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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 color-graphics-oriented personal computer is shown atop 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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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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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 editorial’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 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.

(At 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
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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.

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 battery.
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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 cueing of the third contact diamond ring sequence. The margin

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 9V transistor 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 table-driven one, with two tables of the data type "an-exposure-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.

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Text continued on page 102

Listing 1: A Pascal eclipse internal-allocation program. This listing contains the first cut at a Pascal camera-control program for the 1980 solar eclipse. The program's name is "eclipse-monitor-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 cueing 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.
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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 hometech 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.

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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 Intelgrand Research mainframe box, the SSM Monitor V.L.O (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 hexadecimak 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 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 biorythms." 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 subconscious minds are. I feel my subconscious 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 \( S = S / (1 - 3) \), instead of \( S = S / (1 - 1) \). This does not affect the curve fit or relative comparisons, but influences the printed value of the standard deviation by several percent.

F R Ruckdeschel
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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 8088?”

“Wait a minute,” Ed and Dave responded, harmonizing, “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 preter could be written to run on it. In case you're interested, the next issue while four chips is a possibility, a preter could be written to run on it. In

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

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

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Visit your nearest computer store for details. And while you're there, do some comparison testing. With all due respect to the others, once you see it, you'll be sold on the Compucolor II.
An exhibit of advancing microprocessor technology. Here are four integrated circuits produced by Intel Corporation. From bottom to top, we have the 8008, the first 8-bit general-purpose microprocessor; the 8080A, one of the breed of 8-bit devices that helped ignite the microcomputing boom; the 8086, the advanced 16-bit processor; and the 8088, the subject of this article—a component that contains 16-bit computing capability in a package that can communicate with the outside world through an 8-bit data bus.

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 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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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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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 extra-segment 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 HS 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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addition to the system and provides an extra 1 K byte 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 single-instruction 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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Adding a printer increases the practicality and usefulness of your personal computer dramatically. You’ll be able to perform all sorts of bookkeeping and accounting functions — from balancing your personal checkbook to monitoring your company’s inventory — and you’ll have a permanent copy for your records. You’ll find that whether you’re controlling your family’s budget, recording your program listing, plotting the growth of a stock in the market, or any of the other thousands of analytical functions your computer can perform, a quality printer is simply invaluable. But you’ll want to be sure to pick the right printer for your system.

The Eaton LRC 7000+ is designed specifically for personal computers. Its plug-in simplicity makes it remarkably easy to interface with any computer. Its simple design features the fewest possible moving parts, making it virtually maintenance free. Unlike many other printers, the 7000+ can print on any type of roll paper, eliminating the hassle and added expense of purchasing a special treated paper. Its rugged case is tough enough for industrial environments, yet attractive enough for home or office use. And most importantly, it offers the high performance and features you demand in a quality printer.

Super Performance

The 7000+ features unidirectional printing with a line speed of 1.25 lines per second. It accepts any single or two-ply paper roll from 3/4 inch to 3-7/8 inches wide, and prints a 3-1/3 inch line. Capacity is adjustable and can be 40 columns at 12 characters to the inch using the single width font; or 20 columns at 6 characters to the inch using the double-wide font. An available option allows the unit to print 64 columns at the single width setting, and 32 columns using a double width font.

An Unbeatable Price

The real beauty of the new 7000+ is the fact that you can’t buy another printer that offers you all these features at anywhere near the price. Eaton LRC’s 7000+ has a suggested retail price of $389.00 and comes with a 90-day factory warranty.

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Whether you’re looking for a quality printer to add to your existing computer, or are about to buy a complete system, don’t settle for less than an Eaton LRC printer. Stop by your local Computerland store or contact Quest Electronics, 2322 Walsh Avenue, Santa Clara, CA 95051, (408) 988-1640 or Sigma International, Inc., P.O. Box 1118, Scottsdale, AZ 85252, (602) 994-3436 for more information. Once you’ve seen the new 7000+, you won’t settle for anything less.

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Southeastern office, 29 Delmont Drive Northeast, Atlanta, GA 30305, (404) 231-4105; Western office, 510 Lawrence Expressway, Suite 210, Sunnyvale, CA 94086, (408) 245-1590.

[Image of a person using the Eaton LRC 7000+ printer]
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 BX, BX ;CLR BX
MOV CX, 5 ; Set loop counter

Average
INC BL ;Increment data counter
IN AL, Port # ;Input data
ADD BH, AL ;Update running total
MOV AL, BH ;Divide running total by data counter.
OUT Port #, AL ;Output running average.
LOOP Average ;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 H, 00 ;Clear H register
MVI E, 00 ;Clear E register

Average
INR E ;Increment data counter
MOV C, H ;Input data
ADD A, Port # ;Add data to running total

Divide
XRA A ;Clear accumulator
MOV B, A ;Clear B register
MOV L, A ;Clear L register
MVI C, 80 ;Initialize bit counter

Loop
MOV A, C ;Shift B and C as a 16-bit unit—one bit left
RAL
MOV C, A
MOV A, B
MOV B, A
CMP E ;Compare data
cmp ;counter (divisor) with
JC Next ;dividend; if divisor is larger,
SUB E ;bypass subtract.
MOV B, A ;Divisor is smaller; subtract.
MOV A, D ;Set current bit of
ORA L ;L to 1
MOV L, A
Next
MOV A, D ;Shift D right and check carry
RRC Loop
MOV A, L ;If no carry, return for next bit.
OUT Output # ;Output running average
MVI A, 05 ;Return unless fifth pass is
CMP E ;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 binary-coded decimal (BCD) or ASCII-encoded 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.

```
MOVDI, ASCBUF ; Destination index points to ASCII buffer
MOV CX, 028 ; C register contains length of buffer
LCLCJCXZ EMPTY ; Skip if input buffer empty
Lods EBOBUF ; Get next EBCDIC character
XLAT TABLE ; Translate to ASCII
STOS ASCBUF ; Transfer ASCII character to buffer
CMP AL, EOT ; Test for EOT character
LOOPNE NEXT ; Continue if no EOT received (CX decrements first)
```

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 handing 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
- 2048 bytes of erasable, programmable read-only memory (EPROM)
- 38 parallel I/O lines
- a 14-bit counter/timer
- power-on reset and nonmaskable interrupt.

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 an 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 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.

Ionization 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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electron affinities see the Handbook of Chemistry and Physics published by the Chemical Rubber Company.) The depth of the potential well of any element, that is, its ability to hold on to an electron, can be estimated by averaging the element's ionization potential and electron affinity.

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.

**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, \( \hbar \) is read as "\( h \)-bar," and stands for a value equal to Planck's constant divided by \( 2\pi \). Planck's constant, \( \hbar \), is an empirically determined value equal to \( 6.6256 \times 10^{-34} \) 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, \( -\frac{\hbar^2}{2m} \frac{d^2}{dx^2} \).

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.
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, $V_o$.

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 $\psi_2$ 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 $x = +a$, $\psi_a$ 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

---

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m$</td>
<td>mass of an electron; $9.109 \times 10^{-31}$ kilograms</td>
</tr>
<tr>
<td>$q$</td>
<td>charge of an electron; $1.602 \times 10^{-19}$ Coulombs</td>
</tr>
<tr>
<td>$h$</td>
<td>Planck's constant divided by $2\pi$; $6.626 \times 10^{-34}$ electron-volt-seconds</td>
</tr>
<tr>
<td>$\lambda$</td>
<td>length of chemical bond</td>
</tr>
<tr>
<td>$V_o$</td>
<td>potential difference between elements</td>
</tr>
<tr>
<td>$E$</td>
<td>total energy of the electron</td>
</tr>
<tr>
<td>$A$</td>
<td>coefficient of the wave equation, $\psi_a$, for the left side of the potential well</td>
</tr>
<tr>
<td>$B$</td>
<td>coefficient of the wave equation, $\psi_b$, for the right side of the potential well when $E &gt; V_o$</td>
</tr>
<tr>
<td>$C, D$</td>
<td>coefficients of the wave equation, $\psi_{C, D}$, for the right side of the potential well when $E &lt; V_o$</td>
</tr>
</tbody>
</table>

**Listing 1:** BASIC program that solves the Schrödinger equation to simulate the behavior of an electron in a diatomic chemical bond.

The program finds $\alpha$, $\beta$, and $\gamma$ in terms of $V_o$.

The correspondence of variables in the program to terms in the equations is as follows: $A$ stands for $\alpha$; $B$ stands for $\beta$; $G_1$ stands for $\gamma$; $V_0$ stands for $V_o$.

10 REM PROFILE OF A CHEMICAL BOND IN A DIATOMIC MOLECULE
20 REM WRITTEN BY MICHAEL LIEBL
30 REM CALCULATION OF N AND V0
40 REM PROGAM LINES 10-1000
50 PRINT: PRINT: PRINT
60 DIM $S(10), R(10), IP(10), EA(10)
70 PRINT TAB(20):"-PROFILE OF A CHEMICAL BOND--"
80 PRINT
90 PRINT" THE ELECTRON DENSITY IN THE CHEMICAL BOND OF A DIATOMIC MOLECULE"
100 PRINT"DEPENDS UPON THE POTENTIAL DIFFERENCE ($V_0$) BETWEEN THE TWO ELEMENTS"
110 PRINT"WHICH ARE BOUND TOGETHER AND UPON THE LENGTH OF THE BOND (A). THE"
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"
160 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 PRINT TAB(10)LITHIUM - Li"
220 PRINT TAB(10)"SODIUM - Na"
230 PRINT TAB(10)"POTASSIUM - K"
240 PRINT TAB(10)"RUBIDIUM - Rb"
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(I), R(I), IP(I), EA(I)
310 IF $S(I)>A$ THEN NEXT I
320 IF I>11 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 J>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 Q=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 V0<0 THEN V0=-V0
530 N=SQR((2*M*V0/Q9)*A/H)
540 N2=N^2

550 PRINT "V0 = " ;
560 PRINT USING "#.##"; V0
570 PRINT " N = " ;
580 PRINT USING "##.###"; N

590 PROMPT : PRINT : PRINT

600 INPUT "WHEN READY TO CONTINUE TYPE A CARRIAGE RETURN. ";A$
610 GOTO 1010

800 REM SYMBOL ENTRY ERROR
810 PRINT
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 Cl, 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 TAB(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 GOTO 1300

Listing 1 continued on page 40
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1-800-421-4645
Listing 1 continued:

```
1270 PRINT"
1280 GOTO 1300
1290 PRINT TAB(36+Y1):"x"
1300 NEXT A1
1310 FOR A=1 TO 60
1320 PRINT 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"A1= ";
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 S<09 THEN G9=S 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 N>A1 THEN GOTO 1560 ELSE GOTO 1610
1550 REM PAIR OF EQUATIONS FOR N>1
1560 Q1=SQRT(N2-A2)
1570 Y1=Q1*SIN(A1)/(A1*COS(A1))
1580 Y2=-(EXP(Y1)-EXP(-Y1))/(EXP(Y1)+EXP(-Y1))
1590 S=(Y1-Y2)^2
1600 RETURN
1610 REM PAIR OF EQUATIONS FOR N<1
1620 Q2=SQRT(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 N=A1 THEN G2=N2-A2 ELSE B2=A2-N2
1700 G1=SQRT(G2)
1710 B1=SQRT(B2)
1720 IF N<A1 THEN GOTO 1760
1730 PRINT"B1= ";
1740 PRINT USING "###.###";B1
1750 GOTO 1780
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 PRINT"DO YOU WANT OUTPUT 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(9);"--------------------"
2120 PRINT
```

Listing 1 continued on page 43
BANK SELECT — 64K BYTE EXPANDABLE MEMORY BOARD

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FULLY COMPATIBLE WITH:

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CROMEMCO
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Listing 1 continued:
2130 PRINT TAB(4);"A";TAB(17);"PSI";TAB(26);"(PSI)^2"
2140 FOR P=-16 TO 0
2150 GOSUB 2610
2160 GOSUB 2900
2170 NEXT P
2180 FOR P=1 TO 16
2190 GOSUB 2680
2200 GOSUB 2900
2210 NEXT P
2220 PRINT
2230 IF F=1 THEN 3000
2240 PRINT"W OULD YOU LIKE TO SEE THE GRAPHICAL FORM?"
2250 PRINT"ENTER A YES OR NO"
2260 F=1
2270 INPUT A$
2280 IF A$="YES" THEN GOTO 2310
2290 IF A$="NO" THEN 3000
2300 GOTO 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"W OULD YOU LIKE TO SEE THE TABLE OF VALUES?"
2530 PRINT"ENTER A YES OR NO"
2540 F=1
2550 INPUT A$
2560 IF 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=16-P/16
2700 X=W*A
2710 IF N=0 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
Text continued from page 37:

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:

\[
\psi_L = \psi_R \text{ at } x = 0
\]

- 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 \( E > V_0 \), \( \psi_L \) is a sine function designated \( \psi_L \), 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 \( \psi_R \). 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:

1. determine the potential difference, \( V_0 \), 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 \( a \alpha \) (where \( \alpha \) is equal to the momentum of the particle divided by \( n \) 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 \( \beta \alpha \) or \( \gamma \alpha \) (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 \( \psi_L \) or \( \psi_R \)
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} = -2mE\psi = -\alpha^2\psi ; \psi = 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 \( \psi \) twice.

B

\[ \begin{align*}
\frac{d^2\psi}{dx^2} &= -2m(E - V_o)\psi = -\beta^2\psi ; \psi_{n,1} = B \sin(\beta(x - x)) \text{ for } E > V_o \\
\frac{d^2\psi}{dx^2} &= 2m(V_0 - E)\psi = \gamma^2\psi ; \psi_{n,2} = C \sinh(\gamma(x)) + D \cosh(\gamma(x)) \text{ for } E < V_0
\end{align*} \]

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 \( \psi \) twice.

C \quad n^2 = \frac{2mV_0a^2}{\hbar^2}

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

D

\[ \begin{align*}
\beta^2a^2 &= n^2 \text{ for } E > V_0 \\
\gamma^2a^2 &= n^2 \text{ for } E < V_0
\end{align*} \]

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

E

\[ \begin{align*}
\tan(\beta a) &= -\tan(\sqrt{n^2 - \beta^2a^2}) \text{ for } E > V_0 \\
\tanh(\gamma a) &= -\tanh(\sqrt{n^2 - \gamma^2a^2}) \text{ for } E < V_0
\end{align*} \]

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

F

\[ \begin{align*}
B &= A \sin(\beta a) \sin(\beta a) \text{ for } E > V_0 \\
C &= D \tanh(\gamma a) \text{ for } E < V_0 \\
D &= A \sin(\gamma a)
\end{align*} \]

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.

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.
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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 \( \alpha \alpha \). Depending upon the relative size of \( \alpha \alpha \) and \( n \), the program then evaluates and prints out either \( \beta \alpha \) or \( \gamma \alpha \).

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 \(-\alpha\) and \(+\alpha\) 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 \( \alpha \) and \( \alpha \alpha \) can be determined. The program evaluates \( \alpha \) 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 eleven-digit accuracy.

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

**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 (\( \alpha \alpha \)) BETWEEN THE TWO ELEMENTS WHICH ARE BOUND TOGETHER AND UPON THE LENGTH OF THE BOND (\( \alpha \)). 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
LITHIUM - Li
SODIUM - Na
SODIUM - K
RUBIDIUM - Rb
CESIUM - Cs
FLOURINE -- F
CHLORINE -- Cl
BROMINE -- Br
IODINE -- I

ENTER ELEMENT NUMBER ONE - Na
ENTER ELEMENT NUMBER TWO - Cl

\( \alpha \alpha = 5.743 \)
\( N = 3.414 \)

WHEN READY TO CONTINUE TYPE A CARRIAGE RETURN.

