

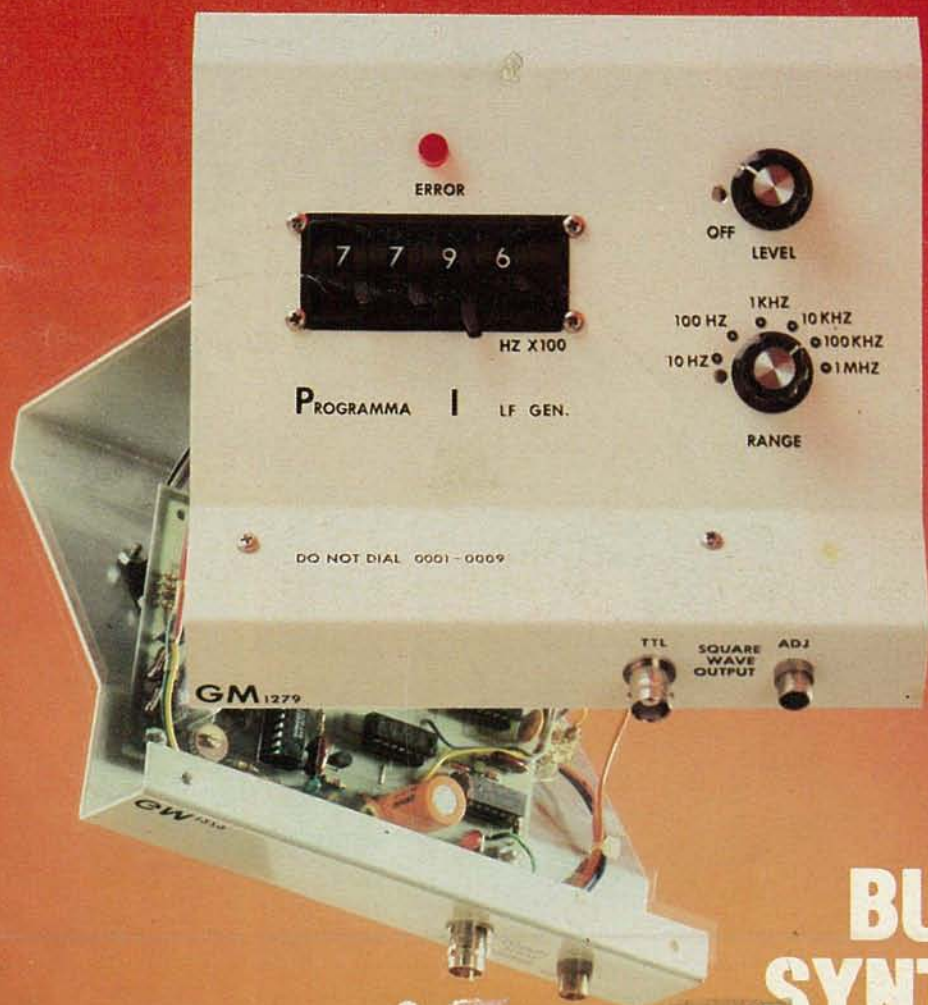
# Radio- Electronics®

**YOUR OWN COMPUTER  
40-PAGE BUYERS GUIDE**

\$1.25 OCTOBER 1980

**Assembling the Unicorn-1 robot  
IC's for LED bar-graph displays  
Nikola Tesla—the pioneer**

**How to use flasher LED's  
Hafler's super hi-fi amplifier kit  
One-IC digital panel meter**



**BUILD THIS  
SYNTHESIZED  
PULSE GENERATOR**





# Radio- Electronics

THE MAGAZINE FOR NEW  
IDEAS IN ELECTRONICS

Electronics publishers since 1908

OCTOBER 1980 Vol. 51 No. 10

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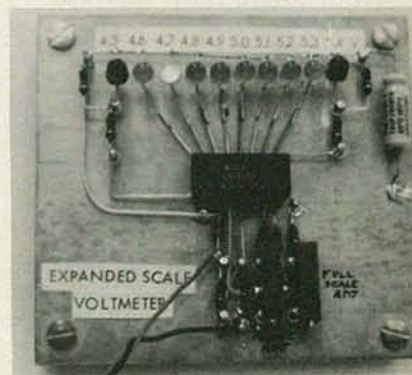
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SPECIAL COMPUTER SECTION covers recent developments in the personal computer field. Find out what's for you, starting on page 45.



LED DISPLAYS are showing up in more and more designs. Learn how to design your own on page 96.

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OCTOBER 1980



# The first personal computer for under \$200.

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Occupation: \_\_\_\_\_ Age: \_\_\_\_\_

Intended use of ZX80: \_\_\_\_\_

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Do you own another personal computer? ☐ Yes ☐ No. \*For Conn. deliveries, add 7% sales tax.

RE-10-0

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# **Computer®**

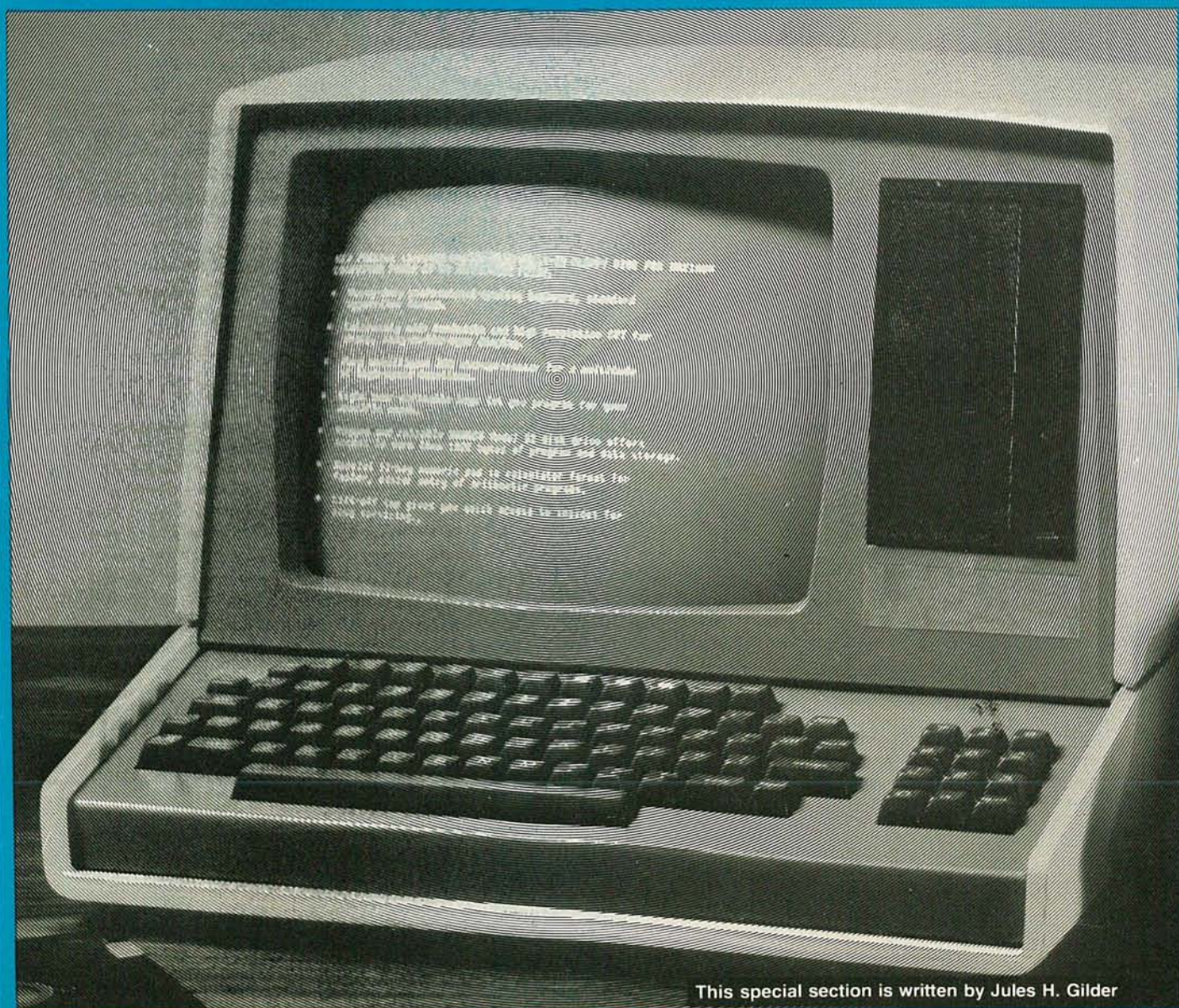
## **BUYERS GUIDE TO HOME COMPUTERS**

**Nifty peripherals and accessories**

**Home computers—what's here and what's coming**

**Dial up networks for home computers**

**Programming on your own level**



This special section is written by Jules H. Gilder



# Radio Shack's TRS-80



*Radio Shack's TRS-80 is not perfect but a quarter-of-a-million owners find this computer to be the right piece of equipment at the right price. Some of the TRS-80's strengths and weaknesses are discussed here.*

SHORTLY AFTER THE PET COMPUTER APPEARED ON THE SCENE, in the early days of personal microcomputing, The Radio Shack division of the Tandy Corporation announced their entry, the TRS-80 for \$595. The price was right; it was competitive with the PET, then the only other take-it-out-of-the-box, plug-it-into-the-wall computer.

Radio Shack put on a strong promotional campaign and succeeded in selling its TRS-80 with Level I BASIC. But Radio Shack had a few things going for it. First, it had a tremendous distribution network which Commodore Business Machines, makers of the PET, couldn't come close to matching. Second, people knew who Radio Shack was, while Commodore was more of an unknown quantity. Third, Commodore was so impressed with its own achievements, that it demanded that anyone who wanted one of their computers pay in advance—and delivery time stretched to three or four months (and in many cases even more). Fourth, and worst, Commodore's attitude towards its customers was bad and support was bad.

Well, with all of these things going for it, the TRS-80 couldn't help but be a success. The tremendous demand really caught Radio Shack by surprise. Initial estimates were for selling a few thousand computers. Sales to date, three years later, are estimated to be over 250,000. Of course, along the way, Radio Shack learned that its Level I BASIC just wouldn't make it and it came out with Level II BASIC, from Microsoft; but the price of the machine also went up. Today, the 4K Level I machine is virtually a thing

of the past and has been replaced in popularity by the 16K Level II unit. Also, Radio Shack has come out with a more business-oriented computer known as the Model II. Shown above are the three latest additions to the Radio Shack line of computers. At the top left is the TRS-80 Color Computer. It provides color graphics and features instant-load Program Pak software. At the top right is the TRS-80 Model III. It's priced from \$699 for the 4K version expandable to 32K plus disk storage for \$2495. Also shown is the TRS-80 Pocket Computer. It weighs a mere 6 ounces and is less than 7-inches long. You'll be hearing more about these units soon.

## System is modular

The basic TRS-80 Model I (as the original TRS-80 is now called) computer is a modular unit that consists of four individual pieces; a 12-inch black-and-white video monitor, a 53-key keyboard/CPU unit that contains Microsoft BASIC in ROM and 4K to 16K of RAM, a power supply for the keyboard console, and a cassette tape recorder.

With all those different units, you need three electrical outlets to set up your computer system. The problem becomes still more acute if you add on an expansion interface and two disk drives: that will require another three outlets for a total of six. It quickly becomes apparent that one of the drawbacks of the TRS-80 design is its rat's nest of wiring. And all of these stray wires can only spell trouble for the high-speed digital circuits found in computers. Worst yet, none of the AC power cords are of the three-wire grounded



TABLE I—BASIC COMMANDS for Model I and Model II TRS-80's

ABS	ASC	ATN	CDBL	CHR\$	CINT	CLEAR
CLOCK	CLOSE	CLS	COS	CSNG	CUD	CUI
CUS	DATA	DATE\$	DEFINT	DEFN(X)	DEFSNG	DEFSTR
DELETE	DIM	DIR	EDIT	END	EOF	ERL
ERR	ERROR	FIELD	FOR	FRE	FRE\$	GET
GOSUB	IF-THEN-ELSE	INKEY\$	INPUT	INSTR	INT	KILL
LEN	LET	LEFT\$	LIST	LIST	LLIST	LOAD
LOAD	LOC	LOF	LOG	LPOS	LSET	MERGE
MID\$	MKD\$	MK\$	MKS\$	NEW	NEXT	ON ERROR
ON..GOSUB	ON..GOTO	OPEN	POS	PRINT	PRINT@	PUT
READ	REM	RENAME	RESET	RESTORE	RESUME	RETURN
RIGHT\$	RND	RSET	RUN	SAVE	SGN	SIN
STOP	STR\$	STRING\$	SQR	SYSTEM	TAB	TIME\$
TROFF	TRON	USR(N)	VAL			



THE ORIGINAL TRS-80 with Level I BASIC and 4K of memory.

type, although the video monitor power plug is polarized to prevent inserting it the wrong way.

Once you successfully save a program on a cassette tape, you face several problems. The first is verifying it, or checking to see that it was properly recorded. To help you in that process, *TRS-80* BASIC has a command called **LOAD** which will compare what has been recorded on a tape to what is actually in memory. Most of the time it works nicely, but recently I have found that it doesn't *always* work. I have loaded tapes into memory and then tried to verify the recently loaded program, with the one that is on the tape. The result was always **BAD**, even though a byte-by-byte check showed that both programs were the same.

Once you do get your program recorded onto tape, you're going to want to load it back in one day. With most computers, if a tape is not being read in correctly, an error message is generated right away. That is not always the case with the *TRS-80*. More often than not, you'll sit and load a long program for three minutes, with everything appearing to go along smoothly. But then when you run the program an error message is generated. Listing the program at that point shows that you have loaded in three minutes worth of garbage, because your volume setting was not exactly set right.

Having gotten those problems straightened out, a new one surfaced, this a lot more serious because it could occur randomly and wipe out my data. It occurs only in disk systems and manifests itself by the disk suddenly rebooting itself, wiping out any program that was in memory at the time. I have been told that it is caused by power-line spikes

and surges and that I should get a constant-voltage transformer to clean that up.

Adding a floppy-disk system to your *TRS-80* provides you with an additional 50K of storage on your first disk and 86K of storage on diskettes in additional disk drives. Assuming that everything in your disk-based system is working fine, you can still encounter difficulty and ruin a good diskette in a snap. All you have to do is to try to turn the system power on or off while your diskette is in its drive, or try booting up your disk while a parallel printer is connected to your system, but not turned on. Any one of those actions could promptly wipe out your diskette. (*Some other computers will also "crash" disks if the system is turned on or off while they are in the drive. It's a good idea to remove disks from their drives during these operations, unless your manual specifically states otherwise—Editor.*)

Expanding a basic 16K-system to more memory or disk-drive capability is expensive. In either case, you must purchase an expansion interface, which costs \$300. Additional memory is sold by Radio Shack at \$149 per 16K, which is 33% to 50% more than you can get it for by yourself. The reason that the expansion interface is so expensive is that it comes with a disk controller capable of handling up to four disk drives. And you get it whether you want it or not. It also comes with a built-in parallel printer interface and a real-time clock which can be helpful in programs where it is necessary to keep track of time.

### Need help?

While Radio Shack probably has a larger distribution network than any other personal computer manufacturer, you can't go into any one of them for technical help. If you need help, try and get to a Computer Center store. I have found that, in general, they have people who are quite knowledgeable and helpful.

### They keep making changes

One annoying feature about Radio Shack, is that they keep making changes to the hardware without telling anyone, making independently-purchased hardware and software incompatible with the new versions. For example, early versions of the *TRS-80* CPU brought out the 5-volt supply to the external connector. Later models eliminated that. Thus anyone designing an accessory that was to use that supply now had to provide his own power supply. A more recent change was in the ROM's supplied with the system. That can play havoc with the existing software on the market, because now some of the internal subroutines are not located where they were. In fact, some people have told me that the new ROM's have even resulted in problems





A NUMBER of printers are available to run with the TRS-80.

TABLE II

**ERASE**—Cancels a dimensioned array and frees its memory space.

**HEXS**—Converts a decimal number to a hexadecimal string.

**NULL**—Sends blanks at the end of a line (communications).

**OCTS**—Converts a decimal number to an octal string.

**RENUM**—Renumbers program lines.

**RESET**—Restores default system settings for all devices.

**SPACES**—Prints a specified number of blank spaces.

**SPC**—Prints spaces on video display.

**SWAP**—Exchanges the values of two named variables.

**WIDTH**—Sets line width for video display.

**ADDITIONAL OPERATORS:** MOD, IMP, EQV, XOR (Integer Division).



VOICE SYNTHESIZER adds speech capability to the computer.



ECONOMICAL Quick Printer II uses electrosensitive paper.

#### For business applications, consider the Model II

In May 1979, Radio Shack decided to make a concentrated effort to capture a large part of the business-computer market and introduced the vehicle it was going to use to do that—the *TRS-80 Model II*. In its most basic configuration, the *Model II* comes with 32K of RAM and a single, built-in, 8-inch floppy-disk drive. The cost of that system is \$3450. The processor used is a Z80A, which is a 4-MHz version of the processor used in the *Model I*. It is possible to add on an additional 32K of RAM for another \$449.

While the basic computer comes with only one disk drive with 500K of on-line storage, that can be expanded to two megabytes of on-line storage by adding three more disk drives at a cost of \$2350.

Radio Shack calls the BASIC it provides with the *Model II* Level III BASIC; that can be confusing, because Microsoft sells what it calls Level III BASIC for the *Model I*, and the two are not the same. Radio Shack's Level III BASIC is almost identical to the Level II BASIC—there are some exceptions. The BASIC in the *Model II* has 23 more commands than the BASIC in the *Model I* machine. A list of the commands in both BASIC's is shown in Table I, while those added to Level III BASIC are shown in Table II. What is not shown on those tables is a serious omission in Level III BASIC, in which the PEEK and POKE and INP and OUT commands from Level II BASIC are no longer available. Radio Shack claims that those commands are no longer needed, but already several companies are advertising short little machine-language programs for sale that restore the PEEK and POKE commands to Level III BASIC.

There are some differences in the DOS (Disk-Operating System) on the *Model II* as well. The principal one is that the DOS responds with positive feedback. If, for example, you tell the computer to "KILL 'file name'", the computer will respond with "'file name' KILLED" or "'file name' NOT FOUND", so you always know what is happening. In addition, when duplicating a diskette, it is necessary to know the master password.

There is a huge variety of equipment and accessories for the *TRS-80*. So before you go any further you really want to get a copy of the Radio Shack Computer Catalog. **R-E**



with some Radio Shack-supplied software, which will no longer run in the new machines. And nowhere is the change documented, except for a short note in the *new* user's manual that states there will be two fewer bytes of free memory and the sign-on message will be different for the new ROM's.

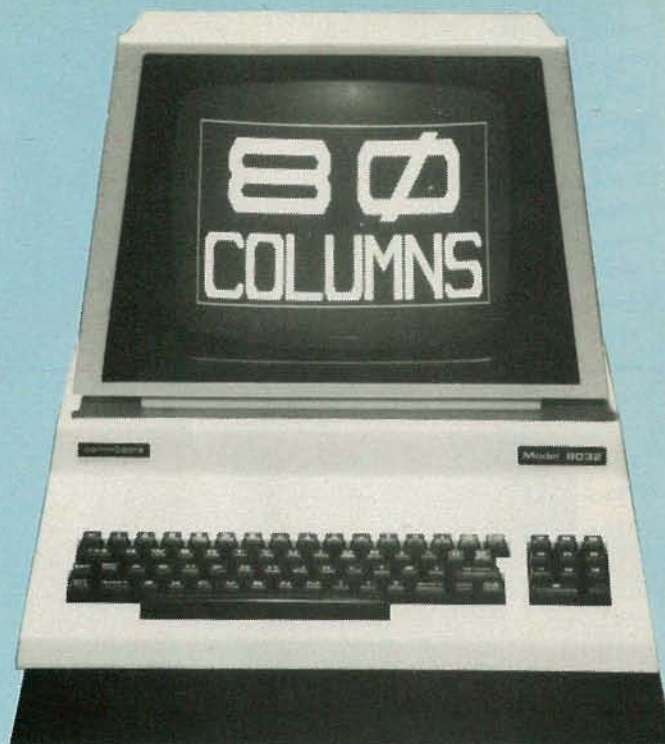
Radio Shack has made some welcome changes too. The first, and most needed, was the switch to a new type of keyboard that doesn't bounce (produce extra letters every time a key is pressed). Another change involving the keyboard, was the addition of a numerical keypad. That is particularly useful if a lot of numbers are going to be entered. It comes free on new computers. You can add it to older units, that didn't come with it, for \$99.

Another hardware modification now available is a lower-case adapter. That board, which plugs into the keyboard unit, costs \$99 and allows you to display lower-case letters on the video monitor.



# PET Personal Electronic Transactor

*Commodore's PET was the first all-in-one personal computer. Since its introduction it has undergone many changes. The toy has evolved into a business machine.*



IF THERE IS ONE COMPANY THAT IS RESPONSIBLE FOR THE personal computer revolution and the development of plug-in-out-of-the-box computers, it is Commodore Business Machines. And if there is one person that is responsible for it, his name is Chuck Peddle: It was he who had the foresight to realize that what the world needed was a ready-to-use home computer that didn't have to be assembled. And the first company to announce such a computer was Commodore.

When the first news articles on the *PET* computer appeared in the technical press five years ago, it seemed too good to be true. They described a full-blown computer with a CRT display and an ASCII keyboard for only \$600. Oh, sure—there were a lot of computer kits available at that time for about the same price; but none of them had the same capability.

The kits gave you a CPU, power supply, and a box to house it in. One or two manufacturers even offered some memory. But you, the purchaser, still had to toil long hours to build and debug the unit—and after that you still couldn't use it, because it required a host of peripheral interfaces and, of course, an I/O device, such as a teletypewriter.

Then came the announcement from Commodore that they were going to supply the entire thing, assembled and ready to run BASIC at the flick of a switch. And all that would cost less than most of the basic kits. Along the way, the \$600 *PET* fell by the wayside, as did most of the Do-It-Yourself computer kits. The 4K *PET* gave way to the 8K *PET*, and the cost went up to \$800, but it was still a bargain. Seeing the interest that was generated by that ready-to-use computer, it didn't take long for other manufacturers to jump on the bandwagon.

