servo-tracks on the lower side of the bottom disk.

Each 21cm diameter surface has a 350-track cylinder with an inner track recording density of 5280 bits per inch. The interface is designed for use with microprocessor-based controllers. The drives utilize eight-bit bidirectional bus transfers. Line transceivers enable daisychain connection of other disks to the bus.

The 4 megabyte drive, the 7000-4, is \$2100; the 7000-12 is \$2300; and the 7000-20 is \$2650. The units are manufactured by Kennedy Co, 1600 S Shamrock Ave, Monrovia CA 91001.

Circle 425 on inquiry card.

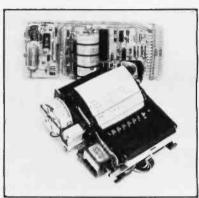
### Stockey Series of Keyboards

The Stockey Series offers ten generalpurpose standard keyboard designs, including six with American Standard Code for Information Interchange (ASCII) encoded alphanumeric formats. These are available in ASR33, ANSI teletypewriter, IBM 3278 ASCII typewriter, IBM 3278 data entry, and IBM Selectric I and II typewriter formats. An eleven- and fifteen-Key Expander pad can be added via a flexstrip jumper to any of the six alphanumeric designs to provide highspeed numeric entry.

The 53-key SK053 for the Model 33 teletypewriter features uppercase, but no lowercase, and costs \$139. The 67-key model includes uppercase and lowercase, a full ASCII set, and is priced at \$173. For additional information, contact Advanced Input Devices, POB 1818, Coeur d'Alene ID 83814.

Circle 426 on inquiry card.

## 12 VDC Alphanumeric Printer System

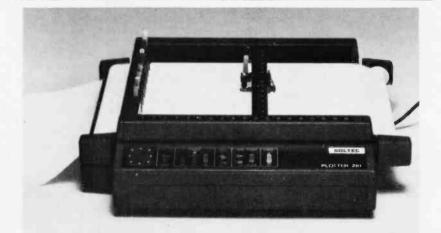


The PR6024 printer controller and any SODECO PR Series print mechanism comprise a print system operable from a 12 V power source. The controller accepts a 7-bit parallel ASCII format and features an integral voltage regulator and adjustable input thresholds for immunity from environmental noise. The unit features a 54-character alphanumeric set. Applications include mobile electronics, such as truckmounted fuel-dispensing systems, police cars, security systems, and battery sustained instrumentation and systems. The price for the 15-column tape printer and PR6024 controller is \$363 in unit quantity. For more information, contact the Sales Manager, Print Products, SODECO, Landis and Gyr Inc, 4 Westchester Plz, Elmsford NY 10523.

Circle 427 on inquiry card:

## Eight-Color Digital Plotter with Microprocessor Control

Soltec's Model 281 Digital Plotter provides graphic representation of measured values, design data and calculated data using up to eight different color pens. A Z80 microprocessor controls the system, the automatic pen changing, off-scale data handling, and coordinate transformation. The programmable pen changing feature incorporates up to eight pens using multicolor fiber-tip pens or Rapidograph drafting pens. Firmware features include circle interpolation, character plotting, generation of axes and grids, various line types, window plotting and more. Model 281 also features character plotting in five fonts. automatic or interactive point digitizing, programmable offsets and programmable limits. The graph paper is standard DIN-A3 format or smaller. Inter-



faces include a choice of serial RS-232C/V .24 and 20 mA current loop. The plotter costs \$4725 and is available

from Soltec Corp, 11684 Pendelton St, Sun Valley CA 91352.

Circle 428 on inquiry card.

### **PERIPHERALS**

#### Miniature Alphanumeric Thermal Printer



The APP-20A2 twenty-column, panelmount thermal printer uses only two input data wires for interfacing. It features serial 20 mA current loop and RS-232C ports. The printer can be used in data systems, factory data acquisition units, and industrial data loggers with a full alphanumeric printer. It can be used with a remote control unit or in medical systems, and as a portable test and measurement tool for laboratory or field use. The unit prints 1.2 lines per second. It measures 20 cm by 7 by 11.3 cm (8 by 2.76 by 4.44 inches) and weighs 1.9 kg (4.25 pounds). It is available from Datel Intersil, 11 Cabot Blvd, Mansfield MA 02048. The cost for the printer is \$880.

Circle 429 on inquiry card.

#### Robotype Converts Typewriter to Printer



The Robotype Model 2100 is capable of interfacing with a Centronics-compatible parallel interface, RS-232C

serial interface, and a 20 mA current loop. The RS-232C serial interface has 110, 134.5 or 150 switch-selectable data rates. The Robotype can be attached to the IBM Selectric, Remington Rand, Olympia and Facit typewriters. The Robotype is placed over the keys of the typewriter. Plungers rest on the keys and push the keys down on command from the computer input. The unit types the maximum speed of the typewriter in use. The unit is available for under \$1000 from Applied Computer Systems Inc, 77 E Wilson Bridge Rd, Worthington OH 43085.

Circle 430 on Inquiry card.

### Alphanumeric Thermal Printers

Priced at approximately \$440, the United Systems 6450 and 6460 alphanumeric thermal printers produce easy-to-read letters, numbers, and symbols on thermal paper with first-line-up printout. They print a set of 64 different characters with 21 characters per line and approximately 6500 lines per roll of paper. The Model 6450 provides a serial input with selectable RS-232C or 20 mA current loop format with data rates of 110 and 300 bits per second (bps). The Model 6460 is 8-bit parallel buscompatible with data rates up to 1000



characters per second (cps). Both models respond to ASCII input. For more information, contact United Systems Corp, 918 Woodley Rd, Dayton OH 45403.

Circle 431 on Inquiry card.

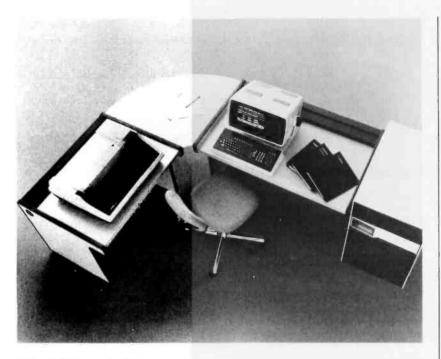
#### Corvus Disk System for Apple Pascal Microcomputer

The Corvus model 11AP disk system being delivered for Apple Pascal is entirely compatible with the Apple system. No modifications are needed for the Apple Pascal disk-operating system, or any applications designed to run on the Apple floppy disks. Corvus has incorporated a utility called "dynamic volume management" that allows the ten million byte data base to be used as a single large block or to be broken into smaller blocks. Applications of the Apple Pascal equipped with the Corvus 11AP system include: customer and prospect mailing lists, accounting data, payroll and personnel records, courses in computer programming and usage, science applications, medical office use, and more. The system is priced at \$5350. The controller can handle up to three additional disks, which are priced at \$3690. Contact Corvus Systems, 900 S Winchester Blvd, Suite 4, San Jose CA 95128.

Circle 432 on inquiry card.



#### **SYSTEMS**



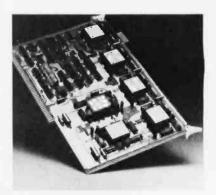
## The 9000 Computer System from Compal

The Compal Model 9000 is designed for business and office environments. The system includes a 16-bit microNova 602 processor, 64 K bytes of programmable memory, video display terminal with a detached keyboard that can support up to three additional keyboards, a 10 M byte hard disk with a 5 M byte removable cartridge, and a high-speed

matrix printer. Included with the system are BASIC and assembly languages, manuals, training, starter supplies, and delivery. Programs for inventory control, sales analysis, accounts payable and receivable, general ledger, payroll, and other business applications are available. The system sells for \$19,995 from Compal Inc, 6300 Variel Ave, Woodland Hills CA 91604.

Circle 433 on inquiry card.

#### TM990 Compatible Bubble Memory Module



A TM990-compatible board with up to 69 K bytes of non-volatile magnetic bubble memory storage has been announced by Texas Instruments Inc., POB 225012, M/S 308 (ATTN: TM990/210), Dallas TX 75265.

The TM990/210 board is supplied with two, four, or six 92 K bit TIB 0203 bubble memories for 23 K, 46 K, or 69 K bytes of storage, respectively. Data transfers from the module are via a memory-mapped mode. Access time is 4 ms, and data transfer rate is 45,000 bits per second (bps). The price for the TM990/210-1 two-bubble device is \$775; \$1150 for the TM990/210-2 four-bubble device; and \$1535 for the TM990/210-3 six-bubble device.

Circle 434 on Inquiry card.

#### Development Tool for 6500 Series Microprocessors

The MDT 1000 enables users to write programs and debug hardware and software. The MDT 1000 includes a 54-key keyboard and case; 12-inch video display; dual cassette interface; power supply; erasable-programmable readonly memory programmer; 4 K byte static programmable memory-board; sockets for extra boards; and a four-slot motherboard. Software support comes as 12 K bytes of read-only memory resident firmware; a 4 K byte monitor with debug features; and an 8 K byte assembler and editor, which operates on line-numbered text. A floating point BASIC and software for printer interfacing and other controls are available. The MDT 1000 is available for \$1495 from Synertek, 3001 Stender Way, Santa Clara CA 95051.

Circle 435 on Inquiry card.



### **MISCELLANEOUS**

#### TRS-80 Printer Controller

The Printer Timer works with the TRS-80 and the Centronics 779 line printer by automatically turning the printer on and off using signals relayed over the printer cable. The device does not require software or hardware modification other than the soldering of three wires and the mounting of the timer inside the printer cabinet. The timer reduces motor wear and excess noise. It is available for \$95 from National Software Marketing Inc, 4701 McKinley St, Hollywood FL 33021.

Circle 436 on inquiry card.

## Voice Terminal for the Exidy Sorcerer Talks and Listens

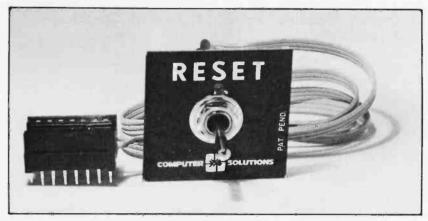
Cognivox plugs into the Sorcerer and offers a sixteen-word recognition vocabulary plus voice response with up to sixteen words or phrases. Recognition accuracies of up to 98% are possible. The unit includes a microphone and amplifier and speaker, making it a complete voice terminal. A software library is provided with Cognivox. It includes Voicetrap, a voice-operated video game, and Vothello, a voice input version of the game Othello. A talking calculator program allows using the Sorcerer as a four-function calculator, and a vocal memory dump program can read its memory out loud. Cognivox is priced at \$149 from Voicetek, POB 388, Goleta CA 93017.

Circle 437 on inquiry card.

### Anti-Glare Device for Video Screens

The product is a black woven nylon mesh stretched on a flexible plastic frame. It is designed to be sandwiched behind the video bezel and to conform against the surface of the tube. This device performs by blocking and absorbing ambient light with a honeycombing effect. The contrast is enhanced by the black matrix effect of the fabric background, while the display characters are transmitted undistorted through the pores in the material. The filters are available in 120 sizes, and each size can be equipped with different opticallygraded fabrics to vary the intensity of the video display. The filters improve the image, lower maintenance, and reduce eye strain and related stress. For more information, contact Sun-Flex Co Inc, 3020 Kerner Blvd, San Rafael CA 94901.

Circle 438 on inquiry card.



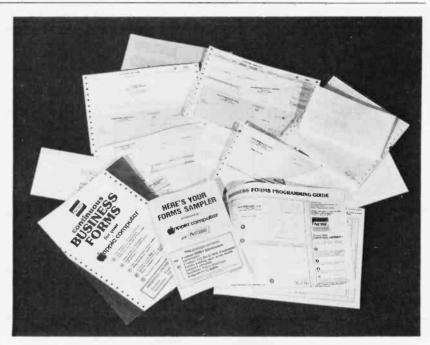
#### Reset Option for the Apple

Model B is a three-position switch giving the user the option of completely disabling or enabling the reset key on the keyboard. It is easily installed between the keyboard plug and the Apple's board. When the switch is in the down position, the keyboard is functional. With the switch in the middle

position, the reset key on the keyboard is disabled, and the user must flip the switch up to reset the computer. The switch automatically returns to the middle position when released from the up position.