GRAPHICAL SOLUTION OF TRANSCENDENTAL EQUATION
```

Text continued on page 56
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† CP/M is a registered trademark of Digital Research Corp.

Circle 22 on inquiry card.
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

<table>
<thead>
<tr>
<th>A</th>
<th>PSI</th>
<th>(PSI)^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>-0.938</td>
<td>0.148</td>
<td>0.022</td>
</tr>
<tr>
<td>-0.875</td>
<td>0.293</td>
<td>0.086</td>
</tr>
<tr>
<td>-0.813</td>
<td>0.431</td>
<td>0.186</td>
</tr>
<tr>
<td>-0.750</td>
<td>0.560</td>
<td>0.314</td>
</tr>
<tr>
<td>-0.688</td>
<td>0.677</td>
<td>0.458</td>
</tr>
<tr>
<td>-0.625</td>
<td>0.778</td>
<td>0.606</td>
</tr>
<tr>
<td>-0.563</td>
<td>0.863</td>
<td>0.744</td>
</tr>
<tr>
<td>-0.500</td>
<td>0.928</td>
<td>0.861</td>
</tr>
</tbody>
</table>

Listing 2 continued on page 52
Now...
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**HIPAD™ Digitizers**
- The perfect small system input device
- Resolution and repeatability of 0.005 in. (0.1 mm)
- Origin is completely relocatable
- RS232C and 8 bit parallel interface selectable at the connector
- Accuracies of ±0.016 in. (0.4 mm)
- Optional LC display shows actual values being inputted
- Digitizing surface 11" x 11" (28 mm x 28 mm)
- Priced at $795*

For complete information contact Houston Instrument, One Houston Square, Austin, Texas 78753. (512)837-2820. For rush literature requests persons outside Texas call toll free 1-800-531-5205. In Europe contact Houston Instrument, Rochesterlaan 6, 8240 Gistel Belgium. Phone 059/27 74 45.

*U.S. Domestic Price Only
Listing 2 continued:

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

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

**GRAPHICAL FORM**

\[
(\text{PSI})^2
\]

\[\begin{array}{ccc}
-1.0001 \\
-0.9381 \\
-0.8751 \\
-0.8131 \\
-0.7501 \\
-0.6881 \\
-0.6251 \\
-0.5631 \\
-0.5001 \\
-0.4381 \\
-0.3751 \\
-0.3131 \\
-0.2501 \\
-0.1881 \\
-0.1251 \\
-0.0631 \\
0.0001 \\
0.0631 \\
0.1251 \\
0.1881 \\
0.2501 \\
0.3131 \\
0.3751 \\
0.4381 \\
0.5001 \\
0.5631 \\
0.6251 \\
0.6881 \\
0.7501 \\
0.8131 \\
0.8751 \\
0.9381 \\
1.0001
\end{array}\]

Listing 2 continued on page 54
For years many small business system buyers thought that in order to get “real” performance and enough storage to be a “real” business system they would have to sacrifice the family jewels.

But with the introduction of the Smoke Signal Chieftain series office computers a lot of people’s minds have been changed.

Because we designed the highly reliable Chieftain small business system with the most innovative combination of performance and efficiency around.

At your fingertips there are 64,000 characters of random access memory and you can address anywhere from 740,000 characters to 2 million characters with Smoke Signals’s new double density controller. For larger concerns, there’s a 20M byte hard disk available.

At a time when other small computer manufacturers tell you “you’re on your own”, Smoke Signal offers an abundance of easy-to-use software programs such as order entry, inventory control, accounts receivable, invoice entry, payroll, word processing and much, much more. There’s BASIC, COBOL and FORTRAN — even a multi-user BOS (Business Operating System) that allows for numerous users simultaneously.

Chieftain systems starting at under $200.00 per month display performance on par with systems costing twice to three times as much.

So call (213) 889-9340 for your nearest authorized Smoke Signal dealer — he’ll be glad to demonstrate the Chieftain’s high reliability and ease of operation.

For dealers only, circle 24
All other inquiries, circle 7

SMOKE SIGNAL BROADCASTING
31336 Via Colinas, Westlake Village, California 91361. (213) 889-9340
Listing 2 continued:

Would you like to study another pair of elements?
Enter a yes or no
? YES

Hydrogen - H
Lithium - Li
Sodium - Na
Potassium - K
Rubidium - Rb
Cesium - Cs
Flourine - F
Chlorine - Cl
Bromine - Br
Iodine - I

Enter element number one - H
Enter element number two - I

\[ \psi_0 = 0.43^\circ \]
\[ N = 1.270 \]

When ready to continue type a carriage return.

Graphical solution of transcendental equation

<table>
<thead>
<tr>
<th>-30</th>
<th>0</th>
<th>+30</th>
</tr>
</thead>
<tbody>
<tr>
<td>-01-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.10-</td>
<td>*</td>
<td>+</td>
</tr>
<tr>
<td>0.20-</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>0.30-</td>
<td>*</td>
<td>+</td>
</tr>
<tr>
<td>0.40-</td>
<td>*</td>
<td>+</td>
</tr>
<tr>
<td>0.50-</td>
<td>*</td>
<td>+</td>
</tr>
<tr>
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<td>*</td>
<td>+</td>
</tr>
<tr>
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<td>+</td>
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<tr>
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<td>*</td>
<td>+</td>
</tr>
<tr>
<td>0.90-</td>
<td>*</td>
<td>+</td>
</tr>
<tr>
<td>1.00-</td>
<td>*</td>
<td>+</td>
</tr>
<tr>
<td>1.10-</td>
<td>*</td>
<td>+</td>
</tr>
<tr>
<td>1.20-</td>
<td>*</td>
<td>+</td>
</tr>
<tr>
<td>1.30-</td>
<td>*</td>
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<td>+</td>
</tr>
<tr>
<td>3.20-</td>
<td>*</td>
<td>+</td>
</tr>
</tbody>
</table>

Listing 2 continued on page 56
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 usable 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.
Listing 2 continued:

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

<table>
<thead>
<tr>
<th>A</th>
<th>PSI</th>
<th>(PSI)^2</th>
</tr>
</thead>
<tbody>
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<td>-1.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>-0.938</td>
<td>0.112</td>
<td>0.012</td>
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<tr>
<td>-0.875</td>
<td>0.222</td>
<td>0.049</td>
</tr>
<tr>
<td>-0.813</td>
<td>0.330</td>
<td>0.109</td>
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<tr>
<td>-0.750</td>
<td>0.433</td>
<td>0.188</td>
</tr>
<tr>
<td>-0.688</td>
<td>0.531</td>
<td>0.282</td>
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<tr>
<td>-0.625</td>
<td>0.622</td>
<td>0.387</td>
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<td>-0.563</td>
<td>0.706</td>
<td>0.498</td>
</tr>
<tr>
<td>-0.500</td>
<td>0.781</td>
<td>0.610</td>
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<tr>
<td>-0.438</td>
<td>0.846</td>
<td>0.715</td>
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<td>-0.375</td>
<td>0.900</td>
<td>0.810</td>
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<td>-0.313</td>
<td>0.943</td>
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<td>-0.250</td>
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<td>0.949</td>
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<td>-0.188</td>
<td>0.993</td>
<td>0.987</td>
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<td>1.000</td>
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<tr>
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<td>0.875</td>
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<tr>
<td>1.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

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...
Color communicates better. That's the obvious benefit of ISC's new CP/M®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 specially-prepared 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, 32 K of user RAM, 591 K 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.

Intelligent Systems Corp.® Intecolor Drive • Technology Park/Atlanta • Norcross, GA 30092 • Telephone 404/449-5661 • TWX 810-766-1561

Circle 26 on Inquiry card.
### Listing 2 continued:

\[(PS1)^2\]

<table>
<thead>
<tr>
<th>Value</th>
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</thead>
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<td>-0.9381</td>
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<td>-0.8131</td>
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</tr>
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<tr>
<td>-0.5631</td>
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<tr>
<td>-0.5001</td>
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<tr>
<td>-0.4381</td>
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<tr>
<td>-0.3751</td>
</tr>
<tr>
<td>-0.3131</td>
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<tr>
<td>-0.2501</td>
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<td>-0.1881</td>
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<tr>
<td>-0.1251</td>
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<tr>
<td>-0.0631</td>
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<tr>
<td>0.0001</td>
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<tr>
<td>0.0631</td>
</tr>
<tr>
<td>0.1251</td>
</tr>
<tr>
<td>0.1881</td>
</tr>
<tr>
<td>0.2501</td>
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<tr>
<td>0.3131</td>
</tr>
<tr>
<td>0.3751</td>
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<tr>
<td>0.4381</td>
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<tr>
<td>0.5001</td>
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</tr>
<tr>
<td>0.6251</td>
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<tr>
<td>0.6881</td>
</tr>
<tr>
<td>0.7501</td>
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<tr>
<td>0.8131</td>
</tr>
<tr>
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</tr>
<tr>
<td>0.9381</td>
</tr>
<tr>
<td>1.0001</td>
</tr>
</tbody>
</table>

**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. To 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.

---

**Bibliography**

Programming Techniques is a series of collected articles concerned with the art and science of computer programming. The first volume in the Programming Techniques series is entitled Program Design. The purpose of the book is to provide the personal computer user with the techniques needed to design efficient, effective, maintainable programs.

ISBN 0-07-037825-8 Pages: 96
Price: $6
Editor: Blaise W. Lifick

Simulation is the second volume in the Programming Techniques series. Both theoretical and practical applications are included. Particularly stressed is simulation of motion, including wave motion and flying objects, and the use of simulation for experimentation.

ISBN 0-07-037826-6 Pages: 126
Price: $6
Editor: Blaise W. Lifick

Numbers in Theory and Practice is the third book in the series. It includes information of value to both the novice and the experienced personal computer user. The mechanics of the binary system are discussed, including software division and multiplication, as well as floating point numbers, numerical methods, random numbers, and the mathematics of computer graphics.

ISBN 0-07-037827-4 Pages: 192
Price: $8.95
Editor: Blaise W. Lifick

The 4th volume of the Programming Techniques series, Bits and Pieces, covers various topics of interest to programmers. It 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, optimization, and real time processing.

Price $8.95
Editor: Blaise W. Lifick

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Card No. ____________ Exp. Date ____________
Add 60¢ per book to cover postage and handling.

70 Main St, Peterborough, NH 03458
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 high-resolution 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.
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, assempler 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.

*Quantity one. Dealer inquiries invited.

Circle 28 on inquiry card.
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.
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).

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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 exist in the directory (i.e., 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...
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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.
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Percom 'peripherals for personal computing'
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 bicycle 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, 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:

```plaintext
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.

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

If you plan to use multi-user software, you need our CPU Support Card's vectored interrupt controller and sophisticated timers. Whether your system is powered by an 8080, Z80 or 8086, this card was designed to make software interfacing easy. The card's I/O ports, EPROM socket, and "sense switch" give you an expanded flexibility that can greatly simplify those difficult jobs.

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OTHER FEATURES

In addition to full modem control and programmable baud rate for the serial port, the card also includes a 8-bit parallel input port, an 8-bit parallel output port, a socket for a 2K EPROM (addressable to F000H, FF00H, F800H, or FF800H — our Monitor fits here if the card is used with our 8086), and an 8-bit "sense switch" input port to use for system control. Power requirements for the card are less than 1.0 amps at +8V (including timer chip) and less than 0.1 amps for each of the +16V and -16V supplies. The card is provided with a 24" cable for the serial port (DB-25 female). Additional cables for the parallel input (female) and output port (male) are available at $11.50 each.

PRICES

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<td>$235</td>
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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 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. . . .

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
```

<table>
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<tr>
<td>100.29</td>
<td>OUTER</td>
<td>1</td>
</tr>
</tbody>
</table>

READY:

```
FRONT DERAILLEUR DEVICE
REAR GEAR SPROCKETS (MOUNTED ON FREEWHEEL HUB)
REAR DERAILLEUR DEVICE
CHAIN
FRONT GEAR SPROCKETS (CHAIN WHEELS)
```

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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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 ambiguous, 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 vice-versa. (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 (i.e., 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.)

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:

\[
B(i,j) = HSC(A(i,j)) = A(i,j) \text{ OR } A(i-1,j+1) \text{ OR } A(i-1,j) \text{ OR } A(i+1,j+1) \text{ OR } A(i,j+1) \text{ OR } A(i+1,j)
\]

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:

\[
X(\text{slant}) = X(\text{offset})
\]

and

\[
Y(\text{slant}) = Y(\text{offset}) + \text{INT}(X/2)
\]

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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 (i.e., 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:

\[ M_n = M_{n-1} \text{ OR } (T_1 \text{ AND } XSC(Z \text{ AND } M_{n-1})) \]
\[ \text{OR } (T_2 \text{ AND } XSC(Z \text{ AND } M_{n-2})) \]
\[ \text{OR } (T_k \text{ AND } XSC(Z \text{ AND } M_{n-k})) \]
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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 terrain, 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.

Directional Terrain Features

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.

The number of directional terrain masks required equals the number of possible movement direction
multiplied by the number of different movement costs of directional terrain. For example, if trails reduce the movement cost to one-half, and roads reduce the movement cost to one-third, on a map using the city metric scatter function, eight directional terrain masks would be required and the unit movement cost would have to be reduced to one-sixth of its original value. This reduced value must be divisible by the least-common multiple of the reduction factors.

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 (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 \( Id(l,J) = Id(l,J) \) AND \( Pd(l,J) \) for all \( l \) and \( J \).

Let us now define our modified scatter functions \( CSC' \) and \( CSC'' \) as follows:

\[
CSC'(A(l,J)) = A(l,J) \text{ OR } (I1(l,J+1) \text{ AND } A(l,J+1)) \text{ OR } (I2(l,J-1) \text{ AND } A(l,J-1)) \text{ OR } (I3(l+1,J) \text{ AND } A(l+1,J)) \text{ OR } (I4(l-1,J) \text{ AND } A(l-1,J))
\]

Similarly:

\[
CSC''(A(l,J)) = A(l,J) \text{ OR } (P1(l,J+1) \text{ AND } A(l,J+1)) \text{ OR } (P2(l,J-1) \text{ AND } A(l,J-1)) \text{ OR } (P3(l+1,J) \text{ AND } A(l+1,J)) \text{ OR } (P4(l-1,J) \text{ AND } A(l-1,J))
\]

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

\[
MN = MN - 1 \text{ OR } CSC'(MN - 1) \text{ OR } CSC''(MN - 2) \text{ OR } CSC''(MN - 4)
\]

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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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, "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 prime-number 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.

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.

30 PRINT "LIST OF PRIME NUMBERS"
40 PRINT
50 PRINT 1;2;3;
55 C=0
70 M=3
80 M=M+2
90 FOR K = 3 TO M/2 STEP K - 1
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
195 PRINT "C = "; C
200 END

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-M = M THEN 190
110 NEXT K
121 PRINT M;
122 C=C+1
190 IF M < 10000 THEN 80
195 PRINT "C = "; C
200 END

"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 DEFIN TM.K
80 FORM=5TO10000STEP2
90 FORK=3TOM/2STEP2
100 IFINT(M/K)*K-M = M THEN NEXTM
110 NEXTK
120 PRINTTM;
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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### LEAR SIEGLER
- ADM 3A
- ADM 31
- ADM 42

### HAZELTINE
- 1400 | 1500 | Mod 1
- 1410 | 1510 | Edit
- 1420 | 1520

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Circle 49 on Inquiry card.
form of single-byte codes. A translation routine is used to spell out the meaning of these codes when the LIST command is given.... RSS]

Test Problem and Level II BASIC

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

<table>
<thead>
<tr>
<th>Test</th>
<th>Listing hours</th>
<th>Run Time minutes</th>
<th>seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>31</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>21</td>
<td>55</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>22</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>56</td>
<td></td>
</tr>
</tbody>
</table>

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 assembly-language 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 32K 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 16K bytes of memory or in the second 16K 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...
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<table>
<thead>
<tr>
<th>Program Name</th>
<th>6800</th>
<th>6809</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLEX for SWTPC</td>
<td>$90</td>
<td>$90</td>
</tr>
<tr>
<td>FLEX for SSB</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Extended BASIC</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Extended BASIC Precompiler</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>BASIC</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>BASIC Precompiler</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>FLEX Sort/Merge</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Text Editing System</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Assembler</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Text Processing System</td>
<td>60</td>
<td>N/A</td>
</tr>
<tr>
<td>Debug Package</td>
<td>55</td>
<td>75</td>
</tr>
<tr>
<td>FLEX Utilities</td>
<td>100</td>
<td>60</td>
</tr>
</tbody>
</table>

These packages are available on either 8" or 5" soft-sector diskettes (5" 6800 is FLEX 2.0). Price includes user's manual and object code diskette. Certain programs are available on cassette. Contact Technical Systems Consultants for pricing. All orders should include 3 percent for postage and handling (8 percent on foreign orders). Master Charge and Visa are welcome.

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Circle 55 on Inquiry card.
Listing 4 continued:

```
PRIME: PROC OPTIONS(MAIN) REORDER;
DECLARE (C, D, M) FIXED BINARY(31) INIT(0);

DO D = 3 TO M/2 BY 2;
    IF MOD(M, D) = 0 THEN GOTO NOTPRIME;
END;
```

**Listing 5:** Test program coded in the PL/1 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 to 10000 BY 2;
    DO D = 3 TO M/2 BY 2;
        IF (MOD(M, D) = 0) THEN GOTO NOTPRIME;
    END;
    GOTO NOTPRIME;
END;
```

Test 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.

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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/1 language and 370 assembler language codings of the prime-number generator. The execution times showed little difference. The PL/1 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 µs 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 µs, 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:

```cobol
x=n 1 INTEGER
x=n 1 INTEGER
which_line 1 (second_contact_line)
which_line 1 (second_contact_line)
which_line 1 (second_contact_line)
which_line 1 (second_contact_line)
time 1 absolute_time
time 1 absolute_time
absolutle_time
time 1 absolute_time
time 1 absolute_time
absolutle_time
time 1 absolute_time
absolutle_time
time 1 absolute_time
absolutle_time
time 1 absolute_time
absolutle_time
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time 1 absolute_time
absolutle_time
max_time 1 exposures
max_time 1 exposures
max_time 1 exposures
max_time 1 exposures
time_traverses 1 exposures
time_traverses 1 exposures
time_traverses 1 exposures
time_traverses 1 exposures
time_traverses 1 exposures
time_traverses 1 exposures
time_traverses 1 exposures
time_traverses 1 exposures

PROCEDURE new_page;
VAR
stuff 1 STRING(24)
clear_screen 1 CHAR
BEGIN
stuff = ’’
clear_screen = CHRC(24)
WHILE(’’
WRITE(’’)
WRITE(’’)
END new_page;

PROCEDURE asl_param_1VAR time 1 absolute_time;
VAR
a_string 1 STRING(128)
period 1 INTEGER
factor 1 INTEGER
BEGIN
a_string = ’
period = 1
factor = 1
WHILE(’
PROCEDURE add_a_dist(position 1 INTEGER);
VAR
dist 1 INTEGER
BEGIN
dist = (ORD(a_string(position)) - ORD(’’)) + 1
IF period THEN
BEGIN
dist = dist + 1
END
IF dist < 8 THEN
BEGIN
dist = dist + 1
END

Listing 1 continued on page 98
```
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Listing 1 continued:

procedure divide_time(a: absolute_time; b: absolute_time; c: integer)

div 

a: integer

procedure add_time(a: absolute_time; b: absolute_time; c: integer)

add_time(a, b, c) = a + b + c

procedure print_time(a: absolute_time)

print_time(a) = a

procedure normalize_time(v: integer)

normalize_time(v) = v

procedure sum_of_rings(rings_total: integer; rings: absolute_time)

sum_of_rings(rings_total, rings) = rings_total + rings

procedure sum_of_eclipses(eclipses_total: integer; eclipses: absolute_time)

sum_of_eclipses(eclipses_total, eclipses) = eclipses_total + eclipses
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Tax: In Co., please add tax.