## **But look at that keyboard!**

One of the most controversial aspects of the *PET* that was first announced was its keyboard. It consisted of 73 keys that were arranged in an ASCII block of 53 keys and a 20-key numeric and control key block. Unlike the keyboards on its subsequent competitors, those on the *PET*

were made with calculator-type pushbuttons. The keys were not arranged in the standard staggered configuration found on typewriters and they were also considerably smaller than typewriter keys. All of that led to complaints about the keyboard and how it wasn't possible to touch-type with it. While most of those complaints were probably justified, as evidenced by the fact that eventually Commodore came out with a *PET* that had a standard-sized keyboard, at the time the issue was really insignificant. Here was a company that was offering a complete computer system for only \$800, a price that only two years before would have been scoffed at. The complaint, however, was a good way for Commodore's competitors to make points, and so the controversy raged.

Another advance from Commodore, that was related to the keyboard, was that the *PET* was the only computer to offer the full upper and lower case ASCII character set, 64 graphics character and 11 special function keys. Among those "special function" keys was a key to enter the value of the math constant ( $\pi$ ); keys to control the cursor (up, down, left, and right); a key to clear the screen and home the cursor; a key to insert and delete data; a reverse field key, and even a key to cause a program to be loaded automatically and run, or to stop program execution. In addition, a slow-list capability was provided by holding down the RVS key while a program was listed.

## **Getting physical**

For those of you who never saw the original *PET*, discontinued last year, here is a quick description of it. It is a one-piece factory-assembled computer that weighs 44 pounds and measures 14 inches high by 16.5 inches across, and is 18.5 inches deep. It has a built-in 9-inch CRT display and a built-in semiautomatic tape-storage system. I call it semiautomatic because the user must place it in the RECORD or PLAY mode, and it does not automatically FAST FORWARD or REVERSE. However, the integral file-handling system that is built into the *PET* does tell the user which mode to place the recorder in (and when) and it does start and stop the





HIGH-QUALITY WORD PROCESSING can be achieved using a printer such as the NEC Spinwriter.

tape automatically under computer control.

Last year, Commodore succumbed to the pressure it was receiving from users and came out with a new version of the *PET* that had a full-sized keyboard. It is housed in the same case as the original *PET*, so its dimensions are the same, but because the keyboard is much larger, the tape recorder had to be made an external accessory, and to get it you had to pay an extra \$95. The new keyboard has added some features that were sorely lacking in the early *PET* computers. To begin with, it contains a SHIFT LOCK key. But why should the lack of a SHIFT LOCK key be considered such a big disadvantage for the *PET*? After all, many other computer keyboards don't give you this function either. That's true, but most other computers also do not provide the wide selection of characters that are available on the *PET*. And the lack of a SHIFT LOCK was very annoying whenever a lot of graphics or lower-case letters were being entered.

When the new keyboard was added, the motherboard inside the computer was redesigned so that up to 32K of dynamic memory could be used. In the original *PET*'s, expansion had to be done externally. Also, static memory was used; it's easier to design with, because no refresh circuitry has to be included, but it generates a lot of heat. In addition, MOS Technology, a subsidiary of Commodore, was the only company that made the memory IC's, and as a result, replacements were very expensive.

With the addition of the new keyboard, Commodore decided that it would increase the basic machine from an 8K machine to a 16K machine, since most people wanted more memory anyway. The base price of the new *PET* was also raised, by \$200, and it now costs \$995 (plus the cassette recorder). The price for a 32K machine, which is identical in every way to the 16K machine except for the extra memory, is \$1295. That means you're paying \$300 for 16K of RAM, an outrageous price.

When it first came out, perhaps one of the biggest selling points, aside from price, was the *PET*'s ability to "speak" BASIC as soon as it was turned on. That's fairly common today, but four years ago it was a real innovation.

Another handy feature that was (and still is) found in *PET* computers, is a very good screen editor that makes it easy to correct mistakes. With the editor, you can move the cursor wherever you want to on the screen and then insert or delete characters or whole words with no difficulty. And, unlike the case with other screen editors, you do not have to re-enter the entire line that is being corrected. All you do is to make your correction and then press RETURN;

the computer automatically enters the corrected line.

### It has a file system, too

As mentioned earlier, the *PET* is capable of reading and writing programs and data files to cassette tapes. The tape recorders used cost \$95 each, which is about two to three times the price of a decent cassette recorder that can be used with most other computer systems. Although the tape unit uses a commercial audio-cassette drive mechanism, the electronics are custom-made so that only that special recorder can be used. I have heard however of a company that sells an adapter, which will permit you to use a conventional cassette recorder with a *PET*, but I haven't seen it. And with such an important task to perform, it's probably better to pay the extra money—or better yet, go to a disk-based system.

The tape system in the *PET* is very reliable. The system records data at 1000 baud, which at first glance makes one think that it is rather fast. However, to insure data reliability, it records everything twice, and when it reads back data, it reads both recorded versions to verify that what it has read is correct. Thus the effective baud rate is only 500 baud, the same as the *TRS-80* Level II.

Unlike other tape systems which require low-noise tapes and meticulous adjustment of volume-control levels, the *PET* system can use just about any kind of tape, and no adjustments whatsoever are needed. I have tried a wide variety of tapes and found that even the cheapest kind available can be used successfully.

A handy feature of the tape system (missing from some of the popular systems) is the VERIFY command. After using it, I can't see how any computer can be without it. That nifty little command allows you to check and see if the program you recorded on tape was recorded without errors. I have yet to find a program that wasn't recorded properly.

In systems without that feature, notably the *Apple*, the only way to check whether the program was recorded properly is to load it into the computer. But that destroys the original program that is in the machine; so if your tape has dropouts on it, or the battery voltage of your tape recorder is low, loading the defectively-recorded program into your computer will wipe out the original program, and several hours worth of work can go down the drain.

Another plus for the *PET* tape system is that it works with named files. That means that you can give each program or data file a name, which is stored on the tape as a program header. Then you can tell the computer to load a program with a particular name, and it will ignore all others on the tape and only load the one with the desired name.

Commodore designers have made the *PET* a little more personal by including routines that keep the user posted about what is going on. For example, while it is looking for a particular file, the computer will let you know, not only that it is making the search, but it will also tell you which files it has passed on the tape while it was looking for the



one that you specified. That makes the *PET* more useful. About the only thing that is missing in the way of basic features, is the ability to use the BELL feature (ASCII character 7) of the ASCII keyboard.

#### Thanks for the memory

When it first came out, the least expensive version of the *PET* was the 4K system, which sold for \$595 and offered the user 4000 words (each digital word represents one character) of random-access memory (RAM). But that wasn't all—you also got 14K of read-only memory (ROM), which contained an 8K BASIC interpreter, a 4K operating system, a 1K monitor program, and a 1K diagnostic program. It was the 14K of ROM that put the *PET* way ahead of all other systems on the market at that time. Now most personal computers have similar features.

Since the *PET* was first introduced, the system ROM's have undergone several revisions. The original ROM's had a bug in them that would occasionally cause the cursor to be lost. That would require that the computer be shut off and turned on again in order to recover. Obviously, any program in the computer would be lost. Commodore acknowledged that bug and replaced the defective part free to anyone who reported problems. The next set of ROM's to be made available were the new ones that were developed for the 16K and 32K *PET*'s. That was not just a simple replacement of a single ROM, but an entirely new set. The changes in those ROM's are many and most of the machine-language routines have been shifted around so that programs using machine language calls from the original ROM set cannot be used without modification on the new set. Commodore is now about to announce an even newer ROM set, BASIC 4, which makes interfacing to the disk drive a lot easier. That set was originally developed for the latest computer to be added to the Commodore line, the 80-column CBM computer. And still another ROM set is in development, this one called BASIC 5. This ROM set will have a lot of utilities built into it such as renumber, append, and many others. The BASIC also includes an additional command called PROTECT, which, when invoked, prevents the user from accessing the source code or making a copy of the program.

While many people complain about the frequent and incompatible ROM changes, I see it as a good point for the Commodore computers. It shows that Commodore is constantly seeking to improve their products, which is really nice to see.

#### New 80-column computer available

Recently, Commodore has announced a new computer, aimed squarely at the business market. Known as the model 8032 CBM computer, it features a 12-inch CRT and a full business keyboard with numeric keypad. The BASIC in the 8032 is Commodore's latest—version 4.0—and it works with the new disk-operating system, DOS 2.0. The new BASIC corrects several errors in the previous basic and adds some enhancements.

Externally, the 8032 is similar to the 16K/32K *PET*'s, except that the shape of the cabinet has been changed slightly to accommodate the larger video monitor. Included in the 8032 is an electronic bell that can be accessed via ASCII character 7. In addition, the bell is used as an end-of-line warning device, much like the bell on a typewriter. It sounds when the cursor passes column 75 on the screen.

#### PET checks itself out

From the repair point of view, the *PET* is a serviceman's dream. For the old *PET*'s, with the aid of a special connector, the *PET* can check itself out. Once the source of a fault has been located, repairing the system is simple. Each of the three boards can be snapped out quickly and replaced with another, so that the system can be up and

running in no time. For the new *PET*'s, Commodore has a special boot-strap loader that clips onto the 6502 microprocessor chip and loads in the diagnostic program. The reason that is necessary is that the new ROM's have no room for the diagnostic routines. Once the diagnostic program is loaded, servicing is as before.

#### Microsoft BASIC is used

The BASIC that is in the *PET* ROM's is a Microsoft BASIC and as such is fairly compatible with the BASIC's that are found in most home computers. Of course it contains the PEEK and POKE commands that have become popular with the microcomputer revolution. In addition, it contains some special commands that are designed specifically for use with the IEEE bus.

Also part of the repertoire are tape-file handling commands, such as OPEN, INPUT#, PRINT# and CLOSE. *PET* BASIC also contains a GET command that inputs a single character from the keyboard without printing it, making it possible to hit the RETURN button without stopping the program.

*PET* BASIC has one more very useful command: TI. That is not an oblique reference to one of Commodore's competitors, but rather a time command; it's used in conjunction with the *PET*'s built-in clock. It can be used to time programs or even set up a time-of-day program in the computer.

#### Plenty of peripherals are available

In the way of mass storage, Commodore has two-disk systems announced and a few more on the way. The first is the 2040 dual-drive minifloppy system. It uses Shugart 390 drives and the system is accessed in the same way as the cassette-operating system.

The 2040 costs \$1295, has access to 340K of data on the two drives, and it doesn't use double density and double tracking techniques. The density is achieved by using two microprocessors (a 6502 and a 6504) and five memory IC's that are built into the disc unit itself. But the real key to the high density is an encoding scheme that packs the data so that less storage space is needed.

The information needed for encoding data to be stored on the disk is contained in 2K of ROM located in the disk unit. Also included is an 8K ROM-based disk-operating system. In addition, the 2040 contains 4K of static RAM.

Only two connections are needed for the disk system; an AC power cord to supply it with 50 watts of power and an IEEE interface cable to connect it to the *PET*. The diskette itself is a soft-sectored one that is formatted by the drive. It has 35 tracks, with a constant recording density. The number of sectors-per-track, however, varies—from 17 for the innermost tracks to 21 for the outermost. Track 18 of the diskette is used for the directory of programs that are on the disc.

For those who require even more data-storage capability, Commodore has just announced a new dual-disk drive system known as the 8050. That system provides three times the storage capability—512 kilobytes-per-diskette or 1 megabyte-per-dual-drive-system—for only 1/3 more money (\$1695).

In the area of hard copy, Commodore has two printers. One is the CBM 2023, which is a matrix, impact printer that has a pressure feed and takes 10-inch-wide roll paper. It prints at 80 characters per second and costs \$695. The second printer, the CBM 2022 is similar to the 2023, except that it is a tractor version and costs \$100 more. Both printers connect to the *PET* via the IEEE bus.

Commodore has two more peripherals available that may be of interest: a voice synthesizer for \$395 and an acoustically coupled modem for \$395. The modem is a half- and full-duplex modem that features asynchronous operation at 300 baud.



# THE APPLE COMPUTERS

*The first Apple computer was the brainchild of two young men working out of a garage. The young men are now rich, and the Apple a resounding success.*

ONE OF THE VETERANS OF THE PERSONAL-COMPUTER REVOLUTION is Apple Computer Company. In 1975, when microcomputers first appeared on the scene, Apple Computer was the first company to offer a single-board computer. The price, for what was then known as the *Apple I*, was \$666. That included an onboard ROM monitor and a built-in video interface.

About eight months after the *Apple I* appeared on the market, the Cadillac of home computers made its debut, *Apple II*. The *Apple II* represented a giant step forward in home computing then and, except for its newly introduced brother, the *Apple III*, it is still the best buy in personal computers around.

Like its predecessor, the *Apple II* has built-in video circuitry that allows it to interface directly to a color-video monitor, or to a television set through an add-on modulator. *Apple II*'s now come in two varieties, the *Apple II* and the *Apple II Plus* (often referred to as minus by experienced Apple owners). The difference between the two machines is in the BASIC that you'll find resident in the computer at the time of purchase.

On the *Apple II*, the computer comes with Integer BASIC resident in ROM. The term "integer" refers to the way the computer performs mathematical operations. In Integer BASIC, for example,  $5 \div 2$  would yield 2 instead of the expected 2.5, because 2.5 is not an integer. While that seems strange and hardly useful, such is not at all the case. Integer BASIC is very fast and as a result lends itself well to application in games programs.

For those who wish to have the floating-point capability (where in the above example you'd actually get 2.5) it is possible to purchase an additional firmware board with Applesoft BASIC in it; that is the BASIC that is available on most computers. In addition, older Apple systems were supplied with Applesoft on disk so that those with a lot of memory and an integer machine could have Applesoft available to them.

The second type of Apple, the *Apple II Plus*, comes with Applesoft as the BASIC that is resident in ROM in the machine. When Apple Computer Co. made this version of the computer available, they also changed one of the system ROM's to add some additional features. Unfortunately, when something is added, something else must always be taken away and in that case it was the built-in mini assembler. Also, Apple Computer Co. decided to give the system the capability of being a turn-key system so that programs could be run as soon as power was applied, if a disk drive were used. Finally, the reset circuitry was modified so that it was software-controllable. All of those features

have pluses and minuses, but owners of the *Plus* see only the minuses, hence the nickname. By the way, all of the features taken away from the *Apple II Plus* are restored to the computer when the Integer firmware card is installed.

The low end *Apple II*, be it the regular or the *Plus*, contains 16K of random-access memory and has sockets that allow the user to expand it to 48K just by plugging in the extra IC's. The 16K *Apple* lists for \$1200, but can be gotten, by carefully examining the ads in computer magazines, for as low as \$950. For that price you get one type of BASIC, a built-in speaker, a standard 52-key typewriter-quality keyboard, an 8-slot expansion bus that is widely supported by independent manufacturers, a built-in video interface, two paddles for interactive games, four built-in analog-to-digital converters, a variety of demonstration programs, and a machine that will give you hours of fun. The built-in speaker can be used to produce music, warning 'beeps', or even play back digitized speech.

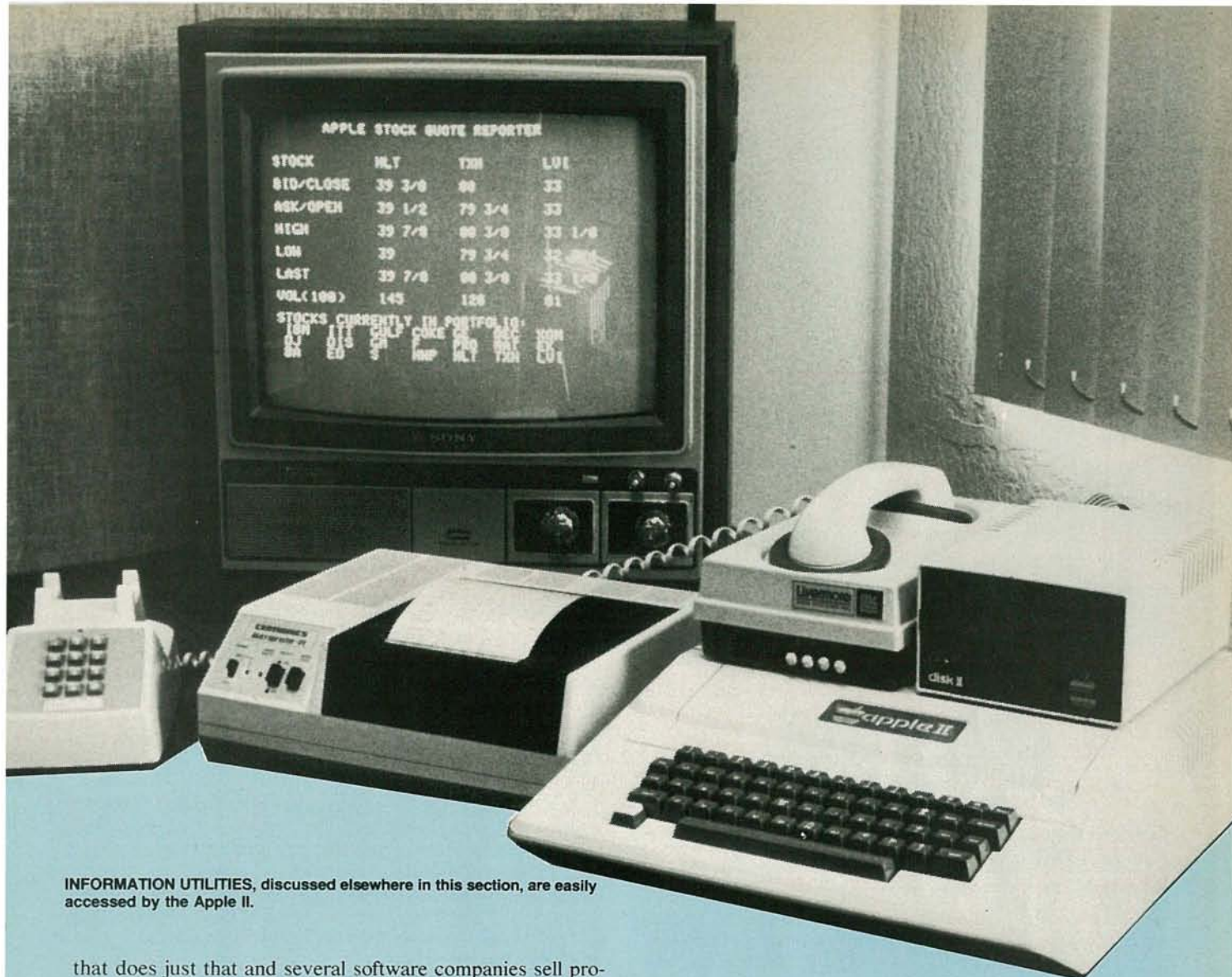
## Five display modes available

The computer has five display modes. The first, and most frequently used, is the all-text display mode. Then there are two low-resolution, full-color graphics display modes: one that combines the 40-x-40 low-resolution graphics with four lines of text and the other that is all graphics. The same holds true for the high-resolution graphics mode. There is one that permits four lines of text on the bottom of the screen and the plotting of points on a grid 280 wide x 160 high. In the all graphics mode the resolution increases to 280 x 192. There are six colors available in the high-resolution mode, including black and white. The resolution in that graphics mode is so fine that it is possible for the user to define his own character set. Apple Computer has a program in its contributors library



APPLE II DISK DRIVE uses uniquely-designed controller card.





INFORMATION UTILITIES, discussed elsewhere in this section, are easily accessed by the Apple II.

that does just that and several software companies sell programs that do it too.

Those character-generator programs are popular, because the *Apple II* has no built-in capability to display lower-case letters. Several independent manufacturers, such as Mountain Hardware and Dan Paymar, have overcome that problem with accessory devices, the cheapest of which is the Paymar adaptor for only \$50. One hardware limitation of the *Apple II* is that it only displays lines of 40 characters. Here again, outside manufacturers have been innovative and come up with accessories that increase that to 80 characters per line, but in those cases, the computer must be used with a video monitor.

In the text-display mode, the *Apple II* has programmable text windows, so it is possible to divide the screen up into several distinct sections and access any one of them under program control while the others stay fixed. Each window has its own scrolling capability, and each can be cleared individually. In addition, characters on the *Apple II* can be displayed in one of three modes. The first—and most often used—is the normal white-on-black display. The next is an inverse mode where letters are displayed black on white. Finally, they can be displayed in a flashing mode. Using Applesoft BASIC, it is simply necessary to invoke the NORMAL, INVERSE or FLASH commands to display the text appropriately. In Integer BASIC the same things can be accomplished by POKEing a particular location in memory with various values. That versatility in handling text makes it possible to produce interactive programs that are both attractive and easy to read.

In addition to the main computer unit, Apple has several accessories available for it. The most important is a disk

drive. Apple disk drives cost \$495 if purchased from Apple Computer and \$395 if a compatible drive is purchased from an independent manufacturer. The drive-controller card, which can handle two drives, sells for \$100. Apple has done some pretty innovative things with their disk system. They use the standard SA400 drive from Shugart, but they don't use the Shugart digital controller card that comes with the drive. Instead, they replace it with their own. Aside from reducing the parts count on the card, which increases reliability, they've made the card smart, so that it can calculate the acceleration and deceleration of the drive and compensate for it when accessing the disk.

The standard Apple disk drive is capable of storing 116 kilobytes of data. However, Apple has developed two new ROM's for its controller card which make it possible to increase storage to 143 kilobytes per diskette, and that upgrade kit, along with a new version of DOS (Disk Operating System) to support it (DOS 3.3) should be available by the time you read this article.

#### It understands Pascal too

Apple Computer Co. is quick to recognize desires of the public and when it became apparent that the computer language Pascal was becoming popular, it set about developing a method of implementing it on the *Apple II*. As a result, about a year ago, Apple came out with an accessory known as the Language System. That \$500 system makes it possible to run the popular UCSD Pascal language on the *Apple II* computer.





**THE WHOLE COMPUTER** weighs only seventeen pounds.

The Language System consists of a card that plugs into one of the slots in the Apple. The card contains an extra 16K of RAM, support circuitry, and a ROM that will permit the Apple disk to boot up automatically when power is applied. A reasonable price for the board alone would be \$100 to \$150. The extra money for the system is for the software that comes with it, the UCSD Pascal system which includes an editor, compiler, linker, and utility programs. The system also includes a 6502 assembler. Finally, two ROM's are included, which must be used to replace ROM's that are on the standard disk-controller card. Those ROM's set up the disk drive to work with 16-sector disks, as opposed to the standard 13-sector ones. The increase in sectors accounts for the increase in density from 116K to 143K that is associated with the Language System.

Although the Language System is commonly referred to as the Pascal card, that is really not accurate since Apple is planning on having other languages available for it soon. Already announced are FORTRAN and Pilot.

