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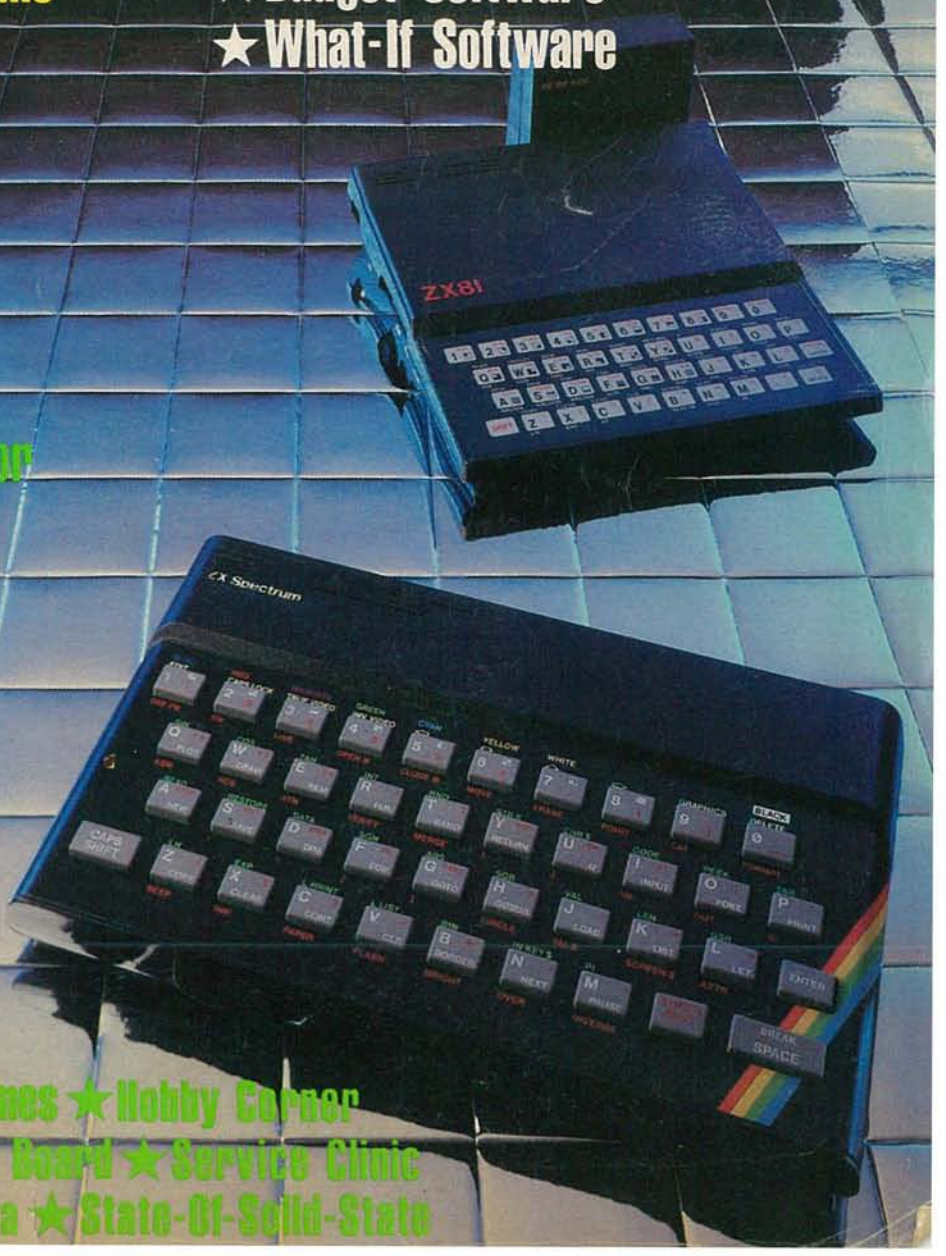

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ON THE COVER

The fascinating world of microcomputers—whether it be a simple entry-level machine for education or entertainment, or a complex, full-featured computer for your business—there's something there for everyone. And there's something for everyone in our Special Section, "Your Own Computer." This month we take an in-depth look at the hardware and the things you should know before you buy. To round things out, "Your Own Software" takes a look at one of the most popular types of software—the electronic spreadsheet—and a look at some software you may never have heard of, but that's surprisingly useful and/or inexpensive. It all starts on page 57.

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VIDEOGAMES

New life for your Atari *2600*

DANNY GOODMAN, CONTRIBUTING EDITOR

DEDICATED ATARI *2600* ENTHUSIASTS become defensive whenever friends carry on about one of the many systems now on the market that offer arcade-like graphics. By comparison, the *2600* seems a generation or two behind. Even after some wonderfully detailed graphic executions like Parker Bros.' *Frogger*, Atari's *Defender*, and Imagic's *Demon Attack*, the *2600* still lacks the "flash" of the *Intellivison* from Mattel, and the newer systems by Atari and Coleco. That is, however, only until you plug Starpath's *Supercharger* into the cartridge slot (see Fig. 1). It's like discovering a completely new game system, and the cost is only about $70.

FIG. 1

One of Starpath's (formerly known as Arcadia) founders, Bob Brown, is an ex-Atari engineer who had a lot to do with the design of the *2600*. As such, it's not surprising that he's very knowledgeable when it comes to working miracles with that console.

Simply put, the *Supercharger* expands the part of the console's memory that creates a graphic image and sends it to the video screen. The *2600* by itself has only enough "screen memory" to handle new video information every other horizontal scanning-line (a TV picture is made up of a few hundred such scanning lines). Thus, the smallest video element is two scanning lines thick. The *Supercharger*, however, supplements the screen memory to accommodate new video information on each line, greatly improving the graphics resolution.

But the hardware—the *Supercharger* unit itself—is only a small part of the story. First, let's clear up a misconception among many game players—and even retailers—about standard game-cartridges for any home videogame. For one reason or another, perhaps because they resemble the old 8-track tape cartridges, the videogame cartridges are often referred to as "tapes." They are nothing of the sort! I don't recommend it, but if you were to open up a game cartridge, you would see a small circuit board, one or two integrated circuits and perhaps a few other components, but no tape. The IC's are, of course, ROM's, and they store the game program. When the cartridge is plugged into the unit and the game is switched on, the contents of the ROM's are downloaded into the console's main memory and the game begins. And so it has been, until Starpath.

With the advent of the *Supercharger* comes a program-loading technique new to home games, but well known to home-computer hobbyists: downloading from a cassette tape. All you need is a cassette player into which you plug the cable coming out of the *Supercharger*. Turn on the *2600* and TV (the *Supercharger* gets all its power from the *2600*) and you are prompted on the screen to rewind the tape and press PLAY. In about 30 seconds, the screen fills up with color and you're instructed to stop the tape. Presto, you're in the game.

Game play, though, is what makes or breaks a system. And, on that score, Starpath comes through with flying colors. The tape packed with the *Supercharger* is called *Phaser Patrol*. Similar to *Star Raiders* (Atari) and *Star Master* (Activision), *Phaser Patrol* puts you at the helm of a space fighter whose goal is to clear 36 galactic sectors of enemy squadrons. Your on-screen control panel makes full use of the super graphics with sharp, clear status indicators, digital readouts, and a graphically unique relative-time keeper. Flip the COLOR/B + W switch on the *2600* console, and an ultrafine sheet of dots slowly fills your viewing area, indicating that your "shields" are on.

The game play is fast, and is sure to keep your attention. If you "survive," you are rated according to your expended time and energy. I prefer this space simulation over any other for the *2600*, and I place it just a notch under the version for the Atari *400/800* computers.

More recently, Starpath has taken full advantage of its cassette-loading technique with games that require multiple loading as you master each level. It is really like getting two or three complete games on one tape.

Dragonstomper may become a cult classic among home-videogame addicts. It's a graphic adventure-type game in which the player fights several different kinds of enemies, and explores various buildings in search of gold and a scroll to gain access to the next level. When those have been found, you do another load and begin trading and buying provisions for the third and most dangerous part of the journey. The final phase (this is a three-load game) is a completely different screen layout with almost insurmountable hazards on your way to face the dragon. In the tradition of adventure-type games, instructions are minimal, so be prepared to spend many hours finding your way around using trial and error.

As cassette tapes are less expensive to produce than ROM cartridges, games range in price from $14.95 to $18.95. And when you consider that, for the most part, the games offer better displays and more involved play than the $35 high-end cartridges, suddenly the initial $70 investment for the *Supercharger* and *Phaser Patrol* doesn't look so bad.

Astrocade's The Incredible Wizard for Astrocade

LIFE FOR THE *ASTROCADE* (FORMERLY *Bally Arcade*) console and its owners has not been too easy of late. For one thing, there have always been pretty slim pickings when it came to cartridges. For another, the manufacturer's (Astrocade, Inc.'s) precarious financial situation, which has become common knowledge in these past few months, has put the future of the machine in doubt. However, to paraphrase Mark Twain, reports of its death may have been greatly exaggerated. The company, at press time, was undergoing reorganization and is hopeful that it can continue producing the console and even introduce some new cartridges in the near future.

In any event, most of the cartridges that

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VIDEOGAMES

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CIRCLE 101 ON FREE INFORMATION CARD

do exist are of high quality, owing largely to the vast graphics and sound resources of the *Astrocade* console electronics. One such cartridge is *The Incredible Wizard*, Astrocade's home version of the mildly successful Midway arcade game, *The Wizard of Wor*.

The game can be played by either one or two persons.

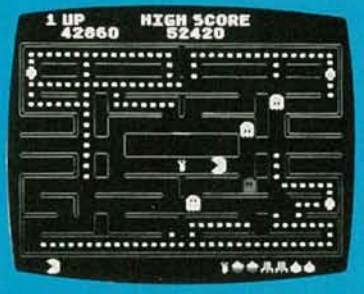
In the game, your warrior descends through many different mazes, battling three different kinds of creatures. The farther you get in the game, the faster and more numerous the creatures become. Some of the creatures are invisible unless you're in their line of sight (when it may be too late), so a radar screen without maze walls indicates the approximate locations of the unseen menaces. When all the creatures have been blasted by your "concentrated unified-field-disturbance rifle" the flying Worluk appears. You've got to shoot him before he either runs you down or escapes through one of the side escape doors. If you get him, the next maze scores double point-values. At random maze levels, the hooded Wizard will appear, racing about like crazy, hurling lightning bolts. If you are good enough to shoot him, you'll exprience a fantastic light and sound show as the dungeon trembles, and your next maze will be worth quadruple points. At higher levels, mazes show up that have no visible walls. As in the arcade game, those are called Pits.

Graphic detail is fine enough to see that your warrior is suited up in a helmeted space suit with a back pack. When he shoots, the kick from the rifle blast sets him back on his heels for a half second.

A diverse sound package adds to the appeal of the cartridge. The chirp-like sound of some of the creatures, the rifle blasts hitting a target, the disorienting sound of the trembling dungeon, and musical interludes all help to keep things interesting.

In many respects, including *Astrocade's* rather nice hand controller, *The Incredible Wizard* is much more enjoyable than its arcade ancestor.

Atari's Pac Man for Atari 5200



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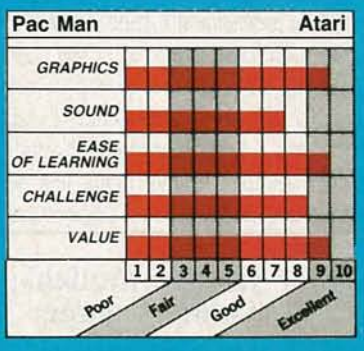

ATARI'S NEW *5200* GAME SYSTEM has the advantage of having some of the best home versions of arcade classics in its cartridge library, and *Pac-Man* is no exception. Arcade addicts who were disappointed with Atari's version for the *2600* will have little to complain about in this rendition. The game designers took great care in copying arcade features such as board-level indicator (standard fruit symbols until you get near the top range—where an Atari logo is the symbol—and keys at highest range); bonus point symbols appear under the monster pen twice during each board; monster "blue time" varies as difficulty levels increase (including some where there is no blue time); 1UP, 2UP, and HIGH scores are shown; maze walls flash between levels; etc. Even intermissions appear between some levels (something even the Atari home computer Pac-Man cartridge doesn't do).

The basic difference between the home and arcade versions is that some of the arcade sounds are missing, like the "wocka-wocka-wocka" of Pac-Man eating dots and the sound of a deflating Pac-Man that's been captured by a monster. Another minor difference is that the monitors used in the arcade version were oriented vertically, while your home color-TV display is horizontal (because your TV is wider than it is tall). But, while the maze is slightly different, it's just as challenging as the original.

A tendency you'll have to overcome is working the joystick too hard. It's not easy when all four monsters are after you and you're a long way from an energy pill, but the controllers on the *5200* need only a very light touch to get Pac-Man moving in the right direction. But for about $40 on the $250 console, you've got the closest thing to the $2500 arcade game you can get. **R-E**

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Radio Electronics YOUR OWN Computer APRIL 1983

Computer Basics

Are you considering buying a microcomputer? Then, you should first learn how a microcomputer operates. Once you have even a basic understanding, it is easier to ask the right questions when it comes time to buy the system.

MARC STERN

IN WHAT HAS SEEMED LIKE AN EXPLOSION, THE COMPUTER revolution has arrived. In only the last eight years, the personal computer has moved from the province of hobbyists and "hackers" to take a place in business offices and—what has really made it a revolution—the computer has moved into thousands of homes.

Whether that has been due to the videogame explosion, or the marketing efforts of major manufacturers, or the public's recognition of the power and capability of the microcomputer, we will not go into. But, suffice it to say that hundreds of thousands of people, who, a few years ago, didn't know BASIC or the meaning of ROM or RAM (and maybe they still don't!), are now using personal computers.

And it seems that each week thousands more are jumping onto the microcomputer bandwagon. They are buying not only low-end, home systems, but also high-end systems such as the IBM *Personal Computer*. Further, it seems that for every person who does buy a computer, two or three more are considering a purchase. However, they are hesitating because they lack information—they have many questions that need to be answered. In the following pages we will attempt to answer some of those questions and familiarize you with some commonly-used terminology.

Overview of a computer system

For the first-time buyer, perhaps the best way to visualize a system is to break it into its major parts. In general, a computer consists of the CPU (*C*entral *P*rocessor *U*nit)—and the *motherboard* or system board that connects the CPU to other devices for input and output (I/O) and storage. Figure 1 shows a block diagram of a basic microcomputer system.

The CPU, which is sometimes called the MPU or microprocessor unit, is the "heart" of the system. But that by itself would not make a computer. It is also necessary to have, among other things, *memory*. There are two basic types of memories: RAM and ROM. RAM (*R*andom *A*ccess *M*emory) is memory in which data can be either *written* or *read*. It is like a large holding area of information. It either holds active information for immediate use, or it stores data for later use by the CPU. A ROM (*R*ead-*O*nly *M*emory) on the other hand is a memory that can only be read. Once the information is put in the ROM it cannot be changed. The mass storage device is another type of memory. An example of a mass storage device is the floppy disk drive, which allows you to store great quantities of information and programs on a magnetic disk.

A CPU with memory still does not make up a computer. There must be some way to input information to the computer and for the computer to output information. One way that is accomplished is by parallel and serial interfaces. Those interfaces connect the microcomputer to other devices such as printers, keyboards, etc.

That, then, is the basic outline of a personal computer. Of course, there is much more that we could have included, but for starters, that outline will suffice.

With those basic concepts established, let's look more closely at the personal computer, beginning with the CPU and progressing to the other areas of the system.

The CPU and bus structure

The CPU includes the microprocessor and any necessary support circuitry. The "standard" CPU is an 8-bit device (a *bit* is a binary digit). That CPU handles information eight bits (or one *byte*) of data at a time. (Thus the data bus shown in Fig. 1 actually consists of eight data lines.) A byte is often referred to as the "word size" of the microprocessor.

The address bus, on the other hand, consists of 16 lines. That lets the microprocessor address 2^{16} memory locations. Although 2^{16} is referred to as 64K (64 kilobytes), the actual number is a little over 65,000, because 2^{10} or 1,024 bytes of information is commonly referred to as 1 kilobyte or 1K of information.

The third standard microprocessor bus is the control bus. It consists of from 10 to 12 lines, depending on the particular CPU. It is mainly used to carry synchronization signals between the microprocessor and other system components. Typical signals are: read, write, interrupt, and reset.

With all of this said, a question probably has arisen in your

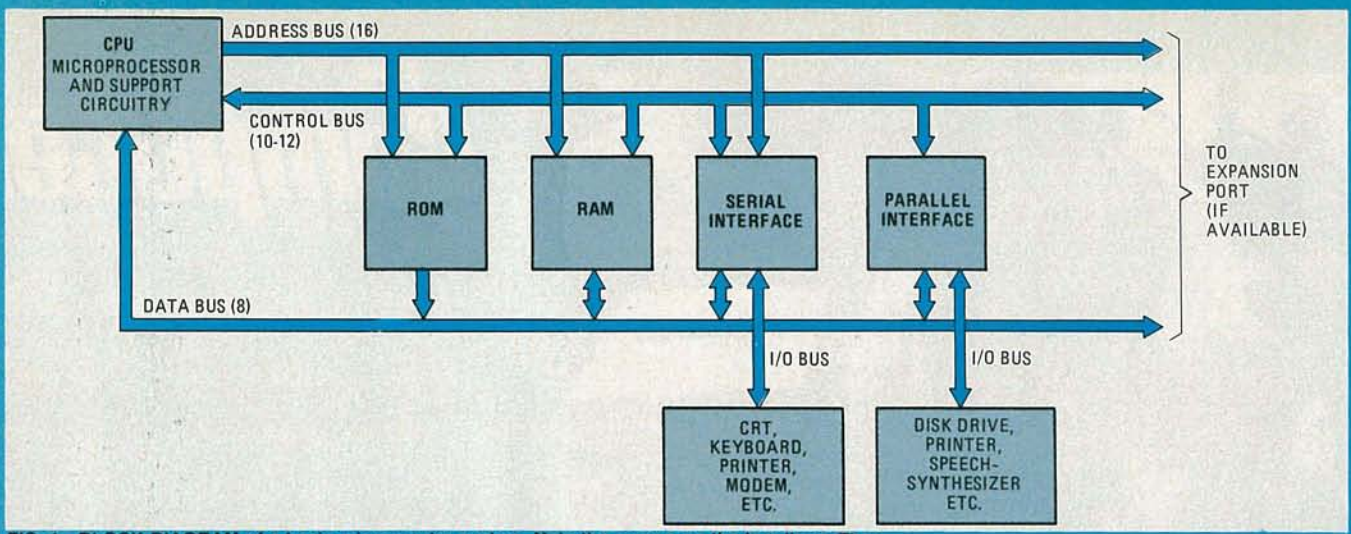


FIG. 1—BLOCK DIAGRAM of a basic micromputer system. Note the arrows on the bus lines. They indicate the direction of information flow.

mind as to which type of CPU is best. The answer is that for most personal computing uses, it makes little difference what type of CPU is used. In a given situation, a 6502 will work just as well as a Z80 or an 8080.

There is a "but" in this situation, though, and that is for the computer user who wants access to, say, the broad range of CP/M programs. CP/M (*C*ontrol *P*rogram for *M*icrocomputers) is the standard *operating system* of the 8-bit-system world and many business programs are written under it. It was written for the 8080 series of microprocessors and is also compatible with the Z80 series. Thus, if you want access to those programs you must use one of those microprocessors. There are *emulators* that allow you to use CP/M with other CPU's, but the programs will work slower when that is done.

We will not discuss operating systems in great detail. What we will say is that the operating system effectively isolates the computer user from the computer hardware. It also makes the particular computer "invisible" to the software. What that means is that if two different computers—even with different microprocessors—use the same operating system (say, CP/M) they will both be able to run the same software, as long as the software is written for that operating system.

The CPU world is changing. Although it is still dominated by 8-bit microprocessors, 16-bit systems are starting to appear in increasing numbers. Chief among the 16-bit units is the 8086/8088 family, which is capable of running under the MS-DOS operating system. That is the operating system that has been adopted by IBM. Because so many systems are being designed to run under it, it is likely that MS-DOS will become the "standard" of the 16-bit microcomputer world. However, a 16-bit version of CP/M—CP/M-86—may give MS-DOS a run for the money.

Memory

Although we previoulsy mentioned ROM and RAM, we did not say what each one was used for. First, we'll give an example where you would want to use read-only memory (ROM).

There are some programs that you would never want to change. An example is the bootstrap loader routine (that program gets the system up and working when the computer is first turned on). That routine is stored in ROM. ROM, as its name implies, is not user-modifiable (you cannot *write* to it). It is important to note that ROM also is *non-volatile*. In other words, ROM will not lose its memory contents even if the power is turned off. Another example of where ROM is used is in videogames. The program that runs the game computer is stored in the videogame cartridge in ROM.

The contents of RAM, on the other hand, are constantly changing. It is in RAM that you would store, say, a BASIC program. RAM can be thought of as the microprocessor's work space. It is essential to a micrcomputer because the system needs a way to store and frequently update information as it is used. RAM is volatile; when power is turned off, the contents of the memory will be lost—unless you record it on disk or other storage medium.

One of the most often asked question by the first-time microcomputer buyer is how much RAM is sufficient? The answer is as much as you can comfortably afford—but there is no such thing as enough memory. A bare minimum, good for games and some applications programs, is 16K. However, 48K or 64K is a much better place to start. No matter how much memory you have, though, sooner or later you're going to run up against a program that needs more memory. Or, you may use a program, which, while it runs with the memory you have, it would perform better with more memory.

Inputs and outputs

There has to be a way to communicate with the computer, and for the computer to communicate with you. The communication is called input and output (I/O). Let's now look at some possible inputs.

First, we'll look at the keyboard. When you input data via the keyboard, the information is first sent to the *keyboard processor*, where the electrical impulses that are generated by the keys are turned into codes that can be read by the microprocessor. Once the keystrokes have been encoded, they are then directed not only to the display, but also to RAM where they are stored until they are processed by the CPU.

Another possible source for an input is a mass storage device, such as a disk drive. The data stored on the floppy disk is first read by the read/write head and is then sent on its way to the system bus. The data may either be used immediately by the CPU or it might be stored in RAM until it's called by the CPU.

Other inputs can also be entered via the input/output interfaces (I/O ports). There are two basic types of interfaces: *parallel* and *serial*. A parallel port transfers the data eight-bits (one byte) at a time. A serial port transfers the data one-bit at a time.

In a microcomputer system, input is generally handled via a serial port, while output-only is usually handled by a parallel port—although either port can be used for both input and output.

One example where you would use a serial port for information input is for connection to a modem (*MO*dulator/*DEM*odulator). With a modem, it is possible to communicate with other computers using a telephone line. (See article on modems, elsewhere in this section.)

That pretty much completes the general picture of the input side of the microcomputer, but that is only half of the picture.

We must take a look at how data is output.

Again the two ports, parallel and serial, are used for output. When a user decides to output something to a printer for hard-copy purposes, he requests that action from the CPU. That keyboard request is then processed and the CPU searches RAM for the information to be output through the printer. When that information is found, the CPU not only flashes a message on the CRT, but it also sends the information to the port that is to be used. If the data arrives too quickly for the printer to handle, the overflow is shunted into a *buffer* where it is stored until the printer or plotter can handle it. Either a parallel or serial port can be used for output to the printer. However, a parallel port handles data much more speedily than a serial port because the data is transferred eight bits (one byte or word) at a time. However, there are disadvantages to using the parallel port. First, it is prone to picking up stray noise that can cause data-transmission errors. That is especially true if you are trying to communicate over long distances.

A second disadvantage is that there is no set standard for parallel ports—each microcomputer manufacturer has his own idea of the type of interconnection to use with a printer or other parallel device. Of course, there is the Centronics-compatible standard for printers, but once you have wired up a connector for such a device, you will find that about the only thing agreed upon with this standard is the type of connector. It seems that each microcomputer handles things just differently enough to cause problems. Another standard parallel interface is the IEEE-488 bus. That bus is most commonly used for scientific peripherals.

The more reliable, although slower, interface is the serial interface. That type of interface uses fewer wires and is much less sensitive to stray noise pickup. Further, since fewer wires are used, cabling costs can be reduced. The key disadvantage when compared to parallel transmission is its speed. It is slower because information is sent serially—one bit after another.

There is a standard to cover serial communications interfaces and make them all compatible (the RS-232C standard). However, while the RS-232C protocol is standard, some manufacturers do not use all of the lines, and others may tie some lines high or low. Keep that in mind when interfacing peripherals.

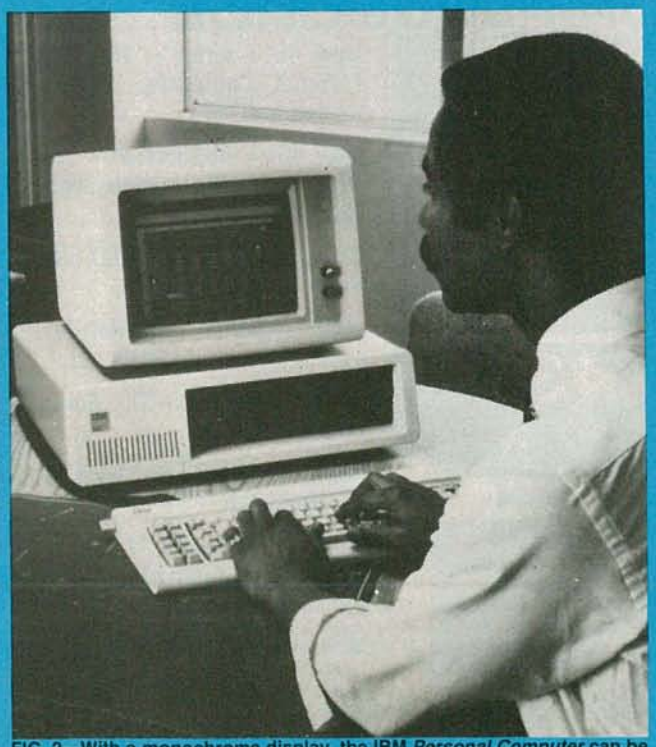


FIG. 2—With a monochrome display, the IBM *Personal Computer* can be used for word processing or other applications that require high-resolution graphics. (See Fig. 3.)

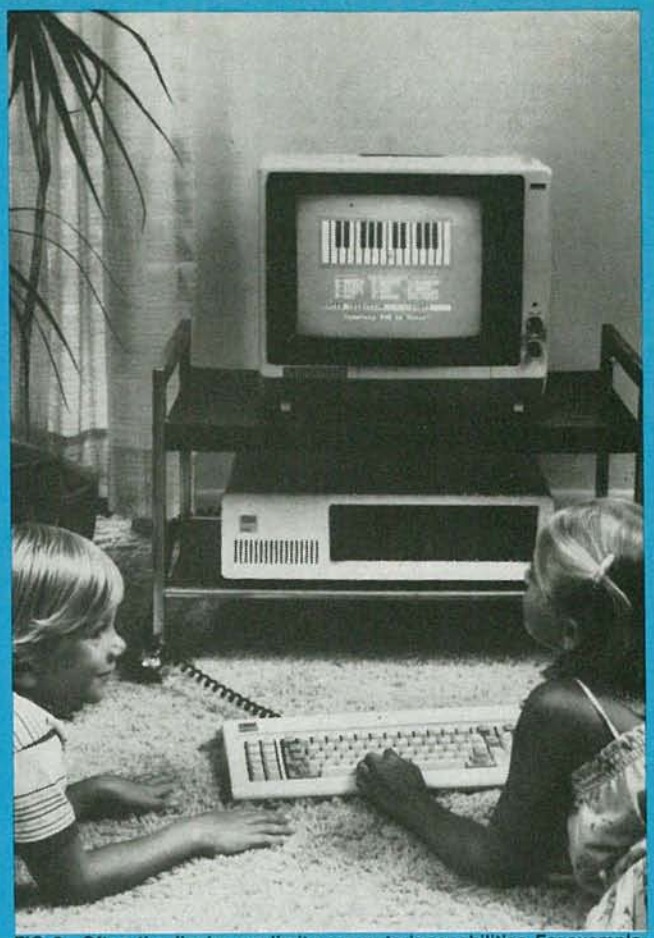


FIG. 3—Often, the display can limit a computer's capabilities. For example, when used with a TV, the IBM *Personal Computer* cannot be used for word processing. (See Fig 2.)

Other considerations

There are other questions that you should ask yourself before buying a personal computer. Of course we cannot cover all situations here, but we will give some examples of things you might want to consider.

Many computers are meant to be used with a TV. That, while reducing the cost of the system, is not all that desirable. The limited bandwidth of the TV does not allow it to reproduce high-resolution graphics. (See Figs. 2 and 3.)

What, then, is the best display? That very much depends on what you plan to do with with the computer.

Let's first presume that you want to use your computer mainly for word processing and record keeping, and thus do not need a color display. Then, the question you should be asking is what type of monochrome (single color) display you should use. Experts have long noted that a black-and-white display is the hardest on the eyes. Although it is highly visible, that type of display is the most fatiguing to use. A green-on-black monochrome display is better on the eyes. It is easier to read and use under conditions of glare, and it is much less fatiguing. There is a current controversy, however, about whether an amber-on-black display is easier on the eyes than the green-on-black. In fact, just about all of Europe has mandated the amber-on-black type of screen format. In reality, though, the jury is still out on the question and it is probable that both displays will come out about even in the final analysis. Definitely, though, either is better than a black-and-white display.

Whichever type of display you choose, it should be capable of reproducing 80 columns by 24 lines of text for word processing. The reason is that that is the industry standard and it is also about the number of columns you can reasonably expect on an average piece of paper.

There are systems which only display 40, 52 or 60 characters and those require special add-on boards to make them capable of 80-column display. Further, many of those units generate capitals-only, which makes them almost useless for true word processing, unless the correct hardware fix is made.

Perhaps you plan to use the computer to generate color charts and graphs, or for other color computer graphics. Therefore, you need a color monitor (of course your computer must be capable of generating color graphics to use that). Although some color computers can use a color TV for a display, a monitor with R-G-B (*R*ed-Green-*B*lue) inputs should be used because it permits higher-resolution graphics. A color TV, because of its narrow bandwidth, is not capable of high-resolution graphics unless it is modified.

Of course, a monitor cannot reproduce high-resolution graphics if the computer cannot generate them. Conversly, it is important to remember that the monitor should be capable of reproducing the graphics that the computer can generate.

Don't forget the keyboard; it should be typewriter-like in its features. That's because that type of keyboard is one with which most of us are familiar. Try to avoid those keyboards which have nonstandard placement of important function keys. A useful convenience on a keyboard is the separate numeric keypad. If you do a great deal of number entry, that feature is a necessity more than simply a convenience.

Another feature that you might find convenient is a detatchable keyboard. That would allow you to use the keyboard in your lap or to move it to a convenient place on a desktop. However, on some systems, that's not possible.

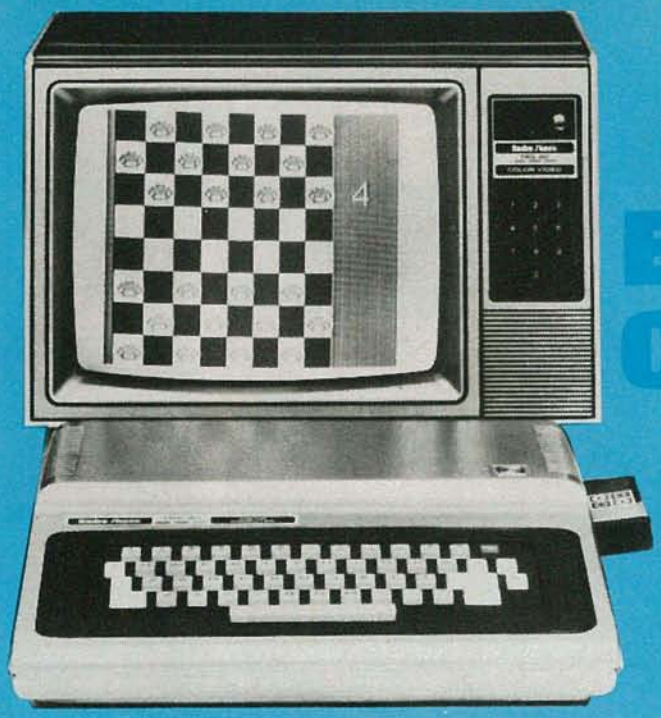
Do not forget some type of mass storage device when shopping for a computer. Two popular mass storage devices are the disk drive and the common cassette recorder. Although you might be able to get along for a while using a cassette recorder, you will really need a disk drive if you want to use your computer for serious applications. To handle as much information as possible, double-sided, double-density drives are preferred for mass storage. However, if those are beyond your means, make sure the single-sided drives you buy are at least capable of double-density data encoding. It gives you far greater data storage.

The microprocessor that the computer is based on can be important. There is no definitive "best" microprocesser. As we mentioned before, though, if you want access to the wide spectrum of CP/M-based business programs, then your obvious choice is a Z80 or 8080-based system because these are the microprocessor units for which the CP/M operating system was devised.

What about the 16-bit CPU's that are becoming more popular? You've probably heard that 8-bit systems aren't as capable as 16-bit devices. In truth, the answer is that the microcomputer industry still hasn't taken advantage of the full power of the 16-bit CPU and most of the programs those systems run are really rewritten 8-bit programs. Eight-bit microcomputers will perform for you equally as well in a single-user situations, so don't worry about it. However, the 16-bit CPU does have an advantage in that it can address more memory—it can address more than 16 megabytes, while the 8-bit CPU is limited to 64K.

What peripherals are most necessary and useful? Probably the first item you should choose is a good printer. The second should be a good modem. Those will allow you to have not only hard copy printouts, but also with the modem you will be able to have access to remote databases, friends' computers, and information services.

Microcomputer buying doesn't have to be frustrating. The key to making it easy is to learn and to take the time to ask questions. Then, you have to ask yourself what you really need. Once you know the answer to that, you'll be able to join the microcomputer revolution that is here—to stay. **R-E**



Entry-Level Computers

If you want to learn about computers and programming, but are not interested in paying a large price to own your own system, take a look at some of these "entry-level" computers. For learning purposes, they offer a value that is hard to beat.