Listing 1 continued:

<table>
<thead>
<tr>
<th>Procedure: preliminary_allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEGIN</td>
</tr>
<tr>
<td>s := 'Allocation of Eclipse Times...';</td>
</tr>
<tr>
<td>new_page();</td>
</tr>
<tr>
<td>print_time(total_months());</td>
</tr>
<tr>
<td>WRITELN();</td>
</tr>
<tr>
<td>which_ring := second;</td>
</tr>
<tr>
<td>sum_rings(sun_diff(second, second_contact_time()));</td>
</tr>
<tr>
<td>s := 'Time required for second contact transient'</td>
</tr>
<tr>
<td>print_time(second_contact_time());</td>
</tr>
<tr>
<td>which_ring := third;</td>
</tr>
<tr>
<td>sum_rings(sun_diff(third, third_contact_time()));</td>
</tr>
<tr>
<td>s := 'Time required for third contact transient'</td>
</tr>
<tr>
<td>print_time(third_contact_time());</td>
</tr>
<tr>
<td>add_time(second_contact_time, third_contact_time, rings_time());</td>
</tr>
<tr>
<td>s := 'Total time devoted to diamond ring sequences';</td>
</tr>
<tr>
<td>print_time(rings_time());</td>
</tr>
<tr>
<td>div_time(moon_fight, second_contact_time, rings_time());</td>
</tr>
<tr>
<td>s := 'Anticipation time for first diamond ring';</td>
</tr>
<tr>
<td>print_time(counter_time());</td>
</tr>
<tr>
<td>WRITELN();</td>
</tr>
<tr>
<td>sun_diff_time(total_months, total_months());</td>
</tr>
<tr>
<td>s := 'Time devoted to total time'</td>
</tr>
<tr>
<td>print_time(total_months());</td>
</tr>
<tr>
<td>s := 'Black time margin at end of total'</td>
</tr>
<tr>
<td>print_time(black_time());</td>
</tr>
<tr>
<td>div_time(sun_diff(time, half_time(), rings_time()));</td>
</tr>
<tr>
<td>s := 'Extra sick due to diamond rings overlap';</td>
</tr>
<tr>
<td>print_time(half_time());</td>
</tr>
<tr>
<td>add_time(sun_diff(time, total_months, total_months()), add_time(sun_diff(time, total_months, total_months()), add_time(total_months, total_months(), total_months()));</td>
</tr>
<tr>
<td>s := 'Total time committed before margin alloc.'</td>
</tr>
<tr>
<td>print_time(total_months());</td>
</tr>
<tr>
<td>WRITELN();</td>
</tr>
<tr>
<td>s := 'margin - disposal'</td>
</tr>
<tr>
<td>margin := 0;</td>
</tr>
<tr>
<td>BEGIN</td>
</tr>
<tr>
<td>div_time(sun_diff_time(total_months, total_months()), total_months());</td>
</tr>
<tr>
<td>FOR i := 0 TO 9 DO</td>
</tr>
<tr>
<td>sun_diff_time(total_months, total_months());</td>
</tr>
<tr>
<td>s := 'Margin per frame'</td>
</tr>
<tr>
<td>print_time(total_months());</td>
</tr>
<tr>
<td>END (margin_disposal);</td>
</tr>
<tr>
<td>END (preliminary_allocation);</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Procedure: final_allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEGIN</td>
</tr>
<tr>
<td>sum_rings(sun_diff_total_months, total_months());</td>
</tr>
<tr>
<td>s := 'Adjusted time devoted to total frame'</td>
</tr>
<tr>
<td>print_time(total_months());</td>
</tr>
<tr>
<td>add_time(total_months, total_months, total_months());</td>
</tr>
<tr>
<td>s := 'Total time committed before margin alloc.'</td>
</tr>
<tr>
<td>print_time(total_months());</td>
</tr>
<tr>
<td>WRITELN();</td>
</tr>
<tr>
<td>s := 'Margin after allocation to total time'</td>
</tr>
<tr>
<td>print_time(total_months());</td>
</tr>
<tr>
<td>END (final_allocation);</td>
</tr>
<tr>
<td>END (allocate_exposure);</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Procedure: allocate_exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEGIN</td>
</tr>
<tr>
<td>frame := (margin - total_months() DIV 2);</td>
</tr>
<tr>
<td>IF frame &gt; THEN error_message();</td>
</tr>
<tr>
<td>time := margin - (total_months + (2 * frame));</td>
</tr>
<tr>
<td>total_months := total_months + frame;</td>
</tr>
<tr>
<td>WRITELN();</td>
</tr>
<tr>
<td>WRITELN('Error message');</td>
</tr>
<tr>
<td>WRITELN('First diamond ring = frame');</td>
</tr>
<tr>
<td>WRITELN('Totalize' = total_months);</td>
</tr>
<tr>
<td>WRITELN('Second diamond ring = frame');</td>
</tr>
<tr>
<td>WRITELN('Totalize' = total_months);</td>
</tr>
<tr>
<td>WRITELN('Error message');</td>
</tr>
<tr>
<td>WRITELN('Press return to continue');</td>
</tr>
<tr>
<td>END (allocate_exposure);</td>
</tr>
<tr>
<td>END (allocate_exposure);</td>
</tr>
</tbody>
</table>

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Listing 1 continued:

```pascal
PROCEDURE diamond_rings_burst;
BEGIN
  (normalization); END;
PROCEDURE awuill_cue;
BEGIN
  (awuill_start); END;
PROCEDURE diamond_ring_burst;
BEGIN
  (diamond_ring_burst); END;
PROCEDURE total_time;
BEGIN
  (total_time); END;
PROCEDURE summarize;
BEGIN
  (summarize); END;
```

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
250
Enter number of exposures during totality
200
Enter time of totality in "seconds, thousands"
248
Enter slack time margin (in seconds)
6
Exposures map:
First diamond ring = 25
Totality = 200
Second diamond ring = 25
TOTAL = 250
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-dispersion" 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 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.
We at Oregon Software are pleased to announce that V1.2, our improved version of Pascal-1, is now available. The value of Pascal in computer software design is becoming widely recognized, and our V1.2 version contains significant enhancements in ease of operation and reliability.

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PDP, RSTS/E, RSX, VAX, and IAS are trademarks of Digital Equipment Corporation.
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.

PROCEDURE ref_anenor address I INTEGER);
THIS procedure uses the variant record technique to reference an address passed to it as an 16 bit signed INTEGER. The Apple-11 hardware will set or reset the annunciator outputs of the Case I/O connector if the
anenor addresses are simply referenced by a record.
PROCEDURE ref_anenor address I INTEGER);
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anenor addresses are simply referenced by a record.

Bar Codes and Home Brewing . . .
Progress Reports
As of early December 1979, we received some exciting word about the state of manufacturing of bar-code-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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Yesterday, microcomputer meant micro performance. Once you outgrew it, you had to step up to a mini. Which meant a big step up in price.

Today, there’s the new Altos ACS8000-6 single-board microcomputer system. It’s the first system for the OEM, small businessman and personal user, that offers minicomputer performance and minicomputer storage capacities—at a microcomputer price.

**MULTI-USER, WINCHESTER STORAGE, FLOPPY BACK UP: $14,260.**

The new Altos ACS8000-6 is a highly advanced Z80* based microcomputer system with high-speed RAM, floppy disk and Winchester hard-disk controllers, DMA, six serial and two parallel I/O ports and the AMD 9511 floating point processor all on a single board. A typical four-user system configuration with two megabytes of Shugart floppy and 29.0 megabytes of Shugart Winchester storage, including CPU and 208K bytes of RAM, costs only $14,260—compared to $30,000 or more for a similar minicomputer system. And that adds up to mini performance at less than half the cost!

**MULTI-USER EXECUTIVE SUPPORTS FOUR INDEPENDENT USERS RUNNING CP/M**

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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.
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**BASIC Interpreters for 8080, 780, 8086, 6800, 6809**
Language features above and beyond any other BASIC have made Microsoft's BASIC the world's most popular interpreter. And now three new versions are available for the 8086, 6800, and 6809. The latest releases of BASIC-80 and BASIC-86 support the new WHILE conditional, plus CHAINing of programs with COMMON variables, dynamic string space allocation and variable length records in random files. All versions have double precision arithmetic, full PRINT USING, tracing, renumbering, edit mode, and many other features. BASIC-80 for CP/M, ISIS-II, TRSDOS: $350. BASIC-86 stands alone on SBC 86/12: $500. BASIC-86 for FLEX: $200. BASIC-69 for FLEX: $250.

**COBOL-80 Compiler**
The best implementation of the world's most widely used programming language is COBOL-80 from Microsoft. As small business applications become not-so-small, COBOL-80 is ready with powerful use of disk files, data manipulation facilities, CHAIN, segmentation and interactive ACCEPT/DISPLAY. Plus three-dimensional arrays, full COPY facility, indexed and relative files and an optional packed decimal format that saves on mass storage by as much as 40%. Comes with macro assembler and loader. Runs on CP/M, ISIS-II, and TRSDOS. $750.

**NEW**

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At last, a sophisticated math package for microcomputers. muMATH performs mathematical operations efficiently and accurately. Use it to solve equations and simplify formulas; or perform exact arithmetic, symbolic integration and differentiation, infinite precision integer arithmetic and symbolic matrix inversion. muMATH is an invaluable tool for engineering and scientific applications involving lengthy, analytical computations. It is also an ingenious teaching method for all levels of math from arithmetic to calculus. muMATH is implemented in muSIMP, a highly structured language for complex symbolic manipulations. muSIMP/muMATH Package, CP/M versions: $250.

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LISP—the lingua franca of the artificial intelligence world—is now available in this efficient, low-cost version for microcomputers. Features include dynamic allocation of storage resources; program control structures such as an extended COND and a multiple exit LOOP; user functions defined as CALL by Value or CALL by Name; and 83 LISP functions. muLISP-79, CP/M version: $200.

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**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**
If you are developing applications software in-house 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 overloaded by the cost and maintenance of a minicomputer, the solution is Micro-SEED. $900.

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The most powerful microcomputer assembler on the market today is Microsoft's MACRO-80. It is fast, and it supports Intel-standard macros, relocation pseudo-ops, conditionals and listing controls. MACRO-80 comes with a relocatable linking loader and runs with CP/M, ISIS-II, and TEKDOS. $200.

**EDIT-80 Text Editor**
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Prices quoted are USA domestic only. OEMs should contact Microsoft for prices.

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We set the standard.
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. TI 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 3-inch Winchester-technology disks, new sizes (4-inch and 6-inch) of Winchester drives, "back-end" 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 megabyte 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-disk controller 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.

BUCKET 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 its 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.
NEW EXPANDABILITY.
ROMPLUS+ is a peripheral board whose added features can turn the Apple * computer into the most powerful personal computer available today.

NEW POWER.
ROMPLUS+ provides six sockets to accept individually addressable 2K ROM's or EPROM's. Keyboard Filter**, a 2K ROM program, comes installed on the ROMPLUS+ board and adds many useful features to your Apple, including:
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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 floppy-disk 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.

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

You will learn how British archaeologists have plumbed the past that lies under the city of York, down through the medieval city into the 9th century Viking city of Jorvik and on below to Eburacum, the great fortress city that held the northernmost boundary of the Roman Empire.

You will read about the spin of comets in their eccentric orbits around the sun. About the virtuosity with which the horned beetles put their horns to work, especially in courtship contests. About the perception of the elusive “gluon” that glues quarks together. About the quantization of risk and safety of nuclear reactors in the wake of the Three Mile Island episode.

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Electronic Planimetry

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 Summagraphics Bit Pad and a Terak microcomputer programmed in UCSD Pascal (Version 1.5).

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 (i.e.: 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 Corporation (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 general-purpose 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 magnetostrictive 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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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 front-panel, 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

![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.](image)
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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 supplies 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 (BYTE), waits for the Bit Pad to clear and then signals
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PROGRAM PLANI\textsc{ME}\textsc{TR} ;

(* Written by: John Frwofer
and modified by Greg Hansen.
This program reads parallel data from a digitizing tablet and calculates
the area and perimeter of a closed figure traced on it *)

CONST
PORTADDR = -160;
OUTRECEIVED = 95(* 01011111 *)
OUTNEXT = 159(* 10011111 *)
MINPTS = 13;

TYPE
(* Output from BIT PAD *)
LOWBYTE = PACKED RECORD
  D : 0..63 ;
  READY : BOOLEAN;
  FIRST : BOOLEAN
END;

(* this is what the device looks like *)
DEVICE = PACKED RECORD
  CSR : PACKED ARRAY [0..15] OF BOOLEAN;
  OUTBUF : INTEGER;
  INBUF : LOWBYTE
END;

VAR
BITPAD : RECORD (* Loads the device address as an integer and
points to it *)
  CASE BOOLEAN OF
    FALSE : (P : TDEVICE);
    TRUE : (I : INTEGER)
END;

CALCD ELTA, CLOSEDELTA, BYT, P : INTEGER;

LOKB : LOWBYTE;

RESPONSE CHAR;

START, (* Start new figure *)
RIDPRINT, (* Already printed for button up *)
  BOOLEA N;

FIRSTX, FIRSTY, LASTX, LASTY, X, Y,
  X1 : PACKED ARRAY [0..13] OF CHARS (* Dual array! Each holds command *)

PTR : INTERACTIVE;

PROCEDURE NEXTBYTE;
VAR W : LOWBYTE;
BEGIN
  (* Reads next byte FROM BIT PAD *)
  IF NOT UNIT BUSY (2) THEN UNIT READ (2%, 9; 3, 1, 1); (* Look for command *)
  LOKB := BITPAD.PT.INBUF;
  UN KILXOR READY OR ( деле = 0); (* Good data *)
  BITPAD.PT.OUTBUF := OUTRECEIVED;
  IF LOKB.FIRST THEN BYT := 0;
  DTY := BYT + 11;
  repeat
    W := BITPAD.PT.INBUF;
    UNTIL NOT W.READY; (* BIT PAD reset *)
  END (* NEXTBYTE *);
END (* NEXTBYTE *);

PROCEDURE DEBUG;
(* used for debugging only *)
BEGIN
  WRITE (LOKB.D);
  IF LOKB.READY THEN WRITE ("
  IF LOKB.FIRST THEN WRITE ("FIRST
  WRITELN ;
END;

PROCEDURE PRINT;
BEGIN
  (* Print results *)
  WRITELN ("# Points :", P, " ; Area :", SGR (HAGR) \& B (CUMAREA) * 1 ;
  ' /Length :", SGR (HAGR) \& CUMLEN) * 16;' ;
  IF (X%3 = P') AND (P < 0) THEN
    WRITE (PTR, "# Points :", P, "/ Area :", SGR (HAGR) \& CUMAREA) * 16;
    '/Length :", SGR (HAGR) \& CUMLEN) * 16; CHR(10);
  END (* PRINT *);
END (* PRINT *)

PROCEDURE NEWFIGURE;
BEGIN
  (* Initialize *)
  START := FALSE;
  FIRSTX := X1;
  FIRSTY := Y1;
  LASTX := X1;
  LASTY := Y1;
  P := 0;
  CUMAREA := 0;
  CUMLEN := 0;
  WRITE("#DOWN", CHR(7));
END;

Listing 1 continued on page 122

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:

\[ d = \sqrt{(X_1 - X_0)^2 + (Y_1 - Y_0)^2} \]

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.
Circle file spread out over multiple disks. Each data disk holds 500 names. When and which data disk to insert, expanding your files automatically and printouts mode.

Attention instead of Last Name / First Name. Three numeric and alphabetical order within the zip code. The program tells you how many 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 INFORMATION 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 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 one alpha code fields are provided to help you use the search and printout mode. BUSINESS MAIL SYSTEM allows you to create files with up 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 program stand apart from "in-memory" data managers is that it uses up to four disks on line as memory or as much as 320K of memory storage. Because disk sorts take more time than in-memory 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 INFORMATION SYSTEM, DATA MANAGER will accept those files. A necessity for organized people, this program sells for $49.50.