### Apple III is coming

In May of this year, Apple Computer Co. introduced its next-generation computer, the *Apple III*, which should be on your dealer's shelf by the time you read this article. Basically, the *Apple III* has everything *Apple II* owners wished they had in theirs and went out and bought accessories for. The *Apple III* has a built-in mini-disk drive; printer interfaces for serial and parallel printers; a real-time battery-powered clock-calendar that will run for three years and keep track of time to within 1 ms; standard IBM keyboard with a numeric key pad with automatic repeat of any key; a 2-inch speaker, a fixed frequency 'beep' generator, a 1-bit squarewave generator, and a 6-bit digital-to-analog converter. The basic unit comes with 96K of memory; that is expandable to 128K.



**THE NEW APPLE III**, aimed primarily at the business market.

Like the *Apple II*, it uses a 6502 microprocessor, but it has been enhanced in two ways. Firstly, a 2-MHz version of the CPU (known as the 6502A) is used. That immediately makes the *Apple II* two times faster. Secondly, external logic has been added to enhance the 6502 instruction set. Additional CPU features include a relocatable base-page register and a relocatable stack.

A nice feature of the new computer is that the character generator is stored in RAM. That means that all characters are software-defineable and that any type font can be generated. So, in addition to defining new character sets, such as Greek and Hebrew, it is possible to generate high-resolution figures in the text mode. Another result of that is that scrolling can occur one dot row at a time, resulting in a smooth, non-jerky movement.

Perhaps the smartest feature of the *Apple III* is its built-in *Apple II* emulator. When activated, that makes the *Apple III* look exactly like an *Apple II*, and all the software that is available for the *Apple II* will work on it. The *Apple III* also has a Language System built in and is thus capable of running Pascal as well.

### Support is the best around

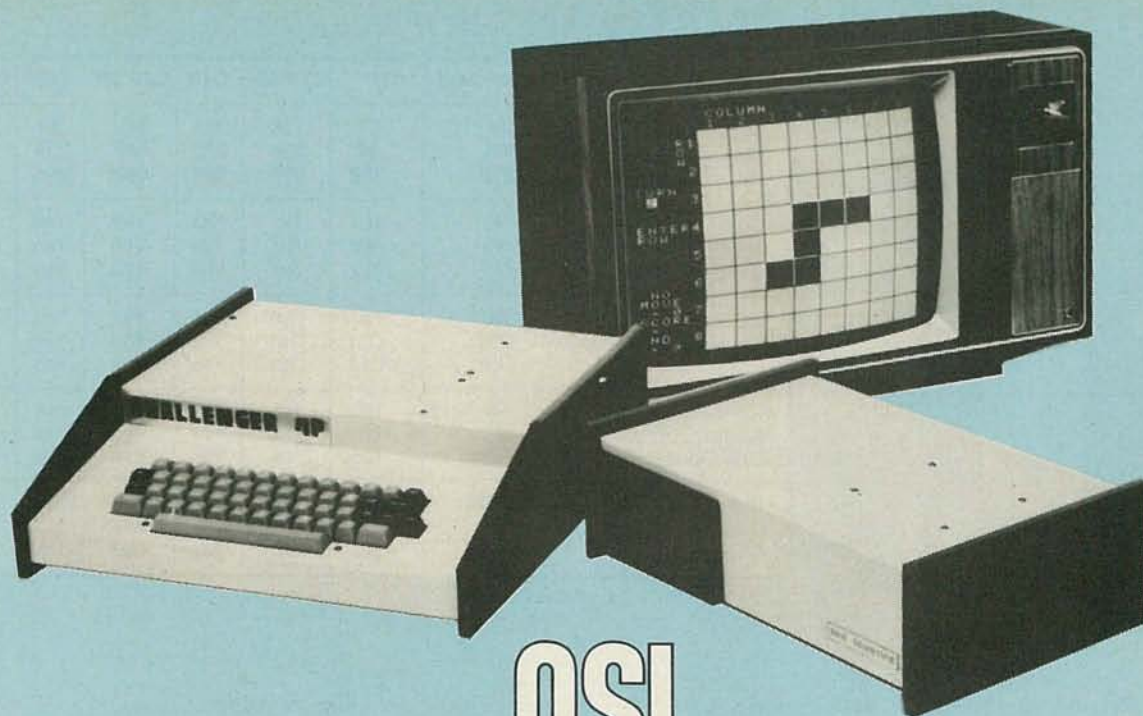
When it comes to helping out a customer or dealing with a problem, be it malfunctioning equipment or answering technical questions, Apple's support is the best around. Apple's network of service centers is geared to repairing or replacing defective parts within 24 hours. While that goal isn't always achieved, their track record is pretty good. And if you've got a technical question, Apple's hot line (408-996-9868) is always staffed during the business day to provide customers the answer to any question, be it hardware-or software-related.

Having used that hot line quite a bit, I can tell you first hand that it is great; the people manning it are both patient and helpful. If they don't know the answer, they'll find someone who does. The only problem with the hot line is that it is only manned by two people at a time with only two telephones; thus getting through can be difficult at times. No other manufacturer, though, has anything better.

The Apple's popularity extends around the world, and the software and hardware support for it are almost beyond belief. Many games, programs and peripherals first developed for it have been adapted for other systems. It's no wonder that the Apple has become one of the top-selling personal computers!

**R-E**





OSI

# SUPERBOARD & CHALLENGER

*These products provide one of the least expensive ways of building up a system.*

OHIO SCIENTIFIC, INC., OR OSI, WAS ONE OF THE EARLY ENTRIES in the home computer market, dating back to the "old" days of 1975. Their present line of computers ranges from simple one-board computers to sophisticated rack-mounted computers and consists of four product lines; the *Challenger I*, *Challenger III*, *Challenger 4* and *Challenger 8*.

The *Challenger I* series, which includes several models, is aimed at the student and hobbyist with prices ranging from \$279 to \$995. For the higher performance needs of the professional and educational user, there are several models in the *Challenger 4* and *Challenger 8* series that range from \$698 to \$2597 price bracket. The small-business computer series, *Challenger III*, starts above \$4000 and will not be detailed here. A comparison chart detailing the key features appears in Table 1.

## Beginners can start "naked"

The first member of the OSI family of personal microcomputers is the *Superboard II*, a "naked" microcomputer, without power supply (5 volts at 3 amps required) and cabinet. The *Superboard II* includes a full 53-key ASCII character keyboard, a 30-row by 30-column video-display interface for use on a video monitor or home television via an RF modulator, and a cassette tape interface that will work with most home cassette recorders. Also included on the board is an 8K BASIC in ROM and 4K or 8K of RAM.

The *Superboard II* is directed toward the computer neophyte who can start getting into this fascinating hobby with an inexpensive basic system that works reasonably well and can be expanded to include other peripherals such as a floppy disk drive. The *Superboard II* with 4K of memory

costs \$279 while the 8K version costs \$348.

Add a power supply and an enclosure to the 8K *Superboard II*, and it becomes a *Challenger CIP*, designed to be used with a standard television set (via a separate RF video modulator). An optional 12-inch OSI black-and-white video monitor is available for another \$115. The *Challenger CIP* offers upper and lower case characters from the keyboard. On the video screen, it will display up to 30 lines of 30 characters each in the text mode. In the high-resolution graphics mode, it will display dots within a 256-by-256 grid.

As is the case with most of the popular personal computers, except for the TRS-80, the OSI computers use the 8-bit 6502 microprocessor. The bare-bones *Challenger CIP*, without the audio cassette recorder and without the video monitor, is \$399.

The next step up is the *Challenger CIP MF* which includes 12K of RAM, the 8K BASIC in ROM, and either one or two 5-1/4-inch mini-floppy disk drives. With disk drives, data retrieval can be achieved in seconds rather than the minutes required when a cassette storage system is used. The cost of a *CIP MF* with 12K of RAM, the 8K ROM BASIC, and one mini-floppy disk drive is only \$995. That price makes it the cheapest disk-based personal computer available anywhere. Need more memory? The *CIP MF* can be expanded up to a total of 32K of RAM. With 20K or more of memory, small-business applications can be handled through OSI's powerful OS-65D V3.0 operating system that supports sequential as well as random access data files directly from BASIC.

Peripherals available for the *Challenger CIP MF* include an electrostatic or impact printer (\$695 and \$1250 respec-



TABLE I

Feature	Superboard	C1P	C1P MF	C4P	C4P MF	C8P	C8P MF
Min. RAM	4K	8K	12K	8K	24K	8K	32K
Max. RAM	8K	8K	32K	32K	48K	32K	48K
Base Price (\$)	279	399	995	698	1695	895	2597
Color Graphics	No	No	No	Yes	Yes	Yes	Yes
Joystick Int.	No	No	No	Yes	Yes	Yes	Yes
Keypad Int.	No	No	No	Yes	Yes	Yes	Yes
AC Remote Int.	No	No	Opt	Yes	Yes	Yes	Yes
Modem Interface	Opt	Opt	Opt	Yes	Yes	Yes	Yes
Printer Int.	Opt	Opt	Opt	Yes	Yes	Yes	Yes
Home Security	No	No	No	No	Yes	No	Yes
Audio Output	No	No	No	Yes	Yes	Yes	Yes
D/A Converter	No	No	No	Yes	Yes	Yes	Yes
Video Display	30x30	30x30	30x30	32x64	32x64	32x64	32x64
Real Time Clock	No	No	Yes	No	Yes	No	Yes
GT Option	No	No	No	No	Opt	No	Opt

tively), a 300-baud modem (\$199), and a home controller (\$175). The AC Remote Control System, or home controller, together with a real-time clock, enables the computer to operate lights and appliances automatically under program control. The AC-control interface permits the computer system to inject control signals on the AC power line circulating throughout the home, and turn lamps or appliances on and off. Also available is a home security system, including smoke and door/window burglar-alarm sensors. Should an entry be attempted, or smoke be present, the computer would be informed immediately, and the appropriate devices would be activated.

#### Do it better with a C4P

The *Challenger C4P* is a cassette-based system and includes the 8K ROM BASIC, just like the *C1P*. But the *C4P* has some additional features. It has over three times the display capability of the *C1P* and is capable of displaying 32 lines of 64 characters each, in up to 16 colors. In the graphics mode, the screen resolution is 256-by-512 points.

Also included in the *C4P* is a 200-Hz to 20-kHz programmable tone generator, an 8-bit companding digital-to-analog converter (DAC) for voice and music generation, two 8-axis joystick interfaces for interactive games, two 10-key keypad interfaces, and an AC remote-control interface for appliance and home control systems. The basic *C4P*, selling for \$698, may be expanded to hold up to 32K of RAM through the use of two expansion slots in the keyboard chassis. The RAM used in the computer is all static and therefore requires no system refreshing; it can easily be backed up using a battery supply. With as little as 24K of RAM, the *C4P* will handle 5-1/4 inch mini-floppy disk drives which cost \$450 each.

If you decide in advance that mini-floppies are the way to go, then the *C4P MF*, at \$1695, provides the same features as the *C4P* but includes 24K of RAM and a single mini-floppy disk drive. In addition, the *C4P MF* contains a real-time clock and countdown timer, a modem interface, 16 parallel lines for additional control interfaces, an accessory bus for an external 48-line I/O board, and a home-security system interface. The system can be expanded to 48K of RAM and two mini-floppies.

The computer features a "foreground-background" capability that allows it to monitor a home-security system and turn appliances on and off while at the same time it is running another application program. The *C4P MF* is the only home computer that has that capability built into it.

According to Ohio Scientific, the *C4P MF* normally operates twice as fast as an Apple II or PET and three times faster than a TRS-80. However, if you need even more speed, it is possible to double that speed by getting the GT option, which is a special ion-implanted 6502, along with faster RAM. The option can only be ordered at the time of purchase and costs an extra \$950.

#### For more expandability try the C8P

The top-of-the-line in personal computers for Ohio Scientific is its *Challenger C8P* series of computers. The *C8P* contains eight expansion slots, only five of which are available to the user. The others are used for the basic configuration. That means that the *C8P* has more than three times the expansion capability of the *C4P*. The basic *C8P* is a cassette-based machine with 8K BASIC in ROM and 8K of static RAM. That can be expanded up to 48K of RAM. To increase program storage, the *C8P* can be interfaced to two 8-inch floppy disk drives. The basic *C8P* costs \$895 with 8K of RAM.

If you need more memory, it can be upgraded to a *C8P DF*, which costs \$2597. That gives you 32K of RAM (expandable to 48K) with dual 8-inch floppy disk drives that are capable of storing up to 250 kilobytes of data. The *C8P DF* offers the same features as the *C8P* plus the Home-Security System. An optional Universal Telephone Interface can dial any telephone number via rotary dial or Touch-Tone (TM) techniques. By combining the Universal Telephone Interface with OSI's Votrax voice I/O board here's what you'll get: A computer system that can dial any number and communicate via voice output, leaving messages, and answering anticipated questions. Add to that combination the home-security system, and the *C8P DF* can automatically dial the police or fire department, and by voice message communicate its emergency needs. A dedicated alarm dialler, however, would probably be more cost effective. Another possibility is that the computer owner can dial home from some remote location and tell the computer to turn specific appliances on and off.

Like the *C4P*, a GT option is available for the *C8P DF* too. If desired, it must be ordered at the time of purchase and costs an extra \$1825.

Software, including Pascal and FORTRAN for 48K systems with at least two mini-floppies, for the Ohio Scientific computers is available on both tape and diskette, with prices ranging from \$6 to \$200.

R-E





# HEATH H89:

## Kit or Assembled

*Originally, all personal computers were available only as kits. Now, just the opposite is true. Heath, though, still lets you build your own.*

IT'S NOT EASY TO LOCATE A PERSONAL COMPUTER SYSTEM that includes a smart terminal plus a floppy disk for under \$2000. But, if you are familiar with basic electronic kit assembly and construction, you can buy a relatively sophisticated computer that uses not one but two Z-80 microprocessors, a smart video terminal, 16K of random access memory (RAM), and a 100K minifloppy-disk storage system. All of that will cost you only \$1695. And with a reasonable degree of patience and confidence, it will work when first turned on.

When personal computers first appeared five years ago, almost all were kits. Today it is just the opposite: almost all are assembled and ready to use. But Heathkits have always been popular and have a reputation for working well the first time. Nonetheless, if kits don't "turn you on," you can still enjoy the Heath computer by purchasing a WH89 (W for wired) All-In-One computer, factory-assembled and tested. Whichever model you get, the H89 is a fully integrated desktop computer with many built-in features plus a wide variety of external peripherals available.

The 8-bit H89 includes a computer, 12-inch black-and-white video display, 5¼-inch minifloppy-disk drive, 16K of RAM and an ASCII keyboard with a numeric keypad. In actuality, the H89 is really an H19 Smart Video Terminal into which the computer, floppy disk, and interface boards have been assembled.

### Two Z-80 microprocessors used.

There are two Z-80 microprocessors used in it, one for the computer and one for the smart terminal; each unit can thus operate independently to allow the H89 to process data at a high speed.

The basic unit comes with a 2-MHz Z-80 microprocessor and 16K of RAM, but is expandable to 48K. Expansion is very easy, because the Heath designers apparently tore a page out of the Apple's designer's book and provided empty sockets already in place in the computer. Thus all that is needed to expand the memory is to buy extra chips and plug them in. It should not take more than 15 minutes.

With 48K of memory space dedicated to user RAM, and since the Z-80 can address 64K of memory, another 16K

of memory must be accounted for, and it is. Two 8K sections of memory are reserved for system use. The first 8K section is located in low memory. Of that, 3K is used for system ROM and 1K for system RAM. The remainder is not currently used. The other 8K block of memory that is reserved is in high memory and it is currently not being used.

The display is presented on a bright 12-inch CRT that contains a P4 phosphor. The screen format is 25 lines by 80 characters, for a total of 2000 characters. One disadvantage of the display is that it is not a memory-mapped display and thus it is not possible to access individual locations on the screen by POKEing a value into a specific memory location. In displaying information on the screen, several different dot matrix formats are used. To display upper case letters, a 5 × 7 dot matrix is used, while a 5 × 9 dot matrix is used to display lower case letters with descenders. And, to display graphics characters, an 8 × 10 dot matrix is used.

The terminal part of the H89 will operate at twelve different, keyboard selectable, baud rates up to 9600 baud. The Z-80 that is included in the terminal adds some versatility to the terminal so that some desirable features are available. Among those are the ability to insert and/or delete characters or full lines of information. It also makes possible a graphics capability. Another handy feature is reverse video. That allows the user to emphasize any particular section of the screen by printing black letters on a white background.

As any true terminal must have, the H89 has a full ASCII keyboard. The 84-key heavy-duty keyboard consists of a 72-key standard typewriter keyboard and a 12-key numeric and control-function keypad. In addition to providing access to the full 128 ASCII characters, the keyboard also provides access to 33 predefined graphics characters and it has eight keys that are reserved for user-defined functions. To simplify and speed the entry of numerical data, a 12-key pad is provided. And if the shift key is used with several of the keys on the pad, control of the cursor for insertions and deletions is provided.

Borrowing another design idea from the Apple II com-





HEATH H19 INTELLIGENT TERMINAL is basis for the H89. Note provision for disks, at right.

A NUMBER of peripherals, such as the H14 printer, are available from Heath.

puter, the *H89* contains a small loudspeaker which is used to generate an audio "beep" that is used whenever the BELL character (ASCII character 7) is printed. That is important, because in good interactive programs, the bell can be used to warn the user of an impending change of state or overflow condition. Also, the speaker can be used to generate various tones and crude music under software control.

#### Hard-sector floppies used

A WANGCO/Siemens *model 82* minifloppy-disk drive is used in the *H89*. That particular drive requires the use of hard-sector diskettes that have 40 tracks-per-diskette, 1 sector-per-track and 256 bytes-per-sector. That provides slightly more than 100K of data storage per diskette. The data transfer rate to and from the disk drive is at 128 kHz.

For applications where 100K of on-line data storage is not enough, an optional *H77* Floppy-Disk System can be added, for only \$595. That adds another 100K of storage to the system. And for still more storage, an *H17-1* (\$345) floppy-disk drive, can be added to the *H77*. That will give you 300K of on-line storage.

For the economy-minded, who feel they can get along without a disk drive (and those people are few and far between), Heath offers the *H88-5* audio-cassette interface. That system operates at 120 bytes-per-second and uses a 2.4-kHz signal for its mark tone and a 1.2-kHz signal for its space tone.

#### System documentation included

Unlike some personal computers, the *H89* comes with a 260-page Operation/Service Manual to teach the basics of microcomputers using the *H89* as an example. The book includes detailed circuit explanations, digital timing sequences and trouble-shooting tips. In addition, a Software Reference Manual, 440 pages long, discusses five systems-software packages that are available. Another 110-page book provides all of the information required for the optionally available Microsoft BASIC.

The five major systems-software packages available for the *H89* consist of the Monitor, HDOS, Dbug, Edit, ASM, and Benton Harbor BASIC. The Monitor is supplied as 2K of ROM firmware and is activated when the system is turned on. It allows the user to display and change data in RAM, load and run programs from cassette tapes, and boot the disk if one is present. Heath's Disk Operations System (HDOS) keeps track of data written to and read from the disk drives. Benton Harbor BASIC is a lan-

guage that was originally written for the *H8* computer, but was carried over to the *H89* as well, to provide upward compatibility. That, by the way, is something that Heath is very conscious of. In fact, when talking with outside software manufacturers, Heath has required that when machine-language programs are written for their computers, all programs must be in 8080 code so that they will be compatible with all Heath computers, the older *H8*'s and the newer *H89*'s.

#### Microsoft BASIC now available

Recognizing that Microsoft BASIC was fast becoming a *de facto* industry standard, and that it also was quite a good BASIC, Heath has also arranged for it to be available on the *H89*. The *H89* Microsoft BASIC contains 116 commands and functions, compared to the 73 in Benton Harbor BASIC. It also features a built-in program editor so that individual lines can be edited without retyping the entire line.

For those hardy souls who prefer to program in machine language, Heath offers a 3-module set of programs to edit, assemble, and debug programs. Again, clinging to their desire to maintain compatibility with the old and the new, Heath has chosen to provide an assembler that works in 8080 code. In the Edit mode, the user can type in text to form source files for assembler programs. Once a source file has been created, the command ASM is invoked to put the assembler into operation. The assembler takes the mnemonic version of the assembly-language program (the source) and converts it into the hexadecimal digits that represent machine language (object code). And if you're not perfect, then after you try to assemble your program, you'll have plenty of use for the Dbug program.

The Dbug program allows the user to single-step through a machine-language program and to inspect the contents of memory locations and data registers, making alterations wherever he wants to. Another convenience of the Dbug program is that it makes it easy to load and dump assembled programs onto diskette.

#### Here are the prices

The *H89* is available, in kit form, with 16K of RAM and an audio-cassette interface for \$1695. A fully assembled *H89* (known as the *WH89*) with 48K of RAM and a serial interface, with a built-in minifloppy disk drive, but without the audio cassette interface, is \$2895. The *H89* can be purchased without the built-in disk drive, but with an audio cassette interface, as the *H88* for \$1295.

R-E





# HERE COMES TI

*It isn't that great a leap from calculators to computers. Texas Instruments, having captured one market, now enters the other with the Model 99/4 personal computer.*

TEXAS INSTRUMENTS (TI), INITIALLY A MAJOR MANUFACTURER of semiconductors, became a leading supplier of consumer products when they launched their digital watches and calculators on the world market. TI's first entry into the field was not overly impressive, but they have moved from that low point to become the major U.S. manufacturer in the calculator market. Throughout 1979, rumors abounded that TI was going to announce an entry into the home-computer market and existing manufacturers feared that the Texas giant would come out with a product that would quickly dominate that market also. At the Consumer Electronics Show in Chicago, June 1979, the suspense ended. TI showed their home computer—the TI Model 99/4—and the industry heaved a sign of relief. Its \$1150 price (since raised to \$1400) non-standard keyboard, and limited capabilities meant that TI's entry would pose little threat to other computers already on the market.

By and large, that first industry reaction has proven to be accurate. A year after its introduction, the TI 99/4 is still not well accepted in the marketplace. But don't count TI out yet. After a slow start in the calculator market they surged ahead to dominate it and they may do the same with computers.