HERB FRIEDMAN

NO MATTER WHERE YOU WORK, OR WHAT YOU DO, ONE THING has now become very clear—your chances for advancement, promotion, or making a success of your own business may depend on how well you adapt to, or understand, modern computerized equipment and programs. Sorry to say, you will not be able to sit out the computer age—even just trying to prove the bank made an error on your checking account will require some understanding of the type of errors computers make.

Start small

Of course, the best way to learn what computers are all about is to simply use one. Unfortunately, to most general-audience newspapers and magazines that usually means a "minimal system" consisting of a color computer with at least 48K of memory, two disk drives, a printer, a color monitor, and about $3500 to pay for it all—anything less "simply isn't worth the expense." In truth, by using a rock-bottom-priced "entry level" computer—a model specifically intended for someone getting started in personal computing—you can attain "computer literacy" for as little as $85; and by the time you're finished you'll have an excellent understanding of how computers and their programs work. You'll also be able to program in BASIC quite competently.

Many of the best known consumer-electronics and personal-computer companies provide models specifically intended for the newcomer to personal computing: among them are, Atari (1265 Borregas Ave, Sunnyvale, CA 94086), Commodore (487 Devon Park Rd., Wayne, PA 19087), Radio Shack (One Tandy Center, Ft. Worth, TX 76102), Texas Instruments (PO Box 225012, MS-84, Dallas, TX 75265), and Timex/Sinclair. Except for the computer from Timex (1579 Straits Turnpike, Middlebury, CT 06762)—the Timex/Sinclair *1000*, perhaps bettter known as the Sinclair *ZX81* (50 Staniford St., Boston, MA 02114)—all entry-level computers are "color computers" that can generate multi-color backgrounds, characters, and graphics, although the nature of the color capability varies from model to model. And, again with the exception of the Timex *1000*, entry-level computers have some form of a musical-tone generator that allows the user to create sound effects for games, or even compose music.

While each manufacturer agrees that computer literacy starts with an understanding of BASIC programming, that's one of the few areas of agreement. As you'll see, each has its own ideas about what an "entry-level" computer should offer. Neither their software nor peripherals (accessory equipment such as printers, modems, etc.) are interchangeable. Also, in most instances, most popular peripherals cannot be used at all without purchasing a relatively expensive interface device. (We'll have more on that subject later.)

It's on TV

Though there are no standards as such, most models have several features in common. To start off, all use a standard TV-receiver for the display, and all come with the necessary switch-box so that the TV can function normally when the computer is not in use.

That display system works this way: A video modulator built into the computer, or one attached through a cord that provides the power and video from the computer, converts the computer's video output to an RF signal on TV Channel 2, 3, or 4. (Two of those three—usually 2 and 3 or 3 and 4—are provided; the user selects the channel not being used in his or her area.) The modulator is really a low-power TV transmitter that "broadcasts" the computer's output to the TV through a shielded patch-cord. As far as the TV is concerned, it is receiving an authentic TV signal so it displays the computer's output as a TV "picture." Also, sound effects and/or the output from the music synthesizers found in those computers are "transmitted" as a TV sound-carrier and are heard over the TV's speaker.

Whether the signal the computer receives is from the computer or a TV-antenna is determined by a switch-box as mentioned earlier. It's exactly the same as the ones provided with videogames: a small metal box with a slide switch that has connections for a TV antenna and the computer's output signal, and an output connection for hooking up the switch to the TV set (see Fig. 1). Whether the switchbox is intended for use with 300-ohm twinlead or 75 ohm coax, depends on the particular computer rather than the price. If you don't get the one you need with the computer, you can buy one at a nominal cost from an electronic-parts or video-tape retailer.

As to the type of TV set or monitor you need, a color unit is required only if you want to take full use of the machine's color

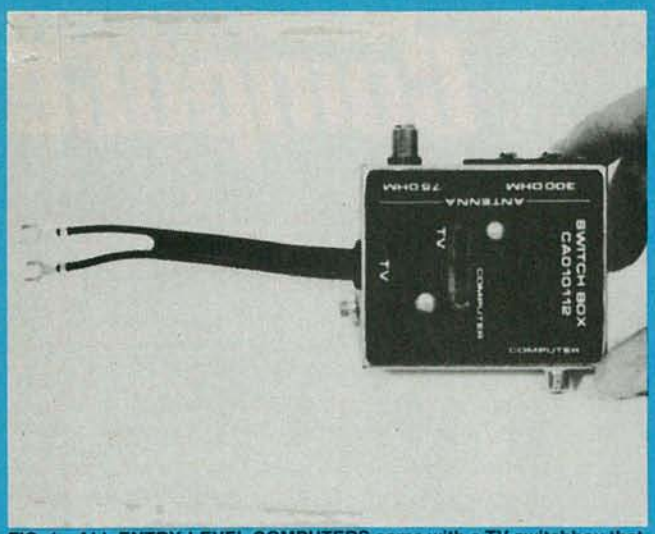


FIG. 1—ALL ENTRY-LEVEL COMPUTERS come with a TV switchbox that allows a standard TV set to serve as a computer monitor as well.

FIG. 2—ANY INEXPENSIVE CASSETTE RECORDER can be used with some entry-level computers. Others require a dedicated cassette-recorder that has a special connector that mates with a special socket on the computer as shown. Surprisingly, the dedicated recorders are an excellent value; they are well made and notably easy to use.

capability. Otherwise, a black-and-white unit will work perfectly well.

Another feature common to all machines of this type is a cassette I/O (*I*nput/*O*utput) connection. All entry-level computers provide some means for using a cassette recorder for mass data-storage. Programs and data written by the user can be saved (stored) on cassette tape, or pre-recorded programs and data can be loaded into the computer from a cassette tape. The cassette I/O connections on the Timex and Radio Shack computers are standard phono jacks, and virtually any cassette recorder—even a cheap $20 model—will work just fine. The Timex uses the least sophisticated system of all and the user must manually start and stop the recorder. On the other hand, the motor of a cassette recorder used with Radio Shack's *Color Computer* is under program (computer) control: It is started and stopped by the computer, or it can be manually controlled (whichever is more convenient for the user).

The computers from Atari and Commodore use what is known as a "dedicated" recorder, a model specifically intended for use with one or more of the manufacturer's computers (see Fig. 2). The dedicated recorders range in price from approximately $70 to $100, and while they aren't any more reliable than a $20 recorder, they can be more convenient because the recorder has been designed specifically for use with the computer. The dedicated recorder connects to the computer through a single cord that carries the input and output signals, the motor on/off switching, and quite possibly the power supply for the recorder. Depending on the model, most or all of the dedicated cassette-recorder's motor functions and video screen cues to the user are controlled directly by the computer; the computer even senses if the recorder is on-line and ready for whatever it's supposed to do. If it isn't, a screen cue to turn on the recorder appears.

Texas Instruments requires that you buy a special dedicated-cable if you want to use a cassette recorder for mass storage.

Another common feature is a port, slot, or connector for a plug-in ROM (*R*ead *O*nly *M*emory) module containing a complete software package (see Fig. 3). (Timex/Sinclair does not offer any of those ROM's, for the *TS1000*, but some independent manufacturers do.) When a program module is connected the computer "comes up" with the program rather than with BASIC. Software in ROM for entry-level computers is available for everything from arcade games, to home- and family-budget management, to elementary business programs, to high-fidelity system spectrum analyzers, to—well, you get the idea: just about anything you can think of is available. The advantage to ROM software is that it doesn't have to be loaded from tape or disk; simply turn on the power and it's running. The problem, however, is that the quality of ROM software ranges from absolute "garbage" to "decent," and it's almost impossible to know what you're getting until you buy it. (Did you realize that computer software is the only product sold for which there is no performance guarantee of any kind? Think about that.)

A lot for the money

Let's now take a closer look at what the entry-level computers have to offer.

For one thing, there's the price. To say that they are inexpensive is an understatement—they are, for the most part, an out-and-out bargain. At discount, prices range from about $80 for the Timex/Sinclair *1000* to perhaps $250 for the Atari *400*. (If you chose to pay a "suggested retail" price of $299 for a computer that can be purchased for as little as $179 maybe you need a computer to oversee your family's finances.)

Radio Shack's *Color Computer* is a somewhat special case, however, because it is sold only by Radio Shack and there is virtually no local competition between stores—although mail order is often discounted about 18%. To meet the competition from the other brands, Radio Shack has sharply reduced the price of their *Color Computer* models. You'll have to decide for yourself whether the higher cost for that machine is justified for your particular needs.

Keep in mind that the least expensive Atari package does not include BASIC; the computer comes with 16K of "empty" memory and BASIC is available in an optional extra-cost ROM module. The advantage to that, at least from Atari's point of view, is that a full 16K of RAM is available for arcade-game modules, and Atari has some of the very best games—such as *Missle Command*. Naturally, the cost of Atari's BASIC module is added to the cost of the computer itself.

Timex/Sinclair *1000*

The least expensive computer is the Timex/Sinclair *1000* computer. It features a very powerful, underrated built-in BASIC, and a membrane keyboard. The best way to describe a membrane keyboard is a plastic sandwich with switch contacts between the "slices." The corresponding "keys" are imprinted on the top directly over the associated switch (see Fig. 4). Obviously, one cannot touch-type on a membrane keyboard.

The only difference between that computer and the Sinclair *ZX81* is that the Sinclair version has 1K of built-in RAM while the Timex version has 2K. But that difference is more substantial than you might think—a skilled programmer can do a lot more with 2K of memory than he can with 1K. In any event,

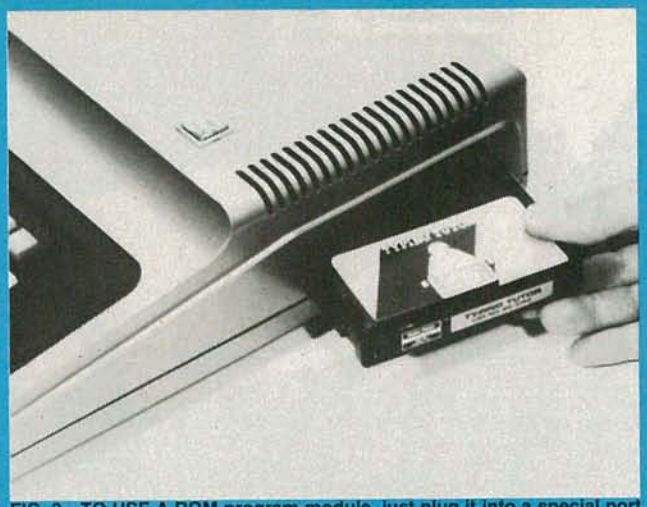


FIG. 3—TO USE A ROM program-module, just plug it into a special port, slot, or connector built into the computer. When the computer is turned on, the machine will come up running that program rather than the resident BASIC.

however, most will want to purchase the optional 16K RAM pack regardless of which machine is owned.

The use of a membrane keyboard would slow programming down to a crawl except for one thing: Every essential BASIC command (LOAD, PRINT, GOTO, IF, etc.) is entered at the touch of a single key. Each key has up to five functions and the computer automatically recognizes when the touch of a key should enter a command or a character. (I know that sounds unbelievable but it really works.) That automatic command-recognition is particularly valuable for young children learning programming. They can just key in the commands and learn to program much more rapidly than if they had to sweat out a precisely spelled key word.

The computer has an expansion port for, among other things, an optional 16K memory-module (about $45) that provides a total of 16K memory (not 2K or 1K plus 16K). Larger RAM modules are available from several independent suppliers.

Evaluating the computer overall, it is a wonderful trainer, for which some rather good software is available at a rock-bottom price (like $18 for a "Calc" type program). But before investing in any expansion peripherals other than the memory module, keep in mind that the lack of touch-typing is a serious limitation for advanced uses.

Commodore *VIC-20*

The Commodore *VIC-20*, which now sells at discount for about $179, is sheer dynamite for the money. It has an excellent version of MicroSoft BASIC, outstanding color capabilities, an excellent typewriter-style keyboard, expansion ports, a serial-output port, a plug-in ROM port, and a port for two game paddles. It comes with 5K of RAM, which is more than adequate for a good amount of moderately advanced programming. It has both a video and an RF output, which means that it can be connected directly to either a video monitor or a TV receiver. Compatible peripherals include additional memory, a printer, modem, cassette recorder, and a disk system.

Unfortunately, it uses an IEEE-488 output bus. To connect a "standard" Centronics-type printer it is necessary to go through the additional expense of an IEEE-488-to-Centronics-type interface. It's an extra cost that you must consider if you plan on expanding the system. On the other side of the coin, Commodore offers a relatively inexpensive plug-in modem. Commodore also sells a direct plug-in printer, but at last look it didn't use standard 8½ × 11-inch paper.

The manual gives excellent operating instructions, and has a great introduction to color-control, but says almost nothing about programming in BASIC; you must also purchase the Commodore book, *Introduction to BASIC Programming*.

FIG. 4—A MEMBRANE KEYBOARD such as this one used on the Timex/Sinclair *1000* (Sinclair *ZX81*) has character, graphics, and BASIC key functions imprinted directly on the membrane—there are no "real" typewriter keys.

Texas Instruments *TI-99/4A*

This Texas Instruments computer system, which when first introduced included a color monitor, started out with a price tag close to $1000. TI's latest version of their personal computer, the *TI-99/4A*, is sold without a monitor but can be purchased at discount for as little as $199. It comes with 16K of RAM and has expansion ports for ROM modules as well as for the usual assortment of peripherals. It also accommodates two game paddles.

The computer has an approximation of a standard typewriter-keyboard (see Fig. 5) that isn't as bad as it's often made out to be, but isn't all that good or easy to use, either. (Why TI, with years of experience in consumer electronics, chose to go with a non-standard typewriter-style keyboard remains one of the mysteries of merchandising.)

One thing TI has going for it is a tremendous assortment of software—over 1000 items at last count—available on cassette tape, disk, and in ROM modules. Texas Instruments has many years experience with their *Speak-and-Spell*-type devices and they know how to select quality software for children as well as adults. They also have separate classes—called "clubs"—for children and adults that teach about computers and programming for a very reasonable price; that's one of the real strong points of the company and the machine.

Texas Instruments has also just announced a new computer, the TI-99/2—the first 16-bit computer selling for less than $100.

FIG. 5—EVEN IF THE CHARACTER ARRANGEMENT isn't standard, as is the case in this Texas Instruments *TI99/4A*, typewriter-style keys are the easiest type to use.

FIG. 6—EXCEPT FOR THE ATARI *400*, entry-level computers have BASIC built in and "come up" in BASIC when the computer is turned on. The Atari *400* contains only memory and a small "start up" software routine. All software, including BASIC, is installed by plugging in a ROM module as shown.

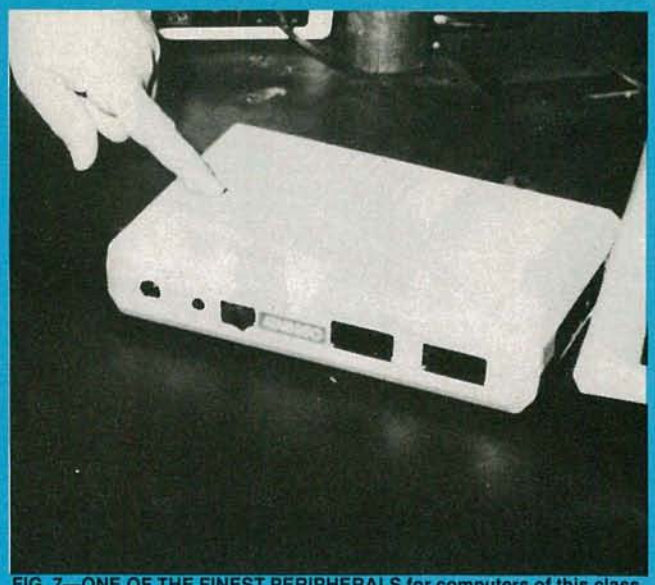


FIG. 7—ONE OF THE FINEST PERIPHERALS for computers of this class, the Atari *850* is more than worth the extra cost, as its four serial-ports and one Centronics-type printer-port allow for serious expansion.

That computer, designed primarily as a teaching computer, will also be well-supported with educational, personal-management, and entertainment software available both as plug-in cartridges and on cassette tapes. The TI-99/2 produces only a black-and-white display, but a 4-color X-Y printer/plotter is available.

Atari *400*

The Atari *400* is a personal computer with strong roots in the area of videogames. It has superb high-resolution color capability and videogames run on that machine look as good as they do in the arcade. As mentioned earlier, BASIC is optional and is supplied in a ROM module (see Fig. 6).

The computer has a membrane-type keyboard, but the "keys" are not only imprinted but indented. It looks almost like "the real thing," but the user still cannot touch-type. That is a serious limitation when programming in BASIC, because the commands must be spelled out.

There are provisions for four game-paddles. All peripherals, which include a modem and a printer, connect to the computer through an optional, accessory interface, the Atari *850*, shown in Fig. 7. The interface is an outstanding concept, even though an extra cost is involved. Among other things it provides four serial ports with programmable baud rates, and a Centronics-type parallel port.

An excellent assortment of game, educational, and general software is available, with more coming on-stream every week. Atari was a slow starter, but they now have a large, continuously expanding software selection. The only problem here is that if you're interested in the *400* you should really be looking at the Atari *800*, a highly under-rated computer with notably good features and performance. It does, however, sell for considerably more.

Radio Shack *Color Computer*

Finally, we come to Radio Shack's *Color Computer*. The lowest priced model, which sells for about $300, has 16K of memory, a good Color BASIC (Extended Color BASIC costs another $100), inputs for two game paddles, a serial port used for both a printer and a modem, and a socket for ROM modules and/or a disk system. Though priced considerably above other entry-level computers, it has the most potential for low-cost growth, and that's the reason we've included the machine in this survey.

Unlike the other entry-level computer manufacturers, Radio Shack's own software selection is relatively limited and somewhat elementary. Fortunately, there is an extensive software aftermarket for which Radio Shack has recently announced full, unfettered support. Some notably excellent software is rapidly coming on-stream.

Radio Shack, like the other computer manufacturers, has always tried to restrict peripherals to their own brand. One reason why Radio Shack computers have become so popular, however, is their inability to do it; aftermarket vendors have made Radio Shack one of the great names in personal computers. Not learning from experience, Radio Shack tried again to restrict peripheral selection for the *Color Computer* to their own brand. The serial output for a printer is a "Mickey-Mouse" circuit that works either with a $400 printer best suited for listing, or an $800 line printer. For those who prefer something inexpensive but great, like an Epson or Okidata printer, there's a *PC180C* parallel-printer interface from The Micro Works (Box 1110, Del Mar, CA 92014) that converts that output to standard Centronics.

While Radio Shack's own word-processing software for the machine leaves a lot to be desired (which is putting it kindly), *Telewriter* by Cognitec, (704 Nob Ave., Del Mar, CA 92014) turns the *Color Computer* into the lowest cost, high-performance word processor on the market (it works with virtually any serial or parallel printer—it restructures the machine's serial output).

The *Color Computer* is supplied with a notably excellent instruction manual for color BASIC (and Extended Color BASIC). Also, Radio Shack computer centers offer outstanding low-priced courses in elementary BASIC, advanced BASIC, and disk BASIC.

Summing up

All the entry-level computers will give you a solid foundation in computer fundamentals as well as in BASIC programming. If learning is your primary goal, and you have no interest in upgrading, then by all means purchase the lowest-cost computer. But if you plan to upgrade, to add peripherals such as a printer that can handle 8½ × 11-inch paper, or if you plan to experiment with complex home- and business-software, consider very carefully the cost/value ratio for the peripherals and software. As a general rule of thumb, the peripherals for entry-level computers—with the possible exception of the *Color Computer*—do not give the best performance for the lowest price. If you plan to upgrade, consider purchasing the least expensive version of a more advanced model. **R-E**

Radio Electronics
YOUR OWN Computer
APRIL 1983

Is an all-in-one computer system better than a component system? While there is no definite answer, we may be able to help you decide which is better for your needs.

MARC STERN

All-in-One vs. Components

THERE IS AN IMPORTANT QUESTION TO PONDER IF YOU ARE thinking of purchasing a microcomputer system—whether to buy a complete, turnkey (ready-to-run) system or to "build" a system from individual components. Each course has its advantages and disadvantages. We'll take a look at each type of system, the advantages and disadvantages of each, and propose some questions for you to ask yourself (and the computer salesmen) before you buy.

All-in-one systems

The greatest advantage to buying a turnkey system is convenience. In one package you get a keyboard, cathode-ray tube (CRT) display, the motherboard and its central-processor unit (CPU), plus input and output ports (if they are standard with the system) and, possibly, one or two disk drives. Usually such a system comes equipped with the minimum amount of RAM (*R*andom *A*ccess *M*emory) the manufacturer thinks you'll need.

An example of an all-in-one system is the Radio Shack *TRS-80 Model III* (Fig. 1). The system is available in different equipment configurations, but we'll examine the version with 48K (kilobytes) of RAM and two disk drives for mass storage. That system is priced at $2295 and, as it comes from the box, it is a fairly powerful, ready-to-run unit.

In fact, for most home uses that system will be more than adequate. But, for the serious microcomputer user, the amount of RAM may be fairly limiting. Some sophisticated programs, such as word-processing or spreadsheet programs, really require at least a 64K machine to run properly.

The *Model III* includes a standard RS-232 serial port that allows the user access to network communications, and a

FIG. 1—RADIO SHACK'S *TRS-80 Model III* is a popular all-in-one computer system.

FIG. 2—A COMPUTER IN KIT FORM might be the right choice for you if you don't mind a little work. Shown here is the *H-89* from Heathkit.

parallel printer-port. Dual minifloppy disk drives are also included with the system; they allow 368K (184K per disk) of mass storage. They are not, however, double-sided, double-density drives, which would permit 320K (or more) of storage per disk.

One advantage that may especialy appeal to many first-time buyers is that, because there are fewer separate components, an all-in-one system is easier to buy. And, since everything in the system is made by one manufacturer, there is the advantage of having it all warranteed by that manufacturer, rather than having several different warranties and service networks to deal with. Another advantage of a one-piece system is that it often takes up less space than a component-type system. For instance, rather than having a system box for the CPU (*C*entral *P*rocessor *U*nit), and a separate CRT, keyboard, and drive(s), everything is in one cabinet.

While the all-in-one concept is appealing to many potential personal-computer buyers, it also has a few drawbacks that should be considered. Usually, when you opt for an all-in-one system, you are locked into whatever configuration you first purchased, unless you want to go inside the system and "get your hands dirty" to make the changes needed (such as adding an accessory board or resetting system switches). If you do that, you may run the risk of damaging the unit and losing its service while it is being repaired. Furthermore, if the system is still under warranty, then merely opening the unit can void that warranty. However, if going inside the computer to make additions and changes doesn't scare you, maybe you should consider building an all-in-one computer from a kit. One of the few such computers is the Heathkit *H-89* (also available fully assembled from Zenith as the *Z-89*). That computer is shown in Fig. 2.

A further question arises as to the ultimate expandability of the system. If you opt for an all-in-one system, you may not be able to add more RAM, or output ports or disk drives, and you may not have access to the system bus. If you opt for an all-in-one system, be sure there is at least an expansion box or some other potential for expansion.

We should mention that even if the manufacturer does not offer expansion options, other companies may. Those options usually require going inside the computer to make additions and/or changes, especially in all-in-one systems.

Another important consideration is the operating system that the computer uses and the software that's available to run under that system. If you opted for the Radio Shack unit, you would get a disk operating system called *TRSDOS* (pronounced "triss-dos"). It supports a large library of Radio Shack programs, as well as programs from outside sources. Other operating systems are available which expand on *TRSDOS*' capabilities, but still allow you to run most *TRSDOS*-compatible programs.

If you want even more flexibility in your choice of software, though, you should consider a disk operating system called CP/M. It is especially valuable if you are going to be using your computer for business purposes, for the amount of "serious" software available to run under CP/M is enormous. To run CP/M on a Radio Shack computer, though, you have to make some hardware modifications. CP/M can be run on most computers, but many of them require considerable reworking, and the conversion can become expensive.

The CRT display must also be considered. The one supplied with the system will probably be more than adequate for the first-time microcomputer user. But, after a while, if you want to use any sort of graphics, you may find the resolution of the display too limited for the task. With an all-in-one system, you could be locked into a situation where there are no options because the CRT is built into the cabinet. The same is true if you want a different type of display (or just want to move the one you have—see Fig. 3). For instance, it has been found that a black-and-white display is more fatiguing to use over a long period than a green or amber one. But, changing a black-and-white display to one of the others cannot be done reasonably unless a replacement is offered by the manufacturer. One alternative is a colored plastic shield that will change the color of the display; unfortunately, it will also cut down on its visibility.

Despite its limitations, though, the all-in-one computer is still a viable option for many.

Component computer-systems

The heart of a component system is a system box that houses the CPU, RAM, and—possibly—disk drives, and has built-in card slots for easy expandability. The keyboard and CRT are separate, although the two may be combined into one unit. The biggest advantage that component systems have over all-in-one systems is flexibility—the ability to upgrade or modify the system easily.

Although you may think of a system such as the IBM *Personal Computer* (see Fig. 4) as being at the mid-to-upper end of the microcomputer scale, a prudent buyer can put together a system that isn't very much more expensive than many all-in-one microcomputers.

The first building block in the IBM system is the system unit. In its simplest form, that box houses the 8088 16-bit microprocessor and 16K of RAM. It contains no disk drives, but has a built-in port for connecting a cassette recorder for data storage. The unit also features space for two drives, and for up to five IBM-compatible cards (for memory expansion, various types of video displays, etc.). A separate keyboard is also included in the basic configuration, but a CRT is not. A user has the option of using his own television set (through the addition of an RF modulator) or he can opt for any of the monochrome or color monitors on the market.

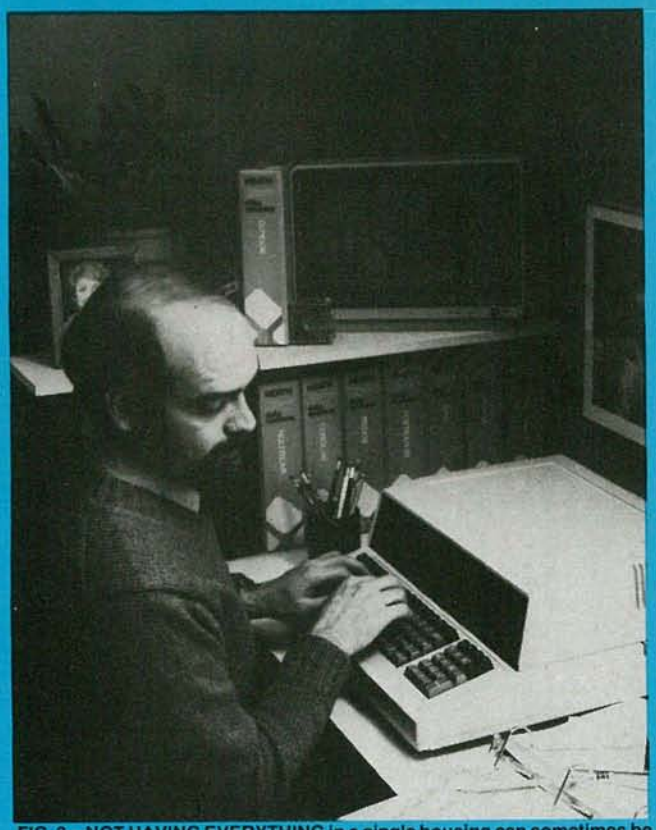


FIG. 3—NOT HAVING EVERYTHING in a single housing can sometimes be an advantage.

FIG. 4—THE IBM PERSONAL COMPUTER is a component-type system that can use a standard TV for display.

In its basic configuration, the IBM *Personal Computer* can be purchased for a little over $1250. However, you may soon find the basic configuration limiting. Your first move will probably be to add more RAM; bringing the total system RAM up to 80K. That requires an investment of only about $150. In that configuration, the computer becomes far more flexible, and capable of running sophisticated programs.

At the same time, you may also find cassette storage restrictive, and may want to add a disk drive or two for mass storage (see the discussion of disk drives elsewhere in this section). One drive and a controller card for it will cost about $420, and, with careful shopping, a second drive can be added for as little as $250. The disk operating system and BASIC bring the total cost of the system up to about $2110, but it now consists of 80K of RAM, a disk-controller card (which can support up to four drives, as can the Radio Shack TRS-80), and two double-sided, double-density disk drives, for a total external storage-capacity of 640K.

Still lacking at this point is a communications option. The computer package has yet to include either a parallel printer-port or an asychronous (serial) communications port. Often—but not always—an all-in-one microcomputer will include those ports as part of the package. Adding them to the IBM component-system will increase its cost by about $480 (bringing the total to $2550), but they will also increase the functionality and flexibility of the system tremendously. And, the system box will still have two slots available for other add-on cards (the disk-controller card and both port cards are plugged directly into the main system-board).

There is still something missing from the picture—a computer-grade CRT capable of displaying high-level graphics; the user is still tied to his RF modulator and television set. Fortunately, the video interface has already been taken care of—the parallel printer-port board also contains a monochrome-display interface. That saves you from tying up an extra slot on the motherboard. Monochrome (black-and-white—or -green, or -amber) monitors—capable of delivering high-quality displays—are available for as little as $95. (You can also pay $350 for the IBM-compatible unit, which sports one of the best displays in the business.)

You might want to change the configuration of the computer to include high-level color graphics capability by adding a $499 color-graphics monitor/printer interface instead of the $350 monochrome/printer interface. That would raise the cost of the system to the $2800 to $3150 range. Of course, a quality color-monitor will further increase the cost of the system. In fact, depending on the type chosen, a color monitor can add from nearly $300 to $1,000 to the price of the system.

Further considerations

While an all-in-one system offers convenience, it does so at the expense of flexibility.

Consider this: in the two examples we've just given, the owner of the component-type of system still has further slots left for other functions to increase his system's versatility. You can add a game-controller card for computer-game use, and still have another slot available for memory expansion. It must be admitted that game-controller access is built into many all-in-one systems, but if it isn't, then you must find out whether you can add one to your system, and whether and where the add-on is available.

Each type of system has its attractions and advantages, but the component or building-block system seems to offer much more flexibility—and the differential in price over the all-in-one type isn't all that great. Component systems can be found in all price ranges, ranging from Commodore's *VIC-20* to the Apple series, and on to the IBM and S-100-bus computers. In fact, just about all of the new generation 16-bit microcomputers are appearing as component-type systems.

Portable computers

There is a special type of all-in-one system that does merit a

look from the business-oriented user who wants to keep costs down, but also wants a great deal of performance from the start—the portable.

The portable-computer trend was started by author and microcomputer-industry pioneer Adam Osborne, who launched the *Osborne I* portable computer nearly two years ago. That computer, shown in Fig. 5, comes with standard features that include 64K of RAM, dual disk-drives, a Z80 microprocessor, the CP/M operating system, a full ASCII keyboard, a built-in miniature black-and-white CRT, and CP/M-based software that includes word processing, a spreadsheet program, the CBASIC programming language and, of course, CP/M and its utilities. All of that could be purchased for the unheard-of price of $1795. (The computer's capabilities have recently been increased through the addition of double-density drives and the inclusion of a data-base program in the software package, but the price has remained unchanged.)

When the computer was announced, industry skeptics said the concept would never get off the ground. But Osborne proved them wrong. His system took off, and his California manufacturing facilities were stretched to the limit. The business community knew a bargain when it saw one, and leaped at it...as did many serious home-computer users.

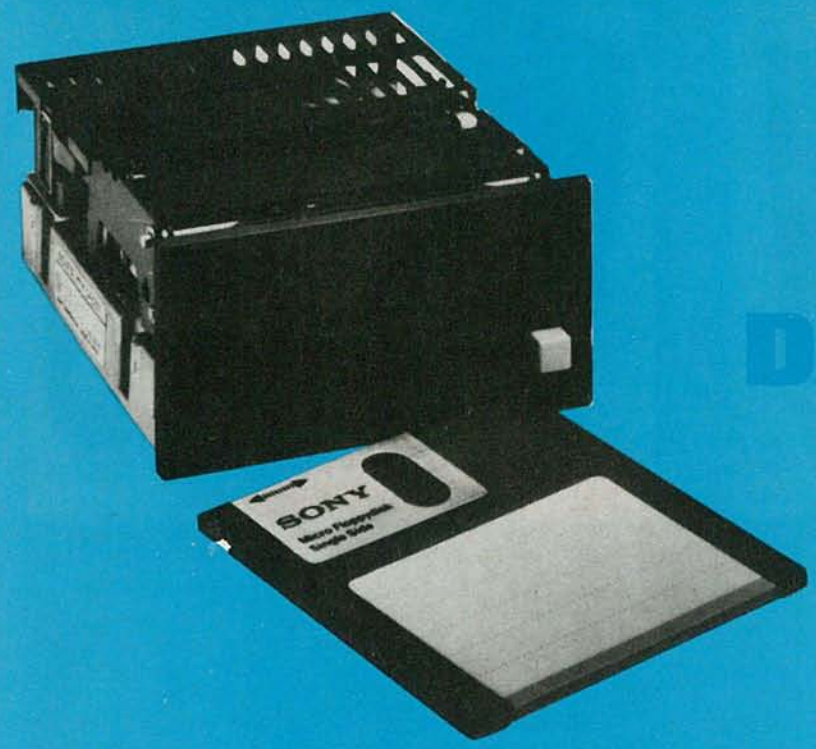
The system is powerful not only in its own capabilities, but also in its ability to allow the user to access remote data-bases via a built-in serial port. About the only item detracting from the appeal of this portable personal computer is its tiny, five-inch display with its limited display-width—while it can display the industry-standard 24 lines, it's limited to a width of 52 columns; you have to scroll the display sideways to access the full 80-column work area. The size problem can be overcome by using an optional external display, and Osborne is, reportedly, making an 80-column-display feature available.