It is available from Computer Solutions, 5135 Fredericksburg Rd, San Antonio TX, 78229, for \$29.95.

Circle 439 on inquiry card.



### Standardized Computer

New England Business Service (NEBS) is offering a line of continuous-form computer checks, statements, and invoices. The forms are available with the name of the firm, address and phone number in six quantities from 500 to 6000 forms. Prices start at \$14.95 for 500 statements; \$32.50 for 500 two-part

invoices and \$29.95 for 500 of either the payroll or all-purpose checks. At 6000-piece order levels, prices per thousand drop to \$12.50, \$33 and \$22.50 respectively. The firm also offers custom personal checks for home computer systems users. For ordering information and free samples write to the New England Business Service Inc, N Main St, Groton MA 01450.

Circle 440 on inquiry card.

### **MISCELLANEOUS**

## Simple Machines for Erasing and Winding Cassettes



Two battery-powered machines offer longer life for cassettes and reduced wear on standard cassette players. The Erase-Sure passes the cassette through a rotating magnetic field that erases the tape and leaves an extremely low residual noise level. The user slides the cassette through the unit once. This

#### Prototyping Kit for High-Resolution Graphics



The SVB-80P prototyping kit is a dual-board system with stand-alone capability in an Intel multibus configura-

single pass completely erases the tape. The Rapid Rewind stabilizes cassette tape tension, eliminates tape binding, helps control wow and flutter, and winds a 60-minute tape in approximately 30 seconds. Both units permit the use of a 115 V AC adapter to reduce battery costs. The machines are available from Magnesonics Sales and Manufacturing Co, POB 758, Ventura CA 93001. They cost \$24.50 each.

Circle 445 on inquiry card.

tion. The graphics package features displays of 640 by 409 or 576 by 455 pixels, alphanumeric characters displayed over 80 by 40 or 72 by 44 lines, and intermixable characters with graphics. It interfaces with other multibus-compatible products. The SVB-90 Soft Video Board and the MIB-85 Memory Intensive Board can also be used individually in computer graphics, text editing, scientific applications, and industrial environments. The price for the SVB-80P is approximately \$1600. Contact DOSC Inc, 175 I U Willets Rd, Albertson NY 11507.

Circle 446 on inquiry card.

### Computer Cables for the TRS-80

Matchless Systems, 18444 Broadway, Gardena CA 90248, manufactures cables for floppy disk and tape drives, printers and other peripherals for the TRS-80 computer. The price for the two-drive cable is \$24.50 and the four-drive cable is \$34.50. The cable for the MS-204 printer or any other Centronics-compatible printer, sells for \$34.50.

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# 46

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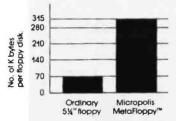
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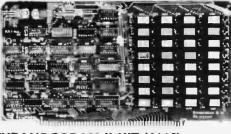
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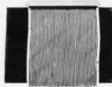
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RNS-20WWG	20	.90	.80	.70	.65	.62
RNS-22WWG	22	1.00	.90	.85	.80	.75
RNS-24WWG	24	1.00	.90	.85	.80	.75 / //////////
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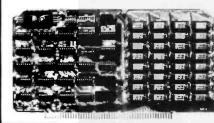
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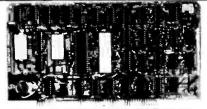
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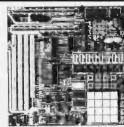
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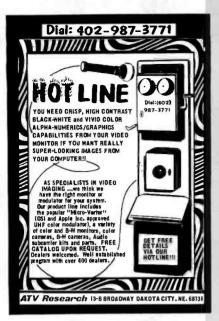
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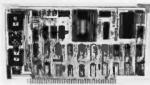
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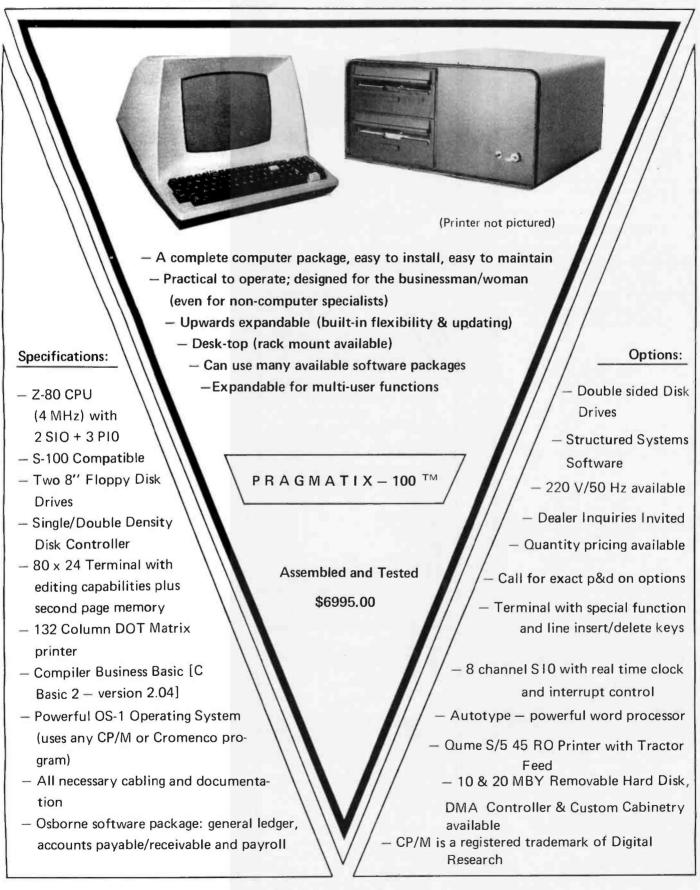
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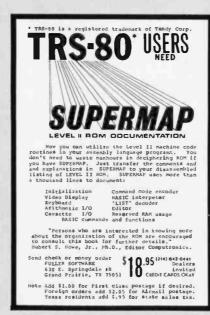




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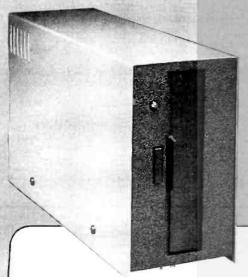
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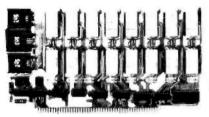
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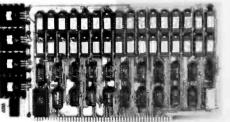
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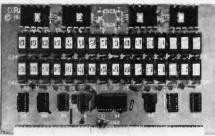
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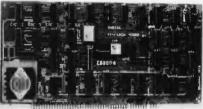
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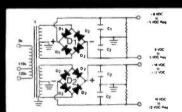
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plus load, reset, run, walt, Input, memory protect, monitor select and single slep, Large, on board displays provide output and optional high and low address. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockels for all IC's are included in the price plus adetailed 127 pp. instruction manual which now includes over 40 pgs. of software info. including a series of tessons 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&O.

A 24 key HEX keyboard includes 16 HEX keys

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.

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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.

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BRANO:	TEXAS INST.							Row Sp.	1-9pc.		s. 25pcs. Up.	ļ				QUANTITY	
4070	50/100 Imsai/Crom.	.250	\$3.95ea.	\$3.55aa.		15105	BI12 SIE PETINSC	.140	\$1.80	\$1.65	\$1.45	DADT	NUMBER	DESCRIPTION.	1.0	10-24ocs.	25 00
4090	50/100 Imsei W/W	.250	4.30ea.	3.85ea.	3.45ea.	15110	B/12 S/T PET/NSC	.140	1.05	1.65	1.50	PANI	MUMBER	DESCRIPTION.	1-9pcs.	10-24pcs.	25-99pcs.
BRAND:	SULLINS: U.L Rag.					15137	6/12 S/T PET/NSC	.200	1.80	1.54	1.45	DE 9	9P	Male	\$1.60es.	\$1.40ea.	\$1.30ea.
129885	50/100 Solder Eye	.140	6.00es.	6.10ea.	5.45ea.	15175	6/- S/E Sgle Row	4 4	1.70	1.50	1.30		9S	Female	2.25ea.	2.00ea.	1.90ea.
129870	50/100 S/T Imsai	.250	4.50ea.	4.10ea.	3.70	15270	10/20 S/E	.140	2.15	1.95	1.70		110963-1	2 pc. Gray Hood.	1.50ea.	1.35ma.	1.20ea.
129875	50/100 W/W Imsai	.250	5.25	4.75	4.20	15275	10/20 S/T	.140	2.00	1.05	1.60						
129085	50/100 S/T Altair	.140	4.95	4.45	3.95	15435	12/24 SIE PET	.140	2.60	2.35	2.10		15P	Male	2.35ea.	2.15ea.	2.00ea.
129990	50/100 S/T Cromem.	.250	4.75	4.25	3.00	15440	12/24 S/T PET	.140	2.85	2.40	2.15		158	Famale	3.25ea.	3.10ea.	2.90ea.
						15445	12/24 S/T PET	.200	2.75	2.50	2.20		51211-1	1. pc. Grey Hood	1.40ea.	1.20ea.	1.15ea.
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12305	22/44 SIE No Ears	.140	4.15	3.75	3.35	15510	15/30 S/T GRI Key	.140	2.40	2.15	2.95	DA 1	110963-2	2 pc. Grey Hood	1.60ea.	1.35ea.	1.30ea.
12759	36/72 S/T	.140	5.40	4.85	4.35	15515	15/30 W/W GRI Key	.200	2.60	2.35	2.10	DB 2	250	Male	2.80ea.	2.60ea.	2.40ea.
12790	40/80 W/W	.250	6.30	5.65	5.00	15800	18/36 S/E	.140	3.35	3.05	2.70		25P 25S	Female		2.00es. 3.40es.	
						15610	18/36 S/T	.140	3.00	2.70	2.40				3.60ea.		3.20ea.
.100 °C	ONTACT CTR CONNECT	TORS:				15015	16/36 W/W	.200	3.60	3.20	2.90		51212-1	1 pc. Grey Hood	1.50ea.	1.30ea.	1.10ea.
10048	13/26 S/E No Ears	.140	3.40	3.05	2.15	15700	22/44 SIE KIM/VEC	.140	2.98	2.90	2.75		51226-1	2 pc. Black Hood	1.90ea.	1.65ea.	1.45ea.
10280	25/50 S/E TRS 80	.140	4.50	4.05	3.60	15705	22/44 SIT KIMIVEC	.140	3.98	3.30	3.00	DB 1	110963-3	2 pc. Grey Hood	1.75ea.	1.50ea.	1.35ea.
10175	20/40 S/E TRS 80	.140	5.85	5.35	4.75	15710	22/44 W/W KIM/VEC	.200	3.49	3.20	2.85	DC 3	37P	Male	4.20ea.	4.00ea.	3.70ea.
10180	20/40 W/W TRS BO	.200	3.30	3.00	2.15	15875	25/50 S/E	.140	4.65	4.20	3.75		37S	Female	6.00es.	5.75ea.	5.50ea.
10190	20/40 S/T TRS 80	.140	3.20	2.90	2.55	15880	25/50 S/T	.140	4.55	4.10	3.65		110983-4	2 pc. Grey Hood	2.25ea.	2.00ea.	1.75es.
10485	36/72 S/E Vector	.140	5.50	4.90	4.40	15865	25/50 W/W	.200	4.85	4.35	3.90			E po. 0.01 11010	E.E.000.	2.0000.	1.7 200.
10490	36/72 W/E Vector	.200	5.80	5.25	4.65	16115	36/72 SIE	.140	6.50	5.65	5.20	DO !	50P	Male	5.50ea.	5.10es.	4.75ea.
10500	36/72 S/T Vector	.140	5.70	4.20	4.60	16120	36/72 S/T	.140	6.55	5.90	5.25	DD 5	50S	Female	9.40ea.	6.80em.	B.00ea.
10535	40/80 S/E PET	.140	5.85	5.35	4.75	18125	36/72 W/W	.200	6.75	6.10	5.40	DD 5	51216-1	1 pc. Grey Hood	2.40es.	2.20es.	2. 00ea.
10540	40/80 W/W PET	.200	6.00	5.40	4.80	16145	36/72 S/T	.200	6.50	5.85	5.20	DD 1	110963-5	2 pc. Grey Hood	2.60ea.	2.40ea.	2.10ea.
10550	40/80 S/T PET	.140	5.80	5.25	4.65	16235	43/86 S/T Mot 6800	.140	6.60	5.95	5.30		20440 2	Hardwara Set	.90ea.	.80ea.	70
10585	43/86 SIE COSIELF	.140	6.95	6.25	5.55	16240	43/86 W/W Mot 6800	.200	7.80	7.05	6.25	0 2	20418-2		.suea.	.0088.	.70ea.
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10595	43/88 W/W COS/ELF	.200	6.90	6.20	5.95	16725	43/88 S/E Mot 6800	.140	7.20	6.50	5.75	Î					
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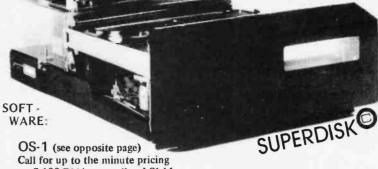


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on S-100 DMA controller, LSI-11 controller, cabinetry, etc.