The basic TI 99/4 consists of a 40-key keyboard, 16K of random access memory (RAM), 26K of internal read-only memory (ROM), and a separate 13-inch color monitor display. The heart of the computer is a TI 16-bit microprocessor chip, the TMS 9900—and the 99/4 is the *only* home computer on the market that has a 16-bit processor in it. While that could give it a tremendous advantage over all the other 8-bit computers (it means that more memory is directly addressable by the microprocessor, and machine language instructions in 16-bit micros are generally more efficient than those in 8-bit units), Texas Instruments has decided to keep the user from accessing the full value of that capability. Much of it just amounts to potential advantages hidden in the machine.

The system provides some nice features, such as color graphics, music, and programmable sound effects. The graphics, which can have a resolution as high as  $192 \times 256$  pixels in 16 colors, can be really great, especially since the computer comes with a high-resolution Zenith

color monitor. But here again, TI thought only about their own interests and not those of the consumer. The high-resolution color graphics are only available from programmed ROM cartridges, and the ROM cartridges are only available from TI. Even if you buy the cartridges from another company—such as Milton Bradley, which has produced some games for the 99/4—the cartridges are still manufactured by TI. After all, their major business is semiconductors. If the user wants to write programs that use graphics, he is stuck with low-resolution graphics that don't come close to the real capabilities of the computer. That is because TI chose not to allow the user to access memory directly. For example, the high-level computer language known as BASIC normally provides PEEK and POKE commands that permit the user to access specific memory locations. TI's BASIC has no PEEK or POKE commands.

## Keyboard is too small

The keyboard layout on the TI 99/4 is in the standard staggered key format, but the keys are smaller than the standard typewriter keyboard and extra care is required if it is to be used by someone who knows how to touch-type.



PLUG-IN COMMAND MODULES contain programs in ROM.





ACOUSTIC COUPLER allows the 99/4 to talk to other computers.

In addition, the keys are calculator-type switches, not the standard keyboard-type switches, and if you place your hands on the keyboard in the standard touch-typing configuration, you realize that there are keys missing on the right-hand side of the keyboard. Commodore was the first company to make the mistake of using a nonstandard keyboard when they introduced the PET computer and they got a lot of flak for it—so much that in the next model they came out with a standard keyboard. It's a pity that TI didn't learn from Commodore's mistake.

The 99/4 has the ability to address up to 72K of memory in its present configuration. That consists of 16K of RAM (random access memory), 26K of internal ROM (read only memory) and up to 30K of ROM in the form of solid-state command modules. The internal ROM contains 13-digit floating-point TI BASIC, which is billed as being fully compatible with ANSI Minimal BASIC. That can be misleading however; just about every BASIC available today is compatible with the ANSI standard, because it is so narrow in its scope. Even with that compatibility with the standard, many are incompatible with each other. Since TI BASIC is not compatible with Microsoft BASIC, the *de facto* industry standard, novice users may find the book, "Introduction to TI BASIC", by Inman, Zamora, and Albrecht, useful. (The authors wrote the manual supplied by TI with the computer.) It is published by Hayden Book Co. Inc. and sells for \$9.95.

In addition to its 13-digit accuracy, TI BASIC includes commands to handle color graphics, and sound and music generation over a full five-octave range. Altogether, TI BASIC contains 24 BASIC statements and 14 commands. Sounds and music are generated by a built-in programmable music synthesizer that features three voices and white noise. The frequency range covered is 110 Hz to 40 kHz (five octaves) and the duration of each note is variable and programmable from 1 ms to 4275 ms. The volume is adjustable up to 30 dB. Another capability of the com-

puter, also in the area of sound, is speech synthesis. That is not available in the basic unit, but in an accessory device. The solid-state speech synthesizer costs \$149.95, which is fairly inexpensive compared to other speech synthesizers. It comes with a 200-word vocabulary and allows the user, under program control, to have the computer give verbal prompts. Also, the quality of speech is quite good. Additional vocabulary modules with different words will be made available.

Included in the available accessories is a 360-degree, multiposition joystick with a side-mounted "fire" button. The joystick is connected via a 4-foot cable and two of them can be connected for real time competitive games.

### Software

Software for the TI 99/4 is available in two forms: cassette tapes and solid-state Command Modules. The Command Modules plug into a slot in the keyboard console and each one can contain up to 30K of programming. TI has several modules available on different subjects. In the area of educational aids there are grammar, math, and early reading. Business-related programs are also available such as investment analysis, statistics, personal record keeping, and tax aids. Games that are available in modules from TI are video chess and football.

In an interesting marketing marriage, TI and games manufacturer Milton Bradley have arranged for a number of Bradley's games to be available in software modules. Specifically, Yahtzee (a dice game), Hangman (a word game), Zero Zap (a pinball game) and Connect Four (a strategy game) have been made available. Command modules both from TI and Milton Bradley range in price from \$19.95 for video graphics to \$69.95 for video chess.

### Peripherals

The TI 99/4 keyboard console includes a number of connectors for adding peripherals to the system. In addition to the speech synthesizer, peripherals available from TI include a 5.25-inch mini-disk drive (\$499.95), a disk drive controller (\$299.95), a thermal printer (\$399.95), a telephone modem (\$224.95) and an RS-232 serial interface (\$224.95). Also available is an RF modulator for \$75. That is grossly overpriced and potential 99/4 owners would do better buying modulators from an outside source at 1/4 to 1/2 the price.

One measure of how successful a personal computer is on the market is the number of independent vendors that support the computer. It is interesting to note that even after a year on the market, to this author's knowledge, there is not a single hardware manufacturer supporting the 99/4 and less than a handful of software vendors producing programs for it. In fact, chances are that if you walk into half a dozen computer stores in your area, you'll be hard pressed to find one that carries any software for the 99/4, aside from that supplied by TI.

R-E





# COMPUTERS COMPUTERS COMPUTERS

*You'd be surprised at who's getting into the computer field (or maybe you wouldn't). Here's information on some products that have been around awhile—and on some interesting newcomers.*

WITH PROSPECTS OF PERSONAL COMPUTER SALES EXCEEDING 500,000 units by the end of this year, more and more companies are entering the market. Since the Altair 8800 was made available in kit form from MITS, Inc., five years ago, personal computer interest has soared. In 1976, the Apple was introduced by the Apple Computer Co., Inc. and was shortly followed to the market place by Commodore's (Personal Electronic Transactor) PET and Radio Shack's TRS-80.

Those three companies represent the major influences on personal computer sales in 1980. But other computer manufacturers, such as Ohio Scientific and Cromemco Inc., intend to increase their share of the market with new and exciting products.

More significantly, several of the world's largest manufacturers of toys and electronic games—Exidy, Mattel, Atari and APF Electronics—see the personal computer market as a natural extension of their home entertainment and education markets. Thus each of those firms has dedicated considerable funds to develop computers that would serve that market adequately. Some, such as Exidy and Atari, have developed a basic computer that will work well strictly in programming applications or for use as a video game. Others, such as APF and Mattel, have developed a sophisticated video game component, to which a keyboard can be added later to produce the final computer.

With the latter approach, the marketing strategy seems to be to capture the interest of the consumer first with a high-level "toy" that can be a powerful learning tool as well as a talented opponent in home games. After the initial investment in the game component, the owner—or more likely the owner's parents—can later add the keyboard component and thus have a relatively powerful computer with a wide variety of educational, business, and financial software available.

## Compucolor II

Compucolor, a division of Intelligent Systems Corp., made a bold decision when it introduced its Compucolor II personal computer in 1978. Rather than entering the market with a computer without a cassette (as some others had done), or a mini-disk drive (as most others had done), or a color monitor (as all others had done), Compucolor offered a self-contained, two-piece, deck-top unit that included a keyboard chassis connected via ribbon cable to a high-quality color monitor. The unit also contained a built-in 51K minifloppy disk drive. Not only was the system unique in that the owner went directly to a diskette, rather than



COMPUCOLOR II can combine business with excellent color graphics.



upgrading from a cassette, but the owner was saved from the frustrations of arguing about who could use the family color television set during prime viewing time.

#### Several models available

The Compucolor II computers all have the same central processor, an 8-bit 8080A. The *model 3* comes with 8K of RAM, the 51K minifloppy disk drive, and a high-resolution color-video monitor. All of that costs \$1595. The *model 4*, comes with 16K of RAM and sells for \$1795, while the *model 5* has 32K of RAM and sells for \$2095. Finally, a special 16K Compucolor computer with an oversize 25" screen is available for schools for \$2895.

An extended version of Microsoft BASIC is used in the Compucolor computers. Special commands have been added to it to accommodate the color-graphics capabilities of the machine. Two other language capabilities are available as well. For \$75, FORTRAN IV can be purchased for the machine; and for only \$24.95, an assembler.

#### Disks have a few disadvantages

Until recently, owning a Compucolor computer had one big drawback: You had to buy blank diskettes from Compucolor, because a special formatting is used on the diskettes and Compucolor wouldn't tell anyone else how to do it. They were the only source for those diskettes, which, consequently, cost more than they should have. The result was that Compucolor owners balked at their involuntary continued connection with Compucolor, but Compucolor had a perpetual market for its blank disks. Worse than that, commercial software manufacturers refused to support that machine, because they, too, were required to purchase formatted diskettes from Compucolor. (Compucolor's price was higher than what commercial software houses could buy diskettes for elsewhere, so prices for software would have to go up considerably.) To my knowledge, even today, Compucolor is the only source for programs to run on the Compucolor computer.

Recently, the disk situation has changed and a formatter program that will format blank diskettes properly for use on the Compucolor computer is now available. Another problem with the Compucolor disk system is that a formatted diskette will only hold 51K of program or data. That is the lowest amount of data being stored on 5¼-inch minifloppy diskettes that I know of. The company claims that the diskettes they supply can be used on both sides. But that's

no better than having two separate diskettes, because on-line storage is limited to 51K per drive. The reason is that while programs *can* be stored on both sides of a diskette, the drive used can only access one side of the disk at a time. By the way, if additional disk storage is desired, an extra drive can be purchased for \$395. Compucolor is working on two advances in disk storage, an 8-inch drive and a 25 megabyte hard disk.

There are three different keyboards offered for use with the Compucolor computer. The least expensive one, which is standard with the basic unit, is a 72-key ASCII keyboard. For an additional \$135, the expanded keyboard can be substituted for the standard one. That unit features numeric and color-coded keys that can be used to specify color graphics when desired. For the person who wants to go first-class all the way, a deluxe keyboard can be substituted for the standard one for only \$200 more than the base price. That deluxe keyboard also offers a numeric key pad and has 16 additional function keys.

While input for the computer normally comes from the keyboard, output from it normally goes to the 13-inch color-video display. The screen can display characters in two modes. In its most dense mode it is possible to get 2048 characters on the screen in a 64-character per line, 32-line per screen format. If larger characters are desired, it is possible to double the size and get 16 lines of text on the screen.

In addition to its text-display modes, the Compucolor computer has a 128 × 128 point graphics-display mode in which it is possible to display 8 foreground and 8 background colors. A nice feature of the graphics mode is that it is possible to mix graphics with text, with characters capable of blinking, if desired.

#### Exidy Sorcerer

Exidy, a major manufacturer of coin-operated video games, entered the personal computer market in 1978 with the *Sorcerer* computer. The 13-pound keyboard console, which does not include a video display or a cassette tape recorder, contains a 63-key ASCII keyboard that allows you to access the full 128-character ASCII set, as well as 128 programmable graphics characters. The keyboard also contains a 16-key numeric key pad.

On the right side of the keyboard console, is a removable plug-in cartridge that physically resembles a standard 8-track stereo cartridge. Many people believe that it is; however the cartridge is really a ROM PAC that contains 8K of read-only memory. When the *Sorcerer* first came out, it was equipped with a BASIC ROM PAC that contained Microsoft 8K BASIC. Nowadays, that costs extra.

The original *Sorcerer* was available in 8K, 16K and 32K versions. However, because of many problems with the original circuit board, it was redesigned and at that point provision was made to add an extra 16K of memory, so that later units now are capable of being expanded up to 48K.

#### It had great potential but...

When the *Sorcerer* first came out, it looked as if it were going to give the *PET*, the *TRS-80*, and even the *Apple* a run for their money. It promised a lot and seemed to take the good points from all of those machines and combine them into one. It had the standard *PET* graphics character set, but allowed the user to define his own graphics characters and assign them to any key. It had a "real" keyboard, which the *PET* didn't. It had a Z-80 microprocessor like the *TRS-80*—and like the *TRS-80*, had the longer 64-character line. Like the *Apple*, it had a very fast cassette-tape interface—1200 baud as opposed to the 300- and 500-baud interfaces of the *PET* and the *TRS-80*—but it also permitted programs to be read and stored at 300 baud if desired. And it featured higher-resolution graphics than the *Apple* (240 × 512 dots), making it possible to get unbelievably beautiful graphics.



Graphics, however, were limited to black and white. The *Sorcerer* has some other nice features, too. It has an expansion box that is compatible with the S-100 bus, making a raft of accessories, both hardware and software, available for use with it. It also has a Centronics compatible parallel printer interface built in, as well as an RS-232 serial interface and a dual-cassette interface.

With all that going for it, how could the *Sorcerer* help but be a big hit? It's simple. The human interface, both to the machine and the company, was terrible. One of the biggest drawbacks of the *Sorcerer* is that it has no screen editor. For the uninitiated, that means that if you make a mistake when entering a program and you notice it after the line has been entered into memory (in other words after you press the RETURN key), it is not possible to list the line on the screen and then move your cursor to it and correct it. Instead, you must retype the entire line in again. While that may seem insignificant, its importance is quickly realized after a few long programs have been written. Exidy's answer to that was that if you bought the word-processor cartridge, which sells for \$199, you can overcome the problem. That's a lot to pay for a feature that should be standard (and is on most other machines).

Another problem with the BASIC is that it is not possible to list a particular line or a range of lines. You can only list a program from the beginning, or from a particular line number, to the end of the program. And if you wish to stop the listing, you have to type a CONTROL-C. There are many other problems with the *Sorcerer*. It is altogether too easy to wipe out the program you are working on by exiting to the monitor and coming back to BASIC. While a warm-start return to BASIC is provided, this is still a situation that arises all too often.

What is one of the biggest problems with the *Sorcerer* is its absolutely atrocious documentation. It comes with two manuals but even after reading both of them you still don't know what all the capabilities of the machine are or how to implement them. An additional manual, originally produced by a *Sorcerer* user, is now being made available by Exidy. That clears up a large number of the questions left unanswered by the other manuals, but not all of them.

If you have a problem and try to call Exidy for a solution, don't be too hopeful. While there is someone who fields such phone calls, that person is not always available and, when available, is frequently less knowledgeable than the caller. In my particular case, several phone calls that got me connected to several different people, resulted in the expected—several different answers. The particular question is not important, but the response is. One response was: "I don't understand what you're talking about." Another was: "It can't be done." Still another was: "I think someone here wrote a program that can do that but I don't remember who." The question was never answered satisfactorily.

But all is not lost for the *Sorcerer*. Exidy's latest plans call for getting away from the hobbyist and aiming the *Sorcerer* at business applications. Let's hope that the quality of Exidy's service department grows along with its aspirations.

The *Sorcerer* with 16K of RAM sells for \$1295; with 48K of RAM, the price is \$1495. A 12-inch black-and-white monitor is available for the outrageous price of \$499. For users requiring fast mass storage, a floppy-disk subsystem, using 5¼-inch minifloppy-disk drives that can store 120 kilobytes of data on a diskette, is available for \$1150. That includes the controller. Additional drives cost \$795. A combination video-monitor/disk-drive subsystem, which will store 308 kilobytes per drive and comes with two drives, is available for \$2995.

#### APF Imagination Machine

APF Electronics' *Imagination Machine*, also known as the *IM-1*, is a home-entertainment center for fun and games and also an effective personal computer for serious activities such as education. The *IM-1* features music output,

games in color, and a built-in dual-track cassette recorder that permits voice to be played back on one track, and machine-readable data on the other.

The *IM-1* consists of two components, a computer console (\$500) and an *MP 1000* game controller (\$130). The console includes a 53-key typewriter-style keyboard, 8K of RAM, a built-in dual-track cassette recorder, an audio section with a sound synthesizer, microphone input, volume control, and loudspeaker. A helpful feature on the keyboard console is the printed instructions for single-key entry of the 24 BASIC commands available.

The *MP 1000* game console, which contains its own 11K of RAM, has been marketed for quite a while by itself as a stand-alone TV game. It contains two 4-directional joy-



IMAGINATION MACHINE, from APF, makes a good introductory computer.

sticks with numerical keypads and "fire" buttons. The *MP 1000* fits into a cutout in the keyboard console and is connected to it by means of a sturdy "U" connector.

The two-component combination, or *IM-1*, offers 9K of RAM and 10K of ROM and has a video-screen format of 32 characters per line, by 16 lines. Output is sent to an ordinary black-and-white or color television set via a built-in RF modulator.

Software for the APF computer is available in two forms, ROM and cassette tape. Among the programs available on cassette are Typing Tutor, Math Tutor, Budget Manager, and Artist & Easel. The solid-state ROM cartridges provide such games as Blackjack and Backgammon as well as APF's 12K BASIC, which is not a Microsoft BASIC.

Musical entertainment is possible by applying a series of symbols after the MUSIC command is entered; tunes with a musical range of up to three octaves can be played with the built-in synthesizer and speaker. Another form of art available on the *IM-1* is computer-generated graphics. In the "low" resolution mode, up to 16 shapes—in up to 8



colors—can be displayed in 512 cells of 32 columns by 12 rows. In the "high" resolution mode, up to 128 × 192-dot resolution is possible.

Accessories recently introduced for the *IM-1* include a printer, modem, minifloppy-disk drive system and a memory-expansion unit. That last one is the most serious shortcoming of the *IM-1*. Currently, it is only expandable to a maximum of 16K of RAM. While that should be sufficient for most applications, it is desirable to be able to go farther.

### Cromemco Z-2 computer

Cromemco Z-2 computers, for the most part, are directed towards the most serious business, engineering, and scientific professionals. At the high end of its product span, the Z-2 system includes 11 megabyte hard-disk drives, a multi-user system capable of handling up to eight users and memory expansion up to 512K. But at the low end of their line, they do indeed supply small systems that fall within the budget of the personal-computer/small-business owner.

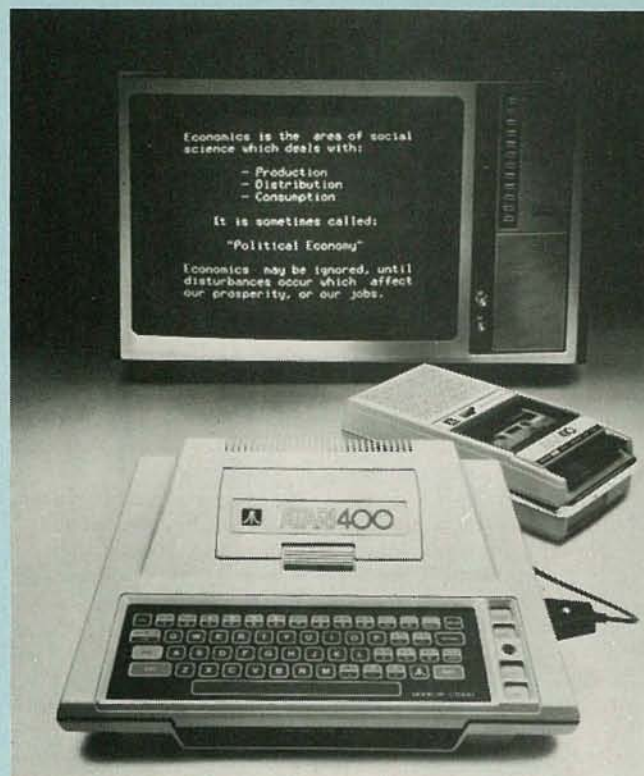
First, Cromemco computers are not packaged in flashy, color-molded cases. Instead, they are housed in standard 19-inch-wide cabinets, suitable for rack mounting. The basic Z-2 unit contains slots for 21 memory and I/O boards plus room for two minifloppy-disk drives. With 4K of RAM, and no disk drives, the basic Z-2 costs \$1290. When a mini-disk drive is added, the system becomes a Z-2D. A Z-2D, with 64K of RAM sells for \$3785 and with two drives it costs \$3990.

Basic input and output to a Z-2 computer must be done through a terminal, preferably a CRT terminal. Cromemco offers one, the 3102 CRT Terminal, for \$1995. It features a 116-key ASCII keyboard with 20 user-definable keys and a 14-key numeric pad. It also has a 12-inch CRT display that will show 1920 characters on 24 lines of 80 characters each, using a 7 × 9 dot matrix display.

Since the Z-2 is designed to support the S-100 bus, there are a host of other peripherals available for it. Software that is available includes several versions of BASIC, FORTRAN, COBOL, CP/M, and a Z-80 Relocatable Macro Assembler, to name a few packages.

### Atari 400 and 800

Atari, well known for its sophisticated home and arcade games, offers two personal computers, the Atari 400 and the Atari 800. The Atari 400 is in the \$600-price class and includes a touch-sensitive, 57-key, flat keyboard (here's another company that didn't learn from Commodore's mistake) with upper and lower case letters, graphic sym-



ATARI 400 is one of two computers offered by this manufacturer.

bols, and full screen-editing functions.

The basic machine comes with 8K of memory that translates into only 5K for the user, because the computer uses the other 3K for internal operations. That 5K however winds up being more like the equivalent of 3K because of the inefficient way in which BASIC programs are stored in memory. That is another BASIC that was not written by Microsoft, but by Shepardson Microsystems; it is also a BASIC that is going to give its owners a lot of problems. Aside from its wasteful use of memory, it handles strings entirely differently from the way Microsoft BASIC handles strings. As a result, 90% of the programs that appear in the hobby-computer magazines will not be usable as they are, and will probably require significant alteration to get them to run on an Atari computer.

A single-cartridge slot is available for plug-in software. That is normally occupied by the BASIC ROM cartridge. While the 400 comes with only 8K of RAM, it is possible to send it back for upgrading to 16K of RAM. That is the maximum amount of RAM possible in the 400. Because of its memory limitations and nonstandard keyboard, the 400 will probably die a fairly rapid death as those people who absolutely must have an Atari computer opt for the 800.

The Atari 800 is priced from \$1000 and boasts a full-size typewriter-type keyboard. It comes equipped with 8K of RAM, 8K of internal ROM and 8K of BASIC in a ROM cartridge. Unlike the 400, however, the 800 has room to place memory-expansion modules that can contain 8K or 16K of additional RAM. Be careful how you insert them, however. While the instructions in the manual tell you how to put them in by referencing the printed material on the top of the memory cartridge, some cartridges have been produced with that information upside down. Thus, trying to insert the cartridge according to instructions could possibly result in damage. Internal ROM can be expanded to 26K.