FIG. 5—THE PORTABLE COMPUTER is growing popular among both business users and home-computer users. Shown here is the *Osborne I*.

Which is for you?

If you are considering the purchase of a microcomputer, which way should you turn? The question really revolves around what you want to do with your system. If it is to be used for casual purposes and game-playing, then any of the inexpensive color microcomputers on the market—whether component-type or all-in-one—should fill the bill. If, on the other hand, you want more power and don't want the inconvenience of piecing the system together, then an all-in-one (or, perhaps a powerful, yet still inexpensive portable computer) is the way to go. If, though, you want the ability to tailor a system precisely to your needs, then a component system is your best bet. **R-E**

Radio Electronics YOUR OWN Computer APRIL 1983



Disk Drives

An invaluable peripheral for the serious computer-user is a disk-drive system for program and data storage. Here's a look at the more popular types, and a discussion of how they work.

MARC STERN

TODAY'S MICROCOMPUTERS ARE TRULY POWERFUL DEVICES. Many come with 64K (64,000 bytes) of RAM as "standard equipment." (In the old days, 4K was *a lot*!). RAM (*R*andom *A*ccess *M*emory) is the part of the computer that holds programs and data when they are in use. In it, data can be manipulated and modified almost instantaneously.

RAM has a serious drawback, though—it needs power to retain its contents. If the computer is turned off, those contents are lost, disappearing forever into the proverbial "bit bucket." Such storage is termed *volatile*, and if you want to retain its contents, you must keep the computer on 24-hours-a-day—not an inexpensive proposition.

There are nonvolatile types of semiconductor memory such as ROM's (*R*ead *O*nly *M*emories) and EPROM's (*E*raseable *P*rogrammable ROM's), but they are intended to be programmed once, and their contents left unchanged afterward. Because of that, and their relatively small capacity and high cost, such IC's are used for programs that will be used again and again without modification, like the computer's operating system or a built-in BASIC language.

What's the alternative for long-term data and program storage? Ideally, it should be fast, reusable, and fairly inexpensive. Fortunately, magnetic media—tape and disks—meet those criteria.

Tape vs. disk

Back in the early days, personal computer users relied on cassette tapes for storage. They could use readily available equipment, and the storage medium was very inexpensive and fairly reliable. Disks, at the time, were an expensive luxury.

But, those early users soon found that tape had several shortcomings. First, because the data was stored serially, one bit after the other, it was necessary to read all the information on a tape until the material that was desired was located; there was no easy way to tell where on the tape that material was. If a program were stored at the end of a tape, all the programs preceding it had to be looked at by the system before the one that was wanted was accessed. If a C-60 cassette were used, that process could take almost half an hour.

Using tape for mass-storage for personal computers also had another drawback, and that was speed. Typically, the data-transfer rate for tape is about 30 to 150 characters-per-second or about 300 to 1500 baud (bits-per-second). Thus, loading a 10K program into the computer required over five minutes.

So, it's evident that using cassette tape, even though it has a potential for about 500K of storage (on one side of a C-60 cassette) isn't very efficient.

To illustrate that another way, suppose you had a database consisting of names and addresses, and you wanted to access a particular name. If that name were stored somewhere near the end of the tape, it could take as long as 30 minutes to find it. In addition, if you wanted to add even just one more item to the database, you would have to re-record *all* the records.

Contrast that with the capabilities of a floppy disk, now an affordable and commonly used mass-storage device. It can access data at random, and its transfer rate is much faster than that of tape.

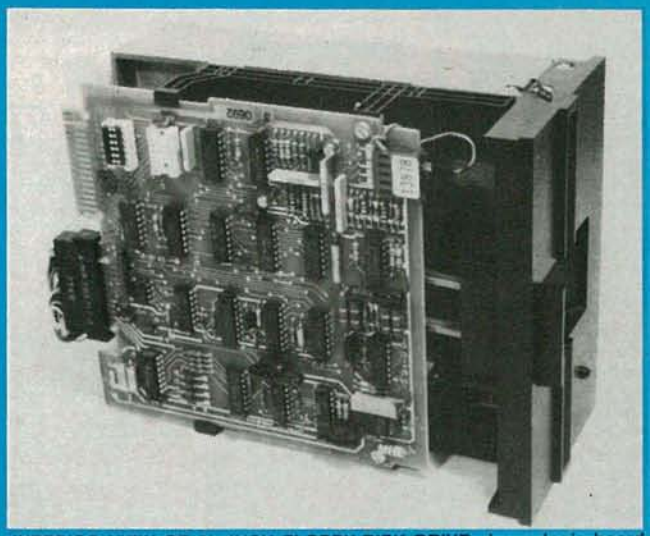
Using the address database as an example, instead of waiting half an hour to locate a particular address, the floppy can access the information in as little time as a second.

And, since the transfer rate for information is so high, instead of spending five minutes loading a program into RAM from tape, the same program can be loaded from disk in a matter of seconds.

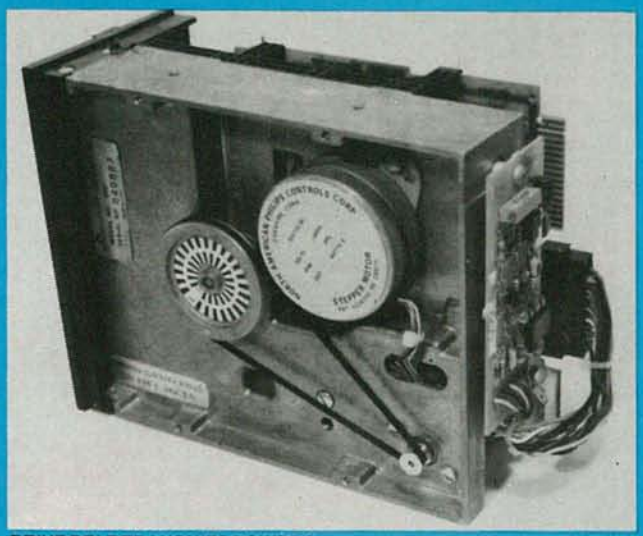
The most popular storage medium for microcomputers today is the floppy disk. Floppy disks are available in two sizes: 8-inch and 5¼-inch minifloppies.

Disk formats

Floppy disks are available in a variety of formats. Those formats include single-sided, single-density; single-sided, double-density; and double-sided, double-density. The densities refer how tightly the data is packed on a disk. You can store data on one side of a single-sided disk and on both sides of a double-sided one. Thus, a single-sided, single-density minifloppy can store about 92K of information, while a single-sided double-density one can store about twice that amount. The number doubles again for a double-sided, double-density disk. Thus a single-sided, double-density minifloppy can store about 180K of information, while that figure increases to as much as



INTERIOR VIEW OF 5¼-INCH FLOPPY-DISK DRIVE shows logic board mounted over read/write head assembly.



DRIVE BELT TRANSMITS POWER from motor to assembly that spins disk. Large round stepper motor controls motion of read/write head.

360K for a double-sided one. Because of their size, 8-inch disks have about twice the capacity of their 5¼-inch relatives.

Perhaps the limiting factor in the density situation is the way the disk is formatted (more about that later). Formatting refers to the way the tracks on the disk are set up when the disk or minifloppy disk is configured to work with a particular system. Thus, even though a diskette manufacturer may claim that his product has up to 128K of space available for storage, in reality, that space is limited to about 92K after formatting, if it is a single-sided, single-density disk. Bear that point in mind when you shop for a disk system—make sure that the storage capacity quoted you is the capacity after formatting.

Disk structure

Let's look more closely at the disk system for a clearer understanding of the way it works.

Floppy disks were an invention of the late 1960's, when IBM sought to replace keypunch cards. Because they were flexible and easily bent, they were termed "floppy."

A floppy disk is a .003-inch thick Mylar disk, covered with a coating of magnetic oxides. In that respect, it is much like an audio tape. The disk is sealed inside a protective jacket, which has several windows cut in it. The jacket also contains a lubricant so the disk rotates freely.

The disk revolves inside its protective jacket at a speed of 300 rpm for a minifloppy, and 360 rpm for an 8-incher.

The units in which the disks work—the drives—resemble file drawers with slots to insert the disks, and doors that close over the slots. Inside, along with other parts we'll discuss shortly, are the read/write heads that access and deposit the data on the disks. During recording or reading, those heads make light contact with the surface of the disk; and when they are not in use, the heads are usually lifted away from the disks to reduce wear and tear.

One of the windows in the disk jacket is a slot that allows the read/write head to make contact with the disk. There is also a large center hole that allows the drive spindles to grip the disk and it to spin. To the right of the center hole is a smaller *index hole* that provides timing information, and at the edge of the disk is a *write-protect notch*. The purpose of that notch is to allow the user to protect the information on the disk from being accidentally written over or erased. A small self-adhesive tab is used to cover the notch. In the case of 5¼-inch disks, when the notch is covered, the disk is write-protected and when it's exposed, data can be recorded on it. On 8-inch disks, the reverse is true.

A disk is covered with magnetic tracks, arranged in concentric circles. To read or write data from or to the disk, a magnetic-sensitive head is placed over a track while the disk rotates. The head senses the changing magnetic states it finds on the disk, and that information is then translated into electrical pulses representing logic-1 or logic-0 states. When it writes to the disk, the head changes the magnetic state of the disk's surface to represent the logic-level signals from the computer.

The number of tracks on a disk varies with the format the microcomputer manufacturer uses. An 8-inch disk will usually have from 77 to 80 tracks, and a 5¼-inch disk will usually have from 36 to 40 tracks.

Using concentric tracks is very convenient for speedy operation, but, if only one file per track were kept, it would be very inefficient. That's because, if one file were assigned per track, it would mean that a short file would leave a large amount of disk space unused. On the other hand, another file might fill up one track and still be large enough to require space on another; most of that second track could also be wasted.

To avoid that sort of problem, each track is divided into units called *sectors*, and data is written to or read from those sectors. On an 8-inch disk, there are 26 sectors per track, while on a 5¼-inch disk, there may be as few as 10 or as many as 16 or more—it depends on the manner in which the microcomputer's manufacturer chooses to handle its disk formatting. Each sector holds 128 bytes, or 1,024 bits, of information. There are, potentially, 2002 sectors available for data storage on a standard 8-inch, single-sided, single-density disk, while there are from 400 to 600 (or more) sectors available on the average single-sided, single-density 5¼-inch minifloppy.

That arrangement makes data storage and handling much easier for the microcomputer and the read/write head. A directory is automatically maintained on the disk, indicating where everything is stored, and where it is possible to place and locate data quickly and accurately.

Keeping track of the data, though, brings another element into the picture: *hard-* or *soft-sectoring*. As mentioned earlier, every disk contains an index hole. It is that hole which determines the timing for proper data access by identifying the starting spot on the disk. On a soft-sectored disk, there is one index hole, and specific sector locations are identified by information contained on the disk. As mentioned earlier, the added storage requirement for the sectoring information reduces the amount of space available for information storage.

The picture changes with a hard-sectored disk. It, too, contains a master index hole, but there are also other holes (which are also visible in the index hole cutout in the disk jacket). They are index markers, or *sector holes*, and may number from 10 to 16 (32 on an 8-inch disk). Their presence means that less timing information has to be stored on the disk, and that frees about 25 percent more space for storage. Since they are exactly spaced, the *sector holes* are able to provide the tight timing-information needed to indicate the exact start spot on the disk.

EIGHT-MEGABYTE HARD DRIVE system from Radio Shack is completely sealed and inaccessible to user.

Format compatibility

Disks made by one system will not necessarily—even if they are the same size and use the same sectoring method—work on another. There are a number of format considerations to be taken into account.

Since format compatibility is so important, let's take a closer look at it. In the 8-inch-drive world, there is at least an industry standard to which most microcomputer makers conform: the IBM 3470 standard, which calls for 77 tracks and 26 sectors, with soft sectoring. Recording density is 3408 bits-per-inch. Unfortunately, no such standard exists for 5¼-inch minifloppies.

For the moment, though, let's look at the 3470 standard. The tracks are numbered from the outer edge of the disk, beginning with 00 and ending with 76, at the innermost edge. As noted earlier, there are 2002 sectors on the disk; each of those sectors is divided into four parts. The first identifies the sector and track number, while the second contains the data. In between these two sections are two *interrecord gaps*.

The identification and data parts of the sectors are broken down even farther, and contain pulses used to synchronize the controller circuitry and to compensate for variations in the rotational speed of the disk. Also contained in them are error-checking bits to permit the controller circuitry to recognize an error, should one occur.

The sectoring information isn't usually contained on a disk when you first take it out of the box. Instead, you have a non-magnetized blank, which must be inserted into the disk drive so the tracks and sectors can be defined. That process is called *formatting* or *initializing*, and a program run by the computer initiates the process using the index hole as a marker. During the formatting process, the disk loses a considerable amount of its storage potential. Thus, a disk which may hold 400K unformatted will only hold about 256K when it's formatted.

In its formatted state, the disk is ready for use by the system. To record data on a single-density disk, frequency modulation (FM) is used. In addition, a 250-kHz clock generator produces pulses every 4 microseconds (ms) that form the data cells on the surface of the disk. If, during the interval between two pulses, data is written to disk, a logic-1 will be recorded at that spot on the disk. The magnetic state of that minute area is changed. If, however, no data appears, the disk oxide material remains unchanged and it will appear to the system as a logic-0.

When the disk is read, if a magnetic change has taken place where there was a data bit written on the disk, not only does the 250-kHz clock pulse register, but so does the data pulse, and the system sees two pulses, which it translates to a logic-1. If the system sees only the clock pulse, then it translates it to a logic-0.

Double-density recording requires another method: MFM, or *M*odified *FM* encoding. Rather than using a constant clock-pulse, many of the pulses are removed and appear only at certain intervals. That frees far more space for data, since only one pulse is used to indicate a logic-1 and none indicates a logic-0. It must be noted that the drive-controller circuitry has to become far more sophisticated to handle that type of encoding.

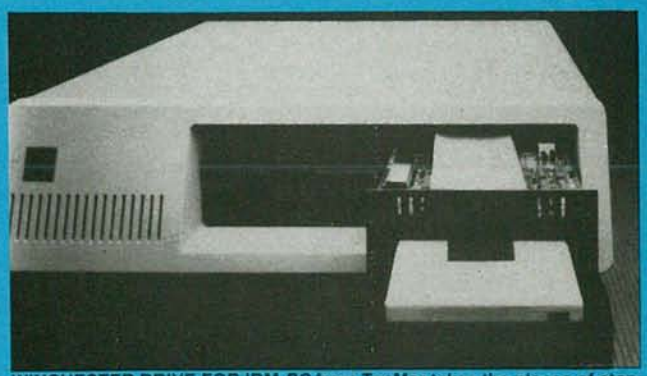
Double-sided, double-density recording uses the same type of arrangement, but adds another read/write head so the system can read and write to both sides of the disk.

Access time is defined as the time it takes the drive to access a piece of data chosen at random. (It is generally calculated as half the slowest, or worst-case, access time.) That figure, in turn, depends on how long it takes for the head to arrive at the proper track, and how long it has to wait for the proper sector to arrive beneath it. The time it takes for the drive to arrive at a track is termed the *track-to-track seek time*, and the time it takes for the proper sector to reach the head is known as the *latency time*.

Latency time is derived by measuring the interval between the time when the read/write head arrives at the proper track just as the proper sector has passed by, and the time when the beginning of the sector passes beneath the head. That, in general, requires a full disk rotation.

Generally, track-to-track seek time varies from 3 to 15 ms for an 8-inch drive, and from 6 to 30 ms for a 5¼-inch drive. Latency time is in the 85-ms range for an 8-inch drives, and is about 100 ms for a minifloppy. Total access-time ranges is about 100 ms for an 8-inch drive, and is about 300–400 ms for a 5¼-inch drive.

Also important is the *data-transfer rate*. That is the rate at which data is read or written from or to the disk. The higher the transfer rate, the quicker the data is fed into the system and the more efficient it is. That rate is on the order of 125–250



WINCHESTER DRIVE FOR IBM *PC* from TecMar takes the places of standard 5¼-inch minifloppy. Removable cartridge can hold five megabytes.

PARTIAL LIST OF DISK-DRIVE MANUFACTURERS AND SUPPLIERS

Amdek Corp.
2201 Lively Blvd.
Elk Grove Village, IL 60007

Apparat Inc.
4401 South Tamarak Pkwy.
Denver, CO 80237

Apple Computer Inc.
20525 Mariani Ave.
Cupertino, CA 95014

Atasi Corp.
235 Charcot Ave.
San Jose, CA 95131

Commodore Business Machines
487 Devon Park Rd.
Wayne, PA 19087

CompuPro Division
Godbout Electronics
Box 2355
Oakland Airport, CA 94614

Corvus Systems
2029 O'Toole Ave.
San Jose, CA 95131

Cybernetics Inc.
8041 Newman Ave.
Suite 208
Huntington Beach, CA 92647

Data Peripherals
965 Stewart Dr.
Sunnyvale, CA 94086

Davong Systems
1061 Terra Bella Ave.
Mountain View, CA 94043

Digital Equipment Corp.
Parker Street
Maynard, MA 01752

Evotek
1220 Page Ave.
Fremont, CA 94538

Genie Computer Corp.
31125 Via Colinas #908
Westlake Village, CA 91362

Heath Company
Benton Harbor, MI 49022

Irwin International
2000 Green Rd.
Ann Arbor, MI 48105

Laredo Systems
2264 Calle DeLuna
Santa Clara, CA 95050

Lobo Drives International
935 Camino Del Sur
Goeleta, CA 90317

Magnolia Microsystems
2812 Thorndyke Avenue West
Seattle, WA 98199

Micropolis Corp.
21329 Nordhoff St.
Chatsworth, CA 91311

Micro-Sci
2158 South Hathaway St.
Santa Ana, CA 92705

MiniScribe Corp.
410 S. Sunset
Longmont, CO 80501

Morrow Designs
600 McCormick St.
San Leandro, CA 94577

PDS Universal Inc.
2630 Walnut Ave. Suite G
Tustin, CA 92680

Percom Data Co., Inc.
11220 Pagemill Rd.
Dallas, TX 75243

Priam Corp.
3096 Orchard Dr.
San Jose, CA 95134

Quantum Corp.
448 Whitehead Rd.
Box 5141
Trenton, N.J. 08619

Qume Corp.
2350 Qume Dr.
San Jose, CA 95131

Radio Shack
One Tandy Center
Ft. Worth, TX 76102

Rana Systems
20620 Leapwood Avenue
Carson, CA 90746

Rotating Memory Systems
1701 McCarthy Blvd.
Milpitas, CA 95035

Seagate Technology
360 El Pueblo Rd.
Scotts Valley, CA 95066

Shugart Assoc.
475 Oakmead Pkwy.
Sunnyvale, CA 94086

Sony Corp.
7 Mercedes Dr.
Montvale, NJ 07645
(micro-floppy disk)

Syquist Technology
44160 Warm Springs Blvd.
Fremont, CA 94538

Tallgrass Technologies Corp.
9207 Cody
Overland Park, KA 66214

Tandon Corp.
20320 Prairie St.
Chatsworth, CA 91311

Tarbell Electronics
950 Dovlen Pl., Suite B
Carson, CA. 90746

Tecmar Personal Computer Products
23600 Mercantile Rd.
Cleveland, OH 44122

Vista Computer
1401 Borchard St.
Santa Ana, CA 92705

Xcomp
7566 Trade St.
San Diego, CA 92121

Xebec
432 Lakeside Dr.
Sunnyvale, CA 94086

Xiten Systems
16815 Hawthorne Blvd.
Lawndale, CA 90260

kilobytes-per-second for a minifloppy (depending on density) and about 250 kilobytes-per-second for an 8-inch disk (500 kilobytes-per-second, double density).

The rest of the system

There are, of course, more parts to the floppy-disk system than just the disk and drive itself. The most important of them are the disk controller and the disk operating-system, which is actually a piece of software.

The disk controller has responsibility for determining head position and sector identification, for disk-motor control, for head loading and unloading, for error detection and correction, and for controlling the data transfer to the interface circuits between the disk and the computer. The disk-controller is usually on a board separate from the computer's main board(s).

The DOS, or *D*isk *O*perating *S*ystem which, by the way, is usually loaded from the first tracks (known as the *system tracks*) of a floppy disk, is actually the manager of the microsystem. It controls data and program transfer between the computer and the disks, and also handles file management, labeling, editing, error detection, and copying.

The DOS is always the first program loaded into the computer from the disk, and its loading is handled by a ROM-based routine called the *bootstrap loader*. Actually, the short bootstrap-loader in ROM loads in a longer loader program from the disk, and *that* loads in the DOS. The process is akin to hoisting oneself by his own bootstraps, and is thus known as "booting the system" or "booting the disk."

Microfloppies

There are types of disks other than floppies. We'll look at two of them here: microfloppies and Winchesters.

One of the most recent developments in disk technology is the *microfloppy*. Microfloppies come in several sizes, ranging from a little over three- to a little under four-inches in diameter. They are basically the same as floppy or minifloppy disks, except for their small size and the fact that, instead of using a flexible protective covering, they are encased in a hard, plastic covering. That plastic shell contains what looks like a sliding door, and, indeed it is. It covers the disk-access notch through which the read/write head contacts the disk surface. When the disk is inserted into its drive, the door retracts so the head can contact the disk. It closes automatically when it is removed. That prevents the delicate disk-surface from contamination by skin oils or particulate matter in the air (like smoke or dust) that can cause the disk to "crash."

Operating at about the same speed as 5¼-inch minifloppies, microfloppies are capable of great data densities. Dense-packing techniques allow a microfloppy to store nearly 500K of data on its surface. The recording technique is similar to that used for double-sided, double-density media, except that the tracks are much closer together.

The potential for miniaturization offered by this medium is of great importance. With 3.5-inch drives occupying about half the space taken by a pair of minifloppies, it is possible to design microcomputers that are even smaller than they are now.

One disadvantage of microfloppies at present is that the drives are not yet available in great quantities. Another, and more serious problem is that the industry has yet to settle on a microfloppy standard.

Winchesters

There is a growing trend toward storage on *Winchester* drives. The concept, first developed by IBM in 1973, was originally aimed at the mainframe market. The early hard disks, code-named "Winchester," were 14 inches in diameter. But, they soon began to shrink toward 8 inches, and eventually to 5¼ inches. The 5¼-inch Winchester has become quite important in the last year or so.

The beauty of Winchester disks is the amount of data they can hold. Even the small ones are capable of storing 10 megabytes, and there is a race on now to increase that figure. In fact, in the next couple of years it is likely that disks that size will have capacities of 20, or even 30, megabytes.

That storage capacity comes at a price: Mini-Winchesters are about four to nine times more expensive than comparably sized double-sided, double-density minifloppies. Their prices range from about $1400 to $2000.

A hard disk like the Winchester differs radically from a minifloppy in the way it is constructed, although not in its basic data-storage function.

The control circuitry is much like that used for the minifloppy and, in fact, Winchester drives are usually pin-for-pin compatible with 5¼-inch minifloppies.

The hard disk is made of metal, polished to mirror brightness. Like a floppy, it is coated with a layer of oxides for recording, but it may spin at speeds of up to 3500 rpm. Dense data-packing and track-packing techniques allow the high information densities of which Winchesters are capable.

Mechanically, a Winchester is as unlike a floppy or minifloppy as day is from night. The disk and read/write head are enclosed in a rigid sealed housing; they're safe from contamination or damage by human hands. Also, the read/write head never touches the surface of the disk; instead it floats on a cushion of air just microns above the surface of the disk, much like a ground-effect vehicle. That planing action is made possible by the high rotational speed of the disk. Even though it is not in contact with it, the sensitive head can still sense the changes in the magnetic state of the disk.

Because of the tight tolerances under which Winchester drives operate, the enclosure must be dirt-free. Thus, air is drawn into it by a fan through a filter and is then circulated. That also helps keep the heat level down; heat is one of the primary enemies of the hard disk.

To give an indication of the speed of the drive—data access and display seem almost instantaneous—the access time is 30 to 50 ms. (On some older models, access time is on the order of 100 ms.) That may seem slow, but it must be considered that the disks contain 800 to 900 tracks of information.

While the storage potential of hard disk drives is awesome, so are some of their inherent drawbacks. First comes the problem of backup copies. They are especially important for hard disks, where a head crash against the disk can ruin the entire data field. The most logical method for backing up data is with a floppy disk, but even with one-megabyte 8-inch disks, it can take 20 disks to backup a 20-megabyte hard-disk drive. That's not only time-consuming, but also expensive. If you use minifloppies, even more disks are needed.

An alternative is called the *streaming tape-drive*, which can copy 20 megabytes in as little as a minute. A high-speed tape unit, it is actually a huge, continuously moving data cassette. Its primary drawback is its expense.

An exciting alternative is the removable-cartridge Winchester disk. A fairly recent development, in that type of unit, the disks are encased in plastic housings and can be removed and stored. It's a good idea, and makes the hard disk much like the minifloppy in flexibility.

Winchesters are also susceptible to shock and vibration. Although most companies ruggedize their units as much as possible, it is still possible for jarring or bumping to cause the head to smash into, and destroy, the disk surface. Excess vibration can also be a potential cause of data errors.

One recent development, which emphasizes the trend toward miniaturization, is the 3.9-inch hard disk. Packaged to be half the height of standard 5¼-inch units, two of those drives can fit in the space taken by one standard drive. The units contain removable disk-cartridges.

Some considerations

Whatever decisions you may make in choosing a mass storage device, there are some caveats that should be remembered. First, try to determine your future expansion requirements. Don't buy a 92K single-density drive when you know you will need far more storage space in the near future. A good starting point is a double-sided, double-density 320K 5¼-inch drive. An 8-inch drive is the choice if your data storage needs are higher. You can get nearly a megabyte of data on a double-sided, double-density 8-inch disk. If you can afford two drives, so much the better. Not only will you double your storage capacity, but you will find making backup copies much simpler and faster.

Make sure the disk-systen is compatible with your computer, and can easily be interfaced with it. It makes no sense to buy an inexpensive disk only to be faced with the monumental task of interfacing it. The result will be a "kluge," and may require a great deal of original software—written either by yourself, or by someone you have to pay to write it for you.

The manufacturer should be one who has been in business for a time, and has established a good reputation. Choose a company that supports its customers and provides a good warranty.

Once you have purchased the drives, remember to back up all your key program and data disks. When you purchase a new piece of software, make a copy of it *immediately*. Use the copy, and lock up the original in a safe place.

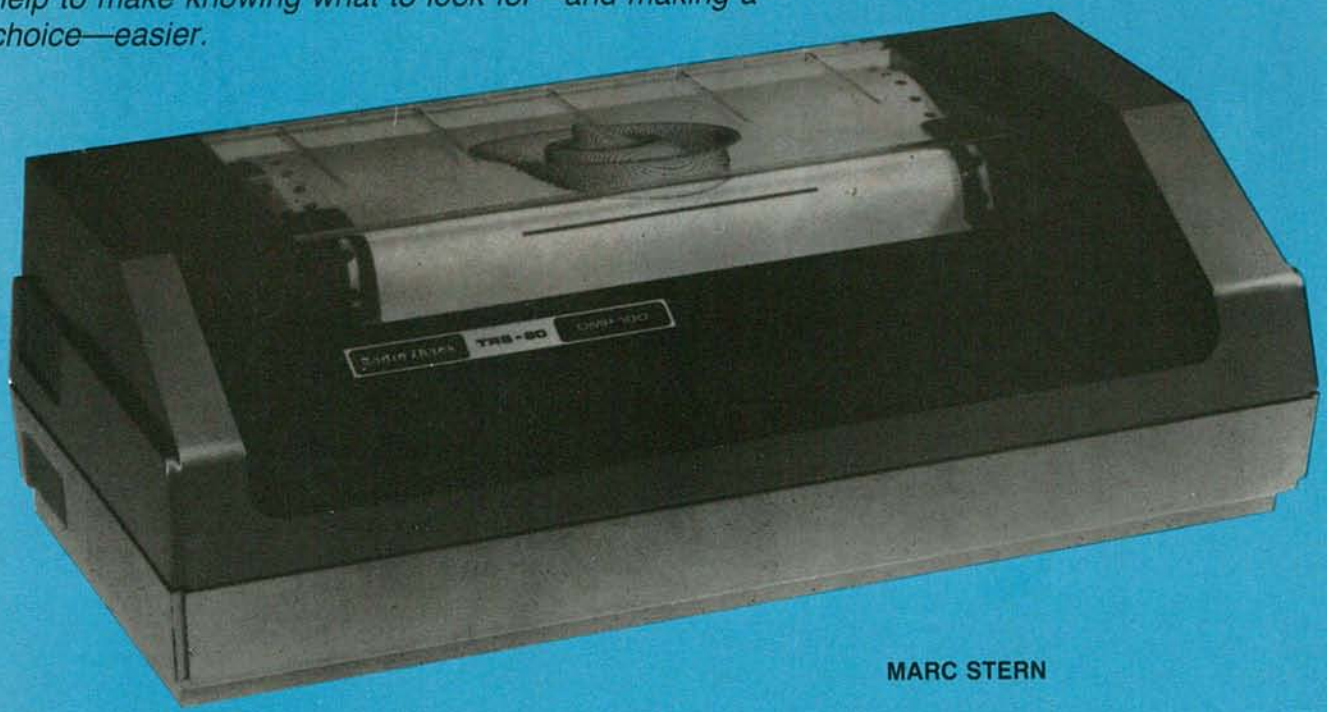
Although the average life of a disk is about two years, it is possible for a disk or program to fail because of mishandling. It pays not only to back up your work and programs, but also to handle your disks properly. Keep them away from dirt and cigarette smoke, and keep them at a constant temperature. A separate room for your computer is advisable.

If you take those precautions, you should get long life and good reliability from whatever drives you purchase. **R-E**

Radio Electronics YOUR OWN Computer APRIL 1983

Printers

One of the first accessories for your computer that you'll find yourself looking for is a printer. Here's some help to make knowing what to look for—and making a choice—easier.



MARC STERN

AT SOME POINT IN THE LIFE OF EVERY MICROCOMPUTER OWNER there comes a time whem he needs a permanent record of what he sees on his display screen. It doesn't matter whether it's a copy of a favorite program, budget or financial data, or a letter—the printout is needed. That usually comes about the time he realizes that he's severely limiting the usefulness of his system without some sort of printing device. After all, there's just so much one can do with a CRT display as the sole output device.

Faced with this situation, there's only one thing the microcomputer owner can do; he must begin the quest for some sort of computer printer. For the veteran computerist, the task is fairly easy. He knows what he wants and sets out to get it. The novice, however, faces a bewildering array of choices—and of terminology.

Almost at once he's confronted with the need to become an expert at deciphering such terms as *bidirectional, impact, dot-matrix, pin feed, tractor feed, KSR, RO, serial, parallel, graphics, thermal,* and the like. To him, it must seem as though the list goes on forever, but it really doesn't. In fact, with a bit of study the novice can become as knowledgable as the longtime computer veteran.

Where should that study begin? Perhaps it's best to start with a simple description of the types of printers available and a glossary of terms.

Inside a printer

In general, a printer is made up of several parts: the printhead, printing mechanism, platen, and the paper-feed mechanism. Those parts are shown in Fig. 1. The **printhead** is what actually makes the impression that forms the letter that appears on the paper. It can be a typewriter-like type bar—or its functional equivalent—or it can consist of a number of wires that are electronically programmed to reproduce the letter in the form of a matrix of closely spaced dots.

The **printing mechanism** is the whole mechanical or electromechanical assembly that drives the printhead. Many print mechanisms are **bidirectional**. That is, they print from left to right *and* from right to left. The result is a greater output rate. When it reaches the end of a line, the printer "looks ahead" to see how long the next line will be. If that line is long enough, instead of performing a carriage return and starting printing from the left, the printhead will simply reverse direction and print it "backwards," from the right side of the page.

The **platen** is the roller—like the one in a typewriter—against which the printhead strikes, and which may also serve as part of the **paper feed**, the mechanism used to move the paper on which the copy is printed. The paper-feed mechanism can be either **friction feed** (like the platen); **tractor feed**, where paper with a series of holes along the sides is pulled through the printer by a sprocket arrangement; or some type of **pin feed**, where small peglike pins that are part of the platen grip and pull the paper forward, always assuring perfect alignment.

If you think that sounds like a glorified electric typewriter, you're right. It's much easier to think of a printer as a typewriter without a keyboard; generally, the microcomputer provides the keyboard.

Thinking of a printer in that way does a great deal to ease some of the confusion you may face as you go about your search. However, of even more importance is our glossary—the words presented here in bold type, along with their definitions. It will help you to make sense of the terms used by a computer-store salesman or in a printer advertisement.

Types of printers

It's quite likely that at some point or another in your search you will come across the terms KSR- and RO printers. Simply put, **KSR** means *K*eyboard *S*end/*R*eceive, while **RO** means

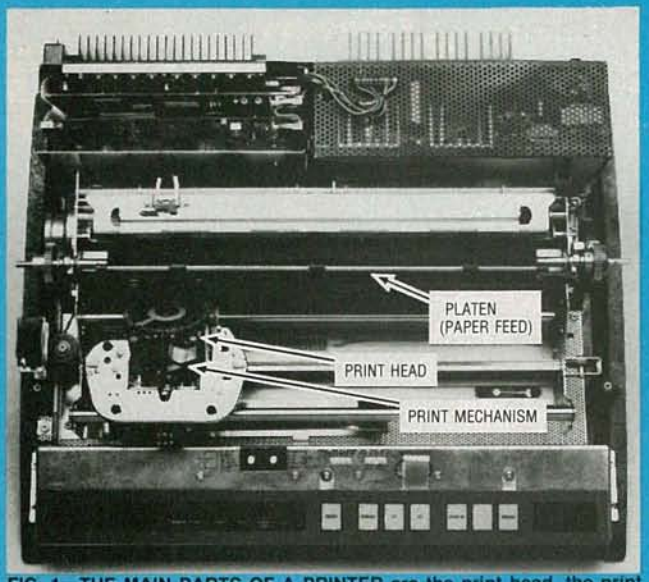


FIG. 1—THE MAIN PARTS OF A PRINTER are the print head, the print mechanism, the platen, and the paper-feed mechanism.