PS: OS-1 runs on the TRS-80, and can transform it from a toy computer to a real business machine !!!

10MBv DRIVE \$3300

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> **POWER** UNIT \$395.00

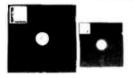
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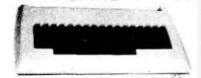
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—Line & character insert√ delete

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"Won't Let Go"

Low Profile

Solder Tail

1 CENT/ Pin!! (0.75/1000's)

40 28 20 24 8 14 16 18 22

CP/M\* Source Code - FREE! when you purchase "OS-1"

Electrolabs' new operating system for the Z-80 designed to have exactly the appearance of UNIX\*\*, including virtual I/O, "set TTY", a tree and a shell, filters and pipes PLUS total compatability with CP/M software!

**FEATURES** 

(Because OS-1 is truly a comprehensive "OS", and not merely a file handling "DOS", we have changed the name from "Superdos" to "OS-1")

VIRTUAL I/O - copy with a single command between floppy and hard disk, or from TTY to printer to tape to disk... etc., etc. No messy I/O routines to write, & no awkward transfers. SECURITY - 9 modes of file protection, user and login protection. MULTI-USER - up to 256 passwords. (non-simultaneous users) 16MBy FILE SIZE - but no limit to no. of directories per device, thus allowing EASY implementation of gigantic storage devices. "SET TTY" - for printer or crt: tabs, page width, buffer, cursor, UC/LC, fonts, formfeed, arbitrary control characters etc., etc. "LOGIN" - automatically executes user selected programs and "set TTY" OCCUPIES 12KBy - only 50% larger than CP/M, but 500% more features. CP/M & CDOS COMPATABLE - your library is guaranteed to run!

\*(Naturally, we are not giving away the version of CP/M written by Digital Research, Please pardon our pun, but they might object. What we ARE giving you is a greatly enhanced version of CP/M which resides on OS-1, and allows the user of OS-1 to run any and all of his programs, packages or system utilities which are already running on CP/M. We give you the source code at no charge so that you may modify any part of the CP/M to suit your own system requirements. At no charge, you also receive the enhancement allowing 4MBy files instead of 256K.)

OS-1 (with debugger, linker and screen oriented editor Update service, per year	\$199.00 29.00 150.00 150.00 660.00 100.00 350.00
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2114 2114-2 pd 411	\$ 5.99 6.99 2.50	Apple, Exidy) 2708 2716	\$69,00 <b>8.</b> 95 <b>35.</b> 00	CPU 6502 Z-80 Z-80A	6,25 9,95
2107 ELECTR	2.00	2516	35,00	8080A 8085 8741	12.05 8.99 22.00 79.00

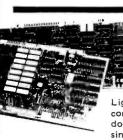
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Telex: 345567 (Electrolab Pla)

FLOPPY CONTROLLERS 1771 \$26,95 1791 37.95

Pd372 39.00 MISCELLANEOUS (CALL US!!)



for B&W and Color Imaging and Graphics

Light pen, A-D, D-A, TV synchro (needs no time base correction or adjustment with anything between random interface & NTSC commercial standard). T.V. single frame grabber ("snapshot"). Up to 1 Byte of attributions per pixel.

#### LSI-100 & S-100 applied to:

Graphic Presentation - such as computer generated animation & other graphic displays up to 256 colors & up to 256 b&w gray scales. Image Analysis – using built-in FRAME GRABBER, for medical Image enhancement, contour analysis, & pattern recognition. Commercial TV Tilting & Advertising - using synchronization capability. Interactive graphics - using light pen accessory.

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LSI-11 \$1995. S-100 \$1265. For TRS-80/Exidy Add \$595.00 Includes: Data Board - 32K (480 x 512 x 1 pixel) D-A 16 level video generator, Video Synchronization Circuitry. Address Control & Timing Board.

FEATURES - High speed, DMA or 2KBy window memory mapped interface. Full NTSC commercial color capability. Low power consumption. Excellent Software

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Call for price and details

\*CPM and \*\*UNIX

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TURNKEY DISK SUBSYSTEMS

DISK

For those who wish to avaggravation, fussing, irritation, annoyance etc., of assembling your own subsystem, plug in and GOIII





- 28" Single Sided Floppy Disk Drives

- Color Coordinated Cabinet with Power Supply

- OS-1 Disk Operating System (Fully CP/M

Full Cabling, Connectors + Documentation

One S-100 Slot available for Memory Expansion

- 28" Double Sided Drives (In place of Single Sided)

- 16K Dynamic RAM Internal Memory Expansion Kit

- 32K Dynamic RAM Memory Board, Assembled

Single and/or Double Density

Full RS-232 Interface

compatible) ce/M ls a region

- Assembled and Tested

- Plug In and GO!!!

OPTIONS:

and Tested

SORCERER

FEATURES:

**✓** SORCERER

~ TRS-80 ~ APPLE ~ HPIB

\$2195.00

\$2845.00

\$ 299.00

\$ 69.00

~ PET

#### APPLE

#### FEATURES:

- 28" Floppy DISK DRIVES (Single Sided)
- Color Coordinated Cabinet with Power Supply
- Expanded version of APPLE-DOS Single Density Disk Controller
- Full Cabling, Connectors + Documentation
- Assembled and Tested
- Plug In and GO!!!

\$1695.00

OPTIONS:

28" Double Sided Drives (In place of Single Sided) \$2395.00

- 16K Internal Memory Expansion Kit

#### PET

Prices and specifications same as for APPLE except PET Operates via PET-DOS

#### TRS-80

Prices and specifications same as for SORCERER with following exceptions:

- Space for up to 48K plug in dynamic memory on Controller Card

- Expansion Interface necessary

- Software package as above

- Deluxe Business Software package includes:

WORD PROCESSING SOFTWARE INTERACTIVE "Big 4":

General Ledger, Accts. Payable, Accts. Rec and Payroll \$ 695.00

- 10 MBY Removeable Hard Disk - Call for Details

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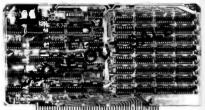
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TLX: 345567 Electrolabs PLA

## Computer Products

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#### OUR BEST SELLING MEMORY **EXPANDORAM**



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-16130K (16K KIT) ... .. \$239.95 MEM-16130A (16K A&T) ..... \$289.95 MEM-32131K (32K KIT) ..... \$309.95 MEM-32131A (32K A&T) ..... \$359.95 MEM-48132K (48K KIT) ..... \$379.95 MEM-48132A (48K A&T) ..... \$429.95

### SOLID STATE MUSIC

MEM-64133A (64K A&T) ..... \$499.95

\$449.95

MEM-64133K (64K KIT) .....

EPROM PROGRAMMER FOR 2708 OR 2	716
MEM-99510K(KIT) \$12	5.00
MEM-99510A(A & T) \$17	5.00

#### **VECTOR GRAPHICS HI-RES GRAPHICS**

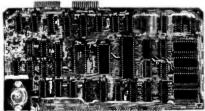
256X240 S-100 HI-RES GRAPHICS BOARD IOV-1070K(KIT) ..... \$150.00 IOV-1070A(A & T) LIMITED TO STOCK ON HAND

#### SOLID STATE MUSIC 1/0-4

2 SERIAL & 2 PARALLEL I/O PORTS IOI-1010K(JADE KIT) ...... \$149.95 IOI-1010A(A & T) ...... \$199.95

#### S D SYSTEMS SBC-100/200

2 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 CPC-30100K (2 MHz KIT) ......\$249.95 CPC-30100A (2 MHz A&T) .....\$299.95 CPC-30200K (4 MHz KIT) ..... \$289.95 CPC-30200A (4 MHz A&T) ..... \$339.95

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Read/write single or double density, 8" or 51/4" drives

On board Z-80 insures reliable operation

CP/M compatible in either single or double density Density is software selectable Up to 4 single or double sided, single or double density drives may be mixed on the same system EIA level serial printer interface on board-up to 9600 baud (perfect for despooling operations) All the hard work of disk access is done by the on board Z-80A and 2K memory, leaving your host CPU free for its normal duties Uses IBM standard formats for proven reliability

THIS BOARD REALLY WORKS IIIIII IOD-1200K (DOUBLE-D KIT) \$285.00 IOD-1200A (DOUBLE-D A&T) \$349.00 IOD-1200D (MANUAL ONLY) ..... .. \$15.00

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985600 bytes on 8" double sided diskettes 259840 bytes on double sided 51/4" diskettes S-100 bus (IEEE) standard compatible IBM 3740 format in single density 8" and 51/4" drives controlled simultaneously Operates with Z-80, 8080, and 8085 CPU's Controls up to 4 drives Vectored interrupt operation optional \$335.95 IOD-1160K (KIT) \$385.95 IOD-1169A (A&T).....

#### S D SYSTEMS VERSAFLOPPY

VERSATILE FLOPPY DISK CONTROLLER

IBM 3740 soft sectored format S-100 Z-80 or 8080 compatible Controls up to 4 single or double sided drives Compatible with all popular disk drives CP/M compatible Listings for control software included \$189.95 IOD-1150K (KIT) \$239.95 IOD-1150A (A&T).....

#### **NEW DISK OPERATING SYSTEM** SDOS IS HERE

WE THINK IT'S SUPERIOR

SDOS is a CP/M compatible operating system designed for the S.D. Sales Versafloppy I or II. It requires the SBC-100/Versafloppy board set and functions as a superset of CP/M. giving 19 additional functions including file attributes, disk label, and read/write logical blocks. It provides additional protection features, and is expandable to a multi-user real-time system. SDOS sells for \$200.00

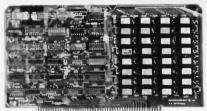
#### **CALL FOR SALE PRICES !!!** 32K STATIC RAM

EXPANDABLE 8K/32K, 2/4MHz, KIT/A&T

#### NEW 2 OR 4 MHz REV. C BOARD THE JADE BIG Z

Z-80 CPU BOARD WITH SERIAL I/O PORT 2 or 4 MHz switchable, on-board 2708, 2716, or 2732 EPROM useable in SHADOW mode (full 64K RAM) Automatic MWRITE generation if no front panel On-board USART for sync or async RS232 CPU-30201K (KIT) ..... \$159.00 CPU-30201A (A & T) ...

#### S D SYSTEMS **EXPANDORAM**



S-100 bus compatible, up to 4 MHz operation Expandable memory from 16K to 256K DIp switch selectable boundaries Page-mode allows up to 8 boards on the same bu's Invisible refresh; PHANTOM output disable Designed to operate in 7-90 has

Designed to operate in 2-60 based system	13
MEM-16631K (16K KIT)	\$295.95
MEM-16631A (16K A&T)	\$345.95
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MEM-32632A (32K A&T)	\$419.95
MEM-48632K (48K KIT)	\$444.95
MEM-48632A (48K A&T)	\$494.95
MEM-64632K (64K KIT)	\$519.95
MEM-64632A (64K A&T)	\$569.95
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#### **VECTOR GRAPHICS** 12K PROM/RAM

1K OF STATIC RAM AND 12 2708 SOCKETS MEM-12340A(A & T. NO PROMS) ...... \$135.00

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**TIMELY SPECIAL 60 Hz TIME BASE** CRYSTAL CONTROLLED KIT ONLY \$4.95

#### **COMING SOON NEW JADE P/S I/O**

PARALLEL/SERIAL/INTERRUPT BOARD

Z-80 SIO/PIO, 2 CTCs, expands to 2 SIOs, 4 CTCs 4 serial ports (async, sync, bisync, SDLC/HDLC) 2 parallel ports with full handshake Software baud rate generators, interval timers. counters, and generates 32 vectored interrupts Designed especially for MP/M multi-user multitasking operating systems. For use with Z-80 only IOI-1045B (BARE BOARD) ...... \$45.00 IOI-1045K (KIT)

## SALE SALE SALE SALE

IOI-1045A (A & T) .....