As far as mass storage is concerned, up to four minifloppy-disk drives can be added to the computer. Each drive is capable of storing 92 kilobytes of data on a diskette, resulting in a maximum on-line capacity of 368K.

Among the recent peripherals announced for the 400 and 800 are the Atari model 825 80-column, dot matrix,





**WIDE RANGE** of accessories is available for the Atari 800.

impact printer; the Atari *model 830* Modem and the Atari *model 850* Standard Interface. That interface permits connection of RS-232 and other peripheral devices to the Atari computer.

To tackle the potential problem of nationwide service, Atari has entered into an agreement with Control Data Corp. to provide service to 400 and 800 owners through 200 service centers across the country. In addition, Atari will market Control Data's powerful Cyberware business investment programs which will run on the 800 only.

#### **Mattel's Intellivision**

Mattel Electronics has invested more than three years of design effort into *Intellivision*, an integrated personal computer that is connected to the user's TV set through a built-in RF modulator.

Mattel's approach to the home computer market is similar to APF's, where there are two components, a video game, and a keyboard unit. The game part of the system is available and is known as the Master Component. It comes with two hand controllers, or keypads, with 12 keys each and four action buttons. The second part of the system, the Keyboard Component, will have a 60-key tactile keyboard, which will display 40 characters per line and 24 lines per screen. Characters will be upper and lower case. Also included are a built-in cassette recorder and an 8-bit 6502 microprocessor.

The keyboard unit has given Mattel a lot of headaches and its introduction has been delayed several times. Lab prototypes, which surface at shows, contain Microsoft BASIC, but final units are expected to contain Mattel's own BASIC. Let's hope it is compatible with Microsoft's.

In the graphics mode, 15 colors can be displayed in a 30,720-point array (160 × 192). In addition, 8 moving foreground symbols are available. To add excitement to TV



**INTELLIVISION** from Mattel will do more than just play games.

games, a synthesizer chip is included in the Master Component to generate cheers when a goal or a win is scored. In the Keyboard Component, the audio channel of the cassette recorder can furnish music or sound effects.

Mattel is currently marketing the Master Component and expects to have the Keyboard Component out by early 1981. At that time, a 40-column printer and modem are also scheduled for release. The cost for an *Intellivision* system will range from \$300 for a system with 2K of RAM, to \$800 for a system with 18K of RAM.

To satisfy those consumers who consider prompt service an important factor in determining which computer to buy, Mattel has arranged for hundreds of General Electric (GE) service centers across the country to operate as authorized *Intellivision* repair centers.

**R-E**



# PERIPHERALS AND ACCESSORIES

## That Expand Your Computer

*When you've made the decision to purchase a computer, you've only just begun to build a system.*

OWNERS OF STEREO COMPONENT SYSTEMS AND OWNERS OF personal computers have one restless desire in common: the urge for change. Rare indeed is the stereo-component buyer who has not "upped" his system with an improved turntable, or added a graphic equalizer or Dolby tape deck. The same for the serious computer hobbyist. After his initiation into the exciting world of computer applications, it is natural to reevaluate his needs for a printer to provide permanent, or "hard copy" output, a floppy-disk system to add considerably more memory storage than his cassette can conveniently provide, or a modem to permit him to communicate with other computers and access "information utilities" (see page 74 this issue). Then there are speech and music synthesizers to add more excitement and fun to the computerized games he plays, AC controllers to permit his computer to control lights and appliances in his house, and a host of other devices.

Peripheral devices permit the basic computer to communicate with the outside world. Hundreds of peripherals are available from a growing number of manufacturers anxious to penetrate the rapidly growing personal computer market. Most personal computer manufacturers themselves offer a wide line of peripherals for their own equipment.

There are a large number of peripherals that might be desirable to add on to personal computers, yet they are not available from the computer manufacturers, but from independent manufacturers. When the computer owner decides to purchase such a peripheral, it becomes his responsibility to see that the device is plug-in compatible (meaning that it is hardware- and software-compatible) or else face the task of matching the peripheral to his computer. Quite often, a particular peripheral can be obtained at a lower cost by buying from a peripheral manufacturer instead of the computer manufacturer. Also, it is not unusual for a computer manufacturer to delay the introduction of a peripheral device until it is sure that there's a large enough market for it. The reason is that frequently computer manufacturers don't make their own peripherals, but purchase them from independent suppliers. In order to get a good price they must purchase in large quantities. Often it is possible to purchase the same device easier, and at a cheaper price, from the independent.

Peripherals can cost more than the personal computer they serve. It is thus important for the user to analyze both his current and probable future needs carefully before making an additional investment. If you buy more than you really need, you will never get a bargain. On the other

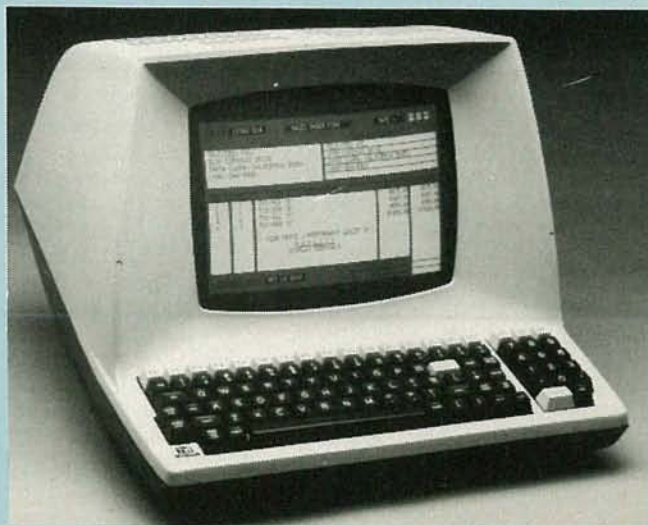
hand, if you buy less than you need, you'll probably have to upgrade in a short time, losing again.

### CRT terminals

In the early days of personal computing (only five years ago), hobby computers were most often equipped with a series of front-panel switches and LED indicators. More convenient input and output required the use of an external terminal, generally a CRT terminal. Today's computers generally have a keyboard and video interface built in, generally eliminating the need for an external CRT terminal. There are however, instances when those external terminals are quite desirable. Most often that occurs with computers that are limited to 40-column displays and have to be used in applications where 80 or more columns are required. A particular example of that is the Pascal system offered for use with the *Apple II* computer, which is designed for 80-column operation.

Well over 500 models of terminals are on the market today, and most use the interface standard set up by the Electronic Industries Association (EIA) known as RS-232. That standard defines the voltage levels, control signals, connectors, and pinouts required. Most display terminals use cathode-ray tubes (CRT's) as displays, although a few use flat-panel plasma displays.

Terminals come in three levels of sophistication; dumb, smart, and intelligent. A dumb terminal is basically a key-



CRT TERMINAL is a necessity for many computer systems.



board plus a CRT display. Add some hardware to provide a programmable cursor (next letter-position indicator) and the user can now do more than just see what is taking place. That is a smart terminal and permits the user to do such editing chores as inserting and/or deleting letters or words. Finally, an intelligent terminal not only allows editing, but is programmable. Tasks such as moving the top lines up and off the screen as new lines are entered and later recalling them are possible. An intelligent terminal needs memory to handle its varied tasks and thus usually has its own RAM and ROM. In addition, it usually has local-storage capabilities on its own cassette or disk systems.

### Get it in writing

Using a personal computer to play the various games that are available is a lot of fun. When you're finished, you turn off the computer and that's that. But if you are using your computer for serious business tasks, or to complete your income tax, you must finish the job and write out your results before you turn the computer off—or lose the information.

So a rather necessary peripheral for the serious computer buff is a printer; and a printer can cost as much as, or even more than, the computer itself. With a printer connected to the computer, the user has the ability to produce a variety of printed material such as program listings, mailing labels, billing, and inventory records to name a few.

Printers can be classified in several ways. First, there are impact printers that operate by transferring a character to paper through an inked ribbon, much the way a typewriter does. In contrast, there are non-impact printers that use such printing technologies as electrostatic and thermal techniques.

Impact printers that produce either complete, typewriter-like characters, or segmented characters formed by a matrix of dots, are available. Fully-formed characters are printed in a single stroke. With matrix printing, a defined series of dots form the character just as a TV picture is created by a series of scanning spots on a television screen. Printers are also referred to as character printers and line printers. A character printer creates one character at a time, and prints it. A line printer prepares a group of characters along the line at the same time and the line appears to be printed at once. The line printer is much faster, but also more expensive.

Which is preferable? That depends on the application. Fully-formed characters printed by devices with a *Selectric* or daisy-wheel type of print head are sharper and clearer than characters printed by a matrix print head. They are particularly pleasing for letters and word-processing applications. Most applications don't require that, so the matrix printers, which are cheaper, are sufficient. For applications that require multiple copies, impact printers are usually to be preferred over non-impact types.

Another key factor in the choice of a printer is speed. The instantaneous printing speed is the rate at which the print head can produce characters. It does not include the carriage return time, which in some printers is minimized by using bidirectional printing techniques. Something else to consider is that the rate at which a printer receives data may be faster than the rate at which it can print it. In such cases, the printer must contain some sort of buffer (extra memory to store the data until it is printed).

One of the earliest, and still frequently used, printers in the low-cost computer market was the *Teletype* cylinder printer, shown in Fig. 1. A complete set of characters is arranged in a series of concentric rings on the printing mechanism. To move the proper character into position, electronic signals direct the motion of the cylinder in a circular, as well as an up-and-down direction. Once the proper character is in position, a hammer strikes the cylinder, causing it to transfer ink from a ribbon to paper.

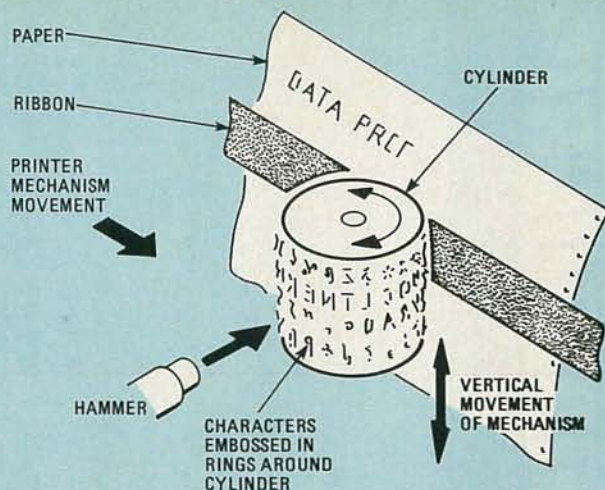


FIG. 1—CYLINDRICAL TYPING ELEMENT is capable of printing speeds of up to 10 characters-per-second. This became the first low-cost printer for the hobbyist market.

Used *Teletype* printers are available from \$200 to \$500, while new ones cost about \$1200.

The *Teletype*, at 10 CPS (Characters Per Second), is very slow and only permits upper-case characters. An improvement in both of those areas was made with the development of printers based on the IBM *Selectric* mechanism, shown in Fig. 2. Here, a type sphere is rotated on its axis until the proper character is selected and then the sphere strikes the ribbon. That mechanism improved printing speed to about 14.5 characters per second. The price tag for such printers is in the \$1000-to-\$4000 range.

Another design for a letter-quality impact printer is the daisy-wheel printer shown in Fig. 3. On each spoke, or petal, is a single character. When the hub is rotated to the correct position, a hammer is energized which causes the letter to strike a ribbon. Both the daisy-wheel and *Selectric*-type print mechanisms have a wide variety of type fonts available, with the *Selectric* balls offering the wider choice. Daisy-wheel printers, such as those produced by Qume, Diablo, and Howard Industries operate at speeds ranging from 30 cps to 55 cps. Prices range from \$2700 to \$7000.

The most commonly used printers in personal computer applications are matrix printers. That is because they are usually the cheapest, generally under \$1000. But high-performance matrix printers can exceed \$9000 in price. In matrix printers, the print head contains a vertical column of small needle hammers that are moved across the page while input is fed from information stored in memory. Print heads usually have seven to nine needles in a vertical row, and a horizontal matrix that is four to seven

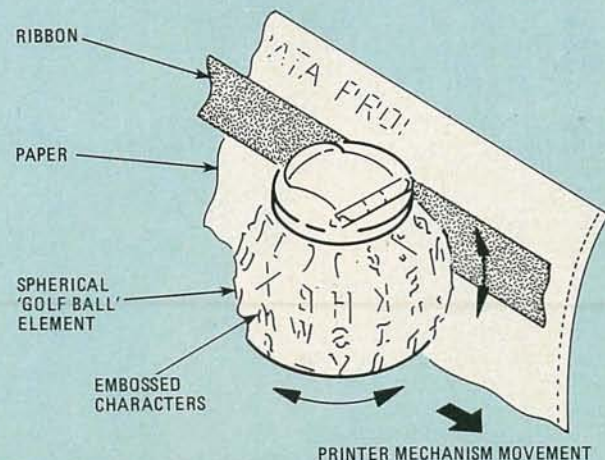


FIG. 2—THE SPHERICAL TYPING ELEMENT, commonly found on *Selectric* typewriters, offers a choice of typefaces and operates at printing speeds of up to 15 characters-per-second.



columns wide, to form a complete image of the character. The larger the matrix, the better the character definition. In fact, some new printers from Sanders Associates, Centronics, and Integral Data Systems, make multiple passes over the same character with the head position moved slightly each time. That produces a character that has more dots and can approach the quality of fully-formed character printers. Character-based matrix printers can print at speeds as high as 330 cps, while line printers can reach speeds of 500 lines per minute.

Non impact printers are generally quieter, cheaper, and faster than the impact types; but they are often less legible and sometimes require a special paper. Also, they do not produce multiple copies on a single pass.

A thermal matrix printer uses a heat-sensitive paper which changes color when heated to 200°F. A typical print head contains a 5-by-7 array of dot-heating elements. The head forms a single character at a time and moves horizontally across the specially coated paper. The speed of such printers range from 50 to 100 cps; speed is somewhat limited by the need for the dot elements to cool down a bit before proceeding to create the next character. Prices for such printers range from \$500 to \$1000.

Electrosensitive printers are somewhat similar to thermal

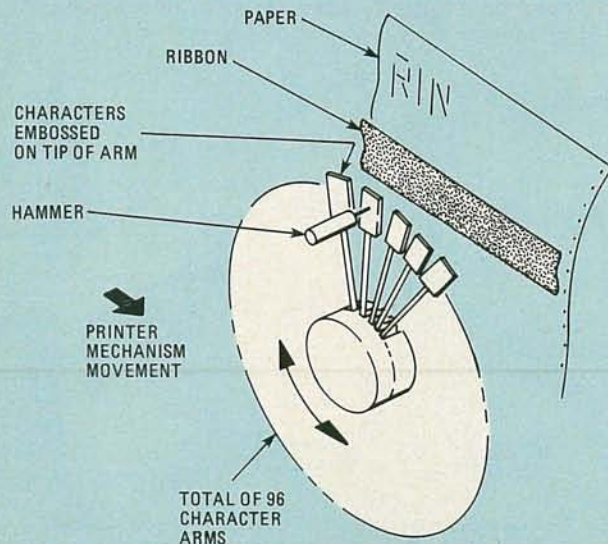


FIG. 3—DAISY-WHEEL PRINTERS are relatively expensive but offer letter-quality printing at speeds of up to 55 characters-per-second. Print wheels can contain up to 96 characters.

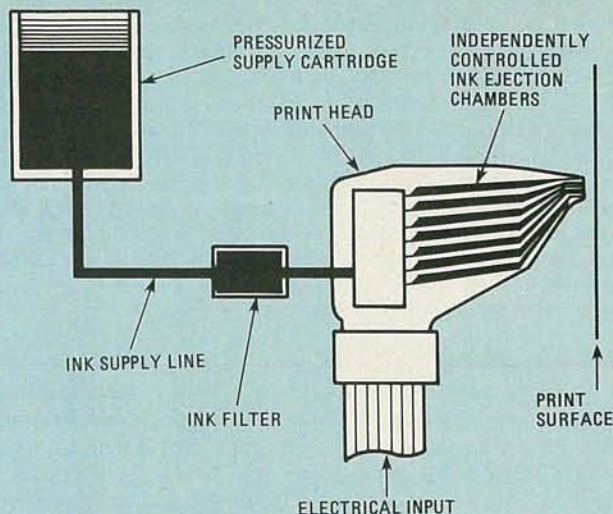


FIG. 4—INK-JET PRINTERS are a relatively new technology and use ink jets to produce matrix characters on paper.

printers in that they also use a specially coated paper, as well as a matrix print head. Instead of having heating elements in the print head, those have small metallic electrodes. A dark paper, coated with a light-colored conductive layer, is pulled in front of the print head. To form a particular character, a series of pulses are applied to specific head electrodes; a voltage breakdown, or arcing, takes place and the conductive coating is destroyed leaving the dark areas exposed to create a character. To form a different character, voltages would be applied to different electrodes on the print head to burn away different areas of the conductive coating.

Another non-impact approach to printing is the ink-jet system, Fig. 4. Here a high-velocity stream of ink, in the form of microscopic droplets, is squirted at the paper. The droplets are given an electrical charge and passed between electrodes whose voltages are varied. The ink droplets are thus deflected, much like the beam of a CRT, and form characters on paper. The printing speed is high and up to 180 lines per minute can be printed.

Here are some typical prices for a variety of printers. A thermal printer (40 cps) for the *Apple II* computer costs \$595; an electrostatic model (150 lines per minute) costs \$695, and an impact matrix printer (60 cps) is available for \$1545. A matrix impact printer (65 cps) for the *PET* costs \$798. Radio Shack markets an electrostatic matrix printer (120 lpm) for \$239 and several impact matrix printers (up to 120 cps) from \$999 to \$1999.

When looking at those prices a few things should be remembered. Not all of the printers have the same capability. Some print only 40 columns across while others go to 132. Some include tractor-feed mechanisms for the paper, while others don't. The prices are not quoted for comparative purposes—not enough information is presented for that—but rather to show a range of prices for currently available equipment.

### Need more memory...add a floppy disk

It doesn't take a serious computer hobbyist much time to feel a craving for more memory than his cassette can handle conveniently. The hobbyist also soon becomes impatient with the slow access time of a tape as he rewinds to search for a particular section. A disk is a randomly accessible memory device that is capable of storing and retrieving information considerably faster than a tape system. Of the various types available, the minifloppy disk is the most popular in the home computer market.

The floppy disk was first introduced to the market by IBM and is somewhat similar in appearance to a 45 RPM record; it is more flexible (see Fig. 5), has no grooves, and is permanently sealed in a square plastic jacket. The only exposed area



is in a slot cut in the jacket which provides a place for a magnetic head to make contact with the magnetic media of the diskette. Tolerances in floppy-disk drives are very close and the magnetic head is in intimate contact with the rotating media. In addition, the speed of rotation is quite high (360 RPM), so that even a small speck of dust, fingerprints, or cigarette smoke can cause a read or write error to the disk. Therefore, users are instructed to replace diskettes back into their protective envelopes immediately after use.

IBM's original floppy-disk entry was an 8-inch disk, the 3740, which featured 77 tracks (48 tracks-per-inch), soft sectoring with 26 sectors-per-track, 128 bytes-per-sector, a recording density of 3200 bits-per-inch and a speed of 360 RPM. Since then, minifloppy disks, 5¼-inches in diameter, have appeared in both hard-and soft-sector formats.

What is soft sectoring? It is a method by which codes are used to identify various sectors on the disk (see Fig. 6). It permits a blank diskette to be formatted in any way desired. For example, on the *Apple II*, diskettes were originally formatted as 35 tracks with 13 sectors-per-track and 256 bytes-per sector. A recent improvement now makes it possible for *Apple* disks to be coded as 35 tracks with 16 sectors-per-track, resulting in 24K of additional data storage on the same physical medium. When a soft-sector disk is used, it is formatted first and information is stored on it that defines each track and sector so that when the disk system wants to store data, it can read that information and know exactly where it is all the time.

The second approach to disk storage is hard sectoring. Here, a series of holes, one for each sector, is punched on the periphery of the center-drive hole. A LED-and-photocell combination permits light to pass through the holes as they rotate, causing pulses to be generated. The electronic circuitry in the drive counts those pulses so that the drive always knows where the head is on the disk.

While all floppy-disk systems operate in a similar manner, storage densities vary from 170K for PET diskettes to as little as 51K for compucolor diskettes. Storage capacity is only one of the parameters to consider in disk systems. It refers to the number of tracks, the number of bytes-per-track and the number of recording surfaces (some drives record on both sides of the floppy disk). Others are access time and transfer rate. Access time is the time it takes to position the head to the proper track, plus the time it takes for the diskette to rotate and reach the appropriate sector, plus the time to read or write the data. The transfer rate is determined by the disk-system speed of rotation, recording density, and the number of tracks that can be accessed in parallel.

Recent advances have improved the performance of disks and disk systems. To increase storage capacity, double-density and double-sided systems have been developed. Double-sided systems include a read/write head on each side of the diskette and thus result in twice the storage capacity. Some double-density systems double the number of tracks per side, e.g. on minifloppies from 35 to 77; others simply pack more information into the same number of tracks. By combining both of those technologies, a fourfold increase in storage capacity is possible.

#### How does it work?

A disk-drive system is a sophisticated combination of servo-mechanisms and control electronics. When a diskette is inserted into the drive, a spindle locates the center hole and a motor brings the speed of the diskette up to 360 RPM. Then the read/write heads are positioned over the first track, 00, by the small index hole in the diskette. The heads are next positioned to whatever location is desired by a seek operation. The heads float over the tracks until the proper position is found; then a head-loading coil pulls the heads down (loads them) to the magnetic surface of the diskette. When the heads must be moved to another location, they are lifted off the media (unloaded), moved, and then loaded again.