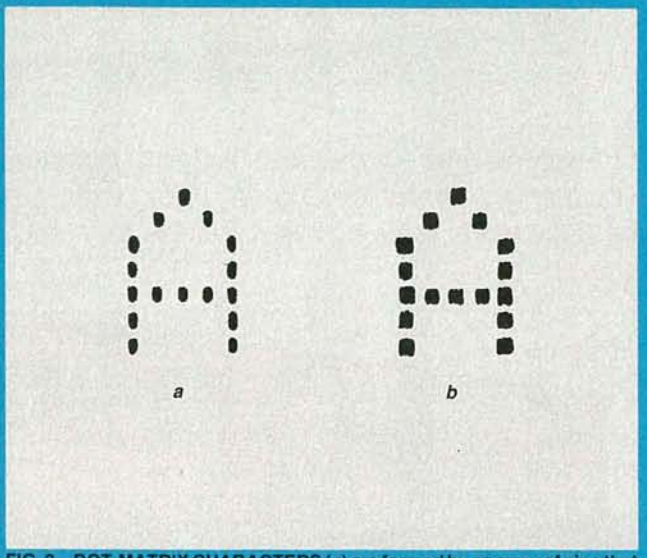


FIG. 2—DOT-MATRIX CHARACTERS (*a*) are formed by an array of pins that press against the ribbon to form an image; print offsetting can provide a much higher quality output (*b*).

*R*eceive *O*nly. If you are familiar with mainframe computers, then you probably have seen KSR's before. They are the *Teletype*-like devices used to input or request data to or from the computer. They may either be linked by a dedicated line or through a telephone modem (see the section on modems elsewhere in this supplement).

That isn't to say that's the only type of KSR device. There are compact versions available from many manufacturers that usually combine not only a printer, but also a keyboard and modem. The RO printer is like the keyboardless printer you may have seen at a friend's house. It is the printer linked to his micro and to which he sends data when he wants a printout. When he wants to send data to or through his computer, he uses the computer's keyboard.

Just as there's nothing especially mysterious about those terms, there's nothing mysterious about the terms impact and non-impact printers. Quite simply, an **impact printer** has some sort of print head that makes contact with the paper through a ribbon and forms a character. A **non-impact** printer is one that does not require the paper to be struck. It can be thermal, electrosensitive, laser, or ink jet. In that type of system, the shapes of the characters are stored in a memory, much like the one in your micro, and the characters are printed using one of the non-impact methods just mentioned.

Impact printers come in two types, dot-matrix and fully formed. A **dot-matrix** print head contains a number of pins that are driven by an electronically controlled solenoid. Those pins, in turn, are what form the actual letters by referring to character-shapes stored in the printer's memory. **Fully-formed**-character printers, on the other hand, rely on special wheels, thimbles, or balls to produce their output. The computer instructs the printer to print a letter, and the printer's control circuitry tells the print head to move that letter into position. A small hammer then strikes the letter, which contacts a ribbon, and an impression of the letter is left on the paper.

In general, non-impact printers are much quieter than their impact counterparts, although some types can be much more expensive. The reason for their quietness is that they don't use a mechanical system to form the letters on the paper. Many non-impact printers can operate at higher speeds than impact models.

The chief drawbacks of non-impact printers are that their output frequently tends to be much less legible than that of impact printers; they can only produce one copy, and they often require expensive special paper. Another drawback for the user who wants full-sized reports is the fact that many inexpensive non-impact printers are only capable of handling limited line-lengths—16 to 40 characters. Some, however, can handle 8½-inch-wide paper.

In general, non-impact printers can perform nicely for the microcomputer user who doesn't need high-quality print output. In fact, some home computer systems offer thermal or electrostatic printers as their standard printers. They are also priced relatively low. In fact, Radio Shack offers a low-cost thermal printer for as little as $129.95, although there are units that can cost upwards of $500. There are other types of non-impact printers—laser and ink-jet—but their costs are still too high for the average microcomputer user and probably will be for some time.

Dot-matrix printers

As noted, a dot-matrix printer generates patterns of dots to form a letter. The characters measure from four to seven dots horizontally by seven to nine vertically. It is that feature that defines the matrix and, in general, the greater the dot density, the better the quality of the printing. Examples of the output of a dot-matrix printer are shown in Fig. 2.

A couple of years ago, it could truthfully have been said that dot-matrix printers produced poorer-quality output than fully-formed-character ones. The situation has changed, though, with the advent of more sophisticated machines capable of print offsetting.

In normal operation, a dot-matrix machine makes one pass over a line and moves on to the next. However, with **print offsetting**, the printhead makes two or more passes at each line, printing the second time in a slightly different position, and making the matrix of dots denser, as can be seen in Fig. 2-b. That feature has made the dot-matrix printer the rival of the fully-formed-character machine because it is now capable of near-letter-quality printing.

Dot-matrix characters are formed by a number of solenoid-actuated pins in the print head. The character shapes are actually stored in a character-generator ROM (*R*ead-*O*nly *M*emory) inside the printer. As the data bits arrive in the ROM, it selects the appropriate dot-pattern to create the letter, and the proper pin-solenoids are selected. The solenoids drive the printer pins forward so they make contact with a ribbon and the character is formed.

Another type of dot-matrix printer is the ribbonless printer. Instead of relying on an inked ribbon, the printer needles actually burst microdots of ink on an impregnated roll of paper. Those pin pricks produce characters directly on the paper. However, the printer paper required is much more expensive than ordinary paper.

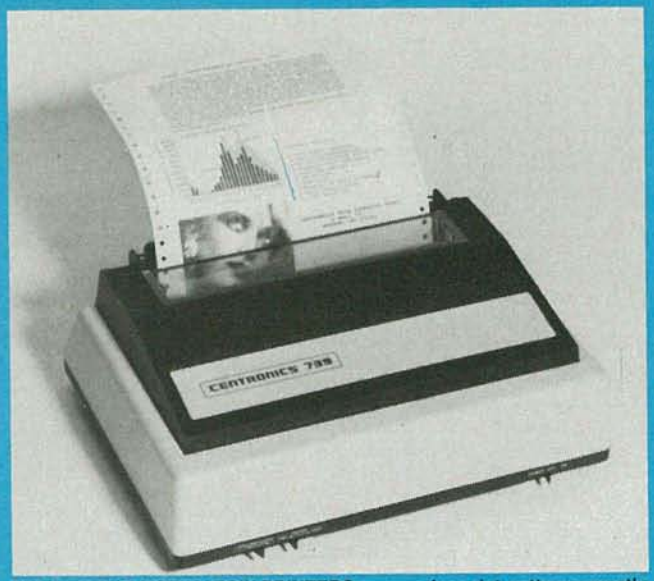


FIG. 3—SOME DOT-MATRIX PRINTERS can produce dot-patterns exactly matching what you see on the computer's display screen. Both line graphics and more complex images can be printed.

FIG. 4—A DAISY WHEEL has one character at the end of each of its "petals." Daisy wheels commonly contain 82, 88, or 96 characters.

Graphics

As microcomputers have developed greater graphics capabilities, so have printers. It's a matter of form following function, because what good is a high-resolution graphics display on a screen if it can't be sent to a printer for output? Only a couple of years ago, the top resolution available from a personal computer was about 240 pixels (picture elements) by 240 lines. Higher resolution was reserved for scientific or engineering computers where it was felt it was needed. But, the technology began to filter down to the microcomputer industry, and systems with higher-resolution graphics began to appear. Soon, resolutions approaching 400 or 500 pixels were common and now the resolution range is well over 600.

That degree of resolution means that a desktop computer can produce sophisticated graphics displays. In fact, the business community is taking advantage of those graphics capabilities, and of the software that makes use of them.

The printer industry, naturally, has followed suit and the character-generator ROM has been joined by the graphics-generator ROM. That integrated circuit contains machine-language routines that control not only the printhead, but also the printing mechanism and the platen. In that manner, the printhead is moved around a sheet of paper, forming the graphics image. Further, that ROM also contains the information needed to print special character-fonts.

Further, dot-matrix printers with graphics ROM's can produce "screen dumps." Since the graphics ROM is able to use the microcomputer screen's bit-mapped memory during a graphics printing session, it is also able to print out a representation of what is shown on the computer's display screen. Many microcomputers have areas of their RAM (*R*andom-*A*ccess *M*emory) reserved to hold that display information. Thus, each area of such a computer's CRT screen will have a corresponding address in RAM. Because of that **bit-mapping**, the RAM is able to output its contents directly to the printer and a user is able to have a real-image dump or "photograph" of the screen. Figure 3 will give you an idea of what some printers are capable of.

Finally, some dot-matrix printers can now print in color. A ribbon with (usually) four horizontal color-bands can be moved up and down in front of the print head and, over multiple passes, a wide variety of colors—corresponding to those generated by the computer for its display—are produced.

So, the dot-matrix printer, because of its versatile printhead, is a far more flexible printer than the fully-formed-character type. But, even with all its capabilities, many people are still put off by dot-matrix printing. They believe it looks too "computerish," and prefer the traditional letter-quality, fully formed characters of a typewriter.

Solid-character printers

Perhaps the earliest solid-character printer was the *Telex* or *Teletype*. It used a print cylinder that rotated on a vertical axis. That printhead was transported across the page by a movable carriage. Inside the printhead is a small hammer that is the print-actuating element. The device responds to the microcomputer's request for a particular letter by raising or lowering the cylinder, and rotating it to bring the correct letter into play. When it is located, the hammer strikes the cylinder, which in turn, strikes a ribbon, and prints a character. The carriage then moves on to the next space.

Units like those—*Teletype* models *33*, *35*, and *38*—are available today for relatively little ($200 to $400), but they do have some drawbacks. They tend to be slow—about 10 characters-per-second (cps)—and they are noisy and difficult to service. Also, they can't print lower-case letters.

An alternative is the ball-type printer. The type of printhead it uses was developed by IBM for its familiar *Selectric* typewriter series and contains a set of fully-formed characters on its surface. In action, it's much like the *Teletype*. The computer requests a letter, and the printhead/carriage mechanism spins to the correct spot. The head then strikes the ribbon and a letter is printed.

There are conversion kits that can turn older *Selectrics* into computer printers. One of them consists of a device that straps to the keyboard and has a series of solenoid-actuated arms. As a letter is requested, the proper arm drops and pushes the key, causing the letter to print. However, that is only one method. There are also companies that recondition *Selectrics* and turn them into true computer printers by adding the proper electromechanical parts internally.

Although the ball-type unit produces good quality printing, it is still noisy and fairly slow—about 15 characters-per-second. On the positive side is the fact that it is available at a relatively low price.

The final type of solid-character printer we'll examine is the daisy-wheel type, and its variant the thimble printer. The daisy wheel was pioneered by Diablo Systems, Inc. in 1973 and offers much higher speeds than were previously possible with solid-character printers.

Running at speeds up to about 55 cps, daisy-wheel printers use a wheel-type printhead, of the sort shown in Fig. 4. Running radially from the wheel hub are flexible arms topped by embos-

sed characters. As the computer requests a letter, the wheel spins the correct character into place and that is hammered against the paper by a small striker to print the character. The print wheels are made of plastic or a metallized material, and are usually good for more than a million impressions.

The thimble printer is a variant of the daisy-wheel type. Unlike the daisy wheel, though, the thimble print-element is shaped like a thimble facing upward, and the letters are on flexible steel shafts extending from the thimble base. Thimbles work on the same principle as daisy wheels.

Like the ball-type printer, those printers have an advantage in their easy interchangability of typefaces (the print elements can be changed in a matter of seconds). They are also much faster. They are somewhat noisy, though.

One alternative a computer user might want to consider is the conversion of an electronic typewriter. Since those units use daisywheels in place of normal type bars, and since many of their mechanical parts have been replaced by electronics, it makes a great deal of sense. You retain the typewriter capability for yourself...while adding, fairly inexpensively, a quality printer for your computer. There are reasonably priced interface boards available or you can purchase a converted unit such as the *Bytewriter* (based on the Olivetti *Praxis* electronic typewriter) for a reasonable price. Print speed is limited to about 10 or 15 cps and they are somewhat noisy, but, for many, they'll fill the bill.

Non-impact printers

The last category is non-impact printers, which were mentioned briefly earlier. It includes thermal printers, electrostatic matrix-printers, and ink-jet printers.

Thermal printers, which are fairly popular, use a specially manufactured paper and a heating element. Common in many calculators, they form characters using heat. The characters are formed as heating elements in the printhead discolor the sensitized paper into a dot-matrix pattern. The printers are lightweight, quiet and quick; however, the paper they use is fairly expensive.

Electrostatic printers also produce a dot-matrix pattern, but they use a special aluminum-coated paper. A voltage is applied between the printhead and a metal plate that burns off the aluminum and exposes a black layer beneath. Electrostatic printers are fairly inexpensive and their print quality is good, but the special paper they require is costly and fairly delicate. **Laser printers** work in much the same way, using a specially treated paper and a low-energy laser to form the characters.

Ink-jet printing is another non-impact process. In that system, a small jet of ink is pumped through a tiny nozzle, and the nozzle is vibrated to create a series of droplets. The resulting spray is directed to the paper, and its path controlled so it will form characters.

There are a number of methods used to determine where the jet will strike the paper, including electrostatic deflection, controlled nozzle movement, and controlled paper movement. There is also another method that uses a printhead with a matrix of nozzles that can be fired selectively; it works somewhat like a dot-matrix printer.

Print lines

Other terms that you may encounter in reference to printers include serial, character, and line. The term "serial" can be especially confusing because it refers not only to the way in which characters can be printed, but also to the way in which data can be transmitted. We'll get to the latter shortly.

In printer terms, a **serial** printer is one that prints a continuous flow of characters in a straight line across a page, one after the other. It's also known as a **character** printer. **Line** printers—which are generally large and very expensive—print an entire line all at once. That makes them much faster than serial printers, and they are used in situations where a high throughput is needed—in data-processing centers, for example, where thousands of checks or documents are printed at a time.

One of the chief advantages line printers enjoy over serial printers is speed. In fact, that's how their performance is rated. A slow line-printer will run at a speed of about 300 lines-per-minute (lpm), while a medium-speed unit will print at between 300 and 600 lpm. High-speed line printers are capable of speeds in the 600 to 1200-lpm range. Line printers are generally categorized in three groups: drum, chain, and scanning-matrix.

Serial-printer speeds contrast markedly with even the slowest of line printers. Rated in terms of characters-per-second (cps), dot-matrix printers have speeds in the 40- to 400-cps range, while fully-formed-character printers may operate between 10 and 60 cps.

Interfaces

There are two ways that a printer can be connected to a computer: through a serial interface, or through a parallel interface.

When a **serial interface** is used, data is transmitted by the computer's print routine to the printer one bit after the other. The task is handled **asynchronously**, which means that the rate at which the data is sent does not have to be constant. Instead, the timing is established by the number of start and stop bits sent at the beginning and end of each byte of data; one byte represents one character. The serial-data format is shown in Fig. 5-a. When the printer has received the correct number of start, stop, and data bits, it knows that it has received a complete byte (also sometimes called a word) and it then begins to piece together another one. Appropriately enough, that type of communication is carried out through a computer's serial port.

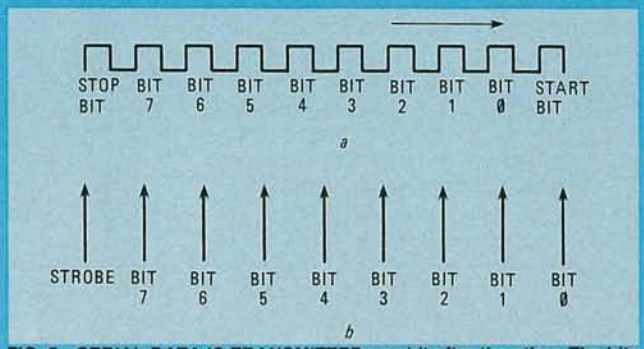


FIG. 5—SERIAL DATA IS TRANSMITTED one bit after the other. The bits indicating the character being sent are surrounded by what are known as framing bits (*a*). Parallel transmissions send all the data bits at once (*b*); a strobe pulse tells the printer when a character is to be printed.

That contrasts with a **parallel interface**, where entire bytes are sent at once, as can be seen in Fig. 5-b. That is possible because, instead of using only one input line to the printer, there are seven or eight data lines used. Thus, each of seven or eight data bits is sent down its own line. The result is a much higher transmission speed, and a corresponding increase in printer speed. A special port is needed to handle parallel communication between a printer and computer because of the number of data lines required. A **Centronics-compatible**, or **Centronics-type** interface is a particular form of parallel interface; it was originated by a printer manufacturer named *Centronics*, and was adopted by many other companies as a sort of standard. Be careful, though—not all interfaces billed as Centronics-compatible are identical; make certain before you buy that the printer will run with your computer.

Which system is better? For distances of up to ten feet, parallel transmission is better because of its greater throughput (ability to send more data in less time). However, over longer distances, the potential for errors induced by such things as vibration, electrical noise, or stray RF from the computer or printer makes parallel communication less desirable. In addition, after they travel some distance, the signals begin to weaken and must be reamplified through a repeater.

For distances of more than ten feet, the serial method is the

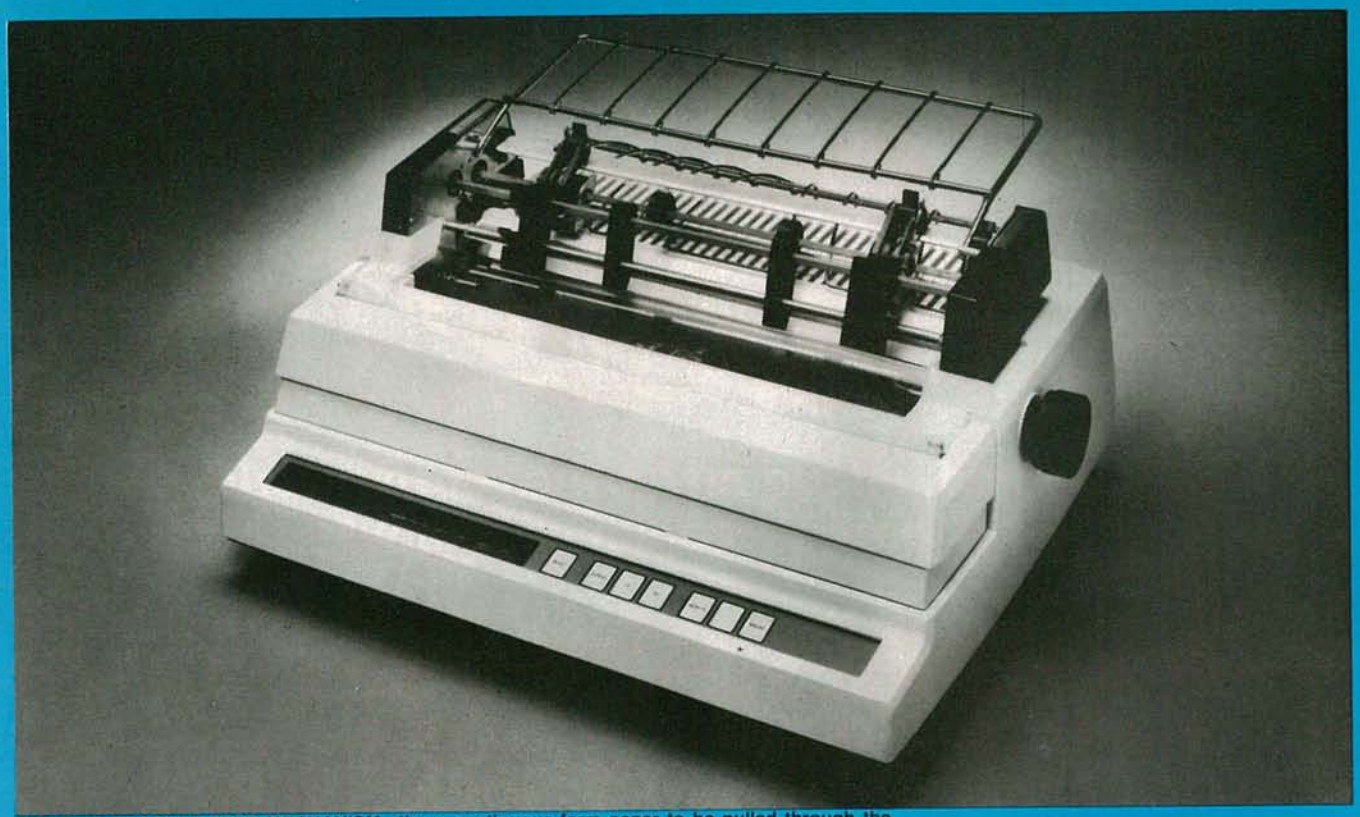


FIG. 6—A TRACTOR-FEED MECHANISM allows continuous-form paper to be pulled through the printer evenly without slipping from side to side. Thus, it allows long unattended runs.

better choice. While it is much slower than parallel data-transmission, the error rate is much lower. Furthermore, serial transmissions will carry for longer distances before needing reamplification. Transmission rates ranging from 110 to 19,200 baud (bits-per-second) are possible, but must be compatible with the capabilities of the printer, of course.

Asynchronous transmission isn't the only type of serial protocol, though; there is also **synchronous** transmission. This type of communication is far more complex than asynchronous. The system must know the exact timing of each data byte. When a synchronous protocol is used, the data flow is broken into blocks, with all the bits being sent at equal intervals.

Using oscillators as clocks, the computer initiates the timing sequence by inserting a series of synchronization signals at the start of each data block. Each block ends with an error-checking character. The clock-oscillators act to keep the timing sequence very tight. And, even if no data is transmitted, nulls (zeroes) are sent to fill each block so the timing chain never varies.

Paper-feed systems

Three different methods are used to move the paper through a printer. In the first method, known as **friction feed** the paper is pulled between the platen and a set of pressure rollers, much as in a typewriter. While it's a simple, trouble-free method most of the time, friction feed can be bothersome because of alignment problems. That is especially true when using continuous-form paper, which tends to skew (slip sidways).

With **tractor feed**, used on the printer shown in Fig. 6, a set of adjustable sprockets engages perforations at the edges of the paper. A gear train, driven by a motor, turns the sprockets which, in turn, pull the paper through the printer line by line. Usually the tractors (sprockets) are moveable, and tractor-feed printers can accommodate paper of any width. Most tractor-feed printers can also use plain paper, a sheet at a time.

Pin feed is similar to tractor feed; a set of pins set into the platen at either end fits into perforations in the paper to keep it aligned. While that system solves alignment problems, it does limit you to single paper-width.

Other considerations

There are several other factors that you should take into account when looking for a printer. Consider the amount of noise the printer makes. Impact printers are generally noisier than dot-matrix printers, but the sound produced by the latter type can sometimes be very irritating. If the sound a printer makes is too obtrusive, it can make working around the printer uncomfortable, and can contribute to fatigue.

Consider, too, the speed at which the printer runs. A slow printer will tie up your microcomputer for long periods, rendering it useless for other tasks unless you add a buffering print-spooler that accepts data from the computer almost instantly, and feeds it to the printer as required, thus returning control of the computer to you. Also, remember that a bidirectional printer will operate somewhat more quickly than one that has to do a carriage return after each line.

Bear in mind the length of the lines you will be printing; don't buy a printer with too narrow a platen. For documents on standard 8½ × 11-inch paper, an 80-column printer is a necessity; some applications may require a 132-column printer. Also consider the typefaces you will need, and the graphics capabilities of the machine. And, consider the type of paper you will be using (single sheets or continuous form) and the amount of attention the printer will need while in operation.

Finally, a word about prices. Like the prices of other microcomputer peripherals, those of printers have been dropping. A couple of years ago it wasn't unusual to find a letter-quality, solid-character printer costing in excess of $3000, with the better-quality dot-matrix printers selling for over $1000. Today, it's possible to buy a letter-quality printer for well under $1000. Furthermore, dot-matrix printers with graphics capabilites were priced in the $1500 range only two years ago; today the same features can be found in printers costing between $300 and $1000.

If you put to use the information that's been presented here, finding the printer you need should become a much less difficult task than you may have imagined it would be. **R-E**

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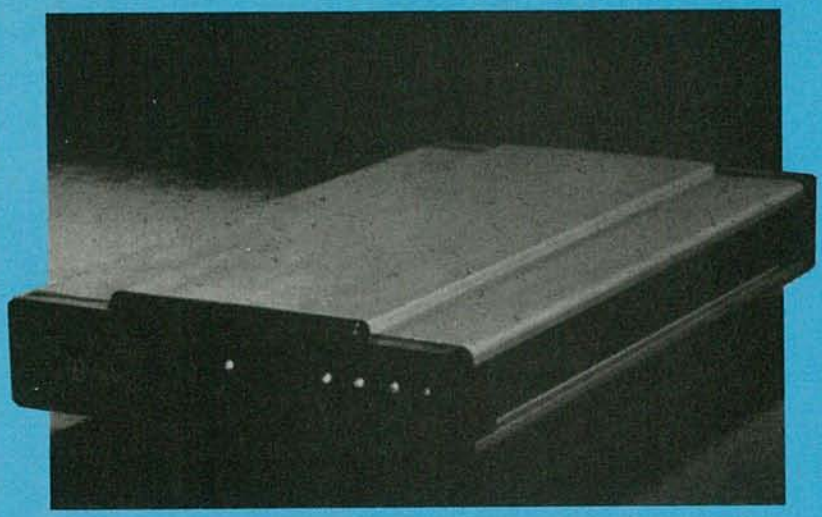


Modems

Your computer can exchange information with any other computer in the world—all you need is a telephone and a modem.

HERB FRIEDMAN

MOST FAMILY AND SMALL-BUSINESS USERS OF PERSONAL COMputers eventually discover that there's a lot more to the world of computers and information-processing than software they can write or purchase. For those who need it, there are the commercial data-banks that will provide up-to-the-minute information on just about anything, as well as "community bulletin boards"—usually run by hobbyists—that will keep you up to date on the latest developments in personal computing.

Then there's customized software to share. You might have written a program (or data) you'd like to share right now with a friend on the other side of town. Or maybe he has some new software he'd like to share with you.

If you're tired of killing a lot of time at the bank every payday, waiting in line to deposit your check and pay your bills, some banks will now allow you to handle all of your banking chores from the comfort of your home using your personal computer. (And if the banks have their way, in a few years you won't have the choice; all banking will be done through some form of personal computer—but that's a whole other story.)

The key to the world of personal computer communications is a modem (*MO*dulator/*DEM*odulator)—a device that permits computer and terminal communications over a voice-grade telephone circuit. It does so by converting your computer's electrical signals to audio tones that can be efficiently handled by the telephone system. Conversely, the modem converts received audio tones back to electrical signals that are understood by your computer.

Modems

There are several kinds of modems in current use. The type generally used for communicating through the dial-up telephone system is called "Bell-System-103-compatible," which means that it uses the same protocols (standards) as the modem that was provided by the Bell System when that company had a monopoly on data exchange over most of the telephone lines in North America.

A Bell-103-compatible modem can transmit and receive data at rates of 0 to 300 bps (*B*its *P*er *S*econd), which also happens to work out to be the "baud rate," because for data transmission, the bit rate equals the baud rate: 110 bps is 110 baud, 300 bps is 300 baud, etc.

While there are modems capable of transmitting and receiving more than 300 bps, they require specially equalized telephone circuits or dedicated lines and are presently not worth the expense for personal-computer use. It often can take several years just to pay off the difference in cost between a Bell-103-compatible modem and a high-speed modem, assuming you can get convenient access to a telephone circuit that will handle more than 300 bps efficiently. Because of that, we will concentrate mainly on Bell-103 compatible modems.

The first modems were rather simple devices as they were most often used to connect terminals—usually teletypewriters such as the *Model 33*—through the dial-up telephone system to large mainframe host-computers. The most common type used was the acoustic-coupled model (we'll get to why shortly), the type with two large rubber cups into which the user places the telephone handset after dialing up another computer or terminal. That type of modem is still popular today; let's take a closer look at it.

One cup contains a small speaker; the other a microphone. When the telephone handset is seated in the device, the handset's microphone is opposite the speaker, while the receiver (earphone) is opposite the modem's microphone. The modem itself is connected to the terminal or computer through a "standard" electrical connection, called an RS-232C interface (usually shortened to simply RS-232), or a 20-mA current loop. When an RS-232 interface is used, all signals are represented as variations in voltage level. In the case of the 20-mA current loop—the original "standard" for teletypewriters—the data is represented by the make/break sequence of a reference 20-mA DC current. Many early personal computers provided a 20-mA current-loop output because almost all commonly available modems could accommodate the 20-mA connection; not all were equiped to handle an RS-232 signal.

Electrical signals from your computer or terminal are converted by the modem to audio tones that are fed to the internal speaker and passed on to the handset's transmitter (microphone). Audio tones arriving over the telephone from another computer are picked up by the modem's microphone and converted to electrical signals.

Making the connection

The usual procedure for getting your terminal or computer hooked up to the remote computer or terminal is to first use a rotary or *Touch-Tone* telephone to call the remote. When the user hears the "carrier" tone from the remote computer, he inserts the handset in the modem's cups. When the modem senses the carrier, it turns on its own carrier, thereby informing the remote computer that the communications link has been established.

To make certain that every terminal can communicate with every computer, all Bell-103-compatible modems use exactly the same protocols. In the early days, because the remote terminal usually originated the "call," its modem was called an originate modem; it transmitted data at frequencies of 1270 and 1070 Hz. Since the host computer answered the call from the

terminal, its modem was called an answer modem. The answer modem transmitted the data at frequencies of 2225 and 2025 Hz. When, as often is the case today, the communications link is computer-to-computer rather than terminal-to-computer, either one can use the answer modem unless one is specifically designated as "the host;" in that case, it is the one with the answer modem.

The reason that those early modems were of the acoustic type was that, at one time, Bell would not allow anyone to connect directly to the telephone system without paying a stiff tariff for some sort of protective device; acoustic modems have no direct connection to the telephone lines. However, for those who could afford the convenience, many early acoustic modems also had provision for direct connection. For example, Fig. 1 shows an Omnitec model *701A* coupler. Many of you will recognize the Omnitec as the workhorse of the early time-share computer systems. Though the acoustic cups are plainly evident, there is also an output jack and switch for a direct connection to the telephone system, as well as a monitor output jack, a selector for half and full duplex operation, and connectors for both a 20 mA and an RS-232 input/output.

The *701A* was built like a battleship, could probably serve as a boat anchor in a howling gale, and was known for reliability. While the advertisements for many modern modems belittle acoustic coupling on the basis of noise interference or microphone distortion, bear in mind that acoustic couplers such as that one were usually bolted to the side of a teletype, which was known as a "Klunker" (because it literally "Klunked" away continuously). What's more, it was usually used in a room full of teletypes hammering away; yet it provided dependable computer communications at maximum convenience. (In case you're short of funds, those old acoustic couplers are available on the surplus market for $15 to $50, depending on the model.)

Full and half duplex

Before we go any farther, let's take time out to cover half and full duplex for those not familiar with the terms. When you use a terminal or a personal computer to communicate with a host computer, what you see on your video screen or printer is not what you sent from your keyboard. The video is an "echo" from the host computer that serves as a check on the two-way path between you and that computer. If the echo display is not what you sent you can be reasonably certain there is trouble with the telephone circuit or the host computer, not your equipment. You check that quickly by switching the modem to half duplex (if possible). In half duplex your own signal is returned by the modem to your video display; what you see is what you sent.

Unfortunately, you usually cannot use half-duplex with a host computer that is echoing for two reasons. Firstly, everything will be repeated, the video display will show your half duplex display and then the echo; the word 'HELP' would be displayed as "HHEELLPP." Secondly, many terminals and computers seem to "go crazy" when they must handle both the half-duplex signal and the echo; it's sort of like trying to speak while listening through headphones to your voice being reproduced with time delay from a tape recorder.

Until recently, most modems available to personal computer users were originate-only because it was assumed the user would only want to communicate with host computers or database systems (which are provided by a host computer). When it became obvious that users of personal computers wanted to communicate with other personal computers, an instant market was created for a combination answer/originate modem because in any communications link someone has to use an answer modem—although it doesn't matter who it is.

Up until a few years ago modems were somewhat expensive, too. A cheap originate-modem could run upwards of $150, while a manually-selected combination originate/answer modem usually cost in the neighborhood of $300-$500. Through modern technology, inexpensive integrated circuits, somewhat severe competition, and Bell losing the fight over whether they can control any and all equipment that generates signals carried on the telephone circuits (the Carterfone case), the price of modems has been sharply reduced. There is now a wide assortment of modem equipment specifically designed and priced for the personal computer user, with features ranging from the most basic to the most sophisticated.

What's available

Other than using a modular connector for modems that connect directly to the telephone system, no two manufacturers seem to have the same idea as to what features should go into a modem intended for use with personal computers. Because of that, we'll take a look at the various features found in some of the most popular or generally available models. You can then select what features you need or want most for your particular computer installation.

We'll start off with one from Omnitec—the people who manufactured the *701A*. Their latest effort is the model *9123AD*. It is a direct-coupled originate/auto-answer modem with automatic telephone-silencing. The modem connects to the telephone jack through a modular connector. The telephone, which formerly connected to the modular jack, now connects to a modular receptacle on the rear of the modem. The computer connects to the modem through a "standard" DB-25S, RS-232 connector.

The unit can be switch-selected to function as an originate, manual-answer, or auto-answer modem. Auto-answer means

FIG. 1—ALTHOUGH OVERSIZED AND HEAVY, older acoustic modems such as this one did an excellent job even in teletype-filled rooms.