1702A				\$4.95
2708				\$8.95
2516			A	. \$34.95
2716(T.I.)				
2716(5 VOL	T)			. \$34.95
2758				. \$34.95
2532				. \$74.95
2732				
CALL FOR	PRICING	G ON LAI	RGE QUAN	TITIES

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## TERMINAL SALE ADDS REGENT

**OUR FINEST LINE OF TERMINALS** 

ADDS REGENT 20	 \$795.00
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## SPECIAL PACKAGE PRICE RS-232 SET \$6.50 1 MALE DB-25, 1 FEMALE DB-25, 1 COVER

## 2708 PROGRAMER

### S-100 CARD CAGE

## SPECIAL CLEARANCE SALE 4K EPROM BOARD

 HOLDS UP TO 16 INEXPENSIVE 1702A'S

 MEM-04220K(KIT NO PROMS)
 \$45.00

 MEM-04220A(A & T NO PROMS)
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#### CP/M 2.0

Olgital Research has done it again! This new release of their industry standard disk operating system is bound to be an even bigger hit than the original version. All of the fundamental file-size restrictions of release 1 have been eliminated, while maintaining full compatibility with the earlier versions. This new release can be field-configured by the user for a single mini-disk up through a multiple drive hard-disk system with 128 megabyte capacity. Field configuration can be accomplished easily through use of the Macro Library (DISKDEF) provided with CP/M 2.0.

A powerful operating system for only ... \$150.00

## JADE'S NEW MOTHERBOARDS THE ISO-BUS

WE'RE PROUD OF OUR MOTHER!

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BARE BOARD	
KIT	\$49.95
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BARE BOARD	\$39.95
KIT	\$89.95
ASSEMBLED & TESTED	\$99.95
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BARE BOARD	\$59.95
KIT	\$129.95
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## SPECIAL PACKAGE PRICE ROCKWELL AIM-65

THE HEAD-START IN MICROCOMPUTERS

KIM-1 compatible On-board printer Full ACSII keyboard

AIM-65 w/1K RAM..\$375.00 AIM-65 w/4K RAM..\$450.00 8K BASIC ROM..\$100.00 POWER SUPPLY..\$59.95 CASE for AIM-65..\$49.95 4K Assembler/Editor..\$80.00

Special Package Price \$599.00
4K AIM-65, 8K BASIC ROM, Power Supply, and Case

#### JADE

MEMORY EXPANSION KITS

#### TRS-80 APPLE EXIDY

Everything you need to add 16K of memory to your computer. Your kit comes neatly packaged with easy to follow instructions. In just minutes your computer is ready to tackle more advanced software.

\$69.00

## SALE SALE SALE SALE TRANSISTORS

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MICROPROCESSORS	6800 PRODUCT
3N81	5/\$1.00
2N6569	4/\$1.00
2N5449	5/\$1.00
2N5434	5/\$1.00
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2N4348	3/\$5.00
2N4013	
2N3904	GK
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2N2222A	.,
2N718	
2N456A	10/\$1.00

3N81	5/\$1.00
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6502 \$11.95	6852P \$7.50
6800 \$12.50	6860P \$9.25
6802 \$20.00	6862P \$12.00
8008-1 \$15.95	6875L \$7.30
8035 \$24.00	6880P \$2.50
8035-8 \$24.00	CHARACTER GENERATORS
8080-A \$10.00	2513 Upper \$7.95
8085 \$23.00	2513 Lower \$6.75
TMS9900TL \$49.95	2513 Upper (5 vott) 9.75
8080A SUPPORT DEVICES	2513 Lower (5 voll) \$13.00
	MCM6571 up scan \$13.00
8212 \$5.00	MCM6571A down scan\$10.95
8214 \$4.65	PROMS
8216 \$2.95	1702A \$5.00
8224 (2MHz) \$4.30	2708 \$8.95
8226 \$2.75	2716 \$39.95
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S2350 \$10.95	2111-1 \$3.25
UARTS	2112-1 \$2.95
AY5-1013A \$5.25	
AVE 4044A	2114L (450ns) \$5.75

## Computer Products

2114L (300ns)

TMS4044 (450ns)

TMS4044 (300ns)

\$5.95 \$8.00

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AY5-1014A TR1602B

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TMS6011



### THE PAPER TIGER

132 COLUMN DOT MATRIX PRINTER

Up to 198 CPS
1.75 to 9.5 inch adjustable tractor and friction feed. Parallel and serlal interface.
98 character ASCII set. 80 to 132 columns.
6 or 8 lines per inch.
Eight software selectable

character sizes. 110, 300, 600, or 1200 baud.

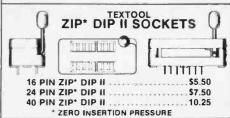
## JADE DISKETTES

MAGNIFICENT MAGNETIC MEDIA I

51/4" single sided, single density, box of 10
MMD-5110103 (SOFT SECTOR) \$29.95
MMD-5111003 (10 SECTOR) \$29.95
MMD-5111603 (16 SECTOR) \$29.95
51/4" double sided, double density, box of 10
MMD-5220103 (SOFT SECTOR) \$39.95
8" single sided, single density, box of 10
MMD-8110103 (SOFT SECTOR) \$34.95
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MMD-8120103 (SOFT SECTOR), \$55.95
8" double sided, double density, box of 10
MMD-8220103 (SOFT SECTOR) \$57.95

#### SPST DIP SWITCHES





### SPECIAL PRICE FOR MARCH NOVATION CAT

ACOUSTIC COUPLER/MODEM



### **■ IDH Series - Headers**

#### PC Mounting



Pins	Straight	Right Angle	1-9	10-24	25-99	
10	IDH-10S	IDH-10SR	.95	.72	.70	
20	IDH-20S	IDH-20SR	1.30	1.15	1.10	
26	IDH-26S	IDH-26SR	1.75	1.50	1.35	
34	IDH-34S	IDH-34SR	2.25	1.95	1.75	
40	IDH-40S	IDH-40SR	2.55	2.35	2.15	
50	IDH-50S	IDH-50SR	3.25	2.95	2.75	

Ejector Ears for above.

20/\$3.00

#### Wire Wrap

Pins	Straight	Right Angle	1-9	10-24	25-99
10	IDH-10W	IDH-10WR	1.95	1.65	1.55
20	IDH-20W	IDH-20WR	2.75	2.50	2.40
26	IDH-26W	IDH-26WR	3.50	3.25	3.15
34	IDH-34W	IDH-34WR	4.25	3.95	3.75
40	IDH-40W	IDH-40WR	4.75	4.50	4.25
50	IDH-50W	IDH-50WR	5.95	5.60	5.40

4/\$1.00 100/\$10.00

- Header is permanently mounted on PCB and accepts IDS socket connectors.

  Straight or right angle mounting options available for both solder and wrap pin terminations.
- Solder termination length for either .062" or .125" PCB.
- Ejector/Latch available, latches IDS socket in place when closed, serves as ejector when

### **IDC Card Edge Connectors**

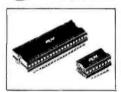
Pins	1-9	10-24	25-99
20	4.15	3.75	3.30
26	4.75	4.30	3.80
34	5.70	5.10	4.50
40	6.50	5.80	5.25
50	7.00	6.30	5.40

### 25 Pin 'D' Subminiature



	1-9	10-24	25-99
Plug	6.00	5.25	4.70
Socket	6.35	5.60	5.00

### Cable Plugs



Pins	1-9	10-24	25-99	100
14	1.30	1.25	1.10	.95
16	1.50	1.40	1.25	1.10
24	2.25	2.15	2.00	1.75
40	3.75	3.50	3.25	2.95

- Provides pluggable termination of cable to PCB thru IDP plugs and standard DIP sockets such as RN ICN series DIP sockets.
- Single piece design for easy handling and assembly.
- Cover latch allows cover swivel for easy cable insertion.
- Tapered pin tip permits easy insertion into IC sockets. Strong leads for multiple insertions without damage.



on Displacement						
Pins	Socket Connector	1-9	10-24	25-99	Strain Relief	
10	IDS10	1.40	1.20	1.10	.25	
20	IDS20	2.00	1.85	1.75	.25	



Pins	Socket Connector	1-9	10-24	25-99	Strain Relief
10	IDS10	1.40	1.20	1.10	.25
20	IDS20	2.00	1.85	1.75	.25
26	IDS26	2.50	2.40	2.30	.25
34	IDS34	3.25	3.10	2.95	.25
40	IDS40	3.95	3.70	3.55	.25
50	IDS50	5.00	4.60	4.40	.25

- Provides pluggable termination of cable to PCB thru IDS sockets and IDH headers. Single piece body construction for easy assembly, strain relief attached after assembly.
- Rugged cover latch and optional strain relief for dependability.
- Strain relief can be purchased separately.

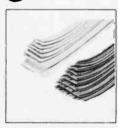
### **Transition Connectors**



	1-9	10-24	25-99
10	1.50	1.35	1.25
20	1.75	1.60	1.50
26	2.25	2.00	1.75
34	2.50	2.40	2.30
40	3.00	2.80	2.60
50	3.60	3.45	3.15

- Connector used to permanently attach cable to PCB.
- Lead length options for .062" and .125" thick PCB. Rugged single piece design for easy assembly and dependability
- Cable can be attached before or after soldering connector to PCB.

### RM Cable



Conductors Solid Color			Color	Coded
	10 ft.	100 ft.	10 ft.	100 ft.
10	2.90	17.00	4.00	30.00
14	3.40	23.80	5.00	42.00
16	3.70	27.20	5.60	48.00
20	4.40	34.00	7.00	60.00
24	5.00	40.80	8.00	72.00
26	5.40	44.20	8.60	78.00
34	6.80	57.80	11.00	102.00
40	7.80	68.00	13.00	120.00
50	9.50	85.00	16.00	150.00

- Compatible with all RN IDC products.
  Wire spacing .050" ± .002", 28 ga stranded.
- 10 thru 50 Conductor Laminated Cable Solid Color (with wire one mark) or Color Coded.
- Available in 100 foot rolls, or 10 foot lengths Meets UL FR-1 Vertical Flame Test.

Note: Custom crimping available on all products for proto-type quantities at 50¢/connection.

Gold: All parts on this page except Cable are gold plated. Because of the volatility of gold pricing, orders may be subject to a gold surcharge.

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With Purchase of The **INTEGRAL DATA 440** 

Paper Tiger Your Choice, \$200 Value

1) Graphics Option Package 2) Interface for APPLE II 3) TRS-80 Printer Interface

California Digital has resently researched the complete low cost printer market. It is out opinion that the IDS 440 Paper Tiger is, without doubt, the most versatile and offers the best value of any printer cost-ing under \$1,000.

This quality dot matrix printer software selectable character size to allow print densities upto 132 characters per line. Full forms handling capabilities and tractor feed mechansim adjustable to 9.5%. The Paper Figer is engineered to accept either parallel or RS232 serial ASCII, 110/220V.50/60Hz. \$995.00 plus shipping

#### S-100 Mother Board

Quiet Buss

your choice

odo.