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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:

\[ \text{Area} = \frac{((X1 - X0) \times (Y1 + Y0))}{2}. \]

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 (i.e., 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 area-tracings 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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VDS-IIMD | 8-slot Mainframe with 2 8" floppies & DD-ASM | 2599.00 | New
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MEM-16K-ASM | Tarbell 16k Static Memory for S-100 bus | 440.00 | (Memories only come assembled & checked out)
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CI-KIT | Cassette Interface Kit (now incl software) | 120.00 |
FDI-ASM | Floppy Disk Interface Assembled & Checked out | 325.00 | Inc
FDI-KIT | Floppy Disk Interface Kit | 225.00 | Inc
DD-ASM | Double Density Floppy Disk Interface A&T | 425.00 |
DD-KIT | Double Density Floppy Disk Interface Kit | 325.00 |
VDS-II | Vertical Disk Subsystem | 1888.00 |
VDS-IID | Double Density Disk Subsystem | 1999.00 |
PS270 | PerSci Model 270 Dual Floppy Disk Drive | 1295.00 |
SIM120 | Siemens Model 120-8 Single Floppy Disk Drive | 495.00 |
SHU800 | Shugart 800/801 Floppy Disk Drive | 525.00 |
CP272 | Power Supply for PerSci 270 Dual Drive | 125.00 |
CP206 | Power Supply for PerSci 299 | 120.00 |
CP262 | Power Supply for Two Siemens or Shugart | 120.00 |
MPM | Digital Research Multi-User OS with our I/O | 400.00 | New
DB-1 | Tarbell Database Software (minimal support) | 25.00 | New
TBAS-CAS | Tarbell Cassette BASIC on cassette incl manual | 72.00 | Inc
TBAS-DSK | Tarbell Disk BASIC on CP/M disk incl manual | 72.00 | Inc
Note: the following two items can only be ordered with Tarbell Disk or Cassette BASIC:
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TBAS-SRC | Tarbell BASIC source on 2 CP/M disks | 36.00 | Inc
PTSW+LST | Proc Tech Assembler/Editor with listing | 15.00 |
EMPL-CAS | EMPL micro APL on cassette & instructions | 15.00 |
EMPL-DSK | EMPL micro APL on CP/M disk & instructions | 20.00 |
CPM-2.0 | CP/M 2.0 Operating system incl documentation | 150.00 |
CPM-1.4 | CP/M 1.4 Operating system incl BASIC-E on disk | 70.00 |
CPM-1.4-M | CP/M 1.4 on soft-sectored MINI-FLOPPY disk | 70.00 |
CPM-MS | CP/M 1.4 Operating system manual set (of six) | 25.00 |
BASE-MAN | BASIC-E Compiler Manual (works with CP/M) | 5.00 |
BASE-LST | BASIC-E Source Listing (in PL/M) | 15.00 |
PBLIC-DMN-1 | Public Domain Disk #1 - includes DISKTEST, BASIC-E, CBIOS, FORMAT, TAPELIB, etc on disk | 10.00 |
PBLIC-DMN-2 | Public Domain Disk #2 - includes Double Density FORMAT, DISKTEST, Auto-BIOS for 1.4 & 2.0; FORTH | 15.00 |
CBAS-DSK | CBASIC-2 disk | 85.00 |
CBAS-MAN | CBASIC-2 manual | 15.00 |
SPLR | KLH Systems Spooler for CP/M on disk | 70.00 |
FAST | FAST! Screen-oriented Editor/Assembler for CP/M | 100.00 |
TELE-COM | Software to operate D.C. Hayes Modem Remote | 195.00 |
POLYVUE | Screen-Oriented CP/M Editor | 135.00 |
PASCAL/MT | Meta-Tech Pascal Compiler for CP/M | 99.95 | Prices are subject to change without notice.
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<td>CMS SOFTWARE</td>
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*The CMS Software (G/L, A/R, A/P) are based on Osborne & Associates trial tested business basic software. Software is complete with full documentation and user instructions. All packages require a printer for output. Commodore recommends the NEC Spinwriter (available from NEECO) as the output printer for WORDPRO.

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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 foot-high 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 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.

The result is a circuit that is, for most applications, less expensive and physically smaller than an isolation transformer. This relay circuit should fit inside almost any television set that you wish to modify for your video terminal. It may protect you and your equipment from a fatal mistake.
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<td>$14.95</td>
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<tr>
<td>MICROPROCESSOR AND MICROCOMPUTER SYSTEMS</td>
<td>G. V. Rao</td>
<td>783 / 659</td>
<td>$19.50</td>
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<td>K. Tracton</td>
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<tr>
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<td>N. Graham</td>
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<td>ILLUSTRATED DICTIONARY OF MICROCOMPUTER TERMINOLOGY</td>
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<td>786 / 631</td>
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<td>HOME COMPUTER PROGRAMS</td>
<td>J. W. Tudell, Jr. and M. Landberg</td>
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<td>FUNDAMENTALS OF COMPUTER ALGORITHMS</td>
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<td>AUTOMATIC DATA PROCESSING HANDBOOK</td>
<td>The Diebold Group</td>
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<td>$17.50</td>
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<tr>
<td>THE Z-80 MICROCOMPUTER HANDBOOK</td>
<td>William Barden</td>
<td>784 / 914</td>
<td>$8.35</td>
</tr>
<tr>
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<td>D. F. Stout, M. Kaufman</td>
<td>617 / 97X</td>
<td>$17.50</td>
</tr>
<tr>
<td>PRINTED CIRCUITS HANDBOOK</td>
<td>C. F. Coombs, Jr.</td>
<td>617 / 97X</td>
<td>$17.50</td>
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<tr>
<td>PRINCIPLES OF INTERACTIVE COMPUTER GRAPHICS</td>
<td>William M. Newman and Robert Sproull</td>
<td>784 / 910</td>
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<td>HANDS-ON OPERATIONAL AMPLIFIER CIRCUIT DESIGN</td>
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<td>784 / 743</td>
<td>$11.50</td>
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<td>PRINCIPLES OF INTERACTIVE COMPUTER GRAPHICS</td>
<td>William M. Newman and Robert Sproull</td>
<td>784 / 945</td>
<td>$8.45</td>
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</table>
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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 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, 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-off.

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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Circle 80 on inquiry card.
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...
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Listing 1 continued:

000002 0044 2E 02 LFIRE 52.
000003 0046 2D 03 BSR EULER 54.
000004 004A 2D 04 STA A X2 55.
000005 004C 2D 05 RTS 56.
000006 004E 2D 06 XXX 57.
000007 004F 2D 07 ASR B 58.
000008 0050 2D 08 ASR A 59.
000009 0051 2D 09 INC A 60.
00000A 0052 2D 0A INC B 61.
00000B 0053 2D 0B INC X 62.
00000C 0054 2D 0C INC XX 63.
00000D 0055 2D 0D INC XXX 64.
00000E 0056 2D 0E INC XXXX 65.
00000F 0057 2D 0F INC XXXXX 66.
000010 0058 2D 10 INC XXXXXX 67.
000011 0059 2D 11 INC XXXXXXX 68.
000012 005A 2D 12 INC XXXXXXXX 69.
000013 005B 2D 13 INC XXXXXXXXX 70.
000014 005C 2D 14 INC XXXXXXXXXX 71.
000015 005D 2D 15 INC XXXXXXXXXXX 72.
000016 005E 2D 16 INC XXXXXXXXXXXX 73.
000017 005F 2D 17 INC XXXXXXXXXXXXX 74.
000018 0060 2D 18 INC XXXXXXXXXXXXXX 75.
000019 0061 2D 19 INC XXXXXXXXXXXXXXX 76.
00001A 0062 2D 1A INC XXXXXXXXXXXXXX 77.
00001B 0063 2D 1B INC XXXXXXXXXXXXX 78.
00001C 0064 2D 1C INC XXXXXXXXXXX 79.
00001D 0065 2D 1D INC XXXXXXXXXX 80.
00001E 0066 2D 1E INC XXXXXXXXX 81.
00001F 0067 2D 1F INC XXXXXXXX 82.
000020 0068 2D 20 INC XXXXXXX 83.
000021 0069 2D 21 INC XXXXX 84.
000022 006A 2D 22 INC XXXX 85.
000023 006B 2D 23 INC XXX 86.
000024 006C 2D 24 INC XX 87.
000025 006D 2D 25 INC X 88.
000026 006E 2D 26 INC XX 89.
000027 006F 2D 27 INC X 90.
000028 0070 2D 28 INC XX 91.
000029 0071 2D 29 INC X 92.
00002A 0072 2D 2A INC X 93.
00002B 0073 2D 2B INC X 94.
00002C 0074 2D 2C INC X 95.
00002D 0075 2D 2D INC X 96.
00002E 0076 2D 2E INC X 97.
00002F 0077 2D 2F INC X 98.

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 optoisolator; 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.)

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□ JAWS 32K RAM fully assembled, tested, burned in, No. 6412, (reg. price $299.95), SPECIAL PRICE $289.95.*
□ JAWS 48K RAM kit, No. 6446, (reg. price $489.95), SPECIAL PRICE $429.95.*
□ JAWS 48K RAM fully assembled, tested, burned in, No. 6446, (reg. price $489.95), SPECIAL PRICE $429.95.*
□ JAWS 64K RAM kit, No. 6446, (reg. price $589.95), SPECIAL PRICE $529.95.*
□ JAWS 64K RAM fully assembled, tested, burned in, No. 6446, (reg. price $589.95), SPECIAL PRICE $529.95.*
□ Expansion kit, JAWS 16K RAM module, to expand any of the above in 16K blocks up to 64K, No. 1825P, $129.95.*

*All prices plus $2 postage and handling. Connecticut residents add $1.25 sales tax.

Listing 1 continued:

00214 010D 27 05 BE8 NOJET 214.
00215 010F CE A03A B08 D08 B88 B08.
00216 0102 BD 00 D88 B08 B88 B08.
00217 0104 CE A03D NOJET D88 B08 B88 B08.
00219 0197 BD 05 D88 B08 B88 B08.
00220 0198 CE A04B LDA B FLAG2 219.
00221 0199 D6 00 B08 D88 B08 B88 B08.
00223 01A2 39 NORD RTS 223.
00224 01A3 A6 00 B08 D88 B08 B88 B08.
00225 01A6 27 12 B08 END 225.
00227 01A7 B7 0004 STA A PIA 227.
00228 01A9 A6 01 LDA A 0 X 228.
00229 01AB B7 0006 STA A PIA 229.
00230 01B3 00 INX 230.
00231 01B4 00 INX 231.
00233 01B5 BD 03 B08 TDELAY 233.
00234 01B7 20 EA BRA D88 B88 B88 B88.
00235 01B9 39 END RTS 235.
00236 01BA C6 80 TDELAY LDA B #$80 236.
00237 01BC 5A DELAY DEC B 237.
0023B 01BD 26 FD BNE DELAY 238.
0023B 01BD 26 FD BNE DELAY 239.
00240 01CE 0010 SURF LDA #$60SURF 240.
00241 01CF 4F CLR A 241.
00242 01C4 E6 00 LDA B 0 X 242.
00243 01C6 B7 0004 STA A PIA 243.
00244 01C9 F7 0006 STA A PIA 244.
00245 01CE BD EC B08 TDELAY 245.
00246 01C6 96 00 LDA A XI 246.
00247 01D0 45 COM A 247.
00248 01D1 3F AND A #$3F 248.
00249 01D3 B7 0004 NEXTS STA A PIA 249.
00250 01D6 BD 02 B08 TDELAY 250.
00251 01D9 00 INX 251.
00253 01D9 E6 00 LDA B 0 X 252.
00253 01D8 F7 0006 STA A PIA 253.
00255 01DE BD DA B08 TDELAY 254.
00256 01E0 00 C004 CPX #$ETSRT+4 255.
00256 01E3 27 04 KEU LAST 256.
00257 01E5 96 40 ADD A #$40 257.
00258 01E7 20 EA BRA NEXTS 258.
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00271 01BA 7B34 FCB 00 276.
00272 01BB 7B38 FCB 00 277.
00273 01BB 7B3C FCB 00 278.
00274 01BB 7B3D FCB 00 279.
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:

\[
\begin{align*}
\frac{dX_1}{dt} &= x_2 \\
\frac{dX_2}{dt} &= \pm SJET \\
\frac{dY_1}{dt} &= y_2 \\
\frac{dY_2}{dt} &= -g + JET
\end{align*}
\]

where:

\begin{align*}
X_1 &= \text{horizontal displacement} \\
X_2 &= \text{horizontal velocity} \\
SJET &= \text{side jet thrust; negative for the right-hand side jet, positive for the left-hand side jet, and 0 when neither are firing} \\
Y_1 &= \text{vertical displacement} \\
Y_2 &= \text{vertical velocity} \\
g &= \text{gravity} \\
JET &= \text{main jet thrust; 0 when it is not firing} \\
t &= \text{time}
\end{align*}

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:

\[
Z_{n+1} = Z_n + hf(t_n, Z_n)
\]

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 \(Z_0\) at \(t_0\), 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 \(\frac{1}{5}\) 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 blocking 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 oscilloscope.

---

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This high speed, high density, dot matrix printer (180 CPS) features an 18 x 9 dot matrix and proportional spacing. 132 characters per line. Ideal for word processing and all business uses. Includes connecting cable.

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*TRS-80 is a trademark of Radio Shack and Tandy Corp.*
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 light-emitting 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 light-emitting 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-from-memory 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 memory-write 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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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.
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 flip-flop. 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, operation 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 line.
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 NORMAL. 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 JNZ 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.

<table>
<thead>
<tr>
<th>Hexadecimal Data Loaded</th>
<th>Instruction Mnemonic</th>
<th>Explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB 00</td>
<td>IN</td>
<td>Input port address (hardware dependent)</td>
</tr>
<tr>
<td>77 MOV M,A</td>
<td>INX H</td>
<td>Copy data from accumulator to memory</td>
</tr>
<tr>
<td>23</td>
<td>JMP</td>
<td>Increment HL, the memory pointer</td>
</tr>
<tr>
<td>00</td>
<td></td>
<td>Jump address, low byte</td>
</tr>
<tr>
<td>00</td>
<td></td>
<td>Jump address, high byte</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Address</th>
<th>Label</th>
<th>Mnemonic</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0100 MARK XRAA</td>
<td>Set accumulator to zero</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0101</td>
<td>MVI B</td>
<td>Set up a counter to count 16 half cycles</td>
<td></td>
</tr>
<tr>
<td>0102</td>
<td>MVIC</td>
<td>And another counter to time 26 loops</td>
<td></td>
</tr>
<tr>
<td>0103</td>
<td>OUT 00</td>
<td>Then output to port 0</td>
<td></td>
</tr>
<tr>
<td>0104</td>
<td>TIMELOOP DCR C</td>
<td>Countdown the timer</td>
<td></td>
</tr>
<tr>
<td>0105</td>
<td>INJ TIMELOOP 07</td>
<td>And stay in the loop until counter is zero</td>
<td></td>
</tr>
<tr>
<td>0106</td>
<td>TIMELOOP 07</td>
<td>Until counter is zero</td>
<td></td>
</tr>
<tr>
<td>0107</td>
<td>CMA</td>
<td>Complement the accumulator</td>
<td></td>
</tr>
<tr>
<td>0108</td>
<td>DCR B</td>
<td>Countdown half cycles</td>
<td></td>
</tr>
<tr>
<td>0109</td>
<td>INJ TIMELOOP 01</td>
<td>And send more until cycle counter is zero</td>
<td></td>
</tr>
<tr>
<td>0110</td>
<td>RET</td>
<td>Then return to main program</td>
<td></td>
</tr>
</tbody>
</table>

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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 JMP 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.

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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 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 $C_3H_8$ ($8 = 2 \times 3 + 2$). 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 way is to create a table that shows which atoms are connected to which other atoms.
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Cl  C2  C3  C4  cs

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.

<table>
<thead>
<tr>
<th>C0</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
<th>C8</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

(a)  

<table>
<thead>
<tr>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
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<td>3</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b)  

<table>
<thead>
<tr>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 5: Using the random method of generating connection tables may result in some difficulties. Two connection tables for C,H8 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.

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,H8 (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 C,H8. 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 4 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:

$$EU = \frac{(2 \times C + 2) - H}{2}$$

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 C₄H₈), 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 high-resolution 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 POKE 204, 4400 MOD 256: POKE 205, 4400/256: POKE 74, 4400 MOD 256: POKE 75, 4400/256
10 GOTO 100
10 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: VTAB 5: TAB 8: PRINT "APPLE-CHEM II"
120 VTAB 10: PRINT "THIS PROGRAM WILL DRAW A MOLECULE": PRINT "FOR A GIVEN MOLECULAR FORMULA.
130 VTAB 15: PRINT "ENTER A MOLECULAR FORMULA": PRINT "IN THE FORM 'C,H', W HERE"
140 PRINT "C' = THE NUMBER OR CARBON ATOMS": PRINT "IN THE MOLECULE, ETC."
150 INPUT NC, NH
152 NF=0
155 IF NC<100 THEN 160: NC= RND (7)+2: NH= (2*NC)/2+2
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
210 FOR I=3 TO NC
220 X=RND (I-1)+1
230 IF C((X-1)*7+1)#0 THEN 250
240 C((X-1)*7)=X: C((X-1)*7+1)=1: GOTO 290
250 IF C((X-1)*7+2)#0 THEN 270
260 C((X-1)*7)=X: C((X-1)*7+2)=1: GOTO 290
270 IF C((X-1)*7+3)#0 THEN 290
280 C((X-1)*7)=X: C((X-1)*7+3)=1
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+1)#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)=X
400 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
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.

Listing 2 continued on page 164
Listing 2 continued:

```
1050- 1E 3F ED DB 24 24 24 DF
1058- 33 36 36 3E DB 1E 3F 07
1060- 2D 24 64 2D 15 06 00 24
1068- 24 24 24 3C 3F 3F 3F 3F
1070- 3F 2D 2D 2D 2D 2D 2D 2D
1078- 2D 2D 2D 2D 3E 3F 3F 3F
1080- 3F 3F 3F 3F 3F 3F 3F 3F
1088- 2D 2D 2D 2D 2D 2D 2D 2D
1090- 2D 2D 2D 2D 3E 3F 3F 3F
1098- 3F 3F 3F 37 3F 3F 3F 3F
10A0- 2D 2D 2D 2D 2D 2D 2D 2D
10A8- 2D 2D 2D 3E 3F 3F 3F 3F
10B0- 3F 3F 3F 3F 3F 3F 3F 3F
10B8- 2D 2D 2D 2D 2D 2D 2D 2D
```

Table 1.

<table>
<thead>
<tr>
<th>Program Lines</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Set LOMEM:4400</td>
</tr>
<tr>
<td>30-40</td>
<td>Subroutines used for drawings.</td>
</tr>
<tr>
<td>100-170</td>
<td>Accept and analyze input.</td>
</tr>
<tr>
<td>180-400</td>
<td>Special features.</td>
</tr>
<tr>
<td>435-500</td>
<td>Subroutine to assign coordinates.</td>
</tr>
<tr>
<td>1000-2330</td>
<td>Subroutines to draw molecule.</td>
</tr>
</tbody>
</table>

Table 2.