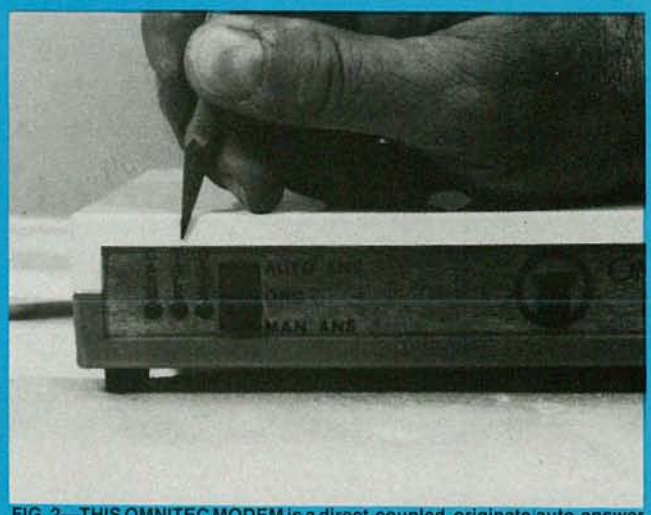


FIG. 2—THIS OMNITEC MODEM is a direct-coupled, originate/auto-answer model. The three front-panel LED's indicate operating status.

the modem literally "answers" a telephone call. When the phone rings the modem connects to the phone line and generates an answer carrier. If it receives an answer-back carrier from an originate modem, it establishes a communications link. If it does not, the modem disconnects itself from the line after approximately 20 seconds.

In the manual-answer mode, the user selects the mode after the telephone contact has been established. For example, if your friend calls you at 3 in the morning bubbling about his latest game and insists you take a download so you can try it immediately, you simply switch your modem to answer if all he has is an originate modem. On the other hand, if you are not enthusiastic about being disturbed in the middle of the night, you can leave your modem in the automatic mode. It will answer the phone, and with the proper software take the download automatically. All around, that is a very classy personal-computer operation.

The automatic telephone-silencer works this way. You are originating a link to, say, The Source. You dial their phone circuit, and when The Source connects with its answer carrier you hear it in the phone. When the modem senses the answer carrier, which takes only a few seconds, it automatically disconnects the handset—the receiver goes "dead." The modem is now connected directly to the line and the handset is disconnected so that when it is set in its cradle it neither goes "on hook" (disconnected), nor generates a glitch in the data stream.

The unit has three front-panel LED's (see Fig. 2). One indicates when the system is in the TALK mode—regular telephone use, one indicates a modem carrier is being received, and one indicates data flow. There is no on-off switch. The disconnect can be forced by a long or short space from the terminal, but few personal computers functioning as terminals can provide the proper space. Alternately, setting the terminal to the LOCAL mode can force the disconnect, but again, few personal computers can simulate that type of disconnect. When we need a fast release of the modem from the line and can't wait the 20 seconds or so for the automatic disconnect, it's done by simply pulling the power plug from its outlet. A simple power-switch would be a lot more convenient.

A somewhat different approach to a direct-connect originate/answer modem is the model *UM1*, a special version of the *Microconnection* from the Microperipheral Corporation. The usual *Microconnection* modem has the standard RS-232 I/O; that model is made to interface directly with the data-bus connector on the back of the keyboard of the Radio Shack *TRS-80 Model I* computer as shown in Fig. 3. It eliminates the necessity of spending $100 for Radio Shack's RS-232 interface. Even if you use the expansion interface for disk drives, the modem can still be connected to the keyboard's data bus connector along with the connection between the keyboard and the expansion interface. And best of all, that modem will work even with the 4K Level I *Model I*—the necessary driver-software is provided on cassette tape.

A somewhat unusual feature is a set of jacks that allow you to connect a cassette recorder so that you can record signals for later playback directly over the telephone line.

The rest of the features are more or less standard. There is manual on-off, manual selection of the originate and answer modes, and voice/data-mode selection—the data mode seizes the telephone line so you can hang up the telephone. Power and carrier indicator-lamps are provided.

While we're talking about relatively low-cost modems, let's take a look at some that use acoustic coupling. Modern versions of the old *701A* are now available from several sources for slightly more than $100. The only substantial difference in operation is that the latest versions now provide for both originate and answer operation. One slightly different modem of that type is the model *MJF-1230* inductively coupled modem from MJF Enterprises, a company relatively unknown in computer circles but with a long track record in amateur radio. Their contribution to modern technology is to use inductive coupling to receive the incoming signal. Supposedly that reduces ambient-noise interference. However, since we've never had problems with ambient-noise interference, even with an acoustic coupler sitting on top of a teleypewriter, we can't be certain that inductive coupling is of any extra value. Essentially, the unit performs like a standard originate/answer accoustic modem. Other features include full/half-duplex selection, TTL and CMOS I/O in addition to standard RS-232 (that should appeal to computer experimenters), and cassette recorder I/O ports that let you record incoming or outgoing signals (see Fig. 4).

Moving up in price, we find some high-technology modems such as the Novation *Auto-Cat*, a miniature originate/answer, auto-answer modem that is directly hooked up to the telephone line through a modular connector. The computer I/O is through a standard RS-232 interface.

Instead of mechanical switches, that modem uses a membrane-switch front panel to select originate or answer operation; the front panel also features three LED indicators.

A RESET front-panel switch clears the unit so that you can select the operating mode. For example, to originate a transmission, first the RESET switch is depressed. Next, the remote computer is called on the regular phone, and when the answer carrier is heard the ORIG (originate) switch is depressed and the phone is hung up. The modem seizes the line when switched to ORIG. The same procedure can be used for manual answer between two personal computers, or the answer connection can be controlled by the terminal through the DTR (*D*ata *T*erminal

FIG. 3—THIS SPECIAL MODEL of the *Microconnection*, the model *UM1* from the Microperipheral Corporation, works with the Radio Shack *TRS-80 Model I* and eliminates the need for the RS-232 expansion interface.

FIG. 4—IN ADDITION TO inductive coupling, some of the extra features found on the *MFJ-1230* modem from MFJ Enterprises include TTL/CMOS and cassette-tape I/O.

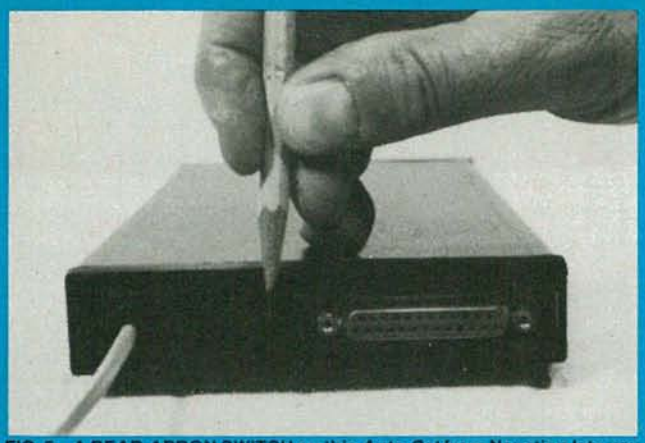


FIG. 5—A REAR-APRON SWITCH on this *Auto-Cat* from Novation lets you choose between normal operation and one of two test modes.

FIG. 6—ALTHOUGH SMALL ENOUGH TO FIT under a telephone, you don't need one to use the *SmartModem* from D.C. Hayes; all dialing is done from the computer or terminal keyboard.

*R*eady) signal on RS-232 pin 20. In the auto-answer mode, the modem automatically seizes and connects to the line when the phone rings.

The *Auto-Cat* has some interesting self-testing features. As shown in Fig. 5, a switch on the rear apron is used to select among NORMAL, AL, and DL operation. When set to AL (meaning, *A*nalog *L*oopback) the telephone line is busied-out, and the modems's output is returned to the input so that the display shows the keyboard entries. If you're having problems on the other end of the communications circuit, and you check out in the AL mode, you know that your terminal (or computer) and modem are working all right.

The DL mode (meaning, *D*igital *L*oopback) is a remote check. All data received is looped back to the remote station for verification. (Yes, an operator is required at the remote station.)

The modem "bails out" quickly if something goes wrong. Loss of carrier results in an almost instantaneous disconnect. Loss of the DTR signal from the computer causes an instantaneous disconnect. Failure to get an answer-back carrier in the answer mode will produce a disconnect in 18 seconds. Failure to get an answer modem's carrier when in the originate mode will cause a disconnect in 10 seconds.

The *Auto-Cat's* operating features are more or less common to other modems within the same general price range. For example, U.S. Robotics, an outfit that's been around personal computing a long time, has a model called the *Auto-Link 300* that has very similar features.

A somewhat unusual modem is the *Signalman* from Anchor, which is priced arround $100. It is a direct-connect manual-dial answer/originate modem with automatic operating-mode selection. It comes up in the originate mode, and if it does not "hear" the carrier from an answer modem it switches to the answer mode and transmits an answer carrier. The modem can only be used with a modular telephone having a plug-in handset. The handset plugs into the modem, and the modem plugs into the telephone's handset jack. When the modem is set for VOICE, the telephone can be used normally; when switched to DATA, the handset is disconnected and the modem goes "on-line." The unit is powered by an internal 9-volt battery or an optional AC adapter. It is available with an RS-232 connector, or with special cables for direct connection to the *Osborne 1* and most commodore *PET/CBM* computers. Cables are also available for the Atari *850* and the Texas Instruments *TI 99/4A* interfaces.

For many users, however, the ultimate modem for personal computers has been the D.C. Hayes *SmartModem*, which is available in a standard RS-232-configuration for somewhat under $300, and in a special version for the Apple and S-100 computers. The unit has its own on-board Z-80 microprocessor. It connects directly to the telephone line through a modular connector and no telephone of any kind is required because all operating functions, including the dialing, is done directly from the terminal or computer keyboard. However, there is a modular phone connector on the back of the device. When the modem is connected to the telephone jack, the phone connection itself is moved to the rear of the modem. In fact, the modem is specifically designed to fit under a standard desk-telephone so that they become an "integral unit" as shown in Fig. 6.

There are no mode switches, because, like everything else, mode selection is done from the keyboard. Other than a power switch and a volume-level adjustment for a built-in speaker, there are no controls. The operating status, test, and checks are indicated by seven front-panel LED indicators.

An internal speaker allows the user to monitor the telephone circuit to hear dial tone, ringing, and the answer. When the call is answered by a carrier, the carrier is heard briefly and then the speaker is automatically muted for the remainder of the session.

Most of the operating parameters are programmable through the keyboard. For example, you can select either pulse (simulated rotary) or *Touch-Tone* dialing, or a combination of the two; such as pulse dialing a computer and then controlling the computer with *Touch-Tone* signals. You can set how many rings are required before the modem automatically answers the line (from 0 to 255), how long to wait after a ring before the modem is reset for another count, what you want the ASCII escape code to be, the ASCII values of the carriage return, line feed, and back space, time delay for dialing to accommodate "dial 9" (outside calls from an office) circuits, waiting time for answerback carrier before disconnecting from the line, echo on and off, loopback, etc. In addition, the default parameters can be configured through a DIP selector-switch that is accessible when the front panel is removed (see Fig. 7).

The operating features of the *SmartModem* are simply too extensive to cover completely here; but though extensive, the modem is unsually easy to use. The only difficulty, if it can be called that, is that few stores are able to demonstrate it adequately. We tried two of the largest local computer shops and found that none of the clerks at either knew what they were talking

FIG 7—The *SMARTMODEM'S* OPERATING PARAMETERS can be set from the keyboard or through the use of this DIP switch; the switch is concealed behind the front panel of the device.

TABLE 1—DIRECTORY OF INDEPENDENT MODEM MANUFACTURERS

Modems are available from computer manufacturers, and also from many independent manufacturers, such as the ones listed below.

ANCHOR AUTOMATION
6624 Valjean St.
Van Nuys, CA 91406

ANDERSON JACOBSON
521 Charcott Avenue
San Jose, CA 95131

APF ELECTRONICS, INC.
1501 Broadway
New York, NY 10036

BIZCOMP
Box 7498
Menlo Park, CA 94025

HAYES MICROCOMPUTER PRODUCTS
5385 Peachtree Corners East
Norcross, GA 30092

LEXICON CORPORATION OF MIAMI
1541 NW 65th Avenue
Plantation, FL 33313

LIVERMORE DATA SYSTEMS
2050 151st Place NE
Redmond, WA 98952

MFJ ENTERPRISES, INC.
921 Louisville Rd.
Starkville, MS 39759

THE MICROPERIPHERAL CORP.
2643 151st Place NE
Redmond, WA 98052

MULTI-TECH SYSTEMS, INC.
82 Second Avenue SE
New Brighton, MN 55112

NOVATION
18664 Oxnard St.
Tarzana, CA 91356

OMNITECH DATA
2405 South 20th St.
Phoenix, AZ 85034

QUEST ELECTRONICS
P.O. Box 4430E
Santa Clara, CA 95054

RACAL-VADIC INC.
222 Caspian Drive
Sunnyvale, CA 94086

RIXON, INC.
2120 Industrial Parkway
Silver Springs, MD 20904

TNW CORP.
3351 Hancock St.
San Diego, CA 92110

US ROBOTICS
203 N. Wabash, Suite 1718
Chicago, IL 60601

UNIVERSAL DATA SYSTEMS
5000 Bradford Drive
Huntsville, AL 35805

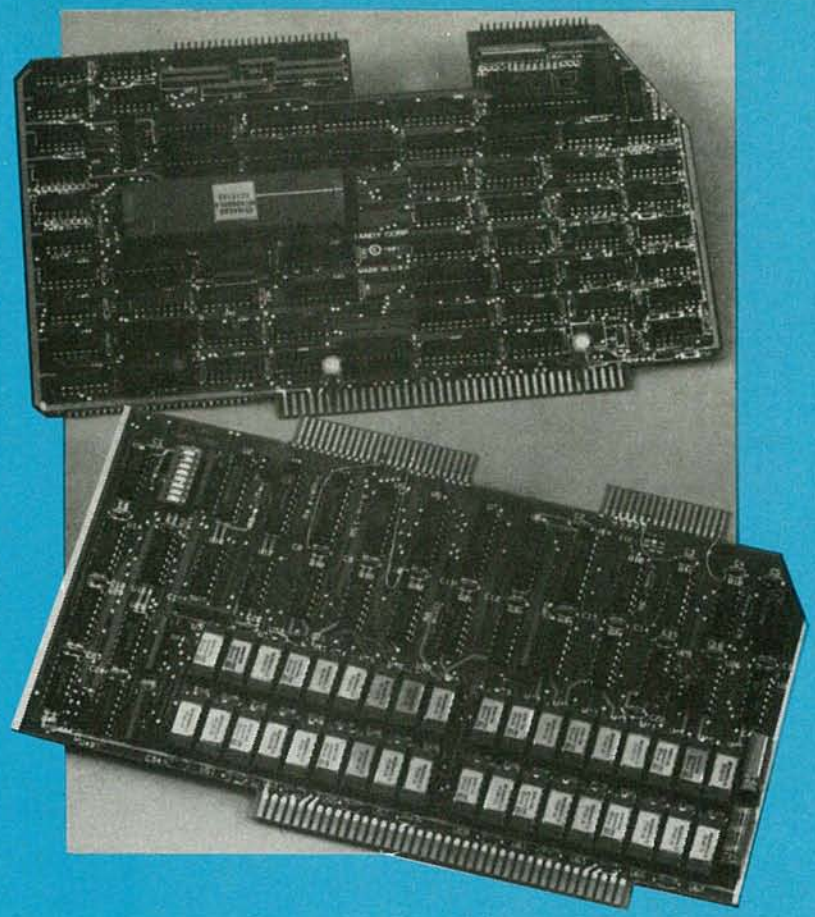
about. One even wanted to sell us the Apple model for use on a Heathkit *H89* computer. If you want information on the unit, write directly to D.C. Hayes.

We've touched only on the highlights of several modems that offer the most common operating features. When you shop for your own unit you're sure to see many more (for your convenience, we've included a list of manufacturers—see Table 1). By looking at the features of the modems listed here, you'll be able to figure out which ones you need or want before you get to your local dealer or place your order. **R-E**

Radio Electronics YOUR OWN Computer APRIL 1983

Accessory Boards

Increase RAM, add color and/or high-resolution graphics, and even add a second CPU to your system with one of these add-on accessory boards. Here's a look at what's available and what they can do.



MARC STERN

BACK AT THE DAWN OF THE PERSONAL-COMPUTER AGE, CIRCA 1975, a company named MITS introduced the first true personal computer—the *Altair 8800*. An interesting facet of that computer's design was that its circuitry was built on several boards and those boards were electrically connected to each other through a wiring structure called a *bus*.

What exactly is a bus? Simply stated, it is a group of wires that carry all of the signals from all of the boards throughout the computer. The importance of that is that all the signals from all the various parts of the computer—memory, processor, video, etc.—are available at any point along the bus; to access those signals, all you need do is tap into it. The cleanest, and most useful way to do that is to insert a card connector into the bus. Then, whatever circuitry that you want to have access to the signals on the bus is simply mounted on a PC board that slips into the connector. Often those card connectors are all mounted on a single PC board called a *motherboard*.

Using some type of bus structure allows your system maximum flexibilty because upgrading or modifying it is greatly simplified. If you want more memory, better graphics, a direct-connect modem for telecommunications, or even a second microprocessor, all you need do is slip in an add-on board into one of the connectors.

The bus developed by MITS for their *Altair 8800* is now known as the S-100 bus; it is the most widely used bus structure for microcomputers. That doesn't mean, however, that it is the only one. Another popular bus is the SS-50 used in computers from Gimix, Southwest Technical Products, and others. Several popular computers, such as the *Apple II*, Zenith *Z-89* (also known as the Heath *H-89*), Radio Shack's *TRS-80 Model II* and *Model 16*, and the IBM *PC* for instance, also are bus oriented but use their own type of bus structure. That means an accessory card for an Apple computer won't work in an IBM *PC*, and vice versa. And, not all S-100-bus boards will work on every S-100-bus machine. Although a formal standard exists, not all companies adhere to it and that can sometimes lead to problems. Thus, before you buy any accessory board, make sure that it will run in your machine.

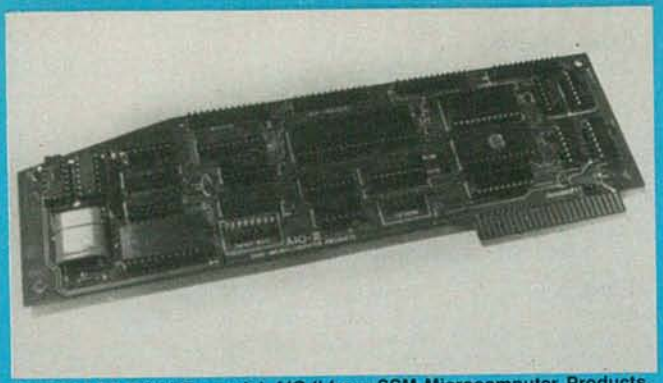
Memory boards

One of the most popular types of accessory board is the memory board. That should come as no surprise, however, since no matter how much memory your microcomputer has, it never seems to be enough. It always seems that sooner or later even 64K of RAM just isn't able to handle the tasks you want to do. The answer, of course, is to add more RAM. That's easy enough to do, particularly for users of 16-bit machines like the IBM *PC*.

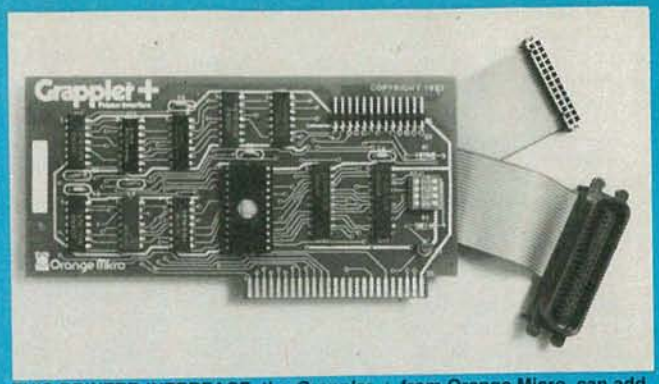
A 16-bit machine, by virtue of its having 24 address lines, can, in theory, access over 16 *megabytes*. In general, however, most memory boards feature a maximum of 256K, although we've seen a couple of boards sporting 512K and one with 576K. Thus, if you're running a 16-bit microprocessor, all you need do is select a board with as much memory as you need or can afford, and slip it into one of the edge connectors.

Actually, it's not quite that simple. If you just slipped the card in and did nothing else, the added memory would never be used simply because the microprocessor would not even know that it was there. Every byte of memory in the computer has a specific address. Before the accessory board is added, the computer is configured so that the microprocessor knows that all the RAM memory lies between two addresses. It will not attempt to store data at a memory location outside those addresses because, at least as far as the microprocessor is concerned, there is nothing there. Thus, before the memory can be accessed, a couple of DIP switches must be reset assigning the new RAM a starting address within the computer's memory.

An 8-bit microprocessor, on the other hand, has just 16 address lines, which means, at least in theory, that the most memory it can address is just a bit more than 64K. In reality, however, even 8-bit machines can access much more, but to do



INTERFACE BOARD, model *AIO-II* from SSM Microcomputer Products, provides the *Apple II* with a full function, highly flexible serial/parallel interface.



THIS PRINTER INTERFACE, the *Grappler +* from Orange Micro, can add many printing features to the Apple computers.

that you've got to play a few tricks on the system. One common trick is to use a technique known as bank select. When that is done, the memory is assigned to an I/O port and all of the data to and from that board is up- and down-loaded through that port. Hobbyists with 8-bit machines have been known to run as much as a megabyte of RAM.

Let's now take a look at some of the memory boards currently available. Turning first to a 16-bit machine, in the relatively short time since its introduction, the IBM *PC* has become one of the best supported machines in the industry. Among its nice features are provisions for easy expansion—i.e., the machine provides five card-connectors for easy installation of accessory boards. Memory boards for that machine are available from Microsoft, Microtek, Davong, Qubie Distributing, Aegis Systems, Seattle Computer, Quadram, Vista, and others. Prices vary from less than $250 to over $1700, depending on memory capacity, manufacturer, and supplier. In addition, many of the boards offer more than just memory expansion. The *Quadboard* from Quadram, for example, also offers a clock/calander, parallel-printer I/O, and an RS-232 interface.

The S-100 bus allows for up to 24 address lines, so either 16- or 8-bit computers can use that bus structure. Pick up an issue of almost any computer magazine and you'll see dozens and dozens of advertisements for S-100 boards, and prominent among them are memory boards of all capacities. Memory boards for S-100-bus machines are available from Intercontinental Micro Systems, Electronic Control Technology, Inc., Netronics, Memory Merchant, and Lomas Data Products to name just a very few. Boards for SS-50 systems are a little harder to find, but are available from several sources, including Gimix.

The *Apple II* is among the most popular 8-bit machines on the market. As it too features a user-accessible bus for easy expansion, there are a variety of accessory boards, including memory boards, available for it. Most of those are 16K boards for upgrading the 48K machine to 64K. A few boards, however, offer as much as 128K. One extremely interesting board is the *Bubble Memory Disk Emulator* from MPC. As the name indicates, it is a bubble memory (featuring 128K of storage) that attaches to a disk I/O-port and takes the place of a disk drive. Bubble technology is ideal for such an application as it is non-volatile—if power is removed from the device, the contents of the memory are not destroyed. More conventional memory boards are available from many suppliers including Advanced Logic Systems, Microtek, Wesper Micro Systems, Saturn Systems, and Davong

Microprocessor boards

One of the few serious drawbacks of the Apple *II* is that its microprocessor is a 6502. Although that is a fine microprocessor in its own right, some of the best 8-bit operating systems, and some of the best 8-bit software, are designed to be run on a Z80 microprocessor. But that doesn't mean you're out of luck. Several manufacturers, such as Microsoft and Personal Computer Products make accessory boards with that CPU for the Apple computer. Simply install one of those boards in your machine, and you can run *CP/M*, *Wordstar*, *dBASE II*, and any other Z80-based software with no difficulty. Boards with other microprocessors, such as the 16-bit 8088 (used in the IBM *PC*) are also available.

A variety of microprocessor boards are also available for S-100-based machines. Those machines are designed to run using just about any 8-bit or 16-bit microprocessor. A user needs only to select a board with the microprocessor he wants to run and install it. Also note that several manufacturers make dual microprocessor boards—most often incorporating an 8-bit and 16-bit microprocessor. Cromemco and Radio Shack, for example, make boards that contains both a MC68000 16-bit microprocessor and the 8-bit Z80. Radio Shack's board is sold as part of an upgrade kit for their *Model II*. With that upgrade, the user gains all of the advantages of the new *TRS-80 Model 16*, including the ability to run both 16-bit *Model 16* and 8-bit *Model II* software. Cromemco's board is for S-100-bus systems

Graphics boards

Another popular type of accessory board is the graphics board. Those are popular for a number of reasons, but primarily because few users are satisfied with the graphics capability of their machine as supplied. For instance, some offer only monochrome displays, others offer only a 40-column (or even smaller) display, while others lack an interface that will allow it to be used with an RGB monitor. Boards to solve each of those problems are available from a variety of sources.

Most graphics boards for the Apple *II* are intended to provide an 80-column display for that machine. As supplied, the Apple's display is just 40-columns, hardly adequate for some applications such as word processing. Most of those cards also allow the display of upper- and lower-case characters.

Although they're a little harder to find at times, there are many boards on the market designed to bring color graphics to the Zenith Z89; as supplied, those computers can generate 24 lines × 80 characters on a built-in monochrome display. Typically, the accessory boards provide good resolution (256 × 192 pixels) and have 15-color capability; of course, you'll need to use a separate color monitor. Some sources for boards for Heath/Zenith computers include Kres Engineering, Mako Data Products, and New Orleans General Data Services.

Turning to S-100 based systems, there are several boards on the market that allow you to generate some rather impressive graphics. One of those boards, the *Microangelo* from Scion, can produce a 512 × 480 pixel monochrome display. As to character generation, it can display 40 lines × 85 characters of text. To add color capability more boards are added, each generating its own monochrome "transparency." The output of the boards are combined by the color mixing board. If eight boards are used, the maximum that can be handled by the system, an image with 255 colors could be generated. An advantage to this type of graphics generation is that colors can be easily added or deleted without otherwise affecting the image.

ACCESSORY BOARD SUPPLIERS

Adisa Corp.
Box 1364
Palo Alto, CA 94301

Advanced Digital Corp.
12700-B Knott St.
Garden Grove, CA 92641

Advanced Logic Systems
1195 East Arques Ave.
Sunnyvale, CA 94086

Aegis Systems
202 W. Bennett St.
Saline, MI 48176

Antex Data Systems
2630 California St.
Mountain View, CA 90404

Apparat Inc.
4401 S. Tamarac Pkwy.
Denver, CO 80237

ASAP Computer Products
1198 E. Willow St.
Signal Hill, CA 90806

AST Research Inc.
2372 Morse Ave.
Irvine, CA 92714

Axlon Inc.
170 North Wolfe Rd.
Sunnyvale, CA 94086

Cactus Technology Inc.
3024 North 33rd Dr.
Phoenix, AZ 85017

California Computer Systems
250 Carribean Dr.
Sunnyvale, CA 94086

Chrislin Industries
31352 Via Colinas
Westlake Village, CA 91362

Comemco
280 Bernardo Ave.
Mountain View, CA 94040

Computer Peripherals
1117 Venice Blvd.
Los Angeles, CA 90015

Davong Systems Inc.
1061 Terra Bella Ave.
Mountain View, CA 94043

Daystar Systems Inc.
10511 Church Rd. Suite A
Dallas, TX 75238

Dual Systems
2530 San Pablo Ave.
Berkeley, CA 94702

Electronic Control Technology Inc.
763 Ramsey Ave.
Hillside, NJ 07205

Gimix
1337 W. 37th Place
Chicago, IL 60609

Godbout Electronics
Box 2355
Oakland Airport, CA 94614

GSR Computers
60-10 69th St.
Maspeth, NY 11378

Hayes Microcomputer Products
5835 Peachtree Corners East
Norcross, GA 30092

Hurricane Labs
5149 Moorpark Ave.
San Jose, CA, 95129

Independent Business Systems
5915 Graham Ct.
Livermore, CA 94550

Indigo Data Systems Inc.
100 E. NASA Rd. 1
Suite 107
Webster, TX 77598

Intercontinental Microsystems Corp.
1733 S. Douglass Rd.
Anaheim, CA 92806

Intermedia Systems
10601 South De Ansa Blvd.
Cupertino, CA 95014

Intex Micro Systems Corp.
755 West Big Beaver Rd. Suite 1717
Troy, MI 48084

JC Systems
1075 Hiawatha Ct.
Fremont, CA 94538

John Bell Engineering Inc.
1014 Center St.
San Carlos, CA 94070

Kres Engineering
PO Box 17328
Irvine, CA 92713

Legend Industries Ltd.
2220 Scott Lake Rd.
Pontiac, MI 48054

Lomas Data Products
729 Farm Road
Marlboro, MA 01752

Macrolink Inc.
1150 East Stanford Ct.
Anaheim, CA 92805

Macrotech International Corp.
22133 Cohasset St.
Canoga Park, CA 91303

Magnolia Microsystems
2264 15th Ave. W.
Seattle, WA 98119

Matco
427 Perrymont
San Jose, CA 95125

Mako Data Products
1441-B N. Red Gum
Anaheim, CA 92806

Memory Merchant
14666 Doolittle Dr.
San Leandro, CA 94577

Memory Technologies Inc.
25 Main St.
Twelve Mile, IN 46988

Memotech
7500 West Yale Ave., Suite 200
Denver, CO 80227

Microcomputer Business Industries Corp.
1019 8th St.
Golden, CO 80401

Micro Intercontinental Systems Corp.
1733 S. Douglass Rd. Suite E
Anaheim, CA 92806

Micromint Inc.
561 Willow Ave.
Cedarhurst, NY 11516

MicroSoft Corp.
10700 Northrup Way
Bellevue, WA 98004

Micro Synergy
1327 Whiteacre Dr.
Clearwater, FL 33516

Microtek
9514 Chesapeake Dr.
San Diego, CA 92123

Mosaic Electronics
Box 748
Oregon City, OR 97045

Mountain Computer
300 El Pueblo Rd.
Scotts Valley, CA 95066

MPC Peripherals Corp.
9424 Chesapeake Dr.
San Diego, CA 92123

Netronics
333 Litchfield Road
New Milford, CT 06776

N.O. General Data Services
7230 Chadbourne Dr.
New Orleans, LA 70216

Orange Micro Inc.
1400 North Lakeview
Anaheim, CA 92807

PDS Universal Inc.
2630 Walnut Ave. Suite G
Tustin, GA 92680

Personal Computer Products Inc.
16776 Bernardo Center Dr.
San Diego, CA 92128

Persyst
15801 Rockfield
Suite A
Irvine CA 92714

Precision Technology Inc.
Computer Products Div.
2970 Richards St.
Salt Lake City, UT 84115

ACCESSORY BOARD SUPPLIERS

Pure Data Ltd.
950 Denison St.
Markham, Ontario, Canada L3R 3K5

Qubie Distributing
918 Via Alondra
Camarillo, CA 93010

Quadram Corp.
4357 Park Drive
Norcross, GA. 30093

Rana Systems
20620 South Leapwood
Carson, CA 90746

Renaissance Technology Corp.
1070 A Shary Cir.
Concord, CA 94518

Saturn Systems Inc.
PO Box 8050
3990 Varsity Dr.
Ann Arbor, MI 48107

Scion
12310 Pinecrest Rd.
Reston, VA 22091

S.C. Digital
Box 906
1240 N. Highland Ave.
Suite 4
Aurora, IL 60507

Seattle Computer
1114 Industry Dr.
Seattle, WA 98188

Sierra Data Sciences
26112 Lorain Ave.
Fairview Park, OH 44126

Sigma Designes Inc.
1400 Coleman Ave. F23
Santa Clara, CA 95050

Sigma Designs, Inc.
3866 Eastwood Cir.
Santa Clara, CA 95055

Sonic Micro Systems
1500 N.W. 62nd St.
Ft. Lauderdale, FL 33309

Southwest Technical Products
219 W. Rhapsody
San Antonio, TX 78216

SSM Microcomputer Products, Inc.
2190 Paragon Dr.
San Jose, CA 95131

Static Memory Systems
401 State Bank Center
Freeport, IL 61032

Systems Group
1601 W. Orangewood Ave.
Orange, CA 92660

Tara Computer Products
3648 Southwestern Blvd.
Orchard Park, NY 14127

Tarbell Electronics
950 Dovlen Place
Suite B
Carson, CA 90746

TK Engineering
Box 1936
Corona, CA 91720

Videx Inc.
897 N.W. Grant Ave.
Corvalis, OR 97330

Vista Computer Co. Inc.
1317 E. Edinger
Santa Ana, CA 92705

Votrax Speech Synthesis
500 Stephenson Hwy.
Troy, MI 48084

VR Data
777 Henderson Blvd., N-6
Folcroft, PA 19032

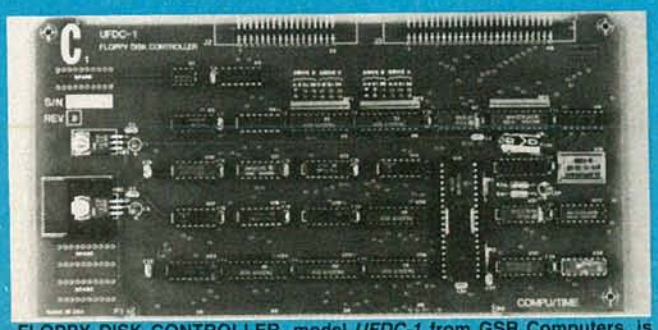
Wesper Micro Systems
3188 Pullman St.
Costa Mesa, CA 92626

Finally, for best resolution, an R-G-B rather than a video output is desirable. Boards that provide R-G-B outputs for computers that lack them are available from a variety of manufacturers.