\$29.95 8803-18 18 slnt IMSAL

**Minidisk Drive for TRS-80** 

#### **TELETYPE MODEL 43**

4320 KEYBOARD

TTL ..... AAA \$1050 RS 232 .... AAK 1150 Friction ... AAE

103 Modem AAB 1575



## PLASTIC LIBRARY CASE with purchase of each box of .... Verbatim mini-diskettes. \$5 value.

### CONNECTORS



DB 255 female \$3,25

Qty. fe. male hd. 10 3.05 1.95 1.15 25 2.95 1.79 1.05 100 2.65 1.67 .95 500 2.25 1.60 .85 1K 1.97 1.27

Edge Connectors 100 PIN IMSAI/ALTAIR

Imsai solder.125x.250 s2.95 3/\$ 7.50 imsal w/w.125centers 44.95 3/\$13.00 SPECIALS \$5.95 3/\$15.00 5PECIALS 22/44 Kim eyelet.156" 25/50 solder tab .156" 36/72 wide post w/w.156 \$1.95 3/\$5.00 \$1.09 3/\$2.00 \$1.95 3/\$5.00

CAL

Includes **Interface Cable** 

## ISK MEMORY

COLOR . GRAPHICS . SOUND

\$988 PLUS SHIPPING

Mfg. Sug. Retail.... \$1195

#### orized Distributo Scotch



IBM soft format Double side soft Double density 53, 00 1.90 6. 60 3. 50 3. 50 Double/Double 70.00 40-32 8" Hard sector 44-(0)(10)(16) 5 1/4"mini Add \$3,00 5,50 Library case for any above: 831 A Data Cassette DC 100 Mini Cartridge DC 300 Data Cartridge 9200 Disk Cartridge

### Shugart Associates

#### SA800-R Floppy Disk Drive

The most cost effective way to store data processing information, when random recall is a prime factor. The SA800 is fully compatible with the IBM 3740 format. Write protect cir-cuitry, low maintenance & Shugari quality.





#### MEMORY

#### TRS-80 \$ 7 APPLE II 16k memory (8) 4116's

Installation is simple. Anyone who has ever changed a spark plug should be able to up-grade his microcomputer.

to up-gratic his interacomputer. How can California Digital offer these memory up-grade sets at 25% below our competition? Simple, we buy in volume, whotesale to dealers and sell the balance directly to owners of personal microsett the balance directly to owners of personal intersystems. These 16k dynamic memory directls are
factory prime and inconditionally guaranteed for one
full year. NOW, before you change your mind, pick
up the telephone and order your up-grade memory
from California Digital. Add 33 for TRS80 jumpers.

1 - 31	32-99	100-5C	-999	114
1.19	. 99	.95	. 90	. 85
1.49	1.39	1.25	16	*
5.95	5.50	5.25	4.75	4.50
B. 95	8.50	8.00	<b>:</b> #	*
5.95	5.50	5. 25	*	*
9.95	9.50	9.00	*	*
11.95	8.50	8.00	*	*
9.95		9.00	*	aje
5.95	5.50	5.00	4.80	4.60
	1, 19 1, 49 5, 95 8, 95 5, 95 9, 95 8, 95 9, 95	1. 19 .99 1. 49 1. 39 5. 95 5. 50 8. 95 8. 50 5. 95 5. 50 9. 95 9. 50 8. 95 8. 50	1, 19 , 99 , 95 1, 49 1, 39 1, 25 5, 95 5, 50 5, 25 8, 95 8, 50 8, 00 5, 95 5, 50 5, 25 9, 95 9, 50 9, 00 H, 95 8, 50 8, 00 9, 95 9, 50 9, 00	$\begin{array}{cccccccccccccccccccccccccccccccccccc$

#### SPECIAL CIRCUITS

Z80A 4 MHz.	24.95
BOSOA CPU	9.95
8085	22.50
8086 Intel 16 bus	85.00
FMS 9900 16 bits	49.95

AY5-1013A BART 4.95 Floppy Disc Controllers WD 1771 single D, 39, 95 WD 1781 Double D 65, 00 WD 1791 D/D 3746 \*



EPROMS 1-15 16-63 4.95 4.50 9.95 9.50 29.95 27.50 4.00 9.00 1702A 2K 2716 5v 16K 24.88 85.00 20.00

#### \$44950



TOUCH TONE® Speaker Phone

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#### **DIP Switch**

### Wire Wrap Center

#### IC SOCKETS

-	97.11	C 44	TAP .	LOW	PIV	1116	
pin	ea.	25	50	ea.	25	50	
8	_	_	_	174	16	15	
14	37	36	35	18	17	16	
16	38	37	36	19	18	17	
24	99	93	85	36	35	34	
40	169	155	139	63	60	58	

KYNARWAR 500 1,000 11,000 59. 515. \$105.

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WWWWW	7400 TTL	WYYYY	G Cromemco	TELEPHONE/KEYBOARD CHIPS   AY-5-9100   Push Button Telephone Dialler   14-75   AY-5-9200   Repertory Dialler   14-75   AY-5-92176   Keyboard Encoder (18-8 keys)   14-75   1
SN7400N .16 SN7401N .18 5N7402N .18 SN7403N .18	SN7472N 25 SN7473N 35 SN7474M 35 SN7475N 49 SN7476N 35	SN74160N .89 SN74181N .89 SN74162N 1.95 SN74163N .89	8K	HD0165 Keyboard Encoder (16 keys) 7.95 74C922 Keyboard Encoder (16 keys) 7.95 74C923 Keyboard Encoder (20 keys) 6.25  ICM CHIPS
SN7404N .18 SN7405N .20 SN7406N .29 SN7407N .29 SN7408N .20	SN7479M 5.00 SN7480N .50 SN7482N .99 SN7483N .59 SN7485N .79	SN74164N .89 SN74165N .89 SN74166N 1.25 SN74167N 1.95 SN74170N 1.59	Bytesaver II  Memory Capacity: 8K bytes Memory Type: 2708 PROM or equivalent	ICM7205
SN7409N 20 SN7410N .18 SN7411N 25 SN7412N 25 SN7413N .40	SN7486N .35 SN7489N 1.75 SN7490N .45 SN7491N .59	SN74172N 6.00 SN74173N 1.25 SN74174N .89 SN74175N .79	Memory Access Time: 450 Banoisconds Weit States at 2MHz: none required Weit States at 4MHz: one per machine cycle sees 5000.	NMOS READ ONLY MEMORIES
SN7414N .70 SN7416N .25 SN7417N .25 SN742ON .20	SN7493N .43 SN7494N .65 SN7495N .65 SN7496N .65	SN74177N .79 SN74179N 1.95 SN74180N .79 SN74181N 1.95	a Dullt-in programmer for Inte popular 2/U8 PROM and has the capacity for a full 8k bytesol PROM memory storage. The BYTESAVER® II 840 of fers a number of new features including Observing Favironment (ASSC)	MISCELLANEOUS   TL074CN   Quad Low Noise bi-fet Op Amp   2.49   TL494CN   Switching Regulator   4.49
\$N7421N .29 \$N7422N .39 \$N7423N .25 \$N7425H .29 \$N7426N .29	SN7497N 3.00 SN74100N .89 SM74107N .35 SM74109N .59 SN74116N 1.95	SN74182N .79 SN74184N 1.95 SN74185N 1.95 SN74186N 9.95 SN74188N 3.95	convenient switch selection of board address and Cromemoco's powerful memory bank selection. The BYTESAVER® 11 is assembled and tested (Model 8K BS-W) for \$245.	TL496CP   Single Switching Regulator   1.75
SN7426N .29 SN7427N .25 SN7429N .39 SN7430N .20 SN7432N .25 SN7437N .25	SN74121N .35 SN74122N .39 SN74123N .49 SN74125N .49 SN74126N .49	SN74190N 1.25 SN74191N 1.25 SN74192N .79 SN74193N .78 SN74194N .89	DISCRETE LEDS  -200 dia.  XC556R red 5/51  XC556R green 4/51  XC209R red 5/51  FIELD EFFECT	MKS0240
SN7438N .25 SN7439N .25 SN7440N .20 SN7441N .69 SN7442N .49	SN74132N .75 SN74136N .75 SN74141N .79 SN74142N 2.95 SN74143N 2.95	SN74195N .69 SN74196N .89 SN74197N .89 SN74198N 1.49 SN74199N 1.49	XC556Y yellow 4/51 XC209/G green 4/51 XC556C Clear 4/51 XC209/ yellow 4/51 XC209 Yellow 4/51 XC208 red 5/51 Wessen 1.185* dis.	MC14433P
SN7443N .75 SN7444N .75 SN7445N .75 SN7445N .69	SN74144N 2,95 SN74145N ,79 SN74147N 1,95 SN74148N 1,29	SN74S200 4.95 SN74Z51N .99 SN74Z79N .79 SN74Z83N 2.25	XC22Y yellow 4/51 XC526G green 4/51 XC526Y yellow 4/51 XC526Y yellow 4/51 XC526Y yellow 4/51 XC526C char 4/51 4 DIGIT - 5" CHARACTERS THREE ENUNCIATORS	(Same as MCT 2 or 4N25) 49¢ each  TV GAME CHIP AND CRYSTAL  TV GAME CHIP AND CRYSTAL
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CD4001 .23 CD4002 .23 CD4006 1.19 CD4007 .25 CD4009 .49	CD4028 _89 CD4029 1.19 CD4030 .49 CD4035 .99	CD4070 .55 CD4071 .23 CD4072 .49 CD4076 1.39 CD4081 .23 CD4082 .23	MAN 2   5 x 7 Doir Malfris-red   125   3.00   4.95   MAN 6740   Common Cathods-red   125   2.5   MAN 6740   Common Cathods-red   187   195   MAN 6760   Common Cathods-red   187   195   MAN 6760   Common Anode-red   180   193   MAN 6760   Common Anode-red   180   193   MAN 70   Common Anode-splow   300   1.25   MAN 6780   Common Anode-red   560   99   MAN 70   Common Anode-red   360   99   0.70   0.70   Common Anode-red   360   99   0.70	XR558   99   XR2206   4-0   XR4151   3.95   XR55767   99   XR2207   3.85   XR4194   4.95   XR567CT   1.25   XR2208   5.20   XR4202   3.60   XR1430P   1.95   XR2209   1.75   XR4202   2.05   XR14680R   3.85   XR2211   5.25   XR4558   2.75   XR2416   XR251   3.85   XR451   3.8
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CD4024 .79 CD4025 .23 CO4026 2.25 CD4027 .69	CD4060 1.49 CD4066 .79 CD4068 .39 CD4069 .45	CD4515 2.95 CD4518 1.29 CD4520 1.29 CD4566 2.25	MAN 6610         Common Anode-orange - D	NS232   5.6   500m   28   1N4735   6.2   1w   1N5234   6.2   500m   28   1N4736   6.8   1w   1N5235   6.8   500m   28   1N4738   8.2   1w   1N5235   7.5   500m   28   1N4742   12   1w   1N5242   500m   28   1N4744   15   1w   5   500m   5   5   5   5   5   5   5   5   5
74C00 .39 74C02 .39 74C04 .39 74C08 .49 74C10 .39	74C00 74C85 2,49 74C90 1,95 74C93 1,95	74C163 2,49 74C164 2,49 74C173 2,60 74C192 2,49 74C193 2,49	MAN 6680 Common Cathode-orange .560 .99 5082-7304 Overrange character (≈1) .500 15.00 MAN 6710 Common Anoder-to-D560 .99 5082-7304 4 x 7 Spt. [10]t-lifetacidorinal .600 22.50 CACCO .000 CONTROL	1N5245 15 500m 28 1N1183 50 PtV 35 AMP 1,1 1N456 25 40m 6/1,00 1N1184 100 PtV 35 AMP 1,1 1N458 150 7m 6/1,00 1N1185 150 PtV 35 AMP 1,1 1N485A 180 10m 5/1,00 1N1185 200 PtV 35 AMP 1,1
74C14 1.95 74C20 .39 74C30 39 74C42 1.95 74C48 2.49	74C95 1,95 74C107 1,25 74C151 2,90 74C154 3,00 74C157 2,15	74C195 2.49 74C922 7.95 74C923 6.25 74C925 8.95 74C926 8.95	CA3033T 2.15 CA3082N 2 00 CHIPS/DRIVERS MM5209 54.95 MC1408L7 54.95 CA2023T 2.56 CA3083N 1.60 MM5726 2.95 MM5311 4.95 MC1408L8 5.75 CA3035T 2.46 CA3089N 3.75 DM8684 2.00 MM5313 4.95 MC1408L8 2.95 MM5311 4.95 MC1408L 2.95 MM5319 2.95 MM5313 4.95 MC1408L 2.95 MM5316 2.95	SCR AND FW BRIDGE RECTIFIERS  [380] 15A @ 400V SCR(2N1849) \$1.95  [384] 35A 600V SCR 1.95
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LM301CN/H .35 LM302H .75 LM304H 1.00 LM305H .60	LM340K-18 1.35 LM340K-24 1.35 LM340T-5 1.25 LM340T-6 1,25 LM340T-8 1.25	LM733N 1.00 LM739N 1.19 LM741CN/H .35 LM741-14N .39	1:24 25-49 50:00  8 pin LP \$17\$ .16 .15  14 pin LP .20 .19 .18  15 pin LP .20 .19 .18  16 pin LP .20 .19 .18  17 pin LP .20 .19 .18  18 pin LP .20 .20 .20	MPSA05 30 2N3055 89 2N3905 4/1.0 MPSA06 5/1.00 MLF3055 1.00 2N3906 4/1.0 T1897 6/1.00 2N3392 5/1.00 2N4013 3/1.0 T1S98 6/1.00 2N3398 5/1.00 2N4123 6/1.0
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LM340K-15 1.35 74LS00 .29 74LS01 .29 74LS02 .29	74LS47 89	RC4194 4.95 RC4195 4.49 74LS138 89 74LS139 89 74LS151 89	3.3k 3.9k 4.7k 5.6k 6.8k ASST, 4 5 ea. 8.2k 10k 12k 15k 18k 50 PCS 1.75 22k 22k 33k 39k 47k ASST, 5 5.ea. 56k 66k 8.7k 100k 120k 50 PCS 1.75	.0047m1 .12 .10 .07 .1ml .27 .23 .17 .01ml .12 .10 .07 .22ml .33 .27 .22
74L503 ,29 74L504 ,35 74L505 ,35 74L508 ,29 74L509 ,35	74LS51 29 74LS54 29 74LS55 29 74LS73 45 74LS74 45	74LS155 89 74LS157 89 74LS160 1.15 74LS161 1.15 74LS162 1.25	150¢ 180° 270° 270° 330° 80° 60° 80° 50° 50° 50° 50° 50° 50° 50° 50° 50° 5	15/35V 28 .23 .17 22/35V 35 .31 .27 .22/35V 35 .31 .27 .22/35V 35 .31 .27 .22/35V 35 .31 .27 .33/35V 28 .23 .17 .33/25V 33 .33 .28 .23 .47 .23/25V 49 .45 .35 .68/35V 28 .23 .17 .68/25V 49 .45 .35 .68/35V 28 .23 .17 .52/25V .75 .68 .59 .17 .22/6 ∨ .75 .68 .59 .23 .17 .22/6 ∨ .75 .68 .59 .23 .17 .22/6 ∨ .75 .68 .59 .23 .17 .22/6 ∨ .75 .68 .59 .23 .23 .23 .23 .23 .23 .23 .23 .23 .23
74LS10 29 74LS11 .75 74LS13 .59 74LS14 1.25 74LS15 .35	74LS76 .45 74LS78 .49 74LS83 .89 74LS85 1.25	74L5163 1.15 74L5164 1.25 74L5175 99 74L5181 2.49 74L5190 1.15	ASST. 8R Includes Resistor Assortments 1 - 7 (350 PCS.) \$9.95 ea. \$10.00 Min. Order - U.S. Funds Only Cellf. Residents Add 6% Sales Tax Spec Sheets - 25¢ 1980 Catalog Available - Send 41¢ stamp	MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS   Axial Lead   Fladial Lead   A77.50V   1.5   1.3   1.0   477.50V   1.5   1.3   1.0   1.0/50V   1.6   1.4   1.1   477.50V   1.6   1.4   1.1
74LS20 29 74LS21 35 74LS22 35 74LS26 35	74LS86 .45 74LS90 .59 74LS92 .75 74LS93 .75	74LS191 1.15 74LS192 1.15 74LS193 1.15 74LS194 1.15	Postage – Add 5% plus \$1 Insurance (if desired)  PHONE ORDERS WELCOME	4,7/25Y 15 13 10 1.0/25Y 16 14 11 10/50Y 15 13 10 1.0/50Y 16 14 11 10/50Y 16 14 12 4,7/16V 15 13 10 2/27/25Y 17 15 12 4,7/25Y 15 13 10 2/27/25Y 22 28.5V 22 20 18 4,7/50Y 16 14 17
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RT300