<table>
<thead>
<tr>
<th>Command</th>
<th>Occurrence</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>POKEs to 204,</td>
<td>line 5</td>
<td>Set LOMEM:4400. This protects the vector table in the Apple's memory from being written over.</td>
</tr>
<tr>
<td>205, 74, 75</td>
<td>lines 30, 35</td>
<td>These locations hold the coordinates for the next point to be plotted.</td>
</tr>
<tr>
<td>POKEs to 802,</td>
<td>line 40</td>
<td>These locations hold the address of the part of the vector table containing the shape about to be drawn.</td>
</tr>
<tr>
<td>801, 800</td>
<td></td>
<td>Initializes high-resolution graphics mode.</td>
</tr>
<tr>
<td>POKEs to 804,</td>
<td>line 2000</td>
<td>Set color to white.</td>
</tr>
<tr>
<td>805</td>
<td></td>
<td>Set scaling factor to 1. (full size)</td>
</tr>
<tr>
<td>CALL 3072</td>
<td>line 2000</td>
<td>Set rotation factor to 0. (right side up)</td>
</tr>
<tr>
<td>POKE 812, 255</td>
<td>line 2000</td>
<td>Causes point to be plotted at coordinates set in SUB 30.</td>
</tr>
<tr>
<td>POKE 806, 1</td>
<td>line 2000</td>
<td>Causes line to be drawn from last point plotted to coordinates set in SUB 30.</td>
</tr>
<tr>
<td>POKE 807, 0</td>
<td>line 2000</td>
<td>Set color to black.</td>
</tr>
<tr>
<td>CALL P</td>
<td>lines 2080, 2110, 2140, 2180, 2220</td>
<td>Causes 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:</td>
</tr>
<tr>
<td>CALL L</td>
<td>lines 2100, 2120, 2130</td>
<td></td>
</tr>
<tr>
<td>POKE 812, 0</td>
<td>line 2180</td>
<td>table location</td>
</tr>
<tr>
<td>CALL S</td>
<td>lines 2190, 2330</td>
<td>figure drawn</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>table location</th>
<th>figure drawn</th>
</tr>
</thead>
<tbody>
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<td>4199</td>
<td>blank space</td>
</tr>
<tr>
<td>4096</td>
<td>C</td>
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<td>4107</td>
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</tr>
<tr>
<td>4130</td>
<td>CH₂</td>
</tr>
<tr>
<td>4166</td>
<td>CH₃</td>
</tr>
</tbody>
</table>

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.
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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 (i.e., a different compound with the same molecular formula is drawn). Thus, you could investigate some of the many isomers of tetrahedrane (CH₄). 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 (e.g., 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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Aardvark Software, Inc. 1979
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 Dreyfus 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). Dreyfus 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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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, character-code 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 number-base 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: absolute jump 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 some similar 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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Table of Contents: Introduction to Assembly Language Programming; Assemblers; The Assembly Language Instruction Set; Simple Programs; Simple Program Loops; Character Coded Data; Code Conversion; Arithmetic Problems; Tables and Lists; Subroutines; Input/Output; Interrupts; Problem Definition and Program Design; Debugging and Testing; Documentation and Redesign; Sample Projects.

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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.

John A Lehman
716 Hutchins #2
Ann Arbor MI 48103

BASEX

Paul Warme
BYTE Books
Peterborough NH, 1979
softcover, 97 pages
$8

BASEX is an interactive compiler written for the 9080 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 run-time 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 well-written 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:

- mass storage capabilities;
- error intercept and recovery routines;
- a trace function for debug purposes;
- a binary look up routine for the symbol table; and
- routines to let the compiler perform memory

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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 three-hour exercise in data entry. Next, move the code through 2103. Then place a hexadecimal locations 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:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>LXI</td>
<td>H, 2000H</td>
</tr>
<tr>
<td>LXI</td>
<td>D, 0H</td>
</tr>
<tr>
<td>MOV</td>
<td>MOV A, M</td>
</tr>
<tr>
<td>STAX</td>
<td>D</td>
</tr>
<tr>
<td>INX</td>
<td>D</td>
</tr>
<tr>
<td>MOV</td>
<td>A, D</td>
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<tr>
<td>CPI</td>
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<td>MOVIT</td>
</tr>
<tr>
<td>JMP</td>
<td>0H</td>
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</tbody>
</table>

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

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Wozniac Receives 1979 ACM Grace Murray Hopper Award

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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 mathematical-function integrated circuit for faster execution time.
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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.

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For information on AIM-65, contact Target, c/o Don Clem, RR 2, Spencerville OH 45887. Inquiries should include a self-addressed, 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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BYTE March 1980 177
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 ComputShop Store, 6353 Camp Bowie, Fort Worth TX. The group has a software program exchange and a library for members. The FWAUG

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, self-addressed 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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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, the compiler generates pseudocode (p-code) that is interpreted 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 run-time 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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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 computer 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 disbeliefing group 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 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$; AS
70 GOTO 50
99 END
```

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March 1980 © BYTE Publications Inc
**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:

$$B = \text{INT} (C_1 \times A + C_2)$$  \hspace{1cm} (1)

The determination of suitable values for the constants $C_1$ and $C_2$ may not be immediately obvious. An empirical method for finding $C_1$ and $C_2$ is trial-and-error substitution using the following BASIC program:

```
110 INPUT C1, C2
120 FOR A = 0 TO 13
130 LET B = C1 * A + C2
140 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 $C_1$ and $C_2$. 

---

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   for (i = 1; i < 30000; i++)
   x = 5;
takes about 4 seconds to execute.

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Figure 1: Fitting the numbers 2, 4, 6, 9, 11 to the straight-line equation $B = C_1 \times A + C_2$. 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 $C_1$ can range between 2 and 2.5 if $C_2$ is suitably chosen between $-0.5$ and 1. For example, setting $C_1$ to 2.25 and $C_2$ 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 $C_1$ in the program we wrote, we find that the output comes close to the sequence we want. A few minutes of tinkering with $C_2$ 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:

\[ B = \text{INT} \left( 30.58 \times M - 30.08 \right) \]  

(2)

A quick check with our BASIC program shows that we can get away with three bytes less with the following equation:

\[ B = \text{INT} \left( 30.57 \times M - 30 \right) \]  

(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 \[ Z = \text{INT} \left( 30.57 \times M - 30 \right) + D \]

220 \[ \text{IF } M < 3 \text{ THEN RETURN} \]

230 \[ \text{IF INT} \left( Y / 4 \right) \times 4 = Y \]

\[ \text{THEN } Z = Z - 1 : \text{RETURN} \]

240 \[ Z = Z - 2 : \text{RETURN} \]

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.

the days in each year between the present year and 1972.

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:

\[ B = \text{INT} \left( 30.57 \times M - 30 \right) \]

(4)

\[ + \text{INT} \left( 365.25 \times (Y - 1 - 72) \right) \]

This may be rearranged to:

\[ B = \text{INT} \left( 30.57 \times M \right) \]

(5)

+ \[ \text{INT} \left( 365.25 \times Y - 26693.25 \right) \]

bringing us to the new BASIC subroutine:

310 \[ J = \text{INT} \left( 30.57 \times M \right) + \text{INT} \left( 365.25 \times Y - 26693.25 \right) + D \]

320 \[ \text{IF } M < 3 \text{ THEN RETURN} \]

330 \[ \text{IF INT} \left( Y / 4 \right) \times 4 = Y \]

\[ \text{THEN } J = J - 1 : \text{RETURN} \]

340 \[ J = J - 2 : \text{RETURN} \]

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, JS(A,B) is the substring of the unsubscripted string variable "JS", from Ath to Bth character.

700 REM-------------------------------------
710 REM DATE HANDLING PACKAGE
720 REM-------------------------------------
730 REM
740 REM-------------------------------------
750 REM CALENDAR TO JULIAN CONVERSION
760 REM-------------------------------------
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•M)+INT(365.25•Y-397.25)+D
840 IF M<3 THEN RETURN X
850 IF INT(Y/41•4=Y THEN RETURN X-1
860 RETURN X-2
870 FNEND
880 REM-------------------------------------
890 REM JULIAN TO CALENDAR CONVERSION
900 REM-------------------------------------
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(Y/365.25)+1
970 LET D=J+INT(l395.25-365.25•Y)
980 LET D1=2: IF INT(Y/41•4=Y THEN LET D1=1
990 IF D>D91-D1 THEN LET D=D+D1
1000 LET M=INT(D/30.57)+D-INT(30.57•H): RETURN
1010 REM-------------------------------------
1020 REM JULIAN COMPACTION
1030 REM-------------------------------------
1040 REM
1050 REM Given julian, J, returns 2-byte
1060 REM representation of J
1070 REM-------------------------------------
1080 DEF FNFJ(J)
1090 LET J1=INT(J/256): RETURN CHR(J1)+CHR(J-J1•256)
1100 FNEND
1110 REM-------------------------------------
1120 REM JULIAN EXPANSION
1130 REM-------------------------------------
1140 REM
1150 REM Given J, a 2-byte representation of a
1160 REM julian, returns decimal value of julian
1170 DEF FNFJ1(J1)=256•ASC(J1)+ASC(J-J1•256)
1180 REM-------------------------------------
1190 REM DAY OF WEEK CALCULATION
1200 REM-------------------------------------
1210 REM
1220 REM Returns day of week (Sunday = 1) given
1230 REM the julian, J
1240 REM-------------------------------------
1250 DEF FNFJ(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:

```plaintext
410   Y = INT ( J / 365.25 + 73 )
420   Z = J - INT (26693.25 - 365.25 * Y )
430   D1 = 2 : IF INT ( Y / 4 ) * 4 = Y THEN D1 = 1
440   IF Z > 91 - D1 THEN Z = Z + D1
450   M = INT (Z / 30.57 )
460   D = Z - INT ( 30.57 * M )
470   RETURN
```

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. ... [RS5]]

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:

```plaintext
510   J1 = INT ( J / 256 )
520   J$ = CHR( J1 ) + CHR( J - J1 * 256 )
```

where CHR (J1) is the character with the ASCII code J1. Converting the string J$ back to a decimal value is done as follows:

```plaintext
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.
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 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 location."
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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.

<table>
<thead>
<tr>
<th>First Nybble</th>
<th>Second Nybble</th>
<th>Decimal Object Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
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</tr>
<tr>
<td>3</td>
<td>1</td>
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</tr>
<tr>
<td>4</td>
<td>0</td>
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</tr>
<tr>
<td>4</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>10</td>
</tr>
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<td>1</td>
<td>11</td>
</tr>
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<td>13</td>
</tr>
<tr>
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<td>0</td>
<td>14</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>15</td>
</tr>
</tbody>
</table>

The two instructions (RIM and SIM) found only in the 8085 are indicated by shading.
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. . . . RS5]

The similarities of the two instruction sets can be seen by comparing corresponding positions of table 1 and table 2. Table 1 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 unusued by the 8080. These, which are clearly indicated in table 2, are used to greatly expand the Z80's capability.

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-
Table 2: Mnemonics of the operation codes of the Z80 microprocessor arranged for conversion to hexadecimal object code. Corresponding positions of table 1 and table 2 generally perform the identical function, despite differences in notation. Enhancements of the 8080 instruction set are indicated by shading. Mnemonics used here are those specified by Zilog.
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 register-indirect 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
Table 3: Enhancement operation codes of the ZBO invoked by the hexadecimal instruction prefix. These CB class operations give bit manipulation, data shifting, and enhanced rotation capability to the ZBO.

<table>
<thead>
<tr>
<th>First Nybble</th>
<th>Second Nybble</th>
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<tbody>
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<td>F</td>
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</table>
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**Table 4: Operations of the Z80 Invoked by the Instruction Prefix D0.** These provide indexed-mode instructions equivalent to the indirect-mode instructions and employ the IX register.
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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$820 (Without 18 function keys)

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- Programmable underscore
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- 14 key numeric pad with decimal
- 16 special function keys
- 8 editor function keys
- 2 block transmission keys
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- Project mode
- Block mode
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Print key...
Shi lllock...
Transparent mode...
Backspace...
Tabbing...
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Table 6: Index instructions employing the IY register. Note the similarity with Table 4. These operation codes begin with the FD prefix.
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<td>RES 4, (IY+d)</td>
<td>RES 6, (IY+d)</td>
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<td>BIT 5, (IY+d)</td>
<td>BIT 7, (IY+d)</td>
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### Table 7: Indexed instructions of the FDCB class, again employing the IY register. Note the similarity with table 5.
Circle 155 on inquiry card.

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Table 8: The class of miscellaneous instructions invoked by the ED prefix.
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.
The Periodic Chart at Your Fingertips

Using the TI-59

Bruce D Marquardt, 1831 18th St Apt 44, National City CA 92050

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Because of my interest in programmable calculators, I am always looking for a challenge. While I was attending a chemistry lecture, a question presented itself to me: What is a chemist without a periodic chart? [Editor's Note: I have no return. . . . RSS]

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.