Printer interface boards

While there are a great many boards on the market whose sole purpose is to provide a serial or parallel interface for use with a printer, there are a couple of types of printer-interface boards that do quite a bit more. One type is the high-resolution graphics interface, an example of which is the *Grappler +* from Orange Micro. That board interfaces an Apple *II* (or *III* with additional software) with any one of several popular printers. Among its features is the capability of providing high-resolution screen dumps to your printer.

Another popular type of printer-interface board is the spooler or buffer. Its primary purpose is to allow the computer to perform a new task while printing is going on. If you've ever just sat around and waited during a lengthy printout, you can imagine why that type of accessory board is in demand.



FLOPPY DISK CONTROLLER, model *UFDC-1* from GSR Computers, is capable of connecting up to four floppy-disk drives to an S-100 system.

Miscellaneous boards

We've only touched on a few types of accessory boards available. A quick look through almost any computer magazine will quickly reveal that there is a board for just about any function. Among the other popular types are modem boards, speech-synthesizer boards, sound-effects boards, PROM- and EPROM-programmer boards, and instrument-controller boards. It is also possible to combine several functions in a single board; an example is Quadram's *Quadboard*.

In addition, while we've been concentrating on boards for bus-oriented systems as those types of systems allow for the easiest expansion, boards are also available for non-bus-oriented systems. The major problems with some of those is installation—while some simply replace existing boards in a machine, others require some modifications to the computer.

All of the types of boards mentioned in this article will help a microcomputer user get the most possible computing power out of his system at a relatively low cost. Still, there are some problems of which you should be aware. First, it's necessary to check the power requirement of any board you may be considering. If your micrcomputer is already on the ragged edge of its power-providing capability then it's likely that any additional expansion boards will send it over the edge. In that event, the only alternative is to "beef-up" your computer's power supply.

Another potential problem that could be caused by adding a board is heat production. If your computer is already running hot, adding another board may just push it over the brink to self-destruction if the system is incapable of handling the heat. If your system is running hot, it is best to add a cooling fan or upgrade an existing one. In fact, if your system is running hot, it's best to do that whether or not you're adding another board.

All-in-all, however, those problems are easily corrected, as we've shown, and should not keep you from upgrading your system with one of the many types of accessory boards we've discussed. **R-E**

GLOSSARY OF COMMONLY USED COMPUTER TERMS

For those readers unfamiliar with computer terminology, we have included the following glossary of some commonly used computer terms.

Address—The label or number identifying the register or memory location where a unit of information is stored.

ALU—*A*rithmetic *L*ogic *U*nit. The part of a CPU where binary data is acted upon.

ASCII—Acronym for *A*merican *S*tandard *C*ode for *I*nformation *I*nterchange. A seven-bit code used to represent alphanumeric characters. It is useful for such things as sending information from a keyboard to the computer, and from one computer to another.

Assembler—A program that translates assembly-language instructions into machine-language instructions

Assembly language—A machine oriented language in which mnemonics are used to represent each machine-language instruction. Each CPU has its own specific assembly language. See *CPU* and *machine language*.

Baud rate—Serial-data transmission speed. Originally a telegraph term, 300 baud is approximately equal to a transmission speed of 30 bits-per-second.

Binary—Refers to the base-2 number system in which the only allowable digits are 0 and 1.

Bit—Acronym for *BI*nary digi*T*. The smallest unit of computer information, it is used to represent either a binary 0 or 1.

Bubble memory—A relatively new type of computer memory, it uses tiny magnetic "pockets" or "bubbles" to store data.

Bus—Parallel lines used to transfer signals between devices. Computers are often described by their bus structure (i.e. S-100-bus computers, etc.).

Byte—A group of eight bits.

Clock—The timing circuit for a microprocessor.

Compiler—A program that translates a high-level language, such as BASIC, into machine language.

CPU—Acronym for *C*entral *P*rocessing *U*nit. The part of the computer that contains the circuits that control and perform the execution of computer instructions.

Data base—A large amount of data stored in a well-organized manner. A data-base management system is a program that allows access to the information.

Disk operating-system—Program used to transfer information to and from a disk. Often referred to as a DOS.

EPROM—A PROM that can be erased by the user, usually by exposing it to ultraviolet light. See *PROM*.

File—A collection of data that is treated as a unit.

Firmware—Programs stored in PROM or EPROM.

Hardware—The physical components that make up a computer.

Hexadecimal—Refers to the base-sixteen number system. Machine language programs are often written in hexadecimal notation.

Interface—The connecting device between a computer and a periphiral.

K—Abbreviation for kilobyte (1024 bytes).

Machine language—Instructions, written in binary form, that a computer can execute directly. Also called machine code or object code.

Microprocessor—A one-IC CPU. One common microprocessor often used in personal computers is the Zilog Z80.

Modem—Acronym for *MO*dulator/*DEM*odulator. A device that transforms electrical signals into audio tones for transmission over telephone lines, and does the reverse for reception.

Motherboard—In a bus-oriented system, the board that contains the bus lines and edge connectors to accomodate the other boards in the system.

Port—A channel through which data is transferred to and from the CPU. An 8-bit CPU can address 256 ports.

PROM—Acronym for *P*rogrammable *R*ead *O*nly *M*emory. A semiconductor memory whose contents cannot be changed.

RAM—Acronym for *R*andom *A*ccess *M*emory. A semiconductor memory that can be both read and changed during computer operation. Unlike other semiconductor memories, this one is volatile—if power to the RAM is cut off for any reason, all data stored in the device is lost.

ROM—Acronym for *R*ead *O*nly *M*emory. A semiconductor memory containing fixed data—the computer can read the data but cannot change it in any way.

Software—Programs stored on tape or disk.

Source code—A non-executable program written in a high-level language. A compiler or assembler must translate the source code into an object code (machine language) that the computer can understand.

Word—Number of bits treated as a single unit by the CPU. In an eight-bit machine, the word length is eight bits; in a sixteen-bit machine, it is sixteen bits. **R-E**

Radio Electronics YOUR OWN Computer APRIL 1983

Gadgets and Gizmos

A true computer system consists of more than just a computer. It also includes many accessories to make the computer more efficient.

HERB FRIEDMAN

THE RANGE OF GADGETS AND GIZMOS THAT ARE AVAILABLE FOR personal computers is astounding. What is available includes rock-bottom-priced aids such as keyboard overlays that make software even easier to use; I/O converters that permit high-performance printers to be used with low-cost computer systems for word processing on a budget; and even disk simulators that add hundreds of thousands of bytes of RAM to a conventional 8- or 16-bit computer.

To show how an add-on can greatly increase a computer's capability or ease of use, let's start our tour through aftermarket hardware with a device that is made for Radio Shack's *Color Computer*: a serial-to-parallel printer converter.

The Radio Shack *Color Computer*—or "CoCo" as it is often called—has been a great value since its introduction. One reason is that it includes a serial output port that can be used for either a modem or a printer. Unfortunately, that port has some unusual characteristics, and until recently it could be connected only to a general-purpose printer that was really best suited for program listings. It wasn't possible to use one of the many high-performance, low-cost parallel printers on the market, such as the Epson *MX-80*.

First to rush in to change that was The Micro Works. Their *PI80C* serial-to-parallel printer adapter converts the serial output from the *Color Computer* to a parallel output. That allows the use of the Epson, or any of the other high-performance Centronics-type printers dumped on the market at rock-bottom prices—such as the Centronics *737*, and even Radio Shack's *Line Printer VII* that was sold off in some stores for the bargain price of about $300.

When the *Telewriter-64* software was introduced by Cognitec, it established the *Color Computer* as a full-featured, professional-quality word processor. The trouble was that there was no suitable low-cost daisy-wheel printer that would work with the *Color Computer* with or without the then-existing adapters. That problem was resolved by Botek Instruments' model *CCP-1* serial-to-parallel converter that works with every popular printer including the low-cost Smith-Corona *TP-1* daisy-wheel printer. With the Botek adapter, it doesn't matter whether you're using one of the old, new, or "salvage" parallel printers—they all work with the *Color Computer*.

Now that we have a picture of how drastically an add-on gadget or gizmo can affect a personal computer and its use, let's take a look at some others that are available and what they can do.

Software aids

Not all computer accessories are electronic. Some add-ons simply make a certain program easier to use. We previously mentioned keyboard overlays that can make software easier to use. They are available for *WordStar*, *dBase II*, and *SuperCalc*. *WordStar* and *dBaseII* are two of the best but most complicated programs to use because they have so many control codes and procedures. If you don't use one of those programs on a steady basis you will have to make frequent and frustrating references to the operating manual. *SuperCalc* isn't as bad—it's among the easiest of all the spreadsheet programs to use, but it also has an arm's-length list of command codes. However, with the *Kleertex* template for the Osborne (shown in Fig. 1), the operation of all three are simplified and they become almost a delight to use. I think that those *Kleertex* overlays by Creative Computer Products are possibly the best operating aids on the market. The precision die-cut keyboard overlays are made of heavy, flexible plastic. They have the commands grouped around the keys, and the grouping is better than the summary cards that the manufacturers supply with their software! The *Kleertex* aids have had test users up and running the three programs in hours rather than days or weeks. And they can quickly get you running a program that you haven't used in a while. They are supposed to

FIG. 1—KEYBOARD OVERLAYS from *Kleertex* can have you running software in hours rather than days.

be in the Xerox stores sometime in 1983. Personally, if I didn't own an Osborne I'd cut the templates down to fit my computer—which is how I'm going to fit the *Kleertext* template for *WordStar* to a Heath *H19* terminal.

Timex/Sinclair accessories

One of the great things about computer accessories is that they can increase the power of even the most inexpensive machine. One of the most popular low-cost computers is the Sinclair *ZX81* and/or the Timex/Sinclair *1000*. (The only difference between them is that the Timex, with 2K of RAM, has twice the memory of the ZX81.) That computer is used by some perople as a trainer for children; by others who are on a budget as a "main" computer; and it's even used by owners of full-blown personal computers who want a portable that fits into an attache case. To say that the Timex has limitations is an understatement—but it is a remarkably powerful computer for the money. The "official" accessory is a plug-in 16K RAM module. Another Timex accessory, the printer (not yet available in the US), is tiny and uses thin rolls of thermal printer paper that are best suited for listings. But there are aftermarket outfits that turn out professional accessories for the Timex/Sinclair computers. For example, Memotech Corp. makes memory modules of 16K and 32K RAM and even 64K RAM. They also make a Centronics-type printer interface that permits the use of a standard parallel printer with the Timex and also a module for high-resolution graphics (198 × 248 pixels). As shown in Fig. 2, each module connects to the rear expansion port and has its own expansion port on the rear so that other modules can be plugged in and stacked. At the end of the line Timex's own 16K module can be installed. (For 32K total RAM you could use a Memotech 16K module and the Timex 16K RAM module.) The "award winner" of all those modules is the Centronics-type parallel printer interface. That lets the user step up to professional quality printing—no more little strips of paper.

Because the Timex/Sinclair computer is low cost and mass-merchandized it might well prove to be the most popular (at least the most widely sold) computer, so we can expect to see many more "expansion" devices offered as accessories. Already, full-sized, typewriter-like replacements for the hard-to-use membrane keyboard are hot sellers, as are keyboard "beepers" that let you know when you hit a key. We have read advertisements describing clock/calendars that plug into the expansion port, and even a communications modem and an EPROM programmer; but inquires to date have failed to turn up a production model—all appeared to be in the "final stages of production" at the time this article was prepared.

Printer accessories

Another gadget for printers—there are lots of them—is hardware generally described as a *microbuffer*. That's an 8K or 16K RAM specifically intended to connect between your computer and the printer. There are even models that provide as much as 64K or 256K of RAM. What's the advantage of one of those devices? You would know if you ever had to wait for your printer to finish printing a document before you could get back to using your computer for something else. The typical matrix printer for a personal computer runs at a top speed of approximately 80 characters-per-second. Some daisy-wheel printers are even slower, some as slow as 12 or 14 characters-per-second. If you have a long document it can take quite a while, perhaps 5 to 10 minutes to print 4000 words (24,000 characters). In "computer time," 5 minutes is a lifetime, and during that period your computer sits unused for any purpose other than to print the document. That's a most intolerable situation.

But if you connect a microbuffer RAM between the computer and the printer then the computer can dump characters into microbuffer RAM at speeds up to 120,000 characters per second, 2600 words in the blink of an eye. When enough RAM is free in the microbuffer the computer does another high-speed dump to fill the buffer RAM. While the printer extracts its data slowly from the microbuffer, the computer has its RAM free and can be used for other purposes.

FIG. 2—ADD-ON MODULES for the Timex/Sinclair computer from Memotech Corp. are stackable.

Microbuffers are available under many different brand names for a host of computers and printers. Some get built into the printer, such as the one for the Epson printer from Practical Peripherals, Inc. Others are outboard accessories such as the *Printer Optimizer* from Applied Creative Technology, Inc.

We previously discussed a serial-to-parallel converter for the *Color Computer*, but other computers or computer users could also use such a converter. (That's not only for printers, but for any other parallel device.) Presume, for example, that you have just replaced some of your early computer equipment and discover that the new stuff is made for serial printers only. Or perhaps for some other reason you decide that serial is the way to go. But all your old printing equipment is parallel, and its trade-in value is zilch. What do you do? No, you do not mortgage the old homestead. Rather,you connect a $79.95 standard (Ho! Ho!) RS-232 serial-to-parallel interface adapter between the computer and the printer (or between the computer any other parallel accessory).

That adapter converts the computer's serial output to Centronics-type parallel, and if all goes as expected, everything should work. One standard serial-to-parallel adapter is manufactured by Engineering Specialties. Its lowest baud rate is 150 (rather than the more or less "standard" 300 baud) and the device will therefore work with Centronics-type parallel I/O, most IBM Selectric printer conversions, and the slow daisy-wheel printers such as the Smith Corona *TP-1* (which can be a real problem with serial/parallel converters because the computer is sending the second character before the first is printed). The Engineering Specialties converter has a one byte memory which allows the printer to finish before it receives the next character, and the printer will work even if the computer cannot send 110 baud. Because nothing in the world of computers is standard, I would suggest that you phone ahead and ask them if their gizmos will work with your system.

Take careful note that your printer, or the computer, must provide the 5V at 20-mA needed for the adapter. Most printers, but not all, have 5 volts on RS-232 pin 18. If not, you must provide the 5 volts from somewhere else.

When trouble comes

Having trouble interfacing your printer or your modem to your computer? Does your printer's output have no relation to the specified formatting? Surprise! Standard RS-232 doesn't turn out to be all that standard; sometimes it seems that everyone puts a zinger or two into their RS-232 connections so you have to purchase their software and hardware. (How I remember spending hours trying to get a modem working until I discovered that Heath held pin 20 of their RS-232 connection at five volts—why?)

If you like to use a lot of hardware peripherals, or if you are using several computers, a gadget that you might want is something called a *Model 50 Breakout Box* from Remark Datatcom, Inc. It has male and female RS-232 I/O connectors, and DIP switches in series with each signal line that permit you to open any of the 24 signal lines. Terminals on both sides of the switches allows the user to patch any input signal to any output terminal. It even has four common bus areas so you can connect two or more terminals together (some modem circuits need that). Six patch cords are supplied, and for those of us with poor memories, the standard RS-232 signal list is imprinted on the enclosure.

If your RS-232 hardware configuration doesn't work right then you can switch open the questionable signal lines, patch the input to what you figure is the output, and when everything works right you simply make up an ordinary patch cable with the wiring configuration that you worked out. The *Breakout Box* is shown in Fig. 3 and it can save hours of troubleshooting and calculations. While the $79 price of the device is a bit stiff for a one-time installation, its a great device for local users' groups. A slightly less sophisticated version (without the DIP switches, just patch terminals) is available for less than $40.

Male or Female?

It never fails: The connectors on your new peripherals are always the reverse of what you've been using. If all your connecting cables are male-to-male the next piece of hardware will require a female connector. Most of the gender problems with RS-232 style connecting cables are easily resolved with a *Gender Reverser* from B & B Electronics. Those are simply small printed-circuit cards with matching RS-232 connectors on each end (male to male or female to female). Attach your present RS-232 cable and *voila*, the gender on one end of the cable is reversed. The price of $19.95 is somewhat high, but that's about what it would cost you if you went out and purchased the connectors and cable from a local store, and the gender reverser is a lot smaller and more convenient. Normally, female-to-female is the most convenient reverser, so if your budget can only afford one, get the female model.

One megabyte on-line RAM.

No, you don't need a maxi-computer to get a megabyte, or even 8 megabytes of RAM on-line; all you need is lots of money and a device known as a disk simulator or semidisk. Consider your disk drive(s); if it's single density you can write about 100K. If it's double density about 180K. If it's double-sided double-density, 360K. Two drives? 740K and so on, all the way up to the megabyte range. Now imagine if you will that you replace the drive with RAM that is driven to operate as if it were a disk drive. The computer will write and read from the "disk;" but now, instead of a disk drive taking (what seems like) forever to locate the desired data, the signals zip through the RAM in microseconds.

To run a disk simulator you simply connect the device in place of a disk(s) drive and run an installation program. The computer then sees the simulator's RAM as a disk, and the data is stored in the RAM at it would be on a disk. There are two important differences: The RAM gives you virtually instant access to the data, and it is volatile. (When you turn off the computer's power, the RAM's data is lost.)

Disk simulators can be obtained as outboard add-on accessories or as cards specifically designed to plug directly into a computer in place of the disk drive. They are available for S-100 computers, the TRS-80 *Model II*, the IBM *Personal Computer*, and the Apple *II*. They are so successful that we can expect models will soon be available for every personal computer that uses a disk system.

One problem with disk simulators is that they lose their memory contents when power is shut down or interrupted. That, of course, is because of the properties of RAM. There is, however, a disk simulator that does not suffer from that shortcoming: the *Bubdisk* from MPC Peripherals Corp. That device is

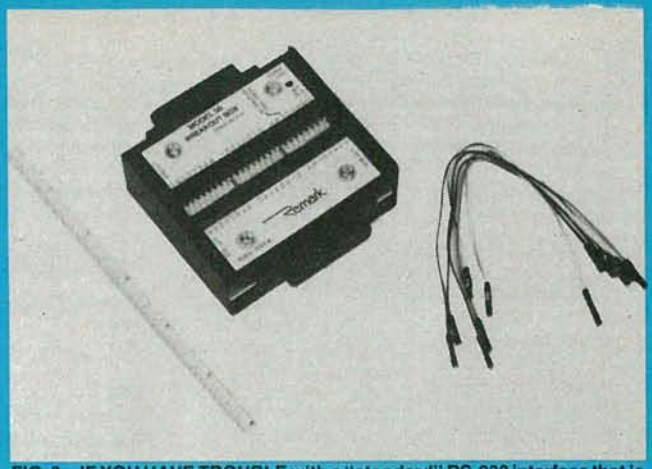


FIG. 3—IF YOU HAVE TROUBLE with a "standard" RS-232 interface that is not standard, the *Breakout Box* can help you figure out what's wrong.

a bubble-memory disk simulator. Bubble memories feature the read/write abilities of RAM's along with the non-volatility of ROM's, and the mass-storage capabilites of a tape or disk.

The 128 K *Bubdisk* has an interesting feature. In the event of a power failure or brown out, the board will automatically power down to ensure the reliability of the stored data.

What happens to the disk-operating system, utilities, and the like? That's all on the first disk drive. The simulators are used in place of the second, third, or fourth drive, depending on the particular computer installation. You can use the simulator RAM for program development, or whatever, and store the end result or data on the remaining disk drive(s).

As with all new things, simulators don't come cheap. A 512K simulator goes for almost $2000—but that's today's price.

More *Color Computer* accessories

One of the major limitations of the *Color Computer* is that you can have only one ROM module plugged in at a time because there's only one ROM module port. Considering that aftermarket distributors are packaging their software in their own ROM modules, it's conceivable that there will soon be a need to run several modules at one time. For example, a disk drive (which uses the module port), a BASIC AID module, and who knows what else—the *Color Computer* is fast becoming a giant in low-cost computing. Among the leading gadgets to expand it is the Basic Technology's *BT-1000* color computer expander, which is a device that converts the single ROM module port into five ports that can handle either ROM or RAM modules. Why would you use a RAM module on a ROM port? To expand RAM. The ROM port address is located above the internal RAM, so RAM used on the ROM port will provide additional RAM at the top which can be used to store utilities, etc.

For those who want to add professional-quality time keeping to their "CoCo" programs, Basic Technology has a crystal-controlled module for a real-time clock/calendar that provides the day, date, month, year, hours, minutes and seconds. An internal NiCd battery keeps the module running when the computer is turned off.

For those owners who want to design and build their own hardware, Computer Accessories of Arizona has a breadboard that plugs into the ROM module port and brings out the data, address, and control signals. It provides 16 square inches of pre-drilled breadboarding area with plated-through holes that are compatable with wirewrap accessories.

There are probably more accessory joysticks available for the *Color Computer* than for all the video arcade games. Those "high performance" or professional (professional?) joysticks can let you zap more Klingons, protect more cities, destroy more missiles, than any other. Each claims to be a breakthrough in the state of the art of joystick technology.

Moses Engineering (PO Box 11038, Ardmore Highway Sta-

SUPPLIERS

Applied Creative Technology
2723 Avenue E East, Suite 717
Arlington, TX 76011

Basic Technology
PO Box 511
Ortonville, MI 48462

B&B Electronics
PO Box 475
Mendota, IL 61342

Botek Instruments
4949 Hampshire
Utica, MI 48087

Cognitec
704 Nob Ave.
Del Mar, CA 92014

Computer Accessories of Arizona
5801 E. Voltaire Dr.
Scottsdale, AZ 85254

Engineering Specialties
1501-B Pine Street
PO Box 2233
Oxnard, CA 93030

General Automation
9600 Roosevelt Blvd.
Philadelphia, PA 19115

Giltronix, Inc.
970 Sab Antonio Rd.
Palo Alto, CA 94306

Memotech Corp.
7550 West Yale Ave.
Denver CO 80227

MPC Peripherals Corp.
9424 Chesapeake Drive
San Diego, CA 92123

Practical Peripherals, Inc.
31245 La Baya Dr.
Westlake Village, CA 91362

Remark Datacom, Inc.
4 Sycamore Dr.
Woodbury, NY 11797

RKS Industries
4865 Scotts Valley Dr.
Scotts Valley, Ca 95066

The Micro Works
PO Box 1110
Del Mar, CA 92014

tion, Huntsville, AL 35805) has a light pen that plugs into one of the *Color Computer's* joystick ports. It takes some programming skill in BASIC to use the light pen, but you can write programs where the pen "selects" the correct answers from a screen full of words, patterns, or anything else. That light pen needs some better documentation if it's to be used by beginners and newcomers to BASIC, but if you know what light pens are all about you probably can make it do many tricks.

For those who need a larger computer but have so much invested in their *Color Computer* that they can't bail out for something larger, there's an expansion interface from General Automation. That gizmo—or is it a widget?—is disk compatable; it provides 64K RAM access for the 32K Revision-E model of the *Color Computer*. It provides a parallel port for a printer or I/O—leaving the RS-232 port available for simultaneous modem use, selects up to 7 more peripheral cards, and can even handle a speech synthesizer.

Expansion

If you're having trouble trying to run several peripherals on one I/O port then you should be aware that Giltronix, Inc. makes "black boxes" that eliminate plugging and unplugging equipment when you want to substitute, say, a printing terminal for a CRT terminal, or a printer for a modem, and so on. Their model *ASU-3* is an automatic port selector that will connect any one of three peripherals to a CPU or CRT by simply entering a command on the keyboard; the appropriate baud rate is set automatically when the peripheral is switched. For those of you trying to get microcomputers to run like a data-processing system, Giltronix has models that switch 5 or 7 peripherals.

Killing the killer

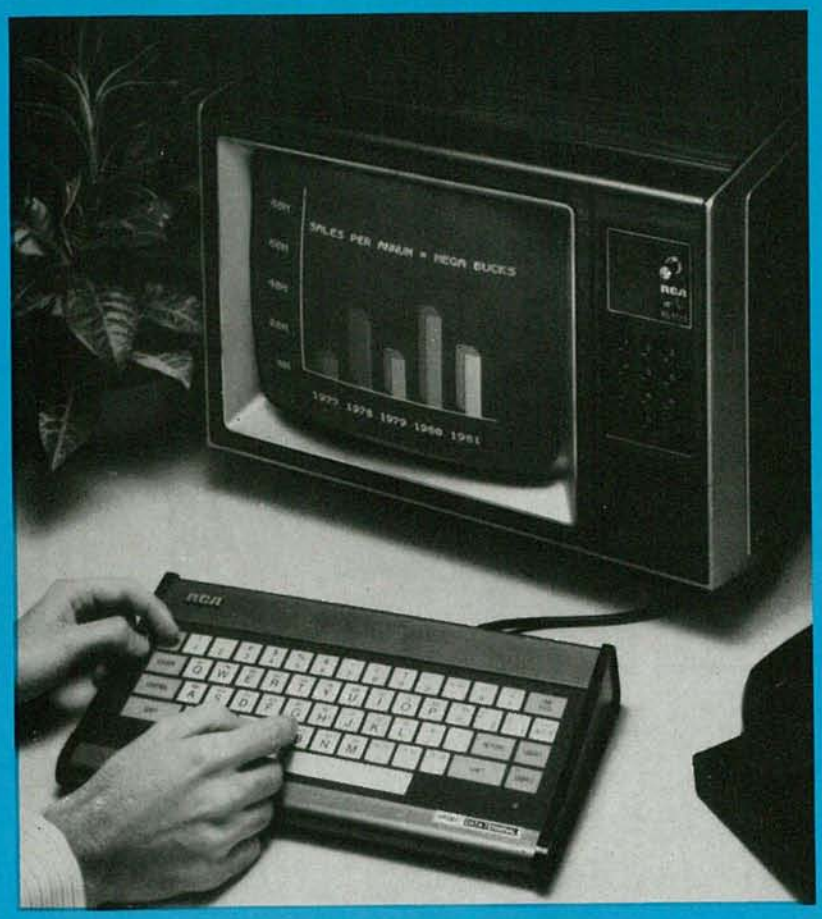
It takes but a single transient surge on the power line to zap hours of programming effort loaded into RAM if it rides through your computer's power supply. Now the kind of surge we're talking about isn't one that dims the lights or shrinks the video display. Rather, it is one so brief that you never know it occurred until you look up and see your screen is filled with "garbage." The fact is that even a lightning hit miles away can cause a transient that will zap your computer. There are many devices on the market designed specifically to squash that type of transient. They go under various brand names but they all accomplish the same result. One example that we will give is the *Surge Sentry* from RKS Industries. That is a protector that plugs into the powerline and the computer plugs into it. Transient surges that exceed approximately 180 volts are suppressed by the device before they even get a chance to enter the computer.

Controlling the world

In the early days of computing, no newspaper article on computers was complete without some anecdotes about computerists who "enhanced" their lives with a home controlled by a computer—or was it really a computer that controlled their lives? The computer turned the lights on and off, answered the phone when no one was home, put up the coffee in the morning, turned on the lawn sprinklers, and kicked the cat out for the night. What those articles failed to spell out was that most of the hardware was customized, very expensive, difficult for the non-engineer to install, and usually wasn't worth the effort: Do you really want coffee made from water that's been standing out all night? But, if you want your computer to control the outside world, it's now easy and relatively inexpensive. Radio Shack has a controller priced at $39.95 that works in conjunction with the BSR controller modules—the same modules that are used with the BSR *X-10* Wireless Remote Control System. As determined by your BASIC program, the controller broadcasts a BSR-type signal through the AC powerline, causing the individual modules to apply or remove AC power from an attached appliance. Though Radio Shack has been more or less the leader in utilizing the BSR-type device for control of the outside world, from time to time other control devices for other computers appear in the marketplace. As a general rule they are usually some form of parallel output port providing a TTL signal to which you must connect a lot of extra switching hardware; or they provide a low-current "dry" contact closure for eight or more circuits. Again, you provide the rest of the hardware. Except for the BSR-type controller, the other designs come and go because they are simply too much trouble for the non-technical personal-computer user. But if a BSR-type controller becomes available for your particular computer, snatch it up, even if you have no use for it at the moment. (It's amazing the uses you find for it after you own one.) They are relatively inexpensive and a delight to use—meaning they are user-friendly; they actually can switch a small room-size air conditioner directly, without any intermediate hardware.

As you have probably noticed we haven't even touched on hard disk drives, disk-storage cabinets, disk-drive cleaning kits, covers, protectors, add-on monitors, or a dozen other things. Those are all standard equipment used or desired by almost all computerists. We've concentrated on the gadgets and gizmos that are relatively unknown or unused, but that can put a lot of power and/or pleasure into your computer system. Often, a gadget you never thought you would need (or maybe that you never even thought of at all!) suddenly becomes the key to a whole new direction in personal computing. **R-E**

Radio Electronics YOUR OWN Computer APRIL 1983



Data Terminals

If you want to access dial-up information networks or data bases, but don't need the power—or expense—of a home computer, then here's an attractive alternative.

MARC STERN

ONE OF THE MOST EXCITING RESULTS OF THE COMPUTER REVOlution is the ability with which we can access and use information. We now have more information we can access than ever before, such as stock reports, world news, and other data. That data is available from the wide variety of information networks that have been established in the last several years—and all of it is only a phone call away.

Those information systems (sometimes called remote databases) include The Source, CompuServe, and Dow Jones, to name just three of the major, general-interest networks. However, there are many other smaller and more specialized services available, too.

Access to those services has been somewhat limited until now. That's because if you wanted to connect to such a database, you had to have a computer and a modem with which to link the computer to the service. However, that left a wide segment of potential users out of the system, because many of them didn't have computer facilities available.

But that situation is rapidly changing as low-cost home computers are becoming more widespread. Any of those personal microcomputers, when used with the right software and a telephone modem, can connect to one of the information networks. It is necessary, of course, that you have a subscription to the service.

However, there are some people in the population who really might not care to own a microcomputer, but still want some way to access one or more of the many networks. What are those people to do? They can opt for any of the personal data terminals available on the market. Those range from keyboard-only "dumb" units to "intelligent" terminals that include their own display screen, modem, and more.

Although some terminals do offer a number of features, none can do as much as a personal computer can. What, then is the advantage of a terminal? The answer, obviously, is cost. Terminals are available as complete units in a price range from $399 to about $700. Compare that to a cost of about $1,000 for the average home computer configured with the equipment and software needed to act in a terminal role. That includes not only the software package that can run up to $150, in some cases, but also the modem, display screen, necessary memory, and possibly a printer. Yes, it is true that a top-of-the-line intelligent terminal with a printer can approach that price level, too, but for the average user who wants to save some money, a terminal is the best bet.

Dumb or intelligent?

Before we go any farther, there are several terms which have to be defined, and we'll start with "dumb" and "intelligent." A dumb terminal is just what the name implies—it cannot act for itself and must be driven by another system. It can be driven by a mainframe computer, a minicomputer, or a microcomputer. That type of terminal, available from many sources, is incapable of all but the most elementary functions, such as rudimentary screen editing and cursor movements.

An intelligent terminal, on the othr hand, is usually driven by an 8-bit microprocessor. While it is capable af acting as a dumb terminal, it can really do much more. It allows you to have a great deal more interaction with the system or network to which it is attached.

Let's now take a closer look at each of those types of terminals, and the features and capabilities that you can expect from each.

Essentially, the dumb terminal is a slave to the system to which it is connected, and the user must access the system's functions to support the terminal's actions. The terminal may include a port for connection to a modem, but it includes little else except for a keyboard processor that decodes the keyboard inputs, a ROM that contains character-generating information,

and a video driver that produces the screen display. It might also include a small amount of RAM—maybe enough to store three or four pages of information from an information network or from a mainframe system. However, it is incapable of supporting any other peripheral equipment, such as a line printer for hard copy.

If we now look at the intelligent type of terminal, we find that the motherboard not only includes an 8-bit microprocessor, but also a good bit of RAM and ROM. The intelligent terminal is also capable of driving a printer for hard copy, and it contains a line editor so you can compose and edit messages for transmission as electronic mail. It might also have some special features. For example, it might be capable of instant access to such services as The Source or CompuServe if its ROM is programmed for that.

ASCII

If you shop for a terminal, another term that you will run into is the acronym ASCII (American Standard Code for Information Interchange). Essentially, ASCII is a a binary data code that takes the information generated by your system and turns it into a binary or machine-level number or code. Its purpose is to allow for information exchange between equipment made by different manufacturers. Since the code is almost universal, the information generated by your XYZ Co. terminal will be readable either by an ABC Co. terminal, a mainframe computer, or a distant database or network. Conversely, your terminal will recognize the information coming into it from any (ASCII encoded) source. If you are in the market for a terminal, be sure that it is an ASCII-capable unit. All of the terminals mentioned in this article use the ASCII code.

In most terminals, the generation of the ASCII codes is handled by an input/output (I/O) processor. The I/O processor contains the necessary code-generating information in ROM, especially if the terminal doesn't use ASCII on its own internal communications bus. The I/O processor takes the digital information it receives from the screen memory or RAM, and then performs the necessary encoding to turn it into properly-coded signals, so that the terminal can communicate with others. If the terminal uses a different internal data-encoding format, then the small I/O processor will turn the ASCII code it receives into machine-usable form. However, it should be noted that most terminals are able to use or generate ASCII directly, so the somewhat complex circuitry needed for translation and code generation isn't normally necessary.

Although ASCII is almost universal for data communication, there are some companies which still insist on using their own coding. A good example of this is IBM which still has many systems in the field using EBCDIC (*E*xtended *B*inary *C*oded *D*ecimal *I*nterchange *C*ode).

Input/output

In order for the terminal to communicate with a computer, an information network, a printer, etc., it must have some type of I/O port. There are two major kinds: parallel and serial. We'll try to explain the difference between the two without going into too much detail. A parallel port sends/receives data eight bits at a time. In contrast to that, a serial port sends/receives data serially—one bit at a time. Therefore, a parallel port can handle data much more quickly than a serial port can. However, a serial port is a more reliable method of data transmission, because it is less susceptible to noise pickup, especially over long distances. Furthermore, we should mention that serial transmission is used over the phone line. Parallel transmission, on the other hand isn't really feasible on any but a hard-wired, dedicated system. (It cannot be used with phone lines.)