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LM-1.....\$70.00



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- Four 630"ht, and two 300"ht, common anode displays
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   Hours easily viewable to 30 feet
- Simulated wainut case 115 VAC operation 12 or 24 hour operation
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   Uses MM5314 clock chip
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**JE701** 

• Simulated walnut case
• 115 VAC operation
• 12 or 24 hr, operation
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• Size: 64" x 3-1/8" x 1%"

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JE205 Adapter. Includes components, hardware and instructions. Size: 3%" x 5" x 2"H



ADAPTER BOARD -Adapts to JE200-±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hispeed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3%" x 2" x 9/16"H

JE205 .....\$12.95

#### MICROPROCESSOR COMPONENTS

	8080A/8080A SUPPORT DEVICES-			-MICONDO	CESSOR MANUALS -	
A0808	CPU	\$ 7.95	M-280	User Manu		57.50
8212	8-Bit Input/Output	3.25	M-CDP1802	User Manu		7.50
8214	Priority Interrupt Control	5.95	M-2650	User Manu		5.00
8216	Bi-Directional Bus Driver	3.49	W-2030	O SEL MAILE	a)	3.00
8224	Clock Generator/Oriver	3.95	_		ROM'S -	
8226	Bus Driver	3.49	2513(2140)		ienerator(upper case)	\$9.95
8228	System Controller/Bus Driver	4.95	2513(3021)		Generator(lower case)	9 95
9238	System Controller	5 95	2516	Character I		10.95
925t	Prog Comm. 1/0 (USART)	7 95	MM5230N		ead Only Memory	1.95
8253	Prog. Interval Timer	14.95	mm3230H	2040 Bit H	Ball Olly Mellioly	1,90
8255	Prog. Periph. 1/0 (PPI)	9.95			- RAM'S -	
8257	Prog. DMA Control	19.95	1101	256X1	Static	\$1.49
8259	Prog Interrupt Control	19.95	1103	1024X1	Oynamic	.99
	-6800/6800 SUPPORT DEVICES		2101(8101)	256X4	Static	3.95
MC6800	MPU	\$14.95	2102	1024X1	Static	1.75
MC6802CP	MPU with Clock and Ram	24.95	21LD2	1024X1	Static	1.75
MC6810API	128X8 Static Ram	5.95	2111(8111)	256X4	Static	3.95
MC6821	Periph. Inter Adapt (MC6820)	7.49	2112	256X4	Static MOS	4.95
MC6828	Priority Interrupt Controller	12.95	2114	1024X4	Static 450ns	7.95
MC6830LB	1024x8 Bit ROM (MC68A30-B)	14.95	2114L	1024X4	Static 450ns low power.	10.95
MC6850	Asynthronous Comm. Adapter	7.95	2114-3	1024X4	Static 300ns	10.95
MC6852	Synchronous Senai Data Adapt	9.95	2114L-3	1024X4	Static 300ns low power	11.95
MC6860	0-600 bps Oigital MODEM	12.95	5101	256X4	Static	7.95
MC6862	2400 bps Modulator	14.95	5260/2107	4096X1	Ovnamic	4.95
MC6880A	Ouad 3-State Bus. Trans. (MC8126)	2.25	7469	16X4	Static	1.75
MICRI	OPROCESSOR CHIPS MISCELLANEO	us ——	745200	256×1	Static Tristate	4.95
Z80(780C)	CPU	\$14.95	93421	256X1	Static	2.95
280A(780-1)	CPU	16.95	UP0414	4K	Oynamic 16 pin	4.95
COP1802	CPU	19.95	(MK4027)	416	Dynamic 16 pm	4.90
2650	MPU	19.95	UPD416	16K	Dynamic 16 pir. 250ns	9.95
5502	CPU	11.95	(MK4116)	FOR	Dynamic to bit 250ms	9.90
8035	8-Bit MPU wiclock, RAM, 1/0 lines	19,95	TM\$4044-	4K	Static	14.95
P8085	CPU	19.95	45NL	411	Stepe	14,55
MS9900JL	16-Bit MPU w/hardware, multiply		TMS4045	1024X4	Static	14,95
	& diside	49.95	2117	16,384X1	Ovnamic 350ns	9.95
	SHIFT REGISTERS		4.11	10.00 11	(house marked)	3.33
MM500H	Dual 25 Bit Dynamic	5.50	MM5262	2KX1	Dynamic	4/1.00
MM503H	Dual 50 Bit Dynamic	.50	mmszoz	Zna,	-	471.00
MM504H	Dual 16 Bit Static	50			PROM'S	_
MM506H	Dual 100 Bit Stafic	50	1702A	2048	FAMOS	\$5.95
AM510H	Dual 64 Brt Accumulator	50	2716INTEL	16K*	EPROM	59.95
4M5016H	500/512 Bit Dynamic	.89	TMS2516	16K*	EPROM	49.95
2504T	1024 Dynamic	3.95	(2716)		single +5V power supply	47.33
518	Hex 32 Bit Static	4 95	TMS2532	4KX8	EPROM	89.95
2522	Qual 132 Bit Static	2.95	2768	8K	EPROM	10.95
2524	512 Static	.99	2716 T.I	16K**	EPROM	29.95
525	1024 Dynamic	2.95			Mages, -5V, +5V, +12V	23.33
2527	Dual 256 Bit Static	2.95	5203	2048	FAMOS	14.95
2528	Dual 250 Static	4.00	6301-1(7611)		Tristate Bipolar	3.49
2529	Dual 240 Bit Static	4.00	6330-1(7602)		Open C Bipolar	2.95
2532	Quad 80 Bit Static	2.95	82523	32X8	Open Collector	3.95
3341	Fife	6.95	82S115	4096	Bipolar	19.95
74LS670	4X4 Registe: File (TriState)	2.49	82\$123	32XB	Tristate	3.95
4530/0	awa nefizies the fattorsie)	2.49	74186	512	TTL Open Collector	9.95
	UART'S		74188	256	TTL Open Collector	3.95
. V. S. 1017		5.95	745287	1024	Static	2.95
A-Y-5-1013	30K BAUO	3'23		.00		ę. Ju

#### JE600 HEXADECIMAL **ENCODER KIT**



- FEATURES:

   Full B bit latched output for micro 3 User Dehne keys with one being bi
- keys LED readout to verify entries Easy interfacing with standard 16 pt

Only +5VDC required for operating
FULL 8 BIT LATCHED OUTPUT—19 KEYBOARO

The JEGO Encode: Rephard provides two separate hexade digits produced from sequential key entires to allow direct camming for 8 bit microprocessor or 8 bit memory circuits (3) additional keys are provided for user operations with one h (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobb.

#### DIGITAL THERMOMETER KIT



\*Dual sensors—switching control for in-door/outdoor or dual monitoring Continuous L.D. 8° hr. display \*Range: 40°F to 199°F / 40°C to 100°C Set for Fahrenholt or Ceislus reading Sim. welnut case AC, well adapter Incl. Size: 3.14° Has 5.78° Wal 13/8° 0°C

JE300 .....\$39.95

### 62-Key ASCII Encoded Keyboard Kit



The JE610 62-Key ASCII Encoded Keyboard The JE610 62-Key ASCI I Encoded Keyboard Kit can be interfaced into most any computer system. The JE610 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.

- 60 Keys generate the full 128 characters, upper and lower case ASCII set
- set
  Fully buffered
  2 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
  Cytopts

- Outputs directly compatible with TTL/DTL or MOS logic arrays Easy interfacing with a 16-pin dip or 18-pin edge connector

JE610 .... \$79.95 62-Key Keyboard only . . \$34.95

#### **LX303 Portable LCD Digital Multimeter** HICKOK



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115V AC ADAPTER
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X10 DC PROBE ADAPTER (Up to 10K)
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The Pennyerhistie 103 is capable of recording data to and to critical speed requirements for the recorder and it is able to co

Datis
Datis Transmission Melhod ... Frequency-Shift Keying, full-duplex (half-duplex selectable),
Maximum Oala Ratis ... 3.00 Baud.
Oala Formal ... Asynchronous Serial (intum to mark level required better sach character).
Receive Channel Frequencias ... Switch selectable (Los (normal) = 1070 space, 1270 mark, High = 205 space, 2225 mark, 17 marmit Channel Frequencias ... Switch selectable (Los (normal) = 1070 space, 1270 mark, High = 205 space, 2225 mark, 1270 mark, High = 105 space, 1270 mark, High = 1075 space, 1270 mark, High = 1075 mark, 1270 mark, 127 parts.