```
000 76 LBL
001 76 XEQ
002 32 XEQ
003 86 STF
004 03 DS
005 97 IFF
006 01 01
007 02 02
008 65 65
009 22 INV
010 66 STF
011 03 DS
012 66 STF
013 01 01
014 66 STF
015 02 02
016 01 01
017 69 DMR
018 17 17
019 47 CMS
020 08 11
021 69 DMR
022 17 17
023 01 01
024 42 STD
025 04 04
026 52 XEQ
027 91 R/S
028 76 LBL
029 11 R
030 71 SBR
031 01 01
032 63 63
033 29 CP
034 57 EQ
035 00 00
036 40 40
037 42 STD
038 04 04
039 51 R/S
040 43 RCL
041 04 04
042 91 R/S
043 76 LBL
044 12 11
045 71 SBR
046 01 01
047 63 63
048 29 CP
049 67 EQ
050 00 00
051 55 55
052 42 STD
053 06 06
054 91 R/S
055 43 RCL
056 06 06
057 91 R/S
058 76 LBL
059 13 C
060 71 SBR
061 01 01
062 63 63
063 43 RCL
064 05 05
065 99 PRT
066 98 AV
067 91 R/S
068 76 LBL
069 15 E
070 71 SBR
071 01 01
072 63 63
073 43 RCL
074 06 06
075 22 XEQ
150 00 00
151 72 ST+
152 02 02
153 48 EXC
154 00 00
155 65 65
156 03 RCL
157 04 04
158 95 =
159 44 SUM
160 05 05
161 99 PRT
162 91 R/S
163 22 INV
164 87 IF
165 09 09
166 01 01
167 92 ST+
168 22 INV
169 86 STF
170 09 09
171 97 EXC
172 76 LBL
173 17 B
174 97 IF
175 76 LBL
180 22 INV
181 01 01
182 08 08
183 43 RCL
184 77 GE
185 00 00
186 01 01
187 18 18
188 55 +
189 01 02
190 52 EE
191 03 3
192 95 =
193 43 STD
194 00 00
195 01 01
196 52 EE
197 06 6
198 22 INV
199 43 PRT
200 01 01
201 43 RCL
202 00 00
203 74 SM+
204 01 01
205 69 DP
206 21 21
207 93 =
208 22 INV
209 44 SUM
210 01 01
211 01 01
212 43 DP
213 27 27
214 43 RCL
215 07 07
216 22 INV
217 43 RCL
218 91 R/S
219 61 GTO
220 01 01
221 61 GTO
222 76 LBL
223 16 A*
224 42 STD
```

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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 b 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.

<table>
<thead>
<tr>
<th>Steps</th>
<th>Procedure</th>
<th>Press</th>
<th>Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>To load atomic weight</td>
<td>E'</td>
<td>does not change</td>
</tr>
<tr>
<td>2.</td>
<td>Enter 1.</td>
<td>A'</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Enter atomic weight for atomic number 1.</td>
<td>B'</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>Enter atomic weight for atomic number 2.</td>
<td>R/S</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>Enter atomic weight for atomic number 106.</td>
<td>R/S</td>
<td>107</td>
</tr>
<tr>
<td>6.</td>
<td>Load data into banks 2, 3, and 4. (Refer to owner's manual for TI Programmable 59/59.) (The program is now complete. The load subroutines will not be needed unless a change of data is required at a later date.)</td>
<td>E'</td>
<td>does not change</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Steps</th>
<th>Procedure</th>
<th>Press</th>
<th>Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>To find atomic weight</td>
<td>E'</td>
<td>does not change</td>
</tr>
<tr>
<td>2.</td>
<td>Initialize.</td>
<td>E'</td>
<td>does not change</td>
</tr>
<tr>
<td>3.</td>
<td>Enter atomic number</td>
<td>B,E</td>
<td>value of atomic weight*</td>
</tr>
<tr>
<td>4.</td>
<td>Repeat step 2 for new atomic number.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>To find molecular weight</td>
<td>E'</td>
<td>does not change</td>
</tr>
<tr>
<td>6.</td>
<td>Enter atomic number</td>
<td>B</td>
<td>does not change</td>
</tr>
<tr>
<td>7.</td>
<td>Enter how many of that particular element</td>
<td>A,E</td>
<td>A X atomic weight*</td>
</tr>
<tr>
<td>8.</td>
<td>Calculate total weight (sum weight.)</td>
<td>C</td>
<td>total weight of molecule*</td>
</tr>
<tr>
<td>9.</td>
<td>To find weight of a new formula, go to step 4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Recall last A entry (when desired)</td>
<td>CLR, A</td>
<td>Last A</td>
</tr>
<tr>
<td>11.</td>
<td>Recall last B entry (when desired)</td>
<td>CLR, B</td>
<td>Last B</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Register Number</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>00 thru 09</td>
<td>Used, these registers are left open to allow the operator to store additional data during program use without altering internal program executions.</td>
</tr>
<tr>
<td>10 thru 19</td>
<td>Used to store atomic weights.</td>
</tr>
<tr>
<td>20 thru 72</td>
<td>Not used.</td>
</tr>
<tr>
<td>73 thru 79</td>
<td></td>
</tr>
</tbody>
</table>

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 sacrifice speed of execution for ease of operation and protection of loaded data.

This program will enable you to:
- Display atomic weights by entering the corresponding atomic numbers.
- 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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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 GR Arnett and JR 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.

<table>
<thead>
<tr>
<th>Address</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>0007</td>
<td>20   (JSR)</td>
</tr>
<tr>
<td>0008</td>
<td>00</td>
</tr>
<tr>
<td>0009</td>
<td>01   (multiply)</td>
</tr>
<tr>
<td>000A</td>
<td>A9   (LDA)</td>
</tr>
<tr>
<td>000B</td>
<td>00</td>
</tr>
<tr>
<td>000C</td>
<td>F0</td>
</tr>
<tr>
<td>000D</td>
<td>FC</td>
</tr>
</tbody>
</table>

### Listing 1b: Calling sequence for 16-bit divide subroutine.

<table>
<thead>
<tr>
<th>Address</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>0007</td>
<td>20   (JSR)</td>
</tr>
<tr>
<td>0008</td>
<td>30</td>
</tr>
<tr>
<td>0009</td>
<td>00   (divide)</td>
</tr>
<tr>
<td>000A</td>
<td>A9   (LDA)</td>
</tr>
<tr>
<td>000B</td>
<td>00</td>
</tr>
<tr>
<td>000C</td>
<td>F0</td>
</tr>
<tr>
<td>000D</td>
<td>FC</td>
</tr>
</tbody>
</table>
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BYTE March 1980 213
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 colleagues 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 0100.

<table>
<thead>
<tr>
<th>Address</th>
<th>Mnemonic</th>
<th>Hexadecimal Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>0100</td>
<td>CLC</td>
<td>18</td>
</tr>
<tr>
<td>0101</td>
<td>CLD</td>
<td>08</td>
</tr>
<tr>
<td>0102</td>
<td>lda #0</td>
<td>A9 00</td>
</tr>
<tr>
<td>0104</td>
<td>STA</td>
<td>AA</td>
</tr>
<tr>
<td>0105</td>
<td>STA #002</td>
<td>85 02</td>
</tr>
<tr>
<td>0107</td>
<td>STA #003</td>
<td>85 03</td>
</tr>
<tr>
<td>0109</td>
<td>LDA #000</td>
<td>A5 00</td>
</tr>
<tr>
<td>010B</td>
<td>BNE</td>
<td>D0 14</td>
</tr>
<tr>
<td>010D</td>
<td>LDA #001</td>
<td>A5 01</td>
</tr>
<tr>
<td>010F</td>
<td>BBE</td>
<td>F0 0C</td>
</tr>
<tr>
<td>0111</td>
<td>cmp #1</td>
<td>C9 01</td>
</tr>
<tr>
<td>0113</td>
<td>BNE</td>
<td>D0 1D</td>
</tr>
<tr>
<td>0115</td>
<td>LDA #006</td>
<td>A5 06</td>
</tr>
<tr>
<td>0117</td>
<td>STA #002</td>
<td>85 02</td>
</tr>
<tr>
<td>0119</td>
<td>LDA #007</td>
<td>A5 07</td>
</tr>
<tr>
<td>011B</td>
<td>STA #003</td>
<td>85 03</td>
</tr>
<tr>
<td>011D</td>
<td>RTS</td>
<td>60</td>
</tr>
<tr>
<td>011E</td>
<td>BPL</td>
<td>10 12</td>
</tr>
<tr>
<td>0120</td>
<td>INX</td>
<td>8B</td>
</tr>
<tr>
<td>0121</td>
<td>LDA #001</td>
<td>A5 01</td>
</tr>
<tr>
<td>0123</td>
<td>CLC</td>
<td>18</td>
</tr>
<tr>
<td>0124</td>
<td>EOR #01</td>
<td>FF 01</td>
</tr>
<tr>
<td>0126</td>
<td>ADC #1</td>
<td>69 01</td>
</tr>
<tr>
<td>0128</td>
<td>STA #001</td>
<td>85 01</td>
</tr>
<tr>
<td>012A</td>
<td>LDA #000</td>
<td>A5 00</td>
</tr>
<tr>
<td>012C</td>
<td>EOR #01</td>
<td>49 01</td>
</tr>
<tr>
<td>012E</td>
<td>ADC #0</td>
<td>69 00</td>
</tr>
<tr>
<td>0130</td>
<td>STA #006</td>
<td>85 00</td>
</tr>
<tr>
<td>0132</td>
<td>LDA #006</td>
<td>A5 06</td>
</tr>
<tr>
<td>0134</td>
<td>BNE</td>
<td>D0 26</td>
</tr>
<tr>
<td>0136</td>
<td>LDA #007</td>
<td>A5 07</td>
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<tr>
<td>0138</td>
<td>BBE</td>
<td>F0 18</td>
</tr>
<tr>
<td>013A</td>
<td>CPM #1</td>
<td>C9 01</td>
</tr>
<tr>
<td>013C</td>
<td>BNE</td>
<td>D0 32</td>
</tr>
<tr>
<td>013E</td>
<td>DEX</td>
<td>CA</td>
</tr>
<tr>
<td>013F</td>
<td>BNE</td>
<td>D0 12</td>
</tr>
<tr>
<td>0141</td>
<td>LDA #001</td>
<td>A5 01</td>
</tr>
<tr>
<td>0143</td>
<td>CLC</td>
<td>18</td>
</tr>
<tr>
<td>0144</td>
<td>EOR #001</td>
<td>49 FF</td>
</tr>
<tr>
<td>0146</td>
<td>ADC #1</td>
<td>69 01</td>
</tr>
<tr>
<td>0148</td>
<td>STA #003</td>
<td>85 03</td>
</tr>
<tr>
<td>014A</td>
<td>CDA #000</td>
<td>A5 05</td>
</tr>
<tr>
<td>014C</td>
<td>EOR #001</td>
<td>49 FF</td>
</tr>
<tr>
<td>014E</td>
<td>ADC #0</td>
<td>69 00</td>
</tr>
<tr>
<td>0150</td>
<td>STA #002</td>
<td>85 02</td>
</tr>
<tr>
<td>0152</td>
<td>RTS</td>
<td>80</td>
</tr>
<tr>
<td>0153</td>
<td>LDA #001</td>
<td>A5 01</td>
</tr>
<tr>
<td>0155</td>
<td>STA #003</td>
<td>85 03</td>
</tr>
<tr>
<td>0157</td>
<td>LDA #000</td>
<td>A5 00</td>
</tr>
<tr>
<td>0159</td>
<td>STA #002</td>
<td>85 02</td>
</tr>
<tr>
<td>015B</td>
<td>RTS</td>
<td>69</td>
</tr>
<tr>
<td>015C</td>
<td>BPL</td>
<td>10 12</td>
</tr>
<tr>
<td>015E</td>
<td>INX</td>
<td>E9</td>
</tr>
<tr>
<td>015F</td>
<td>LDA #007</td>
<td>A5 07</td>
</tr>
</tbody>
</table>

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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.
Listing 2 continued:

<table>
<thead>
<tr>
<th>Address</th>
<th>Mnemonic</th>
<th>Hexadecimal Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>0161</td>
<td>CLC</td>
<td>18 FF</td>
</tr>
<tr>
<td>0162</td>
<td>EOR FF</td>
<td>49 FF</td>
</tr>
<tr>
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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.

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<td>004C</td>
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<tr>
<td>0050</td>
<td>EOR FF</td>
<td>49 FF</td>
</tr>
</tbody>
</table>

Listing 3 continued on page 216
Listing 3 continued:

```assembly
0052  ADC #0       69 00
0054  STA 00       85 00
0056  LDA 06       A5 06
0058  BNE       D0 26
005A  LDA 07       A5 07
005C  BEQ       F0 18
005E  CMP #1      C9 01
0060  BNE       DO 32
0062  DEX       CA
0064  BNE       DO 15
0066  LDA 01       A5 01
0067  CLI       18
0069  BNE       DO 26
006A  STA 00      BS 00
006B  SEC 38
006C  STA 02      85 02
006E  RTS 60
0070  ADC       HI 69 01
0072  ADC #0       69 00
0074  STA 02       85 02
0076  RTS 60
0078  INX       10 12
007A  BNE       DO 15
007C  STA 03      85 03
007E  LDA 01       A5 01
0080  STA 07      85 07
0082  EOR FF      49 FF
0084  ADC #1       69 01
0086  STA 06      85 06
0088  EOR FF      49 FF
008A  ADC #0       69 00
008C  STA 05      85 05
008E  STA 04      85 04
0090  STA 03      85 03
0092  LDA 02       A5 02
0094  ADC       HI 69 00
0096  STA 01      85 01
0098  STA 00      85 00
009A  STA 05      85 05
009C  STA 04      85 04
009E  STA 03      85 03
00A0  STA 02      85 02
00A2  SEC       38
00A4  LDA 01       A5 01
00A6  SEC 38
00A8  BNE       65 01
00AA  STA 01       85 01
00AC  STA 00       85 00
00B0  LDA 00       A5 00
00B2  BNE       DO 00
```

Listing 4: Multiplication subroutine in hexadecimal memory-dump form.

```assembly
00B4  LDA 01       A5 01
00B6  BNE       DO 0C
00B8  BNE       FD 0D
00BA  BNE       38
00BB  BNE       DO 03
00BD  BNE       39 01
00BF  STA 03       85 03
00C1  LDA 02       85 02
00C3  STA 02       85 02
00C5  STA 01       85 01
00C7  STA 00       85 00
00C9  STA 02       85 02
00CC  STA 03       85 03
00CD  STA 03       85 03
00CE  STA 02       85 02
00CF  STA 02       85 02
00D0  STA 03       85 03
00D1  STA 02       85 02
00D2  STA 01       85 01
00D3  STA 00       85 00
00D5  STA 02       85 02
00D6  STA 03       85 03
00D7  STA 04       85 04
00D8  STA 05       85 05
00D9  STA 06       85 06
00DA  STA 07       85 07
00DB  STA 08       85 08
00DC  STA 09       85 09
00DD  STA 0A       85 0A
00DE  STA 0B       85 0B
00DF  STA 0C       85 0C
```

Listing 5: Division subroutine in hexadecimal memory-dump form.

```assembly
00E0  ADC #0       69 00
00E2  STA 01       85 01
00E4  LDA 00       A5 00
00E6  STA 00       85 00
00E8  STA 05       85 05
00EA  STA 04       85 04
00EC  STA 03       85 03
00EE  STA 02       85 02
00F0  STA 01       85 01
00F2  STA 00       85 00
00F4  STA 07       85 07
00F6  STA 06       85 06
00F8  STA 05       85 05
00FA  STA 04       85 04
00FC  STA 03       85 03
00FED  STA 02       85 02
00FEE  STA 01       85 01
00FE  STA 00       85 00
```

The purpose of computation is insight not numbers

---Hamming

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<th>Price</th>
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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 22-25
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 various aspects of computer-aided design, engineering, business management, tool design and graphics; computer-aided assembly, facilities planning, inventory control, and management information systems; numerical control in various areas; database 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 Exhibition 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.

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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 scheme, 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
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<td>Dual Liquid Temperature Sensors</td>
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<td>QK-105</td>
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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 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?
“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.
Listing 1: Super TIC, a three-dimensional tic-tac-toe 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.

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:

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- 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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**TYPE FILE SIZE SORT TIME (Bytes) (Sec) TYPE FILE SIZE SORT TIME (Bytes) (Sec)**

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
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<td>SORT</td>
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<td>33</td>
<td>SORT</td>
<td>340K</td>
<td>1061</td>
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<tr>
<td>SORT</td>
<td>32K</td>
<td>49</td>
<td>SORT</td>
<td>680K</td>
<td>2569</td>
</tr>
<tr>
<td>SORT</td>
<td>85K</td>
<td>173</td>
<td>SORT and 85K</td>
<td>1757</td>
<td></td>
</tr>
<tr>
<td>SORT</td>
<td>170K</td>
<td>445</td>
<td>MERGE</td>
<td>1275K</td>
<td>Merge</td>
</tr>
</tbody>
</table>

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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 three-dimensional tic-tac-toe, table 1 shows all of the 76 possible winning combinations. 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.

Table 1: The 76 possible ways to win in 4 by 4 by 4 three-dimensional tic-tac-toe. 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.

<table>
<thead>
<tr>
<th>COMB</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>5</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>7</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>6</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>11</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>13</td>
<td>25</td>
<td>26</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>15</td>
<td>21</td>
<td>22</td>
<td>23</td>
<td>24</td>
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<td>21</td>
<td>33</td>
<td>34</td>
<td>35</td>
<td>36</td>
</tr>
<tr>
<td>23</td>
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<td>43</td>
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<td>66</td>
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<td>74</td>
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<td>39</td>
<td>75</td>
<td>76</td>
<td>77</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Listing 3: Sample printout of the beginning of Super TIC.

```
O TO 9 : 0 I PLAY BEST AND 9 WORST ? 0
HERE IS MY BOARD
01 = 02 = 03 = 04 17 = 18 = 19 = 20 33 = 34 = 35 = 36 49 = 50 = 51 = 52
05 = 06 = 07 = 08 21 = 22 = 23 = 24 37 = 38 = 39 = 40 53 = 54 = 55 = 56
09 = 10 = 11 = 12 25 = 26 = 27 = 28 41 = 42 = 43 = 44 57 = 58 = 59 = 60
13 = 14 = 15 = 16 29 = 30 = 31 = 32 45 = 46 = 47 = 48 61 = 62 = 63 = 64
ENTER MOVES BY NUMBER AND YOUR'RE X
YOUR MOVE ? 1
I WENT 64
XX = 02 = 03 = 04 17 = 18 = 19 = 20 33 = 34 = 35 = 36 49 = 50 = 51 = 52
05 = 06 = 07 = 08 21 = 22 = 23 = 24 37 = 38 = 39 = 40 53 = 54 = 55 = 56
09 = 10 = 11 = 12 25 = 26 = 27 = 28 41 = 42 = 43 = 44 57 = 58 = 59 = 60
13 = 14 = 15 = 16 29 = 30 = 31 = 32 45 = 46 = 47 = 48 61 = 62 = 63 = 64
YOUR MOVE ?
```

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-tac-toe 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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Circle 203 on inquiry card.
<table>
<thead>
<tr>
<th>Combination</th>
<th>Variable</th>
<th>Value (Defensive Version)</th>
<th>Value (Aggressive Version)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Blanks</td>
<td>P(0)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>One X</td>
<td>P(1)</td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>Two Xs</td>
<td>P(2)</td>
<td>147</td>
<td>22</td>
</tr>
<tr>
<td>Three Xs</td>
<td>P(3)</td>
<td>1030</td>
<td>147</td>
</tr>
<tr>
<td>One O</td>
<td>P(4)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Two Os</td>
<td></td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>All Others</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

NOTE: The computer is 0 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.

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Circle 204 on inquiry card.
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.

<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>IDENTifying variables</td>
</tr>
<tr>
<td>15</td>
<td>DIMM(6)</td>
</tr>
<tr>
<td>20</td>
<td>CLS(1)</td>
</tr>
<tr>
<td>25</td>
<td>DATA 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10</td>
</tr>
<tr>
<td>30</td>
<td>FORA = 0 TO 39 STEP 4</td>
</tr>
<tr>
<td>35</td>
<td>N(O,C) = X</td>
</tr>
<tr>
<td>40</td>
<td>IF A = 0 THEN B = 1</td>
</tr>
<tr>
<td>45</td>
<td>FORB = 1 TO 100</td>
</tr>
<tr>
<td>50</td>
<td>GO TO C = 88</td>
</tr>
</tbody>
</table>

SL5...A NEW PROGRAMMING SYSTEM FOR A NEW DECADE

James H Goldberg
Silicon Valley OES Corp.

March 1, 1979

Dear Jim:

We've done it. SL5 is ready for distribution, and its use is free. It contains the new programming system for the 8080. SL5 is a well structured, built-in language, and CASE statements, stack oriented, interactive processing tool for small systems and is based on the 1977 FORTRAN standard. The execution speed is in fact, our normal development system runs in BASIC on a Commodore System, and the program code is very compact. We think this is a great step forward to our OES development scheme which tries to give all the tools that can be used to create an application system. We are fully compatible with CP/M, with an 8080 version and a compatibility driver for the 68000 version available. Since SL5 is a system in SL5, it can easily adapt to other CPUs. The version for the 68000 is not fully compatible but is for use in a multiprocessor environment. The stackworks 68000 is almost entirely replaceable with new source code.

We have decided to keep our prices low initially to get wider distribution. The $240 version of the program includes all the features of the program, plus the stackworks 68000. The version for the 68000 is not fully compatible but is for use in a multiprocessor environment. We think it's perfect for your programmers. It gives them a feel for the new system, and even if they've used SL5 there's no going back to BASIC, FORTRAN, PASCAL, or Assembly.

Sincerely,

Dave Dentler

Please note the next time you're in the Midwest, come to Janet and James Paul.

Circle 205 on inquiry card.
Listing 6: Modifications to listing 1 to avoid the need for a disk data file.

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.

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.
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The package will be available in those same three configurations. The CP/M version will run on any CP/M environment (includes CDOS, IMSAIDOS, etc.) and has its origin at 100H. The Northstar system will run on any Horizon or any non-relocated DOS system. It has origin at 2D00H. The SOLOS/CUTER system will run on any SOL or any CUTER system, and it has origin of 100H. All versions are designed to operate correctly in an interrupt driven environment.

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™ 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 synthesizer.

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.
Programming Quickies

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.](image)

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:

```pseudocode
factorial (n)
if (n==0)
  return(1);
else
  return(n * factorial(n - 1));
```

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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Data up to 255

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BYTE March 1980 241
vious — move the disk from the source to the destination rod.

- When \( n+1 \) disks are to be moved:
  - 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
  - 3) Move \( n \) disks from the intermediate rod to the destination rod.

Listing 1: Recursive solution to the Towers of Hanoi problem in BASIC.