On some terminal systems, you will not see a serial port. Instead, you will see a modular phone jack. However, don't be misled; inside the box there is an interface to handle the work of input and output. What the manufacturer has done is to put the modem inside the terminal. All you have to do is plug in your (modular) phone plug.

Displays

The quality of the display that you can obtain is limited by both the terminal's ability and the ability of the display screen itself. First, we'll start with the terminal.

If you look closely at the display, you'll see that the characters are actually made up of dots. The quality or clarity of the characters is determined by the size and number of the dots in the *dot matrix*. A matrix of 5 dots (width) by 9 dots (height) will yeild characters with reasonable definition. However, a 7 × 9 matrix is better because the dots are closer together and therefore the letters have more clarity.

Just because the terminal's character generator is capable of producing characters with high resolution, that doesn't assure you of having a readable display. The capability of the display screen comes into play here. The display screen is divided into a series of *pixels* (a horizontal measurement) and picture lines. It is the interaction of those two parameters that defines the sharpness or clarity with which you will see a graphic display or character. The more picture lines and the more pixels you have, the sharper will be the characters you can obtain. Thus a high-resolution screen may have a display capability of 512 × 250 (512 pixels × 250 lines) and will give a good display. Conversely, a display with a resolution of 140 × 200 will have relatively poor graphics or character-generating capability. That principle can be seen easily by comparing a magazine photo to one from a newspaper. Although both are made up of dots (look closely!), the magazine photo is sharper because its dots are smaller and closer together.

The display on an intelligent terminal is normally 24 lines × 80 columns—the commonly accepted industry standard. On most of those terminals there is a 25th line. That is the *status line*, and it gives the operator an indication of what mode the terminal is in.

The status line usually appears at the top of the screen and it is a non-changing feature of the screen. It will display the mode the terminal is in, whether it is on-line or off-line etc.

Menus

Many terminals are also user-friendly in that they display a series of *menus*. A menu gives the user a list of commands and the key to push to execute any of those commands. This prompting guides the user through the steps needed to access a function. The menu routine is usually accessed via a HELP key or keyboard routine. An example of a menu for an auto-dial function is shown in Fig. 1. Note that it tells the user exactly how to use the function. For example it says to press a letter to dial, to press F2 to change the directory, etc. If a system is menu-operated, even a first-time user should have little problem in running it.

Now we have covered some of the basics that you'll have to know when you are first in the market for a terminal. However,

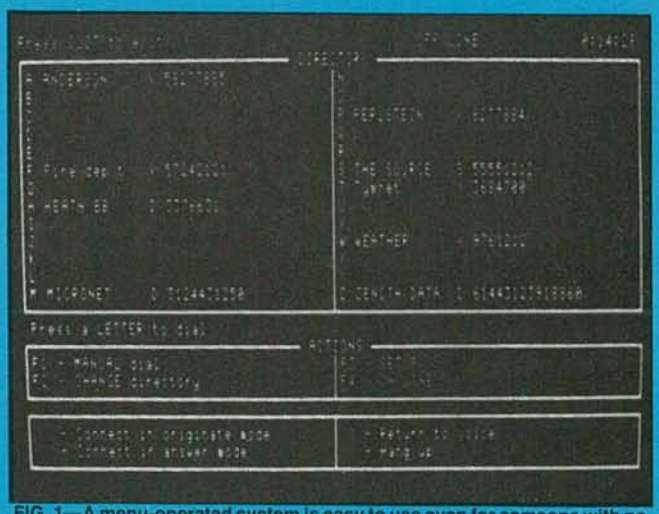


FIG. 1—A menu-operated system is easy to use even for someone with no previous experience.

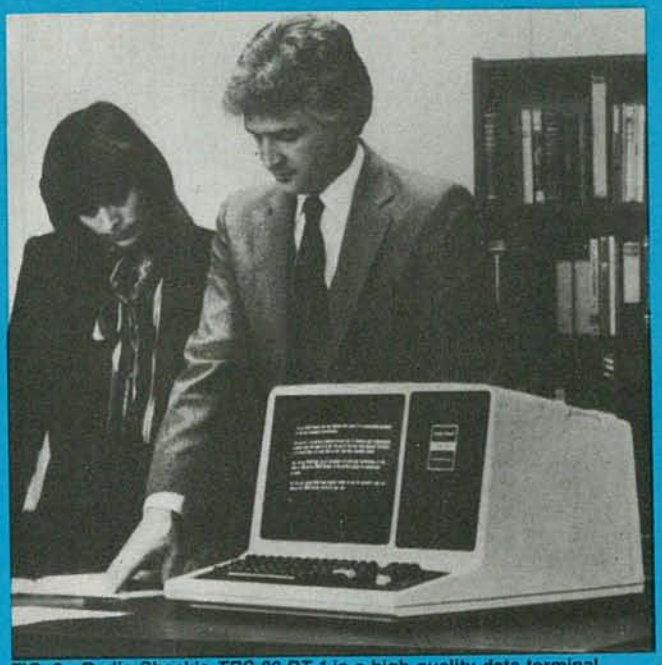


FIG. 2—Radio Shack's *TRS-80 DT-1* is a high quality data terminal.

FIG. 3—The RCA *VP3501* Videotex Data Terminal includes, among other features, a built in modem and built in tone and white-noise generators.

there are other things to be considered, and we'll get to those next.

Modems

Because modems are covered in detail in another article in this magazine, we will not discuss them here in great detail. We will, however, mention a couple of considerations to keep in mind. First, the modem should be Bell 103 compatible. That is a communications protocol which allows transmission at 300 bits per second or 300 baud. If it is Bell 202/212 compatible it is possible you may not be able to log onto an information network. (That type of terminal or modem runs at 1,200 baud and most information systems are geared to run at 300 baud.) If, however, the network offers a 1,200 baud option,and you can use it, then do—you'll save a lot of time.

Many terminals themselves can be configured to run at many speeds up to 9,600 baud of more and can be hard-wired to a local mainframe or dedicated minicomputer. But, unless you have a dedicated phone line or circuit, then the highest speed possible for reliable communication over a phone line is 1,200 baud. After that, the bandwidth taken by the signal is too broad and there are too many chances for error.

Two more items about computer communication by phone of which you should be aware are the method of dialing and the phone-jack requirements. If your terminal is capable of auto-dialing and it uses the DTMF (*D*ual *T*one *M*ulti-*F*requency) system (commonly called *Touch-Tone*) but your phone system hasn't been computerized and still uses the older form of pulse (rotary) dialing, then it is possible that you won't be able to access the information network directly from the keyboard. Instead, you'll have to use your phone to establish communication. Further, if your terminal is equipped with a modular plug and your home has only the older-style block terminals, then you'll have to buy an inexpensive adapter.

Some examples of terminals

Now that we have looked at the different types of terminals and what they can do, let's take take a look at representatives of the types of terminals available for you. Those include the dumb terminal, the intelligent keyboard-only unit, and the all-in-one intelligent terminal.

The *TRS-80 DT-1* (from Radio Shack, One Tandy Center, Fort Worth, TX 76102) shown in Fig. 2, is a good example of a dumb terminal. Although it is best-suited for hard-wiring to a mainframe computer or interoffice information network, it can also be used, with a modem (not included in $699 purchase price), to access an information network. The video display is in black-and-white and it is capable of displaying the standard 80 columns by 24 lines and both upper and lower case letters. That display is housed along with a standard keyboard (with separate number keypad) in one cabinet.

Ten data transmission rates are keyboard-selectable, and range from 75 to 19,200 baud. Also included in the *DT-1* is an RS232C-compatible communications port and serial and parallel printer ports.

An interesting feature of the terminal is that it is code-compatable with four popular terminals: the TeleVideo *910*, Lear Siegler's *ADM-5* and *ADDS 25* and the Hazeltine *1410*. The particular configuration that you want to use is keyboard selectable.

The second type of terminal that we will give an example of is the keyboard-only intelligent terminal. That type is best typified by the RCA *3301* (RCA MicroComputer Products, New Holland Ave., Lancaster, PA 17604). That terminal is intelligent because it has many features including user-definable characters, full control over color graphics, tone generator, and more. It features a membrane-type keyboard, rather than a typewriter-like keyboard. However, the embossed characters are arranged in standard "QWERTY" typewriter style.

The *3301* is priced at $369. That does not include the external modem which must be used for network access. (A similar RCA terminal, the $399 *3501* is shown in Fig. 3. It *does* include an internal, direct-connect modem. It also includes a built-in printer interface, and can be hooked up to RCA accessories to make it capable of such funcions as auto-dialing to make it even more intelligent.) It offers the choice of interfacing with a standard color or black-and-white television or a computer-grade monitor (which will provide better resolution than the standard TV). However, this keyboard unit is capable of generating a display which is only 40 columns wide—that is half of the 80-column industry standard. In another mode, the characters become double-sized, cutting the display in half to 12 lines by 20 columns. The dot matrix is 5 by 6, which means, the letters do not have good definition. Besides generating 52 upper and lowercase characters, 10 numerals, 32 punctuation and math characters, and 31 control characters, there are also some user-definable characters. Also, since it is intended to be linked to a color terminal or TV, it can display eight colors in eight levels of brightness.

The unit also offers the option of setting transmission parameters. For example, six baud rates from 110 to 19,200 can be selected. Also, even or odd parity can be chosen. (Parity refers to a error-checking code where the the total number of 1's or 0's in a character code is counted. If even parity is chosen, and

an odd number is counted, then you know that an error has occured in the transmission.) If even or odd parity is not chosen, then you can select the status of the eighth bit of a character to be either a mark or a space.

Full or half duplex can also be chosen. Let's see what that means. In the full-duplex mode, when you type in a character, the terminal waits for an *echo* from the computer or network before it displays it on the screen. In the half-duplex mode, whatever you type on the keyboard is shown on the screen while it is transmitted.

Another example of a keyboard-only intelligent terminal is Radio Shack's *TRS-80* videotex terminal. That $399 terminal is shown in Fig 4. It features a full, standard keyboard and interfaces with either a color TV or a monitor. The unit features a 6809E eight-bit microprocessor. It also has 16K of RAM so a user can store up to 32 pages of information for later viewing. One advantage of that is that in some cases it can cut down the amount of time that you are connected to the network, thus saving you money. A user also has the option of interfacing a 128K disk for mass storage.

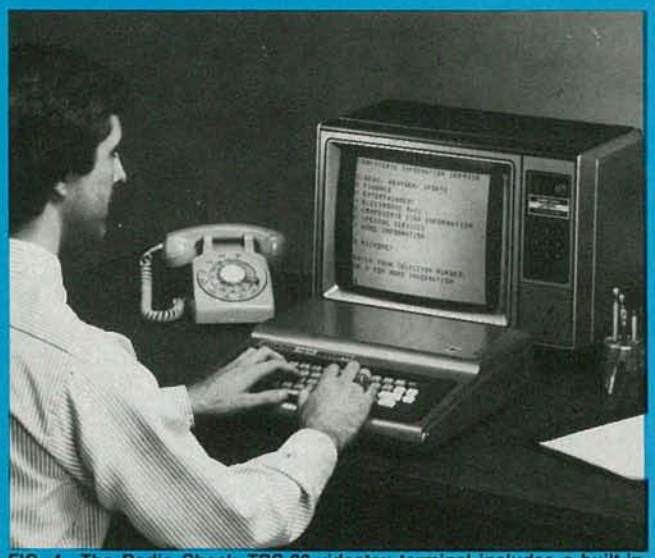


FIG. 4—The Radio Shack *TRS-80* videotex terminal includes a built-in modem and 16K RAM.

Another type of intelligent terminal is best typified by the Zenith Data Systems *ZT-1* (1000 Milwaukee Ave., Glenview, IL 60025). That terminal, one of the best on the market, is shown in Fig. 5. The *ZT-1* is menu-driven—it displays the choices available from the moment the power is turned on. A series of menus makes it possible to use one key to perform most functions.

FIG. 5—The *ZT-1* from Zenith is one of the most intelligent terminals on the market. Its built-in prompts also make it one of the easiest to use.

One of the interesting features of the *ZT-1* is its built-in auto-dial modem, which we mentioned previously (the phone directory is shown in Fig. 1). You can store a directory of up to 26 phone numbers in battery backed-up RAM. Then, to make a call, all you need do is press the single key that the menu indicates.

A real-time 24-hour clock runs when the *ZT-1* is turned on. That can be used to keep track of on-line time, or just to keep track of the time of any telephone call.

The $699 *ZT-1* includes a 12-inch green-phosphor monitor that displays the industry-standard 24 lines of 80 characters (plus a status line). It is also capable of producing a double sized display. The character dot matrix size is 5 × 9. It will also support both RS-232C and TTL communications at rates from 110 to 4,800 baud.

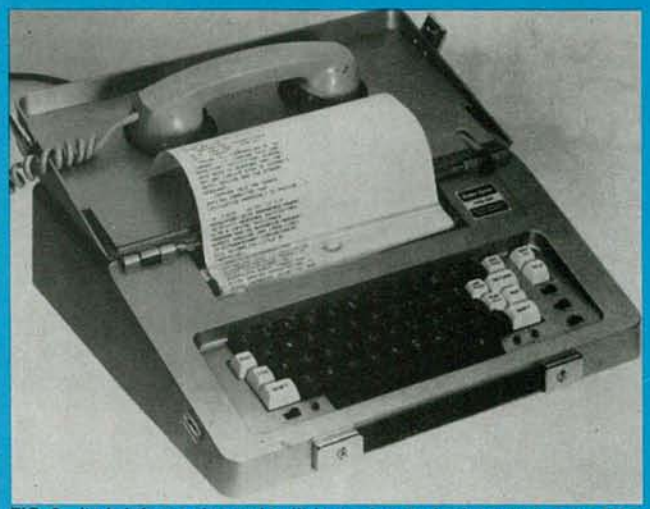


FIG. 6—Its briefcase size and built-in modem and printer makes the *TRS-80 PT-210* ideal for anyone who needs a portable data terminal.

The next termal that we will look at is different from those discussed above. This terminal—Radio Shack's *PT-210* portable data terminal (shown in Fig. 6)—is not meant to be used with a display screen. Instead, it contains a built-in non-impact thermal printer. Also built in is an originate-only modem with acoustic coupler. An RS-232C interface module, which allows you to connect the *PT210* directly to a host computer, is available from Radio Shack for $70.

The unit comes with a full-sized, ASCII-encoded keyboard. It will operate at 110 or 300 baud, in duplex or half-duplex modes, and with even or odd parity. Although the keyboard does not contain a separate numeric keypad, it does include an interesting feature: a switch-selectable number-entry keypad. When that feature is chosen, thirteen of the letter keys form a calculator-style keypad so that you can easily enter numbers and signs.

The built-in printer uses a 5 × 7 dot matrix and it offers a variable contrast control. Seventy-one characters are printable, with lowercase letters printed as their uppercase equivalent. Each line can be the industry-standard 80-characters long.

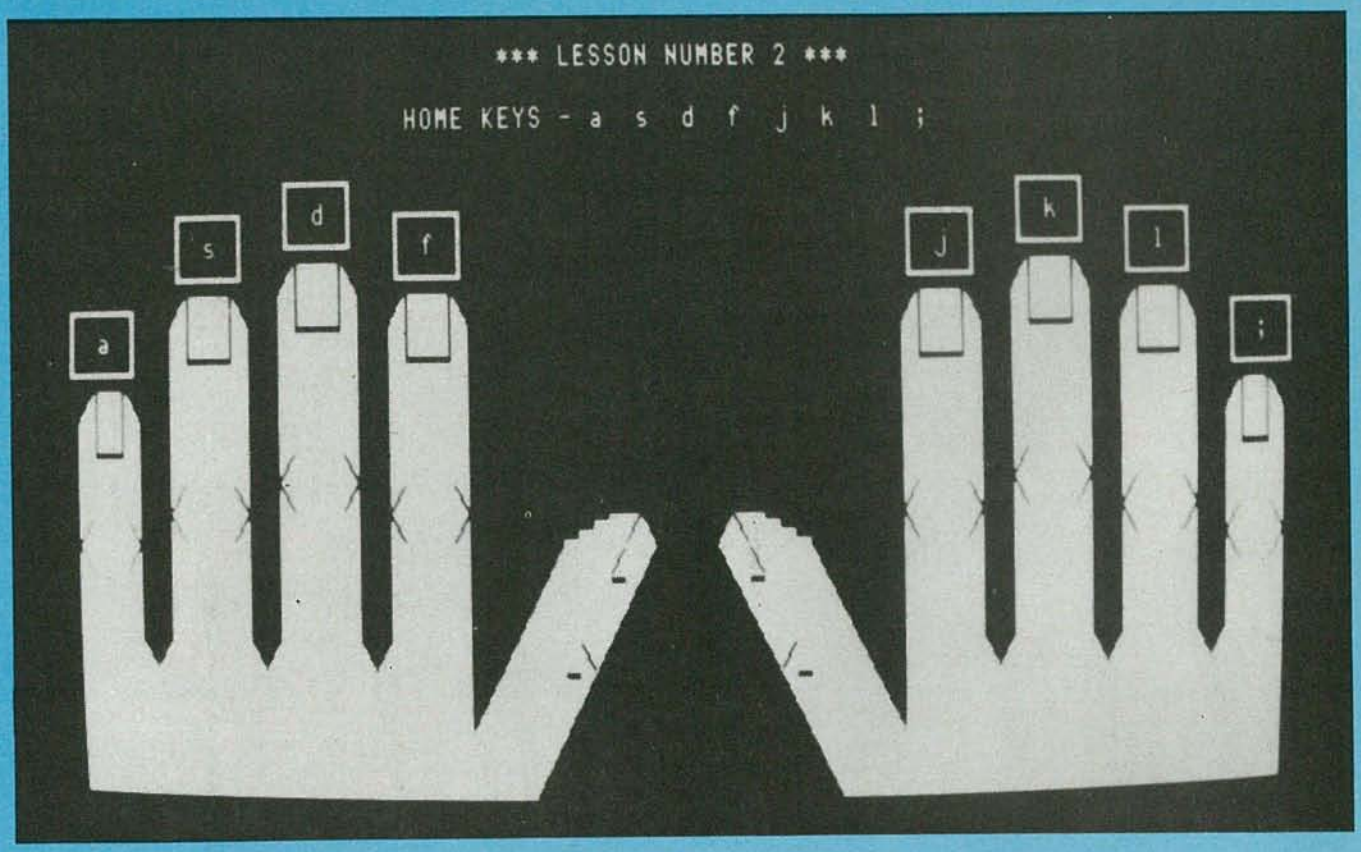
So, is a personal terminal for you? Well, in short, a terminal is perfect if you want to be able to "enter the information age," but do not want (or can't afford) a microcomputer. It might also be ideal for you if you *do* have a microcomputer. For instance, you might want to quickly check the latest stock market report at the same time you are using your computer for another task. With a terminal, you can get that report while your microcomputer keeps on working. **R-E**

Radio-Electronics

YOUR OWN Software

- **Budget Software**
- **What-If Software**

Budget Software



Need some software to perform an unusual task—or even an ordinary one—at a reasonable cost? There are quite a few low-cost, sometimes unusual, and almost always overlooked programs available that just may do the trick.

HERB FRIEDMAN

RESPONDING TO A CRITIC'S REMARK ABOUT "...A LITTLE-known work that never got the credit it deserved," the great playwright Noel Coward observed that: "Little-known works that never got the credit they deserved never deserved any."

As a general rule of thumb, Coward's observations are true, except when it comes to personal computers—where quite a bit of good, low-cost software is ignored in favor of the more expensive, more sophisticated, and more famous programs whose very names have become so well known that they have become almost synonymous with their function: *Wordstar* for word processing; *VisiCalc* and *SuperCalc* for electronic spreadsheets; *dBase II* for database management, etc. There were, of course, good reasons for the success of *VisiCalc* and the others—they stood, and in some instances still stand, head and shoulders above the competition, and their performance often exceeds what's available for mini- and mainframe computers.

But not every user of personal computers needs all of the power offered by that sophisticated software. In fact, many of you probably have no need for any of the high-priced programs. Often, all the computer functions you truly need may be available at a rock-bottom price in a small, unsophisticated program, or from the highly specialized but underadvertised software that is available from the smaller software houses (some of which are no more than someone's garage or kitchen table).

Little things can cost a lot

When looking for low-cost or unusual software that really works, keep in mind that a seemingly insignificant variation in features or function can represent a substantial increase in programming effort and a corresponding increase in price; you may have to accept a compromise to get the computing power you want at a price that fits your budget. For example, one of the largest auto-rental companies catering to driving schools keeps its records on a minimal computer system (no disk drives) using a $19.95 software package. It provides all the records needed by almost 50 schools and their students, the individual driving instructors, the State Motor Vehicle Bureau, and the tax accountant. How is all that possible for under $20? Simple—the program does not keep track of auto repairs or write the checks for those repairs. After much testing, the rental company discovered it could easily keep track of service on 3 × 5 file-cards, and the total number of checks per month for repairs never exceeded 12. A program to keep track of repairs and pay the bills would have cost several hundred dollars, required a computer

with at least two disk drives, and a fairly competent and experienced staff of CRT-terminal operators. The reason that adding repairs and repair payment to the program would sharply increase the program's complexity and cost is that software features generally interlock. If a programmer decides to provide extra function A, he may have to rewrite the code for functions B, C, D, K, L, M, and Z. And, modifying C may require new code for O, P, and Q, which in turn may affect the original work for A. That is why a so-called "simple" patch for commercial software often ends up as a series of patches.

While the $19.95 software-package has none of the esoteric functions of the super-duper database systems presently being touted for even the casual personal-computer user, it nevertheless does the job—and that's the purpose of any piece of software.

Ideas to work with

Whether it's widgets, gizmos, or computer software, locating the obscure or inexpensive is usually simply a matter of knowing what you're looking for, or at least having some idea of what's available that can possibly be used as a substitute; so we'll take a look at some of the programs that have never received the attention they deserve—usually because they don't offer high-powered features. And we'll look at some highly specialized software whose value isn't apparent at first—or even second—thought. Most of it is quite decent for the money and a good idea of what's available in "far out" software. While some examples are listed specifically by name and computer type, similar software is generally available for most, if not all, of the popular computer systems.

Looking up

Heading our list of unusual software is the most expensive of all, because the package takes at least 6 disks. That gem is something called *THE WORD Processor*. No, it isn't yet another text editor or word processor, it is actually a database for the King James version of the Bible. The software allows the user to search out any information or reference in the Bible by range—such as Genesis 1:1 to Genesis 50:12—or by text, phrase, or word—like locating "Beer-sheba." Using combined search criteria (several words or phrases) it's possible to look for complex relationships of words or text. It's also possible to construct a dynamic (easily modified) index of specific words or phrases—a library of Biblical research-materials. You can merge indexes, modify indexes, delete indexes, and print just about any combination of anything. As a research tool for the home, or for the college student majoring or minoring in religious studies, the program is dynamite—it would be nice if most commerical data-bases were done as well. *THE WORD Processor* is from Bible Research Systems and was originally written for Radio Shack's *TRS-80 Model III*, Apple computers, and 8-inch *CP/M* systems. If you have a different computer write to the company. (Its address is in the list of suppliers elsewhere in this article.)

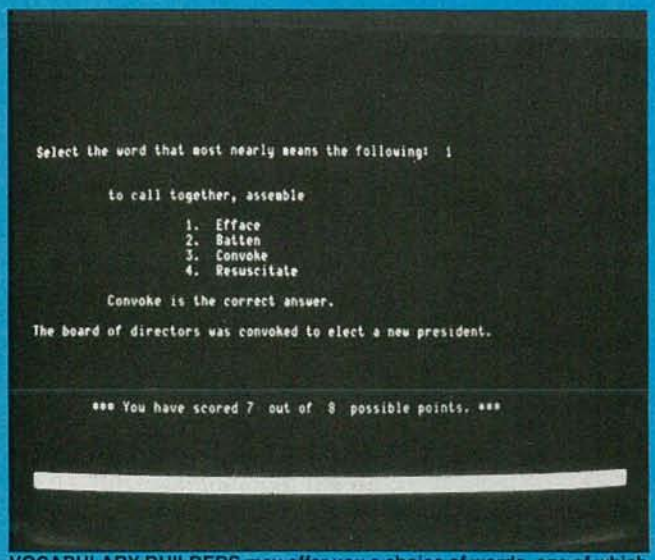
While on the subject of indexes and the like, a program not to be overlooked by the serious—and involved—personal-computerist is *Index-80* by MTS, Inc., a yearly indexed disk catalog of all the articles that appeared in *80-Micro* (a publication specifically for *TRS-80* users). Simply enter the words or phrases and the software will locate the related articles and the issue they appeared in. While there have been many so-called "magazine indexes," this one offers perhaps the best implementation, and its style appears to have been copied for disk indexes for other specialized computer publications. If you're into one specific type or model of computer you cannot go wrong with a yearly index to a publication specializing in it. It's probably the only thing that will locate some obscure reference to a software patch you barely remember seeing about six months ago—the one you skipped over because you thought you would never own the software.

There are probably more label-printing programs than there are word processors, but there's only one *Lablmakr*, from ETS Center. It's specifically for use with the Radio Shack *TRS-80 Model I* and *TRS-80 Model III*, and an Epson printer. *Lablmakr* can produce twenty kinds of highly unusual "standard-size" labels using both text and graphic representations of text, and virtually every combination of character styles is provided automatically by the software. Each label type comes up on the screen as a template complete with a character count for each line, and simply touching the space bar provides automatic centering of a line. If you like, a software-constructed file will save your labels for future use. A companion program called *Casslabl* prints cassette labels. The difference between the two is that the cassette version spaces the text lines to allow for the cutout in the cassette labels. The key to the success of this software is the printer, not the computer, so it's logical to assume that similar software will become available for other computers.

Next to mailing-label programs, word-processing programs are probably the most common. Unfortunately most of the better ones are somewhat expensive, and the inexpensive ones, most designed for "entry-level" computers, usually leave a lot to be desired. The exception to both rules is something called *Telewriter-64*, by Cognitec, for the Radio Shack *Color Computer*. This piece of software far outshines anything similar on the market. Instead of 20 to 32 characters per line (and often upper case only) this word processor is able to create upper or lower case characters and line lengths of 51, 64, or 85 characters. While there is no way anyone is going to be able to display 85 characters clearly on a TV set, that feature does allow the user to see how the actual print will appear—which is something some high-priced word processors can't do. Now for the best part: the program is available in a cassette version for only $50, and will run on any version of the *Color Computer* with 16K or more of memory.

In the end you must pay

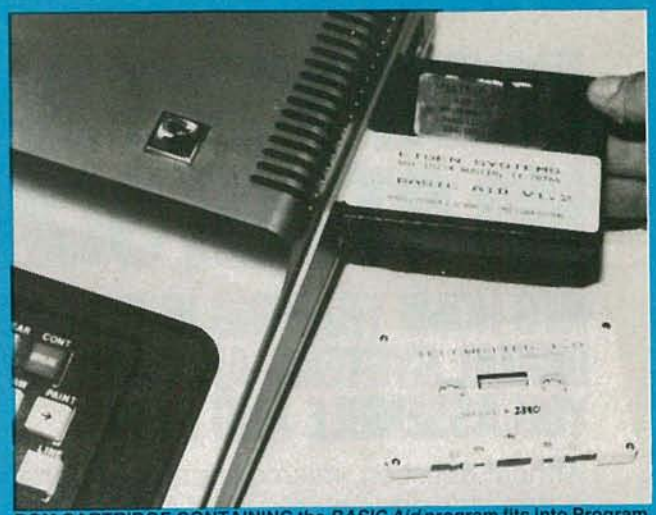
With the income-tax season in full swing, it's no wonder that "income tax" software seems to be all over the place. Actually, except for the stuff specifically intended for accountants, which is very expensive, much of what's available has little value because the really complicated parts of the tax calculations—the schedules—aren't part of the package. You generally have to do that part by hand and plug the calculated values into the software, and the whole thing ends up taking longer than doing the return by hand. Also, the tables change yearly, and updates don't come cheap. But for those of you who want the fun of being an amateur tax-accountant and don't need the absolute precision of a "professional" program, there's a very nice



VOCABULARY BUILDERS may offer you a choice of words, one of which fits the definition supplied by the computer. Examples of usage may also be given.

package called *Tax Forecaster* by the Micromatic Programming Company. That program asks for pertinent tax information entries and then gives a very close approximation of how much you'll have to pay to—or get back from—Uncle Sam. It does not prepare the tax return itself, it just does all the hard arithmetic, and it allows you to ask the question "What if?" and then instantly recalculate the results. For example, "What (happens to my taxes) if I donate $500 to charity?" It's a fun program, not expensive, and if you want to provide entertainment for friends it can be a lot of fun at parties and charity fund-raisers; but remember, it doesn't prepare the tax return and it's not a substitute for an accountant.

If you'd like to knock hours off preparing your taxes come every April 15 there's an excellent record-keeping system specifically intended for tax time. It's called *The Color Accountant*, from The Programmer's Institute and, at present, versions are available for the Atari *400* and *800* and for the *Color Computer*. In addition to the usual checkbook maintenance and summary files, you can record bills, analyze various accounts of stocks, even color-graph any of the files. The Atari versions need a little extra in the way of RAM, so make certain you have enough.



ROM CARTRIDGE CONTAINING the *BASIC Aid* program fits into Program Pak slot in *Color Computer*.

Faster BASIC

Because of the mass distribution of the Timex/Sinclair *1000* computer, many programmers, both amateur and professional, have been exposed to the advantages of single-key entry of BASIC commands. Instead of typing out every command such as GOTO, GOSUB, FOR, NEXT, PRINT, etc., a command is entered simply by touching a single key; the computer seems to know when the touch represents a command and when it's actually the key's character.

Utilities and programming aids that provide single-key entry of BASIC commands have been around for a long time, but they have usually concentrated more on adding obscure enhancements to BASIC than on making it easier to write programs. (Of course, the subject is debatable.) By not getting tangled up in yet more "new enhancements" to BASIC, Spectrum Products has produced an outstanding single-key command-entry program for the *Color Computer* called *BASIC Aid*. It is supplied as a plug-in ROM module, and a plastic overlay template for the keyboard shows every single-entry function as well as the standard key characters. There is no complex software routine for single-key entry—a touch of a key switches the single-key function on and off. Would you believe all that, including the ROM module, is only $40? It makes you wonder why some other software costs upward of $200 or $300.

Speaking of making programming easier, there is no substitute for touch-typing. Even if you don't program, with computers becoming so commonplace, you'll almost certainly eventually face the task of spending some hours entering data into a computer terminal. That job becomes a lot easier if you can touch-type. There is an almost endless list of software available for touch-typing training. In general, most work in the same manner—the computer displays several characters that the "student" must type on the keyboard. Depending on whether or not the computer has a sound output, either the screen blinks, or a tone beeps when the wrong key is struck. Sometimes there's a beep when you strike the correct key and a honk when you strike the wrong key. At the end of the lesson the computer tells you know how many errors you made and calculates your typing speed. Just about all typing programs work well, whether it's for Radio Shack, Commodore, or Heathkit/Zenith computers.

CLEAR PLASTIC TEMPLATE with overprinting for *BASIC Aid* fits over *Color Computer's* keyboard. Now, single-key BASIC commands are easy.

While were're on the subject of self-improvement, there are some remarkably good "vocabulary builders" floating around for all age groups. Texas Instruments has some award-winners for children, while many of the others are aimed at the high-school/adult level. Most of the programs have a basic vocabulary of approximately 200 words (that can usually be modified by the user), which can be used to "test" by definition, synonym, antonym, or a random combination of the three (those 200 words go a long way). Similar software is available for building vocabularies in a foreign language, and there is software that allows you to write your own "vocabulary exams"—you can plug in the new words learned at school and have the computer scramble them in a "test" format.

As for learning a foreign language on your own, every week or so some new brand of self-teaching language software comes into the marketplace—some of it good, some of it worthless; the problem is that you can't really know how good it is until you get it home and try it (and by then it's too late). On the other hand, the self-teaching conversational foreign-language software from Atari for their *400* and *800* computers is actually better than it appears in the TV commercials—and it comes off great on TV. If you want to learn any foreign language on your own, and you don't have an Atari computer, ask a friend who speaks the language to look over the software's documentation before you buy it. And, whatever else you do, make certain that the program comes with audio cassette-tapes that teach the proper word pronunciation. (Would you believe someone actually sold a language program for one of the most difficult languages to learn without supplying a pronunciation tape? And, would you believe people *bought* the software?)