Deta Transmission Method .....Frequency-Shift Keying, full-duplex (half-duple

#### TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with: \*8 each UPD416-1 (16K Dynamic Rams.) 250NS-\*Documentation for conversion

TRS-16K .....

\$75.00

14.95 14.95



#### JUST WRAP Replacement Wire

IW.1. Y

	The state of the s
Part No.	Calar Price
R-JW-B	Blue 50 ft. roll \$2.98
R-JW-W	White 50 ft. roll 2.98
R-JW-Y	Yellow 50 ft. roll 2.98
R-JW-R	Red 50 ft. roll 2.98
R-JW-W R-JW-Y	White 50 ft. roll 2. Yellow 50 ft. roll 2.

#### JUST WRAP" Unwrap Tool \$3.49



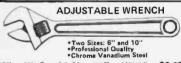
## Vacuum Vise

White

Yellow

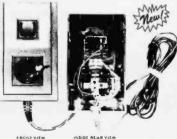
Vacuum-besed light-duty vise for small components and assemblies. ABS con-struction. 1%" jaws, 1%" travel. Can be permanently installed.

VV-1.....\$3.49



6"- AW-6 . . \$4.95 10"- AW-10 . . \$6.95

#### JOYSTICK **VIDEO CONTROLLER**



IDEAL FOR ALL VIDEO GAMES OR REMOTE CONTROL PROJECTS

SMALL CASE SIZE: 1-1/2"H x 2-3/8"W x 4-5/16"L

2 MINIATURE POTENTIOMETERS - 40K OHM EACH SPST PUSH BUTTON CONTROL

5-WIRE CONNECTION CABLE - 5 FEET LONG

· RUGGED PLASTIC CASE

JVC-40 ...... \$4.95 each

#### TRS-80 E.S. 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 heard 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. D.T.R. line 

Requires +5,
-12 VDC 

Board only \$19.95 Part No. 8010, with parts \$59.95 Part No. 8010A, assembled \$79.95 Part No. 8010 C. No connectors provided, see below.



EIA/RS-232 connector Part No. OB25P \$6 00, with 9'. B conductor cable \$10.95 Part No. OB25P9.





**RS-232/TTL** 

INTERFACE

Converts TTL to RS-

232, and converts RS-232 to TTL ● Two sep-

arate circuits . Re-

quires -12 and +12 volts • All connections

go to a 10 pin gold

plated edge connector,

kit \$ 9.95 Part No. 232A 10 Pin edge connector \$3.00 Part

No. 10P.

dillo

#### **RS-232/TTY** INTERFACE

This board has two active circuits, converts RS-232 to 20mA, and the other 20mA converts RS-232. Requires and -12 volts. \$9.95 Part No. 600A



### S-100 BUS **ACTIVE TERMINATOR**

Board only \$14.95 Part No. 900, with parts \$24.95 Part No. 900A



#### MODEM APPLE HIS ● Type 103 ● Full or

half duplex • Works up to 300 baud . Originate or Answer . No coils, only low cost components . TTL input and output-serial • Connect 8 Ω speaker and crystal directly to board • Uses XR FSK demodulator ● Requires +5 volts ● Board only \$7.60 Part No. 109, with parts\$29.95Part No. 1094



#### DISKETTES



Box of 10, 5" \$29.95, 8" \$39.95 Plastic box, holds 10 diskettes, 5" - \$4.50, 8" - \$6.50.

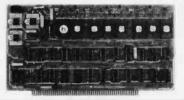
### SERIAL I/O INTERFACE



Baud rate is continuously adjustable from O 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 DTR • Board only \$15.00 Part No. 2, with parts \$42.00 Part No. 2A, assembled \$62.00 Part No. 2C

#### 8K EPROM PIICEON

Saves programs on PROM permanently (until erased via UV light) up to 8K bytes. Programs may be directly run from the program saver such as fixed routines or assemblers. • S-100 bus compatible • Room for 8K bytes of EPROM non-volatile memory (2708's). • Onboard PROM programming . Address relocation of each 4K of memory to any 4K boundary within 64K • Power on jump and reset jump option for "turnkey" systems and computers without a front panel • Program saver software available • Solder mask both sides • Full silkscreen for easy assembly.
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

2102 type RAMS. PCBD \$24.95, \$168 Kit PCBD \$24.95, \$168 Kit QMB-12 MOTHER BOARD, 13 stot, terminated, \$-100 board only \$89.95 Kit CPU-1 8080A Processor board \$-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 \$25.95.\$60.95 Kit card PCBD \$25.95 \$60.95 Kit card PCBD \$25.95 \$49.95 With parts less EPROMS EPM-2 2708/2716 16K/32K EPROM card PCBD \$24.95 With parts less EPROMS GMB-9 MOTHER BOARD. Short Version of GMB-12. 9 Slots PCBD \$30.95 \$67.95 Kit

GMB-12. 9 Slots PCBD ..... \$30.95 \$67.95 Kit MEM-2 16KxB Fully Buffered 2114 Board PCBD ..... \$25.95, \$269.95 Kit

#### T.V. TYPEWRITER

Stand alone TVT 32 char/line, lines, modifications for 64 char/line included Parallel ASCII (TTL) input • Video output 1K on board memory Output for computer controlled curser ● Auto scroll ● Nondestructive curser • Curser inputs: up, down, left, right, home FOL. 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



TAPE

INTERFACE

Play and record Kan-

sas City Standard tapes

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 . Ear-

#### HEX ENCODED KEYBOARD

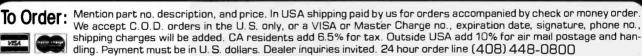
This HEX keyboard has 19 keys, 16 encod-ed with 3 user definable. The encoded TTL outputs. 8-4-2-1 and STROBE are debounced and available in true and complement form. Four onboard LEDs indicate the HEX code generated for each key depression. board requires a single +5 volt supply. Board only \$15.00 Part No. HEX-3, with parts \$49.95 Part No. HEX-3A. 44 pin edge connector \$4.00 Part No.



#### DC POWER SUPPLY

 Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. . Power required is B 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





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#### FLOPPY DISK STORAGE BINDER

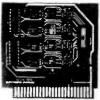
This black three-ring b comes with binder ten transparent plastic sleeves which ac-commodate either twenty, five-inch or ten, eight-inch floppy disks. The plastic sleeves may be ordered separately and added as needed. A contents file is in-cluded with each cluded with each sleeve for easy identification and organiz-ing. Binder & 10 holders \$14.95 Part No. B800: Extra holders 95° each. Part No. 800



#### **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



#### TIDMA

 Tape Interface Direct Memory Access • Record and play programs without bootstrap load-er (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 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 documentation with \$12.95

#### **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



#### **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. \$1:19.95.



#### **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 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 \$229.95. Part No. TA 1000C

#### DISK JACKETTM

Made from heavy duty .0095 matte plastic with reinforced grommets. The minidiskette version holds two 5-1/4 inch diskettes and will fit any standard three ring binder. The pockets to the left of the diskette can be used for listing the contents of the disk. Please order only in multitudes of ten. \$9.95/10 Pack.



ATARI 800

Computer with BK \$995.00, disk drive \$549.00. printer \$599.99



#### **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 select-able • Memory 1024 characters (7-21L02) Video processor chip SFF96364 by Neculonic • Control characters (CR, LF, →, ←, 1, 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.



#### RS-232/20mA INTERFACE

This board has two passive, opto-isolated circuits. One converts RS-232 to 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, Board only \$9,95, part no. 7901, with parts \$14.95 Part No. 7901A.



#### COMPUCOLOR II

Model 3, BK \$13 95, Model 4, 16K \$14 95, Model 5, 32K \$16 95. Prices include color computer, monitor, and one disk drive.



#### **PET COMPUTER**

With 16K & monitor \$ 795. Dual Drive - \$10 95



## II siggn

**APPLE II PLUS** 16K - \$975, 32K -\$1059, 48K - \$1123.



#### **CASSETTE TAPE** ERASER



REMOVES RECORD-INGS IN ONE SEC-OND! The process eliminates static positive / negative ions and maintains original tone quality with min-imal tape hiss • To im-prove tone quality • To reduce hissing • For quick and easy to erase • No battery or liquid required . Powerful and effective action • Unconditional 2 year guarantee. ERASER-8 \$19.95.

#### **16K RAMS**

For the Apple, TRS-80 or Pet \$8 each Part No. 4116/

#### APPLE II HOBBY/ PROTOTYPING CARD

\$14.95 Part No. 7907

#### 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





#### **PARALLEL TRIAC OUTPUT BOARD FOR APPLE II**

This hoard 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.



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16K (200/250 ns.)

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Range DVM, ½" LCD displays
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Large Digital

CS-1 10 Amp Current Shunt

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# PUTER

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- Provides one, two or three drives.
- Adds up to 1.5 million bytes of on-line storage.
- 120 day warranty
- Does everything Radio Shack's expansion system will do...for less!

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\$1550.00 Two drive Expansion System \$2100.00 Three drive Expansion System

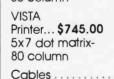
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#### The TRS-80 Printers

Centronics 730... **\$945.00** 7x7 dot matrix-

80 column Anadex

DP8000... \$895.00 9x7 dot matrix-80 column



#### Other Products

1.	VISTA Verbatim diskettes (hard or soft sector) Certified
	40 track\$ 38.95
2.	16K RPM upgrade kits, guaranteed for 120 days.
	PRIME PRODUCT
3.	NEW! DOS +\$ 110.00
4.	LNW expansion bare board\$ 66.95
5.	H.C. Pennington book, TRS-80 Disk
	and Other Mysterles\$ 18.95
6.	DDT Disco-Tech disk drive timer\$ 19.95
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MPi B51	40 Track, Double
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	Density-408K\$375.00
Siemens	FDD100-5 40 Track Double
	Density 204K\$275.00
Slemens	FDD100-5 Flippy,
	records both sides\$290.00
Siemens	FDD100-8 8" Single
	Sided Drive\$448.00

VOS

#### The VISTA V-200 for Exidy

 Completely packaged system, tested and ready to plug in, Includes: power supply, two 40 track drives, case, controller, all cabling and total CPM documentation.

Storage capacity from 400K to 1.2 meg.

 System software-VISTA CP/M Disk Operating System and BASIC-E Compiler recorded on 5-1/4" diskettes.

Price: Starting as low as \$1199.00



CALL TOLL-FREE 800-854-8017

\*TRS-80 is a registered trademark of Radio Shack

The Vista Computer Company 1401 Borchard Street ● Santa Ana, California 92705 ● 714/953-0523

## Unclassified Ads

FOR SALE: RCA Cosmac VIP CDP1802. Fully assembled and working beautifully. Pixe-Verter for television and cassette recorder included. Also, two manuals and one issue of Viper magazine. Asking \$200 or best offer. I pay shippling. Jeff Roberts, 1800 Huntington Tpke, Trumbull CT 06611, (203) 375-9430.

FOR SALE: Three 6800 systems at my cost less 50 to 70%. AMI PROTO processor, Davis 16 K random-access-memory boards, MSI/GSI disks, IDS printers. Buy system or components. Send SASE for complete list of components and prices. Phil Reagan, 1557 Jackson St #106, Oakland CA 94612, (415) 839-3409.

FOR SALE: Radio Shack TRS-80, Level II. 16 K. Complete system (processor/keyboard, video monitor, cassette recorder). Plus some programs, assorted books, and many cassettes. One-year-old, used three months. Sacrifice at \$650, Stan Birnbaum, 1610 Hudson St Apt 4, Helena MT 59601, (406) 443-7320.

WANTED: Sanders 708 video display terminal, or equivalent, for X-Y vector displays. Send details, including price and condition. George B Konizer, 2008 N Brailsford Rd, Camden SC 29020.

WANTED: A ZE, ZB, ZC, or ZD erasable read-only memory for Digital Group Z80 board. A Z80 operating system cassette for 1024 TVC, also by Digital, or a good copy of same. You name the price. Fred A Bufanlo, 96 Overlook Ter, Bloomfield NJ 07003.