```basic
010 REM Declare the stack arrays.
020 DIM S$(15), D$(15), I$(15)
030 PRINT
040 PRINT "Number of disks " ;
050 INPUT P
060 REM If P is too large or too small, STOP.
070 IF (P > 15) THEN 170
080 IF (P < 1) THEN 170
090 REM Move P disks from Left to Right.
100 LET S$(P) = " L "
110 LET D$(P) = " R "
120 LET I$(P) = " C "
130 REM Move those disks!
140 GOSUB 180
150 REM Since that was so much fun let us do it again.
160 GOTO 30
170 STOP
180 REM This is the recursive HANOI procedure.
190 REM IF P = 1, move one disk from source to destination.
200 IF (P > 1) THEN 230
210 PRINT "Move a disk from " ; S$(P) ; " to " ; D$(P) ; " ."
220 RETURN
230 REM Else, move P - 1 disks from Source to Intermediate.
240 LET P = P - 1
250 LET S$(P) = S$(P + 1)
260 LET D$(P) = I$(P + 1)
270 LET I$(P) = D$(P + 1)
280 GOSUB 180
290 REM Move one disk from Source to Destination.
300 PRINT "Move a disk from " ; S$(P + 1) ; " to " ; D$(P + 1) ; " ."
310 REM Move P - 1 disks from Intermediate to Destination.
320 LET S$(P) = I$(P + 1)
330 LET D$(P) = D$(P + 1)
340 LET I$(P) = S$(P + 1)
350 GOSUB 180
360 LET P = P + 1
370 RETURN
380 END
```

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  
  decrement low byte of the pointer.
- **LDA** POINTL  
  move result to accumulator.
- **CMP $FF**  
  test for page crossing.
- **BNE 02**  
  if not FF, no page crossing  
  — decrementing complete.

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  — decrementing complete.
Pf1R!EZ-U[]lJS Pf1Sfll?

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The following code produces the same result, but requires two fewer bytes of code and executes 2 µs faster:

```
100 PRINT 'ENTER THE NUMBER FROM THE KEYBOARD. IF THE CORRECT NUMBER IS:
110 PRINT 'THE CHILD WILL BE SHOWN A SET OF CHARACTERS.
120 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
130 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
140 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
150 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
160 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
170 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
180 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
190 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
200 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
210 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
220 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
230 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
240 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
250 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
260 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
270 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
280 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
290 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
300 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
310 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
320 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
330 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
340 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
350 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
360 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
370 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
380 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
390 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
400 PRINT 'THE CHILD WILL BEEN SHOWN A SET OF CHARACTERS.
```

Sets

Tutoring in BASIC

Linda M Schreiber, 29143 Carlton, Inkster MI 48141

Listing 1: Altair Extended BASIC listing for helping children learn about sets.