There are many applications where it is necessary to store a

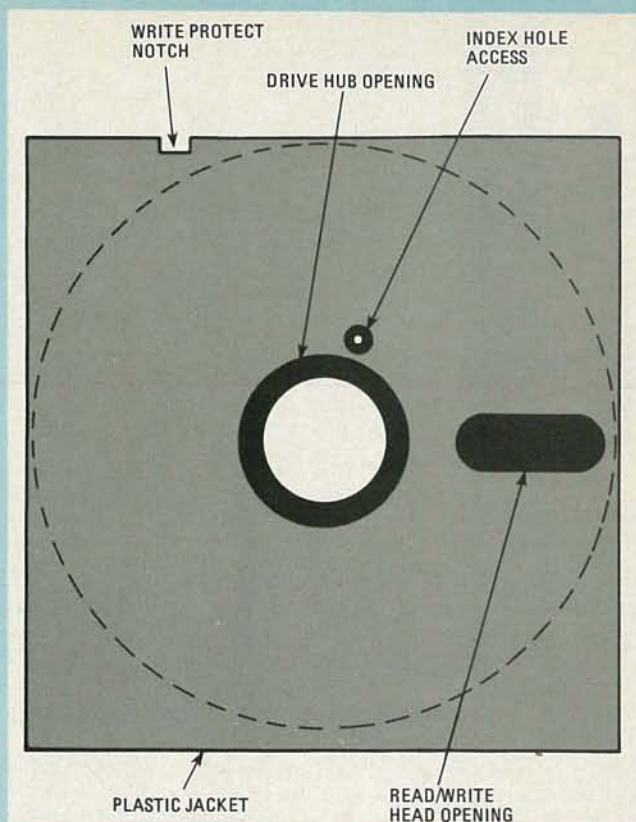


FIG. 5—A FLOPPY DISK is almost fully enclosed in a jacket to protect the surface from dirt and physical damage.

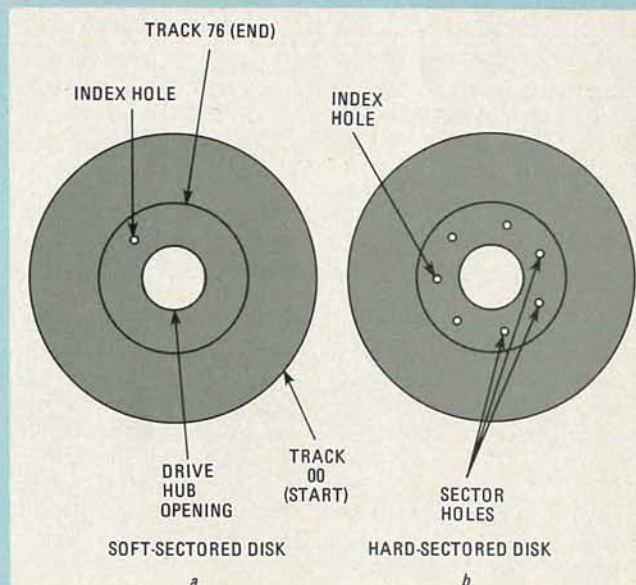


FIG. 6—A SOFT-SECTORED DISK, shown in a, uses one index hole to locate the data on the surface of the disk. A hard-sectored disk, shown in b, uses many index holes for the same purpose and is more efficient because less computer memory is required for the system.

lot of information on disk. Frequently that can exceed the storage capacity of a single diskette. For such applications, there are other types of disk drives that do not have flexible media. Those are called hard disks. A new type of mini hard-disk that uses a technology originally developed by IBM has just recently been announced. Those disks are known as micro-Winchester disks and they provide a phenomenal 6 megabytes of storage on a 5¼-inch hard disk. Prices for the disks are expected to be in the \$1500 range.

#### Computers can chit-chat...with a modem

Once a user gets used to working by himself at his personal computer, it doesn't take long for him to start thinking of



communicating with other terminals, computers, or "information utilities." At that time, he is ready for a peripheral called a modem (for *MOD*ulator-*DEM*odulator) which permits digital information to be transmitted over long distances via phone lines.

Basically, a modem provides a means for a digital signal to modify an audio signal so that the digital information can be sent over the phone lines. On the sending end, the audio signal is encoded, or modulated, with the desired information and at the receiving end, it is decoded, or demodulated. The modulation is generally done by a technique known as FSK (Frequency-Shift Keying).

Connection of computer modems to telephone lines can be direct or indirect. Indirect connections are done via an acoustic coupler. The acoustic coupler has a cradle that holds a telephone receiver, into which the electronic signals to be transmitted are acoustically coupled. With an acoustic coupler, the user must dial the phone himself and then place the handset in the coupler.

With a directly coupled modem, the modem is connected directly to the phone line and, with the appropriate hardware and software, it is possible for the computer to dial numbers, or answer phones, and then transmit the required data and hang up.

The cost of acoustic couplers is generally about half the price of hardwired modems because the acoustic devices must then be connected to a serial interface, which generally more than compensates for the difference in price. One of the most popular acoustic modems is the CAT by Novation Inc., 18664 Oxnard St., Tarzana, CA 91356. It usually sells for between \$150 and \$199. The most popular direct connect modem for the *Apple* computer is the D.C. Hayes Associates, Inc. (10 Perimeter Park Dr., Atlanta, GA 30341) Micromodem II, which sells for about \$400.

### Computers can talk and play music

Computers operate from digital signals, a fact known even to the novice. Thus it is startling to hear a voice or music coming from a computer. Similarly, it is entertaining to watch the reaction of an observer when the owner of a home computer commands his computer to do things with spoken words; yet the observer, using the same words, cannot get any reaction from the computer.

The ability to generate voice or music from digital signals is called speech or music synthesis. Music is easier to generate than speech, since a musical tone contains a fundamental frequency and a series of harmonics. Speech, with its various sounds and inflections, is generally a complex, non-repetitive waveform that is more difficult to synthesize.

To generate a musical note, an algorithm is developed and the computer is instructed on the duration and amplitude of the signal. To form chords, a number of different tones are



MODEMS LIKE THIS allow computers to use the telephone.

combined. To generate speech, a variety of techniques are used. One approach consists of feeding a microphone's output to a computer, where an analog-to-digital (A/D) converter samples the waveform and converts it to digital signals, which are then stored in memory. For adequate reproduction a high number of samples is required, demanding considerable memory storage. For example, to reproduce four minutes of speech properly would require almost 250K of memory—enough to fill an 8-inch floppy disk.

Another approach to speech synthesis makes use of phonemes, basic elements of speech, which do not correspond to words or letters of the alphabet; instead, they are sounds that can be combined to form words. That technique is much more efficient in the use of computer memory. The drawback is the somewhat unnatural sound that is produced. Digitized speech output is available on the *Apple II* computer with the *Super Talker*, which is a speech-output device produced by Mountain Hardware, Inc., 300 Harvey West Blvd., Santa Cruz, CA 95060. The price is about \$400.

The new Texas Instruments 99/4 computer has a solid-state speech synthesizer module that contains over 200 predefined words in its vocabulary. When the operator types SAY "DOG", a bark will be heard from the computer's self-contained audio circuits.

In addition to talking, computers are capable of listening to and understanding spoken words. A speech-recognition system generally includes a microphone, a preprocessor, and a feature extractor. When the operator speaks into a microphone, the preprocessor analyzes the spoken word while the feature extractor investigates any unique or unusual features of the voice. The computer then identifies the word and stores the information leading to the decision. That all takes place during an initializing session called training. Once the system has been trained, it will recognize those words on which it was trained. Since the speech-recognition system has averaged and stored the unique speech pattern of the trainer, it will not always respond to the same words spoken by a different individual. As such, it is possible to use it to identify individuals by voice only.

### A variety of other devices used, too

In addition to those major peripherals, computer owners often find need to purchase other devices to improve the operation of their system. Those can range from filters for the power line to accessory devices such as the *Data Dubber* from The Peripheral People in Mercer Island, WA that makes it easier for the TRS-80 to read computer tapes. **R-E**



# SOFTWARE AND DATA VIA TELEPHONE

*Even the largest personal computer has its limitations. You can get around these, though, by using the information utilities offered by several services.*

THE NEWEST AND FASTEST-GROWING UTILITY TODAY IS THE "information" utility. Many modern philosophers and educators claim that information is power. The more you know, the better you can plan. The faster you can predict will determine your success as a student, businessman and professional.

Top performing corporations have been using large and expensive computers for years to increase their lead over competitors; they make use of their "information utilities" to power their growth. And now, the home computer owner can have access to the same type of computing power so that he can search legal documents, track down news stories, reserve airline or theater tickets, identify stock market prices and trends, research term papers, pinpoint government research projects—all without leaving his home. Low-cost timesharing is available now from Telecomputing Corporation of America's (TCA) *The Source*, CompuServe's *MicroNet* and Lockheed's *Dialog*. The information utilities are here now, at a modest cost, ready for the home computer owner to "plug-in" and draw upon enormous stores of information.

## Software is the key

Only five years ago, home computers hardly existed, except in the basements of serious hobbyists. Estimates for 1980 run to \$1 billion in retail sales...that's growth! Although the cost of the computer hardware has dropped considerably, much of the credit for the rapid surge is due to the large number of programs, also known as software, available from a large number of suppliers.

No longer is the home computer market limited to the serious computer buff who can tailor his software to match his hardware limits; now, a novice can purchase a low-cost home computer, spend a half hour with a carefully detailed instruction manual, connect all the pieces together, plug in a tape or disk drive and proceed to run a program. Within hours he can lose all his hangups and fears and write his own simple programs. That's fine—what next?

The new owner of a home computer can store names, addresses and phone numbers of friends, do regular mailings to customers of his small business, prepare his weekly payroll and other business chores. His wife can keep recipes in the computer's memory and balance her checkbook. His children can play games with the computer and use it to learn spelling, math and many other subjects.

Lots of fun, lots of record keeping and lots of choices to keep the new "toy" busy. But what next?

What's next is time-sharing, or the capability to connect the home computer with huge data banks or "information utilities." A home-computer owner can literally plug into a

vast library, a huge newspaper network or other large storage banks of facts, data and information. Until now, only major corporations or large government agencies could afford to store and gain access to such data banks. Now, large-scale computer-systems houses are making their data banks available to the home computer owner during off-peak hours. It makes sense—the data is there anyhow, so why not offer it at low cost during hours when the demand is low?

Furthermore, communications between computers offers an attractive alternative to the faltering U.S. mail service; electronic mail is another service provided by information utilities.

## Getting on line

It's not difficult to avail yourself of these information utilities. Assuming that you are already the owner of a home computer, what you must add is a device that will convert digital output signals from the computer into audio tones that can be sent over the phone lines and, in some cases, a serial interface (more about that later) to allow you to connect this device to the computer.

Actually, you do not even need the complete computer, but can get by with just a computer terminal—the separate keyboard and video-display unit used to get information into and out of most large, and some small, computers. Using your own computer, though, does have its advantages.

Because the computer is programmable, you can instruct it to communicate with one of the networks even when you're not around.

To give one example, suppose you want to get the closing Dow Jones averages hot-off-the-wire, but will not be able to do so yourself when the news is fresh. You can instruct your computer to call up the appropriate computer at a specific time and ask for that information. When it is received, your computer can either store it in its memory, to await your return and instructions, or can automatically transfer it to a more permanent storage medium, such as a floppy disk, where it will be permanently retained, perhaps as part of a data base you'll use yourself to compile a monthly average of closing prices.

In another instance, you might program the computer to answer the phone when it rang and, if it detected a computer at the other end of the line, to respond to the effect that you were not there at the moment but that it would be glad to take a message for you that the other computer cared to leave. You could even, if you were anticipating a message from someone over one of the networks, have a message waiting for him in your computer's memory, to be transmitted when he called.

The device that actually takes the information from the



computer and sends it over the phone line, or receives the incoming information and translates it into a form that the computer can use, is known as a *modem* (MODulator/DEModulator). Modems can be divided into two categories. There are acoustically-coupled, and all-electronic modems.

The acoustically-coupled kind ties the computer into the phone line without any direct connection to the telephone company's equipment. It is designed to accept a telephone handset and to link the computer with the phone equipment through a built-in microphone and speaker, using sound, rather than electricity as the medium. The other end of the acoustic coupler is connected electrically to a *serial port*—sometimes referred to as an *RS-232 interface*—of the computer.

What's a serial port? Most small computers come with a *parallel* port, generally used to connect to a printer. This is fine, as long as you have at least eight wires—one for each of the eight bits that make up a single ASCII character. Telephones, however, use only one line. Therefore, the bits must be arranged to travel in single file—or serially—rather than in parallel. That is the function of a serial port and, if your computer is not equipped with one, it can usually be obtained through the computer's manufacturer. And, if he does not have one available, there's sure to be someone else who does sell such an interface that will work with your setup.

Acoustic couplers, though, require you to be present to answer the phone and to place the handset into the coupler. There's a more elegant method.

The other type of modem is the all-electronic one which is permanently connected directly to the phone line. This means that it can easily be programmed to work under computer control—to answer the telephone automatically, to determine whether there's a computer at the other end of the line, etc. It can also, in many instances, dial a number under the computer's direction, as would be the case in the Dow Jones example given above.

This type of modem is usually connected to the computer more directly than through a serial port, because of the complexity of its functions. Telephone company regulations may also require that a special coupling device be

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>
>UPI N G DEBAGAN
ENTER STARTING & ENDING DATE - OR PRESS RETURN FOR TODAY

PICK A STARTING STORY NUMBER - FROM 1 (THE EARLIEST)
TO 13 (THE LATEST).
13

READ FORWARD IN TIME (RF), READ BACKWARD (RB),
SCAN FORWARD (SF) OR SCAN BACKWARD (SB)?
SF

13 07-03 03:00 ped=

(9 graf lead, pickup 4th graf: the trip xxx _ carter attacks reagan tax
cut)

PICK A STARTING STORY NUMBER - FROM 1 (THE EARLIEST)
TO 13 (THE LATEST).
13

READ FORWARD IN TIME (RF), READ BACKWARD (RB),
SCAN FORWARD (SF) OR SCAN BACKWARD (SB)?
RB

13 07-03 03:00 ped=

(9 graf lead, pickup 4th graf: the trip xxx _ carter attacks reagan tax
cut)
urgent
previous washington
Carter attacks Reagan tax proposal
By HELEN THOMAS
UPI White House Reporter
LOS ANGELES (UPI) - President Carter today attacked Ronald Reagan's
tax cut proposal as irresponsible, inflationary and impossible to carry
out without cutting federal social services.
For his first public comment on the tax-reduction proposal made by
his probable Republican opponent for the presidency in November, the
president flew to the former California governor's home state.
He told a meeting of the National Education Association, which has
strongly supported Carter's campaign, that Reagan's suggested $36
billion tax cut is "a classic free lunch something for nothing.
That kind of hasty offer can only be called by one word -
irresponsible," the president said.
"It is sheer deception to promise the American people that we can
have this enormously expensive and unfair tax cut that we can
dramatically increase defense spending" and still maintain social
programs, he said.
Carter did not mention Reagan by name but press secretary Jody
Powell made it clear the president was directing his remarks at Reagan
and other GOP tax-cut proponents.
Powell also told reporters Carter has not made up his own mind
about a tax cut, but has agreed to work with House and Senate Democrats,
who want to pass their own _ lesser _ tax cut to rival the Republican
proposal.
Carter was met at the airport by California Gov. Edmund Brown Jr.,
a former rival for the Democratic presidential nomination. Brown praised
Carter's cooperation with California officials and said there is no
hostility between the two men.
Brown has not endorsed Carter. Asked whether he would, Brown
replied: "Not this morning ... It's not the appropriate forum for
that."
The trip, which will be partly paid for by the Carter-Mon
WE ARE ON STORY 13
TYPE "B" "R" "M" "S" OR "G" AND A STORY NUMBER
QUIT
```

THE NEWS, even before it's "hot off the wire," from UPI, via The Source.

added between this type of modem and the phone line, to prevent any possible interference with normal telephone functions. Many modems have such a coupling device built in.

In all cases, special software will be needed—at the very least to enable the computer to communicate via its serial port. Software for the more sophisticated modems is generally available from the modem's manufacturer to work with your particular computer.

## The Source

An inexpensive information retrieval system, *The Source*, can be tied to a personal computer through a modem, as just described, and a toll-free telephone line. Whether you own an Apple, Pet, TRS-80, Heath, Exidy, Atari or other computer, you can gain immediate access to United Press International (UPI) newswires, the New York Times Consumer-Data Base, airlines schedules and reservations, restaurant and wine guides, tax tables, computer games and electronic mail—and that's just for openers.

*The Source* is not a novelty or game to while away leisure time, although games and educational courses are part of the network. It is a low-cost computer service that provides the hobbyist, student and small-businessman access, through time-sharing, to an enormous information network. The system is offered by Source Telecomputing Corp., a subsidiary of Telecomputing Corporation of America, 1616 Anderson Rd., McLean VA 22102.

How cheap is this service? Would you believe only \$2.75 per hour during non-prime time (6 PM to 7 AM, Monday through Friday; all day Saturday and Sunday) and \$15 per hour during prime time? An initial \$100 hookup charge includes a user account number, a secret password (which can be personalized) and a local toll-free telephone number to

```
>
>DATA GAMBBP
*** GAMES LIBRARY - NO PRINTER REQUIRED ***

ADVENTURE-EXPLORE COLOSSAL CAVE (SUPER GAME!!!)...PLAY ADVENTURE
BACKGAMMON.....PLAY BACKGAMMON
CASINO STYLE 21.....PLAY BLACKJACK
CIVIL WAR SIMULATION AGAINST THE COMPUTER.....PLAY CIVILWAR
CHECK CHECKERS CHALLENGE.....DATA CHECK
COIN FLIPPING.....PLAY COIN
SHOOT CRAPS.....PLAY CRAPS
STATISTICS CONCERNING A PARTICULAR DATE.....PLAY DATES
TIC TAC TOE IN SPANISH.....PLAY ESTIC
GET THE FARMER, FOX, CHICKEN, AND GRAIN ACROSS.....PLAY FARMER
MONDAY NIGHT FOOTBALL.....PLAY FOOTBALL
GOLF FOR ONE OR MORE PLAYERS.....PLAY GOLF
GUESS THE COMPUTER'S NUMBER.....PLAY GUESS
HANGMAN WORD GAME.....PLAY HANGMAN
GOVERN ANCIENT SUMERIA.....PLAY HMMABI
HORSE RACE GAME.....PLAY HORSE
10 GAME OF SKILL.....PLAY 10TEST
GOVERN THE ISLAND OF SETATS OETINU.....PLAY KING
LARGE GAME OF GOLF.....PLAY LGOLF
LIFE (COLONY GENERATION).....PLAY LIFE

LUNAR LANDING SIMULATION.....PLAY LUNAR
COMPANIES COMPETE TO SELL A PRODUCT.....PLAY MARKET
MASTERMIND.....PLAY MIND
ANCIENT GAME OF NIM.....PLAY NIM
ANOTHER NIM.....PLAY NIM2
CARE TO TRY YOUR LUCK ON THE SLOT MACHINE?.....PLAY UNEARM
PICA-CENTRE (NUMBER GUESSING GAME).....PLAY PICA
A NEW ADVENTURE GAME.....PLAY PITS
RANDOM POETRY.....PLAY POETRY
POKER AGAINST THE COMPUTER.....PLAY POKER
SCORE FOUR AGAINST THE COMPUTER.....PLAY SCOREFOUR
RANDOM SHAKESPERIAN SONNETS.....PLAY SONNET
FILL IN THE MISSING LETTERS.....PLAY SPELL
STAR TREK (SUPER VERSION!!!).....PLAY STOKS
PLAY THE STOCK MARKET.....PLAY STOCKS
RULE ANCIENT SUMERIA (A DIFFERENT ONE).....PLAY SUMER
TARGET PRACTICE AS WEAPONS OFFICER ON THE ENTERPRISE.....PLAY TARGT2
TIC TAC TOE.....PLAY TICTACTOE
A REGULAR CASINO OF GAMES FROM LAS VEGAS.....PLAY VEGAS
ROULET FOR UP TO SEVEN PEOPLE.....PLAY WHEEL
PATROL THE CITY STREETS.....PLAY WATCHMAN
HUNT THE WUMPU.....PLAY WUMPU