FOR SALE: PerSci dual 8-inch disk drive, double-density rated with cable for direct input/output (I/O), Model #2142; also, controller card for S-100 bus. Both one-year-old and working. Original cost over \$2700; sell for \$2300. Richard Turner, 1420 Balboa Av Apt J-75, Panama City FL 32401, (904) 769-8025 Wednesday and Friday evenings and weekends.

FOR SALE: TRS-80 computer system 16 K Level II, expansion Interface, RS-232 interface, and disk drive with disk operating system disk (all cables included). Excellent condition. Buying larger system. My cost \$1900, will sell for \$1600 or best offer. S Phail, 4900 Bristow Dr, Annandale VA 22003, (703) 941-4075.

WANTED: MITS 88-2SIO input/output (I/O) board. All integrated circuits must be socketed and board must be in working order. R Tsubota, Rt 2 POB 442, Ontario OR 97914.

FOR SALE: Heathkit H8 computer system with 16 K, H8-5 input/output (I/O) cassette interface, H9 video terminal, and HC8-14 cassette software system. All factory tested and running. Includes all manuals, documentation, and software. \$1000 or best offer. (Canadian funds) WIII ship. Reason selling: I have two computer systems. Robert Tremblay, 1316 Teillet, Ste-Foy Quebec, CANADA G1W 3C2.

WANTED: Apple II or Apple II Plus. No Apple is too small. If you want to trade up, give a hand to a beginner. Send a description and price. Please include your phone number. Everyone will receive a reply if at all possible. David Hayes, 537 Hall St, Ripon WI 54971.

WANTED: Information about fixes or patches for bugs in TDL-Xitan FORTRAN and/or Disk BASIC. Will pay with money or similar information known to me. Have written FORTRAN program for communication and file transfer between Micro and WYLBUR on 370. Will be happy to share. M Frankel, Dept of Statistics, Baruch College CUNY, 46 E 26 St, NYC NY 10010.

WANTED: Diablo 1650 print mechanism with or without interface. Or Selectric print mechanism with ASCII interface. Dennis Toeppen, 409 S Hi Lusi, Mount Prospect IL 60056, (312) 255-2255 after 6 PM weekdays.

FOR SALE: Expandor Black Box printer. See 11/77 Kilobaud for detailed article or 5/79 Jade ad for brief description of this compact eighty-column impact printer. Case, parallel interface, cable, connectors, documentation, and shipping included. Cost new is \$470. First \$300 bank check or money order gets mine. Used nine months. Fred Lepow, 1700 Circo del Cielo Dr, El Cajon CA 92020, (714) 440-9310 (nights) or (714) 276-3414 (days).

FOR SALE: Two Friden Flexowriter units. Each has paper-tape read/write on keyboard, a desk/console, and an auxiliary scanning/reader. \$265 each. Also, Tektronix 513 oscilloscope DC to 18 MHz; \$195. Gerald Ortman, 7619 Forrest Av, Munster IN 46321, (219) 836-1514 evenings.

FOR SALE: IBM 1050 Data Communication System (RS-232). Consists of control unit, Selectric-based printer-typewriter, paper-tape punch, paper-tape reader. Full documentation. Excellent condition. \$800. SASE would be appre

FOR SALE: Two 2315 2.4 M bytes disk cartridges, Hewlett-Packard Model #12869A, in Wright Line Model #5835-20 disk pack cartring case; \$100 or reasonable offer. Fourteen Hewlett-Packard 9162-0050 digital cassettes; \$28 or reasonable offer. James R Schueler, 317 Chilean Av Rear, Palm Beach FL 33480.

FOR SALE: Altos/8000 (Model ACS 8000-1) with two 8-Inch drives (½ Mb), 64 K main memory, CP/M operating system, Xitan Extended Disk BASIC, Texas Instruments' (Model 810) 150 characters per second (cps) printer with forms length control, Volker Crelg video display with numeric pad, detachable keyboard, and addressable cursor. John Whiffen, (416) 279-1496 (CANADA).

FOR SALE: Intel single-board, computer-based system. Includes: SBC-80/10 (8080A processor card), SBC-104 (4 K random access memory, input/output (I/O), etc), SBC-116 (16 K random access memory, read-only memory, I/O), SBC-310 (high-speed math processor), SBC-534 (four-channel serial I/O), SBC-604 (card cage), SBC-635 (14 A power supply). Also, SBC-80/04 (8085 processor), ultraviolet programmable read-only memory eraser, National Multiplex digital cassette recorder, and DEC LA-36 terminal. Will negotiate price or trade. Jim Mortons, POB 65, Fond du Lac WI 54935.

FOR SALE: PDP-11 boards. Removed from working PDP-11/15. Complete processor. Very powerful. Too many boards to list. One Hex (front panel), four Quad, six Dual, three Single, seven Single small. Twenty-one boards in all. \$60. Take advantage of the low value of the Canadian dollar and buy. Write for complete information. David Lai, 13250 Racine St, Plerrefonds Quebec, CANADA HBZ 1Y7.

FOR SALE: Three IMSAI 4 K random-access-memory boards for S-100 bus with individual 1 K write-protect. 885 each. One Polymorphics video board with 16 by 64 characters, 48 by 128 graphics, 1 K of on board random access memory, and an 8-bit parallel port for keyboard. Also for S-100 bus. \$160. Everything assembled. Peter Hack, 579 Diamond St, San Francisco CA 94114, (415) 824-4225.

FOR SALE: Commodore PET 2001/8 with full documentation. Assorted software games included. Excellent condition, burned In, and running. \$525. Michael DiMario, 4300 N 92 St Apt 1, Milwaukee WI 53222, (414) 476-8300 ext 720 days, (414) 463-0836 evenings.

FOR SALE OR TRADE: I will design and print a single- or double-sided printed-circuit board from your specifications on my Tektronix graphics computer. Will trade for surplus computer gear. Send SASE for sample of my work. Rex Taylor, 2367 NW Kearney, Portland OR 97210.

#### **Unclassified Policy**

Readers who are soliciting or giving advice, or who have equipment to buy, sell or swap should send in a clearly typed notice to that effect. To be considered for publication, an advertisement must be clearly noncommercial, typed double spaced on plain white paper, contain 75 words or less, and include complete name and address information.

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Please note that it may take three or four months for an ad to appear in the magazine.

FOR SALE: VIM single-board microcomputer in original box with all documentation; \$195. Also, Radio Shack Editor-Assembler for TRS-80 unused; \$25. V M Faulkner, RR 2 POB 294A, Yorktown IN 47396, (317) 289-4138.

FOR SALE: IMSAI 8080, 22-slot mother board, 2P+S, Tarbell cassette, 16/32 K erasable-programmable read-only memory, Godbout active terminator, 8 K Seals + 24 K Godbout random access memory, H9 terminal, Mullen extender. \$2000. Larry, 516 E St, Galt CA 95632, (209) 745-1843.

FOR SALE: Two Processor Technology 16 K dynamic programmable memory boards #16KRA for SOL or S-100 system. See January 1977 BYTE, page 10. With manual. 32 K for \$200. Not sold separately. First check or money order takes it. Bob Duke, 13526 Pyramid Dr, Dallas TX 75234, (214) 241-2888.

OLD COMPUTING DEVICES: Do you have or know about planimeters, Integraphs, Integrators, mechanical computers, pre-1900 calculators, or other unusual early computing machines? Do you have books, manuals, or other documentation about them? I am buying, studying, and exchanging stories about these things. What's the weirdest computing machine you know of? I'd particularly like to hear about unusual projects, both historical and recent. Dick Rubinstein, 15 Maugus Av, Wellesley MA 02181.

FOR SALE: Digital Group standard mother board, Z80 processor board, input/output (I/O) board, TVC/cassette interface, George Risk keyboard in oak cabinet, TV monitor conversion kit, dual Phi-Deck and controller board, nonstandard power supply and cabinet. All documentation and system programs included. Boards assembled by professional digital technician. System never calibrated or run. \$800 complete or trade for TRS-80 disks or printer. Jim Lewis, POB 22045, Knoxville TN 37022

WANTED: I need a few odd integrated circuits for repairs to circuit boards made by Intel Corp. Type numbers are: P3404, MC3002, 8267, 8263, NE550, MC3003. Damaged boards with salvageable usable circuits would be satisfactory. Merle Vogt, POB 145, Von Ormy TX 78073.

WANTED: Hewlett-Packard 9830 in excellent working condition, preferably under H-P maintenance. With plasma display, tape cartridge drive, thermal printer, BASIC, and manual. R Kesell, 345 W 88th St, NYC NY 10024, (212) 873-5556.

FOR SALE: Upgrading all TRS-80 Model I equipment to Model II. Must sell Ilke-new expansion interface with 32 K random access memory. Only \$470. Two Shugart disk drives with cable, and four MPI disk drives with cable. Your choice only \$385 per drive. Buy two or more drives and get the cable free. One Centronics printer (call or write for price). Bruce Taylor, 118 S MIII St, Pryor OK 74361, (918) 825-4844, after 6:00 PM (918) 434-5242.

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#### December BOMB Numerical Analysis

"Add Nonvolatile Memory to Your Computer" by Steve Ciarcia (page 36) proved to be the most popular among those readers who voted. Second place in the BOMB voting went to James L Peterson for "Text Compression" (page 106). These two authors receive the \$100 first-place and \$50 second-place prizes. Third place was shared by F R Ruckdeschel ("Frequency Analysis of Data Using a Microcomputer," page 10) and Christopher O Kern ("A User's Look at Tiny-C," page 196).■



BREAKING THE SOUND BARRIER



THE TRAP DOOR

September 1977

March 1979

## Byte Cover Prints -- Limited Editions.

The September '77 and March '79 covers of BYTE are now each available as a limited edition art print, personally signed and numbered by the artist, Robert Tinney.

These prints are strictly limited to a quantity of 750 for each cover, and no other editions, of any size, will ever be published. Each print is 18" x 22", printed on quality, coated stock, and signed and numbered in pencil at bottom.

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Ohio Scientific's top of the line personal computer, the C8P DF. This system incorporates the most advanced technology now available in standard configurations and add-on options. The C8P DF has full capabilities as a personal computer, a small business computer, a home monitoring security system and an advanced process controller.

**Personal Computer Features** 

The C8P DF features ultra-fast program execution. The standard model is twice as fast as other personal computers such as the Apple II and PET. The computer system is available with a GT option which nearly doubles the speed again, making it comparable to high end mini-computer systems. High speed execution makes elaborate video animation possible as well as other I/O functions which until now, have not been possible. The C8P DF features
Ohio Scientific's 32 x 64 character display with
graphics and gaming elements for an effective
resolution of 256 x 512 points and up to 16 colors. Other features for personal use include a programmable tone generator from 200 to 20KHz and an 8 bit companding digital to analog converter for music and voice output 2-8 axis joystick interfaces, and 2-10 key pad interfaces. Hundreds of personal applications, games and educational software packages are currently available for use with the C8P DF.

Business Applications
The C8P DF utilizes full size 8 to floppy disks and is compatible with Ohio Scientific's advanced small business operating system, OS-65U and two types of information management systems, OS-MDMS and OS-DMS.

The computer system comes standard with a high-speed printer Interface and a modem interface. It features a full 53-key ASCII keyboard as well as 2048 character display with upper and lower case for business and word processing applications.

#### **Home Control**

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

#### **Process Controller**

The C8P DF incorporates a real time clock, FOREGROUND/BACKGROUND operation and 16 parallel I/O lines. Additionally a universal

accessory BUS connector is accessible at the back of the computer to plug in additional 48 lines of parallel I/O and/or a complete analog signal I/O board with A/D and D/A and multiplexers

Clearly, the C8P DF beats all existing small computers in conventional specifications plus it has capabilities far beyond any other computer system on the market today.

C8P DF is an 8-slot mainframe class computer with 32K static RAM, dual 8" floppies, and several open slots for expansion.

Or get started with a C8P with cassette interface, 8K BASIC-in-ROM which includes most of the features of the C8P DF except the real time clock, 16 parallel I/O lines, home security interface and accessory BUS. It comes with 8K static RAM and Ohio Scientific's ultra-fast. 8K BASIC-in-ROM. It can be expanded to a C8P DF later. Base price \$895. Virtually all the programs available on disk are also available for the C8P cassette system on audio

Computers come with keyboards and floppies where specified.

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