Whistles, squeaks, and other noises

While we're on the subject of education, a word or two about educational software for the younger members of the family. As a parent or relative you have their best interests in mind, and computer programs that put them one-up the rest of their nursery-school class in number and word recognition are most appealing. That's why it comes as little surprise that as soon as you see that mountain of pre-school software for sale at the local

PARTIAL LIST OF SOFTWARE SUPPLIERS

Acorn Software Products, Inc.
634 N. Carolina Ave. S.E.
Washington, DC 20003

Activity Research, Inc.
PO Box 4875
Hayward, CA 94550

Addison-Wesley Publishing Co.
2725 Sand Hill Road
Menlo Park, CA 94025

Apple-Cations
21650 W. Eleven Mile Road
Suite 103
Southfield, MI 48706

Artworx Software Co.
150 N. Main Street
Fairport, NY 14450

Avant-Garde Creations
PO Box 30161
Eugene, OR 97403

Bargainbyte
PO Box 23195
Harahan, LA 70183

Basics And Beyond, Inc.
Box 10
Amawalk, NY 10501

Bell And Howell
7100 N. McCormick Road
Chicago, IL 60645

Bible Research Systems
8804 Wildridge Drive
Austin, TX 78759

Bluebird's Computer Software
2267 23rd Street
Wyandotte, MI 48192

Brain Box
601 W. 26th Street
New York, NY 10003

Business And Pleasure Software
6011 San Felipe
Houston, TX 77057

California Software
PO Box 275
El Cerrito, CA 94530

Class 1 Systems
17909 Maple Street
Lansing, IL 60438

Cognitec
704 Nob Ave
Del Mar, CA 92014

Comm Data Systems
PO Box 325
Milford, MI 48042

Commsoft
665 Maybell Ave.
Palo Alto, CA 94306

Compumax, Inc.
PO Box 1139
Palo Alto, CA 94301

Computer-Advanced Ideas, Inc.
1442A Walnut St.
Suite 341
Berkeley, CA 94709

Computer Aided & Managed Instruction
PO Box 2030
Goleta, CA 93118

Computer-ED
1 Everett Rd.
Carmel, NY 10512

Computer Information Exchange
PO Box 159
San Luis Rey, Ca 92068

Computer Learning Connection
One Boston Place
Boston, MA 02108

Computronics
50 N. Pasack Rd.
Spring Valley, NY 10977

Cottage Software
614 N. Harding
Wichita, KS 67208

Creative Computing
39 E. Hanover Ave.
Morris Plains, NJ 07950

Creative Software
201 San Antonio Circle ›70
Mountain View, CA 94040

Cybertronics International
999 Mt. Kemble Ave.
Morristown, NJ 07960

Dynacomp
1427 Monroe Ave.
Rochester, NY 14618

Educational Activities
1937 Grand Ave.
PO Box 87
Baldwin, NY 11510

Educational Micro Systems
PO Box 471
Chester, NJ 07930

Edu-Ware Services, Inc.
PO Box 22222
Agoura, CA 91301

Entelek
Ward-Whidden House
The Hill
PO Box 1303
Portsmouth, NH 03801

Etronix
14803 NE 40th St.
Redmond, WA 98052

ETS Center
Box 651
35026-A Turtle Trail
Willoughby, OH 44094

EZ Software
PO Box 591
Novato, CA 94947

Futureview
PO Box 101
Joplin, MO 64802

Gooth Software
931 S. Bemiston
St. Louis, MO 63105

J.L. Hammett Company, Inc.
Hammett Pl.
PO Box 545
Braintree, MA 02184

Hartley Software
PO Box 431
Dimondale, MI 48821

Hayden
50 Essex St.
Rochelle Park, NJ 07662

Howe Software
14 Lexington Road
New City, NY 10956

Information Unlimited Software
281 Arlington Ave.
Berkely, CA 94707

Instant Software
Peterborough, NH 03458

Intelligent Investor
810 Camelview Plaza
6900 E. Camelback Rd.
Scottsdale, AZ 85251

International Software Marketing, Ltd.
120 E. Washington St.
Syracuse, NY 13202

Interpretive Education
2306 Winters Dr.
Kalamazoo, MI 49002

Investor Software
48 Iron Ship Plaza
San Francisco, CA 94111

J&S Software
140 Reid Ave.
Port Washington, NY 11050

Kate's Komputers
PO Box 1675
Sausalito, CA 94965

Kensoft
2120 50th St.
Kenosha, WI 53140

Krell Software
21 Millbrook Dr.
Stony Brook, NY 11790

Learning Tools Inc.
4 Washburn Pl.
Brookline, MA 02146

Level IV Products Inc.
32461 School Craft
Livonia, MI 48150

The Liberty Software Co.
635 Independence Ave. SE
Washington, DC 20003

PARTIAL LIST OF SOFTWARE SUPPLIERS

Lighting Software
PO Box 11725
Palo Alto, CA 94306

L&S Computerware
1589 Fraser Dr.
Sunnyvale, CA 94087

Macrotronics, Inc.
1125 N. Golden State Blvd.
Suite G
Turlock, CA 95380

Manhattan Software
PO Box 1063
Woodland Hills, CA 91365

Mastertype
PO Box 5223
Stanford, CA 94305

Masterworks Software Inc.
1823 W. Lomita Blvd.
Lomita, CA 90717

Mentor Software
PO Box 791
Anoka, MN 55303

Mercer Systems Inc.
87 Scooter Lane
Hicksville, NY 11801

Microgrome
5834 Montgomery Rd.
Elkridge, MD 21227

Micro Lab
2310 Skokie Valley Rd.
Highland Park, IL 60035

Micro Learningware
PO Box 2134
N. Mankato, MN 56001

Micromatic Programming Co.
PO Box 158
Georgetown, CT 06829

Micro Power & Light Co.
12820 Hillcrest Rd., No.224
Dallas, TX 75230

Monument Computer Service
Village Data Center
PO Box 603
Joshua Tree, CA 92252

MTS, Inc.
Box 596
Niceville, FL 32578

Muse Software
347 N. Charles St.
Baltimore, MD 21201

National Software Marketing
4701 McKinley St.
Hollywood, FL 33021

Optimized Systems Software
10379 Lansdale Ave.
Cupertino, CA 95014

Options-80
PO Box 471
Concord, MA 01742

Osborne/McGraw-Hill
630 Bancroft Way
Berkeley, CA 94710

PCD Systems
PO Box 143
Pen Yan, NY 14527

Pear Systems Corp.
27 Briar Brae Rd.
Stamford, CT 06903

Powersoft Corp.
PO Box 157
Pitman, NJ 08071

Practical Programs
1104 Aspen Dr.
Toms River, NJ 78377

Prentice-Hall
Sylvan Ave.
Englewood Cliffs, NJ 07632

Prescription Learning
1301 S. Wabash Ave.
Chicago, IL 60605

Program Design, Inc. (PDI)
11 Idar Court
Greenwich, CT 06830

The Programmer's Institute
PO Box 3191
Chapel Hill, NC 27514

Programs For Learning
PO Box 954
New Milford, CT 06776

Program Research And Software Corp.
257 Central Park West
New York, NY 10024

Quality Education Design
PO Box 12486
Portland, OR 97212

Quality Software
6660 Reseda Blvd. No. 105
Reseda, CA 92335

Rell
1145 Stanford Ave.
Redondo Beach, CA 90278

Resource Software International
140 Sylvan Ave.
Englewood Cliffs, NJ 07632

Scott, Foresman & Co.
1900 East Lake Ave.
Glenview, IL 60025

Serendipity Systems, Inc.
225 Elmira Rd.
Ithaca, NY 14814

Silwa Enterprises, Inc.
PO Box 400
Big Flats, NY 14814

Softbyte Computing
Box 217
Wallingford, CT 06492

The Software Connection
10703 Meadowhill Rd.
Silver Spring, MD 20901

The Software Exchange
6 South St.
Milford, NH 03055

Software Resources, Inc.
286 Alewife Brook Pkwy.
Suite 310 Cambridge, MA 02138

Southfork Software
68 Fairlake Dr.
Hattiesburg, MS 39401

Spectrum Products
93-15 86th Drive
Woodhaven, NY 11321

Stekette Educational Software
4639 Spruce St.
Philadelphia, PA 19139

Storybooks Of The Future
527 41st Ave.
San Francisco, CA 94121

Tara
PO Box 118
Selden, NY 11784

Terrapin, Inc.
678 Massachusetts Ave.
Cambridge, MA 02139

T.H.E.S.I.S.
PO Box 147
Garden City, MI 48135

3R Software
PO Box 3115
Jamaica, NY 11431

TYC Software
40 Stuyvesant Manor
Geneseo, NY 14454

Tycom Associates
63 Velma Ave.
Pittsfield, MA 01201

Max Ule And Co., Inc.
6 E. 43rd St.
New York, NY 10017

Unicom
297 Elmwood Ave.
Providence, RI 02907

Versa Computing, Inc.
3541 Old Conejo Rd. Suite 104
Newbury Park, CA 91320

We Software
800 Greenwich Dr.
Chico, CA 95926

Window Inc.
469 Pleasant St.
Watertown, MA 02172

XPS Inc.
323 York Rd.
Carlisle, PA 17013

software shop, you're absolutely certain that your three-year-old niece or nephew is ready to learn the numbers 1 through 20 from a computer. The question remains, however: "Is the Sesame-Street style of computer software with exploding color and shrieking sound a substitute for parents or relatives?" At certain ages, and for certain subjects, the computer's capacity for untiring repitition makes for a great study or training aid, but for pre-schoolers it's better to be sure of what you're getting ahead of time; if the dealer is reluctant to demonstate the program you're interested in, it may be because he has something to hide. Sesame-Street-style effects have proven very effective on TV, but on a computer they can range from the superb efforts of Texas Instruments (with a long and excellent record with such products as their *Speak-&-Learn* machines), to junk so poor that it might actually do more harm then good. Thus, as a parent or relative, be extra careful when purchasing software for the youngsters.

A computerized paintbrush

Moving along to the fun part of computing, there's a lot of software for both computer art and graphics coming on-line all the time. One of the more typical graphic-art programs is Pioneer Software's disk-based drawing program called *Crayon*, which allows the user to draw graphic designs on the screen and then make the graphics part of a BASIC program (up to 30 separate screens depending on the available memory). The graphics screen is called through a USR function. Alternately, the program can be used just to create camera-ready computer art for photo-offset printing because the software can put both graphics elements and alphanumeric characters on the screen at the same time.

There are many different types of computerized pallets, paintbrushes, and whatever available for almost every model computer. The exact type of graphics creation and display, and whether it's in black-and-white or color, will depend on the computer and software. This is one of the few areas where just about everything is good, because everything is different.

For commercial applications, we are seeing more and more software that creates charts and graphics from either user-entered data, or using the data from another program.

If you're just starting

With few exceptions, technicians, electronics hobbyists, and students must have a working knowledge of how to write programs in BASIC. If you are part of that group, or have just bought your first personal computer, you've probably given some thought to using one of the "computer courses" that use cassette-based instruction, a manual, and your computer. Beware—look before you buy. Many of those courses are so elementary, or so confusing for the beginner, that you'll be better off without them.

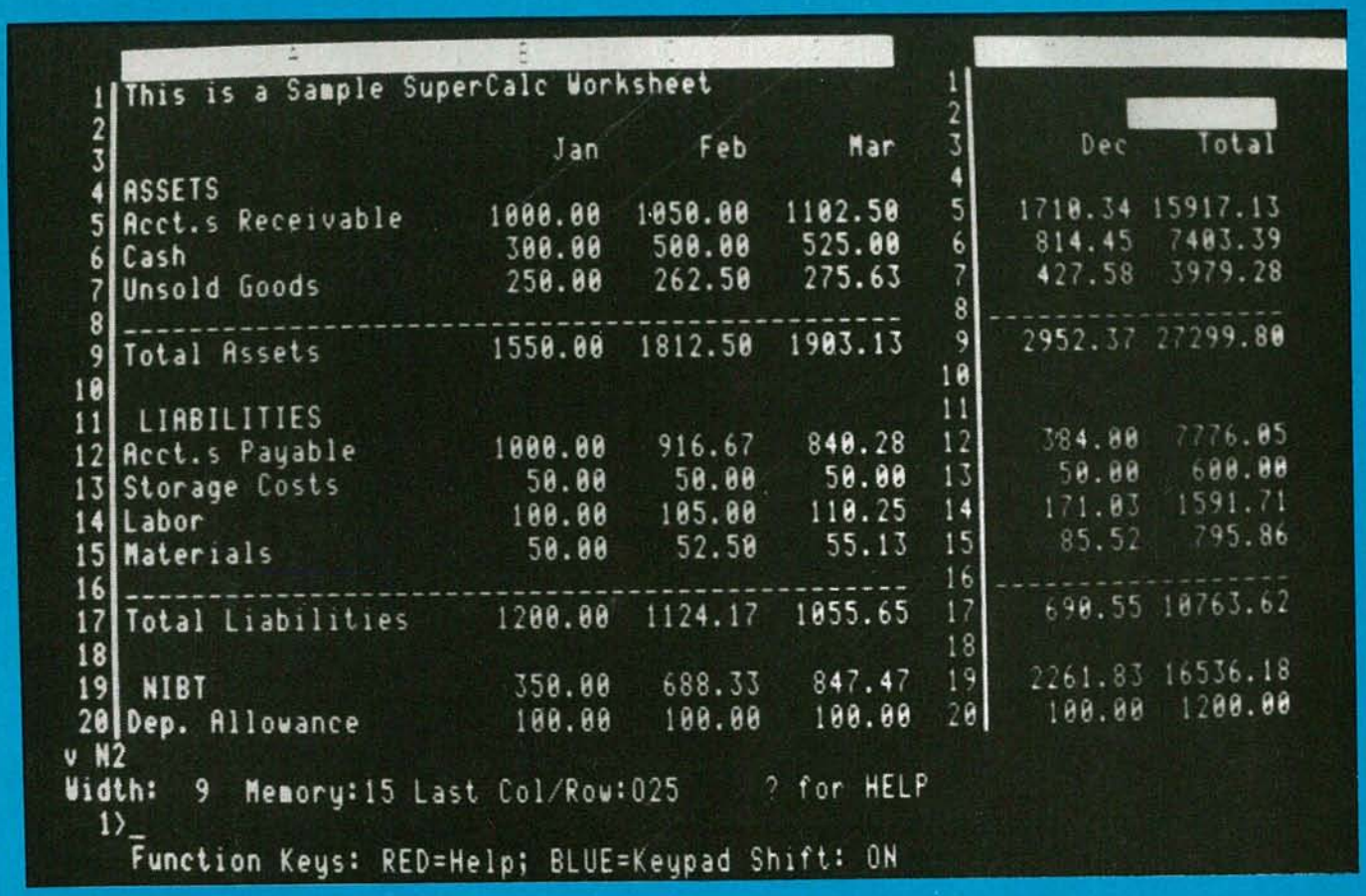
On the other hand, if you have a *Color Computer*, the best entry-to-intermediate level course you are going to find anywhere at any price, or in any format, is Radio Shack's own *Color Computer Learning Lab*. It comes on eight cassettes, has outstanding documentation at a real beginner's level that takes you through sorts, color graphics, game design, and even dynamic debugging. The course is integrated with "hands on" use of any model of the *Color Computer*, and in less than a week anyone can be a decent BASIC programmer. Considering that both college and continuing-education courses in BASIC are usually priced between $100 and 400, it's the best $49.95 investment you can make.

You're not alone

Perhaps the most important thing to keep in mind if you need something unusual is that there are probably many others with the same needs, and most likely some of them have already written the program you need and are selling it from their garages or kitchen tables. You'll more likely to find what you're looking for if you search out the little known and unusual, rather than the best known and most expensive. **R-E**

Radio Electronics YOUR OWN Computer APRIL 1983

What-If Software



Stop wearing out those pencils and erasers. With an electronic-spreadsheet program you can see how changing one piece of data can affect hundreds, or even thousands of others—instantly!

HERB FRIEDMAN

TO MANY OF US WHO STARTED OUT AT THE BEGINNING OF personal computing, the single most important piece of software after MicroSoft BASIC was *VisiCalc*. Overnight, *VisiCalc* transformed the personal computer from a plaything for the hobbyist into a required tool for anyone engaged in planning anything: the financial structure of a school district, town, or city; how much dirt, fertilizer, and weed killer you'll need to keep your garden green, or even how much soda, pretzels, and potato chips to order for your school's homecoming-game pep rally.

VisiCalc (from Visicorp) is an example of "What If?" software; meaning, it lets you ask the question: "If I do A, what will happen to B, C, D, and a hundred other things?"

In the not-so-good old days—before computers—to answer that required that you tape several sheets of paper together into one giant sheet, draw a grid (matrix) of many boxes called cells, and then fill in the cells with facts and figures showing how they related to each other. The information or data in the cells was interlocked with—and affected by or related to—other cells. The interrelationships of the cells meant that one change in one cell could affect several hundred cells. Changing the cells to reflect those changes wore down many erasers and pencils because every change in cell data produced by the question "What If?" resulted in yet another round of changes in the matrix.

That type of matrix or "model" has an official name when used for financial planning: it's called a spreadsheet. Depending on the size of the spreadsheet, the variations produced by changing the value of a single cell could require hours for recalculation of all the affected cells.

Now this is precisely the kind of job best done by a computer because a computer can be programmed to take the variation in cell information produced by the question "What If?", and in the blink of an eye recalculate hundreds of cell changes and instantly show the new spreadsheet on a video display, or provide a hard copy on a printer. Instead of having to scrub away

at a penciled spreadsheet to erase all the affected cells, the planner, accountant, etc., just has to key in the new information for a cell and the computer takes care of the rest. Just imagine how convenient that all is if there are two cell changes, or ten, or twenty, or fifty, or a hundred.

VisiCalc, which was initially written for the Apple computer, was the first of the electronic spreadsheets for personal computers, and many feel it is the reason for Apple's commercial success. Since its introduction, there have been numerous spin-offs, knockoffs, and customized electronic spreadsheets. Today, the "Calc" or spreadsheet program, is one of the major and most popular types of software for users of both home-and-family and business personal computers.

There are many different versions of spreadsheet software priced from less than $20 to well over $200. Each, of course, claims to be the best. Actually, though most are similar in concept, there are wide variations in features, capacity, flexibility, and, most importantly, speed. One does not expect the $17.95 *VU-Calc* program (from Timex) for the Timex/Sinclair *1000* computer to be the equal of the $200 *SuperCalc* (from Sorcim) software, though *VU-Calc* is a most surprising piece of software (more on *VU-Calc* later).

Other than the major differences determined by price, within the price range there are minor differences in features and performance that can make one brand of spreadsheet software better than the others for a particular application. In other words, one may be easier to use than the others depending on the application. As a general rule, however, spreadsheet software is being continuously upgraded—becoming more and more complex—and the latest versions are so intricate and can do so much they are often treated like a programming language.

A closer look

Figures 1 and 2 show how a spreadsheet works. The basic arrangement of a spreadsheet, the interrelationships between the cells, is called a template. The template for the spreadsheet shown in Fig. 1 does many things. After the user enters the first value at the top of the column labled 100%, the spreadsheet automatically adds "1" to the entered number, and then prints a total of all the numbers in the column at the bottom of the column. The same will occur in the other columns with the exception that 10% will be added to the value of the previous column. The columns with the automatic increase of 10% are labled 110%, 121%, 133.1%. (Read this over carefully if you don't follow it. It's important you know what's happening.)

	100%	110%	121%	133.1%
ENTER VALUE	1	1.1	1.21	1.331
add 1	2	2.2	2.42	2.662
add 1	3	3.3	3.63	3.993
add 1	4	4.4	4.84	5.324
add 1	5	5.5	6.05	6.655
TOTAL	15	16.5	18.15	19.965

FIG. 1—THE VALUES SHOWN ARE CALCULATED the instant the first value is entered in the 100% column.

	SAMPLE	SPREADSHEET		
	100%	110%	121%	133.1%
ENTER VALUE	2	2.2	2.42	2.662
add 1	3	3.3	3.63	3.993
add 1	4	4.4	4.84	5.324
add 1	5	5.5	6.05	6.655
add 1	6	6.6	7.26	7.986
TOTAL	20	22	24.2	26.62

FIG. 2—WHEN THE VALUE at the top of the 100% column is changed, all the values in all of the columns are recalculated

If you imagine that Fig. 1 is a computer display, the screen would show no values until "1" was entered at the top of the column labeled 100%. The instant "1" was entered, the spreadsheet filled out with all the values shown in the figure.

Figure 2 shows what happens when we change the entry from 1 to 2. Instantly, the spreadsheet calculates the new values and enters the correct values in all the cells.

How it works

The cells of the template can be empty (waiting for user input), can contain a label that might describe anything at all, or can contain a simple or complex formula that might use data input by the user, data from other cells, data calculated by other cells, or any combination of data, computations or whatever. In short, within limits, anything goes. As a general rule, spreadsheet software can be programmed to multiply, divide, sum, average, compare relationships, etc. The precise type of calculations are determined by the specific spreadsheet program, but most are similar.

The spreadsheet exists only in a computer's memory, not on the video display. The spreadsheet itself might represent cells formed by a matrix of 60 columns by 244 rows (14,640 cells). Obviously, that much data cannot be displayed on even a 80 column by 24 row CRT. The screen serves only as a window for a small part of the total spreadsheet stored in RAM. The window can be moved around to examine any part of the spreadsheet, and the video window can even be split vertically and horizontally so data from any part(s) of the spreadsheet can be displayed side by side for comparison. (With the exception of the rock-bottom priced spreadsheet software, all can provide at least one vertical or horizontal split-screen display, or both.)

Of course, if the spreadsheet is small enough it can all fit on the video display. Figures 3 through 6 show how a small spreadsheet is created using the Heath/Zenith version of *SuperCalc*. While *SuperCalc* is similar to many other spreadssheet programs, it is the only one that simultaneously indicates all cell values and formulas directly on the video display.

Figure 3 shows how the spreadsheet's template appears on the video display. Note that each row is designated by a number while each column is designated by a letter. A similar scheme is used in all software of this type as it is the only sane way to set up the template. The junction of each column and row is a cell, and each cell is identified that way (i.e. cell B10). You can enter a label, formula, or value into a cell, or leave it blank for the entry of values when you test for "What If?".

	A	B	C
1		OUT OF POCKET CAR EXPENSE	
2			
3		1982	1983
4		----	----
5	ESTIMATED REPAIRS		(B5*1.15)
6	MILES DRIVEN		B6
7	$ PER GALLON OF GAS		(B7*1.10)
8	$ PER QUART OF OIL		(B8*1.10)
9	INSURANCE		(B9*1.10)
10	MILES PER GALLON		B10
11	TOTAL GAS USED	(B6/B10)	(C6/C10)
12	COST OF GAS	(B11*B7)	(C11*C7)
13	OIL USED (QT./500 MI.)	(B6/500)	(C6/500)
14	COST OF OIL	(B13*B8)	(C13*C8)
15			
16	TOTAL CASH CAR COST	(B5+B9+B12+B14)	(C5+C9+C12+C14)
17			

FIG. 3—*SUPERCALC* TEMPLATE used for calculating out-of-pocket car expenses. This is what you see as you are assembling the template.

The template shown in Fig. 3 is the spreadsheet for calculating estimated out-of-pocket auto expenses based on assumed cost of insurance, repairs, gas per gallon, and oil per quart, as well as the estimated mileage, how many miles the car travels per gallon of gas, and how much oil is expected to be used. The spreadsheet takes into account assumed inflation factors and changes in individual costs. The blank (empty) cells are for the information to be filled in by the user. The other cells contain the information or the formulas to be to used to calculate the desired information.

Everything within brackets is a formula that uses information from other cells. Entries not in brackets are simply instructions to use the same information from another cell. For example, note that total gas used in 1982 is represented by the formula (B6/B10). If you look at cell B6 you'll find it represents MILES DRIVEN, while B10 is the MILES PER GALLON delivered by the car. When the B6 and B10 values are filled in by the user cell B11 will automatically calculate total gas used. On the other hand, note that for 1983 cell C7 shows we believe the price of gas will be 10% higher than the value we plug into cell B7 for 1982 (B7 × 1.10), while cell C6 will use the same information the user stores in B6. (Study the template until you get a clear understanding of how the cells can interrelate and interreact.)

Okay! That's enough theory—let's do the calculation as shown in Fig. 4. For a neat presentation, we turn off the border, and set up the display so the formulas are no longer displayed. When there are no values for a formula to work with, *SuperCalc* shows the word ERROR so you know some data hasn't been entered. In Fig. 5 we have filled in the data needed for cells B5 through B10. That is how the display would appear when all the variable data was entered if *SuperCalc* were set for manual calculation—the user must specifically press a key to force the spreadsheet calculation. (Usually, the recalculation is set to AUTO, and the recalculation is performed the instant enough information to perform the calculation(s) is entered.

OUT OF POCKET CAR EXPENSE

	1982	1983
ESTIMATED REPAIRS		.00
MILES DRIVEN		.00
$ PER GALLON OF GAS		.00
$ PER QUART OF OIL		.00
INSURANCE		.00
MILES PER GALLON		.00
TOTAL GAS USED	ERROR	ERROR
COST OF GAS	ERROR	ERROR
OIL USED (QT./500 MI.)	.00	.00
COST OF OIL	.00	.00
TOTAL CASH CAR COST	ERROR	ERROR

FIG. 4—HOW THE SCREEN APPEARS before the required information is inserted in the 1982 column. The "errors" are caused by the template not yet having all the information needed to make the calculations.

OUT OF POCKET CAR EXPENSE

	1982	1983
ESTIMATED REPAIRS	500.00	.00
MILES DRIVEN	10000.00	.00
$ PER GALLON OF GAS	1.39	.00
$ PER QUART OF OIL	1.45	.00
INSURANCE	450.00	.00
MILES PER GALLON	15.50	.00
TOTAL GAS USED	ERROR	ERROR
COST OF GAS	ERROR	ERROR
OIL USED (QT./500 MI.)	.00	.00
COST OF OIL	.00	.00
TOTAL CASH CAR COST	ERROR	ERROR

FIG. 5—IF SET FOR MANUAL RECALCULATION, this is how the screen will look when the required information is entered (see Fig. 6).

Figure 6 shows what happens when the last piece of data is entered if *SuperCalc* is set for automatic calculation, or if the manual-calculate key is pressed. Instantly, the spreadsheet fills with all values for the years 1982 and 1983.

Preparing the template is not all that difficult even if you're using hundreds of cells because most of the spreadsheet programs have an assortment of cell-handling functions that simplify the construction of the template; those include functions such as *replicate* and *tag*. Replicate permits you to write a few cells and then, at the touch of one or two keys, have the software automatically replicate them across hundreds of rows or columns. With tag you "stick" a cell's entry to the cursor, move the cursor directly to a desired cell or cells and "drop" the attached data into the new cell. You might also be able to instantly move or exchange columns or rows of "written" cells.

OUT OF POCKET CAR EXPENSE

	1982	1983
ESTIMATED REPAIRS	500.00	575.00
MILES DRIVEN	10000.00	10000.00
$ PER GALLON OF GAS	1.39	1.53
$ PER QUART OF OIL	1.45	1.60
INSURANCE	450.00	495.00
MILES PER GALLON	15.50	15.50
TOTAL GAS USED	645.16	645.16
COST OF GAS	896.77	986.45
OIL USED (QT./500 MI.)	20.00	20.00
COST OF OIL	29.00	31.90
TOTAL CASH CAR COST	1875.77	2088.35

FIG. 6—AT THE TOUCH of the recalculation key the screen would blink and all the cells fill with the calculated values as shown. If the program were set up for automatic recalculation, that would happen as soon as the last required value were entered.

The exact number and degree of cell-handling procedures depend on the particular software used, but within a given price range most offer similar features.

The exception to most of our illustrations is the plug-in ROM module (not disk) version of Radio Shack's *Spectaculator* for the *Color Computer*. Though it is an electronic spreadsheet, it does not permit individual cell calculations. The calculation for each cell in a column or row is the same for every cell in the row or column. This is somewhat limiting for general use, but it's particularly useful for calculations where two out of three variables are known. For example, it is easy to use—and a decided convenience—when calculating frequency, reactance, dimensions, volume, or anything else where two values are used to calculate a third. Figure 7 is a sample of what the program can do when calculating reactance. The spreadsheet is set up to calculate the reactance of inductors at 3 MHz.

The frequency in MHz is fixed throughout column 2. The user enters the inductor values in column 1. When the command keys to calculate are pressed, the display ripples through the spreadsheet and shows the calculated reactance values in column 3.

SAMPLE SPECTACULATOR

L(UH)	3 MHZ	REACTANCE
0.15	3.00	2.83
0.25	3.00	4.71
0.50	3.00	9.42
1.00	3.00	18.84
1.50	3.00	28.26
2.00	3.00	37.68
2.25	3.00	42.39
2.50	3.00	47.10

FIG. 7—USING *SPECTACULATOR* to calculate reactance. This program is particularly useful for calculations involving three variables where one is known.

Only a little bit at a time

Since the video display is only a "window" into the spreadsheet stored in RAM, the more sophisticated spreadsheet programs such as *SuperCalc*, *VisiCalc*, and *ScratchPad* (from SuperSoft) allow you to divide the video display into two or more smaller windows so several sections of the memory can be simultaneously seen for comparison. For example, we could have had our auto-expense spreadsheet calculate expense until the year 2000, and then split the video display and show only the years 1982 and 2000 side-by-side for comparison. If we had thirty, forty, fifty, or a hundred items in each column or row, we

could still control each screen "window" independent of the other, and roll or scroll each window independent of the other. Usually, we can even treat each window as a separate spreadsheet, and ripple through one without affecting the others.

Though the more popular electronic spreadsheets can be used with several different computers, the exact nature of the implementation often depends on the available features of the computer or the associated terminal. Sometimes it works out that the same spreadsheet software is somewhat more convenient to run on one computer than another. For example, while *SuperCalc* generally uses a blinking-line cursor or created brackets to denote the cell's boundaries, the Heath/Zenith implementation uses the "smart" features of the *H89* computer and *H19* terminal, and the cell area is completely filled by a reverse video (white) rectangle, while the computer's built-in function keys are used for direct access to a HELP table and a keyboard shift. On the Osborne computer, the operating system provides a directional arrow shift specifically tailored for *SuperCalc*, while the software itself can be customized for the user's printer.

More money means more features

As with almost everything else in this world, the more you pay the more you get. In particular, the higher the price the greater the permitted mathematical operations, such as automatic summing, averaging, relational operators, sine and cosine functions, etc. The object is to decide what specific math functions you will need and then make your selection from the software that does the required calculations. In almost all instances the necessary math functions are more important than the maximum size of the available matrix (number or rows times number of columns).

The less-than-$20 cassette-tape based *VU-Calc* for the Timex/Sinclair *1000* computer is extremely powerful for the money, will probably handle most household projections, and is a superb spreadsheet trainer for schools, but it is limited to the basic arithmetic operations of addition, subtraction, multiplication, and division. However, its template of 26 rows × 36 columns (936 cells) is quite adequate for small jobs. (The program is written in BASIC and would be frustratingly slow to run if the template were larger.) The basic matrix takes almost three minutes to load, and a SAVE of even a small template using but a portion of the available matrix can take more than five minutes; but the price is a real winner.

About double the price of *VU-Calc*, the ROM module version of *Spectaculator* for the Radio Shack *Color Computer* handles a template of 99 rows × 99 columns (9801 cells). Since it's supplied in a ROM module it is up-and-running almost as soon as the power is turned on. The program is among the easiest systems to use, but it has the limitation we mentioned earlier of not permitting individual cell formulas.

Just about everything else is in the $150-and-up price range, is disk-based, and often proves to be some variation of *SuperCalc*, *VisiCalc*, or *ScratchPad*. Between discounting and special implementations, the same spreadsheet software might cost between $150 and $400.

ScratchPad, which has an unusually small number of commands, features many mathematical functions, both terminal and printer customizing, and virtual memory. Virtual memory is a means whereby the disk is used as RAM when the computer's RAM runs out. The usual matrix for a 56K RAM is 26 rows × 100 columns (2600 cells), but memory won't run out because the disk provides virtual memory when running. What is placed on the disk is transparent to the user when the session is completed so there is no loss of disk space as unusable files.

If for nothing else, *SuperCalc* stands alone because it's supplied with outstanding sample business and scientific templates (for practice and understanding) and because it allows the user to see all the cell formulas in their respective cells, not one at a time on a command line in some distant corner of the screen. Its matrix is 254 rows × 63 columns (16,002 cells). A full matrix would exceed the capacity of most personal computer RAM areas, but different portions can be used for different templates, then interrelated, interlocked, etc. It also provides the usual assortment of advanced math functions. The instruction manual is an absolute gem, easily understood by non-hardware oriented users. The problem with *SuperCalc* is that it came on the scene after *VisiCalc*, and simply never got the credit it deserved.

VisiCalc is the grandfather of all the personal computer spreadsheets. While legend has it that it got its reputation from the Apple implementation for business use, most computer hobbyists are most likely familiar with it through Radio Shack, who has always featured it as its centerpiece for both personal and business software. The original implementation for Radio Shack's *Model I* computer had a matrix of 254 rows × 63 columns (16002) cells, the same as the typical *SuperCalc* versions. It, too, provides advanced math functions, sectional interlocks and relationships, etc. The thing with *VisiCalc* is that it's dynamic; it's constantly growing, with features being added all the time to accommodate the latest computer features. Some implementations are so sophisticated, *VisiCalc* has become what is essentially an independent programming language. There are *VisiCalc* "programmers" who specialize in spreadsheets that might take weeks of preparation.

Being the most famous of the spreadsheets *VisiCalc* has the most aftermarket support, particularly in the area of pre-written templates for both home-and-family and business use. Pre-written templates are precisely what they imply; instead of you designing the template and calculating the cell structure and formulas, you simply load in from a disk a pre-written template that most approximates what you need. You can customize the pre-written template if necessary. (Most users find pre-written templates require some slight changes—but many hours, days, or weeks of programming can be saved through their use.)

SPREADSHEET SOFTWARE SUPPLIERS

Chang Laboratories
10228 North Stelling Road
Cupertino, CA 95014

Micropro
1299 4th Street, Suite 400
San Rafael, CA 94901

Microsoft Corporation
10700 Northup Way
Bellevue, WA 98004

Pocket Info Corporation
7795 S.W. 184th St.
Beaverton, OR 97007

Radio Shack
One Tandy Center
Ft. Worth, TX 76102

Sorcim Corporation
405 Aldo Ave.
Santa Clara, CA 95050

SuperSoft
PO Box 1628
Champaign, IL 61820

Timex Corporation
1579 Straits Turnpike
Middlebury, CT 06762

VisiCorp
2895 Zanker Road
San Jose, CA 95134

Something new every day

It often appears that each new issue of a computer magazine has advertisements for a new type of electronic spreadsheet. In fact, that is what's been happening because there are more and better programmers coming on-line almost daily. However, most of the latest electronic spreadsheets are essentially variations of the best known programs with some highly specialized features or implementations.

If there is perhaps one general rule of thumb for selecting an electronic spreadsheet it's to purchase one that offers easist use of the features you really need. Also be sure that it comes with an instruction manual you can understand. Some of the best software is unusable because the accompanying documentation is almost incoherent. **R-E**