```
10 ****** SETS WIR. 1 ******
20 ****** SETS WIR. 2 ******
30 ****** SETS WIR. 3 ******
40 ****** SETS WIR. 4 ******
50 ****** SETS WIR. 5 ******
60 ****** SETS WIR. 6 ******
70 ****** SETS WIR. 7 ******
80 ****** SETS WIR. 8 ******
90 ****** SETS WIR. 9 ******
```

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-
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.

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.
**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 Multi-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.

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**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 programmable 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.

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**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 Intel's 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 Intel's 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 edition, 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.
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.

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-Metzger 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 48930.

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.
What's New?

SOFTWARE

Pascal for the 8080 and Z80 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 8080/280 and PDP-11 Pascal Development Systems, are available from Lifeboat Associates, 2248 Broadway, NY NY 10024, for $750 per single microprocessor license.

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 eight-inch 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.

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 08802, is available on CP/M or North Star floppy disk with one extended language for $30. Additional languages are $10 each.

Machine Language Disk File Sorting Program for Apple II

Datapace, POB 55033, 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 CP/M and 60 other

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.

A Forth Software Development Tool

The XLS is an interactive programming system with compiler, interpreter, assembler, disk operating system, and a library of procedures. It is written in XLS 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 XLS development system requires less than 32 K bytes of memory. The $100 package includes source code and a reference manual. XLS 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.

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.

**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.

**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—basic, 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.

**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.

**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!, 5207 11th Ave NE, Seattle WA 98105.

**Publications 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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**Documentation Standards for Computer Systems**

Norman I. Enger’s *Documentation Standards for Computer Systems, Second Edition*, is a reference manual that shows how to document a computer application to use 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 section 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 well-documented 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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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 21 cm 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 daisy-chain 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 general-purpose 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 flex-strip jumper to any of the six alphanumeric designs to provide high-speed numeric entry.

The S3-key SK053 for the Model 33 teletypewriter features uppercase, but no lowercase, and costs $129. 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.

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. Interfaces 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 Pendleton St, Sun Valley CA 91352. Circle 428 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 truck-mounted 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.
What's New?

PERIPHERALS

Miniature Alphanumeric Thermal Printer

The APP-20A2 twenty-column, panel-mount 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 bus-compatible 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 $3350. The controller can handle up to three additional disks, which are priced at $2690. Contact Corvus Systems, 900 S Winchester Blvd, Suite 4, San Jose CA 95128.

Circle 432 on Inquiry card.
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.

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 read-only 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.

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 30B (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 TM990/210-2 four-bubble device is $1535; $1150 for the TM990/210-2 four-bubble device; and $1535 for the TM990/210-3 six-bubble device.

Circle 434 on Inquiry card.
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.

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 Voice Trap, a voice-operated video game, and Voethello, 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 Voice Tek, POB 386, Goleta CA 93017.

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 optically-graded 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.

Standardized Computer Forms

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 $22.50, $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.

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.

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 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.

Prototyping Kit for High-Resolution Graphics

The SVB-80 prototyping kit is a dual-board system with stand-alone capability in an Intel multibus configuration. 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 price for the SVB-80 is approximately $1600. Contact DOCS 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.

Circle 447 on Inquiry card.
OUR BEST PRICE EVER!
MICROPOLIS™ DISK DRIVE SUBSYSTEMS

At Micropolis, complete means complete. Some suppliers offer only hardware and call that complete. At Micropolis complete means everything: hardware and software and documentation. The hardware set is complete with S-100/8080/280 compatible controller, drive(s), cable—even a built-in Autoload bootstrap ROM to eliminate tiresome button pushing.

Our full Disk Extended BASIC and DOS, assembler and editor software comes complete, too. On its own diskette, ready to go. Software from Micropolis includes a DOS and Disk Extended Basic designed for 8080/280-based microcomputers.

DOS is a complete package, including an assembler, editor, file management functions and utilities, which provides total support for 8080 programming. BASIC is itself a self-contained package which provides a powerful set of tools for developing, testing, executing, and maintaining BASIC programs.

BASIC is designed for microcomputers with at least 24K bytes of RAM and a Micropolis MetaFloppy disk system. DOS can be used alone in a 16K bytes memory system.

Activating the built-in Auto Load ROM brings up the system under control of the DOS executive. BASIC can be accessed by issuing a simple DOS command.

The 1053 MOD II Subsystem is designed for flexible, efficient programming, 8080 programs created under DOS can be loaded and accessed from BASIC. Data files created under BASIC can be processed by user written application programs running under the DOS.

At Micropolis, complete means COMPLETE.

Imagine getting all the capacity of an 8-inch floppy in a 5¼-inch format.

MetaFloppy can give you this higher capacity because it packs more data into every disk. You get the capacity of larger 8-inch drives with the lower price and smaller packaging of 5¼-inch drives.

An ordinary 5¼-inch floppy provides just 35 tracks/drive and stores only 70K bytes. Not nearly enough for anything useful. So instead, we put 77 tracks/16 sectors of 256 bytes each for a capacity of 315K bytes! And why we call this one “quad density.”

Combine two of these drives in a compact dual module and you can copy diskettes from one drive to the other, or rearrange data files, and so on. The dual unit stores 630K bytes enough for almost anything. But just in case that isn’t enough, our controller can handle two duals (or four single drives). That means your micro can have more than a million bytes of formatted disk storage.

If that still isn’t enough, on special order you can add a second controller with up to four more drives. That will give you a grand total of over 2,500,000 bytes of storage on-line. That means, if your application keeps growing, we’ve got you covered in easy steps. And you get all these bytes at surprisingly low cost.

Each one of our floppy disks has a remarkable storage capacity, eliminating the need to keep bothersome stacks of paper.

Faster than a speeding bullet.

At Micropolis, we don’t skimp on performance to deliver maximum capacity. So you can expect professional operating speed and efficiency. Like checks and balances, such as automatic read verification after writing, that you would expect in a sophisticated data processing system.

Like fast track-to-track positioning time of only 30 milliseconds. And a data transfer rate of 250,000 bits per second.

Up, Up, and Away!

MetaFloppy gets along well with almost everyone.

So choose the microcomputer you want. MetaFloppy’s controller is completely compatible with the S-100/8080/280 buses. It just plugs into your MITS 8800, IMSAI 8080, COMPAL-80, SOL-20, Polymorphic 88, CROMEMCO, TDL, or similar micro and it’s ready to go. The memory mapped controller/worksheet may be oriented at any 1K byte boundary in the 48K to 64K byte region of memory.

For small businesses, for engineers who want to develop their own software, or for the advanced hobbyist, MetaFloppy is ideal.

LIST PRICE $1895.00

SALE PRICED AT JUST $1595.00

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4 MHZ EXPANDORAM II KIT

The S-100 Memory Board for the 80's

SD SYSTEMS' Expandoram II is a state-of-the-art dynamic RAM board with capacities from 16K bytes (412) to 256K bytes (4164). It operates on the industry standard S-100 Bus. The Expandoram II is designed to operate from the same S-100 Bus. Page mode operation provides the system with the capability of servicing multiple users without RAM interference. Invisible refresh and synchronization with wait states provides greater reliability, and processing speeds up to 4 MHz.

The Expandoram II is compatible with most S-100 CPU's based on the 286 microprocessor. Other SD SYSTEMS 200 series boards are combined with the Expandoram II, they create a microcomputer with exceptional capabilities and features.

-RHS 40WWG 40 1.65 1.45 1.35 1.25 1.20
-RNS 22WWO 22 1.00 .90 .85 .80 .75
-RNS 20WWO 20 .90 .80 .70 .65
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The Rockwell AIM 65 with 4K ROK-AIM65-4K 8 lbs. ..... $445.00
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1/16 Vector BOARD .041 dia holes on 0.1 spacing for IC's

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The EXPANDORAM is available in versions from 15K up to 64K, so you can have a memory system that will grow with your needs. This is a dynamic memory with the initial onboard refresh, and it WORKS.

- Interface with All Intel, MOS, S100, 8080, and 8085
- Bank Switching
-保護
- Power Switch; 16.15VDC, 5 Watts
- User Programmable -11V RAMS
- Model is double sided double mask and has silk-screen part layout.
- Extra documentation clearly written.
- Complete Kit includes all Sockets for 64K Memory access time 35ns. Cycle time 200ns.
- No wait states required.
- 16 Channels and Protection via DIP Switches.
- Designed to work with 240, 800, 850 CPUs.

**PHYSICAL**

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- With on-board 8024 Microprocessor
- S-100 bus Compatible
- Full 80 Characters by 24 Lines Display
- Characters Displayed by High Resolution 7 x 10 Matrix
- Composit or TTL Video Output
- Keyboard Power and Interface
- Forward and Reverse Scrolling Capability
- Blinking, Underlining, Field Reversal, Field Protect, and Combinations
- Full Cursor Control
- 99 Upper and Lower Case Characters
- 32 Special Character Set
- 128 Additional User Programmable Characters (Optional)
- On-Board 8024 Microprocessor
- 2K Bytes Independent On-Board RAM Memory
- Glitch-Free Display
- List Price $50.00
- Sale Price $370.00

**SDS-ROM-100 KIT**

- List Price $200.00
- Sale Price $175.00

**PROM-100 Programming Board for PROM Development**

**NEW**

**SD SYSTEMS' PROM-100** is a versatile PROM programming board offering complete EPROM programming capability. The board operates on the industry standard S-100 Bus. Support software verifies the erasure of EPROM and verifies the loaded program. SD SYSTEMS' PROM-100 offers a support software using its operations manual.

- S-100 Bus compatible
- Programs the following EPROM s: 2708, Intel 2716, 2716, 2726, and Texas Instruments 2516
- DIP Switch Selection of EPROM type
- VDC Programming Pulse Generator on Board
- Maximum programming time: 25000 Bits in 100 Seconds
- Power Requirement: +5VDC at 300 ma, +5VDC at 100 ma, +5VDC at 60 ma
- TTL compatible
- Software Protocols for Reading of Object File from SDROM, CIPROM or PROM and Programming into PROM
- Program Verification and Verification of Erasure
- Zero Insertion Force Socket
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**CENTRONICS 730 Dot Matrix Printer**

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**VDB-8024 VIDEO DISPLAY BOARD**

- With on-board 8024 Microprocessor
- S-100 bus Compatible
- Full 80 Characters by 24 Lines Display
- Characters Displayed by High Resolution 7 x 10 Matrix
- Compositive or TTL Video Output
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<thead>
<tr>
<th>Item</th>
<th>Price</th>
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<tbody>
<tr>
<td>Commodore Dual Floppy Disk Drive</td>
<td>$2,395.00</td>
</tr>
<tr>
<td>Commodore Printer (tray)</td>
<td>$1,295.00</td>
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<td>$995.00</td>
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<tr>
<td>Commodore Printer (tray less)</td>
<td>$995.00</td>
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<tr>
<td>Commodore PET Service Kit</td>
<td>$300.00</td>
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<tr>
<td>Bally-Tellis when tape is loaded</td>
<td>$24.95</td>
</tr>
<tr>
<td>Petunia - Play music from PET</td>
<td>$24.95</td>
</tr>
<tr>
<td>Video Buffer - Attach another CRT</td>
<td>$29.95</td>
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<tr>
<td>Combo-Petunia and Video Buffer</td>
<td>$49.95</td>
</tr>
<tr>
<td>TNW-Bl-Dir. RS-232 printer X-face</td>
<td>$229.95</td>
</tr>
<tr>
<td>KIM 1 (A Single Board Computer) from Commodore</td>
<td>$179.95</td>
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**SANYO MONITORS**

**SALE!**

<table>
<thead>
<tr>
<th>Size</th>
<th>Model</th>
<th>Price</th>
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<tbody>
<tr>
<td>9-inch</td>
<td>SANYO</td>
<td>$169.00</td>
</tr>
<tr>
<td>15-inch</td>
<td>SANYO</td>
<td>$279.00</td>
</tr>
</tbody>
</table>

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**NEW**

**ZENITH COLOR VIDEO MONITOR**

ZENITH'S first color video display designed specifically for computers. The 13-inch monitor is ZENITH's first color video display designed specifically for computers. Features include automatic color level, color processing and degaussing circuits.

**Zenith Color Monitor**

**$499.00**

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**SALE!**

**9·inch 15-inch**

<table>
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**HAZELTINE**

**Super Terminal Sale!**

<table>
<thead>
<tr>
<th>Model</th>
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</thead>
<tbody>
<tr>
<td>1410</td>
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<tr>
<td>1500</td>
<td>$1,069.00</td>
</tr>
<tr>
<td>SALE! $749</td>
<td>SALE! $995</td>
</tr>
</tbody>
</table>

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**PAPER TIGER 440SPE**

The Graphics Printer for Apple II

Now you can print illustrations, block letters, charts, graphs, and more—all under software control! And with the expanded buffer, the Paper Tiger can hold the text from an entire 24-line-by-80-column CRT screen.

**$119.00 440 Reg. w/o graphics: $395.00**

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**HEATH**

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Dual 24-Processors Basic 102K Floppy Disk 14K RAM 25 x 80 Character Display Upper/Lower Case and Line Graphics 80 Character Keyboard Auto-Search and Auto-Scroll Built-in Disk and Printer Interfaces NO SPECIALS ON VCRS, TVS, FAX, COMPUTERS, 8-TRACKS, etc., **$795.00**

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The ADM-3A is industry's favorite dumb terminal for some very smart reasons:

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**HEWLETT-PACKARD'S HP-41C**

130 built-in functions + 400 lines expandable to 2,000 + program memory + Continuous memory + RPN logic + **$2,995.00**

**Call 7-4188**

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HEWLETT-PACKARD's HP-41C. **$795.00**

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- Built-in variable delay circuitry — 1μSec to 5 Sec. 5mV/Div. Vertical Sensitivity.

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**NTSC Color Bar Pattern Generator**
- Model LCG-396
- NTSC color bars
- 3.58MHz subcarrier
- 3.58MHz subcarrier

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This is truly an all-inclusive system that has all the desirable features of the Super Elf for so little money. The Super Elf is a small single board computer that does most everything. It is excellent for training and learning programming with its microprocessor and yet it is easily expanded with additional memory. Full Basic, Audio, Keyboards, video character generation, etc.

Before you attempt a computer, the Quest includes the following features ROM monitor. State and mode displays, single step, optional address displays, Power Supply, Audio Amplifier and Speaker. Fully socketed for all IC'S. Real cost in warranty repairs. Full documentation.

The Super Elf includes a REM monitor for program loading, editing and execution with SIMPLE STEP for program debugging which is not included in others at the same price. With SIMPLE STEP you can use the microprocessor chip operating with the state address and data bus displays before, during and after execution. Also, CPU mode and instruction cycle are decoded and displayed by 8 LED indicators. An RCA 1801 video graphics chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a speaker system included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relay for control purposes.

Super Expansion Board with Cassette Interface $89.95

This is truly an entry level system that has been designed to allow you to decide how you want it equipped. The Super Expansion Board can be expanded to over 5200 EPROM chips and is addressable anywhere in 64K with built-in memory protection. This board has been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the Super Elf. The board includes sockets for up to 6 of EPROM (2702, 2706, 2716 or 2727) 1K EPROMs and also be used for the monitor and Tiny Basic or other purposes.

At $5 Super ROM Monitor $15.95 is available as an on board option 2008 EPROM which has been preprogrammed with a program loader/ editor and error checking multi cassette read/write software. This cassette is an excellent companion to Quest. It includes register searches, program diagnosis and code compare and is easy to use with only one single step. The Super Monitor is written with a 24 key HEX keyboard includes 16 HEX keys plus load, reset, run, wait, input, memory protection, monitor select and single step. Large on board displays provide output and optional high level and address. There is a 4 pin connector for PC cards and 52 pin connector for the Super Expansion Board. Power supply and sockets for all IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pg. of BASIC. Complete system of lessons to help get you started and a music program and graphics taste game. Many schools and universities are using the Super Elf as a course of study. EMI uses it for training and R&D.

Remember, other computers only offer Super Elf features at additional cost or not all at all.

Compare before you buy. Super Elf Kit $106.95. High address option $9.95. Low address option $9.95. Custom cabinet with dished and labeled partslist in front panel $24.95. Expansion Cabinet with room for 4 S-100 boards $41.00. NICAD Battery Memory Saver Kit $5.95. All kits and options also completely assembled and tested. A 12 page monthly software publication for 1802 computer users is available by subscription for $12 per year. Issues 1-12 bound $16.50. Tiny Basic Cassette $10.00, ROM $29.00, original Elf kit board $14.95. 1802 software: Mooves Video Graphics $3.50, Games and Music $3.00, Chip 8 Interpreter $3.50.

RCA 2702/03 1K EPROM $2.49 each.

Multi-volt Computer Power Supply with built-in 5 volt, 12 volt and 15 volt for S-100 bus. This power supply is capable of driving many S-100 devices such as display boards, keyboards and other components, all of which can be added on charge cards.

LRC 7000 - Printer $398.00

46/46 column dot matrix impact, slip paper interface, contrast control, line feed, line on/off, reverse, cut off, on/off, curl.

Teletext Terminal $584.00

102 key, upper, lowercase, 10 baud rates 24 x 80 char. monochrome video card only.

Interfibe Terminal $1029.00

Super Brain

Floppy Disk Terminal $2859.00

791C Upgrade Master Manual $29.95


S-100 Computer Boards

6K Static RAM Kit $375.00

16K Static RAM Kit $450.00

32K Static RAM Kit $625.00

16K Dynamic RAM Kit $199.00

32K Dynamic RAM Kit $470.00

44K Dynamic RAM Kit $740.00

Video Interface Kit $129.00

Video Modulator Kit $8.95

Convert TV set into a high quality monitor with special features like available. Needs no additional components. Wall mounting, full operation. Will measure 1000 to +2000 of human. S-100 standard only.

Woodgrain case $10.00. 50k shopping.

Digital Temp. Meter Kit $34.00

Outdoor and indoor. Switches back and forth. Beautiful! Scale 0-120 F. Requires AC power. Price includes all needed components.

New 1982 model. 3/4" display, AC line frequency, call for price.

Circle 259 on Inquiry card.
FACTORY PRIME

GlM IX'

OuBl/ry E lec 11 omc pr oduc 1s sin ce

FOR THE SSSO ANO SS50C BUS (SWTP elc . )

2114L 450 4044 450

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

The Company that delivers.

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• w ,11e P1 otec t

• Go ld B us Connec10 1 s

32K ... . . .. . . .. . . .. . . . . $548 . 15

• SS50C Exiended A ddress in g (ca n

24K ... . . .... . . .. .. . .. .. .. $438 .14

• 4

C 1P 5 " FLOPP Y 20 K $1198 .00

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C-3 · 23 MEG HA RD D I SK $9900 .00

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CH AL LE NGE R ! COLO R ) C4 P BK 5698 .00

C OLO R · DUA L 8 " FLOPPY C 8P S 2 597 .00

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C 4P FL O PP Y 24K

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C OLO R · DUA L 8 " FLOPPY C 8P S 2 597 .00

SU PERBOARD C l P $ 279 .0 0

S A N CHECO . C A t7111

G H O S -r" aie

Rllgis ll!nld
### EDGE CARD CONNECTORS: GOLD PLATED:

<table>
<thead>
<tr>
<th>Abbreviations: S/E Solder Eye</th>
<th>S/E Solded Tail</th>
<th>W/W Wire Wrap</th>
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#### REGULATORS AND MISC. COMPONENTS

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**ALL PRIME QUALITY — NEW PARTS ONLY**

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**NOTE:** NO C.O.D. OR CREDIT CARD ORDERS WILL BE ACCEPTED.

**Circle 271 on inquiry card.**
FLOPPY SYSTEMS

8" Siemens FDD120-8D
All Siemens options included. This drive may be configured hard or soft and single or double density. We find this to be an extremely reliable drive. $430.00

5¼" BASF Magical Miniature Mini drive only 2/3 the size of others is reliable and durable and quickly gaining in popularity with our customers. Single or dual density fast access times $269.00


Cable Kits For 8" Drives with 10' 50 cond. cable and connectors. Also power cable and connector kit. Flat cable assem if you wish. For one drive 27.50, two 33.95, three 38.95

Cable Kits for 5¼" Drives as above, but 34 cond. For one drive 24.95, two 29.95.

"Power One" Model CP206 Power Supply adequate for at least two drives. 2.5A/24V. 2.5A/5V, 0.5A/5V beautiful quality. $99.00

CABINETs for FDD120 and 801A drives, or CP206 supply. Matte finish in mar resistant black epoxy paint and stacking design 29.95

DISKETTES (Mrx, Verbatim, Georgia Magnetics)
8" $39.95/10
5¼" $34.95/10

STATIC RAM MEMORY, S-100
32K - $549.00
16K - $349.00

"BACK TO SCHOOL" KEYBOARD SPECIAL
CHERRY "PRO" Keyboard $119.00
Streamlined Custom Enclosure $34.95
Both only $134.95!!!!!!!!!!

10MB DRIVE $3300
S-100 DMA CONTROL

POWER UNIT $395.00

For the first time in something like 10 years, a new STANDARD in removable media has evolved. Selected by Datapoint, and others who have not yet announced, this drive is beautifully simple and easy, if not trivial to maintain, 820k/sec transfer rate, 3600 RPM 39 lbs and only 125 Watts.

Software:
OS-1 (see opposite page) Call for up to the minute pricing 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!!!

Daisy Wheel Printers

Gume Sprint 3\45

PRINTER (factory warr.) $1499.00
POWER SUPPLY (Boschert) 349.00
(shown mounted on rear of printer)
COMBINATION SPECIAL $1699.00
Cases available ................. 200.00
S-100 interface card .......... 149.00
DATA DISPLAY MONITORS

Used 12" Sylvania monitors. Composite Video, 15 MHz, 120VAC, Re-built with NEW P39 anti-glare tube $119.00 New P4, 109.00, used P4 79.00.
U-fix model, 10/$300.00

"OEM STYLE" as above, will fit any case. (Both versions serviced by qualified tech), Identical to above but subtract $12.00

Televideo 912B Televideo 920C
($860.00) ($1020.00)

New!

SOCKET SPECIAL

"Wont Let Go"

Low Profile

Solder Tall
1 CENT/ Pin !! (0.75/1000's)

274 BYTE March 1980

Circle 272 on Inquiry card.
**OS-1**

Source Code - FREE when you purchase "OS-1"

Virtual I/O - copy with a single command between floppy and hard disk, or fromTTY to printer to tape to disk, etc.

MULTI-USER - up to 266 passwords, non-simultaneous users

SECURITY - 9 modes of file protection, user and login protection.

The OCPM (Operating System for the Z-80) designed to have exactly the features, and none of the bugs found in the Z-80's competitors. Fast, reliable, completely compatible with CP/M and UNIX. "OS-1" is truly a comprehensive operating system, designed from the ground up for the Z-80, not merely a file handling package.

"OS-1" gives you the best of both worlds - CP/M compatibility, plus a host of enhancements that are not available in CP/M.

What we ARE giving you is a greatly enhanced version of CP/M that you may modify any part of the CP/M to suit your own system requirements. At no charge, you also receive the enhancement software "PLOT" 20 or 30, allowing easy implementation of gigantic storage devices.

CALL FOR PRICE AND DETAILS
SOLID STATE MUSIC

PB-1
EPROM PROGRAMMER FOR 2708 OR 2716
MEM-95910K (KIT) $125.00
MEM-95916A & T $175.00

VECTOR GRAPHICS

HI-RES GRAPHICS
256X256 S-100 HI—RES GRAPHICS BOARD
IOV-1070K (KIT) $150.00
IOV-1070A & T $199.95
LIMITED TO STOCK ON HAND

SOLID STATE MUSIC

I/O-4
2 SERIAL & 2 PARALLEL I/O PORTS
IOI-1010K (JADE KIT) $149.95
IOI-1010A & 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 2706, 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

OUR BEST SELLING MEMORY

EXPANDORAM
EXPANDABLE TO 64K USING 4116 RAMS
Interfaces with most popular S-100 boards
Bank selectable, PHANTOM provision
Draws only 5 watts fully populated
Designed to work with Z-80, 8080, and 8085 systems
No wait states required
16K boundaries & protect via dip switches
Kits come with sockets for full 64K
Invisible refresh
MEM-16130K (16K KIT) $329.95
MEM-16130A (16K A&T) $399.95
MEM-32131K (32K KIT) $599.95
MEM-32131A (32K A&T) $699.95
MEM-48132K (48K KIT) $929.95
MEM-48132A (48K A&T) $1,099.95
MEM-64133K (64K KIT) $1,129.95
MEM-64133A (64K A&T) $1,299.95
MEM-12340A (A&T, NO PROMS) $135.00

GET THE INSIDE TRACK

JADE DOUBLE-D
DOUBLE DENSITY DISK CONTROLLER
Read/write single or double density, 8" or 5½" drives
Onboard 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 onboard 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!!!!
IOD-1200K (DOUBLE D KIT) $289.95
IOD-1200A (DOUBLE-D & T) $349.95
IOD-1200A (MANUAL ONLY) $15.00

S D SYSTEMS

VERSAFLOPPY II
DOUBLE DENSITY DISK CONTROLLER
Single or double density floppy drive controller
IBM 3740 format in single density
IBM 3745/44 format in double density
8" and 5½" drives controlled simultaneously
Operates with Z-80, 8080 and 8085 CPU's
Controls up to 4 drives
Vectorized interrupt operation optional
IOD-1150K (KIT) $335.95
IOD-1150A (KIT) $385.95

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 includes all of CP/M's 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 $290.00
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 usable in SHADOW mode (full 64K RAM)
Automatic INWRITE generation of on-board panels
On-board USBART for sync or async RS-232
CPC-30201K (KIT) $159.00
CPC-30201A (A & T) $209.00

S D SYSTEMS

EXPANDORAM II
4 MHZ RAM BOARD EXPANDABLE TO 256K
S-100 bus compatible, up to 4 MHz operation
Expandable memory from 16K to 256K
Dip switch selectable boundaries
Page-mode allows up to 6 boards on the same bus
Invisible refresh. PHANTOM output disable
Designed to operate in Z-80 based systems
MEM-56631K (16K KIT) $295.95
MEM-56631A (16K A&T) $345.95
MEM-56632K (32K KIT) $399.95
MEM-56632A (32K A&T) $419.95
MEM-56634K (64K KIT) $449.95
MEM-56634A (64K A&T) $499.95
MEM-56638K (128K KIT) $569.95
MEM-56638A (128K A&T) $629.95

VECTOR GRAPHICS

12K PROM/RAM
1K OF STATIC RAM AND 12 2708 SOCKETS
MEM-12340A (A&T, NO PROMS) $135.00

BEST BUY RATED
TV-1 ONLY $7.95
OUR BEST SELLING R. F. MODULATOR

GET YOUR "ROCKS" OFF...THE SHELF
CRYSTAL SALE
WE STOCK 40 STANDARD FREQUENCIES FOR $12

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, extends to 2 SIOs, 4 CTCs
4 serial ports (async, sync, bisync, SDLC/HDC)
2 parallel ports with full handshaking
Software baud rate generators, interval timers, counters, and generates 32 vector interrupts
Designed especially for CP/M multi-user multi-tasking operating systems. For use with Z-80 only
IOI-10458 (BARE BOARD) $45.00
IOI-10459 (KIT) $69.95
IOI-10455 (A & T) $224.95

SALE SALE SALE SALE SALE
EPROMS
BUY NOW AND SAVE

276 BYTE March 1980

Circle 273 on inquiry card.
**DIGITAL ELECTRONICS**

**IDH Series - Headers**

<table>
<thead>
<tr>
<th>PC Mounting</th>
<th>Wire Wrap</th>
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<tbody>
<tr>
<td><strong>Pins</strong></td>
<td><strong>Pins</strong></td>
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<tr>
<td><strong>Straight</strong></td>
<td><strong>Right Angle</strong></td>
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<tr>
<td>10</td>
<td>IDH-10S</td>
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<td>20</td>
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<tr>
<td>26</td>
<td>IDH-26S</td>
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<td>34</td>
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<td>IDH-40S</td>
</tr>
<tr>
<td>50</td>
<td>IDH-50S</td>
</tr>
</tbody>
</table>

- 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.

**IDC Card Edge Connectors**

<table>
<thead>
<tr>
<th>Pins</th>
<th>1-9</th>
<th>10-24</th>
<th>25-99</th>
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<td>20</td>
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<td>50</td>
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</table>

- 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.

**Cable Plugs**

<table>
<thead>
<tr>
<th>Pins</th>
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<td>40</td>
<td>3.75</td>
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</table>

- 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.

**Insulation Displacement Sockets**

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<td>4.40</td>
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</table>

- 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.
- Molded orientation tab.

**Transition Connectors**

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<td>50</td>
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<td>3.45</td>
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</tr>
</tbody>
</table>

- 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.

**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.

**Notes**

- Custom crimping available on all products for prototype quantities at $50/connection.
- Wire spacing .050" ± .002", 26 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.

**Cable**

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- Compatible with all RN IDC products.
- Wire spacing .050" ± .002", 26 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.

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The Microprocessor Components section lists various components and their specifications, including CPU and memory modules. It also includes information on jumpers and interfaces.

The Proto Boards section lists various proto boards and their specifications, including size, shape, and number of pins. It also includes information on the materials used and the company name.

The Proto Boxes section lists various proto boxes and their specifications, including size, shape, and number of pins. It also includes information on the materials used and the company name.

The 62-Key ASCII Encoder Kit section lists various components and their specifications, including keyboard layout and input/output specifications. It also includes information on the materials used and the company name.

The Digital Thermometer Kit section lists various components and their specifications, including power requirements and display type. It also includes information on the materials used and the company name.

The Jumbo 6-Digit Clock section lists various components and their specifications, including power requirements and display type. It also includes information on the materials used and the company name.

The 6-Digit Clock section lists various components and their specifications, including power requirements and display type. It also includes information on the materials used and the company name.

The Regulated Power Supply section lists various components and their specifications, including power requirements and display type. It also includes information on the materials used and the company name.

The Hickok section lists various components and their specifications, including power requirements and display type. It also includes information on the materials used and the company name.

The Jameco Electronics section lists various components and their specifications, including power requirements and display type. It also includes information on the materials used and the company name.

The TRS-80 section lists various components and their specifications, including power requirements and display type. It also includes information on the materials used and the company name.
TRSI-80 E.S.

SERIAL I/O
- Can input into basic
- Can use LUST and LPRINT to output, or output continuously
- RS-232 compatible
- Can be used with or without the expansion bus
- On board switch selectable baud rates (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

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- Type 103 - Full or half duplex
- Works up to 100 baud
- Universal or Answer
- No colls, only low cost components
- TTL input and output
- Connect B in speaker
- On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity odd or even
- Jumper selectable software
- Input and Output routine from monitor or BASIC to teletype or other serial printer
- Program interface for using an Apple II for a video or an interface terminal.
- Also can output in correspondence code interface with some selectrics.
- Also receives DTR - Board only $18.95 Part No. 109A

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SERIAL I/O INTERFACE
- Baud rate is continuously adjustable from 0 to 30000.
- Plug ins and into interfaces
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- Also can output in correspondence code interface with some selectrics.
- Also receives DTR

8K EPROM PICEON
- Saves programs on PROM permanently until erased
- 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

8K EPROM:
- Board only $19.95 Part No. 801A
- Box of 10, 5" $29.95, 8" $39.95
- Plastic box, holds 10 diskettes, 5" $4.50, 8" $8.50

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- Converts TTL to RS-232
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**BOMB - BYTE's Ongoing Monitor Box**

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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)."
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.

The price of each print is $25. This includes 1) a signed and numbered print; 2) a Certificate of Authenticity, also signed personally by the artist and witnessed, attesting to the number of the edition (750), and the destruction of the printing plates; and 3) first class shipment in a heavy-duty mailing tube.

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C8P DF $2,597

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, 2-6 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" 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-AMS.

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 (UTT). 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 downloadable 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.

C8P $895

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Computers come with keyboards and floppy drives where specified. Other equipment shown is optional.

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