NOTE:
FOR INFORMATION ON ANY GAME TYPE.....INFO (GAMENAME)
I.E., INFO ADVENTURE; TO VIEW A DEMONSTRATION OF CERTAIN
OF THE MORE COMPLEX GAMES, TYPE DEMO (GAMENAME).
```

TO PLAY GAMES from The Source, type "PLAY," followed by the name of the game.



access *The Source* in areas where there are a lot of members. In areas with only a few members, it may be necessary to dial long-distance. To illustrate cost in another way, a user with a 300-baud modem (which sends out 30 characters per second) could get as many as 200,000 characters of data-base information for only five dollars. The subscriber can have billing charged to any one of several credit cards including American Express, VISA, and MasterCard (formerly Master Charge).

#### Get the news while it's hot

UPI's network extends to more than 7000 news-service customers who print newspapers, magazines and market reports based on timely input. Let's see how a college senior with a personal computer could benefit from *The Source*. Assume that he has to prepare a term paper on the political strain between the U.S. and Iran.

As a subscriber to *The Source*, the student would request UPI and then be queried by the computer on whether he was interested in National (N), Regional (R), State (S) or Federal (F) departments; next whether General (G), Business (B), Sports (S) or Miscellaneous (M) news categories. After National (N) and General (G) selections were made, the screen would request a key word or search phrase to identify the request to review U.S.—Iran news stories. *The Source* would then indicate the number of stories available within a selected time period (week or month) and allow the subscriber to scan the first paragraph of each story; if the entire story is required, just a simple keyboard command would display it on the screen. Thus, within minutes, and without leaving his room, the student could access UPI's filed stories and prepare a factual, timely paper. How timely? A story on a major political move in Iran filed in Teheran would reach a *Source* subscriber within two minutes of its initial transmission. A fast-reaction newspaper would carry the story perhaps hours later. Thus, our college senior could submit a term paper to his professor during an afternoon class and discuss items that might be covered in the next day's newspaper! A clever student could earn many an A with such a masterful play.

#### What's happening back home

A novel form of news coverage offered by *The Source* is called UPI Newshare, to deliver local news items generally considered insignificant for the National, Regional, and State categories.

For example, if your hometown lost the Little League Championship, the story would hardly be picked up by the major UPI network. However, with Newshare, local newspapers will be adding their stories to the UPI computer.

Users of *The Source* would have quick access to local news without waiting days for delivery of their old hometown newspapers. And think how easy it will be to keep up with news of old friends just by tapping a few keys on your home computer.

#### Neither rain nor sleet...

Have you reached your threshold of tolerance for excessive delays in mail delivery? Electronic mail is just one offering of *The Source*. Not only can time of delivery be considerably compressed, but two-way message exchange is possible at modest costs.

Electronic mail can be "delivered" in three ways. The simplest method allows one subscriber to send a message at 30 characters per second to another subscriber's "mail-box", where the second subscriber's terminal indicates Mail Call. When the second subscriber types MAIL on his keyboard, the message "mailed" to him will appear on the CRT.

A two-way message exchange is possible between two subscribers in the CHAT mode. Finally, a message can be sent from a subscriber to a non-subscriber via *Datapost*, a service competitive with *Mailgram*. *Datapost* is a service of TDX Systems Inc., and receives the messages at its center located at O'Hare Airport in Chicago; the messages are then converted to hard copy and sent on express flights for next-day delivery in cities around the country. Cost? Only 75-cents-a-message additional charge above *The Source* and telephone line fees.

#### MicroNet

*MicroNet*, a service of CompuServ Inc., permits personal computer owners in 175 major cities in the U.S. to access their large DEC K1-10 and K1-20 central processors in Columbus, Ohio. The *MicroNet* system offers (1) a variety of computer programs on a time-sharing basis, (2) the ability to expand the potential of the personal computer, (3) a means to buy and sell software through the *MicroNet* Software Exchange, (4) a Feedback feature to contact *MicroNet* headquarters at no charge, and (5) nationwide contact via its National Bulletin Board and Electronic Mail capabilities.

The personal computer service is only available during off-peak hours, 6 PM to 5 AM weekdays and all day Saturday, Sunday and holidays. *MicroNet* may be accessed via local telephone service from more than 175 major metropolitan areas. The service costs \$5 per hour connect-time in over 30 proprietary cities; an additional \$2 per connect-hour surcharge is added for customers using *MicroNet* from *TymNet* network cities. (*TymNet* is a telephone-interconnect network between *MicroNet* and several major cities. Thus, if you live in one of these major cities and you use *TymNet*, you will be billed for local phone calls when accessing *MicroNet*.) The initial fee is \$9; however, the first hour of use is free, thus reducing the cost by \$5.

Among the programs in the *MicroNet* library are (1) BASIC with double precision, linking capability, file-to-file sorting and a debug mode, (2) FILGE (for File Generator and Editor) which has powerful text-manipulating capabilities, (3) FINTOL for solving financial problems, and (4) MicroQuote to provide rapid access to information on securities traded on exchanges and over-the-counter. FORTRAN, APL, and Pascal are also available.

#### Become a Wall Street wonder

Over 32,000 stocks, bonds, and options are available in the MicroQuote database. Trading information is updated daily and, for the analyst who relies on charting historical data, prices and volumes are available back to January 1, 1968. Press the buttons with the *MicroNet* system and you can immediately become informed on your favorite stock's current and historical prices (high, low, and closing), dividends, earnings per share, ratings and shares outstanding. If bonds are more to your liking, you can obtain information on yields,



maturity dates, option information, Moody's ratings and exercise prices.

Cost for the use of MicroQuote is \$5 per hour of connect-time, a per-access fee of \$1 for each use of MicroQuote, plus additional transaction fees based on the amount of information requested. For example, if you requested a list of 25 issues, a 25-cent charge is applied. Daily, weekly and monthly price and dividend sets cost 5, 10 and 25 cents for each set, which supplies date, volume, high/ask, low/bid and close prices. If you wanted to examine a particular stock issue in detail, the charge would be \$1.25.

A wide assortment of games—Space War, Star Trek, blackjack, chess, golf, craps, and football—is also available to keep the subscriber entertained.

MicroNet users are permitted to store up to 64 kilobytes of their own data on the system. However, those files must be accessed at least once every seven days or they will be deleted.

An interesting and innovative service offered by MicroNet is the opportunity to market software via the personal computer through two approaches. The first approach is for software guaranteed by CompuServe, MicroNet's parent. Vendors will sell their tested software to CompuServe on a direct or royalty basis. A user finding this particular software beneficial to his business or interests can test the program on MicroNet and then purchase it using his credit card. The program would then be downloaded from CompuServe's mainframe to the personal computer. In a second approach, users will have an opportunity to test programs available from software retailers. In this case, CompuServe will act as a retail outlet, renting space on its network to software merchants.

A Feedback system is available for subscribers who desire user guides and reference manuals for MicroNet programs that are not self-documenting.

### Electronic mail

MicroNet's electronic mail system relies on a bulletin-board format. The user places a message on the bulletin board using his personal computer. But, unlike other bulletin boards, on this one, only the person to whom the message was addressed can receive it. Subscribers using this mode must scan the bulletin board as they enter the system to see whether any messages have been posted for them.

A variation of personal-computer CB is also available from Micronet. A subscriber offers his "handle" or nickname and selects the channel he wishes to participate in. He is then informed of the number of other subscribers on the same channel and can then choose merely to "listen" via his CRT display or to take an active role. Needless to say, a crowded channel on a computer display is as unintelligible as a group chatting over a jammed CB voice channel.

To join the MicroNet set, you add a modem to your personal computer and set it for 300 baud. Request and return a service application to CompuServe's Personal Computing Division, 500 Arlington Center Blvd., Columbus, OH 43220. Your VISA or MasterCard credit card number is requested. You will then receive by return mail a user kit containing a user identification number, a secret password, a local network telephone number (if there is one) and basic documentation of the MicroNet system. Then to make life easier for you and to achieve compatibility between the MicroNet system and your personal computer, a MicroNet Executive program is loaded into your computer at no charge. Billing for connect time, other surcharges, and any software purchases will be done through your charge card.

### Lockheed's Dialog

Lockheed's Dialog, started in 1972, now provides access to over 100 databases which cover subjects including science, technology, literature, arts, business and finance. A subscriber can search over 40 million records including magazine articles, conference proceedings, legislative documents,

>DATA LIBRARY	
*** THE SOURCE ***	
ADVANCED APPLICATIONS & PROGRAMS.....	DATA ADAPPR
AIR SCHEDULES.....	DATA AIRSCHD
ANNOUNCEMENTS (UPDATED FREQUENTLY).....	DATA ANNOUN
ASTROLOGY LIBRARY.....	DATA ASTRO-LIB
AWARE FINANCIAL SERVICE.....	DATA AFS
BUSINESS & FINANCE.....	DATA BIZDEX
CLASSIFIED ADS & BULLETIN BOARD.....	DATA CLASSI
CONSUMER INFORMATION.....	DATA CONSUM
CROSS X-ASSEMBLERS.....	INFO X-ASSEMBLERS
DINING OUT..(WASHINGTON, D.C.).....	RESTOD
DISCOUNT SHOPPING SERVICE (MONEY SAVERS).....	DATA BUCKS
EDUCATION.....	DATA EDUCAT
ENERGY SAVING NEWS & TIPS.....	ENERGY
FINANCIAL NEWS.....	DATA BIZDEX
GAMES.....	DATA GAMES
HOME ENTERTAINMENT.....	DATA HOMENT
INFORMATION ON DEMAND.....	DATA 100
MAILCALL.....	DATA MAILCALL
MAIL DELIVERY.....	INFO DATAPOST
NEW YORK TIMES NEWS SUMMARY.....	DATA NYTNS
NEW YORK TIMES CONSUMER DATA BASE.....	NYTCDB
POLITICAL ACTION REPORT.....	DATA PAR
PERSONAL CALENDAR & NOTEBOOK.....	DATA PERSON
PERSONAL FINANCE.....	DATA PERSFI
SCIENCE & ENGINEERING.....	DATA SCIENG
SELF-PERCEPTION.....	DATA ESP, DATA LORE
SPORTS.....	DATA SPORTS
SUGGESTION BOX.....	DATA SUGBOX
TRAVEL CLUB.....	DATA TRAVEL
UNITED PRESS INTERNATIONAL (UPI).....	DATA UANews
USER DIRECTORY.....	DATA USEDIR
VOICEGRAM.....	DATA VOICEGRAM
WEATHER.....	DATA WEATHR
WISDOM OF THE AGES.....	WISDOM

SOME OF THE SERVICES offered by The Source to users of personal computers.

technical manuals, patents, newspaper articles, directories and dozens of other sources.

Put another way, Dialog offers the equivalent of a vast library to the owner of a personal computer to use in the comfort of his home.

What are the costs? There are no startup, no initiation, or monthly fees. You pay only for the time on the system plus the communications-lines fees. For example, if you were researching a paper on Computer Programming and Computer Systems, you would access INSPEC (which includes Physics Abstracts, Electrical and Electronics Abstracts and Computer and Control Abstracts); the cost would be \$55 per on-line hour. If you were interested in a specific government-funded research and development program, you would browse through the NTIS (National Technical Information Service) which has a fee of only \$35 per on-line hour. According to Lockheed, a typical search might require 10 to 15 minutes time for a cost of \$10 to \$20. This includes TymNet or TeleNet charges.

When you think about it, it's a fantastic bargain. The databases include periodicals going back ten years or more, with the most current issues available. Think of the time, gas, and parking fees involved in visiting your local library to search through their files manually. When you locate the specific items, the librarian would require additional time to locate some of the outdated material (if the library is large enough to maintain a lengthy file of the publications you require).

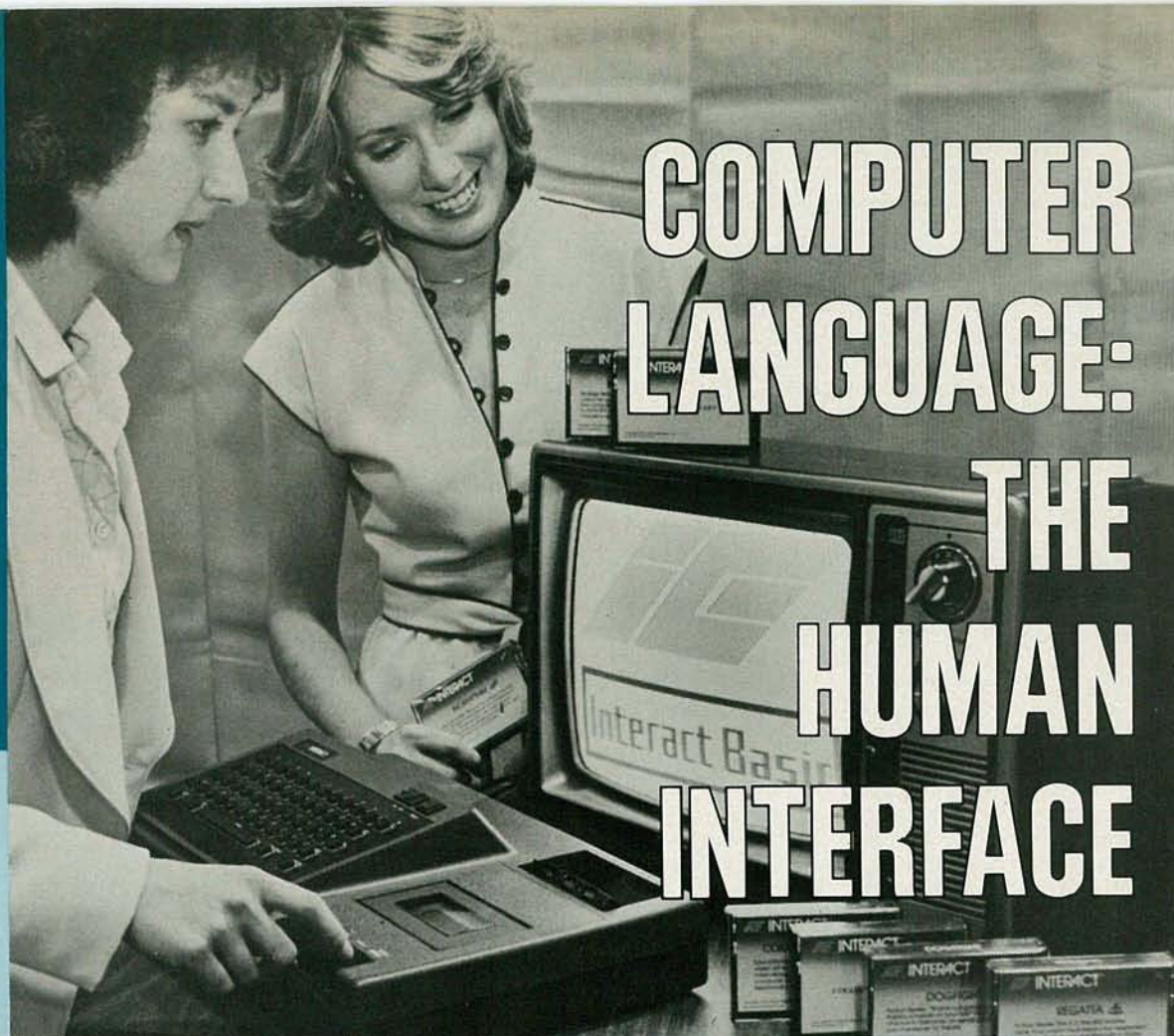
An active training program is available for new users at a cost of \$65 per person for a one-and-a-half day session and \$25 for a half-day refresher course. However, whether you sign up for these courses or not, you will be entitled to receive a credit of up to \$100 for practice time. (Communications costs are not included.)

To initiate service with Dialog, an order form may be obtained from Lockheed Information Systems, Dialog Marketing, 3251 Hanover Street, Palo Alto, CA 94304. There is no minimum amount of on-line time to be contracted for and the service may be cancelled by the subscriber upon 30 days notice. During the first month of service, up to \$100 will be credited towards search efforts since training will be taking place. Dialog service is available 110 hours a week, from Monday to Saturday.

Just a sampling of the subjects comprehensively covered by the Dialog databases includes: accounting, acoustics, advertising, aerodynamics, agricultural engineering, aircraft, anatomy, art and art history, astronomy, banking, biology, biophysics—and that's only part way through "B". With your home computer linked to an enormous on-line system such as Dialog, you have access to a vast library that would be the envy of a multimillionaire!

R-E





# COMPUTER LANGUAGE: THE HUMAN INTERFACE

*Computers cannot act on their own—they have to be told what to do. Here's a discussion of several of the languages used to instruct them.*

IF YOUR RICH UNCLE PASSED AWAY AND LEFT YOU A MULTI-million dollar IBM computer, it probably wouldn't do you any good (unless you sold it). All you would possess would be a well-designed piece of computer hardware unless he also left you the software (programs) to tell the machine what to do.

The computer is a machine. It doesn't understand the English language. Yet it is capable of performing an endless number of tasks, involving lengthy calculations and complex procedures. And the computer can respond to a computer language, so the obvious step is to develop a language that can be understood by humans and somehow converted to the language a computer can follow.

A computer *program* is a set of instructions that tell the computer what to do. A computer *language* defines the rules of grammar and vocabulary for writing instructions. If you don't follow the rules, the computer cannot understand the instructions, and it will be unable to perform its assignment.

A *statement*, or *instruction*, in a computer program, is a string of elements from an alphabet that includes letters, digits and symbols. A set of rules, or *syntax*, establishes the form of each statement which conveys a specific operational meaning or *semantics*. Thus a computer language includes the alphabet, syntax and semantics.

Computer languages in use today can be grouped into three broad categories: machine languages, assembly languages, and problem-oriented languages. Both machine and assembly languages are considered *low-level* languages while a problem-oriented language is concerned *high level*.

## Machine language

The most elementary language is machine language since it is the only language that the computer understands directly; any other language is "foreign" to the computer and thus it will not recognize or execute proper commands. Machine language is written with the computer's hardware or design configuration in mind so the programmer must be well aware of how the machine works. Because the vocabulary and grammar rules are rather limited, machine language is considered simple. However, because of the limited vocabulary, a fairly long program is required to lead a computer through a relatively simple assignment.

A machine-language program consists of a list of instructions in binary form to direct the computer to perform an operation or a series of operations such as add, multiply, read, write, or store. For the programmer's convenience, decimal, octal, or hexadecimal numbers may be used and then converted into binary numbers inside the machine. The operation to be performed is given by a code that directs the computer to perform a specific operation and also supplies the operand, which is the quantity to be operated upon. Instructions in machine code are binary numbers, not letters or words. A series of binary numbers representing a very small part of a machine-code program would look something like this:

Operation Code	Operand 1	Operand 2
01011001	01001100	11011010

To perform a simple addition of just two numbers would involve the above listing of 1's and 0's, in the binary lan-



guage that makes the computer perform. Imagine the enormous sequence of 0's and 1's required to perform a complex calculation!

Obviously, the computer programmer who attempts to prepare a lengthy program in machine language will be prone to making errors since it is a tedious and tiresome task. The task is somewhat lessened with the aid of an octal or hexadecimal program that accepts the programmer's inputs in octal or hexadecimal (special numbering systems that are more intelligible to humans than binary) and converts them to binary.

The advantages of machine-language programming are (1) the ability to instruct the computer directly and (2) the low requirement for supporting software or memory. The disadvantages include (1) the need for the programmer to have full awareness of the machine's hardware structure, (2) the lengthy and tedious effort involved in writing the program and (3) the lack of flexibility in using a program written for one computer on another type. For example, a machine-language program written for a Motorola 6800-based computer cannot be applied, without extensive modifications, to a computer using an Intel 8080 CPU.

Perhaps the greatest drawback to machine-language programs is their lack of intelligibility to non-computer users. A detailed machine-language program, with its lengthy series of 0's and 1's—or even their octal or hexadecimal equivalents—has no meaning to the student, engineer, businessman, or layman eager to apply the computer to his specific applications. Indeed, even a professional machine-language programmer has quite a task keeping track of the meanings of the machine code.

## Assembly language

To make computer programs easier to comprehend, symbolic languages were developed. Such a language makes use of letters or names for instructions, data and addresses. These names or "mnemonics" refer to the terms they represent so a computer user can, by association, relate the term to the function. An example of mnemonic symbols in everyday use is DOD for Department of Defense and IRS for Internal Revenue Service. Only three letters are used as shorthand identification, yet most people know immediately what they represent.

Not all instructions are as easy to remember as ADD, SUB, or AND. But it is not too difficult for the programmer to associate LA with "load the address" or P to punch a card. Such use of symbolic code rather than a lengthy string of ones and zeros was the first major step to bring computer-programming capability to the non-professional programmer. If we wanted to have the computer calculate  $X = A + B$ , where  $A = 3$  and  $B = 5$ , in assembly language, we would use the assembler instructions listed in Table 1.

TABLE 1

Location	Operation	Operand 1	Operand 2	Comments
Begin	LDA	REG 6	B	Load B into register 6
	ADD	REG 6	A	Add A to register 6
	STA	X	REG 6	Store register 6 at X

The symbolic instructions listed in Table 1 would be translated into machine-language form by the assembler.

Now a non-professional programmer can write what's known as a source program, using symbolic language, with instructions or statements to guide computer activities. Next, a processing step is required to translate the source program (easy for a human to write and understand) into an object program, which is a machine-language program that the computer can understand. The program that accomplishes this task is called a *translator*. Its output, the object program, is what the computer requires to direct its operation.

The grammar of assembly language is similar to that of machine language but the vocabulary is different. Since a computer is still being directed, the operations available and the sequencing are unchanged. However, mnemonics, rather than numbers, are used in preparing the program.

Symbolic languages make computer-program preparation easier, since terms, rather than numbers, are used to relate to the problem-solving needs.

A profound advantage of symbolic language is the ability it gives one type of computer to process programs written in many different languages, provided a translator program is included with each language. This means that one computer can handle programs written in either BASIC or FORTRAN (to be described later), as long as a separate translator is available to convert each into the computer's machine-language code.

This first step to make programming a bit simpler is called assembly language, machine-oriented language, or low-level programming language. Although symbolic notation makes program-writing easier than straight binary coding, it takes about as many symbolic instructions to write a program as machine language does. Stated another way, there is a one-for-one conversion of language instructions. Thus, the assembly-language programmer still must write lengthy instructions and must be familiar with all the peculiarities of the computer he is programming. For complex programs, many of the abbreviated mnemonics will not take convenient comprehensive form and will require extensive commentary to keep track of all the definitions of terms.

The translator that converts the assembly-language (source) program into the computer object program is called an *assembler* and is usually located in the computer's memory. As the source program, written in symbolic language, is entered into the computer, the assembler converts each symbol into machine-language form (or the object program). At this stage, the computer is only recording the object program in its memory, or onto punched paper tape, magnetic tape or disk. When the translation task is completed, the object program can be entered in its entirety into the computer; now the computer can understand the instructions and data, and can proceed to execute the program.

Assembly language is an improvement over machine language, but is still machine-dependent. Every type of computer requires its particular assembly language.

## Problem-oriented languages

The next step in program design makes the computer hardware (and type of computer) relatively unimportant with respect to the task to be performed. This type of language is known by such names as: "problem-oriented," "procedure-oriented," or, simply, "high-level." It approaches the programming problem from the viewpoint of the goal to be achieved, rather than the specific machine that will achieve it.

Broadly speaking, there are two types of high-level language—compilers and interpreters. Compilers will be considered first.

A compiler allows a program to be written in English-like terms and translates it directly into machine language. With it, a single statement, such as "PRINT," can cause a whole series of machine-language instructions to be executed. From the human point of view, a compiled language is much more efficient than assembly language.

As with an assembler, the compiler first translates the source-language program into an object program before running it. A program, that originally has been written using a compiler cannot be run unless the entire program (or a complete section of it) has first been translated (compiled) into machine code. Here's how a program would be compiled on a large computer system (smaller systems use floppy disks



rather than punch cards):

First the program is laid out, and debugged to the greatest extent possible (getting the bugs out of an already compiled program is not the simplest task in the world), using coding sheets. Then, assuming that a punch-card system is being used, a keypunch operator punches or codes one card for each line on the coding sheet. The complete set of such cards is called the "source deck."

Then, with the compiler already in the computer's memory, the program is fed into the computer one card at a time. After all the cards have been fed in, the program is compiled, and a new set of cards, containing machine-language instructions, is generated. This set is known as the "object deck." Since one "source" card may require several machine-language instructions to be carried out, the object deck contains many more cards than the original source deck.

After compilation, the code from the object deck is loaded back into the computer, and the program can be run.

The other type of high-level language we'll discuss is the *interpreter*. Most of the BASIC's used with small computer systems are interpreters. Interpreters, like compilers, allow programs to be written in an English-like form, but operate somewhat differently internally. The most significant difference is that no compilation takes place and that the source code is always accessible.

An interpreted language translates instructions into machine language as the program executes—in real time—rather than "predigesting" them all at once, as does a compiler. Because an interpreter is constantly "interpreting" (or translating) as well as actually executing the program, it tends to run more slowly than a compiled language. Furthermore, the interpreter retains no memory of what it has interpreted so, even if it has already executed a certain routine a hundred times, it must interpret it anew when it encounters it for the hundred-and-first. This makes for an even greater reduction in speed.

Interpreters have their advantages, though. Because you are always working with source code, it is simple to modify a program should a change be necessary. A program can even be stopped while it is running, altered, and the run continued. This is an impossibility if you are using a compiled language. Also, while a compiled program may occupy much less memory than an interpreted one, the *compiler itself* may take up so much room in a small computer that it would leave little or no memory space for the program it was intended to run.

Machine and assembly languages are designed to match specific computers, and bear no relation to the applica-

tions the computers are intended to perform. Problem-oriented, or high-level, languages disregard the hardware aspects of the computer and concentrate instead on the applications. To simplify programming, it was desirable to develop different languages for different applications. Languages have been developed for mathematical and scientific needs, for business procedures, for text editing, and for other specialized needs. Only one problem-oriented language has been developed as a *universal* language to replace all others: the IBM PL/I or Programming Language/1.

The premise was that scientists, businessmen, engineers, and computer experts could program nearly everything they needed with this language. Unfortunately, the language is so complex that few programmers can handle it. Secondly, a powerful computer is required to use the program. And finally, it turns out that the scientific programmer using PL/I involves himself only with the scientific portion while the business programmer only identifies with the business section. It may well be that the goal of an ideal computer language is not unlike that of a universal language for speech around the world. Wouldn't it be convenient to have one language spoken and written throughout the world? No need for guide books, language-phrase books, language courses for the traveler—but as obvious as the need appears, the prospect of a universal language is far distant. So too, perhaps for a universal computer language.

## Advantages of high-level language

What are the advantages of high-level languages? Programs are shorter, easier to write, and debugging (locating errors) is simplified. Programs written for a particular application can be supplied to users around the world, regardless of the computer they have, as long as a compiler or interpreter is available for the language used. And, of course, there is no need for the programmer to be concerned with the inner workings or details of his computer's hardware or machine language.

Then why are low-level assembly- or machine-languages still in use? High-level languages require considerable memory and programs run slower since a translation process is involved between the human-oriented and machine language. Often the compiler is expensive and requires a large amount of memory. If an interpreter is used rather than a compiler, translating each statement and executing it, less memory is required. The tradeoff is a loss in efficiency since translation must be performed every time the user runs the original program.

Which is best? For the non-professional programmer, high-level languages are much simpler to prepare and use; programs are relatively easy to comprehend from the symbols involved. Assembly and machine-language programs, when properly prepared, can make the computer perform faster; also, programmers familiar with the particular strengths of a computer's hardware can make the computer "do tricks" and thus operate more efficiently than would be possible with general-purpose high-level programs. Even today, assembly and machine languages offer efficiency unmatched by high-level languages.

## Popular high-level languages

High-level languages, or problem-oriented languages, can be general-purpose, or can be specifically tailored for applications such as engineering, education, banking or process control. Over a thousand languages are in existence, some used only by a handful of specialists and others enjoying widespread use by a large number of computer users.

Among the most popular computer languages are:

**ALGOL** (*Algorithmic Language*)—a math and science language in common use in Europe.



**APL** (A Programming Language)—a language to handle long strings of numbers or letters with ease.

**BASIC** (Beginner's All-Purpose Symbolic Instruction Code)—a language developed to introduce students to computers; simplicity and ease of use highlight this language. Widespread use with personal computers.

**COBOL** (Common Business-Oriented Language)—the original language designed for the non-professional programmer for business, rather than scientific, applications.

**FORTRAN** (Formula Translation Language)—Probably the most widely used language. Although originally intended for scientists, it is in widespread use for business applications.

**LISP** (List Processing)—a language developed by a group at MIT to handle list processing. Lists are finite sequences that can appear in a large variety of structures in the form of numbers, letters, or even computer words.

**Pascal**—an extended version of ALGOL developed for teaching structured programming to students.

**PL/1** (Programming Language/1)—a complex language combining the advantages of COBOL, FORTRAN, and ALGOL. The language contains more features than any other language; however, because of its complexity, it is difficult to learn and apply.

**RPG** (Report Program Generator)—a language for requesting and defining reports.

### Languages in detail

Wouldn't it be ideal if all computers understood instructions written in the English language? Yes, it would, but there would always be problems. Human languages are extremely complex and yet imprecise. Words don't mean the same thing to everyone. For example, "watch" may indicate "observe" to one person and "timepiece" to another. With computers, words and instructions must be exact, without ambiguities to confuse the computer.

High-level, or problem-oriented, languages are a good compromise for efficient communications between humans and the computer. It has been estimated that well over 1,000 high-level languages have been developed; perhaps 200 enjoy some form of popularity.

Why so many languages? High-level languages are intended to handle problems and thus deal with a multitude of applications. While many languages have a rather broad appeal and application, there always seems to be a reason for programmers to develop a specific language for a specific need. There are high-level languages, for example, exclusively tailored for numerically-controlled machine tools, electronic circuit design, hydraulic system analysis, graphical analysis and other such specialized applications.

### ALGOL

ALGOL (*Algorithmic Language*) was developed in the mid-1950's for scientific and mathematic applications. ALGOL is much more popular in Europe than in the U.S. and is well respected as a powerful language capable of handling very complex programs.

One version of ALGOL of particular significance is the "publication" version which many computer scientists use to describe new programs they have developed. Thus, there are many programs published in ALGOL even though the program authors or potential users do not have the sophisticated hardware to run or test the programs. The publication version of ALGOL is based upon the type faces generally available to printers and thus includes upper and lower case letters, methods to indent lines, and bold-face type.

The language's power and versatility are assets which are hampered by the need for a relatively large, slow, and expensive compiler. Programs in ALGOL are separated into blocks, with smaller called-subroutines or procedures.

### APL

In 1960, Ken Iverson of IBM developed APL (*A Pro-*

gramming Language) as a notation for describing algorithms. (An algorithm is a prescribed set of well-defined rules or processes for the solution of a problem in a finite number of steps.) Based on a series of symbols for logical and mathematical functions, APL is easy to learn and requires relatively few characters to define complex operations. It is used in applications ranging from complex mathematical and scientific problems to text editing and computer-assisted education.

APL's major attraction is its powerful problem-solving capability coupled with a high degree of interactivity. This allows top-level managers, such as businessmen and financial analysts with key decisions to make, to "have a conference" with their computers using APL. Since the language is easy to learn and use, these busy managers do not require extensive training nor added staff to handle the program.

APL makes use of several unusual symbols, such as an upside-down T, and thus special terminals are required for APL to put these symbols into the machine. APL is not a scientific language, but is considered more of a manipulative language for handling long strings of numbers or letters; it's ideal for text editing. The text of an article or a book can be fed into a computer using an APL program; the manuscript can be rewritten or altered with spelling corrections or hyphenation, and then retrieved from the computer in its new format. Many modern automated printing and publishing firms use APL for such automatic typesetting applications.

APL, as well as BASIC, are languages based on interpreters rather than compilers. This means that programs can be written, tested and debugged rapidly.

The APL language is used by large firms as a powerful analytic tool for long-range planning.

### BASIC

BASIC, *Beginner's All-Purpose Symbolic Instruction Code*, was developed at Dartmouth College in 1965 as a language for introducing students to computer science. The project was supported by a grant from the National Science Foundation and was managed by Professors Kemeny and Kurtz. BASIC was originally intended for use on a time-sharing computer.

The object of the project was to come up with an easy-to-use computer language; its success has made it the most popular language among non-professional programmers and computer hobbyists. It is a language intended for an amateur programmer who has a problem, wants to use a computer to solve it, wishes to prepare his own program rather than hire a programmer, and doesn't have a large budget.

A major advantage of BASIC (and APL) over other languages is its use of an interpreter rather than compiler. Programs prepared by an amateur can be inspected, modified, debugged and corrected without tedious recompilation. BASIC can accept program changes with a minimum of effort on the part of the programmer. Another advantage of BASIC is its interactivity.

BASIC is easy to learn because it has a limited vocabulary compared to FORTRAN, COBOL or other popular languages. The primary statements are arithmetic, program control and input/output. Every language consists of a set of characters; BASIC uses the 26 letters of the alphabet, all ten decimal digits (0 to 9), and fewer than two dozen additional characters (arithmetic operators, punctuation, etc.).

Here are some of the fundamental rules that were established in the original Dartmouth BASIC:

- A line can include only one statement.
- Each statement must include a line number followed by a keyword.
- Statements or instructions are performed in order of



line number.

- A BASIC program must be completed with an END statement.

A keyword indicates the type of instruction such as LET, PRINT, DATA, END, OR REM. REM (for REMARK) is a comment to inform or remind the user of the program content but is not acted on by the computer. LET takes the form of LET X = A + B + C where LET means the value of the expression A + B + C replaces the variable X. PRINT, appearing by itself, simply allows a line to be skipped on the printer or display device; PRINT, followed by words enclosed in quotation marks, commands the computer to display the words. For example, PRINT "THE SKY IS CLEAR" would result in THE SKY IS CLEAR being displayed or printed out. The instruction READ orders the computer to obtain data from within the program and store it in a particular memory location. The READ and DATA instructions are used together in this manner: the first variable listed in the READ statement corresponds to the first number in the DATA statement. A simple BASIC program to add 2 plus 3 will demonstrate and clarify how these statements relate:

TABLE 2

```
10 REM A SIMPLE ADDITION PROGRAM
20 READ A, B
30 LET X = A + B
40 PRINT X
50 DATA 2, 3
60 END
```

The REM comment allows us to identify the program content. The READ instruction sends the computer to the DATA storage where the first variable, A, corresponds to 2 and the second variable, B, has a value of 3. The LET statement means that the expression A + B or 2 + 3 or 5 replaces X. Then the PRINT instruction directs the value of 5 to be displayed on the output. The END statement concludes the program. For comparison purposes, the same problem listed in Table 2 is given again in binary and hexadecimal machine code for an 8080-based computer in Table 3.

There are quite a number of versions of BASIC available today with no two types exactly interchangeable. Thus a BASIC program written for an Apple computer won't necessarily work on a Radio Shack TRS-80. The programs are similar enough so that even an amateur can understand the differences; but the lack of conformity is frustrating when the program for one computer is wanted to run on another and extensive reprogramming is required.

There are several reasons why programs written in one

TABLE 3—HEX & BINARY Representations of 8080 "addition" machine code:

Hex	Binary
AF	10101111
3E	00111110
02	00000010
06	00000110
03	00000011
80	10000000
21	00100001
88	10001000
13	00010011
77	01110111

TABLE 5—ADDITION of two numbers in FORTRAN:

```
A=2+3
WRITE 10,A
10 FORMAT (12)
END
```

BASIC will not run when transcribed into a machine that uses another BASIC. First and foremost is the fact that some BASIC's have commands that others haven't. The reason for this is often related to the amount of memory available. For example, one of the first BASIC's available for home computers was known as Tiny BASIC. In its original form, Tiny BASIC had no string capability and could not handle trigonometric functions. Some versions of it only worked with integers and no floating-point calculations were possible. These early versions generally needed only 1 or 2K of memory. But, as memory got cheaper, functions were added to these Tiny BASIC's and programs written with the updated versions were incompatible with the earlier ones.

Today, there are still more variations of BASIC. The first distinction is between integer BASIC and floating-point BASIC. Integer BASIC is generally faster, and is good for video graphics applications. A computer that offers both integer and floating-point BASIC's is the Apple II, and the incompatibility between the two languages is clearly demonstrated when one tries to run an integer BASIC program in the floating-point mode. For example, INPUT statements in floating-point are followed by a semi-colon, while in integer BASIC, they are followed by a comma. Strings are handled differently, too. Integer BASIC simply has no string functions (e.g. RIGHT\$, LEFT\$, MID\$, STR\$, etc.). These functions are present in the Apple floating-point BASIC, and, are similar to those used by North Star basic.

Another thing that makes BASIC's incompatible is the way they use abbreviations. The Microsoft BASIC's use a "?" as an abbreviation for the PRINT statement. North Star BASIC uses a "!" and Radio Shack Level I BASIC uses "P." Not all versions of these languages convert the abbreviated form back to the full word when the program is listed, so that trying to transcribe a program with these abbreviations for a noncompatible machine could be quite disastrous.

If you stick to using the full word and avoid abbreviations, you'll find that there is a subset of BASIC commands that is common to almost all personal computers. Table 4 contains a list of 41 commands that are fairly universal. However, even though a command may exist in two different BASIC's, it may not do the same thing in both. An example of this is the GET command. In Applesoft BASIC this command tells the computer to wait for the user to input data from the keyboard. The computer waits for a key to be pressed and then returns the value of that key. In PET BASIC, when the GET command is encountered, the computer also looks at the keyboard for a key closure. However, if no key is pressed, it immediately returns the value 255 instead of just waiting for a key to be pressed. This means that programs must be written a little differently for each case, as illustrated below:

In Applesoft the GET statement would be used like this:



## 10 GET AS

To get the same action (without having the computer return the value 255) in PET BASIC you'd have to write:

```
10 GET AS:IF AS=" " THEN 10
```

This is a perfect example of how two BASIC's having the same commands can result in programs that are incompatible with each other.

TABLE 4

ABS	AND	ASC	ATN	CHR\$	COS
DATA	DEF	DIM	END	EXP	FN
FOR	FRE	GET	GOSUB	GOTO	IF
INPUT	INT	LET	LIST	LOG	NEW (or SCR)
NEXT	NOT	OR	PEEK	POKE	PRINT
READ	REM	RESTORE	RETURN	RND	SIN
STEP	TAB	TAN	THEN	TO	

Assuming that the BASIC's do have compatible commands, you're still not out of the woods. The reason is that some commands link BASIC to machine language or specific memory locations; notably PEEK and POKE. These commands are available in most BASIC's except those from Texas Instruments and Hewlett-Packard. However, because different computers have organized the use of memory differently, it is not always possible to use programs that have PEEK and POKE statements in them directly. For example, if the POKE statement is used to temporarily store a number in memory for later use on one machine we could be in serious trouble using it in another. In the Apple, memory locations around 768 are available for use by the programmer, while in the TRS-80 this area of memory is used by the operating system. So before using these commands, be sure you know a little bit about how both your computer and the one the program was written on are organized.

Finally, different computers have additional commands designed specifically for their own hardware configuration. The Apple-II for example has several commands, designed to be used in its low- and high-resolution color graphics modes, that would be meaningless on another machine.

## FORTRAN

One of the earliest and still very widely used, high-level, problem-oriented languages is FORTRAN (*Formula Translation*). Developed in the mid-1950's by a group of several firms headed by Jim Backus of IBM, FORTRAN took three years of effort involving some 25,000 lines of detailed machine instructions.

FORTRAN is always compiled, never interpreted. FORTRAN compilers are available for just about any computer manufactured in the world.

As its name implies, it was intended for use on mathematical and scientific formulas. However, its applications became more diverse due to its early acceptance at colleges and universities where computers were introduced to the student body. As graduates with knowledge of computers and the FORTRAN language went into the business world, they proceeded to solve business problems with variations of FORTRAN.

In a steady, evolutionary manner, FORTRAN has been expanded into an extremely powerful language and its name has been modified to FORTRAN I, FORTRAN II, FORTRAN IV and FORTRAN 77. A high degree of standardization has taken place over the years so that a program written in FORTRAN IV will perform properly with most FORTRAN IV compilers.

FORTRAN, although geared for complex mathematical assignments, is rather straightforward in its approach. For example, to solve  $X = A + B$  when  $A = 3$  and  $B = 5$ , the instructions would read  $A = 3$ ,  $B = 5$ ,  $C = A + B$ , STOP. These source instructions would, in turn, be trans-

lated by the FORTRAN compiler into machine language to execute the step to solve the problem. An actual FORTRAN program is listed in Table 5. This program is identical to the BASIC program listed in Table 2.

A compiler to handle a FORTRAN IV language is quite extensive. Not only must it handle a considerable number of mathematical operations, but it must perform such math functions as trig, square roots, exponentials, complex numbers, and logarithms. It must also manage to cope with strings of numbers and letters and lengthy mathematical arrays.

In FORTRAN, a number can be represented as a fixed point or as a floating point. A fixed-point number must be an integer or whole number and can be positive or negative. A floating-point number is similar to scientific notation where "number" may be expressed as a number from 1 to 10 multiplied by some power of ten; 580 could be expressed as  $5.8 \times 10^2$ . A floating-point number always includes a decimal point; a fixed-point number does not.

FORTRAN includes provision for two other types of numbers: constants and variables. A constant maintains the same value during the program execution while a variable can be assigned different numerical values while computations are being performed. The name assigned to a variable can include up to six characters and is selected, where possible, by the programmer for his ease in remembering its meaning. For example, SQRTF signifies square root.

The basic mathematical symbols for FORTRAN operations are:

- Addition +
- Subtraction -
- Multiplication \*
- Exponential \*\*
- Division /

For example, to indicate 2 raised to the 3rd power, we use  $2^{**}3$ . As with standard math notation, parenthesis are used for groupings; For example:  $(2 + 3)$  raised to the 3rd power is written as:  $(2 + 3)^{**}3$ .

Input-output statements in FORTRAN are expressed as READ, WRITE, PRINT, PUNCH and FORMAT (this describes how the output information should be accepted). A GO TO statement informs the computer to execute an instruction or statement other than the next statement in sequence. An IF statement provides for a conditional transfer of control, or proceed to another statement if specific conditions are met. An END statement informs the compiler that the program is completed.

## COBOL

COBOL (Common Business Oriented Language) was developed in 1960 by the Department of Defense together with users and manufacturers of computers. Its purpose was to handle relatively large volumes of business information for rather simple applications. The intent was to enable non-programmers such as accountants and clerical staff to express their business problems in English. For example, if a clerk wants to know the value of present stock in inventory, the COBOL statement would request "COMPUTE STOCK VALUE," leaving no doubt of the meaning to the human. A COBOL compiler in the computer would convert the statement to the necessary machine-language instructions required to initiate the actions.

The basic COBOL vocabulary consists of 250 key words; additional words can be created merely by specifying names for data and instructions.

Scientific applications generally require complex steps and considerable calculations, but have few input and output demands. Business applications, on the other hand, demand considerable input and output with relatively little computation. COBOL is designed to handle extensive filing on punched cards, tapes or magnetic disks.



Another significant difference between a scientific and business application is the repeated use of a particular program. Scientific programs may be developed for a particular problem, used for awhile and then become obsolete. A business program, on the other hand, is often repeated and used over a considerable period of time; for example, a payroll program may be used every week for years with only minor modifications for tax-rate alterations.

Since COBOL statements are expressed in a language very close to commonly-used English, its programs can be shared by many users with little chance for confusion. Every COBOL program has an Environment Division describing the computer used to compile the program and to run the program. Thus a COBOL program can be compiled on one computer and run on another completely different machine. It is also possible to interchange input and output equipment, a convenient feature since the program can be run even if the system printer becomes defective and a different model is the only available unit on hand.

COBOL's major attraction is its ability to handle large amounts of records and data, making it ideal for reporting and record manipulation. In applications where complex calculations and business decision-making is involved with such record keeping, it is not unusual to use both FORTRAN and COBOL languages, separately of course, to achieve the required results.

Since COBOL is intended for business applications, its language resembles a sequence of English words, used as variables for its mathematical applications. Thus, COBOL is concerned with rules for nouns, verbs and punctuation.

A COBOL program consists of four elements or divisions: (1) Identification, which provides a name for the source program, (2) Environmental, which identifies the computer to compile the source program and run the object program, (3) Data, which defines the files of data to be worked with or prepared by the program, and (4) Procedure, which specifies the steps the computer will execute. Precise rules dictate the reference format (spacings, margins, etc.)

COBOL's English-like sentences make it relatively simple to describe the data to be used and the operations to be performed. Of course, a clear analysis of the problem is necessary before the program can be written.

A simple COBOL program to calculate 2 multiplied by 3 might look like the program in Table 7.

**TABLE 6—ADDITION of two numbers in COBOL:**

```
ADD 2 TO 3 GIVING A
MOVE A TO PRINT LINE
WRITE PRINTREC
```

**TABLE 7**

```
IDENTIFICATION DIVISION.
PROGRAM-ID. SAMPLE COBOL.
AUTHOR. THOMPSON.
DATE WRITTEN. JULY 2, 1979.
REMARKS. SAMPLE PROGRAM COMPUTES
        AND PRINTS PRODUCT OF 2 AND 3.
ENVIRONMENT DIVISION.
SOURCE COMPUTER. IBM-360.
OBJECT COMPUTER. IBM-360.
DATA DIVISION.
WORKING STORAGE SECTION.
43 NUMBER ONE VALUE IS 2.
43 NUMBER TWO VALUE IS 3.
PROCEDURE DIVISION.
CALCULATION. COMPUTER TOTAL =
        NUMBER ONE * NUMBER TWO.
        DISPLAY TOTAL. STOP RUN.
END PROGRAM.
```

Although the program appears quite detailed for the short example used, the words are simple for even a novice to figure out what the computer is being asked to do.

### Pascal

Writing a large program is considerably harder than writing several smaller programs; thus, a large program requires detailed organization and systematic procedures. Structured programming is a technique used to handle such large projects as an airline reservation system or a fully automated warehouse. The objective of structured programming is to make program structure simpler using a series of simple sequences of operations; in this way errors can be precisely located and corrected before the entire lengthy program is completed.

A language geared to structured programming is Pascal, developed in Switzerland in the early 1970s. The language is simple and efficient and its compiler is not complex, making it attractive for manufacturers of mini- and micro-computers. Its creator, Professor Wirth of Zurich, gathered together useful features and instructions from existing successful languages to simplify the task of writing large, complicated programs. For example, a Pascal program is closer to plain English than BASIC.

**TABLE 8—ADDITION of two numbers in Pascal**

```
(* ADDITION OF TWO NUMBERS IN PASCAL *)
PROGRAM ADDITION (INPUT,OUTPUT)
VAR SUM: INTEGER;
BEGIN (* ADDITION *)
    SUM := 2 + 3;
    WRITELN (SUM)
END. (* ADDITION *)
```

Pascal is rapidly becoming a popular language among manufacturers of microcomputers and thus may eventually become a more common language for smaller systems and computer hobbyists than is BASIC. For comparison the same program written in BASIC in Table 2 is shown written in Pascal in Table 8.

In summary, there are quite a number of computer languages in existence today. The question of which language is best is no different than asking a TV serviceman which of his tools is best: the VTVM, the scope, the VOM, or perhaps even his diagonal cutters? A computer language is also a tool.

For a particular business application, COBOL may be the first choice, while FORTRAN wins out for an engineering problem. With limited computer size, BASIC may turn out the only alternative for a particular problem.

Just as computer hardware manufacturers proceed at a fast clip to improve their products' performance and capabilities, so too will programmers expand their thinking to produce more efficient and creative languages. **R-E**